NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SUBCOMMITTEE MEETING

ON

SEQUOYAH NUCLEAR PLANT

Place - Washington, D. C.

Date - Monday, March 12, 1979 **Pages** 1 - 247

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Monday, March 12, 1979

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING

ON

SEQUOYAH NUCLEAR PLANT

Room 1946, Tenth Floor
1717 H Street, Northwest
Washington, D. C.

Monday, March 12, 1979

The ACRS Subcommittee on the Sequoyah Nuclear Plant met, pursuant to notice, at 8:30 a.m., DR. J. CARSON MARK, Chairman of the Subcommittee, presiding.

PRESENT:

MR. WILLIAM M. MATHIS.

C O N T E N T S

P R O C E E D I N G S

DR. MARK: The meeting will now come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Sequoyah Nuclear Plant.

I am Carson Mark, Subcommitee Chairman.

The other ACRS member present today is William Mathis on my left

We also have with us consultants, Ivan Catton, from UCLA, Mike Trifunac, Mr. White, and Zoltan Zudans.

The purpose of this meeting is to discuss the application of the Tennessee Valley Authority for a permit to operate Units 1 and 2 of the Sequoyah Station.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act.

Richard Savio, on my right, is the designated Federal employee for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on Monday, February 26, 1979.

A transcript of the meeting is being kept and it will be available in five days. So it is requested that each speaker first identify himself and speak with sufficient clarity and volume so that he can be readily heard.

We have received no requests for time to make oral statements or written statements from members of the public.

We will proceed with the meeting.

I will call upon -- well, I am wondering if the consultants or the subcommittee have matters to raise which are not indicated on the agenda, or which they feel should have special attention.

DR. CATTON: I have a couple of questions, I have raised them before, and I might as well raise them again.

DR. MARK: It might be good if you raised them so that people coming on later could address them.

DR. CATTON: Okay.

DR. MARK: And take those into account.

DR. CATTON: Sure. The list is too long, but I'll summarize.

DR. MARK: Excuse me.

Are you having difficulty hearing us back there?

(Chorus of "yes".)

DR. CATTON: Does this thing work?

VOICE FROM AUDIENCE: It seeems the microphones aren't working.

(Pause.)

DR. MARK: Mr. Catton had some questions which he expected to want to see some discussion of; and you are going to mention them now so that in the presentations they would perhaps be kept in mind.

MR. CATTON: I'll just mention a couple of them. I have really too many to go through them all.

First, as I recall during the McGuire meeting some of the calculations looked to me a little bit speculative. As a result I would like to hear more about the downcomer flow during refill and interaction with the upper head injection system.

Second -- can you hear me?

VOICE FROM AUDIENCE: Not very well.

MR. CATTON: Maybe I ought to not just use this and speak loudly.

I would like to hear about downcomer flow during refill and interaction with the upper head injection system.

The effect of pipe break expansion wave on core internals.

I am not sure how the calculation is made for Sequoyah; on some of the other plants the flexibility of the core barrel was taken advantage of in decreasing flow levels. If the core barrel was flexible at the mouth the expansion wave passed through into the core, and the pressure gradient on fuel.

Also characteristics of steam generators during blowdown following a pipe break.

In particular flow instability to unequal loop length.

There are some others but maybe I would bring them up as they come along. I haven't really had a chance to organize my list.

DR. MARK: That's agreeable and you can have those in mind and find out if you have further ones.

MR. ZUDANS: In the same spirit I like to ask two questions. This may be answered during the presentation.

One is: how did the applicant handle asymmetric loading in respect in particular to buckling of the containment.

I don't see any reference to that.

The other one: the ACRS says that the applicant will do the operation and testing which will simulate actual loading conditions in confidence in plant operations.

I would like to have some qualitative explanation how is it that they will make it similar to actual operation? How is it possible to do that?

These are the two major ones.

DR. MARK: Well, you can let us know if those seem to be covered.

MR. ZUDANS: Yes.

DR. MARK: Or if you want more elaboration.

I will now call on Harley Silver, NRC Staff to give their introduction to the situation.

MR. SILVER: I am Harley Silver, NRC Staff.

I am project manager for the Sequoyah operating license application.

Just by way of background the construction permit for Sequoyah was granted in May of 1970. The operating license application was tendered in December of '73 and docketed in January of '74.

We had actually completed our review late in '75 and in fact had prepared a draft SER, late '75, January '76.

At that time, however, there were a large number of open items and, coincidentally, the TVA construction schedule seemed to be slipping severely.

And both the Staff and the Applicant in effect minimized their efforts upon the review.

The review was then reactivated in mid to late 1977, after which many of the original items were resolved; but, of course, many new issues were identified. For example, the seismic issue which we will discuss later.

For a description, Sequoyah is a two-unit plant. The units are essentially identical. Each one includes a Westinghouse four-loop pressurized water reactor in a dual containment utilizing the ice condenser concept.

The review is reported in the safety evaluation which was distributed on March 2. I hope everyone has a copy.

There were no differing technical views expressed by any members of the Staff with regard to the review as summarized in the safety evaluation.

Except for the issues identified in section 1.6 and 1.7 of the SER, our review is complete.

Section 1.6 lists outstanding issues defined as issues not fully resolved with the Applicant. There are five identified in the safety evaluation; and since its publication one is essentially closed, but it's still awaiting documentation. So it's essentially now a confirmatory issue.

Section 1.7, confirmatory issues defined as -- our review was completed with no significant disagreement with the Applicant, and in most cases awaiting confirmatory information.

There were 17 identified in the safety evaluation, and since its publication three have already been resolved.

Additionally, Section 1.8, titled Staff Position on License Conditions, defined as implementation and/or documentation required after a license is issued -- there are seven items identified in the SER.

And in fact one is expected to be fully resolved prior to licensing and will not be a licensing condition. I will discuss these later.

We have received information already or information is expected very shortly on most issues, in fact all issues.

The farthest receipt of information is April 15; but most are essentially expected to be received within the next few days.

We expect most of the issues, many of them at least, to be resolved by the time of the full ACRS committee meeting and, of course, all of them will be resolved prior to licensing.

I should mention one other item, perhaps, which is not discussed in the SER.

Since the initial review, again, in 1975, or thereabouts, the Staff organization and review responsibilities have changed in some cases several times; as a result of this the review in one area was not updated in the '77 time frame, namely, in foundation engineering.

That review is in progress, and we have no reason to expect any open issues will result from that review. We will expedite the review with the Applicant's cooperation, and expect to be able to report on the matter fully to the full committee.

With regard to ACRS generic matters, the status of our efforts to resolve these matters was transmitted to the committee on December 4; Appendix C of the safety evaluation discusses these further, and, where appropriate, relates those issues to the Sequoyah review.

I should note in section 1.9 of the SER, which discusses generic issues, the Staff generic issues, in our program for resolution of these issues, is not discussed in the SER at this time; it will be discussed in a supplementary.

For the information of the committee, as far as schedule for fuel loading, I&E, that is, our Office of Inspection and Enforcement, has predicted -- and I am told this morning by the Applicant -- it is now officially predicting approximately the same date: a fuel load of June 1979. The date I am told is late May, early June; and, of course, there is always a possibility of some further slippage depending on the progress of testing and so forth.

Only the seismic issue has a specific item for Staff discussion. We will have members of the Staff here I hope during the day to discuss all the open items and, hopefully, any other issues that are raised by the committee or its consultants, such as those that have been identified so far this morning.

If there are any others, I would certainly appreciate knowing about it so I could call the appropriate people and have them here for discussion.

That completes my introductory remarks.

DR. MARK: Thank you, Mr. Silver?

Mr. Zudans?

MR. ZUDANS: One question:

Reading your writing, you listed on page 1-9 one item that says, seismic design of structure and components, the operating license will be conditioned to require a relation showing margin available in structure and components in function during and after design.

When you will discuss these things I like to see what kind o: answer do you expect.

MR. SILVER: I am told as of late Friday afternoon that there has been a rather successful meeting between Staff and Applicant personnel; and we will indeed have a presentation on t.at, which should be quite detailed. And I hope we can answer your question.

MR. ZUDANS: Okay, thank you.

DR. MARK: Any other questions?

(No response.)

If not, I would ask Mr. Gilleland to produce the Applicant's presentation.

MR. GILLELAND: Mr. Mark, we discussed earlier the extensive agenda today, and my opening remarks will be fairly brief.

I am J. E. GIlleland, Assistant Manager for Power for TVA. I am happy to be with you today to review the operating license for Sequoyah Units 1 and 2.

You can see behind me I have quite a back-up contingent, TVA personnel and Westinghouse personnel, who will be talking today on the agenda items and to answer questions.

As I am sure you know, TVA is an independent agency of the United States Government. As to questions about the organizational chart, I will omit those as I think the committee has seen that from time to time. There have not been any substantial changes in the organization since we were here last except in some portions of the organization which do not affect the nuclear power, mainly in the Office of Engineering Design and Construction. There have been changes in other organizational elements.

I thought you might be interested in some statistics about the system iteself:

This is as of September 30, 1978, the end of the fiscal year 78, at that time we had capacity installation of 20-1/2 million killowats, of which 4-1/2 million are hydro, 18 million coal-fired steam, 3-1/2 million nuclear, which consists of the three units at Browns Ferry, and 2-1/2 million killowats of combustion turbines.

Last year generation was 131 billion kilowat hours of which 12 percent was produced by Browns Ferry.

We have under construction 1-/2 billion killowats of pump storage, a 4-unit plant at Chattanooga; three of those units are now operating, the fourth should be in operation by the summer.

We have under construction 18 million killowats of nuclear power, which means that when this program is completed, we will have a total of 48 million killowats, 21-1/2 being nuclear, or about 45 percent of the system.

I mentioned before the Department of Powe: and Office of Nuclear Design and Construction are the two primary organizations dealing with nuclear program in TVA, since we build and design all of our own systems, facilities, the Office of Design and Construction is responsible for all the design and construction. The Office of Power has responsibility for the power program overall.

Within the Office of Power, the Division of Power Production is responsible for the operation of plants, and is represented here today by Mr. Walter Popp. With me at the table on my left is Mark Wisenburg, supervisor of the Pressurized Water Reactor Section; on my right, Dave Lambert, who is the licensing engineer for Sequoyah.

To answer questions, we will start with Mr. Lambert who will give a brief description of the plant.

MR. LAMBERT: I am David Lambert, Licensing Engineer for the Sequoyah Nuclear Plants, with the Office of Power in the TVA authority staff, and I report to Mr. Jack Gilleland.

Gentlemen, I will try to give a brief pres..ntation on the plant features; so I have two presentations -- site and plant description.

I believe we have sufficient staff and documentation here today to answer your questions. I wish to spend as much time as possible answering your questions, but I suggest you hold your questions on site until I have completed. It is a short presentation.

(Slide.)

The first slide shows the location of Sequoyah Nuclear Plant in relation to the entire TVA system. Note the expanse of the TVA grid; Sequoyah is at the center of TVA's nuclear plants and is marked in red on the handout and in blue on the slide.

The plant site is located on a peninsular on the west shore of Chicamauga Lake, about 18 miles northeast from downtown Chattanooga, Tennessee.

There are over 20 reservoirs or lakes upstream of the site.

The TVA grid extends into Central Missippi, through all Tennessee, parts of Kentucky, part of Alabama, a little of Georgia.

(Slide.)

This shows the general site plan. The site comprises approximately 525 acres which are owned by the United States Government.

The site is a hilly, moderately clear area, and the land rises from the water surface, 682.5 feet pool elevation to a small hill at about 750 feet elevation.

Plant grade is designated at 705 feet elevation.

The site boundary and security area boundary will be discussed in the security presentation.

As noted in the handout, the plant boundary is designated by this dashed line (indicating) and follows the shoreline of Chicamauga Lake, and to the west the plant boundary is more of a straight line; and it goes off the edge of the slide (indicating).

(Slide.)

This slide shows a recent aerial view of the site. It's looking down-river, looking west; Chattanooga is in the background, and the river curves down and goes through the two mountains.

(Slide.)

This slide shows the population density of the area surrounding the site. Only two cities within 20 miles have a population exceeding 10,000. The minimum exclusion of all population distances is 1824 feet and three miles as secondary.

The low population zone is about 1,[illegible]0 people, and projections to the year 2,000 shows little change for the low population zone.

The climatology and meteorology data for the area shows a moderate climate, average annual temperature is 61 degrees, historical maximum about 106 Fahrenheit to minus 7 degrees Fahrenheit.

Rainfall averages 57.7 inches, ground fog occurs about 36 times a year.

The probability of tornado occurrence is extremely low, one every 10,000 years.

The predominant winds have an up-down value, therefore the winds blow from northeast or southwest. The most adverse onsite atmospheric dispersion conditions occur about 20 percent of the time.

Stagnant conditions is defined by atmospheric classes F and G.

The hydrology of the site show that groundwater is derived principally from precipitation and flows to the reservoir.

The design basis flood, either floods associated with the probable maximum precipitation or with the safe shutdown seismic event, were extensively studied by TVA and reviewed by NRC.

The evaluation established the design basis flood elevation at 720.8 feet, including approximately a 3-foot wind-wave run. This is a 43-foot flood level.

The plant is designed to operate and shutdown safely in the unlikely event of such a flood.

In comparison with historical flood of 8 feet in 1867, the design flood is a colossal event.

The site is located in the Appalachian Valley the southern region of the valley and ridge province of the Appalachian Highlands.

In layman's terms this means the ridges are about 2,000 feet high, and the valleys are about 500 feet above sea level.

The site is in a valley about 10 miles wide, 60 miles long.

The site geologic structure was extensively explored in 1953 and again 1968 and '69.

The seismological presentation this afternoon will describe in considerable detail the techtonics of the site and the region.

Are there any questions?

(no response.)

DR. MARK: I am not familiar with the local area. Is Chicamauga Lake a lake that is very heavily used in summer for recreation?

MR. LAMBERT: Yes, it is.

It is one of the two lakes in the Chattanooga area that is used for recreation.

DR. MARK: Have you estimated or collected statistics, surveys of the water-borne population or people camped on the lakeshore?

MR. LAMBERT: Yes, we do, both in the FSAR and Appendix I submittal to the Staff. The Appendix I submittal has both transient and permanent population distributions, which were updated for purposes of those calculations.

DR. MARK: Where is the lake with respect to the LPZ and exclusion area?

MR. LAMBERT: The scale is the one mile circle, 20-mile circle (indicating slide); and then I think a 50 -- I am not able to back up the slides in this projector.

DR. MARK: All right.

Anyhow, you had to consider plans to clear some of the water area?

MR. LAMBERT: Yes, sir.

(Slide.)

The next slide again shows an external view of the plant. This time we are looking at it across the lake in a general easterly direction.

(Slide.)

Zooming in on the plant to explain the principal structures of the site (indicating).

It cuts off a little bit this dam structure here (indicating) which encompasses the lake which we call the forebay; this (indicating) is the intake structure; this (indicating) is the deisel generator building; here (indicating) is the gatehouse; this (indicating) is the service office building; this is the turbine building; these are the containment buildings, unit 1, unit 2, (indicating); this general structure of concrete between the two containment buildings is the auxiliary building and part of the auxiliary building is this (indicating) building, the control building (indicating); these two purple tanks here are secondary condensation demineralizaer water storage, this is the refueling water storage tank, and this purple tank is the primary water storage tank.

These transmission yards, that's 500KV transmission yard, and starting down here (indicating) leading off the slide is a 160KV transmission yard.

This is the transformer yard (indicating) running along the turbine building.

Let me step back and see if I've missed any important structures.

It is interesting to note that this transmission yard has been in use for some time and is TVA's largest switchyard facility.

DR. MARK: The cooling towers are off to the left?

MR. LAMBERT: Here (indicating), two 500-foot natural draft cooling towers.

I've got a backup slide.

DR. MARK: We saw them in the first slide, but not in this context.

MR. LAMBERT: Yes.

Tht next slide --

(Slide.)

— shows a cutaway of the Sequoyah Nuclear Plant.

I have provided a handout of that cutaway. It would be easier to look at than trying to follow this slide.

It shows a cutaway of the Sequoyah Nuclear Plant and in that cutaway the significant features are shown, the nuclear steam supply system is the four-loop Westinghouse reactor, 17 x 17 fuel design, rated at 1125 megawatts electric.

This plant has the first combined ice condenser system, free standing steel containment vessel, and an upper head injection ECCS system.

The steel containment is 115 feet in diameter, 169 feet high, and results in about half the volume of a dry containment, and it has approximately 2.9 million pounds of borated ice in compartments placed in a 300-degree arc around the reactor.

We have a presentation later on how well the loaded ice in the 1944 baskets that make up this ice condenser system work.

The upper head injection system was added to the design after the ECCS rulemaking.

The purpose of UHI is deliver approximately 1,000 cubic feet of borated water to the upper head of the vessel in 25 seconds, about 12 to 25 seconds after safety injections signal.

The cold leg accumulator injection system provides additional water to the core for possibly the next 25 seconds, during a design basis loss of coolant accident as defined by the evaluation model.

We will discuss the ECCS analysis in a later presentation.

As I said, the cutaway shows the principal NSSS and ECCS components.

Are there any questions?

MR. CATTON: What are the differences between this and McGuire? Or is it basically the same?

MR. LAMBERT: Basically the same.

MR. CATTON: Thank you.

MR. LAMBERT: And for a little design comparison between the plants, I go to vugraphs --

(Slide.)

-- again, you have copies of this.

For comparison of design features we will be comparing Sequoyah with D. C. Cook and Trojan Nuclear Plants; these are tables of similarities and differences, with primary items of comparison,- fuel containment, and the use of the UHI system as an adjunct to the ECCS system.

Otherwise, Cook, Trojan and Sequoyah Nuclear Plants have very similar design features.

I think you can read through this thing better than I can talk to each item; so if there are any questions about any of the statements?

(No response.)

Otherwise, if not, I'll just go to the next slide.

(Slide.)

MR. CATTON: I notice it says here the Sequoyah upper internals have been modified to incorporate UHI.

MR. LAMBERT: That's correct.

MR. CATTON: You mean Sequoyah was not originally planned to have injection?

MR. LAMBERT: That's correct.

MR. CATTON: Was this a difficult charge?

The question is for my own education, if no other reason.

MR. LAMBERT: Yes.

I am not sure how to define the difficulties; but, yes, the upper head had to be modified and there had to be a considerable amount of design work in the modification of the reactor vessel and of the piping systems, so forth; everything that is associated with adding on a major piece of hydraulic systems.

MR. CATTON: I guess the question could be put better:

Was it costly?

MR. LAMBERT: I guess those things are relative today.

MR. CATTON: Okay.

MR. LAMBERT: Yes, I think the answer to your question is yes; and it continues to be costly to add it on.

MR. ZUDANS: The question here is --

MR. GILLELAND: It was costly, also it will add to the cost of operation. This additional equipment has to be disassembled when you refuel.

MR. ZUDANS: I note here in your requirement for fracture testing; what were these requirements? More samples? Or different series?

MR. LAMBERT: Keep in mind these slides were put together prior to January 31, '74 when the FSAR was submitted. Those comments, most of them, have not been revised since that point in time. In the 1968 time frame it was a different set of fracture toughness requirements -- someone can correct me -- compared to other similar plants.

Probably that statement is no longer appropos.

MR. ZUDANS: What you are showing is four years old?

MR. LAMBERT: Yes.

MR. ZUDANS: I guess the same answer to the next sentence:

"New means of determining heat-up and cool-down rates."?

MR. LAMBERT: Yes, it does.

MR. ZUDANS: I am curious to see what you really mean there. Are the quantities measured different or what? I don't understand, a new means of determining heat-up and cool-down rates; what is this measuring, temperature rates, changes?

MR. LAMBERT: I am more familiar with current ongoing questions. I am not sure I can answer that historically. We can get the answer for you.

MR. ZUDANS: It may not mean anything, but I am curious.

MR. LAMBERT: My assumption is it is a methodology of deriving heat-up and cool-down curves. But we'll check that out and get you an answer.

(Slide.)

Again the important point is in terms of differences, Trojan does not use an ice condenser.

(Slide.)

I think there are differences here that are plant-specific for any plant in terms of the electrical system.

MR. CATTON: Under control systems it says Sequoyah has 50 percent more load rejection capability while that of the D. C. Cook Plant is 100 percent.

What are the implications of that, if any?

Right at the bottom corner of that slide?

MR. GILLELAND: Mr. McDonald?

MR. CATTON: Is 100 percent far more than one would need?

MR. LAMBERT: I know of no issues that have been raised by Staff in the last three years with respect to that rejection capability being either 100 or 50 percent.

MR. CATTON: I am just curious.

MR. GILLELAND: We'll check it.

MR. ZUDANS: It should be quite different.

MR. LAMBERT: The last one --

(Slide.)

-- in this series making comparisons -- one point here under auxiliary systems, the condensate clean-up system Sequoyah has an add-on condensate demineralizer backfit.

Also included in your handout is a comparison of Sequoyah and Trojan thermal and hydraulic design parameters.

(Slide.)

The principal difference is noted -- it's the peaking factors -- we will discuss that as part of the ECCS presentation.

Trojan has a peaking factor of 2.32; Sequoyah's peaking factor is 2.25 as defined in the SER.

MR. CATTON: Looking at the diagram you showed us, I can't find where the pressure relief tank is located?

MR. LAMBERT: The pressure relief tank is located in the containment floor near the steam generators. If I had a copy of that and could get to it, I could give you a general feeling for where it is (indicating handout).

There's a considerable amount of detail not provided here. Right here (indicating) pressure relief tank.

MR. CATTON: Oh.

If you have an overpressurization and you lose the pressure relief tank, does that lead to a safety question?

MR. LAMBERT: Well, it does.

Would you like to address it?

MR. CATTON: Yes.

MR. LAMBERT: If you lose the pressure relief tank does that lead to a safety question during an overpressurization event?

MR. ESPOSITO: Vince Esposito, Westinghouse.

No, that does not. In fact, the pressure relief tank has a blow-out to relieve the pressure; there's no safety problem.

MR. CATTON: So if it comes apart, it's a mess; it's no problem.

MR. ESPOSITO: Right.

(Slide.)

MR. LAMBERT: This is the last vugraph.

It shows fuel mechanical design comparisons between Sequoyah and Westinghouse typical operation fuel, a 15x15 rod array, versus 17x17 rod array, as used in the Sequoyah plant. The 15x15 is at Cook, Unit 1.

The basic point, though, is the 17x17 is not new; Trojan, Farley, North Anna, Cook Unit 2 and Salem Nuclear Plants have used 17x17 fuel, as Sequoyah will use.

That concludes my presentation. Are there any questions on either parts of the presentation.

MR. CATTON: On your fuel mechanical design, I don't see pellet diameter. Do you know what it is?

MR. LAMBERT: I do not, offhand.

We have the SER here, we can look it up.

MR. CATTON: It's not a very important question.

DR. MARK: Are there further questions?

(No response.)

MR. LAMBERT: All right, if not, the next presentation will be given by the Assistant Plant Superintendent.

MR. ZUDANS: I don't have to get the answer now, but I am curious to find out what is the implication of the question Dr. Catton made on that rejection capability, and how one assumption can justify as compared to the other.

In my mind I am not seeing what it means. Does it mean you will never have this load rejection accident? Or it means something else?

MR. LAMBERT: Something else.

MR. GILLELAND: We are working on it and will have an answer.

MR. WISENBURG: I am Mark Wisenburg.

As we understand the question it is related to turbine bypass, direct dump to the condenser; that's strictly an economical choice on our part. I don't think it has anything to do with the safety of the plant.

MR. ZUDANS: What I don't understand, because I have not the details, probably, what does it mean?

What is the sequence of events?

MR. WISENBURG: You never get to that situation in real life. The plant is not designed to be operating at 100 percent power.

MR. ZUDANS: I guess I have to do some more homework.

The answer should have been if you have more than 50 percent injection, you shut down the reactor?

MR. WISENBURG: That's correct.

MR. POPP: I am Walter Popp, I am the Assistant Superintendent for Sequoyah Nuclear Plant; and my topic is plant organization and status.

At present the plant organization is fully staffed; staff is trained and onsite as a functioning unit.

Appropriate personnel have had the training with the education and background and experience to meet the requirements of ANCI 18.1, 1971.

I have some rather simplified block diagrams of the plant organization that I think would best show you what we have.

(Slide.)

I would invite your questions as I go through these, gentlemen.

Plant Superintendent, that's Jerry Ballantine, and coming down below him, we have the Quality Assurance Group, who report directly to the plant superintendent.

Below that is the Assistant Superintendent, myself.

And then we drop down to the three major sections within the plant organization: Results, Maintenance, and the Operations Section.

And I would like to elaborate on these three a bit further in just a moment.

Let's go back on up to the Service Organizations we have within the plant:

The Administrative Section, of course, is clerical help, accounting help and general office clerical.

Item 2, Plant Services, is a group headed up by an industrial engineer who takes care of our document control, our validated vendor manuals, and also administers our surveillance program to see that the clock doesn't run out on us on our surveillance requirements.

Item 3, Security forces are onsite, functioning as a unit.

Item 4, the Health Physics Group, is onsite, fully trained and our radiation protection program is in effect.

Item 5, the Stores Group, we have a multi-million dollar spare parts program, and the Stores Group administers.

Systems Operations, a group of engineers who analyze communications, relaying and transmission.

And, of course, Item 7, Medical, consists of a nurse and a doctor who is on call.

Item 8, Safety, involves the Safety Engineer who takes care of fire prevention and fire protection.

Do you have any questions on this slide, gentlemen?

(No response.)

Now I would like to move back to the three major groups:

The Results Section, just to show you a basic layout -- the Results Section is responsible for the instrumentation unit, for the instrument engineers and technicians and instrument mechanics; a chemical unit, engineers and technicians, the radchem analyst group; the nuclear unit with our reactor engineers and nuclear engineers and technicians, and a mechanical unit, primarily concerned with component testing on secondary side, heating and ventilation and so on.

MR. MATHIS: What is the relationship between this group and the maintenance people?

MR. POPP: Our maintenance group handles all the mechnical and electrical maintenance. I have it on the next projection.

This group does handle maintenance on instrumentation: that's the extent of their maintenance function.

MR. MATHIS: Thank you.

MR. POPP: This is our maintenance group, a maintenance supervisor and engineering staff to prepare work plans and do the planning for maintenance requests. And it's broken up in two units.

Now, this is both electrical and mechanical maintenance under one department; so he has two assistants, and each of them have approximately half of the foremen and craftsmen in the plant.

MR. MATHIS: Most maintenance jobs are going to involve instrumentation; what is the relationship between this guy and the fellow that heads up the instrument work?

MR. POPP: None, except a compatibility in their working relationship. They are meeting together every day.

Now, the electrical aspect of the maintenance group, electricians, do handle maintenance that you might consider instrumentation in the sense of timers in the ice condenser system and that type of thing — refrigeration problems.

MR. MATHIS: Your maintenance schedule, then, outage work, and so forth, has to be coordinated between this group and the other engineering people?

MR. POPP: Yes. Each morning in the plant at 7:30 people sit down with a list of work requests for that day, and sort them out and allocate them properly. Occasionally there is an interchange back and forth here.

MR. MATHIS: And if there's a conflict on priorities, who gets it?

MR. POPP: No, sir, if there is a conflict, that's one of the responsibilities I have.

MR. MATHIS: Fine.

MR. POPP: I don't say that they are always harmonious, there's times when there's conflict.

(Laughter.)

The Operations Section, of course, is responsible for the day to day operation of the plant, see that we operate within our license, et cetera.

The Operations supervisor and the assistant are both senior licensed operators. Down below the assistant operations supervisor we have a training coordinator, who is a senior reactor operator with a full-time job of training and retraining operators.

And then our shift supervisor or shift engineer -- who will be an SRO -- assistant shift engineers, who will be SRO; the unit operator, the man with his hands on the knobs, a reactor operator; and the assistant unit operator is a leg man and equipment operator, who gets out and works around the individual pieces of equipment. The unit operator is confined to the control room.

(Laughter.)

Literally.

DR. MARK: It sounds a bit severe.

(Laughter.)

DR. MARK: How many are there? Do you have numbers?

MR. POPP: We have seven shift engineers, 13 assistants, 15 unit operators.

MR. MATHIS: What kind of shift arrangement do you have?

MR. POPP: On a normal shift, we'll have a shift engineer in charge of the shift; he will meet all of our license requirements.

We will have an assistant shift engineer working between the shift engineer and the unit; he meets a license requirement.

The unit operator will be on the console; starting up and shutting down we also have two unit operators on the console; so that would be four people.

Assistant unit operators, right now we are using nine; this number goes up and down depending on the status of the plant and the equipment in operation.

We are talking about 12 people, roughly, on a shift.

In addition to this, we have a health physicist on shift, and we also have a radchem analysist on shift.

DR. MARK: Are there radchem people on around the clock?

MR. POPP: Yes.

DR. MARK: Gee, what do they do?

MR. POPP: They monitor samples, do some analyses, but I don't have the details with me.

But we have quite an involved program for the radchem group involving surveillance testing, periodic sampling; enough warrant around-the-clock attendance.

DR. MARK: Yes.

MR. POPP: Any additional questions?

MR. ZUDANS: What is the total number of people on-shift, separate for Unit 1, and separate for Unit 2?

MR. POPP: I have only talked of Unit 1.

When we go to Unit 2, from the operators' standpoint, we will increase by a factor of one -- this gentleman (indicating) -- and a factor of two for the unit operator, one or two depending on the status of the unit.

And then we may have to add tw, or three people in this category (in'icating).

Basically we are staffed for two-unit operation, but I've only talked Unit 1 right now.

MR. ZUDANS: Well, how many are there, total?

MR. POPP: About 12 people on a shift; when we go to Unit 2, you can increase that by 3; talking 14 or 15 people.

Now, excuse me, I did not include the health physics technicials, that would be one more; and the radchem analyst; that would be two more.

MR. ZUDANS: Fourteen on a single unit, and 17 on a two-unit basis.

MR. POPP: Yes, sir, that's a reasonable number. In the normal TVA plant we are talking about -- two-unit plant -- we are talking about 345 people.

MR. MATHIS: What about your chemistry surveillance for the primary coolant, this sort of thing? Is that on shift-coverage?

MR. POPP: Yes. The radchem analysts handle that, too. It's part of their function.

MR. MATHIS: You do have an analyst on each shift?

MR. POPP: Yes, sir.

Do you have any other questions on organization, gentlemen?

(No response.)

Apparently not.

DR. MARK: Further questions?

(No response.)

Does that complete your presentation?

MR. POPP: No, sir, I want to mention just a few words about the plant staff.

DR. MARK: Fine.

MR. POPP: At present the construction status of Unit 1 and common systems is 96 percent complete.

We are deep into our preoperational test program. We are 57 percent complete.

Of 73 operational tests yet to be run, 30 are in progress right now; and the remaining are dependent upon our test planning program from here to fuel loading.

One of our major milestones is taking place this morning: the containment leak rate test. We started that Saturday, Saturday evening when I left the plant they were just getting into it. We should be right into it this morning.

When we complete that we hope to move into hot functional tests.

And from hot functional then to post-hot functional tests.

As I say, training is complete. We are fully staffed. Our procedures have all been written and approved by the Plant Operations Review Committee.

We have run every bit of equipment that is possible to run. We take advantage of every opportunity we have to run equipment. We've pulled vacuum on the main turbine, have condensate systems in operation; we used our procedures as thoroughly as possible so that right now we have a plant staff and a group of operators and people who are quite eager to see the fruits of our labor these past few years.

MR. MATHIS: What is the average experience of your staff?

MR. POPP: Specifically, sir, do you mean operators, or do you mean --

MR. MATHIS: Well, operators and first-line supervisors?

Do they have nuclear experience, and how much?

MR. POPP: Some do. My next topic is going to be operator training, and I am going to get into some more detail on that.

But as far as the supervisors are concerned, they are all older people, a lot of them with elaborate fossil plant backgrounds; some from Browns Ferry Nuclear Plant, with anywhere from two to four years at Browns Ferry; some going back as far as the experimental gas-cooled reactor.

MR. MATHIS: Thank you.

MR. CATTON: In your preop testing, do you test out things such as the UHI accumulators?

MR. POPP: Yes, sir.

MR. CATTON: How, what kind of a test do they go through a cycle?

MR. POPP: Yes.

MR. CATTON: Okay, thank you.

MR. POPP: Gentlemen, as operator training and technician training -- our operator training program actually was started six years ago.

It's been a continuing effort since, culminating this Saturday morning when NRC cold-license oral examination are being administered at the plant -- today, last week and this week.

Now, the initial group of cold-license candidates were experienced power plant operators. They worked 10 to 20 years in power plant operating experience. Also people from Browns Ferry Nuclear Plant.

I will mention more about that in a minute.

These gentlemen were given a basic nuclear course by TVA. They received their reactor training at Oak Ridge National Laboratory; and then they were put into a Westinghouse cold-license training program.

They had their plant observation at Point Beach or Zion, and they were all certified on the Zion simulator.

Following that they had Westinghouse on-lecture type training, on-lecture -- excuse me -- onsite plant system lecture; and they were audited by Westinghouse prior to taking their NRC exams.

Now, in January we submitted 22 people to the NRC for the cold-license written examination. All of these candidates passed the RO portion; 17 passed the SRO portion.

Last week and this week we are taking the oral examinations; and, of course, we don't have the results. We feel optimistic, but we won't feel real comfortable until we really hear of course.

But I need 15 licenses to start up the plant and run it without getting into overtime; that gives them 40 hours a week.

In addition to that -- now, these were experienced middle-aged people for the most part, people who, in fact, many of them had been licensed at Browns Ferry; one of them was an SRO at Browns Ferry.

Now, in addition to that we have four younger men who cut their teeth at Sequoyah, who, this morning are starting observation training at Donald C. Cook. They had simulator training, they've had their reactor experience at Oak Ridge; and when they complete observation at Cook, by the middle of April we hope the NRC will give them a cold-license RO examination.

This will give us four more at the RO level to work with these older men on the plant product.

Now, in addition, when we reach 20 percent power, we have 12 more hot license candidates. Now, these are experienced powerhouse men, plus younger men. We are drawing a whole new generation of operators now.

The men who are going to take the hot license have had the equivalent of a cold-license training program but they lack adequate observation; so they'll receive their observation during our startup. Each man will have to go through five reactivity changes at the bare minimum. I am sure we'll do better than that; but they are obligated to have five reactivity changes to be involved in, and then we'll complete this phase of our licensing program.

Now, to back that up we realize that we'll have attrition and losses, so TVA has a very elaborate program of training nuclear plant operators from the ground up.

We were lucky that after we started our training, TVA built a very elaborate training center within five minutes of the plant for Sequoyah's simulation.

And I didn't mention our cold-license candidates have also had four to eight weeks time on our own simulator. This has been very good for them.

The license examinations are being given on the simulator. They are pulling critical on the simulator and going through malfunctions on the simulator.

So these young operators that are going in, these are inexperienced people, but picked with the proper educational background and aptitude to put through an 18-month academic program at the training center; then six months on the job in the plant; and then we use them as assistant unit operators or equipment operators.

About three years from the day a man starts if he passes a very elaborate system with examinations, he would be about ready to place in an NRC examination as a reactor operator.

MR.CATTON: No.

MR. MATHIS: These people actually followed construction onsite?

MR. POPP: Sir, these people have been onsite six and seven years; they've followed construction from the day they started pouring the concrete reactor building; and they've been involved in all operational testing. They've been involved in all the flushing of chemical cleaning and all. All of that and switch opening and closing has been done by these people.

It's a very good training program.

MR. MATHIS: Yes, thank you.

MR. CATTON: Many water hammer type events are operator-related; is there anything built-in to your operator training program that would help with this?

MR. POPP: Yes. We have no problem with that at all.

As part of our training program -- plus the men who've been out on fossil plants, they've heard water hammer that sometimes would make you want to go home; they know how to avoid them and they know what they are.

The younger men haven't heard them, but I hope they don't hear them; but they are surely training on what a watter hammer is.

MR. CATTON: You build in specific steps into the way you carry out particular operations with water hammer in mind?

MR. POPP: Yes, sir, we have very, very detailed operating procedures to keep a man out of this kind of trouble, and precautions where water hammer would be possible.

MR. CATTON: Has there any thought been given to maybe some kinds of instrumentation in your plant that would warn you of potential water hammer in certain circumstances?

MR. POPP: I am not qualified to answer that. To my knowledge -- I don't know, somebody else may answer that?

MR. CATTON: I don't know, I was just curious.

MR. POPP: Not to my knowledge.

MR. CATTON: Thank you.

MR. POPP: Just one more moment, I don't know if I have used up my time, but -- I mentioned the instrument mechanics earlier.

We also know that we've got to keep instrument mechanics training and coming into this system; so we have an apprenticeship program for instrument mechanics.

They receive one year of academic training at the training center, and then two years hands-on in the plant before they qualify as instrument mechanics.

When the qualify as instrument mechanics they have the proper attitudes and they pass evaluation to move them up into a senior instrument mechanic program, which involves another five or six months at the training center.

Chem lab analysts, the same situation. We bring in people with the proper background and then put them in class for six months, and teach them analytical techniques and our administrative policies; and then put them in the lab with an older man for another year before they are on their own.

Operator requalification training is worth mentioning:

When we receive our operator licenses we start the clock on operator requalification training. And this involves 96 hours formal training each year, which includes 32 hours on the simulator. And it also means a man has to pass the examination with a satisfactory grade before we are satisfied with that.

Do you have any additional questions on this?

MR. ZUDANS: Is the operator retraining on a continued basis?

MR. POPP: Yes, sir.

MR. ZUDANS: Every year he works, he have to do that?

MR. POPP: Yes, sir.

Gentlemen, thank you for your attention.

MR. GILLELAND: On the question of instrumentation on water hammer, we have no special instrumentation for that.

MR. CATTON: Thank you.

DR. MARK: I wonder if I could cut into the presentation here and rearrange the schedule slightly, and have Stephenson on Item (e) on the Security?

MR. GILLELAND: Yes, sir, we can do that.

DR. MARK: If he can come up now he will be sure to make his plane.

MR. GILLELAND: Yes, sir, we can do that.

DR. MARK: Let's consider having his presentation in open session, unless there are enough questions to regroup for those -- and that we will find out.

MR. STEPHENSON: My name is Victor Stephenson.

My duties as TVA Office of Power Security Officer includes coordination of planning for nuclear plant industrial security measures.

From the industrial security experience gained at TVA's Browns Ferry Nuclear Plant, in developing a security program to meet the Nuclear Regulatory Commission's rules and regulations dealing with the physical protection of plant and materials, mor specifically, 10 CFR 7355.

TVA has developed a physical security plan for the Sequoyah Nuclear Plant that uses the same criteria as established in the approved Browns Ferry security plan.

These criteria include the necessary physical features to thwart attempted sabotage by providing the means to:

One, control entry to the plant protected area, or portions of the protected area.

Two, deter or discourage penetration by unauthorized persons.

Three, detect such penetration in the event they occur.

And, four, delay and apprehend in a timely manner unauthorized persons or authorized persons acting in a manner constituting a threat of sabotage.

The design requirements of the Sequoyah plant will include designation of three security areas, increasing in degree of protection as one approaches the vital equipment and the facilities of the plant.

These are the owner-controlled area bounded in green --

(Indicating slide.)

-- the protected area, shown in blue; and vital areas, shown in red (indicating).

MR. CATTON: Are the brown circles the cooling towers?

MR. STEPHENSON: No, sir.

MR. CATTON: Where are the cooling towers?

MR. STEPHENSON: These are, (indicating) yes, sir. These are the two cooling towers.

MR. CATTON: So they are considered of lesser importance?

MR. STEPHENSON: Yes, sir.

The plant security force consists of uniformed, armed, and trained guard personnel known as the TVA Public Safety Service, which has functioned for many years as TVA's security and visitor reception organization.

Written security procedures detailing the security plant's security force duties are provided in plant construction; general post arrangements are provided in the plant physical security plan.

Members of the plant security force have been carefully selected and trained in duties and responsibilities directly associated with the operation of the physical security system, in the use of firearms and equipment, protection of the facility, and other security skills involving access control, search techniques, et cetera.

When Unit 1 becomes operational, with Unit 2 still under construction, an integrated emergency procedure plan has been developed to cover the period of transition of Unit 2 plant systems from construction to operations.

This plan provides for orderly integration of security functions and emergency procedures between construction and operating organizations.

Local and State police will provide offsite assistance in handling serious security threats, civil disturbances, or radiological emergencies.

Strict access control will be provided to the protected area. The main plant building and other structures which contain vital equipment, or facilities located in the protected area, are enclosed by security barriers and intrusion detection systems.

The security area meets the requirements of 10 CFR Part 73, is alarmed with an on-fence and offset system; an isolation zone and a perimeter control road has been provided.

A closed-circuit TV system located along this barrier using low-level cameras with zoon lenses and remote pan and tilt control is provided for monitoring the isolation zone and threat assessment.

The protected area shall be well-lighted. The isolation zones in the protected area are relatively flat and free of obstructions that might hinder the surveillance system or survillance by security patrols.

The main plant structures which contain vital equipment or facilities are, as well as the internal compartments of these structures, to be kept closed and locked at all times. Entry will be controlled by card key access control systems.

There are redundant communications facilities at the Sequoyah plant for both onsite and offsite communication by both plant operations' and plant security forces.

Central and secondary alarm stations have been provided. Each will have the capability of directing a security force response during an intrusion attempt and calling for offsite assistance if required.

Employees will be screened. Examinations of those who are to have access to the plant without escort will be conducted for the purpose of identifying persons whose behavior may present a potential risk to the safe and secure operation of the plant.

A security investigation will be conducted on all employees who are to have access without escort.

Identification photographs will be included on badges issued to persons admitted without escorts.

The security measures and arrangements that I have just presented are covered in more detail in the Sequoyah plant physical security plan and the Sequoyah physical security instruction manual.

Gentlemen, do you have any questions?

DR. MARK: The plans you have made here I presume have been influenced by 7355, and also discussed with the people on the Staff who are concerned about the same things?

MR. STEPHENSON: Yes, sir.

DR. MARK: And there's no argument as to whether or not --

MR. STEPHENSON: No, sir, we have no arguments going at all.

I understand there are some concerns, but I believe we are able to work these out.

They don't have any open items that I know of.

DR. MARK: Are there any comments on this general point of view from the Staff?

MR. SILVER: Mr. Gaskin, the chief leader of this review will speak to this.

MR. GASKIN: I am Charles Gaskin from NRR, the team leader on the security review.

There are no open items at this time.

As Mr. Stephenson said, we do have some questions that we are in process of resolving; but there are no open items.

And in my opinion the security system does meet the requirements of 7355 very well.

DR. MARK: That's what I think we really needed.

MR. STEPHENSON: I would liked to have said my plan was approved, but I don't have it in hand yet.

(Laughter.)

DR. MARK: It looks as this is going to meet the needs.

MR. STEPHENSON: Yes, sir.

DR. MARK: You have, I presume, in the TVA system sort of a basic training for guard work which may relate to Sequoyah or Browns Ferry or any of the locations in the system?

MR. STEPHENSON: Yes, sir, we have a common training program for our security forces, which encompasses those subjects that are covered in the annex to 7355, which covers the various subject matter that we need to train our people in.

DR. MARK: So if a person goes through that he learns to point a gun in the right direction?

MR. STEPHENSON: Yes, sir.

DR. MARK: And then you will have a particular period of specific familiarization with the needs and nature of one plant?

MR. STEPHENSON: Yes, sir, they must have onsite training to address those specific things which are different, such as guard post arrangements, various differences in configuration of control roads, and other things such as control facilities may be slightly different, one from the other.

DR. MARK: Are there further questions?

MR. ZUDANS: Yes, a quick one, please.

Could you put back the slide with color lines on it?

(Slide.)

I have a few questions for clarification.

Could you indicate where is this forebay that reference was made to before, and where is the intake structure? I can't read it.

MR. STEPHENSON: This (indicating) is the intake structure right here, sir.

MR. ZUDANS: Okay.

And the forebay?

MR. STEPHENSON: This is the forebay (indicating) right in here, sir.

MR. ZUDANS: Okay.

MR. STEPHENSON: Here (indicating) is the skimmer dike, I believe it's called, across the forebay.

MR. ZUDANS: Yes.

Now, your green line is right on that dam on the dike, or is it beyond the dike?

MR. STEPHENSON: It's on the dike, sir.

MR. ZUDANS: On the dike?

MR. STEPHENSON: Yes, sir. It goes along the dike, around the countour at maximum pool level.

MR. ZUDANS: Okay.

Now, with respect to tourists that might be floating on boats down the reservoir, would they be allowed to get in the bay, or forebay, what you call? In other words, can somebody in the boat drag the boat over the dike?

MR. STEPHENSON: This is a boom, sir, which will restrict visitors from this area (indicating), and this area will be under patrol.

MR. ZUDANS: Uh-huh.

MR. STEPHENSON: Our officers have the responsibility of, if they catch anybody or see anybody trying to circle this barrier, to stop them.

MR. ZUDANS: They won't be allowed to get there, right?

MR. STEPHENSON: They will not be allowed to get in there, sir.

MR. ZUDANS: Are there any restrictions beyond this green line on the reservoir as far as boating or fishing or motorboating is concerned?

MR. STEPHENSON: No, sir. Not in the water areas.

MR. ZUDANS: Okay.

That's good, then I can go there and swim.

(Laughter.)

DR. MARK: The water will be nice and warm.

(Laughter.)

MR. ZUDANS: And the discharge?

MR. STEPHENSON: The discharge is right here, sir, (indicating).

MR. ZUDANS: And that has no dike on it?

MR. STEPHENSON: Yes, a dike all the way around the holding pond.

MR. ZUDANS: I see.

DR. MARK: Mr. Stephenson, I think the need of a closed meeting didn't arise. That being such a relief, I suggest we take a break for ten minutes, until quarter after ten.

1 (Recess.)

DR. MARK: Mr. Gilleland, will you continue?

MR. GILLELAND: Our next topic is on quality assurance and quality control, Mr. Crevasse.

MR. CREVASSE: I am Crevasse, Quality Assurance Manager for TVA's Office of Power.

The Office of Power Quality Assurance Program in the operation of its nuclear plants is described in Topical Report TVA-TR-75-1.

This document has been extensively reviewed by NRR and has been found acceptable.

The topical report addresses all regulatory guides pertinent to quality assurance and quality control programs in plant operation.

The program described in the topical report is now in effect at our Browns Ferry plant, and it will eventually apply to all of our plants.

The Office of Power Organizational structure for quality assurance and quality control has several tiers, as this chart will show --

(Slide.)

-- This (indicating) is the Office of Power, responsible for the operation of our plants. The quality assurance and audit staff is under the Assistant Manager of Power, Mr. Jones.

Under the manager of power operations we have our Division of Power Production, which is responsible for the operation of the plant; there is a quality assurance staff there.

In the operating plant, as Mr. Popp mentioned, there is a quality assurance staff, also.

Then in addition to that, under the quality assurance and audit staff, there is an office of power policy assurance coordinator assigned to the plant.

Now, let me explain the relationship of these various people:

At the top, the quality assurance and audit staff, is responsible to establish the basic policy for the quality assurance program, and to assure effective implementation throughout the lower-tier organizations.

Also, it deals with the supporting organizations which are outside the Office of Power.

At the next level down, the division level, the organizations are responsible to translate power-quality assurance policy into requirements, and impose these requirements within their areas of responsibility.

The divisional organizations are engaged in both quality assurance and quality control activities.

As Walter Popp told you earlier, the quality assurance staff reports directly to the plant superintendent.

This staff is responsible to execute the quality control function in the plant.

This organizational structure has been examined by NRR and found to have the required degree of independence.

The documentation for the quality control and quality assurance program also consists of several tiers, and it follows the same organizational lines.

To illustrate this, the next vugraph --

(Slide.)

-- shows a simplified organization and the document tree from the Office of Power through the Division of Power Production, to the plant.

The Office of Power is really what would normally be considered corporate level. It has the topical report which I mentioned.

In addition, we also have the quality assurance manual, which is a policy manual.

The manual expands upon the commitments in the topical report, and it defines the basic QA policy and assigns the responsibilities for carrying this out.

At the next level, the division level, the power production quality assurance staff maintains the operational quality assurance manual.

This manual translates the basic QA policy into procedures which detail the requirements for implementation in both the central office and in the plant.

Finally, at the plant level are the various instructions. These instruction manuals provide the step by step directions for the actual performance of work.

There are a number of TVA organizations outside the Office of Power that support power operations.

We interface with these organizations in a number of ways. We interchange and review each other's procedures, we audit their activities in some cases; in other cases, we perform joint audits with them.

For example in the plant turnover plant systems, in plant modifications, we perform joint audits of purchasing and various other areas.

In addition to that we have a quality assurance steering committee which is made up of quality assurance managers and assistant directors of divisions for quality assurance and quality control or ganizations.

The Office of Power also conducts an extensive program for training QA and QC personnel.

This training may be for job qualification alone, or it may provide for formal certification to establish industry standards, such as nondestructive examinations.

The quality assurance and audit staff has been assigned responsibility for providing quality assurance training to the division level QA personnel.

The divisions are responsible to provide quality assurance and quality control training below that level, and to assure that such training is carried out.

We have a number of activities for assessing the effectiveness of various elements of the quality assurance and quality control program.

The quality assurance and audit staff conduct a comprehensive system of audit of all QA program activities. As this next vugraph will illustrate --

(Slide.)

-- we cover a number of areas outside of quality assurance programs. For example, we perform audits in the jrb57

Office of Natural Resources, which deals with water quality.

We did an offsite supply and contractor audit. We audited the division of fuels, which has our nuclear planning branch, and some quality assurance involved activities there.

We audit, of course, the Division of Power Production, the audit staff and the various organizations in Power Production.

There is a calibrations activity carried on in our Systems Operations Central Lab. We audit there.

We audit in the area of health and safety, this is the radiological hygiene area.

So our program extends far beyond the normal bounds of quality assurance.

The auditors of this quality assurance and audit staff are all qualified in accordance with ANCI Standard 1045-223, and this qualification program also meets the provisions of the draft regulatory guide released for comment by the NRC last month.

The Sequoyah plant staff conducts a planned system of surveys, of planned activities, on a daily basis.

In addition the resident QA coordinator who reports to me and is assigned at the plant, monitors activities on a day to day basis. He monitors NRC I&E inspections, follows up on corrective actions, resulting from these inspections or from our audit, or from Licensee Event Reports, and regulatory violations.

Finally, we have an annual evaluation of the quality assurance program from a management perspective. Portions of the program are done each year with the total program being covered every two years.

In the past, we have used TVA's management personnel to help us to perform these evaluations.

More recently we have joined with other public utilities in joint audit programs. In this program, a utility is audited by a team made up from the other participating utility.

We are scheduled for our first evaluation under this joint program in the fall of 1979.

That's a very brief overview of our program. I would be happy to answer any questions you may have at this time?

DR. MARK: You spoke of calling on people from other utilities, not just other parts of the TVA system?

MR. CREVASSE: Other public utilities, Washington Public Power Supply.

DR. MARK: How wide a consortium takes part in that?

MR. CREVASSE: Well, there are about five or six in the public utility area.

A number of private utilities are doing the same thi ng.

We have, let's see, Washington Public Power, Sacramento Municipal Distric t, Omaha Public Power, Nebraska Public Power, Power Authority of the State of New York, TVA; and we had Los Angeles until Sun Desert went down the tubes.

DR. MARK: Now, people from these groups come and look over the shoulders of the people going through some aspect of your program, and like you do, recriprocate?

MR. CREVASSE: Yes, sir.

We normally have a four to six man team in an intensive week of examination.

In our case we use it as a management evaluation. Other utilities use it in a different way; for example, they may ask us to look into their design or some specific area.

So it's the option of the utility to use it as they see fit.

DR. MARKS: Further questions for Mr. Crevasse?

MR. CATTON: I am not sure this falls under the area of QA, but --

In your Licensing Event Reports, are there mechanisms by which review of the Licensee Event Report can lead to design modifications or procedural changes?

MR. CREVASSE: Yes.

MR. CATTON: This is built into your QA?

MR. CREVASSE: This is not really a part of the quality assurance function; but, yes, the answer to your question is yes.

MR. CATTON: Thank you.

MR. MATHIS: How does quality assurance relate to plant configuration?

In other words, how do you handle design changes?

MR. CREVASSE: Well, quality assurance really doesn't get too involved in that area, either, sir.

We handle design changes by referring them back. If it is a change that originates, or the idea originates with the plant, the change request goes back to our Division of Design, and is reviewed there.

It is given another review and so forth. So we have our own in-house design, of course; and our changes in configuration are handled in exactly the same way, as our our original design is handled.

Now, from a quality assurance standpoint, we do participate in a joint audit with the design quality assurance organization; so that the modifications, we go with them to review the modification process in our Division of Design.

MR. MATHIS: And you would assure that were a design changed in your quality assurance system that an as-built drawing is as-built up to date?

MR. CREVASSE: We don't review every one, no, sir.

We do review only on an interim basis, so to speak; and the modification area is one that is audited every six months. But we do it on a sampling basis.

MR. MATHIS: Thank you.

DR. MARK: Thank you.

MR. GILLELAND: John Lobdell of our rad hygiene branch.

MR. LOBDELL: I am John Lobdell and I will cover the emergency plans.

The Sequoyah radiological emergency plan was developed in June 1972, and submitted with the Final Safety Analysis Report.

This plan and the Browns Ferry plan were developed using the guidelines stated in 10 CFR 50, Appendix B, and Guide to the Preparation of Emergency Plans for Production and Utilization of Facilities.

This plan is in compliance with NRC Regulatory Guide 1.70, the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants.

The Tennessee Department of Public Health has the overall responsibility for protecting the health and safety of the general public from hazards associated with ionizing radiation and for coordinating the development of radiological emergency plans in Tennessee.

Therefore, the development of the radiological emergency section of the State of Tennessee was coordinated with the Tenness(Departmentof Public Health.

A list of agencies involved in the development of this plan is shown on the slide.

(Slide.)

Agencies from the State of Tennessee — there's a group of local agencies, ambulance, fire, hospitals and then various Federal agencies.

Now, there was a question earlier on evacuation of the reservoir. I believe that's handled by the Tennessee Department of Conservation.

DR. MARK: Why does the Tennessee Department of Agriculture find itself placed away from the other Tennessee organizations?

MR. LOBDELL: No special reason, just haphazard arrangement.

(Laughter.)

DR. MARK: I believe you referred to Browns Ferry's style of arrangement as being similar?

MR. LOBDELL: The plan is quite similar, yes, sir.

DR. MARK: And the difference would then be that they have relations with other fire departments and other local police, and it wouldn't have to involve Alabama, things like that?

MR. LOBDELL: Right. Since Browns Ferry is in

Alabama and is associated with other counties and hospitals and so forth.

DR. MARK: But otherwise the layout of the plan -- it's coverage would be similar?

MR. LOBDELL: Yes, sir.

DR. CATTON: Don't these different people get involved?

MR. LOBDELL: That was my next statement.

It's obvious that some of these agencies will need extensive training, some of the Tennessee State agencies, some of the local agencies, the hospitals; these have all been trained and will be trained every year as long as the plant operates.

Some other agencies, it's obvious that training will not be needed.

But all the local, State agencies, hospitals, are all trained.

MR. CATTON: Does this training program actually include simulating circumstances, running through the scenario?

MR. LOBDELL: Yes, sir, as our presentation goes on I'll discuss some of that.

MR. CATTON: I am sorry.

MR. LOBDELL: TVA has committed to notify State officials as soon as possible, detailing release rate, meteorological conditions, estimated release duration, and potential environmental impacts. This notification would come from the central emergency control center, the operations duty specialist, if time permits, or directly from the plant, depending upon accident severity.

The CECC, located in Chattanooga, has responsibility for evaluating, coordinating and directing the overall activities involved in coping with the emergency situation.

The operations duty specialist, also in Chattanooga, is on duty 7 days a week, 24 hours a day.

TVA has trained teams that can be dispatched from the Sequoyah Nuclear Plant, Potts Bar Nuclear Plant, and the Central Health Physics Office in Montrose, Alabama.

These teams will periodically be retrained.

At least three emergency vehicles and a mobile laboratory with monitoring equipment will be available for environmental assessment.

Helicopter and fixed-wing aircraft can be made available to transport men and equipment to any location.

Rapid assessments of projected environmental doses can be made from graphs in the radiological emergency plan. These graphs have been developed specifically for Sequoyah Nuclear Plant and can be used to estimate doses based on planned release rates.

More comprehensive estimates can be made with real-time meteorological data transmitted to the plant control room and central health physics office in Montrose, Alabama.

The Browns Ferry plant has been tested on five occasions. During one drill for approximately 2,100 construction workers, we evacuated them.

During another drill, a visit was made by local officials to every residence and business within a seven-mile radius of the site, and an informational brochure regarding evacuation was distributed.

On another occasion a transportation accident was simulated that involved a low-level radioactive waste shipment from the plant.

All the drills showed that all aspects of the plan worked effectively.

The Sequoyah plan was tested in July 1978. On this occasion the waste tank gas rupture was assumed with a noble gas and iodine release.

TVA, Tennessee and local officials were mobilized and evacuation of the environs was simulated.

The Regional Advisory Committee on Radiological Emergency Drills, which is composed of NRC, EPA, FDA, and DOT officials was present.

The Committee was impressed with the planning and coordination of the Hamilton County Civil Defense, which will have the evacuation responsibilities around the site.

An integral part of the TVA emergency plan is the medical assistance plan which assures medical care for contaminated and/or irradiated workers from the plan.

TVA has an agreement with an ambulance service to transport the workers to local hospitals.

TVA has provided health physics training to the ambulance drivers, who are emergency medical technicians, and will continue to do so annually.

In addition, TVA has an ambulance that will be at the plant and will be used to transport injured workers.

TVA has two -- has agreements with two hospitals to accept inju·ed personnel, the Baroness Erlanger Hospital in Chattanooga is the closest agreement hospital; and it will be used to treat injured and potentially contaminated workers.

The REAC/TS hospital in Oak Ridge, Tennessee will accept patients with serious contamination or who potentially receive a dose greater than 50 rem.

Erlanger has a health physicist on the hospital staff to provide health physics coverage and to retrain hospital staff.

Staff has been trained and will be periodically retrained.

TVA has provided instrumentation and equipment for use by the hospital staff.

TVA health physics personnel from the plant, from the Watts Bar plant, and from Chattanooga, will accompany injured workers to the hospital to provide any health physics assistance needed.

A drill was conducted with the Erlanger Hospital on April 25, 1978, simulated injured workers were transported to the hospital and satisfactorily treated.

The Chattanooga and Soddy-Daisy Fire Department have agree to respond to a request for aid from the plant in fighting plant fires.

Training has been provided and will continue to be provided to these departments yearly.

TVA has in the past provided whatever assistance was necessary to appropriate States to assist them in deriving and maintaining radiological emergency plans.

TVA, State and local agencies have worked together to ensure that everyone that would be called upon to respond can perform their responsibilities, and are properly trained.

TVA has three emergency vehicles and a mobile laboratory with monitoring equipment and trained health physics personnel that are available to assist State agencies as required.

Helicopters and fixed-wing aircraft will be made available to transport men and equipment to any location.

The Southern Mutual Radiation Assistant Plan and the Inter-Agency Radiological Assistance Plan are available to assist TVA and the Stage agencies in any radiological emergency, whether associated with the Sequoyah plant or others.

Therefore, when the radiological emergency plan for Sequoyah is implemented, TVA, Tennessee and local officials will have the knowledge and experience to maintain an adequate plan, to respond to emergency conditions, and to protect the health and safety of the public.

If you have any questions, I would be glad to answer.

DR. MARK: Questions?

(No response.)

Thank you.

MR. LOBDELL: Thank you.

MR. GILLELAND: Mr. Steve Jacobs will present ECCS and UHI; he is from Westinghouse.

MR. JACOBS: I will be presenting results today of the Sequoyah plant ECCS analyses.

(Slide.)

Briefly, I would like to get into the upper head injection system design, the model which is used in ECCS analysis, and how it differs from the non-UHI analyses; and then directly into the Sequoyah plant results.

Plants like Sequoyah are equipped with ice condenser containment building, and an increased heat capacity in the ice beds of the containment, which leads to a low contain ent pressure following the loss of coolant accident.

This is beneficial with respect to containment integrity. However, when we look at ECCS performance, we see that a low containment pressure has the effect of slowing the flow rate during reflood.

As a means of offsetting and minimizing this impact, Westinghouse has included in the design of the ECCS system, upperhead injection, which injects large amounts of cooling water directly into the reactor vessel during the blowdown portion of the transient, removing large amounts of stored energy; so that the reflood transient can then proceed.

I've shown a schematic here --

(Slide.)

-- of the flow diagram of the system.

I might mention first off the upper head injection system is separate and independent from the conventional ECCS systems. There are ECCS consisting of low pressure accumulators and pump safety injectors.

This is a path of the system which provides large amounts of cooling water directly into the head of the reactor.

The main components of the system are two large volume, approximately 1,800 cubic feet, tanks which inject directly into the reactor vessel head.

Following a depressurization of the reactor coolant system, as existing pressure drops below the UHI setpoint, approximately 1,250 p rupture disk membrane bursts on a delta psi of approximately 40; water is then injected through the isolation valves which are open under normal operation, then through two redundant check valves, directly into the upper head through four symmetrically located injection ports.

The system injects approximately 1,000 cubic feet of water directly into the head, then a low-level signal on the tank sends a signal to close the isolation valves, thus that the injection is stopped during a portion of the blowdown transient, approximately 25 seconds into the transient.

DR. CATTON: What percentage of the accumulator was has been used?

MR. JACOBS: The tanks are topped off with 1,800 cubic feet of water, and they deliver approximately 1,000 feet of that water.

DR. CATTON: Have you conducted tests of these things?

MR. JACOBS: There is preoperational tests that I think have been completed.

MR. GILLELAND: They have been completed.

DR. CATTON: If for some strange reason your level sensor acted in a malignant way --

MR. JACOBS: Yes, sir?

MR. CATTON: What problems would result?

MR. JACOBS: There are four separate independent trains of level sensors on the tank; and we do take into account a single failure into the sensing device in our analysis -- which I'll get to a little bit later -- we are required to consider the range of volume delivery.

So we do indeed account for possible hang-up of this.

MR. CATTON: I guess the question I am asking is, if some of the nitrogen was to blow through into the upper head, would it cause any problems?

MR. JACOBS: I believe it would. However --

MR. CATTON: Well, then, I'll listen closely when you tell me why it won't.

(Laughter.)

MR. JACOBS: I think there is an allowable percentage of nitrogen which can be injected in the upper head.

We have concluded in the design that we will not exceed that acceptable amount.

The model which is used in the ECCS analysis conforms to Appendix K requirements and the Safety Evaluation Report was issued in April of 1978.

In this SER there were a number of differences between UHI and non-UHI test analyses which were reported out.

One of these differences with respect to upper head mixing which is relevant to the discussion today -- I'll talk a little bit about that.

As I said before, the systems, the reactor coolant system pressurizes, water is injected directly into the reactor vessel head. There are four symmetric injection points on the upper head.

This water then mixes with the inventory of water which was originally in the upper head; as it depressurizes and is flowing down through this guide tube into the core, the fuel region.

As spelled out in the SER there are two conditions we look at of upper head mix:

The first being imperfect mix, where the water injected, this cold water, approximately 100 degrees, entrains small amounts of the previous inventory which is in the upper head, and settles in a lower region of the upper head due to the density gradient.

And as the transient progresses, the depressurization continues in the system, the upper region of the reactor vessel head flashes, forcing water down the guide tubes, and support columns.

Then as we enter the period of transient of negative core flow rates, this water flows directly through the core, moving, removing, stored engery, and out of the break.

If you look at the other assumption of upper head --

MR. CATTON: Would you give me the rationale for a one-dimensional flow in the core? I mean, what appears to be at least a two-dimensional flow?

MR. JACOBS: Okay.

In the SATAN model we do have radial flow path --

MR. ESPOSITO: Westinghouse.

We did extensive studies of flow models, and studied extremes and bounds for postulated core flow problems.

And we came up with the assessment that the most limiting case appears to be homogeneous flow.

MR. CATTON: So what you are saying is the one-diemensional flow is conservative?

MR. ESPOSITO: Right.

MR. CATTON: Thank you.

MR. JACOBS: To look at the injection in the upper head again, the other case we looked at is perfect mix, where the injected water mixes with the entire contents of the upper head volume, this way we have a homogeneous control volume.

If we look at the behavior of this as the system depressurizes, -- if in normal operations there is flow from head cooling jets into the upper head, this flow passage from the top of the guide tube -- so it's virtually at cold leg temperatures -- flows into the upper head, flows down the guide tubes and column; as the system begins to depressurize -- there's a cold leg break -- the flow through the head cooling jets has reversed, since this is a direct flow path for a break; water continues to flow down onto the guide tubes.

Approximately 25 seconds into this transient, after delivering approximately 1,000 feet of water, the UHI isolation valve has closed, and the flow now from the vessel -- from the core region flows up into the head to match the delta p through the break, through the head cooling jet flow path.

This water -- the steam flow path that mee s the water which was sub-cooled, following injection, and during this time we meet saturation conditions in the upper head, from which the upper head flashes, and sprays water di-ectly into the core.

To look at the Sequoyah plant results, I' shown the C_D to .6 case for the imperfect and perfect mixing.

If the break serves as time zero, the SI signal is reached approximately 5 seconds into the transient, upper head injection begins at approximate 2-2-1/2 seconds into the transient; the cold leg accumulator injection begins approximately 20 seconds; this is -- as this pressure drops below the cold leg accumulator setpoint, approximately 400 psi, the isolation valves from the upper head injection system close;

delivery is completed at approximately 25 seconds in time. Pump injection we get at approximately 30 seconds, which is 25 seconds after receipt of signal.

End of bypass occurs at approximately 48 seconds to 58 seconds into the transient.

This is really where the effective upper head mix begins to show a divergence from the transient.

In the perfect mix case, we still have a lot of water draining from the upper head into the core, providing steam for neg·tive flow rate, which then pulls the cold leg injected water elevated into the downcomer so we cannot achieve end of bypass until a little later in time.

The non-UHI plan analyses, where there is no water injected into the upper head, shows that end of bypass is achieved approximately 25 seconds into the transient, and this is the time in which we get sustained down flow down the intact loop side of the downcomer.

And in this case it's a little later intime because there is still steam being generated in the core.

This delay period in the upper head mix leads to a much later bottom of core recovery time, approximately 128 seconds -- versus 72 seconds in the imperfect mixing case.

The cold leg accumulator and the --

MR. CATTON: What happens to the end of bypass if you have a smaller train? Can you wind up with a situation where you can send in a bypass beyond the point the accumulators are emptied?

MR. JACOBS: I don't think so.

MR. CATTON: Don't let me mess up your presentation.

MR. ESPOSITO: We analyzed smaller breaks and essentially the period from the time the accumulators start injecting to the time you get into bypass is about the same time.

You have a longer period of depressurization from 2200 psi down to 400 psi. But the transient from .00 psi into bypass looks about the same.

MR. CATTON: Thank you.

So you don't get into a situation where you just sort of balance the pressure to hold it?

MR. JACOBS: Yuh.

MR. CATTON: Is that a three-inch pipe?

MR. ESPOSITO: No.

MR. CATTON: Okay, thank you.

I have to think a little bit more about the question.

VOICE (FROM STAFF:) With UHI you don't run into problem as you run into with a non-UHI plant; at the end of bypass you still have good cooling of the core because of the water that you have on the bottom levitating above the core; it gives good heat transfer; in a non-UHI plant at the end of bypass you go into adiabatic heat-up.

MR. CATTON: Well, from the arguments you just gave me, the homogeneous limits the load.

VOICE (FROM STAFF:) Yes, but you can get trapped in two cases, the perfect and the imperfect mixing; where with perfect mixing the water levitates quite a while.

MR. JACOBS: You'll get an idea of this on the next slide, end of blowdown at about 120 seconds.

But the perfect mixing you blowdown the upper head almost immediately and you don't have that levitation. There's a tremendous difference in dynamics in both cases. Yet the peak clad temperature is relatively small.

(Slide.)

Okay, using these calculated hydraulic transients we then performed analysis to establish response to cladding for the criterion of Appendix K.

With two breaks, -- the clad, worst case break in terms of peak clad temperatures, is the imperfect mixing which had a clad temperature of 2190; versus 2111.

The location of this peak clad temperature is 7-1/2 feet; the local zirconium-water reaction is a max of 7-1/2 percent -- perfectly within an allowable 17 percent.

The location is at the 7-1/2 foot node.

The total zirconium-water reactor is less than .3 of a percent of a conservative and allowable one percent.

The hot rod burst time doesn't apply until 72 seconds.

This analysis was done at 100 percent of electrical power, 3411 megawatt thermal; the peak linear power of 12.25 kilowatts; the peaking factor at license rating is 2.25.

In summary, the ECCS analysis -- excuse me -- the requirements of the acceptance criteria presented in 10 CFR 50.46 is a peak clad temperature of less than 2200 degrees.

DR. CATTON: Let me try again: Just bear with me, I am trying to understand myself.

I spoke with some of the people in Germany and their concern with the KWU reactor, that you can get yourself into a situation with a leak size and your accumulator flow and your steam generator all balance; and as a result, you wind up uncovering the core, or part of the core.

Is the US, the Westinghouse reactor different and is this particular circumstance impossible?

Or am I not understanding something?

MR. JOHNSON: Bill Johnson, Westinghouse.

Yes, we have looked at that situation for Westinghouse plants and you will reach a quasi-static state situation for a small break.

But if one looks at the Sequoyah ECCS flow rate for a half-inch diameter break, it is just slightly larger than the largest break size for which charger flow does not make up break flow; you find that at about 1400 psi.

The charging pumps under minimum safeguards configuration with one line spilling with a flow in excess of 2,000 psi, and the hot head safety in' :tion flow, cutoff heads, about 1500 psi.

There would always be sufficient flow to cover.

Now an analysis for another typical Westinghouse plant, a similar four-loop plant, even a higher power rating we didn't even take credit for charging flow; and we found flow rate at around 1400 psi with a shutoff head and high injection pump, was about to become uncovered for that break size.

Because we had safety injection flow up to that pressure it was not a situation where you could have a pressure above that which would allow safety injection flow to be delivered.

MR. CATTON: I think I understand you.

DR. MARK: Yes.

VOICE (FROM STAFF:) When you get down to a small break the heat is being removed from the steam generators and blowing through the safety valves. The 1400 psi corresponds to -- well 50 psi setpoint (inaudible.)

MR. CATTON: I see.

I have a couple more questions.

I am not sure if this is the place, but in looking at the agenda it seems to me the only place.

Are you going to comment on the -- what happens during the initial stages after the pipe break, when the expansion wave is traveling into the core; in particular what happens to the fuel as the expansion wave passes across it? What's it's magnitude?

MR. JACOBS: I think Dr. Esposito can answer that.

MR. ESPOSITO: I would attempt to answer your concern, Dr. Catton.

To try to put the question into perspective, just to make sure I understand it:

We have a pressure wave coming in due to the break in the pipe, the pressure wave, the pressurization -- the depressurization wave -- enters the downcomer and travels around the downcomer and down.

We modeled that situation using the multiplex computer model which accounts for fuel interactions.

Is the question being asked: have you accounted for the direct propagation of the wave accoss the bound?

MR. CATTON: That's correct.

You take credit for movement of the core barrel, and calculating -- well, if you take credit for one, it seems to me you have to consider the latter.

MR. ESPOSITO: Okay.

We -- you've raised this question before --

MR. CATTON: And I have not yet had an answer.

MR. ESPOSITO: And to that end we have performed some calculations where we represented the barrel as an infinite cylinder, and applied the oscillation to that barrel.

We then through an analytical solution, using potential flow theory, we were able to calculate the pressure gradient interior to the barrel -- if you wish, the water inside.

When we did this calculation the results came out that you had an additional load on the fuel which amounted to some 4 or 5 percent of the maximum calculated blowdown.

This load however occurs early in time. Peak load occurs around 100 milliseconds.

And load due to the direct pressure wave through the barrels occurs in about 20 to 30 seconds.

And as I said its effect was about 4 or 5 percent.

We have not taken any benefit in that calculation for the decrease of the pressure load on the barrel, because if we can have direct penetration through the barrel, instead of having the wave travel around the circumference of the annulus, you decrease the pressure load across the barrel rought by two over pi, or about 30 percent short of the time the maximum delta p would exist across the barrel, which would even reduce the loads for the multiplex calculation.

MR. CATTON: I understand — but is it possible to see it?

MR. ESPOSITO: I can show it to you sometime during the day.

MR. CATTON: Fine.

DR. MARK: Questions?

MR. CATTON: One more question, if I may?

I have asked this question before, as well, about the characteristics of the steam generator during blowdown following a pipe break, in particular I am interested in the flow stabilities that may occur in the steam generator, and possible damage to the steam generator?

If breaking up the tubes doesn't do anything, I am not interested.

MR. ESPOSITO: Dr. Catton, I believe this was also discussed in the McGuire hearing, and it was referred to as a generic question that was to be answered at some undefined future date.

It was also discussed at Diablo Canyon and referred to in the same vein, that is, it is a generic question to be answered at some future date.

MR. CATTON: I am just asking if it's been answered.

MR. ESPOSITO: The future date has not arrived yet.

MR. CATTON: Thank you.

(Laughter.)

DR. MARK: Is there in fact a future date?

MR. ESPOSITO: We have not made any specific plans.

DR. CATTON: There were specific plans alluded to in the McGuire meeting.

MR. ESPOSITO: I am not aware of them, Dr. Catton.

DR. CATTON: Dr. Cermak was the one who alluded to them.

I believe at that time you were not the person in the responsible position.

MR. ESPOSITO: That's correct.

(Laughter.)

MR. JACOBS: If there are no further questions, the next speaker, I believe, is Dr. Langlau.

DR. LANGLAU: Yes.

DR. CATTON: I have a question I think for Westinghouse and the fellow up here looks like TVA.

DR. MARK: How could you tell?

(Laughter.)

DR. CATTON: This again relates to the fill load on the vessel, and as I understand it the annulus pressure build up following a LOCA calculated using the TMD code -- now I have sort of a generic concern:

When the basically one-dimensional models are used to make calculations of a multi-dimensional phenomena, particularl when I see no data to demonstrate; is somebody from Westinghouse who would like to make a comment?

MR. ESPOSITO: I would like to make a comment, Dr. Catton.

There are some pieces of data that are available, the TMD code in particular.

There was a configuration which had a shortened ice bed of full scale baskets tests performed, where we had a blowdown into a volume that was consistent with the geometry of the containment used in TMD as compared with the results on that particular program.

There are a number of explicit conservatisms that are in that code which we feel definitely bound the situation comparing the 1-D code with the 2-D code.

More recently we have been made aware of the comparisons that were made between a TNB FITE pipe(?) (phonetic) code and the DECON code from the Los Alamos people.

MR. CATTON: DECON code is Idaho.

MR. ESPOSITO: Idaho.

And DECON code does have an exclusive representation of the multi-dimensional flow phenomena, and some comparisons have been made between the TNB pipe code and DECON code, and from the information that we had, there is about a factor of 2 difference between the pressure drops depicted by the TNB code and the more sophisticated multi-dimensional

DECON code.

MR. CATTON: Could you give a reference to that information?

MR. ESPOSITO: I do not have it here. I can get it to you.

MR. CATTON: Okay.

DR. MARK: Which direction is that pressure?

MR. ESPOSITO: The TMD code is more conservative than the multi-dimensional type.

DR. MARK: Gives a bigger pressure drop.

MR. ESPOSITO: That's correct.

MR. CATTON: Which in some circumstances is surely in the proper direction.

You realize that the annulus is -- turns on a flow kind of problem.

I have another question as long as we are talking about TNB.

Table 6-2, page 6-11 of the SER, there's a comparison of pressure drops across several different pieces of structure, a deck plate for one; and I notice you go from one node to six nodes, the delta-P first increases then deceases and all of sudden the number of nodes at six just stops.

And it stops after an increase of 3.3 psi in going from five nodes to six nodes.

It seems to me that that's an indication of no conversion, and that will not continue much further before you can conclude anything.

MR. ESPOSITO: We would like to dwell a little bit on that question and respond to you later.

MR. CATTON: Fine.

VOICE (FROM STAFF:) What you are looking at in Table 6-2 is not a sensitivity study. This is results of analysis on the ice condenser transient response.

MR. CATTON: Why does five nodes differ from six nodes?

VOICE (FROM STAFF:) That is just control volume.

MR. CATTON: Okay, thank you; I'm sorry.

DR. MARK: Does that cover it at the moment?

MR. CATTON: Yes.

DR. MARK: Proceed, then?

MR. LANGLAU: Thank you.

My name is Langlau. I am a senior nuclear engineer with the Division of Engineering Design at TVA.

The next ten minutes or so I would like to present to you some of the special features we have incorporated into the design of the secondary containment at Sequoyah.

In the early days of our prior design we made a commitment to come up with a good secondary design for containment. And we think we have succeeded with the only containment in the country that has no containment secondary bypass leakage.

Let me explain:

(Slide.)

Figure 6.2-94 in the FSAR shows the primary containment, the annulus, the auxiliary building and outdoors.

It also shows all the possible leakage paths that occur.

Our objective was to eliminate path E -- as in "Edward" -- which is the secondary containment bypass path.

The first thing we did was to design a ventilation system to maintain the annulus at the negative pressure not only during normal power operations, but also during the entire duration of the LOCA.

This is to avoid out-leakage from the containment.

The safety system will provide will provide the circulation, hold-up, uniform mixing, and penetration.

I will return to this for a little bit more detail.

Next we put in a ventilation system in the auxiliary building to create an active pressure during normal operation and post-LOCA.

However, because of the large volume and various very conservative assumptions we made, there may be a slight positive pressure in the auxiliary building immediately after a LOCA.

It is about a quarter of an inch water gage, and about two minutes long in duration.

Of course we accounted for that in our offsite dose analysis by assuming a ten-minute bypass nor holdup nor filtration.

Before I change slides, notice that Path A -- A as in Able -- is from the auxiliary building toward the annulus, because the annulus is always more negative in pressure than the auxiliary building.

(Slide.)

Figure 6.2-2 in the FSAR shows as an example what we seek in our design to eliminate secondary containment bypass.

In most designs if the containment atmosphere leaks through a containment isolation valve, one of the isolation valves then close; the leaking proceed along the ventilation system, and travel up and out, bypassing the auxiliary building.

What we did was put in a third bar with signals from either safety trains to close and then let the emergency system create an active pressure in the annulus and have it, and pool the leakage through the leak valves, leakoffs into the annulus space, and be processed by filtration prior to release.

By the way the containment isolation valves are normally closed.

Another example is the central water cooling system which among other things supplies water to some essential air coolers inside the primary containment.

Perhaps we should note that these coolers have diesel power supply. It is a good system. I call it nonessential because they isolated from the primary containment and we do not take credit for it after a LOCA.

Now, even if the piping ruptures ins de the containme nt after LOCA and get the containment atmosphere leaks through the containment isolation valves, we do not want the leakage to come directly to the river through the piping bypassing cleanup systems.

By paying attenticn to the system design and the routing of the piping, we make sure that the head of the water column just outside the isolation valves is always higher than the containment pressure; therefore, if there is any leakage, it would be inleakage rather than outleakage.

In some cases especially for the supply lines there is some system pressure to further increase the water pressure outside.

Let me point out that although the idea of water column outside is a good one, it was made practical because the containment pressure is only 12 psi gage.

If there are no question on my presentation so far, I would like to return to the emergency gas treatment system and the auxiliary gas treatment system building design and talk a little bit more about some design features and assumptions used in the design.

The annulus space is maintained by non-ECCS systems and minus five inches of water gage pressure during normal power operations.

The safety break emergency gas treatment system is started only upon an ESF signal. That way the emergency gas treatment system filter is fresh and clean.

Immediately after the LOCA the growth of the sealed containment due to internal pressure and thermal expansion is assumed to be instantaneous, causing a sudden jump in the annulus pressure.

The annulus is heated up due to heat transfer through the steel containme nt, again causing a pressure rise.

However, the pressure never get above minus-quarter-inch water gage, even with assumed delay in operation of the emergency gas treatment system due to diesel startup.

The constant negative pressure in the annulus plus the holdup, recirculation, mixing and filtration are the keys to a good secondary containment design.

In fact, it is hard to see how you can do better.

The auxiliary building gas treatment systems cover such penetrations as equipment hatch, personnel locks and through transfer tubes, and also cover the spent fuel pool area.

The fact that the equipment is not conveniently open directly to outdoors indicates that if a decision to minimize bypass leakage is to be made, it should be made very early in planning and layout.

T he short duration during which the auxiliary building secondary containment at pressure positive is mainly due to the assumed delay in switching from a nonsafety system to diesel powered safety system.

It is also due to various conservative assumptions such as heat load inside a building, heat from outdoors in hot summer days, maximum wind load, et cetera.

In all likelihood the building would remain negative in pressure.

This we believe is a rather good and unique design feature.

This is the end of my presentation.

MR. CATTON: I have a couple of questions.

After your test on this system, I believe there were two aspects — there is level sensors in the sump in the vortex; there are level sensors in the sump; are there level sensors above the sump?

If I recall the height at which vortexing started it was something like 8 feet or so. If you have a leak, how do you know it?

And do you plan to put level sensors in? Or do you just assume that there will not be a leak?

MR. LANGLAU: You are referring to leak inside to outside?

MR. CATTON: Yes.

MR. LANGLAU: We have leakage detection system, but that is for normal operation.

MR. CATTON: What do you do so that the operator will know that there is sufficient water in the pool over the sump to preclude gas ingestion?

VOICE (FROM WESTINGHOUSE:) There are four level sensors that are spaced in a 90 degree arc around there, so an operator does have indications of this.

MR. CATTON: Can you indicate what the level inside the crane wall is?

MR. LANGLAU: Those are the post accident monitoring system? Yes, also used for transfer of injection.

MR. ZUDANS: My question is as follows:

What -- how do you determine the sizing of this system that's supposed to maintain negative pressure in the annulus.

And other part of the same question is

During the containment leakage test, are you going to check out the system for its capacity?

MR. LANGLAU: Yes. We assume a leakage rate and we tech spec the value; we do operational tests to make sure the system can get that pressure.

MR. ZUDANS: I understood you are testing the containment now?

MR. LANGLAU: Yes, sir.

MR. ZUDANS: And is that evacuation of the annulus included?

MR. LANGLAU: No, sir.

What we are doing now is the primary containment leakage rate, leakage outward; and the test on the secondary containment, you know, the ability for the emergency gas treatment system and auxiliary building emergency gas treatment system to hold negative pressure in those buildings, is not part of that.

It is a separate test.

MR. ZUDANS: Is there a test to check the amount leaking in the annulus if you maintain five inch negative pressure.

MR. LANGLAU: Yes, sir.

MR. ZUDANS: Okay, good.

Now, this picture you showed, do I understand your leakoff system will maintain negative pressure; and you are sure there's no outleakage?

MR. LANGLAU: Correct.

Basically you just open a flow path into the annulus so that, you know, so that whatever leakage through the first tube, main primary containment isolation valve, then into the annulus.

MR. ZUDANS: If you maintain it negative.

MR LANGLAU: Yes.

MR. ZUDANS: With respect to the other side.

MR. LANGLAU: Most negative point in the plant.

MR ZUDANS: Okay, thank you.

MR. CATTON: I understand there are two check valves between your high pressure system and low pressure system? And in the SER it talks about a test procedure.

Would you in a couple of sentences describe this for me?

VOICE (FROM TVA:) I am vaguely familiar with it, not in detail.

I'll check on it and let you know.

MR. CATTON: Thank you.

DR. MARK: Are there further questions?

(No response.)

MR. GILLELAND: Next is by Mr. Popp, ice condenser loading.

MR. POPP: Gentlemen, at this point the ice condenser is completely loaded with ice, awaiting program completion, and we are in an operating program configuration.

We started cooling down the ice condensers last

August. We spent approximately eight weeks cooling down the ice condensers, trouble-shooting the equipment; started preoperational tests.

And during that time we ran through all of our procedures. We actually made the ice, trained our personnel, until in October we were satisfied that we had ice condenser temperatures and conditions that were compatible with supporting a permanent ice bed.

On October 24th we loaded our first basket. We had allowed 90 days for the filling operation. And in 83 days, on January the 15th of this year, we filled the last basket.

During that time we filled 1944 baskets with an average basket weight of 1529 pounds.

Now, we arrived at that average weight with two weighing programs.

The first program was part of the preoperational test. And in that program we weighed 222 baskets. This included 100 percent weighing in a single bay, and six randomly selected baskets in each of the other 23 bays; there are 24 bays.

This gave us an average weight of 1528.

A second program involved weighing 1122 baskets. And in this program we weighed 100 percent in two bays and better than 50 percent in each of the remaining bays.

Again we arrived at an average of 1529; it's interesting that there was only a pound difference, and we were conservative in the tests of the 222 baskets, which more closely resembles what our reweighing program will be.

Now, we were real pleased with the weights that we had in the ice condenser, but, of course, we realized a high average weight was only good if we had good distribution.

So I have a plot of the average basket weight --

(Slide.)

-- per bay that I would like you to look at.

The average weight, 1529 (indicating) and you may notice the first bay here with 1523 pounds; that was our initial filling, and we were running a little bit there.

We experimented with ice, and we were lower; that won't happen to us again on Unit 2.

But after that we came up, we pretty well stayed within the curve.

If you look at this closely you'll see that the spread -- well, this is below the spread (indicating) 1503 to 1529, but the rest of them were less than 20 pounds.

If you take the first eight bays, one through eight, and nine through sixteen and then seventeen through twenty-four, you'll find that the average basket weight varies by ten or eleven pounds.

So we feel we have good distribution as well as good basket weights.

DR. MARK: What is the weight or an average weight that would raise concern? Below 1500, or what?

MR. POPP: 1400, below 1400.

DR. MARK: You -- oh, okay. On this graph that lower line is the one at which you would be outside of specification if you went below?

MR. POPP: If the average weight was below that; yes.

MR. CATTON: If weight starts to get low, how easy is it for you to go back in and refill that particular basket?

MR. POPP: It's not easy to refill that basket.

But there is a process of adding chilled water to the basket, whereby we can change some weight.

MR. CATTON: Has that process been worked out so that you are confident in it?

MR. POPP: It's been used at D. C. Cook and McGuire, I believe.

MR. CATTON: If you add chilled water, doesn't that sort of just freeze the whole mess together, in a solid chunk?

MR. POPP: Yes, you add water to the top. Of course, you have a 48 foot column of ice; and you add water to the top 12 feet.

MR. LAMBERT: The whole column after a period of time after loading, it depends on how well you've kept your temperature conditions within the bay; but it does freeze to a solid column before you ever consider reloading.

MR. CATTON: Why are you concerned at the outset with the proper chip sizes?

MR. LAMBERT: In order to get good basket weight distribution, blowing those chips into the basket, the mechanics of chip sizes is correlatable to the effectiveness of the loading.

DR. MARK: Are these ice cubes or --

MR. LAMBERT: No, they are sheets of ice that are broken up into fragments.

DR. MARK: More like the ice in a daqueri?

(Laughter.)

MR. LAMBERT: They are 2 or 3 tenths of a centimeter in thickness, about 2 centimeters; they come in all sorts of irregular shapes. They get broken as they go into smaller chips.

DR. MARK: I see.

MR. ZUDANS: I seem to recall sometime in the D.C. Cook history there was a concern of not having a solid block of ice, because of the possibility or creating a channeling effect in discharging LOCA through ice baskets, and therefore creating dramatic results.

Have I missed some research on the concern about solid ice?

MR. LAMBERT: I did not know they were concerned about solid ice. There is a concern, you have baskets that are grossly underweight in a particular area, and therefore you get a maldistribution of flow during the blowdown transient.

MR. ZUDANS: When you calculate with today's technology the conditions, we assume the ice basket is in a solid section of the flow and heat transfer only takes place on the outside surface?

Or do you assume heat penetrating the core of that ice?

MR. LAMBERT: It's only on the outer surface, that's the assumption.

Of course the analysis is conducted with minimum ice basket weight which is lower than tech specs.

MR. ZUDANS: In that case it would indicate solid blocks to begin with would be acceptable.

MR. CATTON: You'd probably have trouble getting them in.

(Laughter.)

MR. LAMBERT: It is 3 million pounds of ice.

MR.CATTON: What do these solid -- let me back up for a minute.

Heat transfer coefficients were measured very early on in this program, and I believe those heat transfer coefficients were measured for the chipped or shaved or ground-up ice.

Now we are hearing about solid blocks of ice, and it seems to me that either -- you have to do something. The heat transfer coefficient is going to be the product of heat times the area; and your area has significantly changed. I don't know what the heat transfer coefficient is now.

It just seems to me it's different.

VOICE: I participated in tests that were run to clarify the heat transfer. There were different kinds of ice that were investigated, all the way from ice cubes to shaved ice.

What was found as a result of those tests was it was very effective heat transfer regardless of the kind of ice you used.

So it's not a real concern.

MR. ZUDANS: You used solid blocks?

VOICE: I don't believe there were solid blocks.

MR. ZUDANS: Then you really don't know.

DR. MARK: Staff?

MR. SILVER: I think it is improper to characterize the baskets as solid blocks. It's flaked ice.

MR. CATTON: It was.

MR. SILVER: Flaked ice in the baskets, and as time progresses the ice flakes go together; they are solid in that sinse and they are fusing together. There are porosities and air gaps, so forth, in the ice itself.

DR. MARK: Did they conclude the idea of putting chilled water on top of the consolidated chips was okay?

MR. SILVER: I don't recall, I don't believe they did.

VOICE (WESTINGHOUSE:) The heat transfer was so good -- that's the major point. You are really talking about third and fourth orders of facts, compared to how quickly the steam condenses.

MR. ZUDANS: It's fair to state if you just consider the outside surface of the mass as the only heat transfer available you still have a margin.

VOICE (WESTINGHOUSE:) That's correct.

DR. MARK: Further questions?

(No response.)

MR. POPP: We feel we have a good ice flow, and part of that is because there were people who went ahead of us. We had people watch ice floating at Cook and McGuire, and we learned some things to do and some things not to do.

We know from them that access into the ice condenser will affect ice bed temperature. When we were loading ice, we had built port able air locks at the exit.

But after a week or two we noticed ice bed temperatures going from 15 up to 16, to 17, getting to 18; so we put guards at the exists and a sign-in, sign-out log; and immediately temperatures started turning down. We are at 11 degrees now, and holding.

DR. MARK: Would you think the people at Cook and McGuire are in a position to benefit from your experience?

MR. POPP: That's difficult to say, sir. We did benefit from their experience.

I guess I couldn't quite answer that.

We did give it very close supervision in moving baskets.

DR. MARK: If they should ask they would be able to get your comments, I presume?

MR. POPP: Absolutely.

MR. LAMBERT: We have joined in a joint program -- maybe "program"may be too formal a word. We are in communication about the ice condenser.

DR. MARK: Right.

DR. CATTON: I was just going to ask one more question:

I don't recall from D. C. Cook analysis -- maybe it's just my lack of recollection -- what happens if the bays that are close to the break, if your heat transfer is as high as you have indicated, the -- most of the flow will go to the bays where the steam is the highest.

Now, once patterns like that are set up they may persist.

And I don't know if maybe I just don't recall or what -- where is the analysis of this particular kind of phenomena?

VOICE (WESTINGHOUSE:) I don't have the details of the Cook analysis or McGuire.

MR. CATTON: When you are looking at the annulus that the break flow is into, do you assume it's homogeneous or do you have a distribution of steam and water as you go around the annulus?

VOICE (WESTINGHOUSE:) Very early in time the distribution due to the pressure gradient, the bays closer to the break get more of a floww

MR. CATTON: That wasn't the question.

The quetion was: the steam content, is the one adjacent to the break much higher than the others?

Or do you just assume -- how do you handle that?

VOICE (WESTINGHOUSE): It's a number of nodes in the content flowing into the ice bed closest to the break you have more water initially, but since we assume a homogeneous flow, 100 percent entrainment later on, water will tend to get to the other bays farther away from the break.

MR. CATTON: Maybe t he 100 percent entrainment is too high.

Has the sensitivity to this been looked at?

VOICE (WESTINGHOUSE:) I am not aware of the particular study.

I know we do maldistribution studies with the ice bed. That's the same kind of thing that you are leading to with the question.

MR.CATTON: Yes.

VOICE (WESTINGHOUSE:) I can get you the details of that.

MR. ZUDANS: In the same vein, I remember that there were a significant amount of studies made as to which of the doors open and whatnot.

Have you done something to time the bays? Have you reached the point where you can assure that all bays will open?

Or are you attempting in some way to sequence the opening in order to balance the asymmetry?

VOICE (WESTINGHOUSE): All doors are set at the same tension.

MR. ZUDANS: You have to have something to assure uniform opening?

VOICE (WESTINGHOUSE:) It's on the order of a few tenths of a psi.

MR. ZUDANS: Is there any difference in the design of this door and D. C. Cook's door?

VOICE (WESTINGHOUSE:) No, I am not aware of any.

MR. CATTON: When you calculate --

MR. ZUDANS: Are there baffles behind the doors?

VOICE (WESTINGHOUSE:) Steel structure.

MR. CATTON: When you calculate the door opening it seems to me the initial door opening is the starting pressure, but once the door starts to swing open, the dynamic load is going to be different than the static load.

Isn't there a chance that the first door that opens may be the one that stays open?

VOICE (WESTINGHOUSE:) The other doors open, too. There's a pressure gradient across them.

MR. ZUDANS: I can't quite visualize it.

MR. LANGLAU: You must be aware that in the low er compartment - now these doors open up at pressure about 2 pounds psi. So basically, you blow on it, and you open it.

All the doors do open in case of LOCA.

TVA did contract out five, six years ago, to Battelle Northwest, to look at issue. They used special computer code; they have concluded no maldistribution pattern.

We were satisfied with that.

MR. ZUDANS: Well, in that calculation was differential and vertically, too. I remember Westinghouse analysis. But did you include all the obstacles that existed in that compartment or was it assumed to be empty compartment? That would be the one that would create maldistribution more than spreading of the water. There might be impact and deflection because of that.

DR. MARK: Let's see if I understand this:

The calculations just referred assumed an arbitrary hypothetical maldistribution?

MR. LANGLAU: No, no. They modeled the three-dimensional state. And the maldistribution analysis is not necessarily conservative.

DR. MARK: I see.

VOICE (WESTINGHOUSE:) In our analysis we conclude K-factors.

MR. ZUDANS: What do the K factors represent?

VOICE (WESTINGHOUSE:) The flow resistance that occurs from the piping and all the other -- he's referring to a different study, you know.

MR. LANGLAU: We used same kind of K factors, but not so detailed.

MR. ZUDANS: I guess you are correct in the information you gave me before. They did consider it.

DR. MARK: All right.

MR. CATTON: What about wing loading on the doors, the lift on the door; is this a part of the model?

VOICE (WESTINGHOUSE:) Vertical.

MR. CATTON: I may be mistaken here.

DR. MARK: Staff?

VOICE (STAFF): The doors are designed to open with a very very light push. Once the cold head behind the door is removed then it only takes about one pound per square foot to move it. You are talking about infinitesimally small pressures.

The flow is spread throughout the whole lower compartment volume. And there are springs on the doors so in the later stages of the blowdown the doors are then proportionately closed, all to the same proportion.

MR. CATTON: The doors are tied together?

VOICE (STAFF:) They are not tied together, but they have all the same spring-loaded closing forces; they all have the same characteristics.

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DR. MARK: All right. Are there further questions of Mr. Popp?

(No response.)

MR. POPP: Thank you, that completes my presentation.

DR. MARK: I guess if that's the case --

MR. GILLELAND: Dr. Mark, on that previous question --

VOICE (WESTINGHOUSE): There's just a few tenths of a psi required to open any of the doors, and that loading is the same for all doors.

Even if you postulate that one door opens first, and the other doors are closed, the pressure increase in the lower compartment all the way around exceeds those few tenths of a psi; so all the doors will open.

DR. CATTON: Gee, that would have been a fine answer at the outset.

(Laughter.)

DR. MARK: I guess that completes this topic, which is to the point where we were going to have a break for lunch anyway.

I would suggest we recess the meeting until one o'clock.

(Whereupon, at 12 noon, the hearing was recessed, to reconvene at 1 p.m., this same day at the same place.)

AFTERNOON SESSION

(1:00 p.m.)

DR. MARK: The next topic is a discussion of seismic design criteria; and it calls first for a presentation by the NRC Staff.

MR. SILVER: Yes, Mr. Chairman, we have a number of representatives in the geosciences area; Dick Denise and Bob Jackson are here and will be available to discuss any pertinent aspects of this at any time.

Leon Reiter of the Geosciences Branch will make Staff's presentation, and we will have comments by other people after that.

MR. REITER: In our review for the construction permit and safety evaluation report, we concluded after a good deal of investigation, that there were no structures locally or regionally that could localize seismicity or that could somehow cause fault displacement.

As a result the controlling earthquake for the Sequoyah plant site was determined to be the largest earthquake within the techtonic province within which the plant was located.

(Slide.)

Here is a outline map of the techtonic province, and this is the southern valley and ridge techtonic province; this direction is north (indicating); the red dots represent

Sequoyah site; the black dots represent other TVA sites in the region.

And this represents (indicating) the location of the controlling earthquake, the 1897 Giles County earthquake.

The distance to Sequoyah and the 1897 epicenter is some 285 miles.

DR. MARK: How well is that location specified, Giles County?

MR. REITER: It's specified in epicenter data; there's no instrumental recording -- at least, I'm not aware of any. That's where the peak intensity was.

DR. MARK: As determined and felt?

MR. REITER: Right, as with all other historical earthquake data, we go back and look at maximum felt effects.

Since that time, since the construction permit review, we've examined records and maps and borings of the excavation at the site; there have also been several additional plants that have been located within the southern valley and ridge techtonic province, the plant at Phipps Bend, Watts Bar, Belefonte; and there is included in their PSAR's extensive regional evaluation.

Well, the result of all these additional regional and local evaluations still has not changed our original evaluation that there is no structure that is localized seismicity or structure that could possibly cause fault movement in the site vicinity or the region.

And that the controlling earthquake would still be the 1897 Intensity-8 earthquake.

During that time, however, some things had changed and what has changed was the way we would characterize the motion from an intensity-8 earthquake.

Here is an example of what I am talking about --

(Slide.)

-- this is a response spectrum. There is this Period on the bottom going from small periods to large periods, and this is a tripartite plot; the vertical is velocity, inches per second; leading off to the left it's accelerations in G; leading off to the right, displacement in inches.

The wiggly line here represents the design used in Sequoyah, while the heavy straight line represent the design used in a plant which had just undergone the review event.

This plant, the straight line, this design spectrum was put together using the procedure outlined in the standard review plan. That procedure is simply taking the mean of the intensity versus acceleration relationship, as put forth by Trifunac and Grady, and combining that with the Reg Guide 1.60 spectrum.

The Sequoyah design -- this procedure had not yet been outlined, and the applicant used modified versions of a different intensity-acceleration relationship for Richter, and a different response spectrum.

So although the controlling earthquake had not changed, the way we had characterized it has changed.

In other words, we have different peak accelerations or reference accelerations, and different response spectra.

DR. MARK: On your previous map, where is Bellefonte?

MR. REITER: Okay.

(Slide.)

There are some other spectra shown here, Watts Bar and Bellefonte -- and if I am correct, I think -- Bellefonte is down here (indicating).

Watts Bar is over here (indicating).

On this map the Giles County earthquake is off the map.

DR. MARK: Right, yes.

The spectra chosen for Phipps Bend, which is the closest of the plants?

MR. REITER: Well, we are showing here several plants, following the philosophy of techtonic provinces approach.

DR. MARK: All right.

We've moved the earthquake from one location to other?

MR. REITER: Right.

If you notice, it's intermediate between Watts Bar and Belefonte; and the Phipps Bend represents licensing practice considered at the time of their licensing.

Sequoyah represents the procedures at that particular point; and Phipps Bend represents that outlined in the standard review plan.

As a result of these differences, we asked the applicant -- we considered it necessary to accept the differences and determine the adequacy of the present design.

TVA, the applicant, came back and they argued that the present design was adequate, and based on several reasons:

One, they said that the maximum intensity 1897 Giles County earthquake was really a 7-8 rather than 8.

Two, they said, they argued, that the intensity ratings for the 1897 Giles County was soil biased; in other words, the maximum intensity occurred in a region of soil cover, while the Sequoyah site was in a region in which the structure founds on rock; and it was consistent to start with information which consistently shows that you get higher damage on soil than on rock.

Therefore, the intensity was soil-biased.

Three, they argued that the intensity-acceleration relationship put forth by Murphy and O'Brien was more appropriate than that found by Trifunac and Grady, which would result in a lower peak or reference acceleration.

And, fourth, they argued that at foundation depth earthquake produced ground motion was less than at surface.

We recognized there was some validity in these points, but we also found there were sufficient problems associated with them, to preclude their use in justifying the adequacy of design.

For instance, with regard to the true intensity of the Giles County earthquake, for previous plants we had asked a special panel of the U.S. Geological Survey, to reevaluate the 1897 earthquake.

And while some of the people in that panel felt it might be better classified as a weak 8, as a result the panel said that this indeed had been an 8 earthquake.

With respect to the soil bias, this argument has appeared and has been observed by many in the literature; however recent evaluations of spectrum for different intensities, for earthquakes of the same magnitude at the same distance, for different sites, indicate as a period of interest is a period of less than half a second; the motion on the rock site might actually be greater than the motion on soil site.

Third, with regard to the Murphy, O'Brien relationship, we felt that while the Murphy, O'Brien relationship may be statistically more correct in that they are assumed to have a larger sample, and it used procedures which might be more correct than the Trifunac and Brady relationship, this does not necessarily mean that this is a better relationship to use in predicting reference acceleration; and the Trifunac and Brady was not necessarily overconservative.

For example, Agabasian (phonetic spelling) and Associates did a study for Department of Energy in which they compared the response spectrum associated with different intensities to various design procedures.

And in that case they found that the mean of Trifunac and Brady and Reg Guide 160 that compared to the intensity data they had, usually did not exceed the mean plus one sigma at periods of interest.

And we felt that this was not overly conservative. And, therefore, in using as a reference acceleration, we did not feel that Murphy, O'Brien at this point supplants Trifunac and Brady.

And finally, with regard to foundation depth, and reduction with depth, taking into account reduction in dept. over shallow soil deposits, is a tricky procedure; and in the past both the ACRS and the Staff had suggested this not be done, particularly in cases such as Davis-Besse.

The Staff, in order to help itself to evaluate what the situation would be, put together a working group and this was a seismologist, engineers with private management, to see if we come out with approaches, recommended approaches, that helped assess the differences between the various design spectrum.

After a good deal of analysis in which we considered most approaches, we came up with five approaches that we thought would have value.

And one of these, the first one, was:

Determine site-specific response spectrum from strong motion records of appropriate magnitude and distance.

The second would be to determine site-specific response spectra from strong motion records of appropriate intensity.

The third would be a non-seismological one: it would be to reevaluate the original seismic structure and floor response spectra analysis, taking into account more realistic methods, and material properties.

The fourth, we thought it was necessary to reevaluate the OBE to see whether it meets the criteria in Appendix A which talks about the reasonability of reoccurrence of an earthquake during the operating life of a plant.

And, fifth, we wanted to have a program to compare the probability of the site-specific earthquake being repeated at Sequoyah with that of the design and other plants, TVA plants, in the region, designed in accordance with the standard review plan.

The applicant, TVA, then submitted another report and after that there was more formal material sent to us; and today we are basing our review on that submitted report and the other material which was transmitted and has not yet been docketed.

And our review is based upon this material, and we are waiting final submittal of material that has been forwarded.

It is my understanding that TVA has done some additional work that they might present later on; but we have not had a chance to review that yet. It has not been submitted. We have not reviewed it.

And our conclusions are not based on any additional material they might have.

To sum up, I guess you might say that the aims of our review are threefold:

First, we'd like to make a realistic, conservative estimate of ground motion for the controlling earthquake.

Two, we'd like to compare this estimate with the existing seismic design.

And, three, we'd like to determine the significance of any difference that might occur between the two.

The first problem that had to be resolved was establishing the parameters of the site-specific earthquake.

Now, it had been listed as an intensity-8, but we felt that it would be better if we could get a more reliable and less controversial estimate of the earthquake.

By that I mean there had been controversy over whether it's an intensity-8, whether it's a weak 8, or an intensity-7-8.

And in conjunction with the fact that we had very little intensity-data, strong motion records, at intensity-8; and if I am not mistaken, none, in the Western United States at least on rock.

So we felt if we could go to a magnitude estimate, this might be better.

Lucky for us at this time several seismologists were developing techniques with which to evaluate intensity data, not just peak intensity, but the whole intensity data; in order to come up with estimates of magnitude.

Professors Nutwig (phonetic), Bollinger and Griffith, had come out with a paper that looked at several ways to evaluate magnitude, in which they started out with an earthquake for which they had both instrumental records and intensity data; they developed a relationship; then went back and looked at those earthquakes to get historical data alone.

And then they used these techniques and they observed data to predict what the magnitude was.

And they paid particular attention to the 1897 earthquake. And the two techniques which they found the most reliable, both came up with estimates of magnitude 5.87 for that earthquake.

We felt, we suggested that the range of magnitudes to be looked at were 5.8, plus or minus a half, or maybe 5.3 to 6.3.

So the next category we looked at was the distance, epicentral distance, in looking at that strong motion record.

And then a study was done for Central U.S. in which they came to the conclusion that maximum intensity was generally felt out to 20 to 25 kilometers.

So we suggested a look at records that are recorded at distances of less than 20 to 25 kilometers.

And finally, since the conditions at the plant were rock, we suggested that we confine ourselves to records which were recorded on rock.

Now, aside from taking into account the uncertainties in our characterization of the control earthquake, distance in magnitude, these ranges allow us to make sure we can get at least an adequate amount of data.

In other words, the idea was if we could arrive at some estimate without having to resort to some scaling procedure, then we would avoid a lot of controversial scaling procedures that appear in the literature today.

In other words, we'd just take this data and treat it as a data set for questioning the uncertainty and see what it would produce.

DR. MARK: Does it matter whether the thing is deep or shallow?

MR. REITER: We restricted ourselves to earthquakes which are crustal or midcrust to crustal size; not the deep earthquake.

The estimated hypocentral depth of the earthquake, the Giles County earthquake, according to Dr. Ballinger, was like 15 kilometers; and the earthquakes that we looked at were in that range.

Another problem that we were interested in were determining could we limit our examination to one particular case, or one particular material used in construction?

And the reason I say that is that in the day, when Sequoyah was designed, the damping values used at that time were more conservative than the damping value which we use today, as indicated in Reg Guide 161.

And we felt that if we looked at the case where the difference in damping was the least, then we'd be looking at so-called worst-case, which would exaggerate the differences between the present design and design the way we do it according to the site-specific earthquake.

So this turned out to be for reinforced concrete, where presently we allow 7 percent damping, and Sequoyah design 5 percent.

And we'll show some examples later on for other materials where the difference is larger.

So finally there are several soil supported structures at Sequoyah, but the applicant in designing those structures has used a very conservative technique, taking into account amplification and as a result with fewer amplifications of a factor of two or three times the original design.

For instance, something like .42G, instead of the .18G that we used for rock structures.

So in examining reinforced concrete we think we are looking at the so-called worst case, for the differences between the present, the design as it is now, and design as it would be using a site-specific earthquake.

Applicant went out and tried to put together as many earthquakes as they could that would fall within the parameters we suggested.

And these, in a sense there's six records from Western United States, and seven records from the very well recorded sequence of earthquakes in Italy in 1976.

And we ended up with 26 records, that is, 13 sets of horizontal components.

The difficult study was to analyze and determine as to what distribution these particular sets of earthquakes and the data would fit; and it turned out that lognormal seems to fit; and from the lognormal distribution the applicant then calculated the 50th percentile and the 84th percentile of the data set.

(Slide.)

This line -- some of you may not be able to se. it -- represents the maximum motion, and minimum (indicating), this represents the 50th percentile, the 84th percentile.

The first decision Staff had to make was what do we consider an appropriate level of conservatism to characterize the size of the earthquake.

We decided an appropriate level would be the 84th percentile.

The reason ve did this was several-fold:

One, in the computation of Reg Guide 160, although it was a slightly different method, the mean plus one sigma or the 84th percentile was the way in which the level chosen.

Two, in some site-specific studies we did in a supportive way the mean plus one sigma to get the implied level of testability.

And, finally, in a revision of the standard review plan, which is now undergoing review, the mean plus one sigma is the implied level of testability.

So we have said in this case the appropriate level would be the 84th percentile.

The next thing to do, we asked the Applicant to compare the spectrum of existing design spectra to that 84th percentile.

And here we have a plot of that.

(Slide.)

This bottom line (indicating) represents the 50th percentile; this dark line represents the 84th percentile; and this dashed line represents the present Sequoyah design.

So we see that the present design exceeds the 84th percentile at periods greater than 3-1/2 seconds -- greater than .35 seconds -- and at periods less than that the 84th percentile exceeds design.

DR. MARK: You don't show on there what happens to that design at 7 percent?

MR. RIETER: Well, no.

What we are doing is we are comparing it from a materials -- and it is an appropriate way to do, because the materials, if we were doing it today we would use 7 percent reinforced concrete.

But the applicant in looking at reinforced concrete used 5 percent.

So in order to compare it to the way we do it today, the way it was done, we have to compare it to a particular material.

That's why we chose to use 5 percent for Sequoyah design, and 7 percent for the rest of them.

And again this represents the worst case.

For other types of materials the differences are greater, such that this (indicating) would shrink down. I think maybe I'll be able to clarify that later.

MR. ZUDANS: Well, it really means that the present Sequoyah design as recorded there for 7 perdent, you would have larger red areas there than there are now?

MR. REITER: In other words if 7 percent was used in the design for reinforced concrete, then this red area (indicating) would be larger.

I am sorry -- it would be less.

(Chorus of "larger".)

MR. REITER: Okay.

If they used like 1 percent or 2 percent that would shrink away.

One way of looking at this is to plot how the Sequoyah design fits into the percentile distribution; in other words, here is the 50th, here is the 84th, and at .1 second, where does the present design lie? Okay?

At .06 seconds, where does the present design lie?

And here is a representation of that.

(Slide.)

Okay?

What do we have here? We have a plot of periods, short periods and long periods, and these are the percentiles, the 50th percentile and the 84th percentile. These are the percentiles as determined by our data set.

Plotted over that are where the present design spectra would lie -- and please excuse -- we have Belefonte and Watts Bar here, and we are concerned with Sequoyah.

We see that at periods less than .35 seconds, Sequoyah design falls below the 84th percentile.

You might say on the average in these periods it's around .the 74th percentile; and the worst-case is around .06 seconds, where it's at around the 67th percentile.

Turning to acceleration, the worst-case is such that it has an acceleration of .18G, while the 84th percentile is something like .28G.

MR. TRIFUNAC: A question?

MR. REITER: Yuh?

MR. TRIFUNAC: What is the fundamental period of the containment?

MR. REITER: Okay.

The periods that we are interested in are generally periods less than half a second.

And fundamental periods of containment are usually between 2 and 9 Hertz, which means .5 and .11 seconds.

MR. TRIFUNAC: But I mean Sequoyah?

MR. REITER: At Sequoyah.

I don't have a natural plot, but we have assumed that this (indicating) of interest; we have assumed that everything less than .5 seconds is the area we are concerned about. The fact that this is exceeded over here (indicating) -- there are no structures within this particular period.

Perhaps the people from TVA might answer that, be able to answer that later on, what the exact period is.

But we looked at and saw various fundamental modes between 2 and 9 Hertz, .5 and .11 seconds.

And there were higher modes at shorter periods.

To give you an example --

(Slide.)

-- in reinforced concrete, here is an example looking at welded steel.

And again, here is the 50th percentile data, here is the 84th percentile data; this dark line represents Sequoyah; and you see the situation is a lot better; and that the periods where there's less need for a percentile or periods less than .08 seconds, and the worst-case is around .95 seconds, around the 74th percentile.

So this is just to show that in the worst-case would be the reinforced concrete case.

DR. ZUDANS: Question at this point:

Is the 84th percentile line in this case the same as the previous graph?

MR. REITER: No. It's a different set of data.

MR. REITER: These are 4 percent damping data, because that is what we would use today. And the other was 7 percent damping data.

MR. ZUDANS: Okay.

If the 84th percentile line is -- corresponds to 4 percent, then?

MR. REITER: Right.

This corresponds to the data which we would use in evaluating welded steel structure today. The damping associated with that.

MR. ZUDANS: All right.

MR. REITER: Again, what we are comparing here is the way we would do it today, taking into account the site-specific earthquake and the damping with the way they did it then.

We think that's the appropriate comparison.

Applicant contends the way that we suggested is the inappropriate way, and they though it might be more appropriate to follow the procedures used in defining Reg Guide 160.

And that procedure said, let's take the acceleration records, the time history, scale them all to peak acceleration, and then compute the response spectra of those, and compute the 50th and 84th percentile.

In other words, you are taking the spectra and

and befc-e you compute the percentiles normalizing them, at very high frequencies in the same spectral accelerations; and when you do that, it turns out the Sequoyah design exceeds everywhere the 84th percentile.

We did not think it was appropriate in this case to do that because of the nature of the problem we were trying to solve.

Reg Guide 160 in trying to determine a standard spectrum shape, which can be moved up and down with various reference accelerations in order to take in to account different earthquake sizes.

And Reg Guide 160 was determined from earthquakes of different sizes, different epicentral distances, different site conditions.

In this case we are trying to pursue a site-specific earthquake. We are not after any particular shape. We are trying to get distribution of spectral accelerations at each particular frequency; and we thought that it was not necessary to go through the intermediate step, but we could treat the data directly.

The next question that came up was what was the significance of the differences? How do we assess them?

Now, we felt that the best way to do this would be probability. And the reason is the probabilistic technique represents open and systematic ways that arrive at a conclusion of assessing the differences.

Now there is some criticism of probabilistic techniques in the past and now in the Lewis (phonetic) report.

Specifically that report talked about over-reliance on absolute probabilities, it talked about lack of data, it talked about inadequacy of consequence models; in the earthquake field it talked about the inadequacy of structural performance apart from determining what the risk was; and in this study, however, we are not concerning ourselves with absolute probabilities.

We are concerning ourselves with the relative probabilities.

We are not concerning ourselves with structural performance; we are concerning ourselves with seismic hazard, that is, the occurrence of the earthquake.

And, finally, we in all cases are relying on data and in every step along the way we have seen, compared what the results are to what they should tell us, and conducted -- the applicant conducted extensive parametric tests to see what the effects of change in the various parameters would be.

In seismic hazard computations we had various types of inputs: one thing we need are the earthquake activity levels for the host techtonic province and that surrounding it; and these items (indicating).

And a critical assumption was the upper intensity cutoff, and there applicant assumed that the maximum historical intensity except in the host province was 9 rather than 8. They were trying to be conservative.

An additional factor you need is the intensity fall-off with distance, for this this we used the very well studied fall-off distance study of the 1886 Charleston earthquake.

Then you had to convert intensities to peak accelerations.

And in that case we used Murphy and O'Brien rather than Trifunac and Brady.

The reason we did this is for the very same reason that we didn't use it before, namely, this case we are not looking at one single value reference acceleration -- we could have used Reg Guide 160 -- but we are looking for a statistical well-distributed log from a large data set for correlation between peak accelerations and intensity.

And for this particular application we thought it might be preferable to to use Murphy and O'Brien. Trifunac and Brady in the original calculation does not estimate dispersion.

Four, peak accelerations were converted to spectral accelerations at selected periods utilizing amplification factors that we had found, or applicant had found or studied in the spectra.

And, five, each one of these parameters had associated with it a dispersion, not to say there was a one value or single value developed, but every factor of dispersion that was described by a standard deviation; and each one of these dispersions were combined in the final dispersion by standard deviation.

One way of looking at it: this allowed the existence of very large peak accelerations for practically any given intensity.

DR. MARK: Could I ask, you are now back to using intensities rather than magnitude?

MR. REITER: Right.

DR. MARK: Does that 9 go with the 6.3 magnitude?

MR. REITER: It's hard to predict -- there are various kinds of relationships to what might go.

DR. MARK: Well, you used one already to --

MR. REITER: But, no, there we did not use any correlation between peak intensity and magnitude.

There we went to this specific earthquake, and said, let's not worry about the peak intensity; let's look at the distribution of intensity over the whole area.

Let's take a look at the way that intensity falls over distance.

Let's take a look at the way the intensity described in the total epicentral -- what they call the isosizamal fault area -- let's look at a total belt area.

Those are the kinds of ways we arrived at intensity 8, not the simplistic conversion from epicentral intensity to magnitude.

We tried to avoid that.

And in this case we are trying to compute it using intensities and converting intensities to acceleration by conversion.

Now, theoretically, if we had analyses, like the 1897 earthquake, for a whole series of earthquakes in the Eastern United States, and we could do this whole technique, program, directly in magnitude rather than intensity.

But we don't have that.

DR. MARK: Okay.

Well, another question: that phrase in the heading, "seismic hazard" -- it's a rather frightening picture; what does it mean?

It means the probability of exceedance of some estimates made with a particular set of data?

MR. REITER: Seismic hazard is used here in contrast to seismic risk.

Now within the engineering and seismological community we tend to separate those two.

Seismic risk refers to the danger that might occur because of an earthquake occurring and the collapse of some structure.

It's not only the earthquake occurrence, but it's the consequence.

Seismic hazard, on the contrary, refers just to the earthquake occurrence alone.

In our particular case it's the hazard associated or the risk associated with a particular spectrum being exceeded.

DR. MARK: All right.

Well, it's a probability, is it not?

MR. REITER: Right.

DR. MARK: To perceive some spectra?

MR. REITER: Right.

DR. MARK: And the spectrum is something that you have manipulated?

MR. REITER: Right.

DR. MARK: Which may or may not be hazardous?

MR. REITER: No.

Hazard is used in a relative and not in an absolute way. Hazard could be very low and it could be very high.

DR. MARK: I think it's a phrase that bothered me in reading the SER a great deal. It was made clear in a couple of places that it didn't -- shouldn't be correlated with risk, but only a comparison of two procedures.

MR. REITER: Right.

DR. MARK: The chance of exceeding some assumed --

MR. REITER: Right.

DR. MARK: -- specification; a specification that's very complicated.

MR. REITER: Right.

Well, I guess we could say that risk also can have negative connotations. There are risk calculations, but the risks being very low. You have a calculation how it can be very low and how it can be very great.

But in recent years there have been attempts to separate the two.

DR. MARK: All right.

If this is very firmly understood and it's very specific, non-dictionary significance, that's fine; I guess. As long as it's understood by everyone.

But I am sure it won't be by Mr. Cronkite.

MR. ZUDANS: I'd like to ask in the same vein:

According to your explanation I understand how the -- it's synonymous with the probability of exceedance?

MR. REITER: Right.

MR. ZUDANS: So why didn't you use probability of exceedance?

MR. REITER: Because "hazard" is a one-word way of saying the same thing.

MR. ZUDANS: But "hazard" has an implication, and that implication is not very nice.

MR. REITER: Excuse me, but I have just used a term which is in wide use in the engineering, seismological community.

And there is some sort of a clarification. We don't mean the connotation of a hazard.

DR. MARK: I think there's a case for a little concern here. Maybe every other time the phrase is used, there should be an asterisk and a footnote at the bottom of the page that says what is meant.

(Laughter.)

DR. MARK: And any document that should fall into the hands of people who don't know, would at least understand the phrase.

(Laughter.)

MR. REITER: The probabilities of exceedance for hazards were computed with input parameters and a hazard code put together by Ross McGuire. It's a very widely used curve, code, and has been studied extensively.

And here are some of the results that would come out from those computations.

(Slide.)

And these represent a series of uniform hazard response spectra. And these hazard response spectra have numbers associated with them, 10^{-5}, 10^{-4}, et cetera; and this means that this response spectra indicated by 10^{-5} has a 10^{-5} chance of occurring, of being exceeded at the Sequoya site.

DR. MARK: In any time frame, or ever?

MR. REITER: This is annual hazard.

DR. MARK: Annual.

It excludes the possibility of earthquakes of intensity-10?

MR. REITER: Intensity-9. The site region takes into account intensity-9.

And by the way we did do sensitivity tests to look at the effect of various levels of cutoffs, looked at the effects of various occurrence rates; we looked -- applicant looked at effects of various G values, to see what effect this would have upon our results.

And I'll get to that in a minute.

There's a very important aspect to that, I'd like to point it out.

If we compare -- in other words, here are the uniform hazard response spectra and/or the various levels of design spe-tra that fit in in accordance with that.

And let me try and explain this complicated plot here:

These lines, these very simple lines, represent the simplified uniform hazard response spectra -- okay.

The dashed line represents the stress design. The heavy line represents the 84th percentile, what we call the site-specific earthquake; and again, the red represents the place where this earthquake is exceeded or where it exceeds the 84th percentile; and finally applicant also put in here a fifth band curve which is the procedure outlined in the present standard review plan.

To get an idea of where we are in terms of absolute hazard, the present design falls in the periods of interest, which is about half a second; it falls somewhere around 10^{-3}.

The 84th percentile falls somewhere between and so does this (indicating).

10^{-3} and 10^{-4} are the kind of numbers that we get from other studies of seismic risk in Eastern United States for intensity 7-8 or intensity 8.

(Slide.)

This particular set of calculations, the Sequoyah design had an average risk of 9×10^{-4} or almost 10^{-3}.

The site specific earthquake had an average risk of exceedance of 4.7×10^{-4}.

And Phipps Bend, 2.3×10^{-4}.

Again, this range seems to be the kind of numbers we get when we do the different calculations using differant programs, alsc.

If we look at the relative value, the relative seismic hazard, that is the difference of the ratio -- then we find on the average -- it's the average of the ratio -- that the Sequoyah design is on the average, has twice the amount of seismic hazard associated with it than the site-specific earthquake.

Specifically this ranges from anywhere from .9 to 3.1; the worst-case being at .066.

In other words, a factor of like two to three between the hazards at the present design versus the hazards in the site-specific earthquake.

And compared to the Phipps Bend site, then the hazard at Phipps Bend -- or at Sequoyah -- is around five fives the hazard at Phipps Bend, ranging from 2.4 to 8.7; the worst-case again being at .067.

Well, there's some conclusions we might want to draw from this:

One is that factors of two or three between the present design and site-specific earthquake are really very small when compared to the absolute risk, which is somewhere of the order of 10^{-4}, 10^{-3}.

Another thing is if we would do a similar kind of evaluation for a whole string of plants in the Eastern United States, we would find that the variations were at least a factor of two and three, going from one plant to another.

In other words, the kind of variation we see here, factors of two or three, is not outside the probable variation for a plant in the Eastern United States.

We asked applicant to address what was the possibility that our data set might be incorrect?

In other words from the 26 earthquakes we put together, tomorrow another earthquake occurs, the next day another earthquake occurs that was in the magnitude and epicentral distance and site conditions we designed for, what effect would that have upon our calculation of the spectra?

And the applicant then took the worst set of records, and I mean the strongest set of motion on the record, and that was for a magnitude 6.2 event that occurred in Italy, and they took that data set, multiplied it by four, and added those eight components of the already 26 components.

So suppose we had an extreme case and all of a sudden we got a whole bunch of high records, and the 50th, the 84th percentiles were computed from that exaggerated data set.

And this heavy line --

(Slide.)

-- represents the 50th percentile, and this heavy line represents the 84th percentile.

Well, if we over-plot the present Sequoyah design in this, we see that although the position of this vis a vis the 84th percentile has changed, we still would fall above the 50th percentile and the worst-case, instead of being the 67th percentile, now comes down to about the 54th or 55th percentile.

We think this is an extreme case. Our examination of the data set at Italy and other earthquake sequences indicates that we don't get data that's only large or high or of strong motion; usually we get data that is both high and low and somewhere in between.

In that case you are really going to get -- you certainly will get records from strong ground motion, but you certainly will get records showing less and the same.

So this sensitivity test really tests and extreme case of the addition of high records alone.

To calculate the probability between the difference in seismic hazards between the present design and this newly-calculated 54th percentile in the average seismic hazard it's something like 5-1/2 times greater than the 84th percentile.

To calculate curves for what the OBE is, which in this case is one-half the SEE, and it turns out that it's somewhere between 150 to 300 years.

And the criteria for the OBE is Appendix A, it states it should be that earthquake which has reasonable chance of occurring during the lifetime of the plant, and we think that fits in that definition.

The next question I'd like to address is determination of records based on intensity.

In other words, suppose we try to compute a spectra based on intensity not magnitude?

And I think that if we did that, we went out and calculated what the intensity -- the records for intensity 8 earthquake would be, I think they would most likely be greater than that calculated for the maximum of 5.8.

For example, here are --

(Slide.)

-- here's one way of looking at intensity data, is to take the terms of intensity using Trifunac and Brady and Reg Guide 160, and we could characterize the various designs by how it would fit according to that procedure.

Well, the Sequoyah design for reinforced concrete would be approximately what we would expect from intensity 7, utilizing this procedure, Trifunac and Brady and Reg Guide 160.

The site-specific earthquake would be a practically 7-8.

And, of course, the Phipps Bend would be an 8.

So we have a difference between 7, 7-8 and 8.

And the question we tried to answer and it's not easy to do that, but we think we could point at some reasons as to what might be the difference.

One, there is little or no data on intensity 8, particularly on rock.

Most of the intensity acceleration curves are based upon recordi:ıg of larger earthquakes or more intensity.

Two, this Giles County earthquake, there is a strong suggestion it may have been a weak 8.

There are some people evaluating the earthquake suggested it's really hard to pinpoint that; we do know that in intensity evaluations of the Eastern United States somehow intensities have been carried out differently than intensity evaluations in the West.

In the East the evaluators often picked the worst-case or the case of the maximum epicentral intensity, while in the West, they very often take the mode of the intensity in the ipicentral region, and pick that our rather than the worst case.

And finally there is a difference in site conditions.

We think that the procedure which the applicant has done here represents a systematic way to take into account all these factors.

And we think that it ends up in a better way of depicting ground motion for the reoccurrence of the 1897 earthquake.

Now, to summarize our conclusions --

(Slide.)

-- for reinforced concrete the present design at Sequoyah represents a more than median description of the controlling site-specific ground motion.

For reinforced concrete, the differences in siesmic hazard are factors of 2 and 3.

And this seems very small when compared to the absolute seismic hazard, which is somewhere on the order of 10^{-3} or 10^{-4}.

Three, in our judgment there already exist variations in seismic hazard associated with design spectra for other plants in the Eastern United States that very likely exceed factors of 2 or 3.

And, finally, we have done all these calculations for reinforced concrete and this represents a worst-case, and the difference in seismic hazard would be even less for other materials.

Taking all these into account, we concluded that while there may be differences in the spectra, the differences between the hazards associated with the site-specific spectrum and the present design spectrum, are not substantial.

DR. MARK: I guess when I first read it and I am not sure if it may still be true, I found the last sentence in conclusion-2 just a little troublesome.

It's only a matter of semantics, but

I wonder if you might have better said, that a factor of two or three is small when considered on the scale of the hazard, which is 10^{-4} or 10^{-3}.

Again, a lay reader like myself, thinks that 2 is a lot bigger than 10^{-3}.

MR. REITER: Thank you.

DR. MARK: Another question:

Somewhere in the SER it says there are relatively few recordings of strong ground motion, intensity 8; and none in the Western United States.

MR. REITER: Not on rock, I think it says not on rock in the Western United States.

DR. MARK: Recorded at rock sites.

Okay.

Now, that is what it should be. Do you have any in the East?

MR. REITER: There are very few recordings in the East of any. I think as of now there are maybe 5 or 6 or 7 spectra at all in the East. Those are for small earthquakes, magnitude of 4.

DR. MARK: Fine.

That gets a little closer to what I thought. This sentence, then, which is on page 2-24, is what I find difficulty with.

MR. REITER: Right?

DR. MARK: There are relatively few recordings of strong ground motion, intensity 8, and none at least in the Western U.S. recorded at rock sites.

But also there's none in the East, either.

MR. REITER: Well, I think somewhere before I discussed why the use of Western U.S. data, and --

DR. MARK: But I am saying there aren't even any in the West.

MR. REITER: Right.

DR. MARK: There should be "aren't any in the East."

MR. REITER: Right.

MR. ZUDANS: May I ask a question?

DR. MARK: Yes.

MR. ZUDANS: All the statistics you have done in connection with these slides that you showed were based on the 13 sample earthquakes; that was the population of all your statistics?

MR. REITER: 26.

MR. ZUDANS: 26.

What kind of statistics can really you get from a sample of 26 that you could believe on your results?

MR. REITER: Well, granted it can certainly be a lot less, you know, if we had 182 or 150 records -- I think in Reg Guide 1.60 the total number of records used was something on the order of 20 to 30 or something like that.

One thing we asked the applicant to consider, was was there any way to determine confidence limits on the calculations.

And we had a discussion with the applicant and their consultant, Dr. Cornell, at MIT; and both agreed that it was a very difficult thing to do.

We have I might point out, made a formal request to Sandia Laboratories as to ways to go about to estimate confidence levels based on these kinds of probabilistic calculations.

They have suggested several alternatives which are not trivial to apply and we are presently evaluating them.

The way that we thought we could estimate the confidence at this point, the most relevant way, was to conduct a sensitivity test.

MR. ZUDANS: And you did the confidence -- estimate -- would you expect all the results would be within the confidence limits?

In other words, there will be no real possibility to make a distinction between one and the other, because they would be so great you couldn't make any conclusion?

MR. REITER: I don't think we arrived at that conclusion.

I might say we did not, and the applicant did not approach this in a brute, number-crunching way. At every point in the way we examined every assumption, to see how that assumption compared to what we know as seismologists or engineers.

And we proceeded very carefully at each step. And we conducted tests to see the effect.

One thing I forgot to point out was that when we varied the input parameters, sometimes we got variations of seismic hazard that were greater than an order of magnitude.

For some calculations instead of being 10^{-3} it was 10^{-4} or even less than that.

However, the important thing was that no matter what these variations were, the relative seismic hazard, what we are at..r here, was very stable; it maybe varied from 2.1 to 2.3, when the actual hazard may have varied a factor of 20 to 30.

MR. ZUDANS: To explain to me at least, what is the meaning of this relative hazard?

Does it have any physical meaning at all?

MR. REITER: Yes.

MR. ZUDANS: In what way?

MR. REITER: To me it tells me that we are designing for rare events, and that these rare events, although one may be different from the other, they are so rare that the differences between those events as compared to the absolute hazard, whatever it is, are small.

MR. ZUDANS: Let me qualify why I asked the question.

If you took one little hazard, what you call 10^{-4}, and take a given structure from that, it may mean nothing -- take a given structure subjected to that, it may result in zero damage.

MR. REITER: Right.

MR. ZUDANS: You can take another one which you label as twice as large a hazard, 10^{-3}, and that may wind it out completely. It's structure-dependent.

So that then your hazard would appear on the paper like 1 to 2, 2 to 1; in reality, it would be infinity into zero.

MR. REITER: We have not talked about structural performance. We are talking about ground motion here.

We have not used the word "risk".

MR. ZUDANS: Okay, I give you credit for that. You are quite right, you just look at the ground motion; but the ultimate objective is not the ground motion.

MR. REITER: Right.

MR. ZUDANS: Therefore your 2 to 3 is really meaningless unless you can show this indeed does not lead to damage and the other one leads to damage.

Both should be sampled.

MR. REITER: I repeat we have not taken into account structural performance, and we have concerned ourselves with ground motion and seismic hazard in this case.

MR. ZUDANS: Okay, I cannot take that away from you.

I like to have another question.

DR. MARK: Yes.

MR. ZUDANS: Two pages, 9 and 12, and you did some different inquiries and you explained it, but I didn't quite understand it.

In one case you had a red zone and the other you didn't.

MR. REITER: Okay.

9 and 12. Okay.

(Slide.)

This is the way which we think is the acceptable way of doing site specific spectra.

And the red zone represents the place where the design which we consider appropriate at the 84th percentile exceeds the present design.

Now, there's another way to do this:

And that is a procedure of normalizing the data first to the same peak acceleration. And this is the way applicant felt would be more appropriate.

To do it that way then there is no red zone because the present design exceeds the 84 percentile over every material.

MR. ZUDANS: Where is this anchoring, at which point?

MR. REITER: If you notice, 84th percentile, 50th percentile?

MR. ZUDANS: Right.

MR. REITER: They've reached the high frequency, they probe each other. And I think it works mathematically that if you anchor one history and take another time history and normalize them to the same peak acceleration and then compute response spectra at zero period they have the same response spectra.

MR. ZUDANS: But in this case Sequoya was not anchored at the same point.

MR. REITER: The present design was not touched. This is a fix. This is a gimmick.

MR. ZUDANS: I see.

MR. REITER: This is ways of treating the data.

MR. ZUDANS: Okay.

Now you have turned around and did the same thing to Sequoyah, you will get the same kind of curve you get on 9?

MR. REITER: You also anchor Sequoyah back; right?

I guess what we are talking about is this curve that indicates Sequoyah is the same curve that appears on 9. Exactly the same curve.

But these two curves, and these two curves, are derived in different manners.

In this manner the data is treated as an ensemble without any normalization, and we compute the 50th and 84th percentile.

In this particular technique before the data is treated as an ensemble, the time history is first normalized for peak acceleration. And I am saying that's equivalent to taking the spectra and anchoring it at the very high frequencies. So it's a matter of the way we treat the data, or the way the data is treated.

MR. CATTON: Which way is correct?

MR. REITER: We think that the first way is correct.

But this particular case for a site-specific earthquake, we are not interested in the spectral shape, but we are interested in distribution of spectral accelerations at each particular period we think the data should be treated as an emsemble.

This particular technique with the data used in Reg Guide 1.60 -- and there the goal was different -- there the goal was to arrive at a standard shape which could be used and moved up and down depending on the size of the earthquake.

DR. CATTON: What if neither is correct?

MR. REITER: That's always a possibility.

DR. CATTON: Or do I pick the method that my design will stand?

MR. REITER: Well, we in this case had examined two possibilities, and we think the one is more conservative and more appropriate; not because it's more conservative, but more appropriate.

MR. ZUDANS: Now is it also true from what I read from your specifications that as far as steel structures are concerned you would always be about 84th percentile, regardless which way you make this presentation?

MR. REITER: Well, the steel structures -- the situation would not be as bad with concrete structures -- and here's the concrete representation again --

(Slide.)

-- looking at where the Sequoyah design fits in terms of the percentiles of the data; we see here at the 84th percentile, and worst-case at 67th percentile.

With welded steel structures, which have -- the Sequoyah goes below the 84th percentile at periods less than .08 seconds, and the worst-case is around 74 percent.

Again the reason for this is the comparison of the damping values used by the applicant to design versus the damping values we have today.

And reinforced concrete generally applicant used more conservative design, and the case where the massive conservatism was least -- was in reinforced concrete, and that would represent in some case, the worst case.

MR. ZUDANS: Thank you.

MR. WHITE: Could you find Slide No. 7?

MR. REITER: Yes, sir.

(Slide.)

MR. WHITE: John Noiman (phonetic spelling) sought some data once, and he looked for a while and he said, well, these are all in the same plain.

(Laughter.)

With only 26 curves you don't like to throw any away, but is it conceivable that by looking at the conditions under which those extreme records were obtained, the highest and the lowest, you might find some reason for discarding them; which would make your plot just a little bit more compact.

MR. REITER: Well, the interesting thing is that the highest and the lowest were both recorded at the same sites. One was a maximum of 6.2 and the other was a maximum of five-point-something.

I wish there was some way we could really shrink that data -- we had lots and lots of records and could just look at some earthquakes and deal with that.

But unfortunately we can't. It is the nature of the data -- and I think we are very happy that in those confines we still can get 26 records.

I point out again in Reg Guide 1.60 the number used there, we covered a whole range of magnitudes and site conditions, was not any greater.

I just mention that we used U.S. data and Italian data -- some of you may be interested in how the U.S. data and Italian data compare.

And I have some slides here, but the interesting thing there was some difference in the mean. The mean of the Western U.S. data was slightly higher than the mean of the Italian data.

But interesting enough, the B-plus-one-sigma were about the same.

I guess it's telling us -- well, that there is no fluctuation but some of the parameters were more stable than others.

I think we have to do the best we can to arrive at what we think is site-specific at this time.

MR. WHITE: My point, though, was this:

There are occasionally situations where you can question things. And if your extremes were somewhat questionable, I would be inclined to discard them.

MR. REITER: Well, for some reason --

MR. WHITE: Other than the fact of their being extreme, obviously.

MR. REITER: I see what you are saying.

I guess I feel in this case if we could find some reason for doing this -- I am not sure we could -- if we could fit some different pattern that -- I don't think we are going to gain from it.

My examination of the data said we cannot do that readily.

DR. MARK: Do you have anything else?

MR. TRIFUNAC: I have a couple of comments, and some questions.

First let me start with comments:

Number one, I would like to compliment you; this seems like a good way to go.

The second comment is that I repeatedly see you using Trifunac-Brady 1975. And I thought I might comment on that, since I am one of the authors.

The purpose of that paper was to present data. The purpose of the curves in that data was not to suggest that those curves should be plotted and employed like this.

I have written, however, another paper nobody seems to reference --

(Laughter.)

-- which does address the question that you are looking for. And that paper was published in 1976.

And it has been presented in the form of tables which enable you to get accelerations, peak velocities and peak displacements with specified ability of being exceeded, provided that you select horizontal and vertical direction of motion, and provided that you know what is the density at the site.

Those tables also reflect the properties of the site.

And I thought it might be helpful both for you and applicant to give you some numbers from that paper.

I have not accidentally but intentionally picked up two levels: One is .18G and the other is .25G. Those two numbers come up in various contexts.

If you take modified Mercali intensity-6 at the site now, then there is 20 percent chance that .18 will be exceeded; and 5 percent chance that .25G will be exceeded.

If you take modified Mercali intensity-7, at the site, there is a 50 percent chance that .18G will be exceeded; and 35 percent chance that 25G will be exceeded.

Finally if you take modified Mercali-8 at the site, there is 75 percent chance that .18G will be exceeded; and there is 60 percent chance that .25G will be exceeded.

Lastly what I did, I took Figure No. 7 from April 1978, Justification of Seismic Design Criteria for

Sequoyah, Watts Bar and Belefonte Nuclear Power Plants, and I have used that, this figure which refers to 2 percent damping for sheer reason of laziness in that I only had my hand calculator programmed for 2 percent damping.

But the implications should be pretty much the same if you are to take 5 percent of the standard.

On the same scale, which contains the minimal design spectra and the actual spectra used in Sequoyah for 2 percent, 2 percent critical damping, I plotted the response spectra in response to the 7 and 8 on hard rock for 2 percent damping, for resultant ground motion, and for 50 percent chance of being or not being exceeded.

And by the way those spectra I calculated are not ever used for duration.

And if I read those curves then I interpret the present actual design for the site, actual design spectra as it is in this figure, to be sort of intensity 6 or so for very high periods.

And then it becomes intensity 7 for intermediate periods.

And "intermediate" I mean like .2 seconds on this figure.

And then for periods reaching about 1 second it becomes intensity 8.

So in the period raised that you are interested in, the present spectra must present an intensity at the site that is somewhere between 6 and 7.

This is the end of my comments.

Now I would like to ask some questions:

MR. REITER: Can I respond?

We were interested in other ways, other techniques, of arriving at ground motion response spectra, what they would predict.

And particularly since we had decided that the maximum 5-8 was the better way of describing earthquakes we went to see what there was in the literature that would be able to predict that kind of technique, that kind of ground motion.

And one of then indeed was something Dr. Trifunac and Dr. Anderson have worked out, data in the Western U.S., I think it was 132 records of -- and based on certain attenuation relationships -- they looked at all the data, the magnitude distance, site conditions, so forth, and attenuation, and tried a way of predicting response spectra for a given earthquake of a different magnitude at a certain epicentral distance at a site condition.

We plotted some of these results to see how they would compare with our technique used by the applicant.

And it's very hard to see, but let me see if I can point this out --

(Slide.)

Here are the 50th and 84th percentiles, by the TVA study; these dashed lines represent the 50th and 84th percentile used by Anderson for magnitude, 5.8 at 15 kilometers at rock site.

It seems the 50th percentile seems to overlap the 84th percentile.

The 84th percentile seems to be above our maximum except in a very small period range.

We asked ourselves: why did we get this difference?

And there are various ways to approach the problem. Our idea was to approach it in the least controversial way, namely, to avoid the controversy that surrounds scaling.

I mean, I didn't go from one magnitude to another.

How do you take a record that was reported at one site distance and project it to another site distance?

How do you take a vertical component and adjust it to a horizontal component?

How do you take -- I mentioned once -- a rock site compared to a soil site?

And we thought if we could get together enough data within the range that described the uncertainty of the earthquake, we could avoid all that controversy over the scaling.

And that's what we've done here. We have not manipulated the data, we have not scaled the data; we've taken every bit of data we could get within a range of uncertainty that we had.

Part of this may be due to the fact that Doctors Trifunac and Anderson had used the only Western data; part of it may be due to the fact that assuming a relationship between, a scaled relationship between magnitude and distances -- we just don't know.

But in our case we attempted to avoid that controversy.

Another matter of interest, the Japanese had been working on similar problems and they had similar data. They had their own data sets, and they have different scaling procedures.

In fact, they have much more simple scaling. And we look at that estimate for a magnitude 5.4 to 6, an average of 5.75, at distances from 6 to 9 kilometers on rock sites; theirs all seemed to come out about the same as ours. Their 84 percentile is the same as our 84 percentile, and the 50th percentile is about the same.

We don't think that this means the approach TVA used is correct. And one does not indicate that it's wrong.

We think that there are differences between these various procedures, and those differences may be partly bound up in the data sets, but they are also very much bound up in the assumptions, the scaling assumptions one assumes.

Again, we hope by going directly at the data and not scaling it, we avoid some of that controversy.

MR. TRIFUNAC: That's an excellent introduction to my question.

MR. REITER: Okay.

MR. TRIFUNAC: My claim is that you do a lot of scaling, both you and applicant, because both of you are using magnitude. And there is no such thing as magnitude in Eastern United States before 1950's and '60's.

Whether you like it or not all the data is in terms of intensities.

And you can take one of each -- there are lots at the moment, some of them good, some of them not so good -- but in either case you have to go from intensity data to magnitude data.

And then you get magnitude data, then you start operating on it.

The net effect is you have long steps, each with uncertainty.

The comparison which I gave you which suggested that the site spectral response to intensity-6 in high frequencies, and intensity-7 at intermediate frequencies, the range in Figure 7, has nothing to do with magnitude.

It is direct intensity information.

Inci'ntally, the Japanese paper -- we have no basis whatsoever to suppose that Japanese magnitude is the same as any magnitude we use in Eastern United States.

There may be a bias there.

So, the first questions that is on the list of several questions that I have is:

Why not go -- why go all this way around? -- to get to the magic number 5.8, and then manipulate all the data -- Italian data, by the way has different magnitude. And there's no way to know it doesn't have a bias in it.

MR. REITER: In terms of magnitude?

MR. TRIFUNAC: Yes.

MR. REITER: Well, there are some people argue that the inclusion of Italian data, which might represent a time situation closer to the Eastern United States, makes the combination of Western data, makes it something better to use than Western data by itself.

Because the Italian data more closely represents an interplay situation, compared to the Western data.

Let me go back to the magnitude problem:

After a great deal of consideration we decided to go to magnitude for several reasons:

One, there is no data or very little data

-- intensity-8 data on rock in Eastern United States.

Second, --

MR. TRIFUNAC: The data in Western United States is the lead data of frequencies associated with intensity-8 or magnitude 7 or 11 or whatever the numbers might be. They are the same data.

MR. REITER: Right, but the magnitude determination -- we don't have intensity data to decide we'd like to use.

In other words the kind of information we are going to get is extrapolation from other intensity data.

Suppose we decided that it was an intensity-8 rock event. We go out, and there are no intensity-8 rock events, at least in the Western United States.

And the applicant has argued that rock is a very strong indication that rock is the best place to build than soil, because you feel it's very hard to get intensity-8 on rock.

But if we went directly to intensity we have either a nonexistent or a very small data base.

Another factor is the argument, the dispute, over the size of the epicenter intensity.

We have the evaluation by USGS, okay? Well, two of the people felt 7-8, other people thought it should be 8; but they strongly indicated that they did not believe there was such a thing as a midwave intensity.

So they had some very critical jump-off points and there was no way to express any sort of variation.

Another thing I pointed out that there's a tendency in evaluation of Eastern earthquakes to emphasize the maximum epicentral effect, while in an evaluation of Western earthquakes the tendency is not so much the maximum, but to look at the predominant intensity in the area.

Third of all, we did not -- I think you are absolutely right -- when we would take the determination and go directly from epicenter to magnitude; and people have those kind of correlations.

But we did not do that. Applicant did not do that.

What we've done was a very thorough study by Nutling, Bound and Griffith (phonetic spelling) of various techniques which not only relies on a controversial epicentral intensity, but the whole intensity distribution.

And in taking that into account, observed correlations between existing intensities for earthquake records that have been recorded, both in magnitude and intensity, then to go back and take the records from many earthquakes, go back and see how we can work with historical earthquakes.

We felt for those various kinds of reasons that the characterization of a 5.8 was a much better place to start than intensity 8.

MR. TRIFUNAC: But you remember, for example,

-- let me see -- (unintelligible name) earthquake.

MR. REITER: Yup.

MR. TRIFUNAC: You remember what was the magnitude for that, surface magnitude?

It was remarkably different, and the accelerations that were recorded were more relatable -- if I could use that word -- to surface magnitude.

A similar situation can be mentioned perhaps for some others.

Body wave magnitude samples are initiation of the process, and if you had a large earthquake, body magnitude may not tell you the whole picture.

What about Alaskan earthquake 1954? That's another example.

Body wave magnitude might be some indices for the first part of your earthquake, and then if we are lucky, if it does not build up -- but if we're not lucky, and it continues to build up, the later phases that would have been included in body wave magnitude are not there any more; and it loses its significance when size goes up.

But that's an open question.

I merely wanted to ask and in a way suggest that perhaps it would have been better to go directly from (unintelligible).

It is not to be looked at as a continuous number, but a discrete site.

We could have gone back maybe and looked at all the reports that has been done for other sites -- I can remember for Skagget that was looked at in this way -- where you simply took all the reports, and you put a histogram, so many reports state that (unintelligible) was such and such; but so many reports say it was bigger and so many say it was smaller.

So instead of getting a continuous function you get a discrete distribution. And by weighting those one gets essentially at the proper estimate for the maximum intensity.

So, indeed, it was a weak 8, maybe 7-1/2 or something that could directly be included in that report.

The second question I have is this,

As I understand it now, the original design spectrum was based --

MR. REITER: The reinforced concrete?

MR. TRIFUNAC: Right.

Now, at this moment you are comparing that spectra with 7 percent damping.

Now my understanding of the Reg Guide 1.61 is that the numbers given there are the largest permissible numbers.

Am I correct in that?

MR. REITER: You'd have to get a structural engineer to respond to that. It's a great deal of controversy.

MR. TRIFUNAC: Well, that means we think here if we use 7, that that is justification for largest. Now, how can we get largest acceptable in other ways?

Let me suggest two:

One is the structure goes into very large deformations, structure load, and thereby through equivalent mechanisms we observe large fraction of (unintelligible).

The other extreme case would be the structure does not go linear but it sits on very flexible soil, and soil impacts and builds up the large phenomenon where we see (unintelligible).

But here we have a situation where we are on rock.

MR. REITER: Right.

MR. TRIFUNAC: And everything we have heard to so far we are talking about solid formation rock, which means that it's very unlikely soil will behave that way.

We had lots of these discussions in the other hearings. I am sure you must have heard some of those; some other people in this room must have heard a lot of them.

It was clear where all the data, virtually all the data except for few experiments which are difficult to generalize, all the data we have are the data that do not represent damping in the structural level, but the percent of damping in the overall system.

Because if I have instrument on the top of building, that instrument is not smart enough to isolate where the damping is coming from. It just looks at the peak width.

And that can be 95 percent (unintelligible) soil, and 5 percent structure -- somewhere in between.

So what puzzles me is what is justification? Maybe there isn't justification.

But at the moment I haven't seen from what I have looked at, that there is a good reason to go to the maximum permissible -- if I understand 1.61 correctly.

My interpretation of 1.61 is that where I make a very good engineering judgment as best as I can what is applicable for this case.

Now, I have certain material, concrete for containment; I have certain information and so forth. And I look at all these, and then I do my best judgment as to what is the proper number.

And then I look at 1.61 and say:

Well, did my estimate exceed the limit permissible; rather than the other way round, just taking the maximum permissible.

Do you understand?

MR. REITER: Yuh.

It's very hard for me to answer that. I am not a structural engineer.

MR. TRIFUNAC: What about your colleagues?

MR. REITER: Well, our reasoning and again, there's a discussion in Reg Guide 1.61 that that's the acceptable way to go and the present procedure, which is normally used.

MR. TRIFUNAC: I am not questioning that.

MR. REITER: Yuh, right.

And therefore, we want to compare what the way it was done at the time to the way we would do it, taking into account those acceptable procedures.

That's what we did.

Now, I am not quite sure what you are saying:

Are you saying we did not take into account soil structure and the interaction effect?

MR. TRIFUNAC: No, I am not.

I suspects that -- what is, incidentally, the sheer velocity of the site?

MR. REITER: Ah--

VOICE (TVA): It's about 6,000.

MR. TRIFUNAC: 6,000, so it is not significant.

So I am just questioning the height.

MR. REITER: Well, again, I didn't address this from the structural engineering point of view; I can just address it from the point of view we thought it was an acceptable procedure.

MR. TRIFUNAC: Is this NRC's decision or --

MR. REITER: Reg Guide 1.61? That appears in the standard review format.

MR. TRIFUNAC: No, but I mean did NRC or applicant decide they should be utilizing the kinds of comparisons that you have?

MR. REITER: NRC.

MR. TRIFUNAC: I see.

Can somebody from NRC comment on that?

MR. REITER: Well, again the reasoning behind that was that this was the way -- what we would allow today.

Now, beyond that -- we discussed this in the working group; there were structural engineers there.

T3

DR. MARK: We will pause to change tapes.

(Pause.)

MR. REITER: I guess I can't -- I can only give you the layout, the rationale, of why we picked 7 percent. I cannot address the concern that you have associated with that figure.

Again, the rationale for picking it, this is the this was the procedure.

The kinds of concern that you address, I really can't address.

MR. TRIFUNAC: I address it to NRC.

MR. REITER: Okay.

MR. TRIFUNAC: Okay.

The next question I have relates to my first question, which is magnitude.

Now, you did some calculations using Robin McGuire's (phonetic spelling) program. And I just wanted to be sure I understand -- you used a logarythm based on an A minus B or M in the statistical input in that program.

MR. REITER: The statistic input is attempted. That's the historical record.

MR. TRIFUNAC: And that was scaled to his information using his program?

MR. REITER: That was first scaled down from -- to localized site intensity; then we went from site intensity to peak acceleration; from peak acceleration to spectral response.

MR. TRIFUNAC: I understand.

Then I have just one more last comment.

And that is the work you have referenced over there, Anderson's, has done a study. He took in Southern California where we have lots of data in both magnitude and intensity, he took the region around Los Angeles.

And he defined seismicity there in terms of A, intensities only -- he didn't know anything about magnitude; and he did a complete calculation, which is very similar to what McGuire's calculation is; but I would guess a little bit more complete. Not fundamentally different.

Then he forgot that whole thing, either way, and he took the data as if he had only magnitude, and he used again the best available information we had on magnitude. He did the whole calculation again using the same probabilistic approach.

And then he took both results and plotted them on the same sheet of paper.

He plotted three curves for each calculation:

One curve was like an average spectrum, that he uniformity spectrum; that is a shape that would not be exceeded more than specified percentage that you select, for all events in the area.

And that spectrum for both procedures was virtually identical, virtually identical, on the top and the bottom -- I mean, above and below the spectrum.

He plotted the average plot of deviation, minus and basically he picked 10 percent chance of nothing exceeded, and 90 percent of not being exceeded; which is somewhat like your 84 percentile.

And a very remarkable thing came out:

Since these standard 90 percent levels measured something like a sigma above and below the average value, that sigma reflects the accuracy or the width of the uncertainty of any estimate that you have.

And it turned out that the width of the estimates -- uncertainty, i.e., sigma -- was very remarkably smaller than the width in terms of magnitude.

This is reinforcing my suggestion that in here it would have been better, forget about all these roundabout ways, and trying to shoot directly; not going to magnitude or what.

We can supply for anybody this analysis. I think it's being published in Seismologist Society of America and and some other places already have that study in great detail.

But the study very clearly shows that for the region for which we have both sets of data, and the data set is uniform in all that is included into this calculation, that the certainty with which you can come up with an estimate is considerably better -- whether we like it or not, that's how it turns out.

So this is a strong basis for my previous question.

MR. REITER: I can only repeat again what I said before, that we were dealing with the Eastern data set, also the uncertainty of the intensity, discussions with knowledgeable people; and we feel in this case magnitude is a better way to go than anything else.

And I am not arguing with you that the caseyou suggested might be better to go by. I don't know.

I think i. :his case the type of data that we have -- we feel the way we went is right.

DR. MARK: You have shown several curves in which we have seen Phipps Bend and Sequoyah?

MR. REITER: Yes.

DR. MARK: Some of those differ, and this had to do with the difference in the sites, and some with the difference in the damping, some the difference with the procedure used to get those curves.

MR. REITER: Excuse me, there's very little difference associated with the sites.

DR. MARK: Are there differences between the plants?

If we put Phipps Bend on the same site and in the same way, will we get the same curve?

MR. REIT ER: In other words, if we did an analysis -- analysis was done comparing Sequoyah with Phipps Bend?

DR. MARK: Yes.

MR. REITER: And you'd get the same kind of uniform hazard curves that you get at Sequoyah. There's a slight difference, not significant.

DR. MARK: That is, the plants are equally --

MR. REITER: Location.

DR. MARK: The plants?

MR. REITER: The sites in terms of the seismic hazards; essentially the same seismic hazard at Phipps Bend as it is at Sequoyah.

DR. MARK: Right.

Now, are the different? And if so in what way?

MR. REITER: The plants are different, and I am sure that somebody from TVA can ampl -y that.

DR. MARK: We can let them later.

MR. SILVER: If I may, we have not at all yet addressed the structures at Sequoyah or any other plants. The plants of course are different.

DR. MARK: You are looking mostly then at methods of treatment, because the sites are not very different -- well, the sites are not enough different to account for this?

MR. SILVER: We have not assumed any difference in the sites.

DR. MARK: Okay.

Is that all?

MR. REITER: Yes, sir.

DR. MARK: I would suggest that the next item will be discussion of --

MR. SILVER: Excuse me, sir.

I do have comments.

DR. MARK: Yes?

MR. SILVER: It was noted in the SER we did at least begin to address continuation of this evaluation.

One of the aims of the study is to determine the significance between the site specific spectra, and the Sequoyah design. We basically determined that significance is small.

There has been a considerable amount of discussion within the Staff to determine what we should do with this information. We did have some other information, other judgments, having to do with the structures.

We believe there are margins available in the structures to withstand an increase in seismic loading.

Such factors for example as pointed out in the FSAR, as use of lower bound material properties, conservative analysis methods, and loading combinations, including such evetns such as LOCA.

Based on the analysis performed by our seismologists and judgement of the structural capability, we concluded that the present design basis for the Sequoyah plant is adequate to withstand the effects of earthquakes without loss of capability in performing required safety functions.

And we determined it was proper to proceed with licensing Sequoyah on this basis.

However, since the assigned spectra do fall below the level that we felt was proper or would be proper tr day, for the design in that plant, and to verify our judgment of structural margins, we did decide to proceed with a structural and component evaluation of Sequoyah.

Now, at the time of the writ:ıg of the SER we had not defined a program to any great extent. However, during the past week two of our structural engineers discussed with TVA engineers this very point; and in fact our people returned on Friday, having gone through a considerable amount of work with Sequoyah, or with the TVA people insofar as the Sequoyah design.

I won't pretent to try to give the results of that, although we do have some structural people here today who can do that.

We did examine, the TVA engineers primarily with our people, did examine the stresses in critical sections of the aux building and the reactor building.

And basically, as I understand it, and again we got a most instantaneous briefing on Friday, most of these sections still retain considerable margin.

And I think at one or two points, if I recall, the structures are overstressed perhaps on the order of 5 percent, using the site-specific earthquake inputs to design.

Frank Rinaldi and Harold Pope are both present at Sequoyah and I am sure will give a presentation if it is desired to explain some more details of these results.

Keep in mind we have not had an opportunity to refine this, and this would be a rough presentation. Perhaps I am doing Frank an injustice, but we could expand on this presentation, too.

In addition to that, — I'll come back to that in a moment -- we are presently defining a program that we would propose to follow to examine the various pieces of equipment needed for safe shutdown of the plant, to examine the margins available in components.

We have I believe defined the specific pieces of equipment we are interested in, although I have not personally seen the list.

Again, this has been ongoing in the last few days.

And we will meet with TVA shortly to perform a similar evaluation of the components.

So we have not restricted our look to the seismological aspect, but are translating that into actual structural effects.

If you would like to hear Mr. Rinaldi's report on stresses in these critical structures, I am sure Frank will be glad to spend a few minutes doing it.

MR. ZUDANS: Before that, may I ask a question?

Do you have information that tells you for specific structure what fraction of critical stress is contributed by seismic events?

MR. SILVER: We have structures we have considered -- I don't know how to phrase this -- we have examined structures obviously in which the seismic event is made part, is one of the loads, which was considered; along with a good load and normal operating modes.

We did not consider the local loads and other accident loads in this review, it is my understanding.

Is that correct, Frank?

MR. ZUDANS: Well, actually for you to decide which components are important in this particular context, the difference between site specific or what you used, is not really that big.

MR. SILVER: Um-huh.

MR. ZUDANS: And if you don't know precisely what fraction seismic events have for a given structure --

MR. SILVER: You mean the original design?

MR. ZUDANS: In your original design.

Then you really don't know what to look at.

For example, in a given component seismic only makes up 10 percent of your critical stress; then you probably wouldn't worry.

If you take another structure such as the reactor building, where the siesmic event is probably significant; and then it's a different story.

So you first go around with the finding out whether or not the information is available, to see what seismic events do to each of the above components.

MR. SILVER: I think Mr. Rinaldi can address this; certainly, in the selection of these structures.

MR. ZUDANS: Any component to a siesmic event, I am sure it has an effect.

MR. RINALDI: We didn't look at each component.

DR. MARK: Would you like to give a rather brief preliminary comment or two on what you think you are going to be able to pronounce after you've had more time?

MR. RINALDI: Well, we looked at the rock supported structures; we thought they were the principal ones to look at.

And we determined that the stress level had some margin, and we found slightly overstressed rebar in the shield building, the concrete, using the code they used in the design; there was a 5 percent overstress in some concrete at the base, and .3 percent overstress in the rebar.

Following that we looked at the soil supported structure to make sure that we had no problem with the soil supported structure. And we put that to rest by looking at the way they put it, the design spectra; in that the applicant used the site spectra, and you put it at the rock foundation and then amplify it back up from the foundation of the soil supported structures.

And when that spectra, response spectra, is compared with the 84 percentile spectra, the structures, the envelopes of the 84 percentile spectra over periods of interest for the structures -- so we put that soil in consideration to rest.

And the next concern was to qualify the components, equipment and components.

And the applicant in the original design used design earthquakes, four earthquakes, to develop the response spectra.

And the applicant will use one of those earthquakes to develop a response spectra which envelopes the 84 percentile spectra.

And using that, we will develop response spectra which will qualify the equipment and components.

So we put to rest with TVA these concerns of overstressing the structure or failure to the structure due to the rates of the response spectra.

MR. ZUDANS: Okay.

That means at least at this time there is no information whether or not any of the components do or do not deal with stress. It will have to be analyzed?

MR. SILVER: It will be analyzed by discussion with the applicant, we feel a lot of the equipment has already been qualified for a worst situation than the Sequoyah spectrum.

And the problem we have to look, after we generate the response spectra, is to qualify the piping or any components, specifically designed for the Sequoyah site.

MR. ZUDANS: Well, I assume applicant knows pretty well he won't be in any trouble after he does this exercise.

MR. TRIFUNAC: Can I have just a quick question?

Did I understand you to say applicant used a calculation to come back up?

MR. ZUDANS: No, no.

MR. SILVER: They put it the other way around, used the surface response spectra and turned it around to apply it to rock and then amplified it back up.

MR. TRIFUNAC: I thought the site was a rock. Maybe I don't know about the site.

MR. SILVER: It's a rock, but the shield building and control building and auxiliary building, are on rock, rock foundation.

MR. RINALDI: There are some category-1 structures which are not on rock.

MR. SILVER: They are like maybe 25 to 75 feet on soil.

MR. TRIFUNAC: I haven't seen that.

DR. MARK: Does that complete your presentation, Mr. Silver?

MR. SILVER: Yes, it does.

DR. MARK: In that case we will recess for ten minutes, after which the applicant will respond.

(Recess.)

DR. MARK: Will applicant proceed with his comments on site seismic situation.

MR. GILLELAND: Dr. Mark, the presentation will be made by Dr. Frank Hand and Mr. Joe Hunt will make some opening remarks first.

MR. HUNT: I am Joe Hunt. I am in the Office of Engineering Design and Construction in the Division of Engineering Design.

I would like just to make a few brief comments to sort of set the tone of my presentation.

Dr. Hand will give a detailed presentation.

Dr. Hand and myself are in the geodetical and earthquake engineering staff in engineering design division.

As you are aware from the previous discussion, NRC requested sufficient information on the earthquake design at Sequoyah, and this was 1977.

The questions were related to the earthquake ground motions and the design.

Since that time we performed several studies -- some 13-odd studies -- again the results have been submitted and reviewed by the Staff.

We have three additional studies that will be submitted by mid-April at the latest.

In doing this work we utilized the services of several consultants: Western Geophysical, who is represented here today; Dr. Cornell, at MIT; and several others in different areas where they had recognized expertise.

From all of these studies that we conducted, our conclusions were that the original earthquake ground motion at Sequoyah were adequate.

As you have heard, NRC Staff did not totally agree with this.

By making our presentation I don't want it to appear to be argumentative or making any types of appeal to the committee; but it was understanding that you did request to hear our side, or our conclusions on the work we did.

We have agreed with the Staff to proceed with examining the structures, systems and components for the site specific spectra which we developed. And as you have heard, that work is in progress.

We hope to complete that as soon as possible.

At this time I will turn it over to Dr. Frank Hand.

DR. MARK: You hope to finish this review as soon as possible; what kind of time as you see it is probably required for that?

MR. HUNT: Well --

DR. MARK: I mean, is it many months or a few weeks, or can you guess?

MR. HUNT: We would hope that it would be just a couple of months.

DR. MARK: Okay.

DR. HAND: I am Frank Hand, of TVA, Engineering Design Division, Civil Engineering Branch, Earthquake Engineering Staff.

I will go over the technical studies

Briefly I would like to go over the seismic design used at Sequoyah; I think that will answer a lot of questions that have been raised.

The original design criteria was specified in the minimum response spectra -- this line here --

(Slide.)

-- (indicating) -- and it is shown in this case for 5 percent damping which was for reinforced concrete structures.

NRC and TVA agreed on the particular curve. TVA then in its analysis needed certain time histories, four time histories, A, B, C and D; and developed all four envelopes for this curve in some fashion or another.

And the particular procedure that was used back then was that the average of the four time histories was used -- the average response spectra of the four time histories was used -- this jagged line up here (indicating); and this (indicating) response spectra was then used.

And we used the jagged spectrum irregardless of whether we were doing a response spectra analysis of the structure or whether we were inputting the time histories and integrating full response spectra from them.

In all cases four analyses for the different four histories were made, and these results were then averaged; a simple average was used for design load and acceleration or whatever.

In connection with these spectra, different damping ratios were used at Sequoyah and are presently used.

These are shown in the accompanying table here (indicating).

(Slide.)

The primary concern that Leon was speaking to earlier, we have a steel containment vessel; we were using 1 percent damping with the safe shutdown earthquake; currently -- this is a welded steel structure -- currently Reg Guide 1.61 uses a 4 percent damping factor.

The otherwould be reinforced concrete -- here's our reinforced shield (indicating) -- and other concrete structures down here -- (indicating) -- this is the one they were mainly concerned with -- and we used Reg Guide 1.61 -- or we could now use 7 percent damping for reinforced concrete.

That is the criteria that was used.

The results, using those criteria, TVA did several studies:

In December of 1977 we received a letter from NRC which questioned present criteria used at Sequoyah.

And in February of '78 TVA outlined a two-part program to address these concerns.

And in May -- March NRC formed a working group and also addressed these concerns.

In May we submitted a phase-1 report, that has items 1 through 5.

In August the phase-2 report was submitted, and it consists of items 6, 7 and 8.

In the interim in late May NRC working group discussions resulted in slight modifications.

And these modifications were submitted in August.

In November -- in October we received six questions on our phase 1 and phase 2 reports.

And in November, early November, we outlined to NRC our responses to these six questions.

And in late November we received nine clarifications of those questions.

And in December, 15th, 1978, we submitted the answers to those six questions.

And those are items 9 and 10 (indicating).

and some additional work we planned to do, item 11.

The first 10 items have been submitted. They have been reviewed by NRC.

Item 11, 12 and 13 are additional studies that TVA has performed, and we will submit those not later than April 15.

We can go over briefly the studies that were performed.

First is evaluation or revaluation of Giles County earthquake. And this refers to working group report item III.A.3 -- out in parenthesis here (indicating).

As Leon has indicated this item, this Giles County earthquake is 8, it actually has been listed as 7 to an 8, and a 7.

And TVA in the early 1970's we did a study to reevaluate the Giles County earthquake; and it is our conclusion it should properly be rated as a 7 to an 8.

Number 2 is to evaluate site conditions on earthquake intensity.

And here the primary impact is that historical earthquakes soil-biased, and Giles County is no particular exception to this. Intensities on rock are 2 to 3 intensity units less than on soil.

And this agrees with the remarks made a few minutes ago.

The third item is evaluation of acceleration variation with depth. This point was not touched in the NRC working group reports, so we have no corresponding number.

But based on data available from Japan and current efforts out in California, we conclude that earthquake accelerations reduce with depth, and since Sequoyah is founded on rock, this rock occurs at depth over the site; and finally that all intensity acceleration relationships are based on recordings made at the surface.

There are no bore hole recordings found where we have any instrumentation to pick it up.

Again I should mention here that the criteria for the response spectra specified on top of rock, not ground. And here basically we are saying that accelerations on rock are less than those on soil at a given site during a given earthquake.

So we took the Giles County earthquake and San Fernando earthquake and the other ones, we have instruments on soil sites and on rock sites the same distance from the epicenter, and we would see lower acceleration on the rock than on the soil.

We found hard data to confirm this, the Italy 1976 events. There were two stations that were less than a kilometer apart, Iberia and San Rocco. The first was a pan-alluvian site; the San Rocco site was a hard rock site.

The soil site in this case had accelerations varying from 1-1/2 to 3.8 times the rock site.

MR. ZUDANS: Let me ask a question.

DR. HAND: Yes, sir.

MR. TRIFUNAC: Are you familiar with a paper published by (unintelligible proper name) Imperial College in England?

DR. HAND: I've seen some papers.

MR. TRIFUNAC: Well, he has written a paper on the very question you are discussing, the difference in peak accelerations and rock and alluvial in Europe.

And he seems to conclude something different than what you did.

DR. HAND: Now, you've got to be careful, because if you go in and say let's look at two reports, one on soil, one on rock, both intensity or damage estimate 6; you probably will find a higher rock acceleration from the soil acceleration. The damage estimates have to be the same.

If we go to one earthquake, two sites, similarly positioned, one on soil, one on rock; damage estimates on soil will probably be higher than on rock and the corresponding acceleration will be higher on soil.

MR. TRIFUNAC: I see a contradiction in what you are saying.

DR. HAND: Okay.

The fifth was a study of the evaluation of intensity-acceleration relationships. This was a recommended approach in the working group report.

And it evaluates certain intensity acceleration relationships.

TVA considers the CSC or the Murphy-O'Brien, as it is also called, as the most appropriate relationship.

And this is based on, it considers more data, it considers data in a more probable statistical treatment; and we have here a simple comparison between Trifunac and Brady 1975, CSC or Murphy-O'Brien, 1978, and Trifunac-Brady, 1976 -- which does appear in the paper you were talking about a little earlier.

In intensity-8 fromthe Trifunac-Brady 1975, you get .25G.

In CSC we would get approximately .15G.

And if we used Trifunac in 1976, we get.19G if it's a soil site.

So the reason for selecting the soil site for the maximum historical earthquake for Giles County is assumed to be soil-biased; based on our evaluation of the site surrounding Giles County, we determined the maximum damage was on soil sites.

So if we are going to assign an acceleration from this historical earthquake, we should use the soil conditions that were prevalent at that time.

So we do see a range of acceleration here. And the anchor point would be .12G.

That was the phase 1 presentation, or our phase 1 report.

Another item suggested in the working group report is one Mr. Trifunac I think has alluded to today, evaluation of response spectra based on intensity, going straight from intensity to response spectra. Don't go to anchor point acceleration, don't go to Reg Guide and pick out a response spectra.

Just go straight to it.

There was a study based on CalTech records, and they have intensity 5, 6, and 7 data, some scarce data in t he 8.

And based on that report they comment that there is a lack of data, and they would not like to extrapolate the curves from the 6 or 7.

They also say that going from one intensity to another is not linearly scalable by one single function; so again they don't recommend the technique.

If we went into the records to find intensity 8 data on rock, there are no data. So we do not have the data base to draw on.

And finally distance effects in the report were not considered. And this is that intensity 6 occurs 20 miles from the site, and intensity 6 with an epicenter 100 miles from the site; those two response spectra would have a slightly different characteristic; and this distance should be taken into account.

Due to these circumstances we did not feel it worthwhile to pursue this area; so we did not.

We then came down to evaluate the response spectra based on site specific records.

Rules had to be established at the outset:

One, we were looking for an earthquake of a magnitude range 5.3 to 6.3

We were looking for fairly close intervals, events; so we were looking at distances of less than approximately 25 kilometers.

We were looking at rock sites, since Sequoyah is a rock site.

We came up with 26 records or 13 pairs that met the particular requirements.

Six of these are Western U.S. events, and 7 are Italian events.

For your own information these are the earthquakes that were selected --

(Slide.)

-- these are the U.S. (indicating) and these are all

Italian (indicating); these are the magnitudes (indicating); the average is about 5.7; these are the distances, the average distance is just under 16 kilometers; and over on the far side, we have the various peak accelerations.

And we run from a high I bel eve of this value (indicating), .35 down to a low of .03G.

This is a spread of about a factor of 10. The magnitude ranges from 53 to 63 using magnitude as logarythm; that's also a range of mangitude in there(indicating).

Those are the references we used (indicating).

From those records statistical treatments were made to determine what the proper distribution was, or at least what the more proper distribution was.

For simplicity we first considered normal, then we considered lognormal; and it turned out the data is more lognormally distributed than normal.

And we are not saying it is exactly lognormal, or they could not be distributed some other way; but the data is showing a preference depending on which particular response spectra frequency you are looking at on being anywhere from 2 to 30 times reference for lognormal than for normal.

Once the distribution was assumed, peak ground acceleration could be calculated, and it turned out to be .10G.

We also calculated response spectra. We calculated among others 50th and 84th percentile, and we calculated these two ways.

One was based on the actual spectra itself; one was based on normalized spectra; and we'll have curves to show what these are.

And as a result of the six questions from NRC and the nine clarifications, a sensitivity study was also requested here and was performed.

And in this sensitivity study which Leon alluded to this morning, we considered four additional high pairs, two additional high pairs, two additional low, four additional low, one high with one low, two high with two low.

So we were fairly well in bracketing possible combinations.

MR. TRIFUNAC: Can I ask a question?

DR. HAND: Yes.

MR. TRIFUNAC: Please correct me if I didn't understand you correctly.

But you have a whole bunch of records that you gave in the previous slide, and then you take those records and calculate the response spectra for them?

DR. HAND: Right.

MR. TRIFUNAC: And these are some of the outputs of that calculation, like .1G and things like that?

DR. HAND: Right.

MR. TRIFUNAC: Now, you have used those records as they are; is that right?

I mean, did you do any scaling for this?

DR. HAND: No, we did not scale for distance or magnitude or anything else.

MR. TRIFUNAC: Okay.

Now, can you then get back your previous vugraph?

DR. HAND: Yes.

(Slide.)

MR. TRIFUNAC: Right.

Does it have a central distance or any distance for that matter that is to be associated with these earthquakes?

DR. HAND: Yes, it does.

MR. TRIFUNAC: Okay.

From 7 to 30?

DR. HAND: From 7 to 27.

MR. TRIFUNAC: Right.

And in almost any case would you agree that this would be a response spectra that you would see from this range of magnitudes as the distance between 15 and 30 kilometers from the site?

Don't worry about the numbers. Okay.

Now, at the same time you claim that this is a representation of the intensity 8 earthquake.

DR. HAND: Giles County earthquake.

MR. TRIFUNAC: Some earthquake that can happen with intensity 8.

DR. HAND: Well, you've got to be careful there. Because we went through a step and characterized the Giles County at whatever its intensity was and a given magnitude, and now we are considering the spread around that magnitude.

MR. TRIFUNAC: I understand that. I am with you on all that.

But, let us say we don't talk about intensities. We talk about magnitudes. Okay?

So it is clear.

Somebody made a study and from it we are conducting an experiment in which we believe the Giles County earthquake had a magnitude of 5.8 - period; right?

DR. HAND: Right.

MR. TRIFUNAC: Now, if you were to make assumption, these are examples of other earthquakes that might look like that.

DR. HAND: Right.

MR. TRIFUNAC: Now, then, we are saying that any of these earthquakes could occur at site.

DR. HAND: Right.

MR. TRIFUNAC: Fine.

Now, what makes us take those earthquakes at a distance of between 15 and 30 kilometers?

Why don't we evaluate a spectra for these earthquakes for the site?

Because I thought and I didn't hear you say otherwise, that the earthquakes in this part of the world can occur just about any place.

Well, what allows us to bias our calculations so that everything that looks bad is 15 to 30 kilometers away?

I could do this and I could pick up other candidates, maybe more or fewer than what you have, and it would all be between 50 and 60 kilometers away.

What allows you to pick this distance?

DR. HAND: The range of distance was picked as zero out to about 25.

MR. TRIFUNAC: Yes, but there is no data at zero.

DR. HAND: And this, the 7 and the 9, are the closest we could go.

MR. TRIFUNAC: I agree with you. That's fair enough.

DR. HAND: Now, if I am --

MR. TRIFUNAC: Why didn't you make the correction, then?

DR. HAND: You are asking why we in some way scaled or tampered with the records to make them reflect zero distance?

MR. TRIFUNAC: That's right?

DR. HAND: First, I don't know how to make such a correction.

Secondly, TVA and NRC agreed that this was an acceptable way.

MR. TRIFUNAC: You see, I could argue that you are designed for too much, and I could go pick up other set of earthquake records which are all 35 kilometers away.

And I can get any acceleration I want.

So I can argue, is too large; you biased your information upwards.

Now, how come you used this data, then?

What is justification for this?

DR. HAND: Well, --

MR. TRIFUNAC: I know there is no other data, but you are using it; right?

So there has to be good reason why this and not something else.

And you are using this as an alternate approach because the others are no good; there are all sorts of trouble with it.

MR. REITER: We went over this and we were involved in the decision. I laid it out before.

We arrived at an epicenter distance, the first consideration was a study by Nutley (phonetic); what are the effects, the maximum effects, the maximum damage, to what extent do you feel that in the central United States.

Their conclusion was that it was only 20, 25 kilometers.

And on the basis of that, we said, okay; let's take a look at those records in 20, 25 kilometers.

I think what you say is correct, when you get to scaling, you have a very difficult situation. You don't know how to scale, particularly in this area.

However, I should point out if you did go to scaling most of the scaling procedures that I have looked at tend to flatten out when you get to 10, 15 kilometers.

So you would look at some sort of scaling -- we prefer not to do it.

We think this is a better way to go.

But if you would look at scaling, most likely anything less than 10 or 15 kilometers would probably be the same on some scale.

Now in the East there is no surface rupture, the earthquakes occurring at depth -- we don't know where; it's very difficult to pin down what does it mean and where would you place that actual fault, at what distance.

Taking all these facts into account, we felt that it was best to take all those records within a distance in which people have estimated maximum damage, and not to attempt to fit that with some arbitrary scaling function which may flatten out at 10, 15 kilometes; and just deal with the data as it is.

By the way, the average of that data is something like 14, 15 kilometers; so half is below and half above.

MR. WHITE: How about moving that diagram to the left to see how much correlation is there between distance and acceleration?

MR. REITER: It's really -- there's one point there, 27 kilometers, and you know, we originally said 20, 25. We decided to include that because that was the largest pair that we had. We felt to exclude that just because it was 2 kilometers more than our original data would not be correct.

We find that in certain cases in earthquakes that are close by, have low acceleration, farther by they have higher acceleration.

In fact for the study of the Italian earthquakes someone pointed out there's some funny way in which the earthquake seemed to be peaking not near the distance but at some distance farther out.

I think all this points out that if we can at all possible avoid scaling, that's best.

MR. TRIFUNAC: But you would agree, though, that taking all this into consideration like we are talking about here, after we go through the averaging, we are talking about acceleration at distance, which is something like we see there.

MR. REITER: We are talking about 15 or something or the average.

MR. TRIFUNAC: But we are not talking about acceleration at 5 kilometers or less.

MR. REITER: Yes, I am saying that we are dealing -- the attempt was made not hide the uncertainty, but to deal with it; and to look at all the data within the range of uncertainty of the defined earthquake, the Giles earthquake, which would cause accident damage at the site.

Now, we picked the magnitude range of 5.3 to 6.3, and all earthquakes at less than 25 kilometers they were reported on rock sites.

And we did not attempt to scale it by any arbitrary method.

MR. TRIFUNAC: Well, if you look at these magnitudes they are surely less than 6.-something.

MR. REITER: I think 5.7 is the average.

MR. TRIFUNAC: Yuh.

So what is the average?

MR. REITER: 7 is the average.

MR. TRIFUNAC: What would be the size of the source for that?

DR. HAND: I have no idea.

MR. TRIFUNAC: If I picked up a number 5 kilometers would you disagree?

DR. HAND: I have no basis to agree or disagree.

MR. TRIFUNAC: Well, I am suggesting 5 kilometers. Make less than 10. Some earthquake with 6.4. You have lots of numbers here which are well below 6. So maybe 5, 10 kilometers in each case, on an average.

So if I take the epicenter distance (unintelligible) we are not in the near field for these earthquakes; we are outside.

MR. REITER: Again, the only thing I can say is we have uncertainty here that there's no way I know at this point for us to know -- no noncontroversial way -- of scaling in the near field.

MR. TRIFUNAC: All right.

MR. REITER: In attempting to apply that would put in another measure of uncertainty that I wanted to avoid.

That's the way it is. We have lots of uncertainties here and we wanted to try to pick at least the least controversial way to go.

MR. HUNT: To answer Dr. Zudan's question about correlation, we can look at three of them very quickly.

We have 62 that occurred 27 kilometers away, peak acceleration is about .3G.

We had a 61 at 9 kilometers, with peak accelerations of 06 to .12; and a 6 at 20 kilometers with peak acceleration of .14.

So just on those three I don't see any way that a correlation could be fixed.

MR. TRIFUNAC: Maybe just proved that my correlations are not good.

(Laughter.)

DR. HAND: We have 26 records used in our study and Reg Guide 1.60 is based on 33.

So they have only 7 more records than we do. Yet we are describing a very narrow range of mangitudes, distance and specific site limitations; they are making a wide range of magnitude, distance and sites.

If I may go on to some results that were obtained?

(Slide.)

Here we have a comparison of Sequoyah spectrum and Phipps Bend for steel for various site specific spectra.

Here we have our Phipps Bend spectra (indicating), the jagged line would be Sequoyah spectra (indicating).

We have several different ways we want to obtain site specific spectra, but the simplest way so far as computation is concerned, is simply to go in and do the 50th percentile for peak acceleration only.

It is .1G. Achor that to the Reg Guide spectra and see how we fall.

Here we have our anchor point (indicating) we come up on this long straight dahsed line (indicating) and up here -- and we are below the supporting curve (indicating.)

We can go very more site specific than that.

We can come in and take the selected earthquakes, perform statistical operations on a full period range predicted in the response spectra.

We do that based on the actual distributions. We will again find the mean will be down here (indicating).

And it will turn out to be this short dashed line that comes up here and down and over, and we've marked that on the drawing as 50%A; the "A" stands for actual distribution.

We could just as well determine any other percentile, and we have determined the 84th.

The 84thN and 84thA; again it is a short dashed line, and it is below Sequoyah, until it gets over down into about this range (indicating), which is around our 06 period. And then we start to move out.

The other approach that could be taken is to go back to the way the Reg Guide 1.60 was determined, normalize our record, anchor that normalized 84th percentile shape to our mean acceleration; in this case the 84th percentile shape would correspond to a rock site, records recorded within approximately 25 kilometers.

So that it would be a specific shape. And here (indicating) is 84 again, normalized. And the dots come in, and it's all below Sequoyah. It comes in and ties to about .1G again.

Based on this procedure we find if we use the 84 normalized it will be okay, if we use the 50 percent actual or some value higher than that, we woud be okay.

If we go as high as 84 actual, we wind up exceeding here (indicating).

To turn around and make the same comparison for reinforced concrete structures as Leon has been doing --

(Slide.)

-- we would have the same curve shown again. The Sequoyah is the jagged dotted line that comes down. Our 50 percentile here, anchored to the Reg Guide, is this solid, long broken line (indicating).

The 50 percent actual is down here (indicating). And the 84 percent actual comes up here (indicating); and our 84 normalized comes in here (indicating).

Based on this result we concluded that we could use any of the 84 normalized, the Reg Guide procedure, or the 50 percent actual or a slightly higher percentile, and it would be acceptable.

And we felt this justified the use of the spectra we used.

(Slide.)

The soil supported structures --

-- these were treated a little differently than what we did our rock supported structures.

Again, the design criteria for soils specified a type of rock; we amplified and came up through the soil that resulted in our peak acceleration -- peak ground acceleration -- that's about here (indicating).

Depending on the particular depth of soil, the particular response spectra changes; but over the range of structures that were soil supported, they fall somewhere within these bounds (indicating).

The Sequoyah rock spectra is shown here -- (indicating).

The 84 actual is shown as this dotted line. And the 84 normalized is shown as this dotted line (indicating).

In either case the soil structure envelope all rock spectra in the 84 normalized and the 84 actual -- we did not see any need to reevaluate any of these structures.

Now in development of response spectra for magnitude --

(Slide.)

-- this method was again suggested by working group support. Western Geophysical performed this work for us, where they go for the magnitude through various mathematical computations, and finally come up with a peak acceleration which we anchor; the peak acceleration later determined for our rock site was .08G; and they anchored a Reg Guide 1.60 shape, 208G, and that would be less than the design criteria that was used.

Dr. Dick Holt is here from Western Geophysical, in case you have any questions on this data.

Ninth, we calculated the probability of exceedence for various response spectra --

(Slide.)

-- this basically required input from the site specific specta, the standard deviations were dispersion of data, and it required some attenuation function to get the intensities historically reported, to a site intensity; we had to make a conversion between site intensity to a peak accleration.

We used several different conversions. We used the CSC approach.

And then we used the 84th percentile normalized shape we had for the amplfiication factors, that would relate to peak, with the anchor point (indicating).

In going through this particular study we cranked out a tremendous number of models.

One of the easy ways to compare these is the spectral acceleration versus the time period curve --

(Slide.)

A comparison is made here for only one period that we were interested in. The beta value is 1.312; the damping is 7 percent, the maximum intensity is an 8; and here we plot spectral accelerations; down at the bottom we plot the return period; and here we have the results of several different models.

The first model we used simply the CSC intensity acceleration relationship.

Then we turned around and used the other CSC relationship, one which we think is the historical CSC.

CSC gives two relationships: one relates only intensity to acceleration; one relates intensity and distance to the acceleration.

And then they have a conversion for historical intensities to magnitude.

We ranother one of CSC to Giles County. We ran another one where we put the maximum intensity in the province at a 9 instead of an 8; and we ran another one where we had what we call an I unlimited; and it winds up with very conservative results.

From each one of these models uniform risk spectral curves were presented and to date Leon has only the curves that deal with CSC. He does not have the ones that deal with the historical CSC or the Giles County limited.

Here we have a comparison on the maximum in the province, it's either an 8 or a 9; and we see here on the uniform risk here (indicating).

We go one step further and take the intensity 8, compare those to the various curves we are interested in, and we have this long broken line here for 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}.

We put on a Phipps Bend curve. We put on a Sequoyah curve. We put on a 50 percent actual, our 80 normalized and actual.

And as Leon indicated earlier, the Sequoyah curve does fall along the 10^{-3} and sometimes between 10^{-3} and 10^{-4}.

(Slide.)

We can compare the risk curve. This would compare what we did between the CSC formulation of what we call historical CSC, only we are now using distance in our attenuation function for acceleration; the curves are shifting, and shifting down for historical CSC.

And the shift that we are getting in the acceleration range that we are principally interested in is on the magnitude order of 3 to 5.

If we make a comparison then between these historical CSC curves and again a plant curve, --

(Slide.)

-- we'll see that Sequoyah, this is again this solid line, has now moved about halfway between our 10^{-3} and our 10^{-4} curve.

This reflects that 3 to 5 numbers we mentioned.

We want one more parametric combination, and restrict the Giles County earthquake to the Giles County area. We pick up another shift in probability. The uniform risk spectra are again compared with the original CSC, and again they are dropping.

And in this case they are dropping by a factor of about 10.

And it's easy to see up here at the very top (indicating) 10^{-5} to 10^{-6}.

Again, we compare with our plant curves --

(Slide.)

--and we wind up in this Sequoyah being the solid line; and it's fairly well paralleling this 10^{-4} curve (indicating).

So in essence, by shifting models we can shift our absolute probabilities by a factor of 5, with the other model we can do them with a factor of about 10.

Again the relative difference between the Phipps Bend site and Sequoyah site remain about the same.

As Leon was saying, in a wide range of parametric variations the relative probability remains fairly stable. And that again has been confirmed here.

Those essentially completed the probability studies that we were doing. The last two of those will be submitted to NRC, again by this mid-April date.

The next thing we performed is an evaluation of the OBE. This was in case our SSE was not accepted.

We performed return period calculations where we have return period and acceleration plotted simultaneously on the left and Modified Mercali on the right --

(Slide.)

(Indicating) -- the present OBE is half of the old SSE, so that is about 09G; and it will come up into this area (indicating) which corresponds to something between 1500 and 2000 year return period for the OBE.

As Leon stated they have found that our return period or probability calculations for the OBE are acceptable.

The other point that can be made in this particular slide is the difference between the Phipps Bend and the Sequoyah plant site; this comparison is for the Sequoyah - Watts Bar sites, Bellefonte site; they are very close in their return period curve.

We also have another plot --

(Slide.)

-- which has them on the same line as these two.

So under the guidelines we are using now we can shift virtually anywhere in that province for return periods.

Studies TVA will perform or has performed and will submit, one is the additional probability study; those are the historical CSC and Giles County.

We have another report, the determination of site specific response characteristics. This is work by Western Geophysical during the spring and summer, they instrumented six selected locations.

One was at Sequoyah and one was at Watts Bar, and four other sites near those particular two.

And they listed, recorded, for about two months any activity that they could pick up forthe site specific response characteristics between these six sites.

During that time we did get several recordings from rock blasting in the area; and some distant earthquakes were also recorded.

The data has been processed and studied and their report is now ready and will be submitted.

The basic conclusion from this study is that all the six sites selected and all six were on bedrock, Sequoyah is either near the mean or below the mean in earth response characteristics for the particular site amplification.

This would imply that of the six sites that were selected, Sequoyah is a well-behaved, relatively low response site; and this adds credence to one of our assumptions: that instead of using an 84 percentile normal distribution, we could use the 50 percentile actual, instead of the 84 percentile actual that Leon and NRC want.

Number 13 is the Southern Appalachian Techtonic Study. This again was one major area that was pointed out in a working group report. They said it would take a tremendous amount of money and a tremendous amount of time to do the study.

We have had a study going on. We are presently prepared to submit that report.

And in this study of the Southern Appalachian Techtonic Province we performed a geophysical, geological study; it's been conducted to delineate basement techtonic structure in that region, regional magnetics and gravit y data are collected for the study. They have been correlated with seismicity, surface structures seen on satellite photos and other related geologic data, into an integrated analysis of the data set.

Examination of the basement derived from these studies shows precambrian crust underlying bolted Appalachian and younger rock in the adjacent geologic province have a much more complex structural pattern than was realized.

This pattern defined a series of techtonic subdivisions or provinces on the basis of geology and structure.

And we further go in the study and conclude it is the opinion of TVA and its consultants that the results of this study strongly suggest the existence of of an east-west trending techtonic structural boundary; this would constitute a techtonic structure as defined by appendix A, with which the 1897 Giles County earthquake was associated, and to which a reoccurrence of an event of this magnitude would be restricted.

This in essence would isolate Giles County again to the Giles County earthquake.

It is furthermore felt that the existence of a long northeast trending element transected by three northwest trending elements as defined by multiple sources of data serve to develop a techtonic subdivision; and these would constitute techtonic provinces having sufficient different seismic characteristics; as such the previously imposed classical interpretation of Giles County and Sequoyah all lie within the same southern valley ridge techtonic province is not warranted.

The basic conclusion drawn from this last study would be that the Giles County event would not have to be translated to the Sequoyah site. As a result the largest other earthquake in southern Appalachia would be a 7, not an 8.

Using the current Staff procedures, Trifunac and

Brady, we get about 413G, with Reg Guide 1.60 again supporting us.

Again, NRC has not had time to study either 13 or 12; they will be submitted by mid-April.

Based on all of these 10 and these additional 3 items, TVA concluded that the basis used was justified; NRC did not and required the 84 percentile. TVA is using the 84 percentile.

DR. MARK: Supposing this realignment of techtonic regions were accepted, where did this magnitude 7 occur and when?

DR. HAND: Intensity 7.

DR. MARK: Where did it occur and when -- just to get ready for some new names?

(Laughter.)

DR. HAND: If I am not mistaken there's more than one.

DR. MARK: And in recent times?

DR. HAND: I think so. I know we have 120 years of record.

MR. ZUDANS: A question that is probably derivable from missing something important:

Where was this lognormal distribution you used, and what quantity was it? I must have missed some point.

DR. HAND: When we calculated the response spectra for each of the 26 components that were used.

MR. ZUDANS: Yes.

DR. HAND: They were all tested down to lognormal and normally distributed, depending on what period you are interested in, whether you want to talk about actual spectra or normalized spectra; they show a preference for being lognormal about 2 to 30 or more.

So that all we are using it for when we are establishing these 50 percentile and 84 percentile response spectra curves; that represents a mean plus one standard deviation.

The mean and standard deviation is calculated using that lognormal distribution.

DR. ZUDANS: Okay.

DR. HAND: And if we use the normal distribution as far as the mean curve goes, the mean normal 50 percentile normal, is above 50 percentile lognormal.

The 84 percentiles were above or fairly close. They are within about 100th of a G of each other.

But at the same time the 50 percentiles are within about .003 of a G.

MR. ZUDANS: Now, if one would look at your calculations where you made this decision of lognormal with normal, is that argument fairly convincing?

DR. HAND: We believe it is.

It is convenient to lower it, but even at the .13 level, you use the 50 percentile.

MR. ZUDANS: Yes.

DR. HAND: Now in response to the six questions, this is in response to questions 3 and 4. We have plots for four selected periods that we go across that give a damping ratio and we show histograms of how the data is actually distributed, how we assume it to be distributed, whether we assume it normal or assume it lognormal.

And we run other statistical tests on it to see which is the better distribution.

MR. TRIFUNAC: Can I make a comment?

If you do this -- what they are doing -- normal distribution is terrible.

If you do it lognormal distribution,it looks all right. But if you make a couple of tests you find it is not acceptable either. Neither normal or lognormal are permitted on KS. But lognormal is much better than normal.

MR. ZUDANS: It is a convenience.

MR. TRIFUNAC: Not necessarily.

DR. HAND: The easiest way to visualize the normal is not a very good distribution. If my mean is .13 and my standard deviation is .1, what happens if I want to go two standard deviations below?

MR. ZUDANS: A negative.

DR. HAND: A negative.

MR. ZUDANS: That's why I questioned the number for the data point for this type test.

DR. MARK: Does that conclude the seismic thing as it is today?

DR. HAND: Yes, sir.

DR. MARK: We will go on to the next item, which is a commentary on the SER.

Is it possible to highlight that, Silver?

MR. SILVER: Yes.

DR. MARK: That's fine.

MR. SILVER: I will try to do that, yes, sir.

DR. MARK: Thank you.

MR. SILVER: Suppose I concentrate for a moment on the 1.6 items, that is, the outstanding issues.

The first of those items is bolted connections and supports, which involves a question of support flexibility in transient loadings.

We received a report from applicant on March 5 in response to our questions. We have started a review and expect to be able to report to the full committee. It's a rather lengthy report.

We do resolve to expect to resolve that issue prior to fuel load.

Please stop me at any point.

The second item is qualification of instrumentation or equipment, which has got two parts, Westinghouse equipment and balance of plant equipment.

We are reviewing specific information received on Sequoyah regarding the Westinghouse equipment qualification; and I hope we can in fact report to the full committee and resolve this for Sequoyah prior to fuel load.

I have nothing new essentially to report on that item now.

On the balance of plant equipment we are waiting for information on one item, a containment isolation valve, which we expect momentarily.

And we hope that this will be resolved shortly. We expect it will based on verbal information on hand.

The third item is fire protection. On this one we have essentially completed our review. We had a site visit and questions to the applicant.

We have a preliminary and revised response from applicant, and will have a meeting to resolve any open issues.

We believe all issues but one are resolved at this moment, that one issue being a question of fire dampers in AC ducts where they are planning fire barriers. There are no dampers in many places, or some places -- I don't know the number.

We do not have a specific schedule for completion of various items, but applicant has indicated he will physically implement as many as he can before fuel load, and will provide a schedule for those items not completed by fuel load; and the license will be conditions to assure the completion of those items.

They are committed to implementing interim fixes for those items for which a final fix is not fully implemented. This interim fixes may of course involve administrative procedures and things of that kind until the final physical fix is made.

The next item is the radiological emergency plan. On that one we have asked Sequoyah to respond to a number of questions which were asked on the Watts Bar docket and which are also applicable to Sequoyah.

TVA did respond in late February, and provided a revised emergency plan.

And I understand there are additional responses to additional questions on Watts Bar again also applicable to Sequoyah, which are due March 20.

We will review all this material and expect to complete our review prior to the full committee meeting; and we will be able to report at that time.

Acceptance criteria for plant trip test; we had requested information on acceptance criteria on turbine trip and generator load rejection tests.

Essentially we want a comparison of test resul's with realistic predictions of other plant response. We have had recent telephone conversations with Westinghouse and TVA which indicate that the response is imminent and will be satisfactory.

We hope we can in fact report acceptance at the full committee meeting.

This item is now essentially a confirmatory item in my view.

MR. ZUDANS: I read this in section 14, and to my mind it is not clear:

What tests are we talking about?

MR. SILVER: We are talking about a turbine trip test.

MR. ZUDANS: Running on the reactor?

MR. SILVER: Right.

And the criteria now are sufficiently specific, the criteria for acceptance are specific enough so we understand what is being looked for.

MR. ZUDANS: Well, the test is to trip the turbine?

MR. SILVER: To trip the turbine.

MR. ZUDANS: What does it mean, trip the turbine.

MR. SILVER: I don't know what is physically done.

MR. ZUDANS: Is it to cut the load off the generator?

MR. SILVER: That is the second part, yes, to remove the load.

MR. ZUDANS: Okay.

VOICE (TVA) You trip the generator and you look at various parameters to see whether or not --

MR. ZUDANS: In case of a major accident.

MR. SILVER: The test was to be performed and always was -- it is not a new requirement.

MR. ZUDANS: Yes.

MR. SILVER: It is simply an understanding of the plant response that we are after.

DR. MARK: Could we hold back a minute to change the tapes?

(Pause.)

T5

MR. SILVER: On Section 1.7 of the SER, the first item is single failure; and, again, the point is to assure that pump suction is maintain in the event of the failure of either of two isolation valves in series.

For the first cucle the applicant has submitted to provide a dedicated operator to monitor flows during shutdown.

If we find this acceptable, we'll consider the item resolved.

The second item is pressure limits for heatup and cool-down. We are still waiting for information from the applicant on that item.

I understand TVA expects in April to obtain that; so we will not be in a position to report on this at the ACRS meeting, but we do expect it to be resolved prior to fueling.

Number three, in-service inspection of steam generator tubes; again, applicant submitted to provide a steam generator inspection program per Reg Guide 1.83.

We find that acceptable and consider this item resolved.

Number four is cold shutdown using safety grade equipment.

We will identify further requirements or further information needed to the applicant very shortly. We are still reviewing their response.

We will require a commitment to do a natural recirculation test to demonstrat boron mixing and heat removal capability, unless applicant can justify that same test performed on other plants is acceptable for this plant.

And we would like to see the ability to manually open the steam generator dump valves, which is one of the procedures that would be required.

We hope to report to the full committee on this item, but we do not have a schedule at this moment from the applicant.

Item 5 is design of steam generator and pressurizer supports.

We requested verification that asymmetric loads in the tube compartments of the steam generator, pressurized compartments, have been considered in the design of supports.

We understand that analyses are being performed to verify this; and we should have results by April 1.

I don't think we can complete the review to make anything but a brief report to the committee, but we will resolve it prior to fuel load.

No. 6, two parts:

Basically, containment response to a steam line break; we have an assessment from Westinghouse that the analyses performed downed the containment response to small breaks. We have asked for and expect a response by applicant by April 1.

We will attempt to report to the full committee.

The second part of that is environmental qualification of Westinghouse equipment; and of course the connection is to be sure the temperature qualification of equipment in the containment is acceptable relative to the containment temperature response.

Upper head injection preop tests; I believe this was discussed a little bit earlier.

The tests have been done. We have not found any problem with the results, but one, namely, verification of the acceptance criteria of the amount of nitrogen carried over.

Applicant has reported nitrogen carryover in the tests with something around 1 to 1-1/2 percent, if I remember. The acceptance criteria is quoted for a fraction of a percent; but the source of that criteria and justification of it has not been provided.

We have asked for that, I assume it's justifiable and we will accept it.

Item 8 is the containment sump.

Applicant has performed an extensive scale model test, and we have reviewed their reports and witnessed a couple of demonstration tests under a variety of conditions.

In Amendment 60 received just a few days ago applicant responded to our most recent concerns and our preliminary review of that material is that it is acceptable, although we may request additional information.

But certainly it is well on the road to resolution, and we do expect to clear it shortly.

Item 9, bypass safety injection signal.

The concern is a line break in a residual heat hold system during normal shutdown when the safety injection signal is blocked and much of the ECCS equipment is bypassed.

Applicant has stated sufficient time is available for operator action to respond to such a break; and we expect to get a reevaluation from applicant by March 15, and hope to resolve fully by the ACRS meeting.

No. 10 deals with LOCA analysis which has been submitted, going to an approved model. We requested additional information to verify analysis; also awaiting on how some small breaks where there is a possibility of the pressure temperature limits may be violated after 27 years of radiation.

This will not be an immediate problem, but it may result in some sort of license condition.

MR. ZUDANS: Did you say something about improved modeling?

MR. SILVER: Yes.

No, approved.

MR. ZUDANS: Oh.

MR. SILVER: We do have a draft response to our various requests which was received March 8, just a couple of days ago; and we hope to be able to report to the full committee.

The next item is response time testing.

They will submit general and detailed test procedures on selected items to measure channel response time including the sensors.

We find the general procedures acceptable but there's some information we would like to have on detailed procedures.

I believe that has been communicated to applicant and we expect to have that information shortly.

We can give a report to the full committee on that item.

Isolation valve -- item 12; we require removal of power during operation and during shutdown to avoid spurious operation of the cold leg accumulator isolation valve, and the lock valve in the suction line from the cooling water storage tank; and we also require continuous position indication for these valves.

The original design was design was such that when power was blocked out the position indication was lost. The design has been modified by applicant. We have reviewed the design and find it acceptable.

So this item is resolved.

Item 13, post accident monitoring separation criteria.

Applicant has committed to providing adequate separation for redundant channels. I believe it's described in section 752 of the SER.

We will review the implementation of these criteria on our site visit currently scheduled for April 2.

So we can have at least a flash report to the full committee on this item.

No. 14 is environmental qualification of balance of plant equipment.

The first part of that is a bookkeeping item, essentially involving erroneous entries in various tables which have been modified by applicant, and received just a couple of days ago.

That is under review.

A major part of it has to do with an environmental monitoring system that we require to assure that balance of plant equipment does not undergo environmental transients beyond the qualification levels of the equipment.

The applicant has committed to provide such a system in the aux building by the first refueling. That commitment is acceptable, but we feel that a similar system should be provided in the ERCW, that is essential raw cooling water building, and diesel generator building; or applicant should justify that no systems are required.

For the first cycle until the permanent monitoring system is installed, we will require interim procedures involving temperature monitoring and logging on a daily basis, as we have done on a number of plants.

If the qualification temperatures are exceeded we would want a report from the applicant to that effect, and would require performance of analyses to demonstrate that the equipment is still acceptable.

I believe applicant has indicated verbally he will comply with this requirement.

And on the assumption that can be done, we will close this item shortly.

No. 15, diesel generator and remote shutdown testing.

Applicant expects to submit within a few days information addressing the testing requirements. We will review and report on those items to the full committee.

Based on verbal information we feel the response will be acceptable, and that item can be closed out.

No. 16 is boron dilution.

We are awaiting additional information on boron dilution events during shutdown, including a discussion of mitigating systems, protection methods and margin to criticality.

At the moment we do not have a schedule from the applicant.

The last item in that group is long term effects of steam line break.

We are reviewing draft copies of mitigating procedures designed to minimize such consequences. The procedures appear satisfactory and we expect to report the resolution to the full committee.

That completes my comments.

I do have one or two on the Staff positions, if there are no questions on the confirmatory issues.

(No response.)

DR. MARK: You may proceed.

MR. SILVER: Item 3, re-ctor vessel overpressurization.

The applicant has provided new coolant values from Westinghouse for the first cycle showing the reactor vessel could be pressurized to the relief mode setting at 100 degrees during first cycle without significant probability of vessel rupture.

Operating procedures have been provided to minimize in such an event.

On the proviso that an alarm is provided to indicate to the operator that such an event is occurring, we will accept that situation.

No. 4 in that group, applicant has indicated a loose parts monitor will be installed prior to fuel load barring any unforeseen events.

They described the equipment they propose to install and we find that equipment acceptable, if the equipment is in fact installed there will be no need for a license condition.

By way of summary, we will have one open issue resolved by the ACRS meeting and four by fuel load.

As far as the confirmatory issues, we have three resolved now, we will have five more resolved by the ACRS meeting, and an additional five will be resolved by fuel load.

That completes my remarks on the open items.

DR. MARK: Are there comments you wish to make on this point?

MR. GILLELAND: We agree with the general assessment as made by the Staff.

We will be working with the Staff, there are some things to be clarified between TVA and the Staff; we will provide the information which they are asking for.

My expectation is to get to them all the information by April 15.

There are I guess three items, confirmatory items, which are going to be fairly tight, item 2, item 6, and item 10.

I hope further discussions between TVA and Staff will help us to clarify these so that we can get that information in.

In summary, we generally agree with the assessment which the Staff has made.

DR. MARK: I take it this wasn't the first time you had heard about those?

(Laughter.)

MR. ZUDANS: I have one question for both applicant and staff.

No. 2, confirmatory items, what is it concerned about?

MR. SILVER: We are wanting information from applicant to verify that the pressure temperature limits selected for heat-up, cool-down use a prediction that we accept for the no ductility transition reference temperature.

MR. ZUDANS: Is this some new set of data Westinghouse is trying to offer to you, or is it the same old data?

MR. SILVER: If I recall, and I am not sure I remember this perfectly, I think it's what they originally submitted.

VOICE (WESTINGHOUSE): Mr. Zudans, I think you are probably aware that Westinghouse over the years had developed procedures and those are less conservative than the curves put out by Staff in Reg Guide 1.99.

Staff has asked that the pressure temperature curves be reevaluated using the more conservative data.

We have submitted to Staff in the last year additional data indicating perhaps Reg Guide curves are conservative; but we've not heard of that evaluation.

MR. ZUDANS: You have not been able to sell that to them yet, huh?

VOICE (WESTINGHOUSE): Not as yet, sir.

MR. ZUDANS: Okay, I hope you do -- if you are :ight.

MR. GILLELAND: There was one outstanding question by Dr. Zudans on the buckling of containment.

VOICE (TVA): The question as I understood it was how the non-axis symmetric pressures were accounted for in the design for stability.

I will attempt to answer that -- I say attempt because I don't have the report that's about four inches thick; and I am relying on my memory of work done about four years ago.

The principal load that contributes to buckling was the LOCA condition. There were 12 cases TVA evaluated, six hot leg breaks and six cold leg breaks.

We did dynamic type analysis for each of these 12 cases.

A word about the containment:

It is a welded steel structure and there are external circumferential stiffeners on this. The density of these stiffeners are about five feet apart; the stringers or vertical stiffeners are about four feet apart. We have panel of about 4 feet by 5 feet.

We did linear dynamic analyses for the 12 cases. We calculated the maximum stresses for all these cases, and then used those results to evaluate LOCA buckling.

LOCA buckling is buckling of the stringers and circumferential stiffeners.

We evaluated not only that the panel buckling in between stiffeners. We looked at gross instability, and in that case we did nonlinear -- referring to geometric nonlinear -- dynamics stability analyses for the critical load cases.

In all our work we found it to be acceptable in regulatory positions on stability.

I don't remember all the details about the margins. One I do remember is for the gross instability, which is the one that is most important; we had a stability for a factor or a load multiplied by a factor of five.

In other words, a factor of safety of five.

MR. ZUDANS: I am glad to have your comment. I had the benefit of conversation in the intermission on this subject.

I am going to get a report on this from NRC, because the factors mentioned are really not factors of safety. They are skewed to the classical buckling load. And there is a factor of translation missing which would translate the classical buckling load into the buckling load of a real structure which is not perfect by geometry.

There is a question of nonlinear dynamics analysis that may be better than the classic buckling; in fact, it might be better than that. So maybe the five is quite adequate.

But I also was told that the local panels in some cases they have as little as five or two in classical buckling loads; and those might be questions.

So I like to review my opinion on the point until I have a chance to review the report.

VOICE (TVA): I hope I didn't tell you the factors were 1.5 to 2.

The best of my memory --

MR. ZUDANS: It doesn't matter.

VOICE (TVA) I think they are considerably above 2; I don't remember the factor though.

And we'd be glad to send you the information.

DR. MARK: Do you have further points?

MR. GILLELAND: Yes, Dr. Mark, just the outstanding questions, Dr. Catton raised when he was here.

We will review the transcript on that, and I think there are one or two references that he wanted that we will get.

And the questions that remain unanswered, I would propose we bring those in to the full committee meeting, if you think that's the proper approach?

DR. MARK: Providing I guess that they can be done in encapsulated form.

I don't think we would like to leave ourselves open to a long presentation in connection with all these questions.

MR. GILLELAND: We are open to any other suggestions, but I think the thing for us to do would be review the transcript.

DR. MARK: Yes. It was only your last point of bringing it to the committee.

I would say fine, providing they are conveyed in a short package.

MR. GILLELAND: Fine.

DR. MARK: I have a question, and I'm not sure whether it's Staff or TVA. You realize it isn't terribly urgent.

But I was really fascinated reading I guess in the SER and hearing it again this morning that if you had a 40 foot flood, that's the maximum -- not permissible, but imaginable -- that would be 30 feet higher than anything in recorded history.

Also, 20 feet higher than the bottom of the doors to the plant.

Well, I guess this has been looked at to assure that the things which have to be kept free of flooding will in fact stay free of flooding, because of watertight doors.

Anyway, they can be kept free of flooding, and the things that will flood won't jeopardize the safety of the thing as it is sitting there.

I guess that understanding is --

MR. SILVER: Yes, that's correct.

DR. MARK: Well, my question then is:

How deep is the water in Chattanooga at this time?

(Laughter.)

VOICE (TVA): That's a good question. Using the evaluation model, it's over 50 feet; and that puts the flood level to the four-story level in Chattanooga.

DR. MARK: It's only to the second-story level at Sequoyah.

VOICE (TVA): Yes.

DR. MARK: There was one or two other items, really quite incidental, I am sure.

Sometime within the last year Westinghouse discovered an arithmetical flaw in the code by which they made the estimates of the UHI behavior; and the effect was that they were -- let's see -- temperatures on this account would run a little higher than as the code had incorrectly stated before.

But there were other things and the net change was not really a large affair.

Have those changes been fed into the revised estimates of UHI behavior in the Sequoyah system?

VOICE (TVA): Yes, they have.

DR. MARK: So the numbers we either see or behind what you tell us are corrected.

VOICE (TVA): Yes.

DR. MARK: One last point:

Most of the comparisons that I remember being referred to today at least between Sequoyah and other plants at least many of them had to do with D. C. Cook, because I guess it was the plant with ice.

McGuire, I wondered if it was even closer parallel to Sequoyah, but of course it isn't operating.

MR. GILLELAND: That is correct on both parts. It is a closer parallel to Sequoyah, although there are some differences in the ECCS modeling area.

DR. MARK: It might be a matter if it could just be covered in a sentence or two to plan to include McGuire in the sort of familiar comparison items, perhaps saying the differences are small, or the differences exist only here and don't amount to much, or whatever that situation is.

Cook is a little further away than an awfully close comparison in some respects.

Am I right about that?

MR. GILLELAND: Are we talking ECCS or across the board?

DR. MARK: Well, across the board, I guess.

The committee I am thinking has fairly recently dealt with McGuire, and so it would be in some respects a more convenient peg-point for comparisons.

MR. GILLELAND: It is a more convenient peg-point and I quite honestly can't think of anything significant in terms of an SER review in the way of differences between the two plants, except in the ECCS area, where there are some slight differences in the steam generator and in the reactor vessel.

That leads to small differences in the peak clad temperature, and may well lead to McGuire easing up with the 232 peaking factor, whereas Sequoyah is a 2.25.

DR. MARK: Well, I think my point was, since this is more recently in mind, it would be a good comparison. I am not trying to say D. C. Cook is bad.

That's the only point, and again not wanting the explanations to be very extensive.

Now, the fact Cook is operating with ice means it's got some features and you might use it, too, for at least those things where operating experience might seem nice to refer to.

Let's see, what else do we have?

(Pause.)

I believe this is the schedule for the next meeting.

MR. MATHIS: We are listed as more or less pending or unresolved -- apparently that's going to be diminished substantially by that time; and it will be down in a workable pattern and number.

So I don't have any particular items; no.

DR. MARK: Would this seem out of place to you?

(Indications of assent.)

We could put this on the agenda.

And we'd like to have a shorter session on it at some time that I don't know yet in the course of the April schedule. Maybe April 5 or 6, but I guess we'll have to let the chairman decide, or Fraley, decide how to phase it in.

A number of points which I don't know whether I want to attempt to discuss here -- we would like the emphasis to be in places where one could treat this more lightly.

I have a few ideas -- or I could leave it with Savio to convey to principals.

What would be your pleasure?

MR. SILVER: Either way would be satisfactory with us.

MR. GILLELAND: That's agreeable.

DR. MARK: I could mention the things that cross my mind, but Savio would be a better and more permanent authority on how to parcel this out.

I think that -- and also I'll have to confer with Mathis in case I put something on he doesn't want to hear.

I think in the items we were both rather impressed with item 2.2(d), TVA's very strong position, at least as it came through to us, on the training at all levels of its personnel.

There have been times in the past when we have felt that wasn't handled so well. I think the other committee members will be really pleased to at least get the feeling for that.

Again, of course, nobody is going to be interested in numbers of people or details, but just the solidity of that program.

Obviously, we will want to hear what there is new to say about the status of the plant, but perhaps rather less about the plant organization.

MR. GILLELAND: Right.

DR. MARK: The status will have changed.

I don't know, it's probably heretical, but I at least would say you could skip the QA and QC programs, as a presentation; but if there's somebody who could say it's well in place, that might be good.

Incidentally, of course, it is also not totally specific, but I believe in a general way your way of going about that have been brought up before.

I think that very little on the emergency plans, beyond the fact that they are in place and are similar in nature and coverage to ones that have been discussed before, with the various State and Federal and local areas are all in touch and are already discussing how things are supposed to proceed.

It wouldn't need to be a very long listing of those things, though.

MR. MATHIS: I think industrial security should be hit. That's a very sensitive subject.

And again briefly outlining your program.

DR. MARK: Yes, what we heard today I believe was about right?

MR. MATHIS: Yes.

DR. MARK: Coming into item 2.3, a little bit at least on the ECCS and UHI, because it is a novel feature; but it is not absolutely the first time. And in there, of course, the reference to McGuire might be useful; because the UHI itself I believe is not basically different.

There were some very interesting things -- oh dear, I've lost the names -- that were said on your approach to containment.

That doesn't have to be totally described, but at least its characteristics, I think would be good to hear.

And then the fact that you are having such straightforward and simple experience in loading the ice.

(Laughter.)

Everything is now in hand in that respect.

This would I believe drop a number of 10-minute items out of that package 2 for applicant.

We obviously want to hear what you say, Silver, about the scope and status.

Seismic will have to be on the list. But I hope it can be kept within an hour rather than three.

Where things stand, like where you brought out the exceedence probabilities, the variations of approach, that chart, would be the kind of thing to head for, or to have carry the main impression.

Now, you've done a great deal of analyses, what 13 questions -- I don't think apart from the fact you have done such things that we would necessarily find it useful to have the studies presented; although questions no doubt should be answered.

Mike, do you think this should be said differently?

MR. TRIFUNAC: No, except that I wish there was a way to justify the difference between other seismic provinces and this one; so that five years, ten years from now the question doesn't raise: why this is .18 and this is .25 and the other one is something else.

They have gone through all the work to show that this is not such a bad number. But the thing is the number stands as a different number.

DR. MARK: Now, let's see, Phipps Bend, is that .2?

MR. TRIFUNAC: I don't remember the names.

You have the same geological province and the same earthquake, and the ground motion varied. So can we find something that is comfortable for them and NRC and everyone else?

Today it came out more like a defense, and I would like the whole thing in proper perspective.

DR. MARK: I agree with you, although I don't have a suggestion to them as to how they could do it.

MR. TRIFUNAC: If they could think about it from that point.

DR. MARK: It would, because there's a need of comment or possible need of comment on this question.

I don't know, part of it is just a change of rules.

MR. TRIFUNAC: That's right, and we see things now with changes of rule that are now ten years old or more, and we look at them again; and we spend more money looking at them again and reevaluate.

Maybe something can be gained by doing it now and asking it again in future ever.

DR. MARK: I don't know, this isn't very useful to you as guidance, Mr. Gilleland, but I guess we've said what we can about what we'd like to pick up from that.

MR. GILLELAND: I think we heard what was said. I am not sure right at the moment how to respond. We will give some thought to it.

DR. MARK: And of course some of the examination which has just started -- there have been conferences, studies that will proceed -- will indicate that this plant has a margin not specifically tied to some specified G value, I guess.

MR. GILLELAND: We will certainly have a complete presentation on the structure.

DR. MARK: I think we will certainly want to hear anything that's fairly firm out of this extended review program that will be helping a little in that direction.

Well, anything that would make this seem explained as clearly as possible, how it came about and so forth.

Let me suggest as further things come up, Savio will explain the positions to you.

Is there anything else to raise, Silver?

MR. SILVER: No, sir.

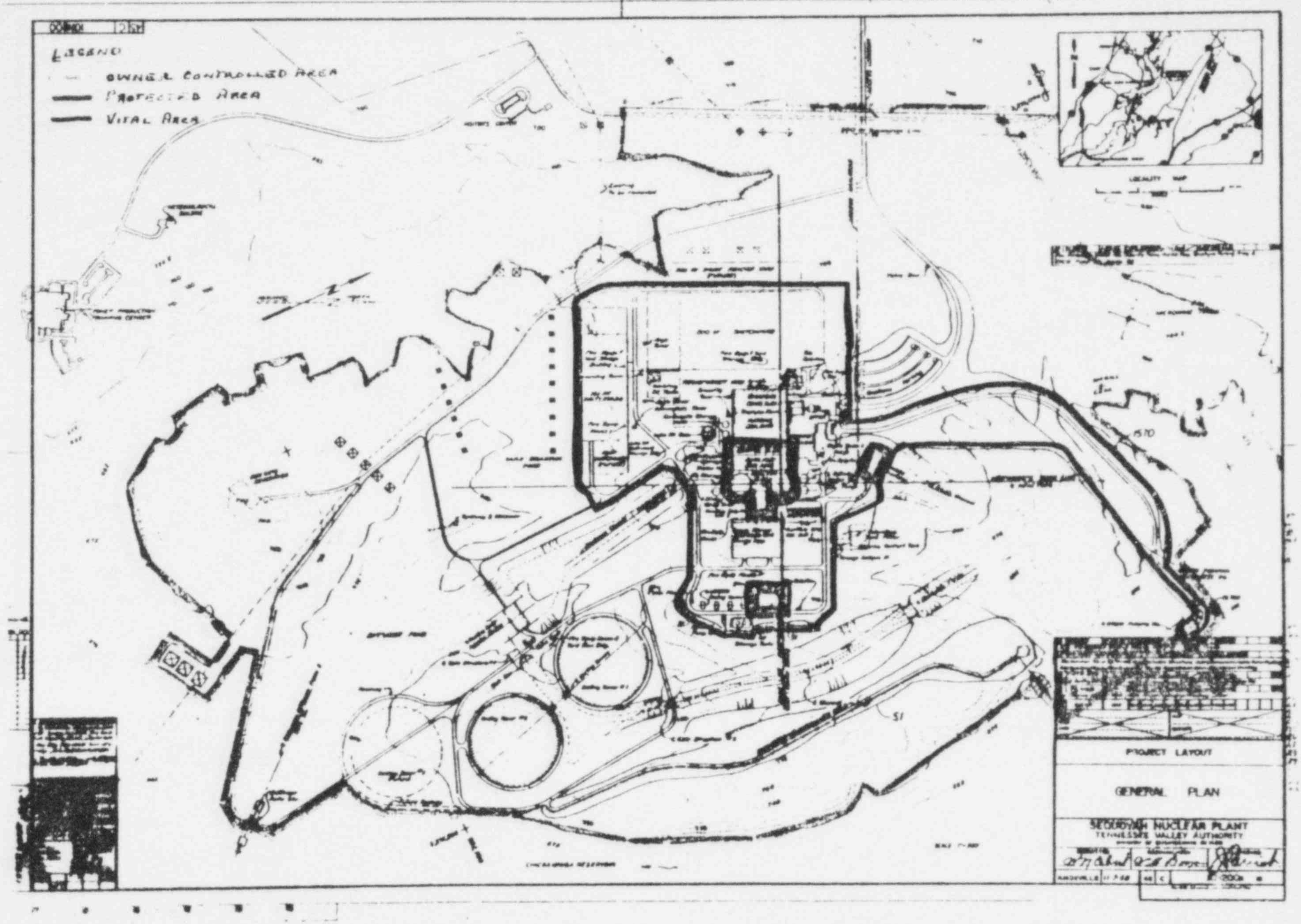
DR MARK: Anything else, Mr. Gilleland?

MR. GILLELAND: No, sir, I have nothing else.

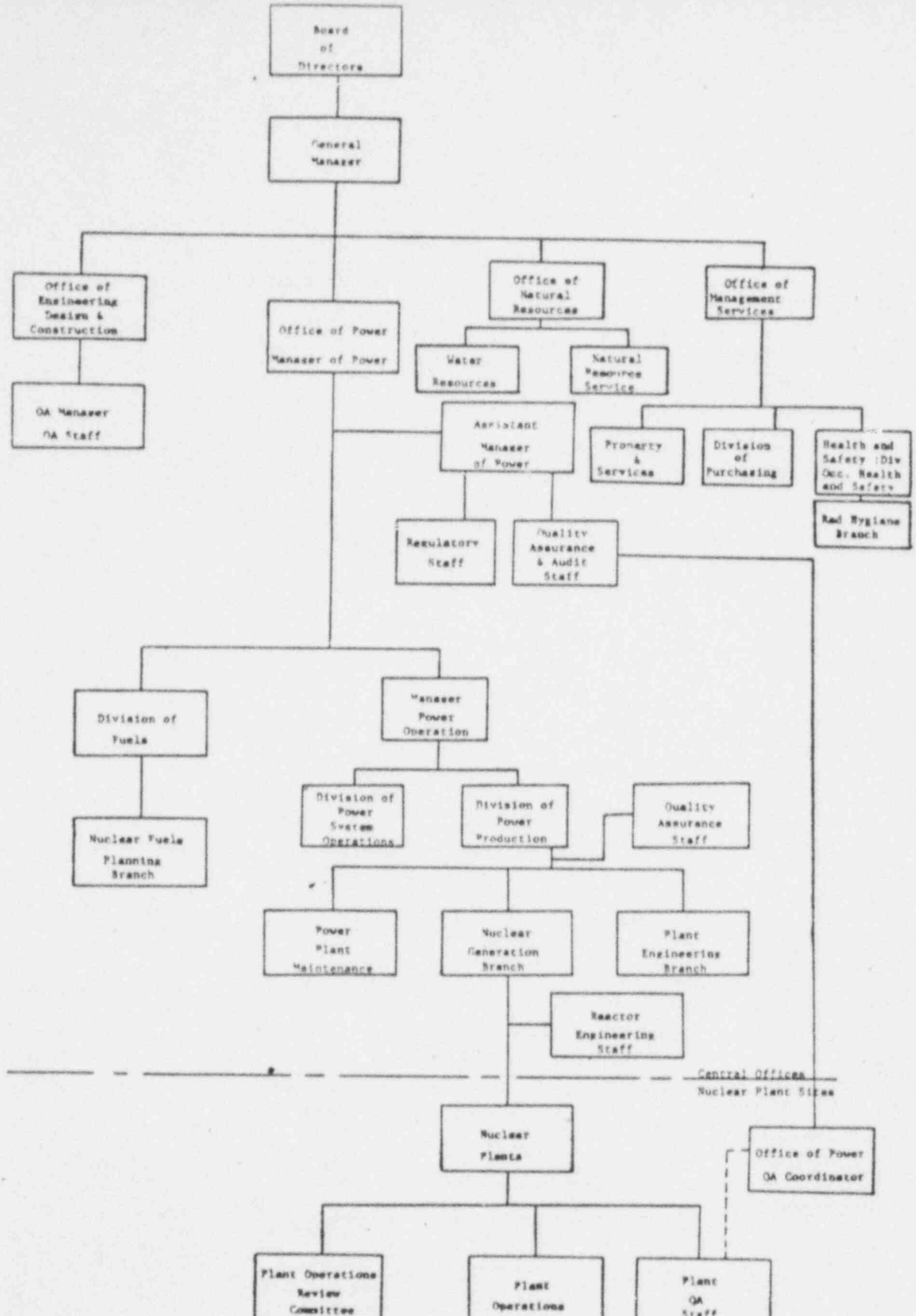
DR. MARK: Okay.

Thank you very much, Staff and particularly Applicant, for trying to help with this. We'll see you in three weeks.

(Whereupon, at 5:25 p.m., the meeting was adjourned.)



LEGEND
OWNER CONTROLLED AREA
PROTECTED AREA
VITAL AREA
LOCALITY MAP
PROJECT LAYOUT
GENERAL PLAN
SEQUOYAH NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY



— Line of Communication

Figure 17.2-1 TVA Organization for Operational Quality Assurance (Revision 2) 8-78

2

TVA ORGANIZATION	QA ORGANIZATION	ORGANIZATION LEVEL	QUALITY ASSURANCE DOCUMENTATION
OFFICE OF POWER	QA & AUDIT STAFF	CORPORATE	FSAR CHAPTER 17.2 - TOPICAL REPORT (PROGRAM DESCRIPTION) QUALITY ASSURANCE MANUAL (POLICY)
DIVISION OF POWER PRODUCTION	QA STAFF	OPERATING DIVISION	OPERATIONAL QUALITY ASSURANCE MANUAL (REQUIREMENTS)
NUCLEAR GENERATION BRANCH		OPERATING SUBDIVISION FOR NUCLEAR	NONE
SEQUOYAH NUCLEAR PLANT	QA STAFF	OPERATING PLANT	WORK INSTRUCTIONS

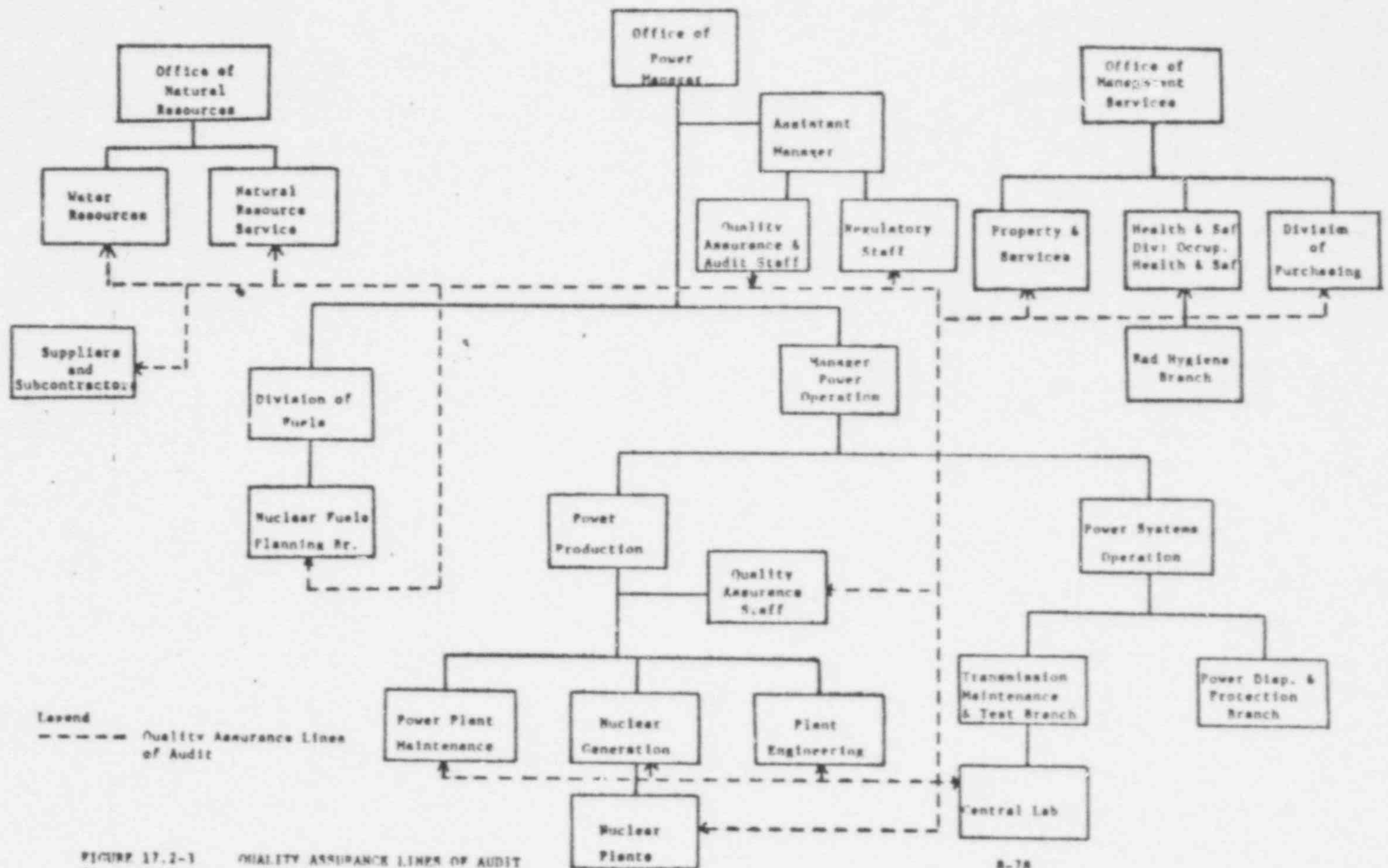
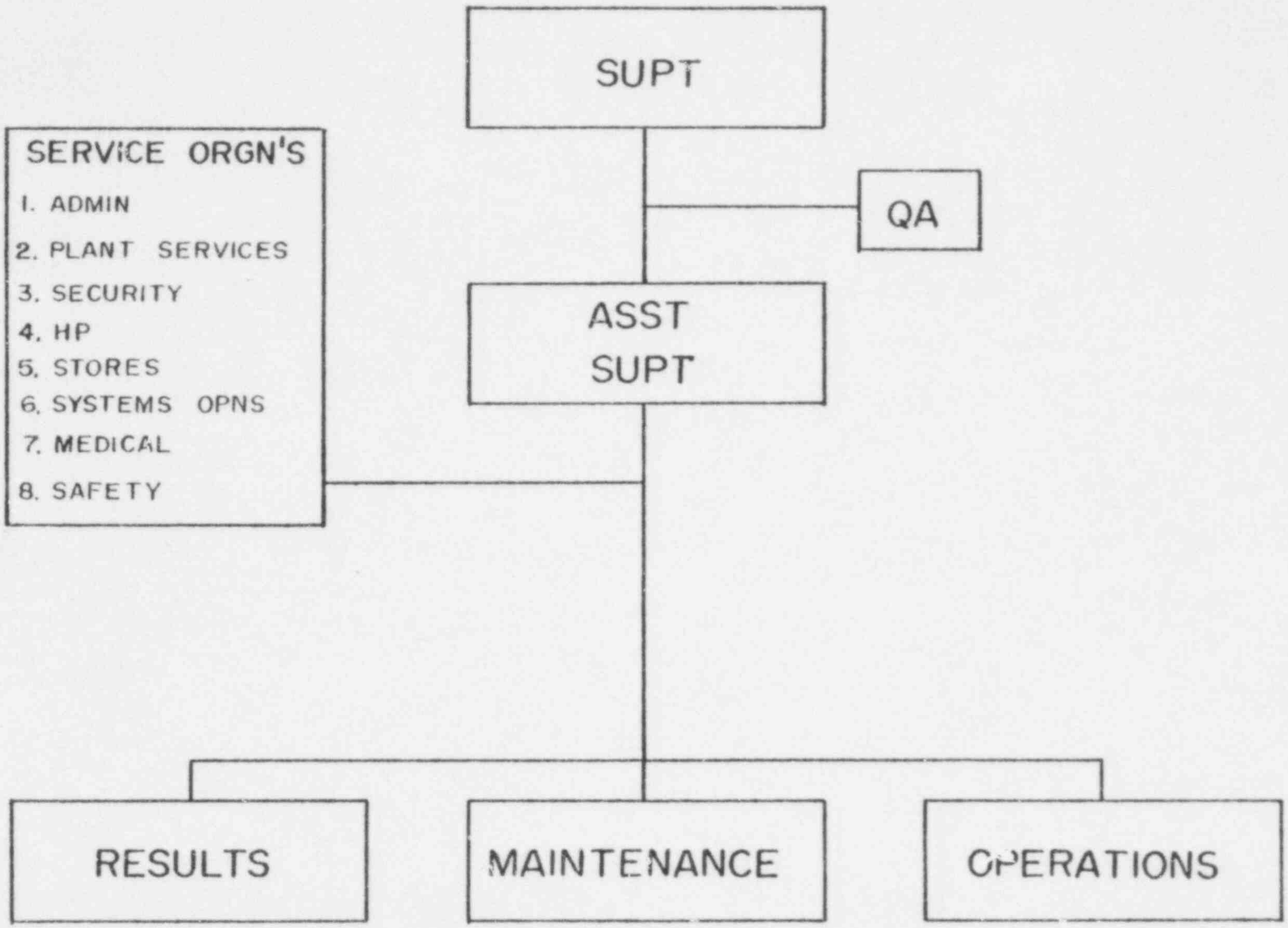
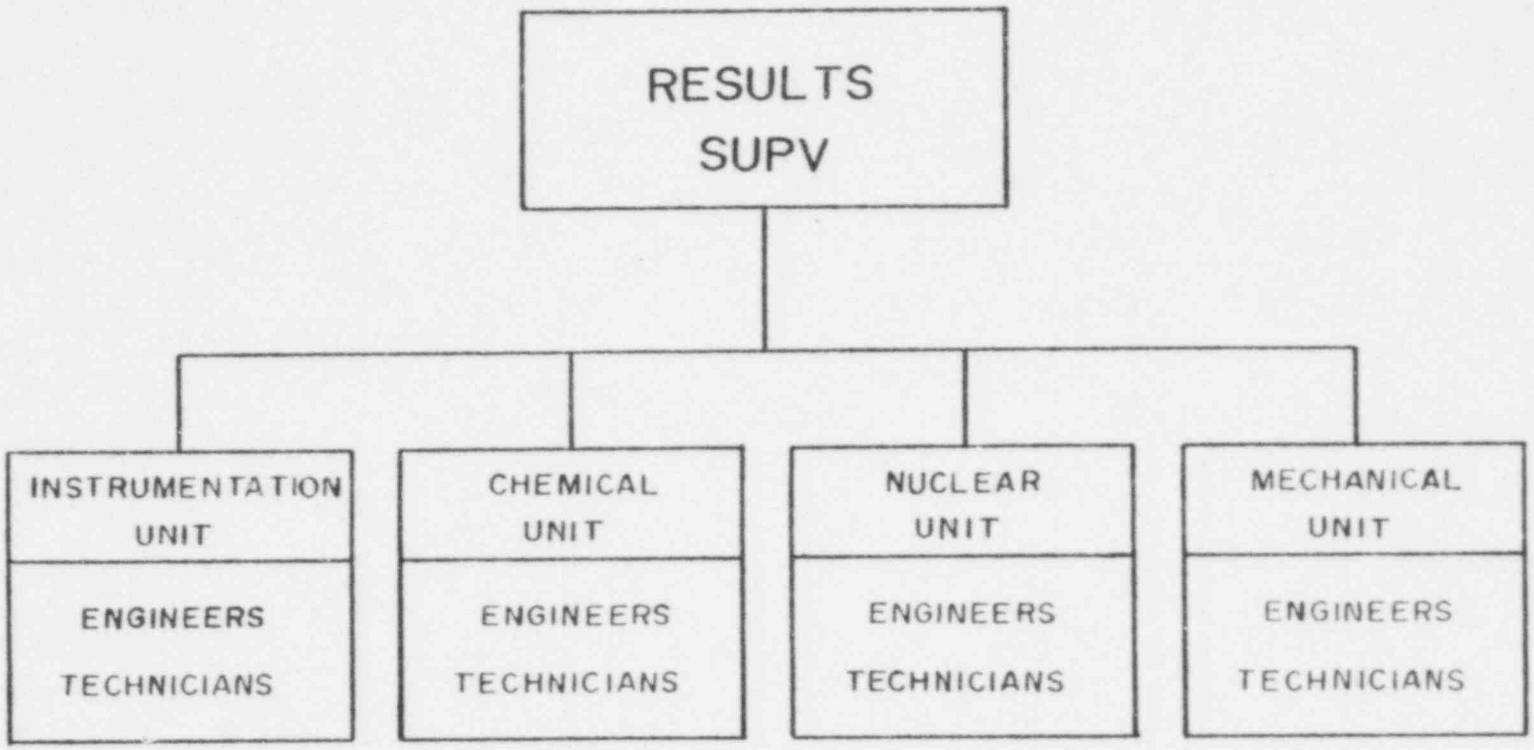
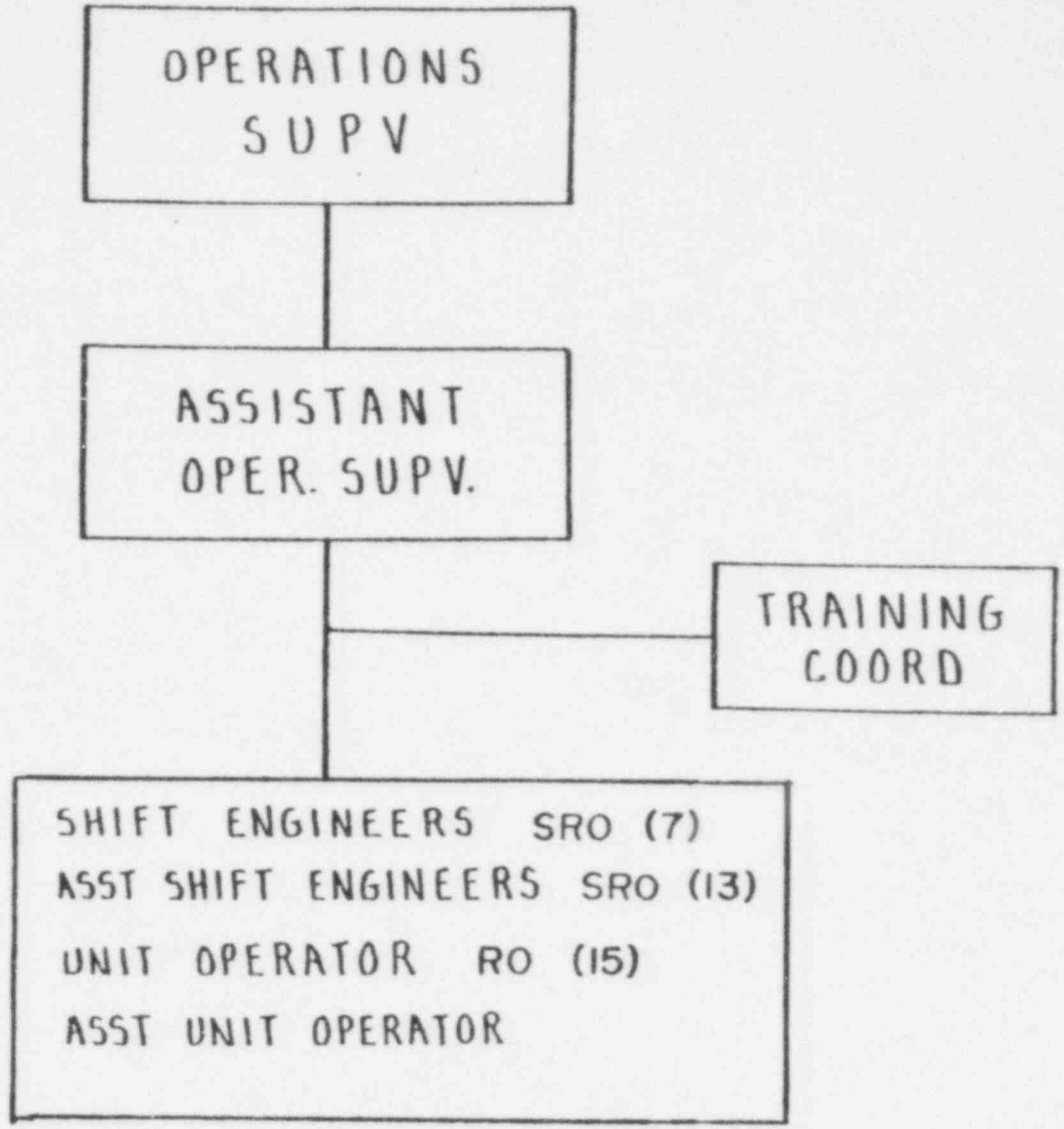
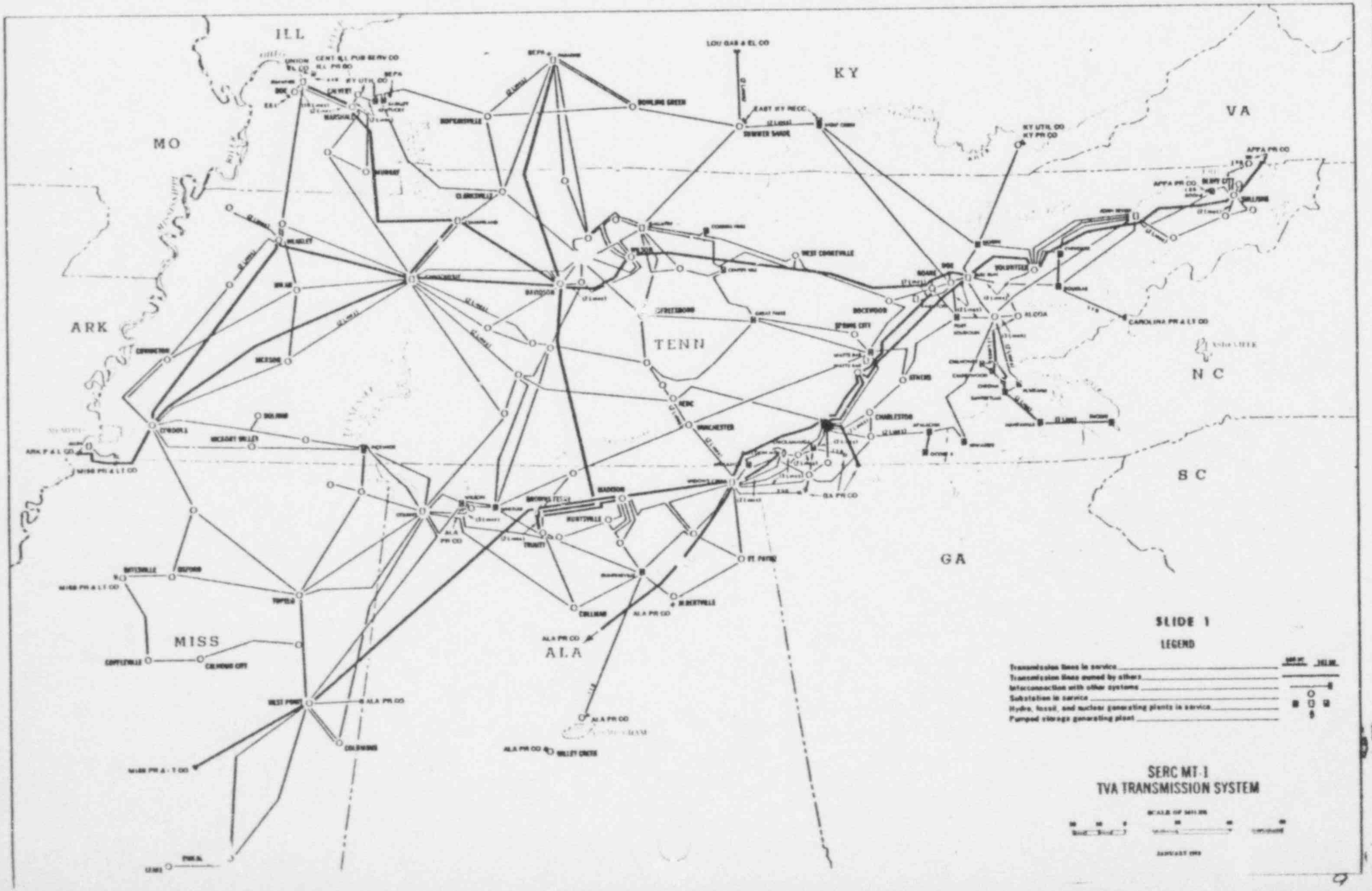


FIGURE 17.2-1 (Revision 2) QUALITY ASSURANCE LINES OF AUDIT


SUPT
QA
ASST SUPT
SERVICE ORGN'S
1. ADMIN
2. PLANT SERVICES
3. SECURITY
4. HP
5. STORES
6. SYSTEMS OPNS
7. MEDICAL
8. SAFETY
RESULTS
MAINTENANCE
OPERATIONS


RESULTS SUPV
INSTRUMENTATION UNIT
ENGINEERS
TECHNICIANS
CHEMICAL UNIT
ENGINEERS
TECHNICIANS
NUCLEAR UNIT
ENGINEERS
TECHNICIANS
MECHANICAL UNIT
ENGINEERS
TECHNICIANS


OPERATIONS SUPV
ASSISTANT OPER. SUPV.
TRAINING COORD
SHIFT ENGINEERS SRO (7)
ASST SHIFT ENGINEERS SRO (13)
UNIT OPERATOR RO (15)
ASST UNIT OPERATOR


ILL
MO
ARK
KY
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TENN
N C
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GA
ALA
MISS
LOU GAS & EL CO
EAST KY RECC
SUMMER SHADE
BOWLING GREEN
HOPKINSVILLE
CLARKSVILLE
MURRAY
UNION
CENT ILL PUB SERV CO
ILL PR CO
KY UTIL CO
KY UTIL CO
KY PR CO
APPA PR CO
VOLUNTEER
KNOXVILLE
ALCOA
CAROLINA PR & LT CO
ROANE
DOCKWOOD
SPRING CITY
WEST COOKEVILLE
CHARLESTON
MANCHESTER
MURFREESBORO
DAVIDSON
COVINGTON
JACKSON
CORDOVA
HICKORY VALLEY
ARK P & L CO
MISS PR & LT CO
BATESVILLE
OXFORD
TUPELO
COFFEEVILLE
CALHOUN CITY
WEST POINT
ALA PR CO
COLUMBUS
MISS PR & LT CO
HUNTSVILLE
MADISON
BROWNS FERRY
TRINITY
ALA PR CO
GA PR CO
FT PAYNE
COLLINWOOD
ALBERTVILLE
VALLEY CREEK
SLIDE 1
LEGEND
Transmission lines in service
Transmission lines owned by others
Interconnection with other systems
Substation in service
Hydro, fossil, and nuclear generating plants in service
Pumped storage generating plant
SERC MT-1
TVA TRANSMISSION SYSTEM

Sequoyah Nuclear Plant
Site Monitoring Stations

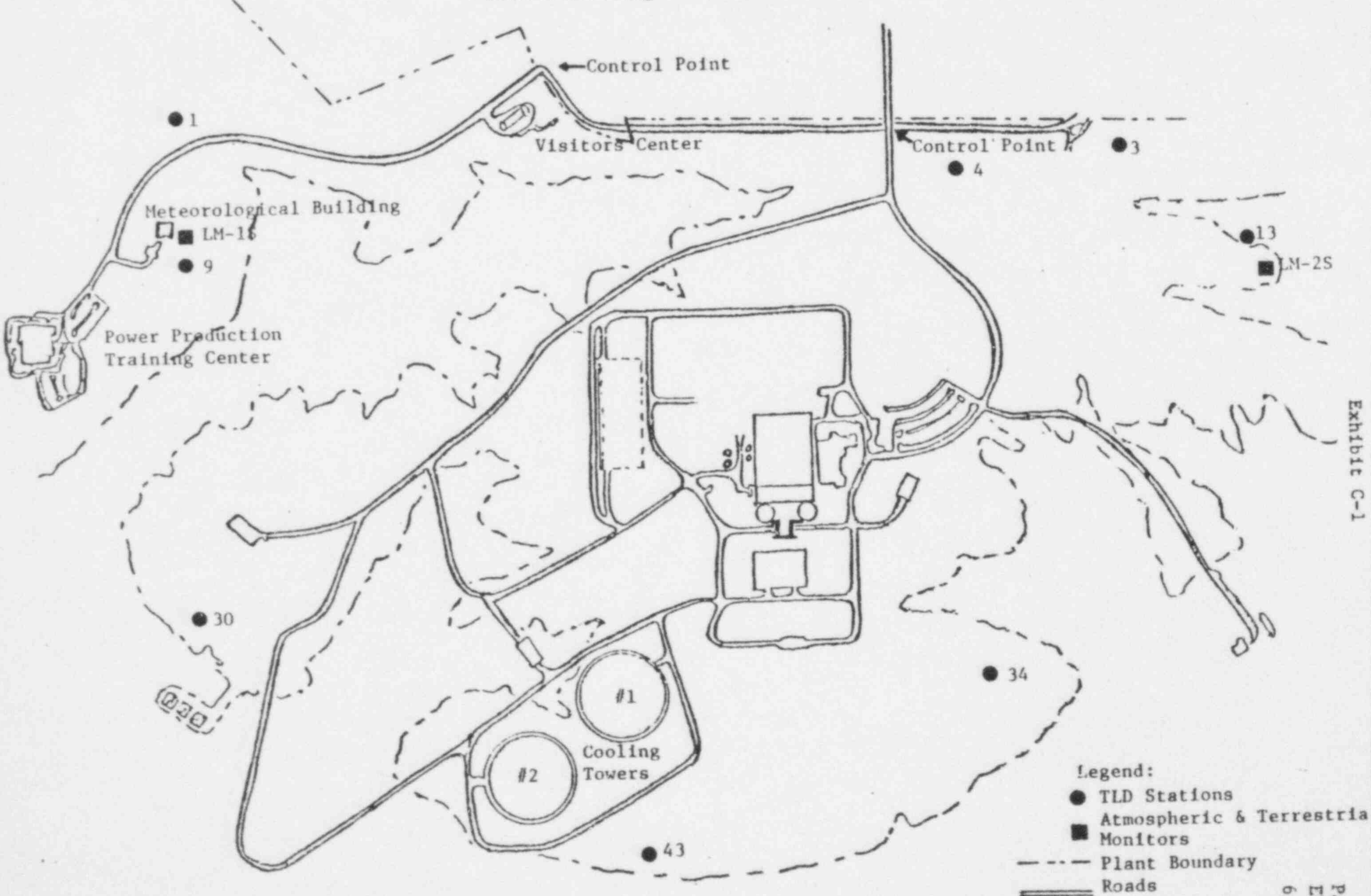
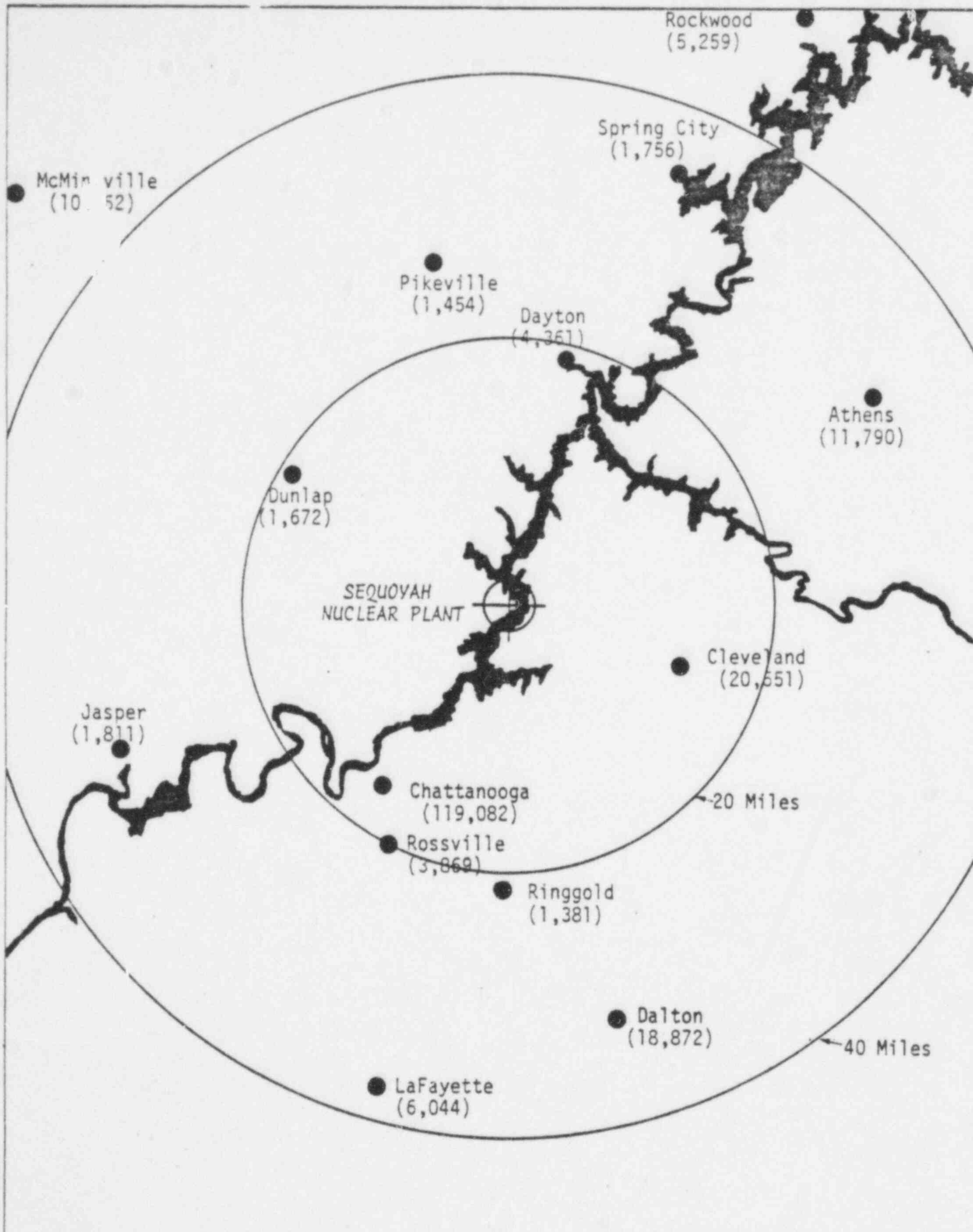


Exhibit C-1

SLIDE 2

SLIDE 3 IS A PHOTOGRAPH OF THE SITE



SLIDE 4

Figure 1.2-8

MAJOR POPULATION AREAS
SEQUOYAH NUCLEAR PLANT

SLIDE 5 AND SLIDE 6 ARE PHOTOGRAPHS OF THE SITE

SLIDE 6A IS A CUT AWAY PICTURE OF THE PLANT

SLIDE 7-1

DESIGN COMPARISON (EXCLUDING SECONDARY CYCLE)

Nuclear Plant Units 1 and 2 - Comparison with Donald C. Cook, Trojan, and Sequoyah

CHAPTER NUMBER	CHAPTER TITLE SYSTEM/COMPONENT	REFERENCES (FSAR)	SIGNIFICANT SIMILARITIES	SIGNIFICANT DIFFERENCES
3.0	Containment	Section 3.8.2	D. C. Cook	Sequoyah uses a freestanding steel primary containment vessel.
4.0	Reactor			
	Fuel	Section 4.2.1	Trojan	None.
	Reactor Vessel Internals	Section 4.2.2	D. C. Cook, Trojan	D. C. Cook Units 1 and 2 and Sequoyah Units 1 and 2 have thermal shields. Trojan has neutron pads. Sequoyah upper interns have been modified co incorporate UHI.
	Reactivity Control	Section 4.2.3	D. C. Cook, Trojan	None.
	Nuclear Design	Section 4.3	D. C. Cook, Trojan	None.
	Thermal-Hydraulic Design	Section 4.4	D. C. Cook, Trojan	The total primary heat output and coolant temperatures are higher for Sequoyah and Trojan than for D.C. Cook Plant.
5.0	Reactor Coolant System	Sections 5.1, 5.2	D. C. Cook, Trojan	The following have been added or changed for Sequoyah; New requirements for fracture toughness testing, New means of determining heat-up and cool-down rates.
	Reactor Vessel*	Section 5.4	D. C. Cook, Trojan	None.
	Reactor Coolant Pumps*	Section 5.5.1	D. C. Cook, Trojan	None
	Steam Generators*	Section 5.5.2	D. C. Cook, Trojan	None
	Piping*	Section 5.5.3	D. C. Cook, Trojan	None.

*All components designed and manufactured to Code edition in effect at date of purchase order.

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SLIDE 7-2

DESIGN COMPARISON (EXCLUDING SECONDARY CYCLE)

CHAPTER NUMBER	CHAPTER TITLE SYSTEM/COMPONENT	REFERENCES (FSAR)	SIGNIFICANT SIMILARITIES	SIGNIFICANT DIFFERENCES
5.0 (Cont'd)				
	Residual Heat Removal System	Section 5.5.7	D. C. Cook, Trojan	None.
	Pressurizer*	Section 5.5.10	D. C. Cook, Trojan	None.
6.0	Engineered Safety Features			
	Emergency Core Cooling System	Section 6.3	D. C. Cook, Trojan	D. C. Cook Units 1 and 2 and Trojan do not have an Upper Head Injection System.
	Ice Condenser	Section 6.7	D. C. Cook	Trojan does not use an ice condenser.
7.0	Instrumentation and Controls			
	Reactor Trip System	Section 7.2	System functions are similar to D. C. Cook, Trojan	None.
	Engineered Safety Features Systems	Section 7.3	Systems functions are similar to D. C. Cook, Trojan	None.
	Systems Required For Safe Shutdown	Section 7.4	System functions are similar to D. C. Cook, Trojan	None.
	Safety Related Display Instrumentation	Section 7.5	Parametric display is similar to that of D. C. Cook, Trojan	Actual physical configuration may differ due to customer design philosophy.
	Other Safety Systems	Section 7.6	Operational Functions are similar to D. C. Cook, Trojan	None.
	Control Systems	Section 7.7	Operational functions are similar to D. C. Cook, Trojan	The Sequoyah Nuclear Plant has a 50 percent load rejection capability while that of the D. C. Cook Plant is 100 percent. The rod position indication for the Sequoyah Nuclear Plant and the D. C. Cook Plant is an analog system; Trojan's RPI is a digital system.

SLIDE 7-3

DESIGN COMPARISON (EXCLUDING SECONDARY CYCLE)

CHAPTER NUMBER	CHAPTER TITLE SYSTEM/COMPONENT	REFERENCES (FSAR)	SIGNIFICANT SIMILARITIES	SIGNIFICANT DIFFERENCES
8.0	Electric Power			
	Offsite Power	8.2		Sequoyah - 2 offsite sources 161 kV/6.9 kV
	Onsite Power	8.3		Sequoyah - Tandem diesel generator arrangement Sequoyah -Four 125V dc batteries for supplying vital dc power

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SLIDE 7-4

DESIGN COMPARISON (EXCLUDING SECONDARY CYCLE)

CHAPTER NUMBER	CHAPTER TITLE SYSTEM/COMPONENT	REFERENCES (FSAR)	SIGNIFICANT SIMILARITIES	SIGNIFICANT DIFFERENCES
9.0	Auxiliary Systems			
	Condensate Cleanup System	Section 9.3.4	D. C. Cook, Trojan	Sequoyah had condensate demineralizers backfitted.
11.0	Radioactive Waste Management			
	Source Terms	Section 11.1	D. C. Cook, Trojan	Differences are based upon plant operational influences.
	Liquid Waste Processing	Section 11.2	Performance characteristics similar to D. C. Cook, Trojan	Sequoyah has similar segregated liquid drain systems.
	Gaseous Waste Processing	Section 11.3	D. C. Cook, Trojan	None.
	Solid Waste Processing	Section 11.4	Functionally similar to D. C. Cook, Trojan	None.
15.0	Accident Analysis	Chapter 15	Similar to D. C. Cook, Trojan	The Accident Analysis sections have been updated. New sections have been added, e.g., single RCCA withdrawal, accidental depressurization of the RCS, compare code descriptions, etc.

SLIDE 8

THERMAL AND HYDRAULIC DESIGN PARAMETERS

	Sequoyah	Trojan	
Reactor Core Heat Output, megawatts thermal	3411	3411	
System Pressure, Nominal, pounds per square inch	2250	2250	
Minimum Departure from Nucleate Boiling Ratio at Nominal Conditions			
Typical Flow Channel	2.22	2.04	
Thimble (Cold Wall) Flow Channel	1.81	1.71	Total
Thermal Flow Rate, pounds per hour	133.8×10^6	132.7×10^6	
Effective Flow Rate for Heat Transfer, pounds per hour	127.8×10^6	126.7×10^6	
Effective Core Flow Area, square feet	51.1	51.1	Average
Coolant Temperature			
Nominal Inlet, degrees Fahrenheit	545.7	552.5	
Average Rise in Core, degrees Fahrenheit	67.8	66.9	
Active Heat Transfer Surface Area, square feet	59,700	59,700	
Active Heat Flux, Btu per hour-square foot	189,800	189,800	
Maximum Heat Flux, for normal operation, Btu per hour-square feet	474,500	474,500	
Average Thermal Output, kilowatts per foot	5.44	5.44	
Maximum Thermal Output, for normal operation, kilowatts per foot	12.20	12.60	
Heat Flux Hot Channel Factor, F_Q	2.25	2.32	
Peak Fuel Central Temperature at 100 percent Power, degrees Fahrenheit	3400	3400	

SLIDE 9

FUEL MECHANICAL DESIGN COMPARISON

Design Parameter	Westinghouse Sequoyah Units 1 and 2	Westinghouse Typical Operation Fuel
FUEL ASSEMBLY		
Rod Array	17x17	15x15
Number of Fueled Rods	264	204
Number of Spacer Grids	8	7
Number of Guide Thimbles	24	20
Inter-rod Pitch, inches	0.496	0.563
Average Thermal Output (4 loop), kilowatts per foot	5.4	7.0
FUEL PELLETS		
Density (theoretical), percent	95	94
Fuel Weight/Unit Length (per rod) pounds per foot	0.364	0.462
FUEL CLADDING		
Outside Radius, inches	0.187	0.211
Thickness, inches	0.0225	0.0243
Radius/Thickness Ratio	8.31	8.68

TENNESSEE DEPARTMENT OF PUBLIC HEALTH

TENNESSEE OFFICE OF CIVIL DEFENSE AND EMERGENCY PLANNING

TENNESSEE DEPARTMENT OF PUBLIC WELFARE

TENNESSEE DEPARTMENT OF SAFETY

TENNESSEE DEPARTMENT OF CONSERVATION

TENNESSEE NATIONAL GUARD

CITY AND COUNTY OFFICIALS OF HAMILTON COUNTY

SHERIFF'S DEPARTMENT OF HAMILTON COUNTY

CIVIL DEFENSE DIRECT . - CHATTANOOGA - HAMILTON COUNTY, TENNESSEE

CHATTANOOGA POLICE

RHEA COUNTY AMBULANCE SERVICE

FIRE DEPARTMENTS - CHATTANOOGA AND SODDY-DAISY

BARONESS ERLANGER HOSPITAL - CHATTANOOGA

TENNESSEE DEPARTMENT OF AGRICULTURE

REAC/TS FACILITY AT OAK RIDGE HOSPITAL OF THE UNITED METHODIST CHURCH

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION - HUNTSVILLE, ALABAMA

U.S. DEPARTMENT OF ENERGY - OAK RIDGE, TENNESSEE

ALABAMA DEPARTMENT OF PUBLIC HEALTH

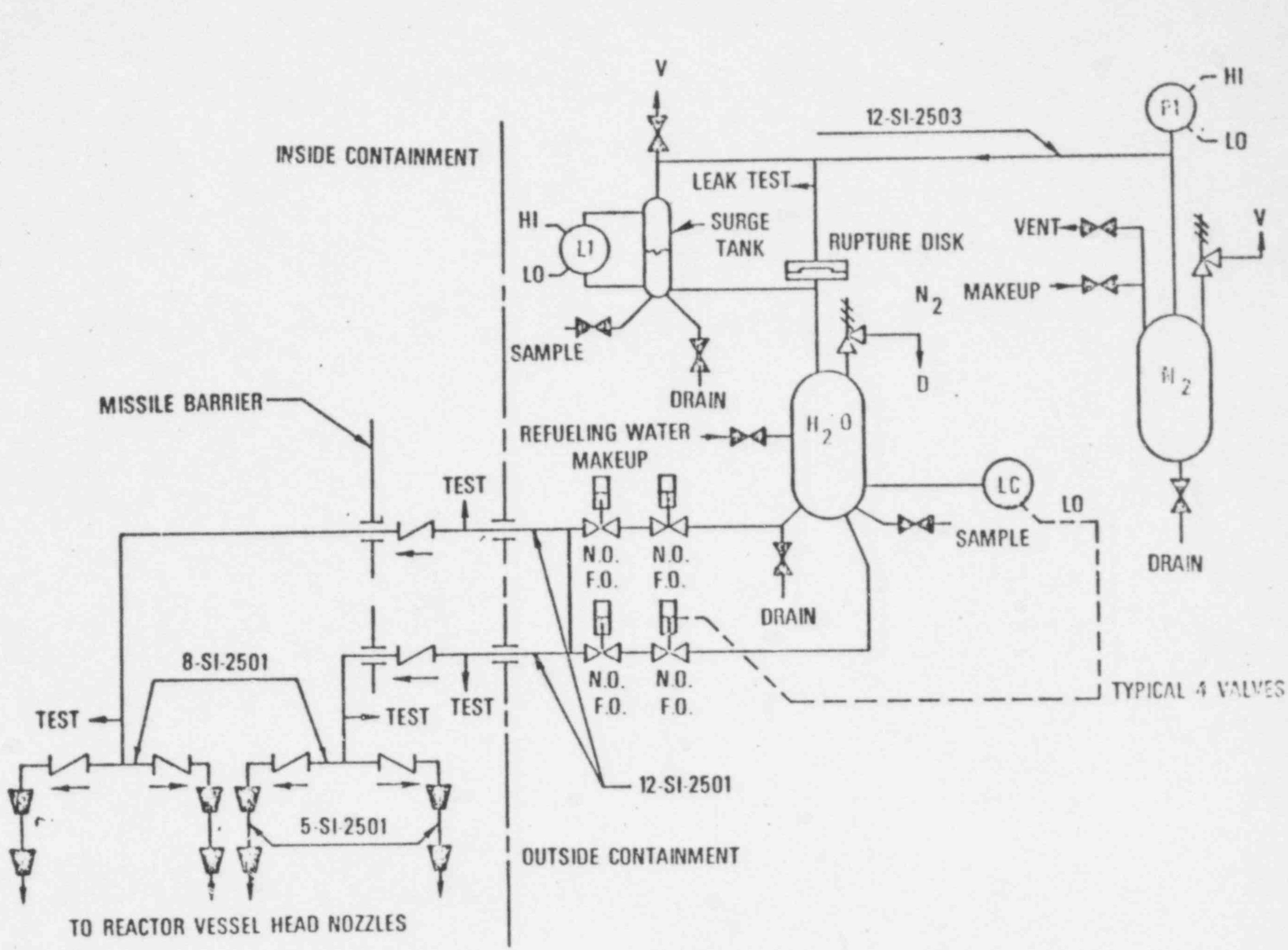
ENVIRONMENTAL PROTECTION AGENCY, REGION IV, ATLANTA

EASTERN ENVIRONMENTAL RADIATION LABORATORY - MONTGOMERY, ALABAMA

OVERVIEW

- DESCRIPTION OF UPPER HEAD INJECTION SYSTEM
- DESCRIPTION OF MODEL
- SEQUOYAH PLANT RESULTS
- CONCLUSION

UPPER HEAD INJECTION SYSTEM FLOW DIAGRAM



ANALYTICAL MODEL

- CONFORMS WITH APPENDIX K REQUIREMENTS
- SAFETY EVALUATION REPORT ISSUED APRIL 1978
- SEQUOYAH RESULTS MEET ACCEPTANCE CRITERIA OF 10 CFR 50.46

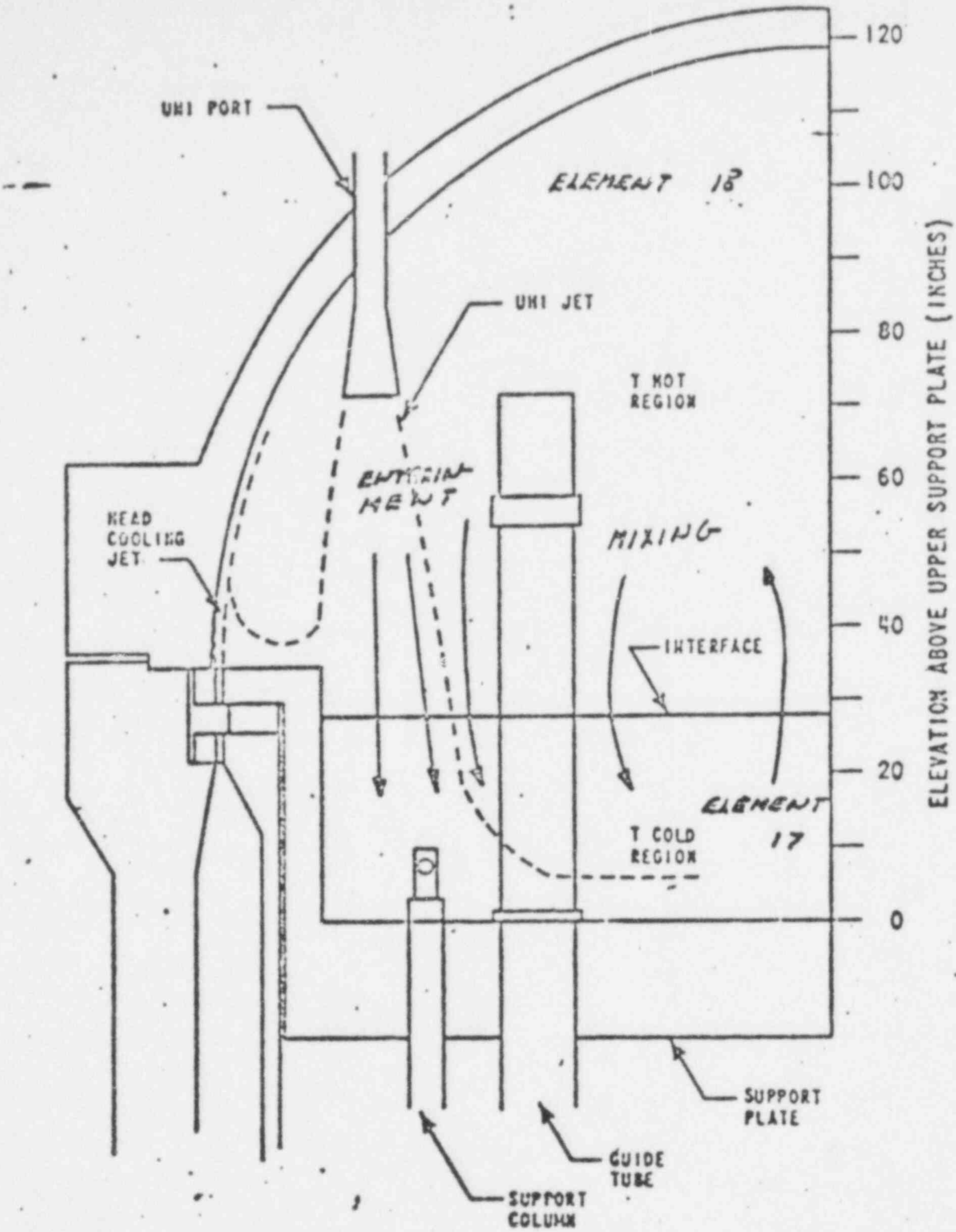


Figure [illegible] Flow Model for Upper Head Region

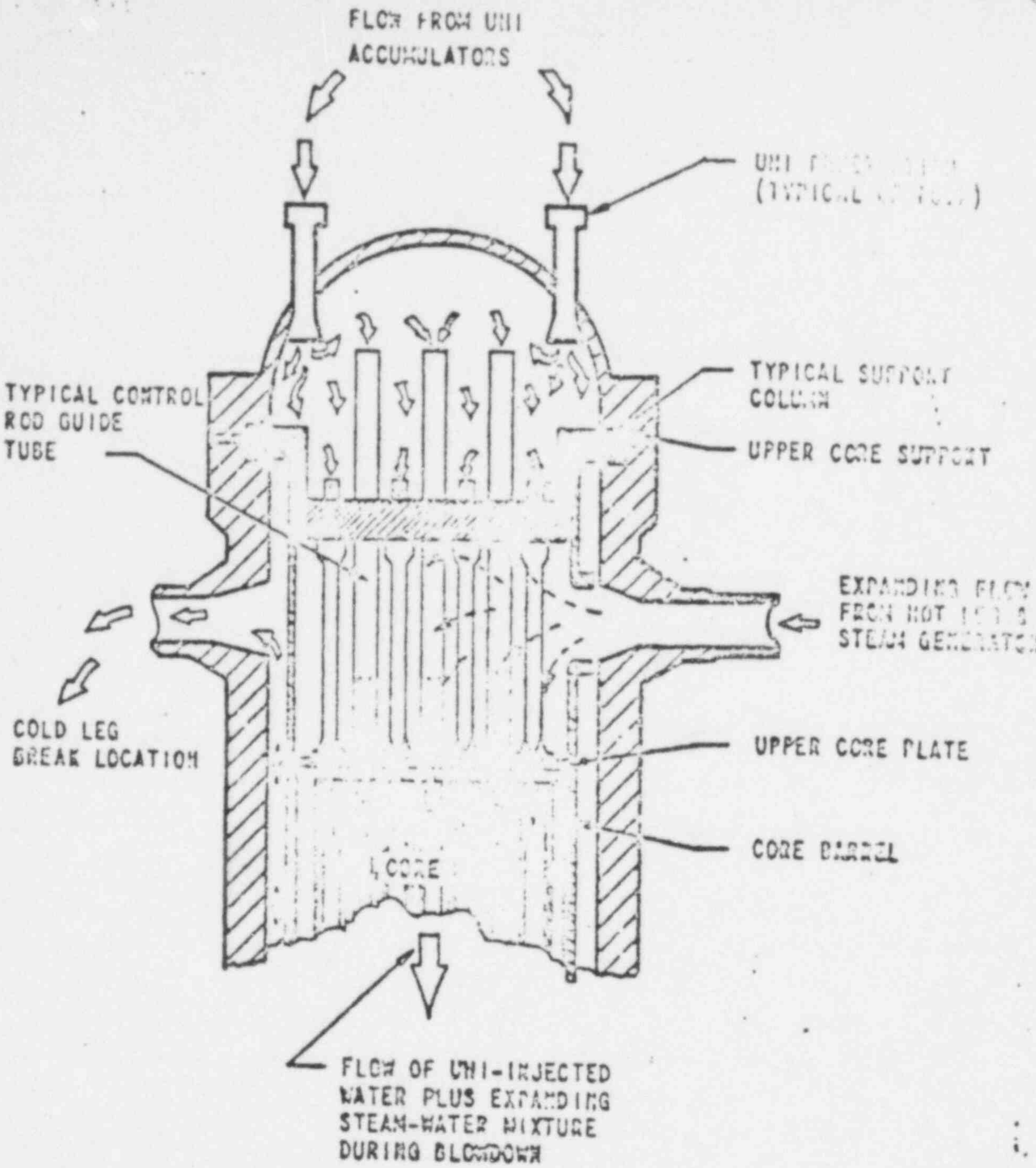


Figure 1.2-2. UHI Flow Pattern Through the Vessel during LOCA Blowdown (8/20 Seconds)

POOR ORIGINAL

NOTES

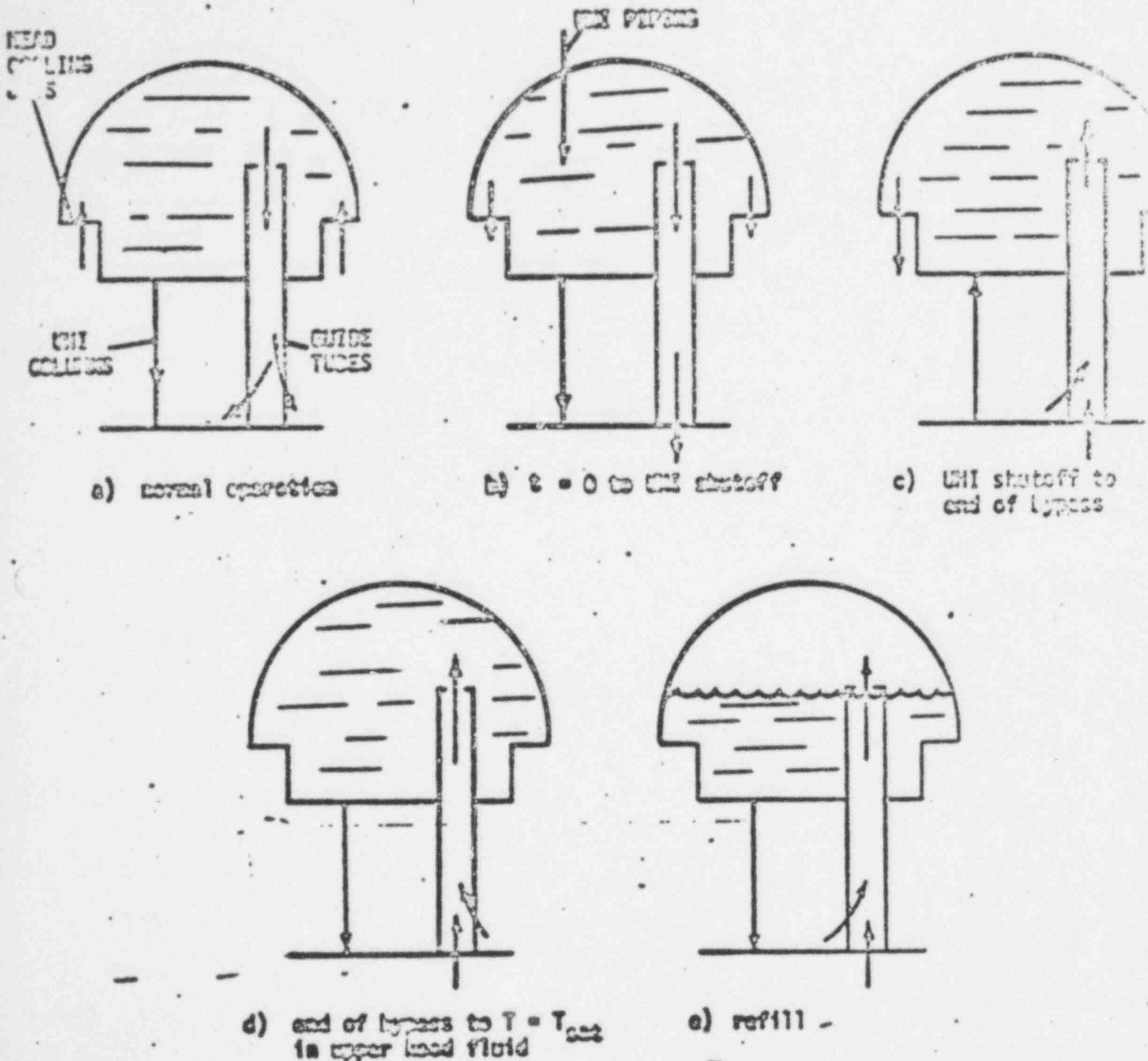


FIG 33

REACTOR VESSEL UPPER HEAD FLOW REGIMES

DURING BLOWDOWN

POOR ORIGINAL

SUMMARY OF RESULTS

TIME SEQUENCE OF EVENTS

ACTION	C_D = 0.6 DECLG PERFECT MIXING (SEC)	C_D = 0.6 DECLG IMPERFECT MIXING (SEC)
SI SIGNAL	4.8	4.8
UPPER HEAD ACCUMULATOR INJECTION	2.62	1.82
COLD LEG ACCUMULATOR INJECTION	19.4	19.9
UPPER HEAD ACCUMULATOR DELIVERY COMPLETED	26.3	23.1
PUMPED INJECTION	29.8	29.8
END OF BYPASS	58.0	48.0
END OF BLOWDOWN AND BOTTOM OF CORE RECOVERY	128.0	71.8
COLD LEG ACCUMULATOR EMPTY	128.9	120.2

POOR ORIGINAL

COMPLIANCE WITH APPENDIX K 10CFR50.46

RESULT	C_D = 0.6 DECLG PERFECT MIXING	C_D = 0.6 DECLG IMPERFECT MIXING
PEAK CLAD TEMP. (^oF)	2111.	2190.
PEAK CLAD TEMP. LOCATION (FT)	7.5	7.5
LOCAL ZR/H2O REACTION (MAX. %)	4.07	7.63
LOCATION OF MAX. LOCAL ZR/H2O (FT)	7.5	7.5
TOTAL ZR/H2O REACTION (%)	<0.3	<0.3
HOT ROD BURST TIME (SEC)	72.8	65.2
HOT ROD BURST LOCATION (FT)	6.0	7.0

LICENSED CORE POWER (MWT), 102% OF	3411
PEAKING LINEAR POWER (KW/FT), 102% OF	12.25
PEAKING FACTOR (AT LICENSE RATING)	2.25

SUMMARY

- ANALYSIS PERFORMED WITH APPROVED MODEL RESULTS IN PCT < 2200°F

- SEQUOYAH ECCS MEETS THE REQUIREMENTS OF THE ACCEPTANCE CRITERIA PRESENTED IN 10CFR50.46

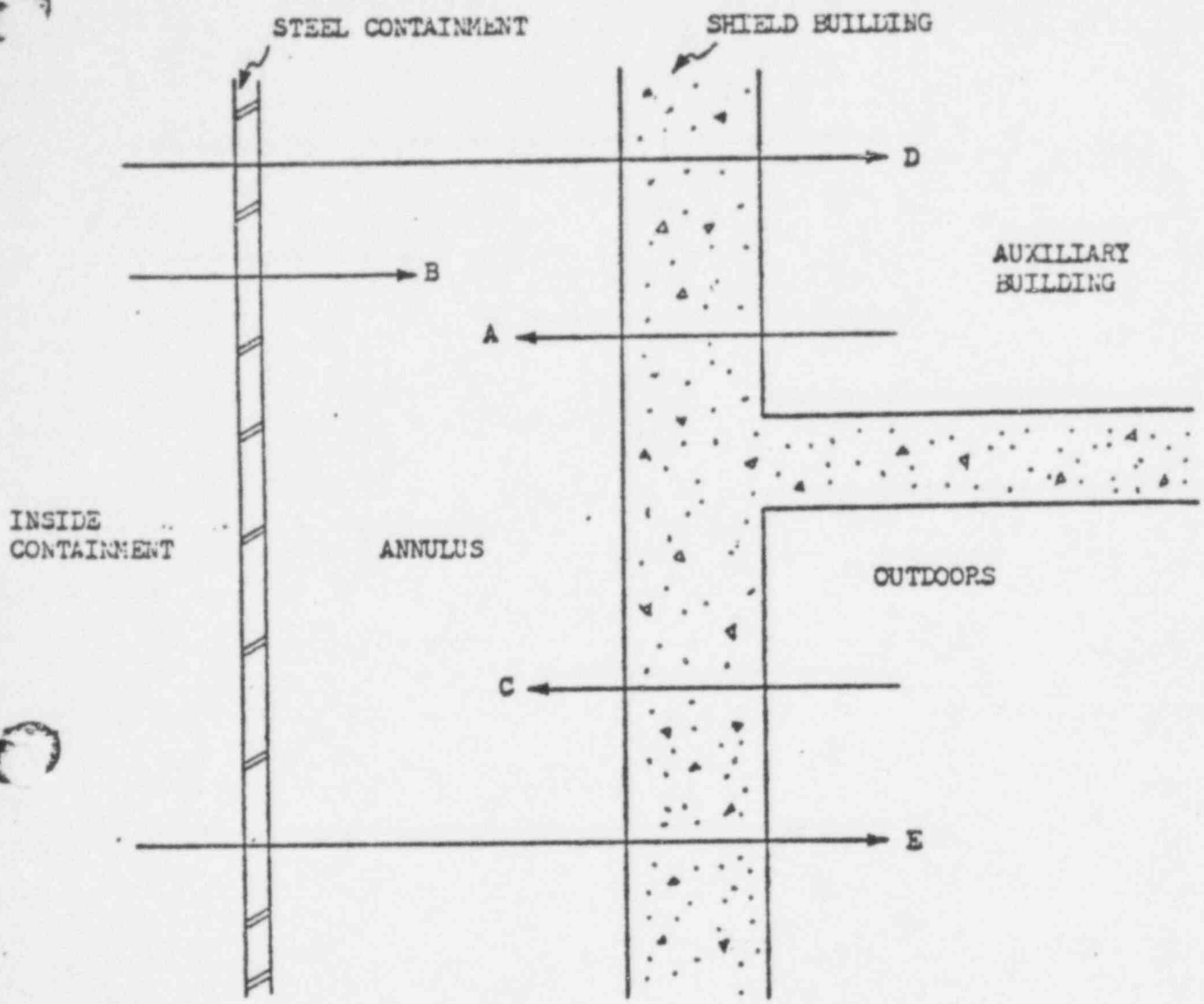


Figure 6.2-94 Schematic Diagram of Leakage Paths

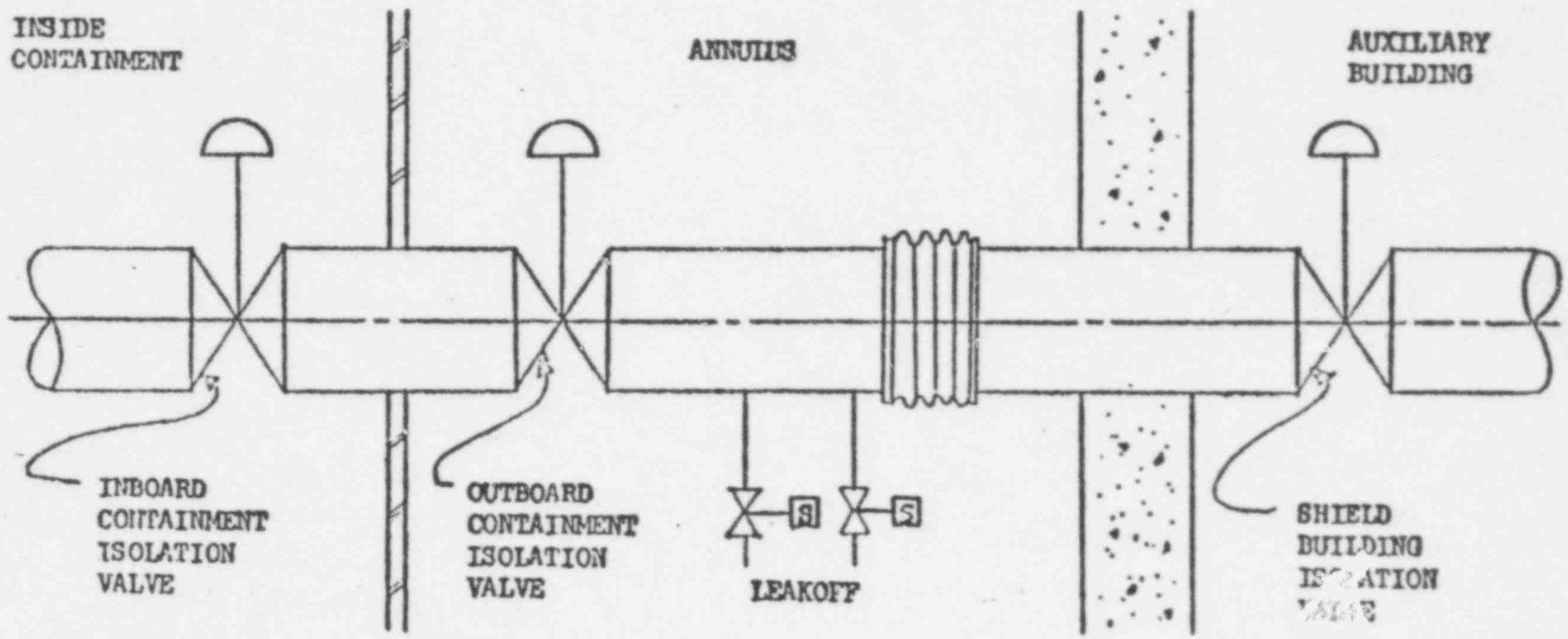


Figure 6.2-2 Typical Purge Penetration Arrangement

Revised by Amend. 16, Feb. 11, 1974

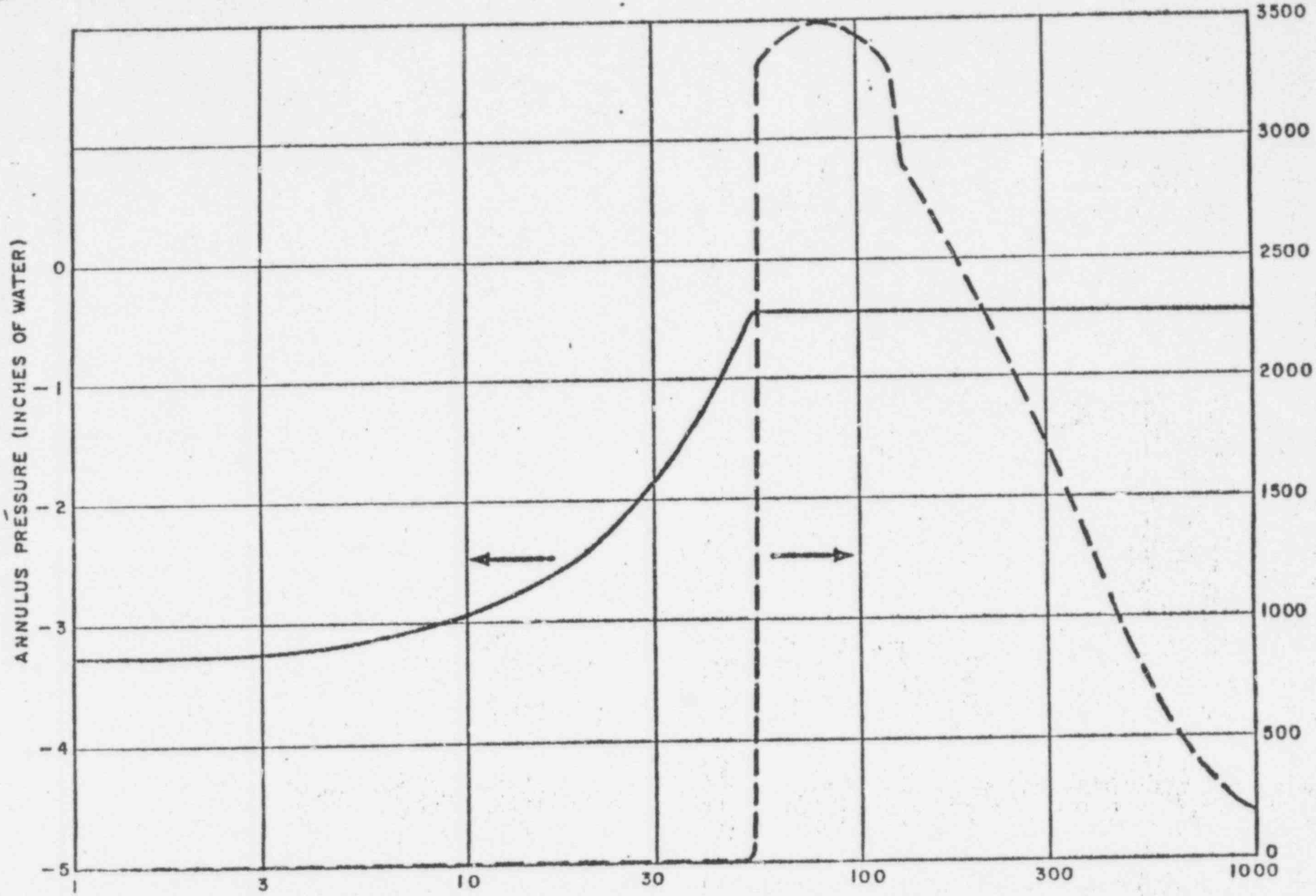
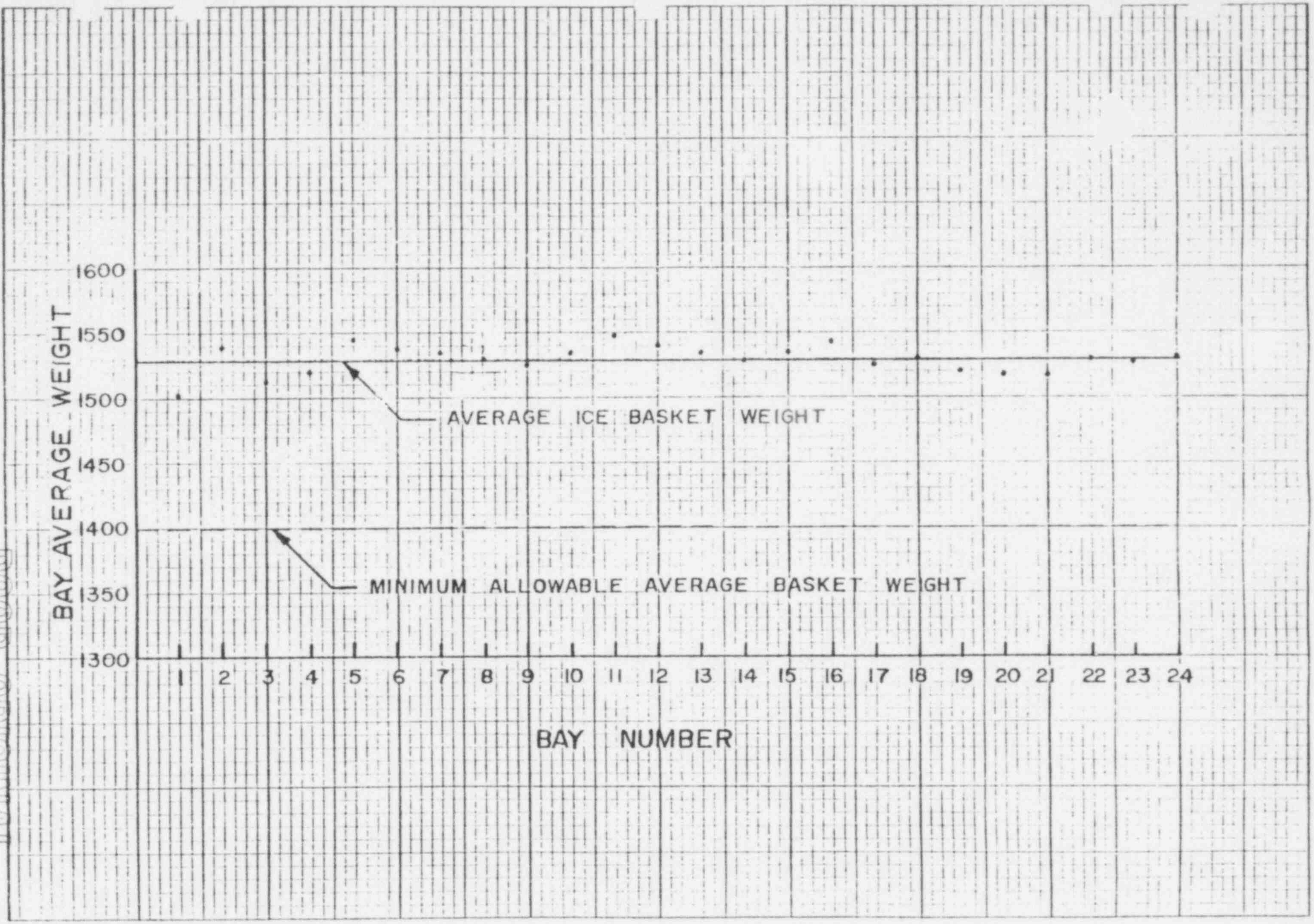


Figure 6.2-73 Post Accident An.ulus Pressure and Reactor Unit Vent Flow Rate Transients


BAY AVERAGE WEIGHT
1600
1550
1500
1450
1400
1350
1300
AVERAGE ICE BASKET WEIGHT
MINIMUM ALLOWABLE AVERAGE BASKET WEIGHT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
BAY NUMBER

33

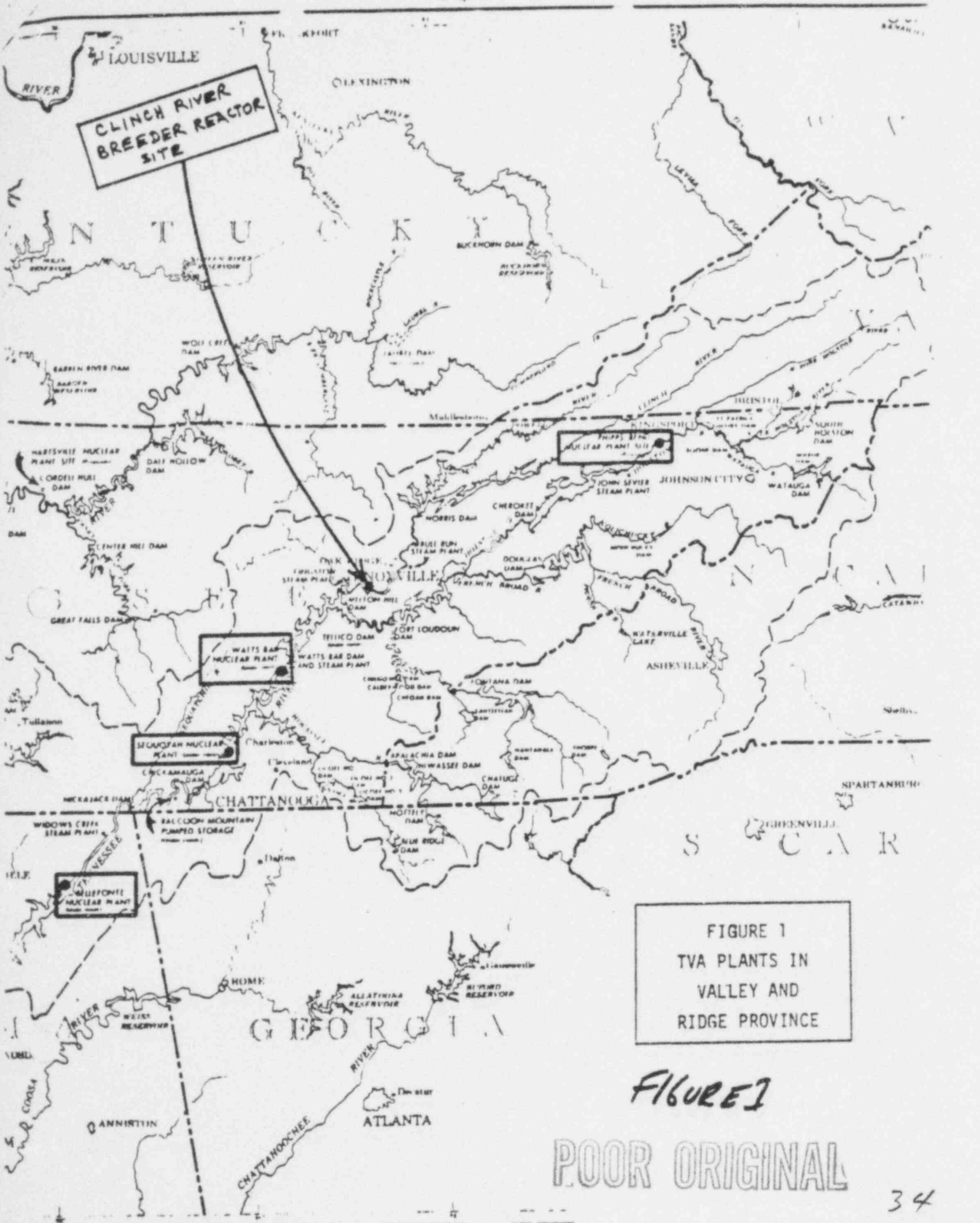


FIGURE 1
TVA PLANTS IN
VALLEY AND
RIDGE PROVINCE

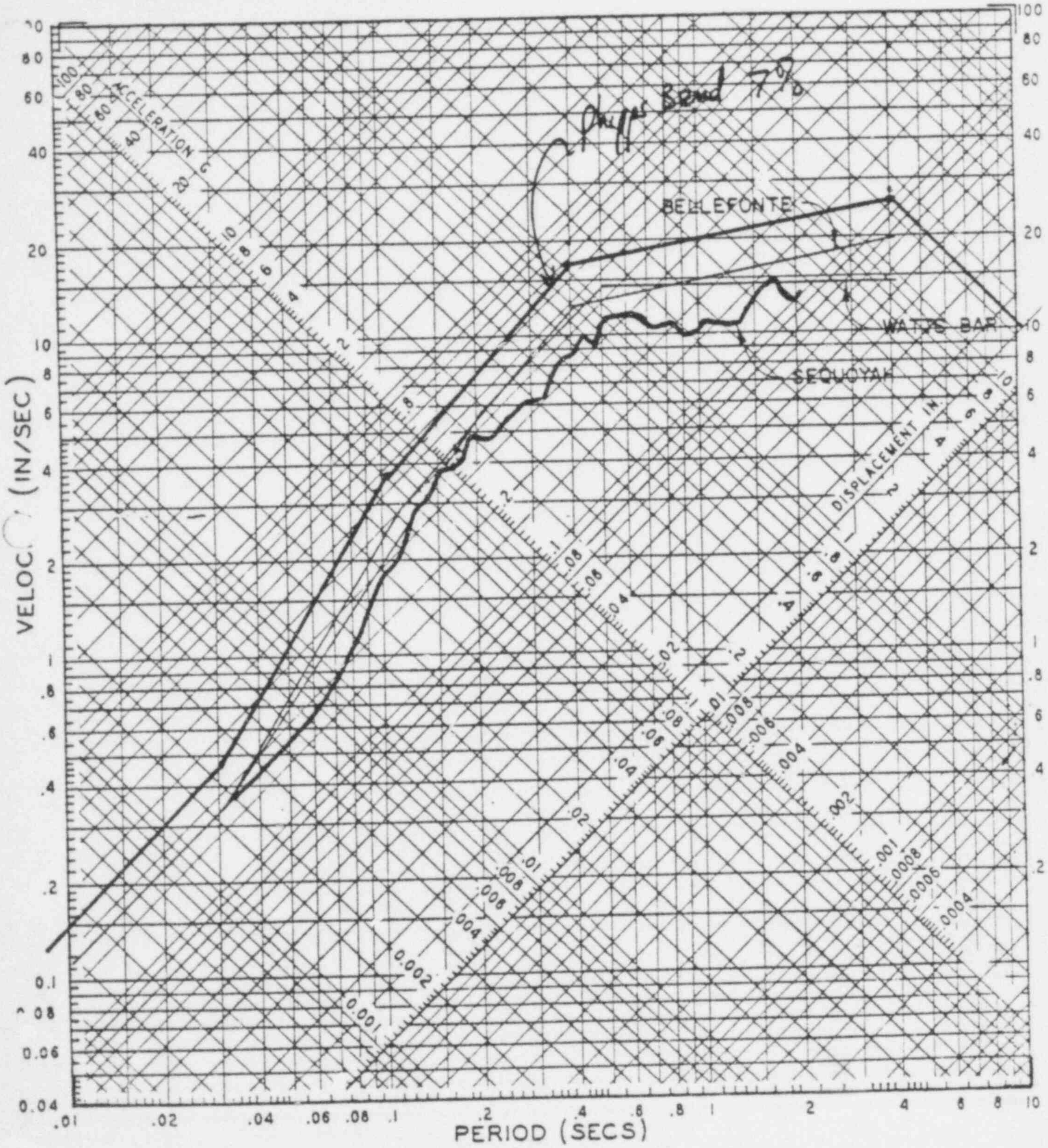
FIGURE I

POOR ORIGINAL

34

COMPARISON OF SEQUOYAH, WATTS BAR, AND BELLEFONTE NUCLEAR PLANTS TOP OF ROCK DESIGN SPECTRA FOR EINFORCED CONCRETE STRUCTURES

SEQUOYAH - 5% DAMPING
WATTS BAR - 5% DAMPING
BELLEFONTE - 7% DAMPING



2

FIGURE 3-8

FIGURE 7

35

POOR ORIGINAL

TVA'S CONTENTIONS (PHASE I)

(1) THE MAXIMUM INTENSITY OF THE 1897 GILES COUNTY EARTHQUAKE WAS REALLY VII-VIII RATHER THAN VIII.

(2) THE INTENSITY RATING FOR THE 1897 GILES COUNTY EARTHQUAKE IS SOIL BIASED AND THAT THE SAME EARTHQUAKE WOULD RESULT IN A LOWER INTENSITY AT ROCK SITES SUCH AS AT SEQUOYAH.

(3) THE INTENSITY-ACCELERATION RELATIONSHIP DERIVED BY MURPHY AND O'BRIEN (1978) IS MORE APPROPRIATE THAN THAT FOUND IN TRIFUNAC AND BRADY (1975) AND SHOULD BE USED IN DETERMINING REFERENCE ACCELERATIONS.

(4) AT FOUNDATION DEPTH, EARTHQUAKE-INDUCED GROUND MOTION IS LESS THAN THAT AT THE SURFACE.

3

AIMS OF REVIEW

(1) MAKING A REALISTIC YET CONSERVATIVE ESTIMATE OF GROUND MOTION FROM THE CONTROLLING EARTHQUAKE.

(2) COMPARING THIS ESTIMATE WITH THE EXISTING SEISMIC DESIGN.

(3) DETERMINING THE SIGNIFICANCE OF ANY DIFFERENCE BETWEEN THE ABOVE.

4

RECOMMENDED APPROACHES:

1. DETERMINE SITE-SPECIFIC SSE RESPONSE SPECTRA FROM STRONG MOTION RECORDS OF APPROPRIATE MAGNITUDE AND DISTANCE

2. DETERMINE SITE-SPECIFIC SSE RESPONSE SPECTRA FROM STRONG MOTION RECORDS OF APPROPRIATE INTENSITY

3. REEVALUATE ORIGINAL SEISMIC STRUCTURAL AND FLOOR RESPONSE SPECTRA ANALYSIS, TAKING INTO ACCOUNT MORE REALISTIC METHODS AND MATERIAL PROPERTIES, AS WELL AS SITE-SPECIFIC SSE RESPONSE SPECTRA

4. REEVALUATE THE OBE TO SEE WHETHER IT MEETS THE RECURRENCE INTERVAL CRITERIA OF APPENDIX A TO PART 100

5. COMPARE THE PROBABILITY OF SSE BEING EXCEEDED AT THE SUBJECT PLANT WITH THAT AT OTHER TVA PLANTS THAT MEET THE SRP CRITERIA

PARAMETERS FOR SITE SPECIFIC SPECTRA OF
1897 GILES COUNTY EARTHQUAKE

(1) BODY WAVE MAGNITUDE - 5.8 ± 0.5 (5.3 - 6.3)

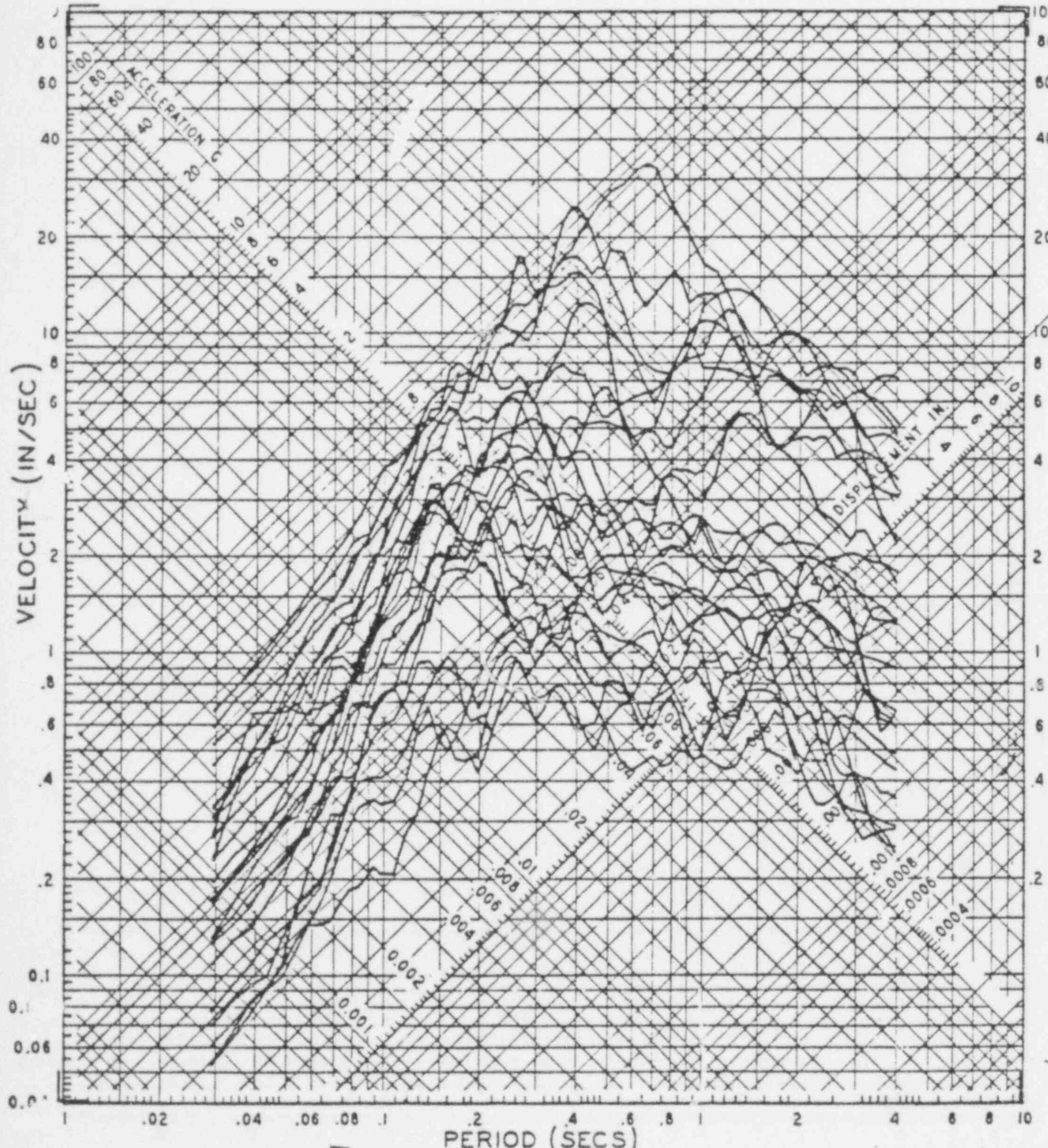
(2) EPICENTRAL DISTANCE - LESS THAN 25 KILOMETERS

(3) SITE CONDITIONS - ROCK

6

3

OVERPLOT OF RESPONSE SPECTRA FOR THIRTEEN US AND ITALY EARTHQUAKES - 7 % DAMPING



7

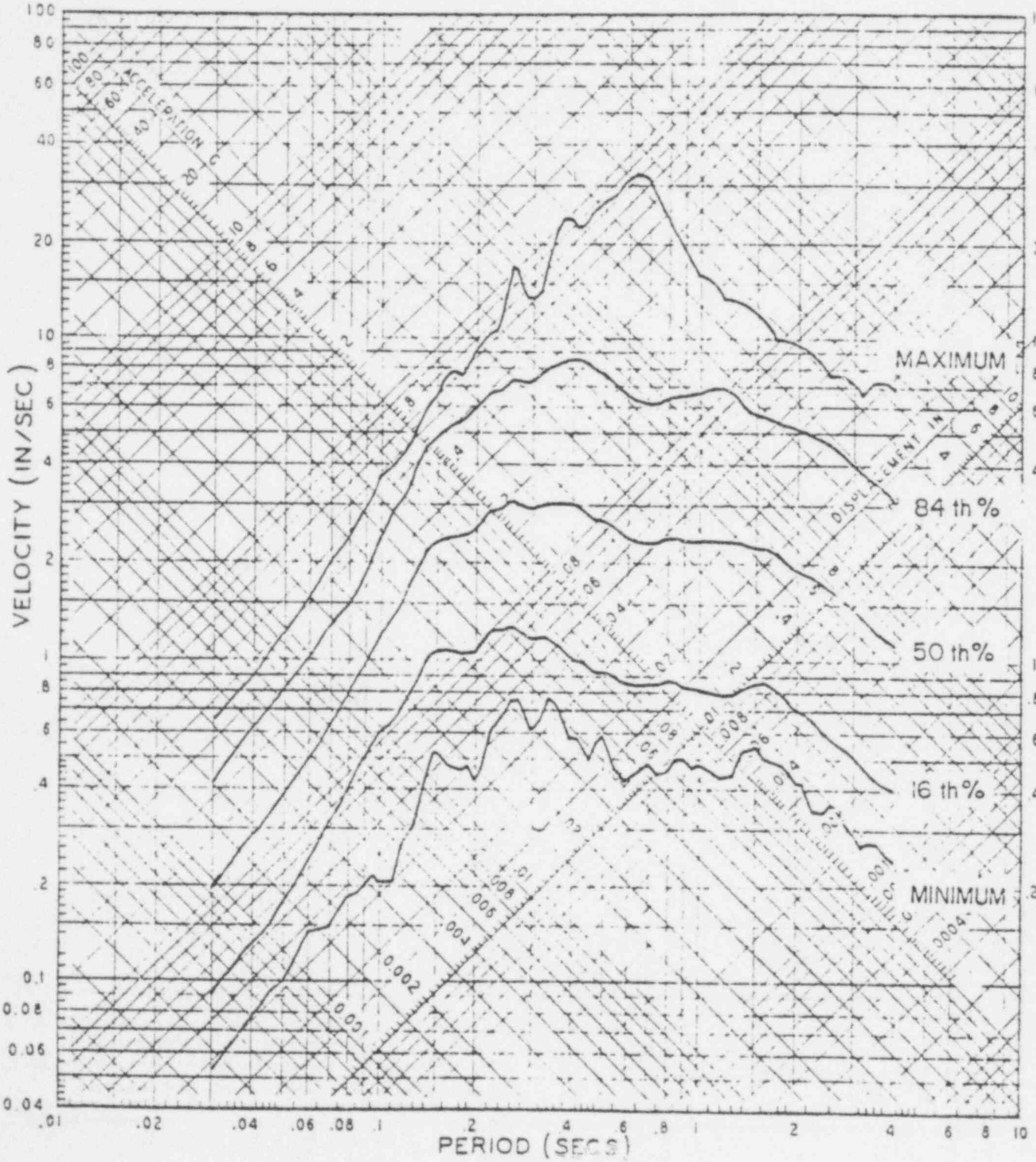
FIGURE A-32

40

4

MAXIMUM, MINIMUM, 16TH, 50TH, AND 84TH PERCENTILE RESPONSE SPECTRA FOR THIRTEEN UNITED STATES AND ITALY EARTHQUAKES

LOGNORMAL DISTRIBUTION- 7% DAMPING



8

FIG. Q3-2

41

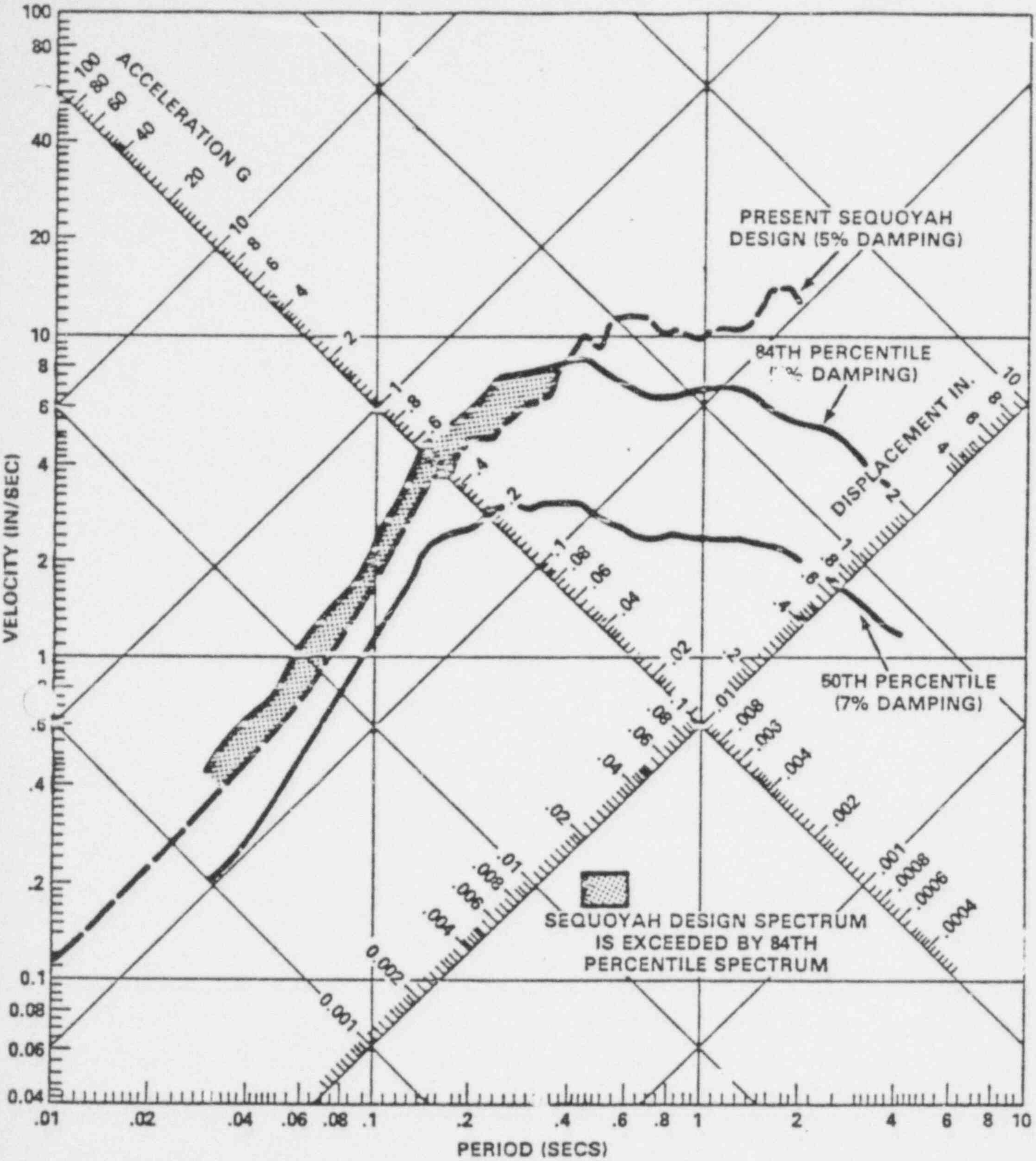
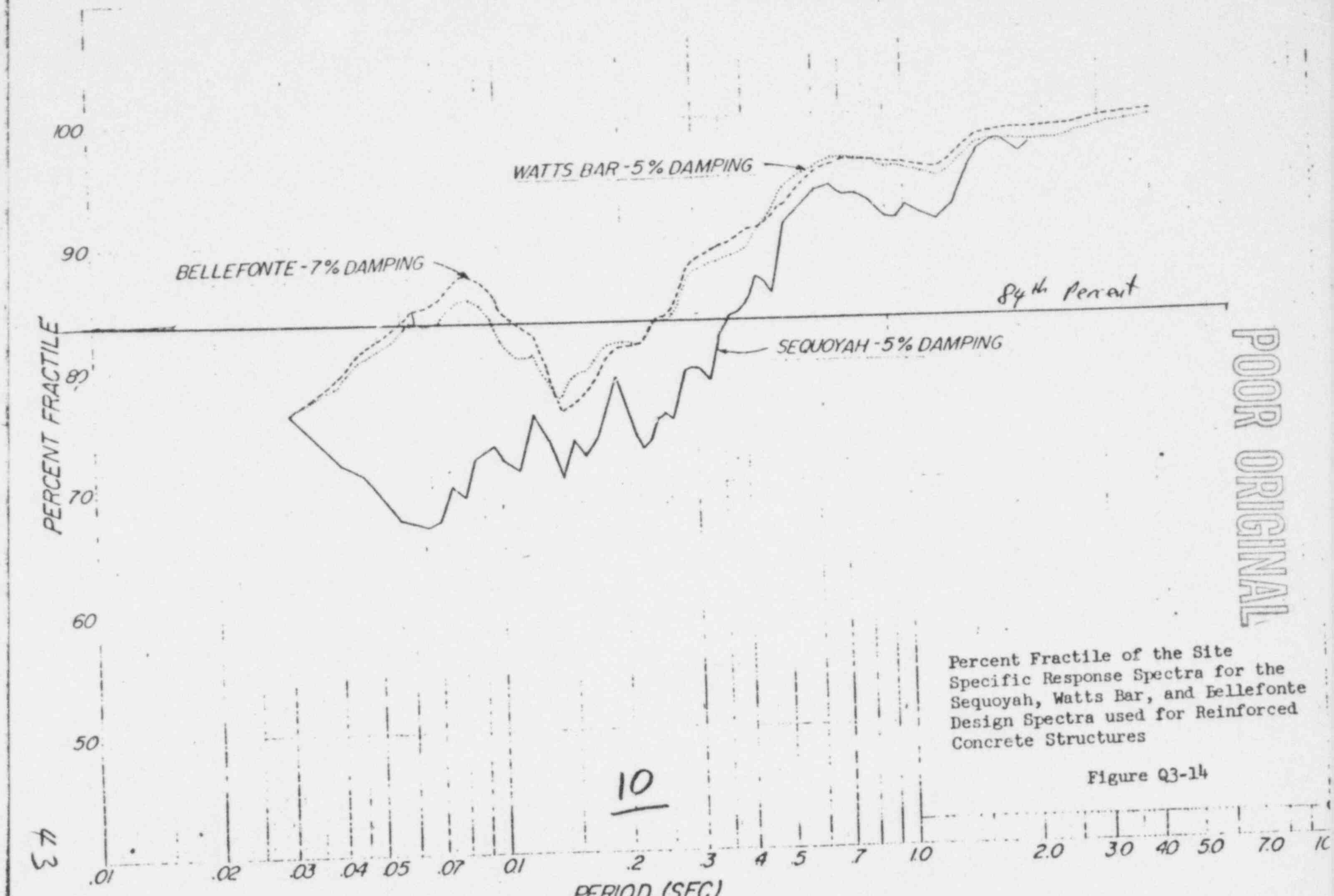


Figure 2-3

Comparison Of The Present Sequoyah Design Spectrum For Reinforced Concrete With Appropriately
mped 50th And 84th Percentile Site Specific Response Spectra.



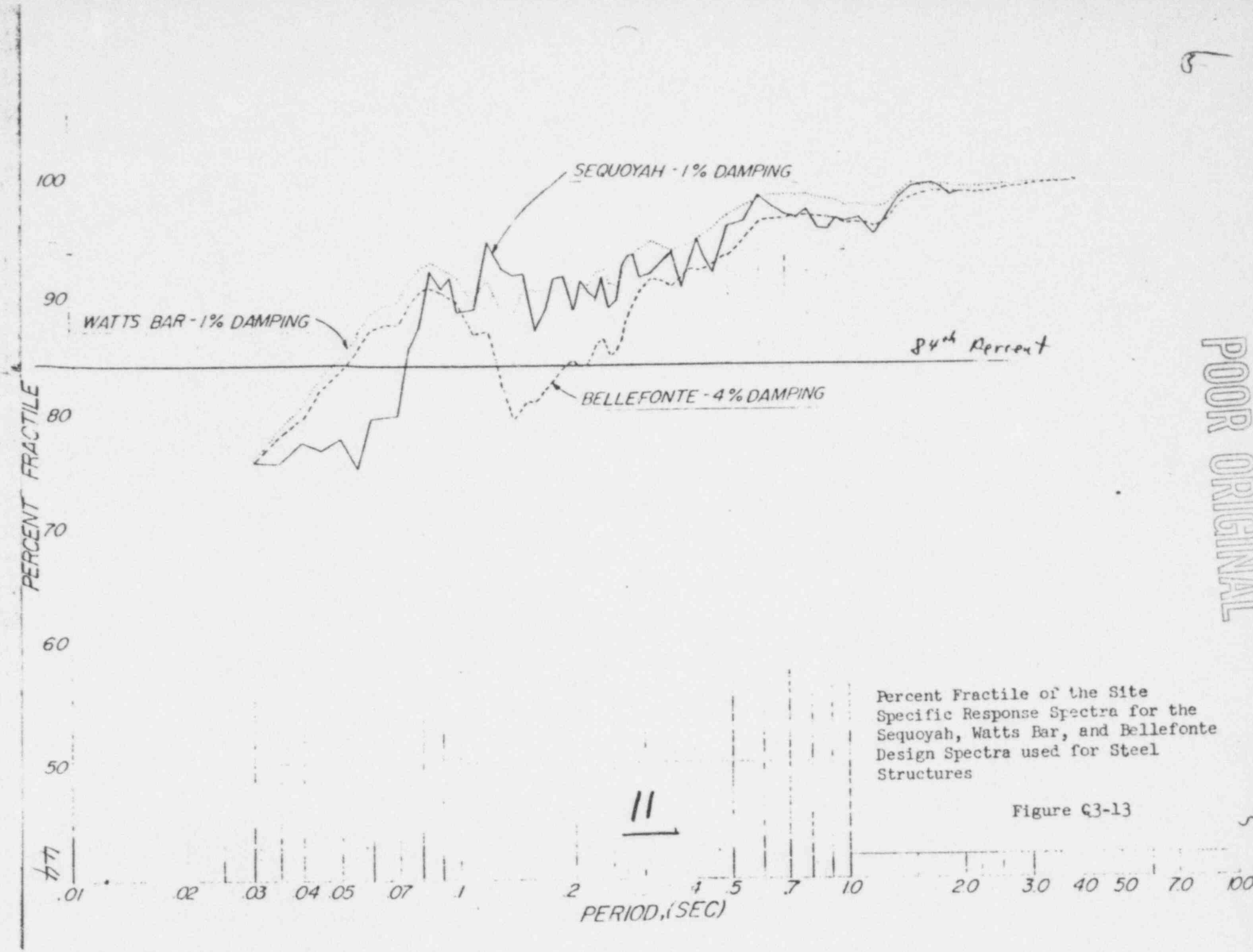
POOR ORIGINAL

Percent Fractile of the Site Specific Response Spectra for the Sequoyah, Watts Bar, and Bellefonte Design Spectra used for Reinforced Concrete Structures

Figure Q3-14

10

43



Percent Fractile of the Site Specific Response Spectra for the Sequoyah, Watts Bar, and Bellefonte Design Spectra used for Steel Structures

Figure C3-13

ꟷPECTRA WITH THE 50 TH AND 84 TH PERCENTILE NOR-
IALIZED RESPONSE SPECTRA FOR THIRTEEN UNITED
TATES AND ITALY EARTHQUAKES
ᴼᴳNORMAL DISTRIBUTION - 7% DAMPING

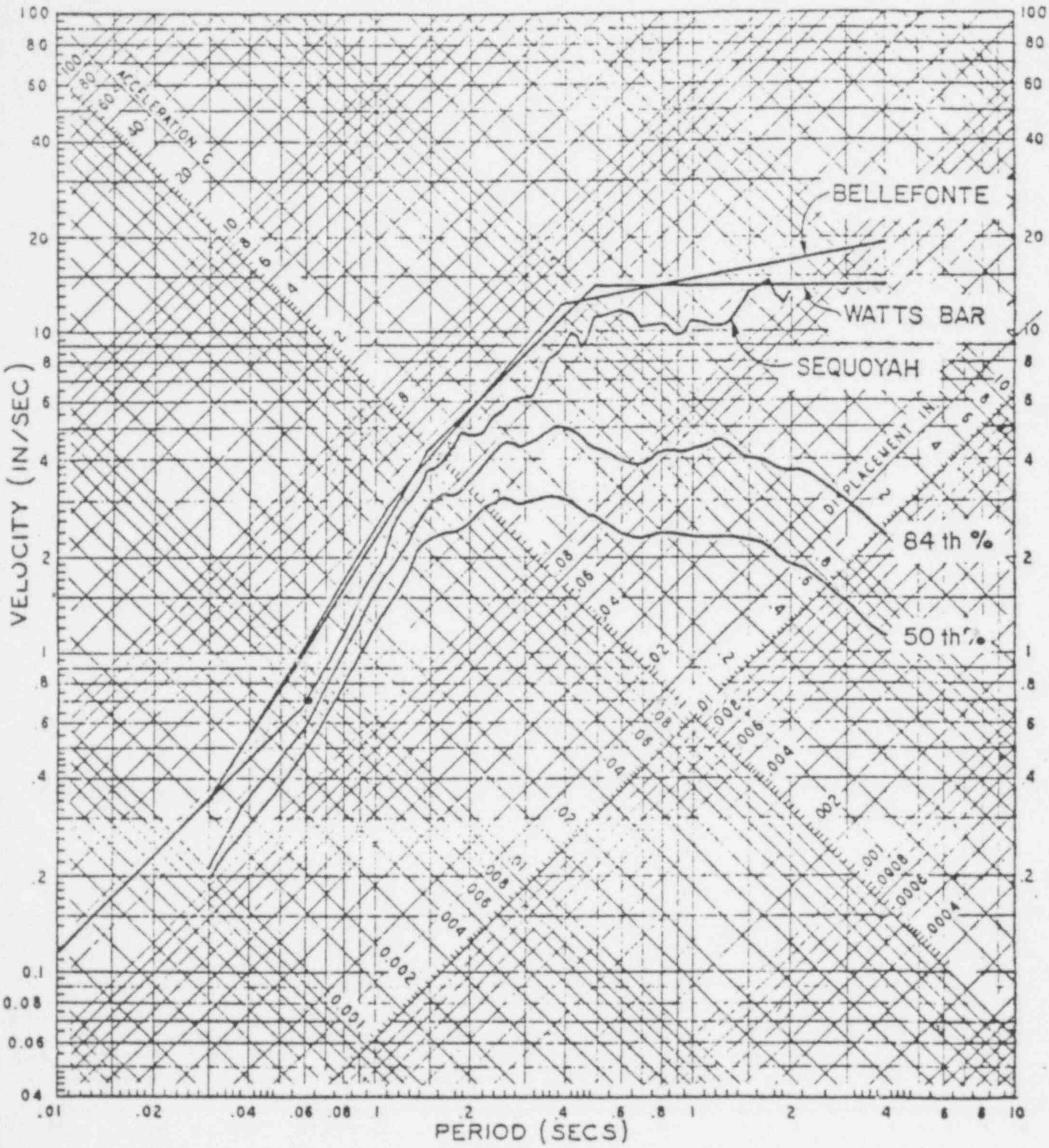


FIG. Q3-26

12

45

INPUT PARAMETERS TO SEISMIC HAZARD COMPUTATIONS

(1) EARTHQUAKE ACTIVITY LEVELS FOR THE HOST TECTONIC PROVINCE AND THOSE SURROUNDING IT. THE ACTIVITY RATE FOR EACH PROVINCE WAS DETERMINED FROM THE SPECIFIC EARTHQUAKE HISTORY. THE B VALUES (RECURRENCE RATES) WERE ALL ASSUMED TO BE 0.57 (CHINNERY, 1979). THE UPPER INTENSITY CUTOFF WAS ASSUMED TO BE THE MAXIMUM HISTORICAL INTENSITY EXCEPT FOR THE HOST (AND CONTROLLING) PROVINCE WHERE THE MAXIMUM POSSIBLE INTENSITY WAS CONSERVATIVELY ASSUMED TO BE IX RATHER THAN VIII.

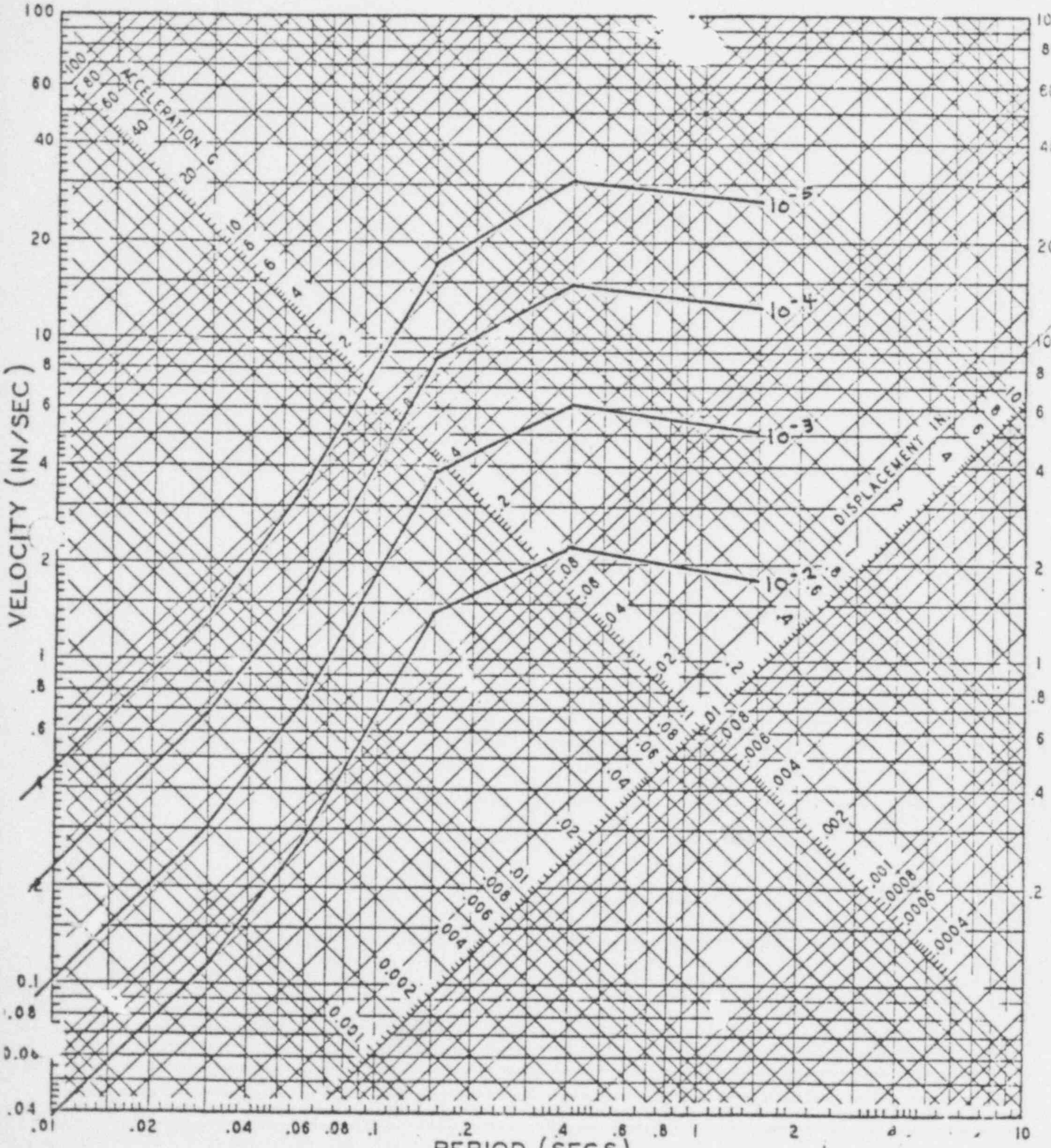
(2) THE INTENSITY FALL-OFF WITH DISTANCE WAS TAKEN TO BE THAT DETERMINED FROM THE 1886 CHARLESTON EARTHQUAKE (BOLLINGER, 1977).

(3) SITE INTENSITIES WERE CONVERTED TO PEAK ACCELERATION UTILIZING THE RELATIONSHIP DETERMINED BY MURPHY AND O'BRIEN (1978).

(4) PEAK ACCELERATIONS WERE CONVERTED TO SPECTRAL ACCELERATIONS AT SELECTED PERIODS UTILIZING SPECTRAL AMPLIFICATION FACTORS CALCULATED FROM THE 26 SITE-SPECIFIC SPECTRA NORMALIZED TO THE SAME PEAK ACCELERATION.

(5) THE DISPERSION ASSOCIATED WITH EACH OF THE LAST THREE RELATIONSHIPS WAS INCLUDED IN A TOTAL DISPERSION DEFINED BY A STANDARD DEVIATION FOR EACH PERIOD.

UNIFORM RISK RESPONSE SPECTRA WITH LIMITED DISPERSION ON UPPER LIMIT OF INTENSITY FOR SEQUOYAH, WATTS BAR, BELLEFONTE AND PHIPPS BEND PLANT SITES



14

$I_{o_{MAX}} = 1X$

$\beta = 1.312$

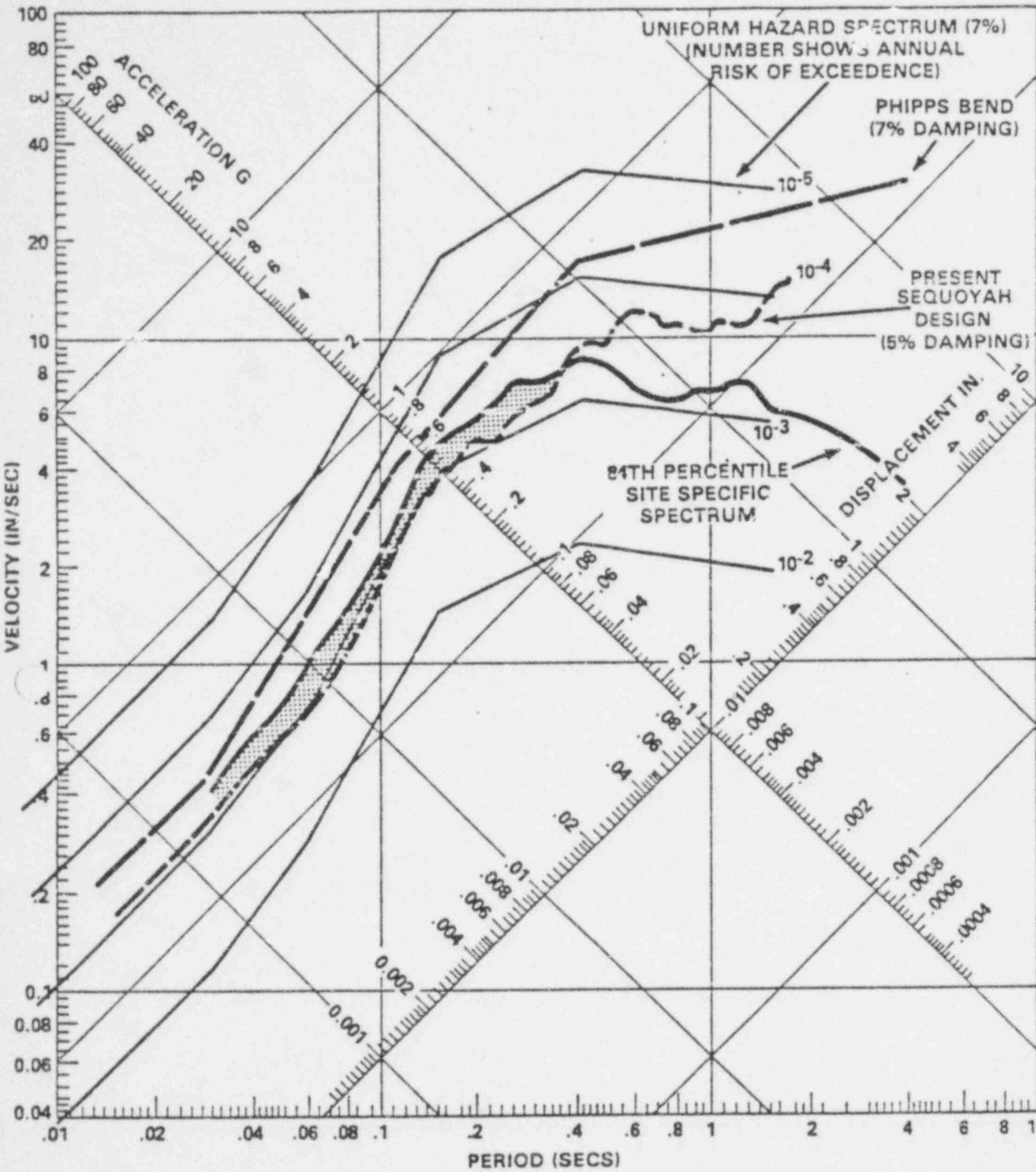


Figure 2-4

Comparison Of 7% Damped Uniform Hazard Response Spectra For The Sequoyah Site With The Present Sequoyah Design Spectrum For Reinforced Concrete, The 7% Damped 84th Percentile Site Specific Spectrum And The Phipps Bend Design Spectrum For Reinforced Concrete.

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AVERAGE RISK OF EXCEEDANCE FOR SPECTRA AT PERIODS LESS THAN 0.5 SECONDS

SEQUOYAH DESIGN: 9.0×10^{-4} PER YEAR

SITE SPECIFIC EARTHQUAKE: 4.7×10^{-4} PER YEAR

PHIPPS BEND SSE: 2.3×10^{-4} PER YEAR

RELATIVE SEISMIC HAZARD

SEQUOYAH DESIGN VS SITE SPECIFIC EARTHQUAKE - 2x - (0.9-3.1)

SEQUOYAH DESIGN VS PHIPPS BEND SSE - 5x - (2.4-8.7)

Sensitivity Study - 16th, 50th, and 84th Percentile Response Spectra for Original 13 Earthquakes, Original Plus 4 High Pairs, and Original Plus 4 Low Pairs Lognormal Distribution - 7% Damping

14

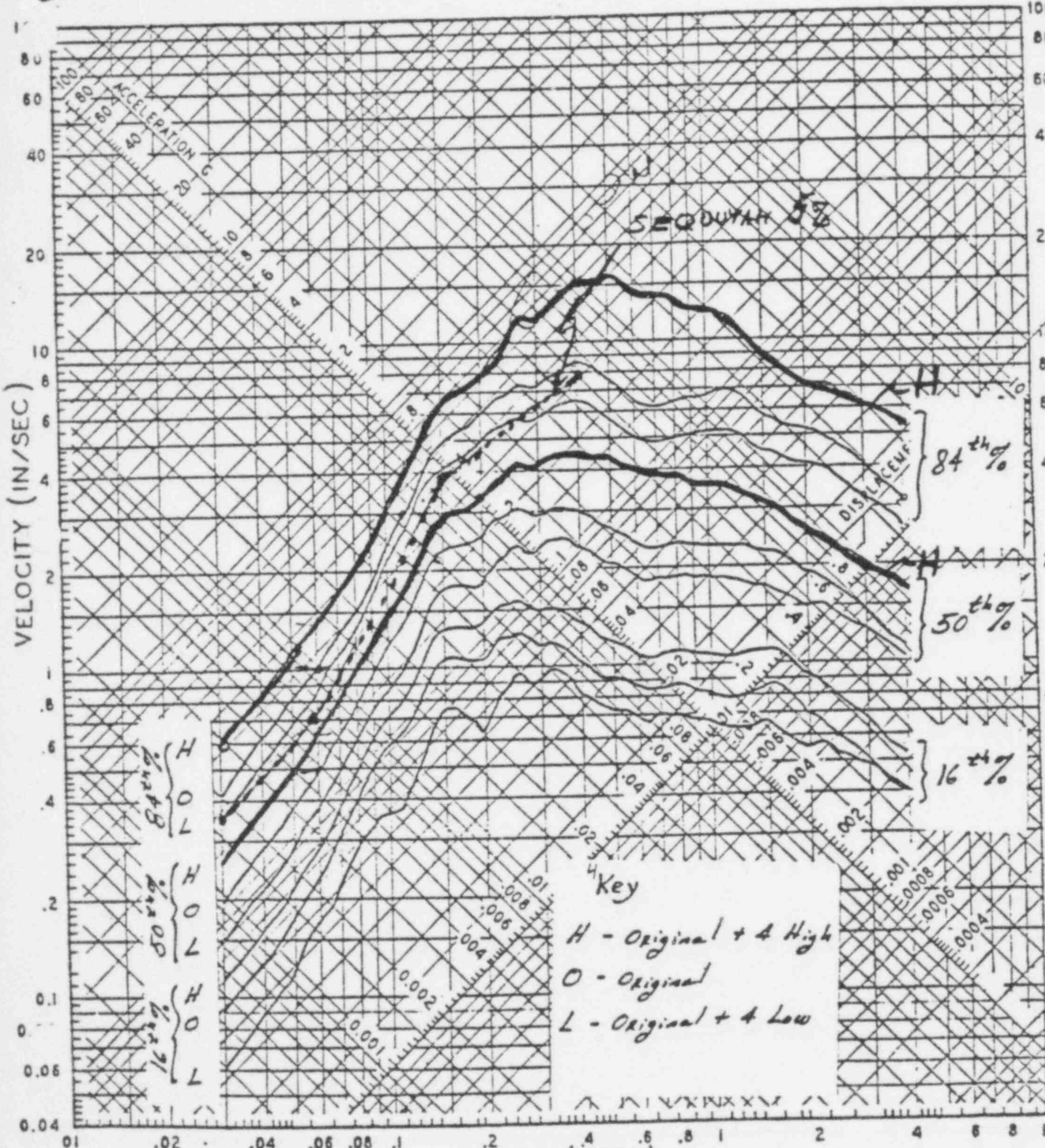


Figure Q3-29 17

50

CHARACTERIZATION OF SPECTRA IN TERMS OF INTENSITY
(UTLIZING TRIFUNAC AND BRADY, 1975 AND REG GUIDE 1.60)

SEQUOYAH DESIGN (REINFORCED CONCRETE) INTENSITY VII

SITE SPECIFIC (84TH PERCENTILE) INTENSITY VII-VIII

PHIPPS BEND INTENSITY VIII

18

SOME REASONS FOR DIFFERENCES

1. LITTLE DATA AT INTENSITY VIII
2. 1897 GILES COUNTY MAY HAVE BEEN A WEAK VIII
3. DIFFERENCE IN SITE CONDITIONS

19

CONCLUSIONS

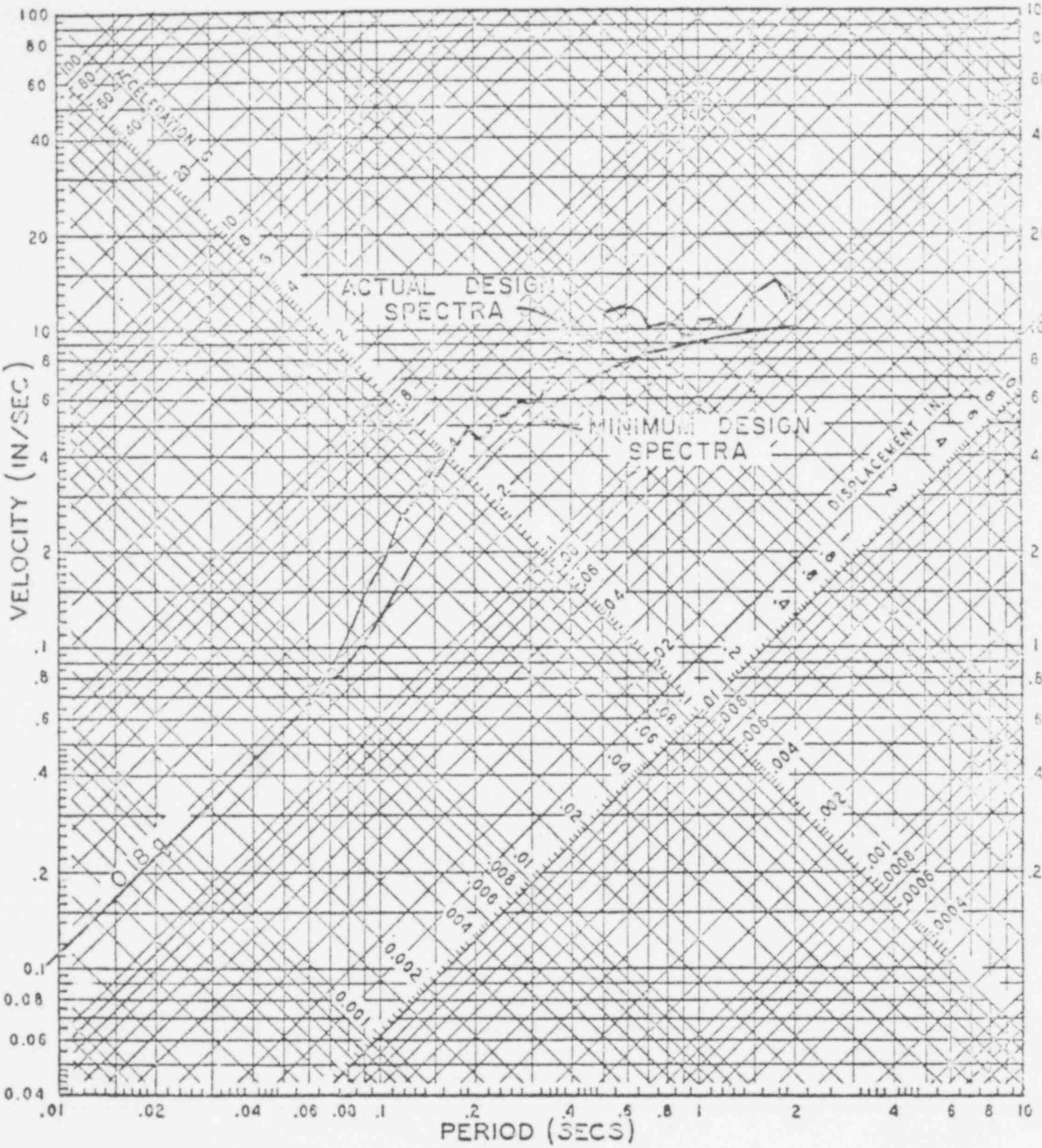
IT IS OUR CONCLUSION THAT THE DIFFERENCE IN ASSOCIATED SEISMIC HAZARD (RISK OF DESIGN SPECTRA BEING EXCEEDED BY EARTHQUAKE GROUND MOTION) BETWEEN THE PRESENT DESIGN AT SEQUOYAH AND THE APPROPRIATE SITE-SPECIFIC RESPONSE SPECTRUM IS NOT SUBSTANTIAL. THE REASONS FOR THIS ARE:

(1) FOR REINFORCED CONCRETE, THE PRESENT DESIGN AT SEQUOYAH REPRESENTS A MORE THAN MEDIAN DESCRIPTION OF THE CONTROLLING SITE-SPECIFIC GROUND MOTION.

(2) FOR REINFORCED CONCRETE, THE DIFFERENCES IN SEISMIC HAZARD ARE FACTORS OF 2 AND 3. THIS SEEMS VERY SMALL WHEN COMPARED TO THE ABSOLUTE SEISMIC HAZARD WHICH IS ON THE ORDER OF 10^{-3} TO 10^{-4}.

(3) IN OUR JUDGMENT, THERE ALREADY EXIST VARIATIONS IN SEISMIC HAZARD ASSOCIATED WITH DESIGN SPECTRA FOR OTHER PLANS IN THE EASTERN UNITED STATES THAT EXCEED FACTORS OF 2 OR 3.

(4) THE HAZARD ASSOCIATED WITH REINFORCED CONCRETE REPRESENTS A WORST CASE AND THE DIFFERENCE IN SEISMIC HAZARD WOULD BE EVEN LESS FOR OTHER MATERIALS.



COMPARISON OF RESPONSE SPECTRA
FOR SAFE SHUTDOWN EARTHQUAKE
5% DAMPING
SEQUOYAH NUCLEAR PLANT

FIGURE 3-4

TABLE 3-1**

DAMPING RATIOS USED IN THE ANALYSIS OF CATEGORY I

STRUCTURES, SYSTEMS, COMPONENTS AND SOIL AT SEQUOYAH NUCLEAR PLANT

Item	Damping Ratio, Percent of Critical Viscous Damping		
	1/2 Safe Shutdown Earthquake	Safe Shutdown Earthquake	
Steel Containment Vessel	1	1	1*
Concrete Shield Building and Internal Concrete Structure	2	5	7
Other Welded Steel Structures	1	1	2
Bolted Steel Structures	2	2	5
Other Reinforced Concrete Structures	5	5	7
Bolted or Nailed Wooden Structures	5	5	5
Damping for Determining Amplification through Soils for Soil-Supported Structures	10	10	10
Vital Piping Systems	0.5	0.5	1

*Damping values used when stress levels are at or near yield. All other damping values are for lower stress levels.

**This is Table 3.7-2 of the Sequoyah FSAR.

STUDIES PERFORMED BY TVA

1. EVALUATION OF GILES COUNTY EARTHQUAKE. (WGR-III.A.3)
2. EVALUATION OF SITE CONDITIONS ON EARTHQUAKE INTENSITY. (WGR-III.A.4)
3. EVALUATION OF ACCELERATION VARIATION WITH DEPTH.
4. COMPARISON OF ACCELERATIONS RECORDED ON ROCK AND SOIL DURING A GIVEN EARTHQUAKE AT A GIVEN SITE. (WGR-III.A.4)
5. EVALUATION OF INTENSITY - ACCELERATION RELATIONSHIPS. (WGR-III.B.3)
6. EVALUATION OF RESPONSE SPECTRA BASED ON INTENSITY. (WGR-III.B.2)
7. DEVELOPMENT OF RESPONSE SPECTRA BASED ON SITE SPECIFIC RECORDS. (WGR-III.B.1 & III.C.1.a)
8. DEVELOPMENT OF RESPONSE SPECTRA BASED ON MAGNITUDE. (WGR-III.B.6)
9. CALCULATION OF THE PROBABILITY OF EXCEEDENCE FOR VARIOUS RESPONSE SPECTRA. (WGR-III.E.1, III.E.2, & III.E.3)
10. EVALUATION OF THE OBE. (WGR-III.D)

ADDITIONAL STUDIES BY TVA

11. ADDITIONAL PROBABILITY STUDIES.
12. DETERMINATION OF SITE SPECIFIC RESPONSE CHARACTERISTICS. (WGR-III.A.4)
13. SOUTHERN APPALACHIAN TECTONIC STUDY. (WGR-II.A, III.A.1, & III.A.2)

Evaluation of Giles Co. Eq. Intensity

- Has been listed as MM VII, VII-VIII, VIII
- NRC regards it as a MM VIII
- TVA considers it as a MM VII-VIII

Evaluation of Site Conditions on Eq. Intensity

- Historical earthquakes are soil-biased
- Intensities on rock are 2 to 3 intensity units less than on soil
- Sequoyah is founded on competent rock

Evaluation of Acceleration Variation with Depth

- Earthquake accelerations reduce with depth
- Sequoyah is founded on rock at depth
- I-a relationships are based on recordings at the surface

Comparison of Accelerations Recorded on Rock and Soil

- Accelerations on rock are less than those on soil at a given site during a given earthquake

- Based on Friuli data a thin alluvium site had accelerations 1.5 to 3.8 times those at a nearby rock site

Evaluation of Intensity-Acceleration Relationships

- TVA considers the CSC as the most appropriate

	VII	VII-VIII	VIII
Trifunac & Brady (1975)	.13g		.25g
CSC (1978)	.09g	.12g	.15g
Trifunac (1976)	.10g (soil)		.19g (soil)

Evaluation of Response Spectra Based on Intensity

- Distance effects not considered
- Lack of data at MM VIII
- No Rock sites with MM VIII

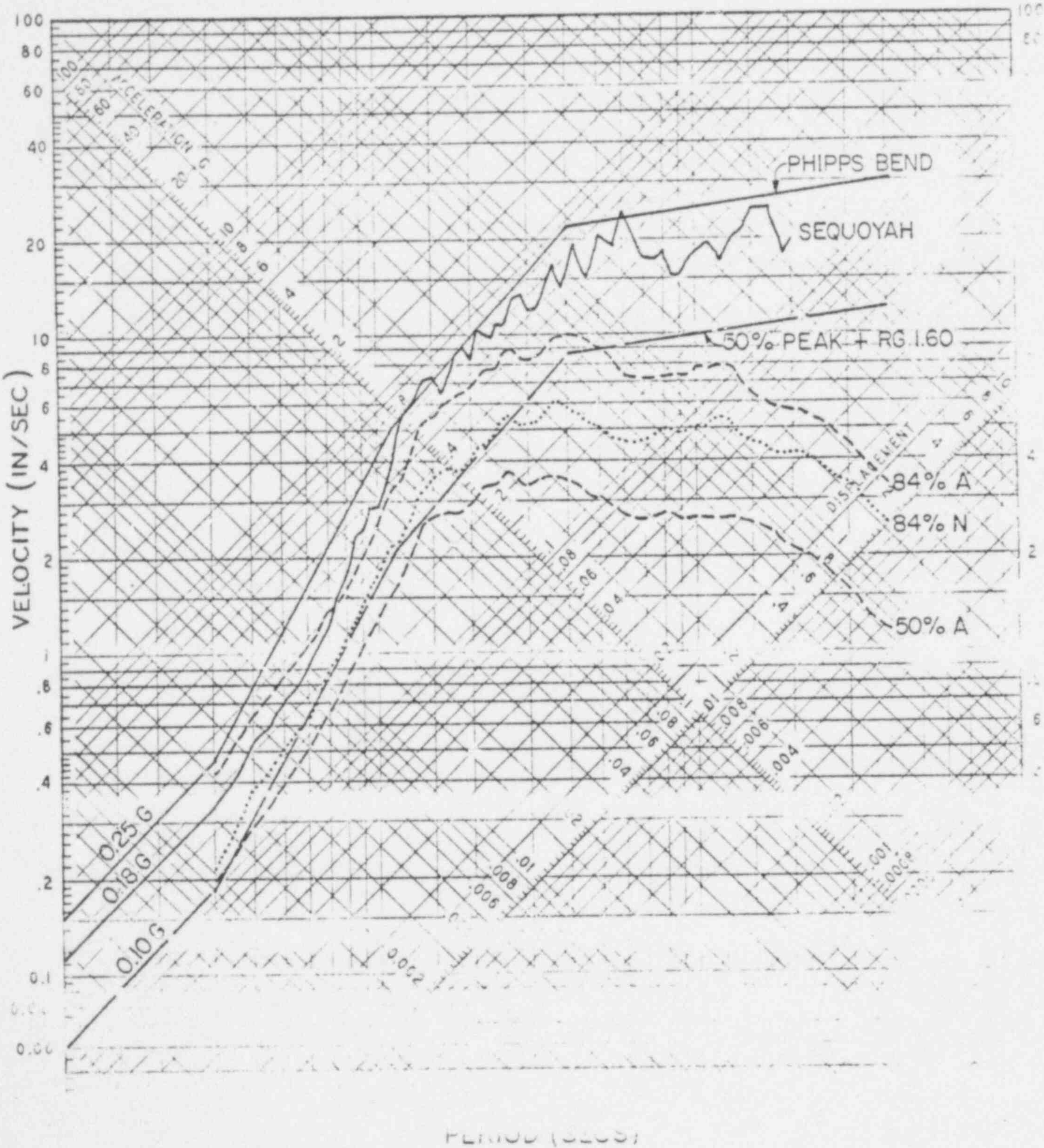
DEVELOPMENT OF RESPONSE SPECTRA BASED ON SITE SPECIFIC RECORDS

MAGNITUDE RANGE 5.3 TO 6.3

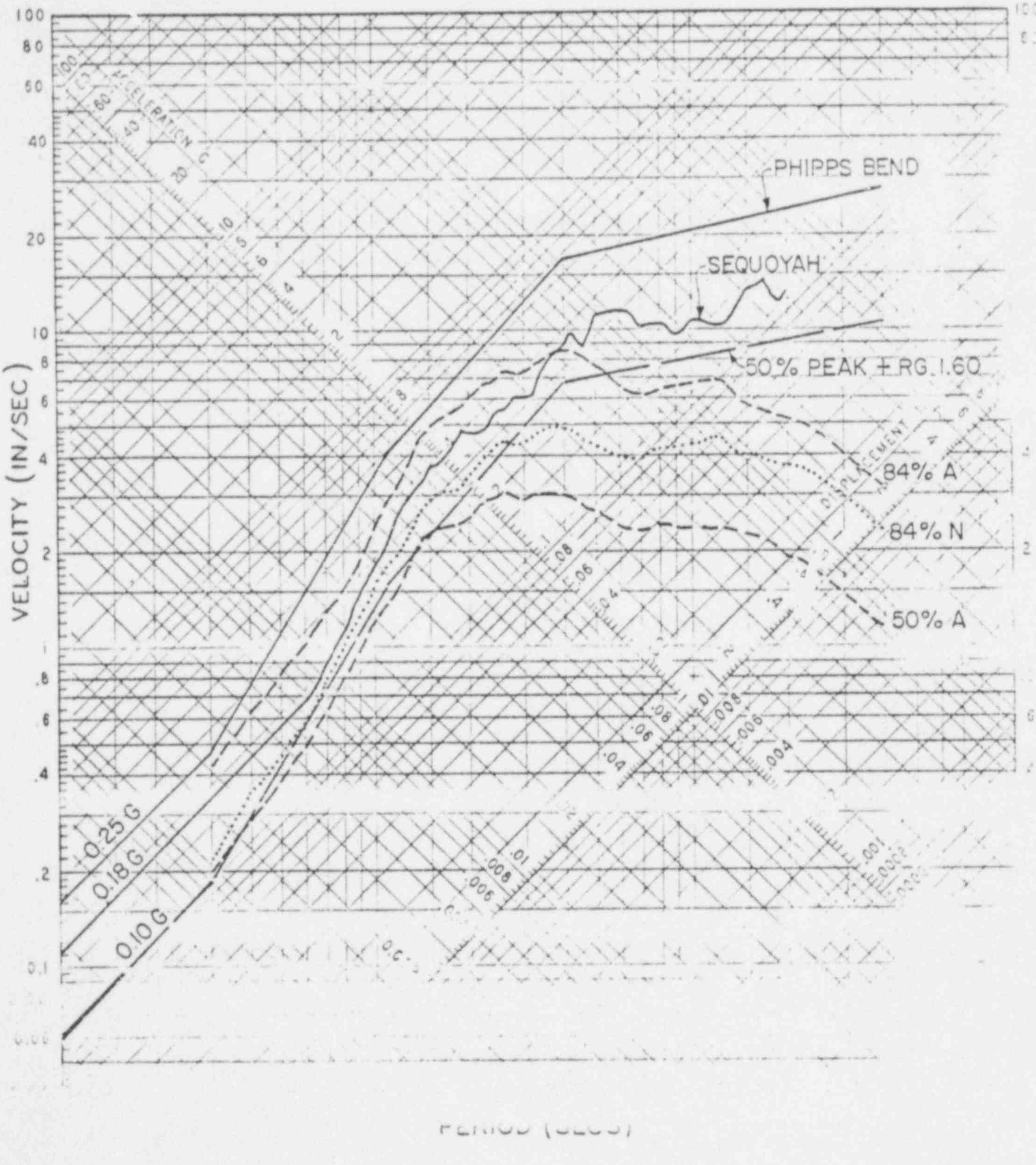
- EPICENTRAL DISTANCE $\leq$ 25 Km
- ROCK SITE
- 26 RECORDS
- LOGNORMAL DISTRIBUTION
- 50th PERCENTILE PEAK ACCELERATION - 0.10g
- CALCULATED 50th AND 84th PERCENTILE ACTUAL AND NORMALIZED RESPONSE SPECTRA
- SENSITIVITY STUDY

COMPARISON OF SEQUOYAH AND PHIPPS BEND DESIGN SPECTRA FOR STEEL STRUCTURES WITH VARIOUS SITE SPECIFIC SPECTRA

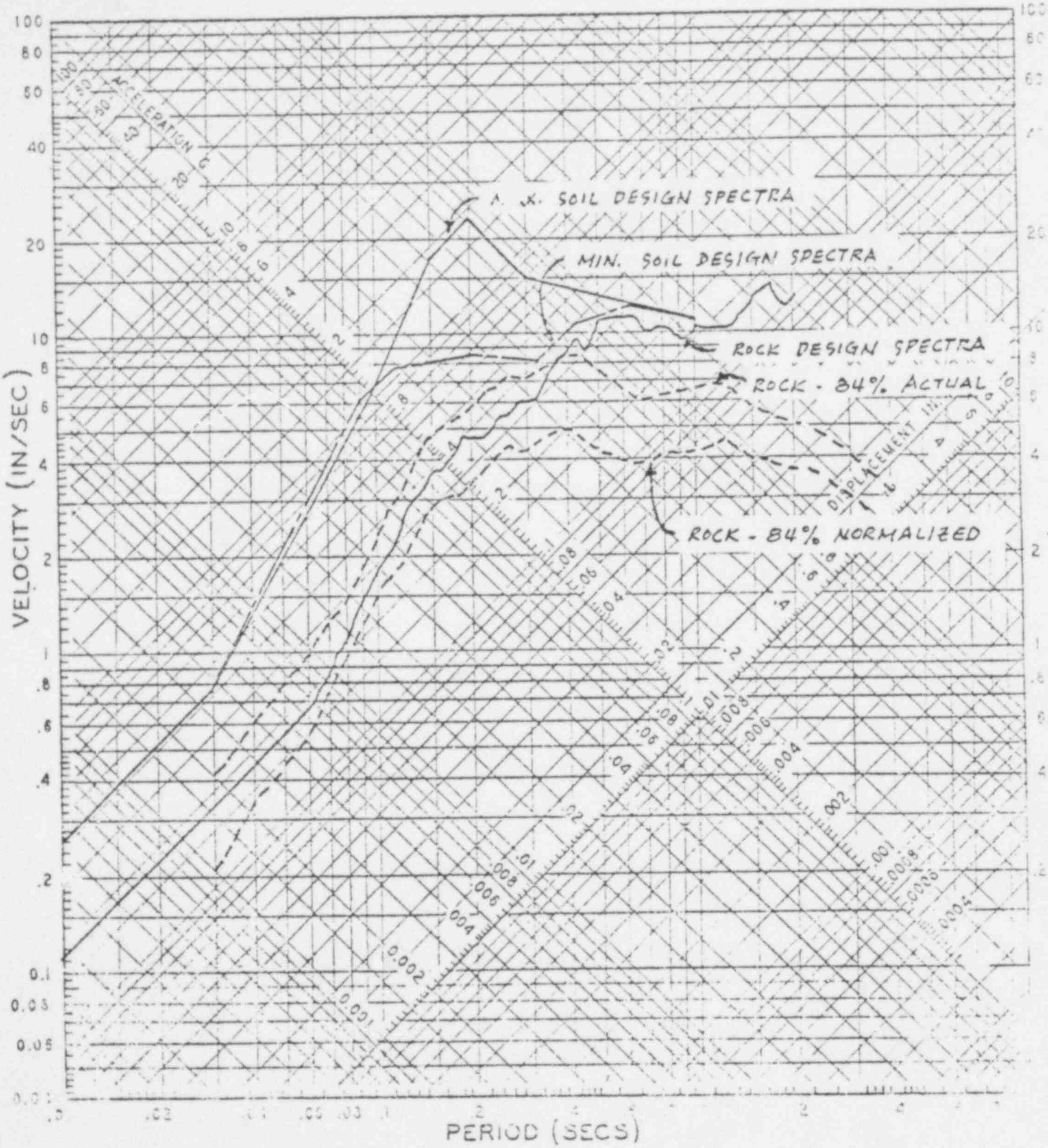
POOR ORIGINAL



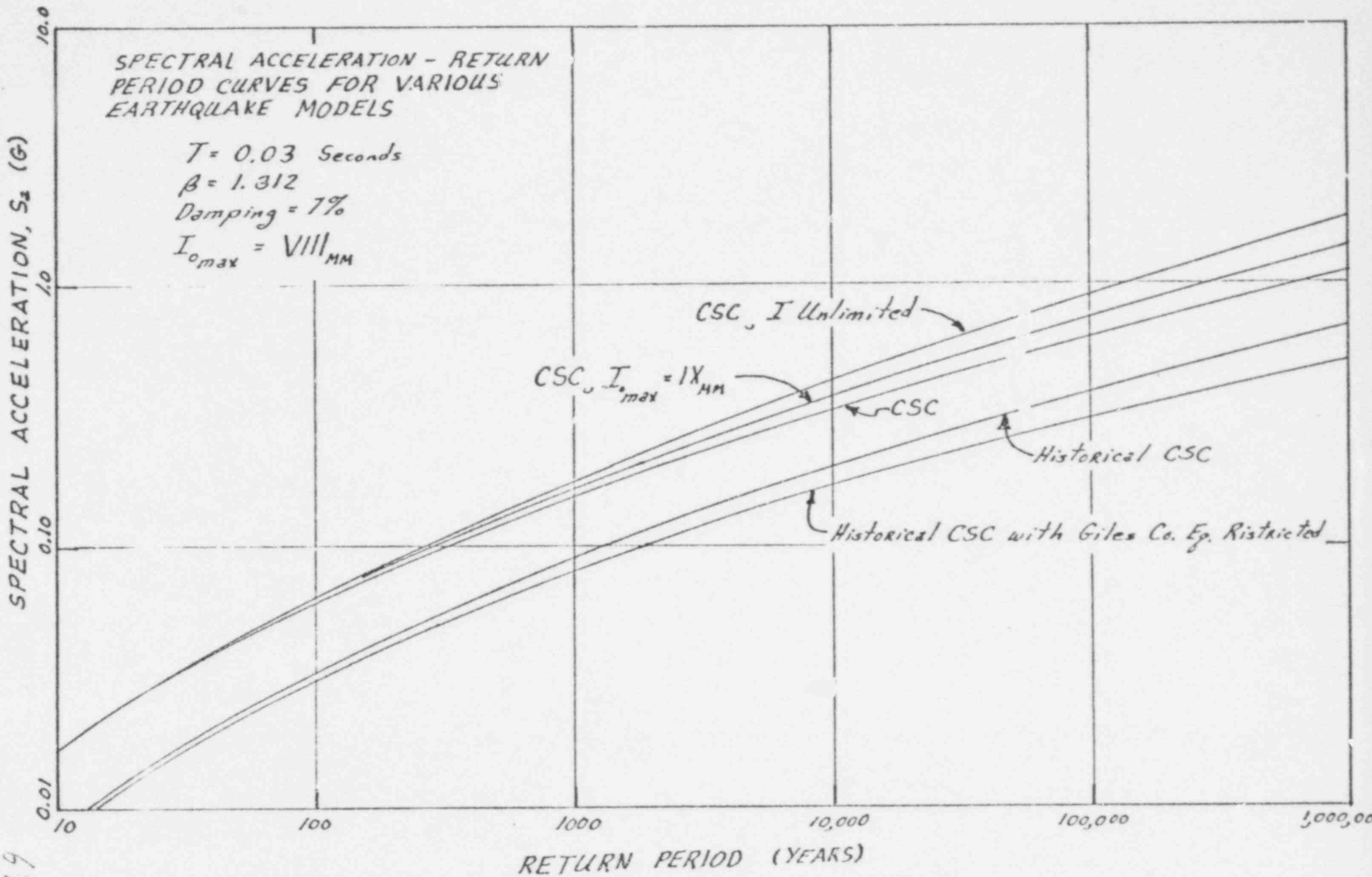
COMPARISON OF SEQUOYAH AND PHIPPS BEND DESIGN SPECTRA FOR REINFORCED CONCRETE STRUCTURES WITH VARIOUS SITE SPECIFIC SPECTRA



COMPARISON OF SEQUOYAH NUCLEAR PLANT ROCK AND SOIL SSE DESIGN RESPONSE SPECTRA FOR REINFORCED CONCRETE STRUCTURES

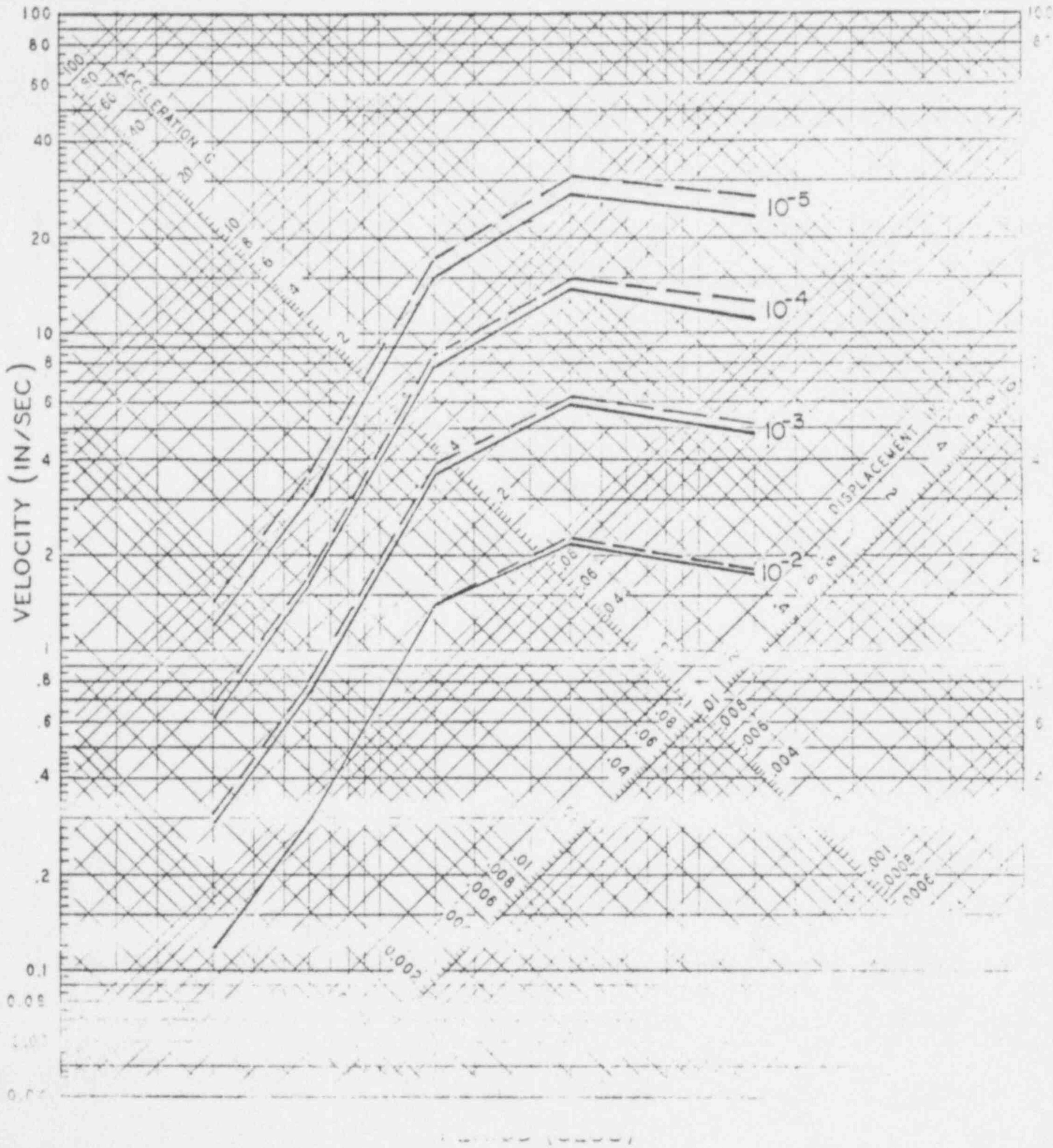


POOR ORIGINAL


SPECTRAL ACCELERATION - RETURN PERIOD CURVES FOR VARIOUS EARTHQUAKE MODELS
T = 0.03 Seconds
β = 1.312
Damping = 7%
I0max = VIIIMM
CSC, I Unlimited
CSC, I0max = IXMM
CSC
Historical CSC
Historical CSC with Giles Co. Eq. Restricted
SPECTRAL ACCELERATION, Sa (G)
10.0
1.0
0.10
0.01
10
100
1000
10,000
100,000
1,000,000
RETURN PERIOD (YEARS)

COMPARISON OF UNIFORM RISK RESPONSE SPECTRA WHEN THE SATP $I_{o_{max}} = VIII_{MM}$ & IX_{MM}

POOR ORIGINAL

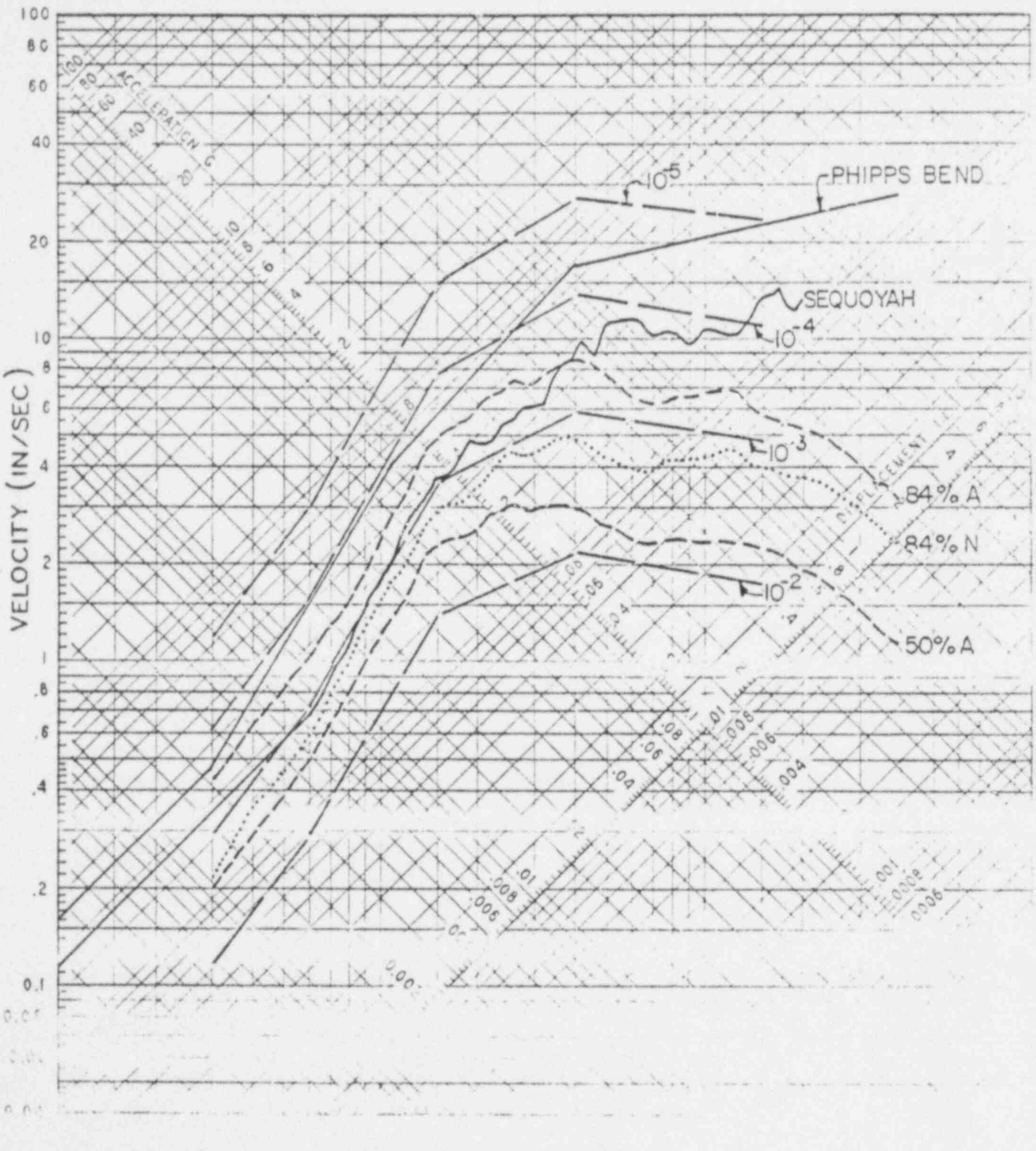


——— $I_{o_{max}} = VIII_{MM}$, β = 1.312

— — — $I_{o_{max}} = IX_{MM}$, β = 1.312

COMPARISON OF UNIFORM RISK RESPONSE SPECTRA WITH VARIOUS SITE SPECIFIC SPECTRA AND THE SEQUOYAH DESIGN SPECTRUM FOR REINFORCED CONCRETE STRUCTURES

POOR ORIGINAL



$I_{o_{max}}$ = $VIII_{MM}$ DAMPING = 7%

β = 1.312 CSC ATTENUATION

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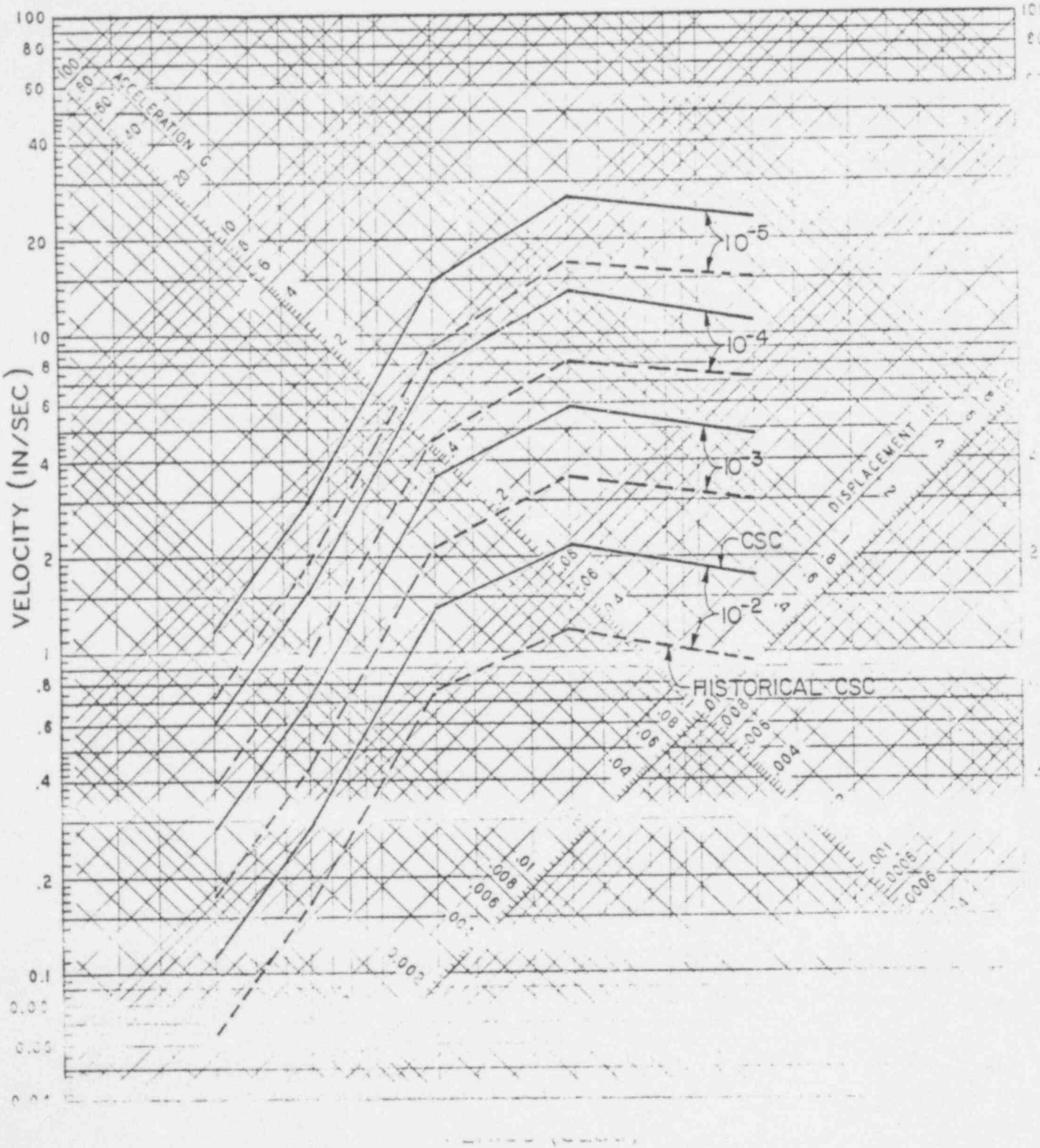
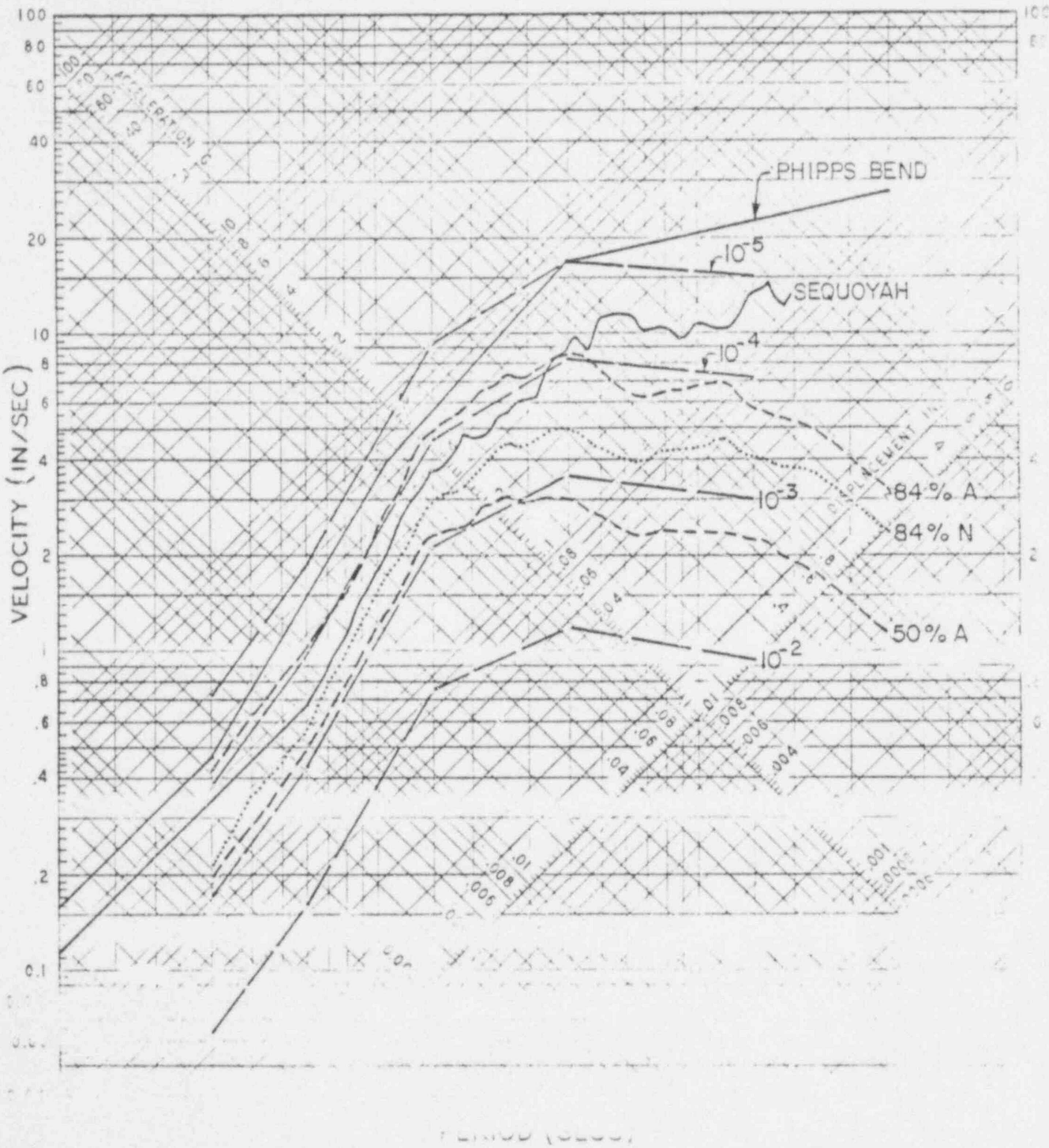
COMPARISON OF UNIFORM RISK RESPONSE SPECTRA FOR CSC AND HISTORICAL CSC ATTENUATION



$I_{o_{max}}$ = $VIII_{MM}$
β = 1.312
DAMPING = 7%

COMPARISON OF UNIFORM RISK RESPONSE SPECTRA WITH VARIOUS SITE SPECIFIC SPECTRA AND THE SEQUOYAH DESIGN SPECTRUM FOR REINFORCED CONCRETE STRUCTURES



$I_{o_{max}}$ = VII_{MM}

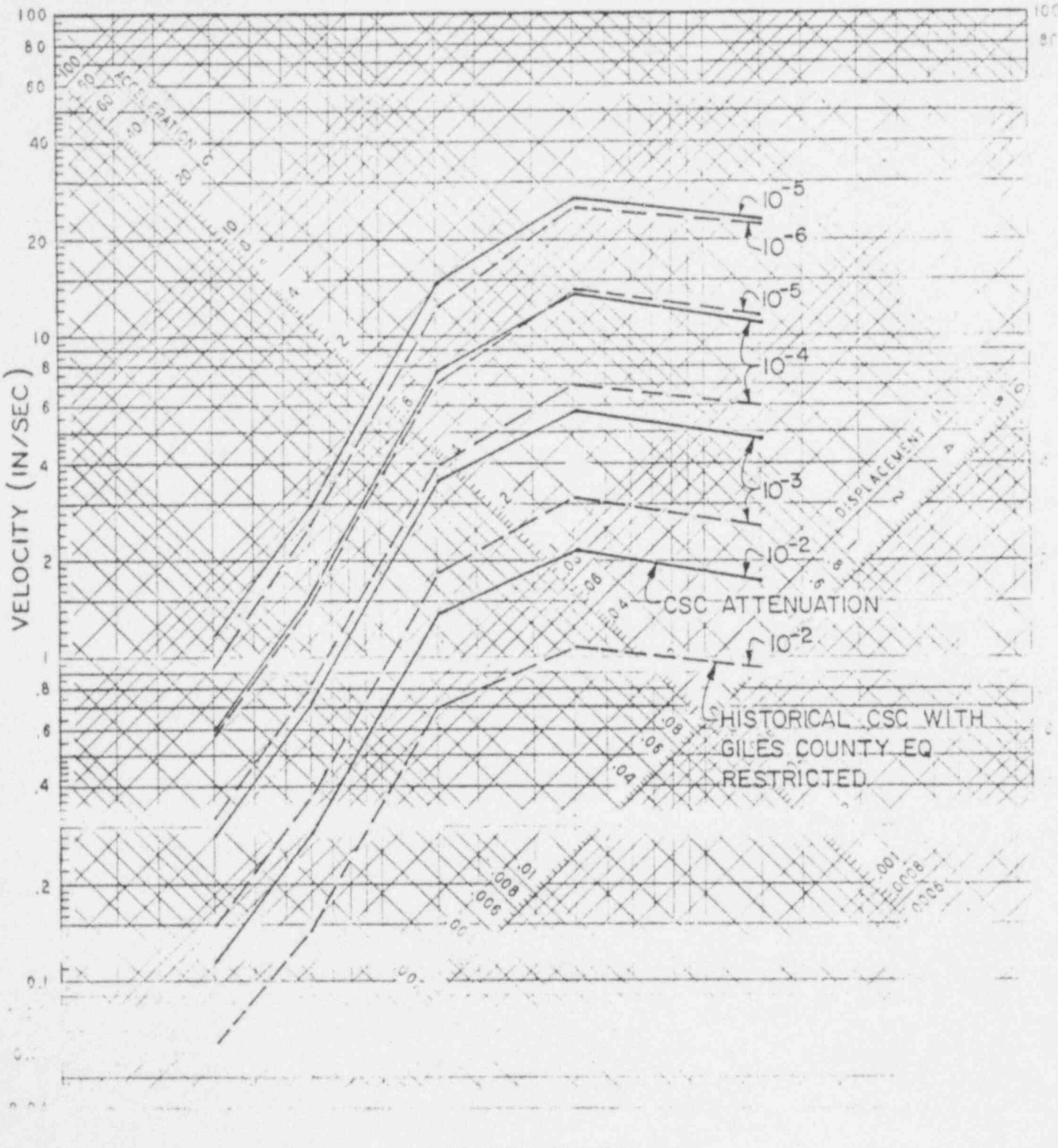
DAMPING = 7%

β = 1.312

HISTORICAL CSC ATTENUATION

COMPARISON OF UNIFORM RISK RESPONSE SPECTRA FOR HISTORICAL CSC ATTENUATION WITH GILES COUNTY EARTHQUAKE RESTRICTED AND CSC ATTENUATION

POOR ORIGINAL



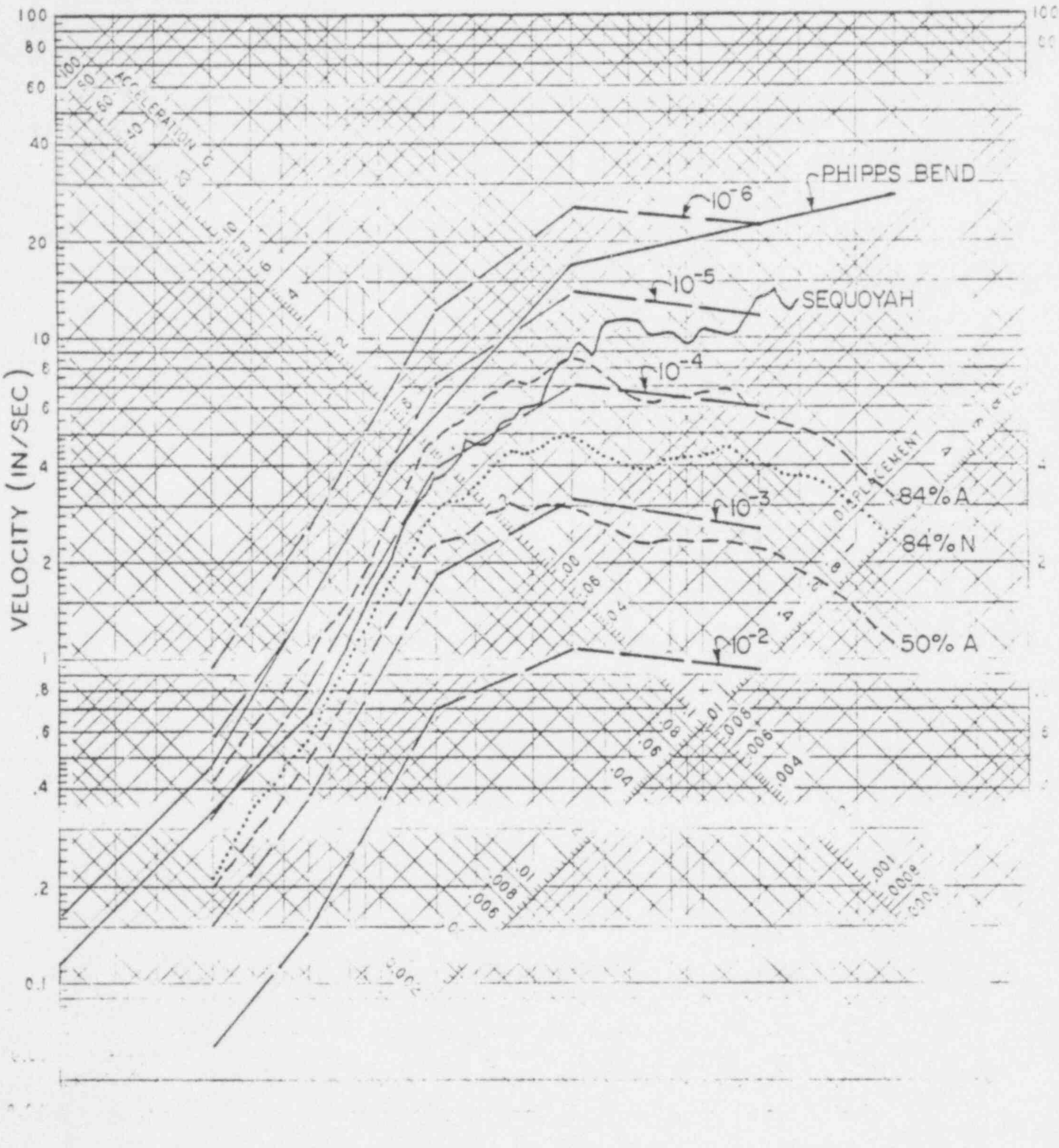
$I_{o_{max}}$ = $VIII_{MM}$

β = 1.312

DAMPING = 7%

COMPARISON OF UNIFORM RISK RESPONSE SPECTRA WITH VARIOUS SITE SPECIFIC SPECTRA AND THE SEQUOYAH DESIGN SPECTRUM FOR REINFORCED CONCRETE STRUCTURES - GILES COUNTY EARTHQUAKE RESTRICTED

POOR ORIGINAL



$I_{o_{max}}$ = $VIII_{MM}$ DAMPING = 7%

β = 1.312 HISTORICAL CSC ATTENUATION

POOR ORIGINAL

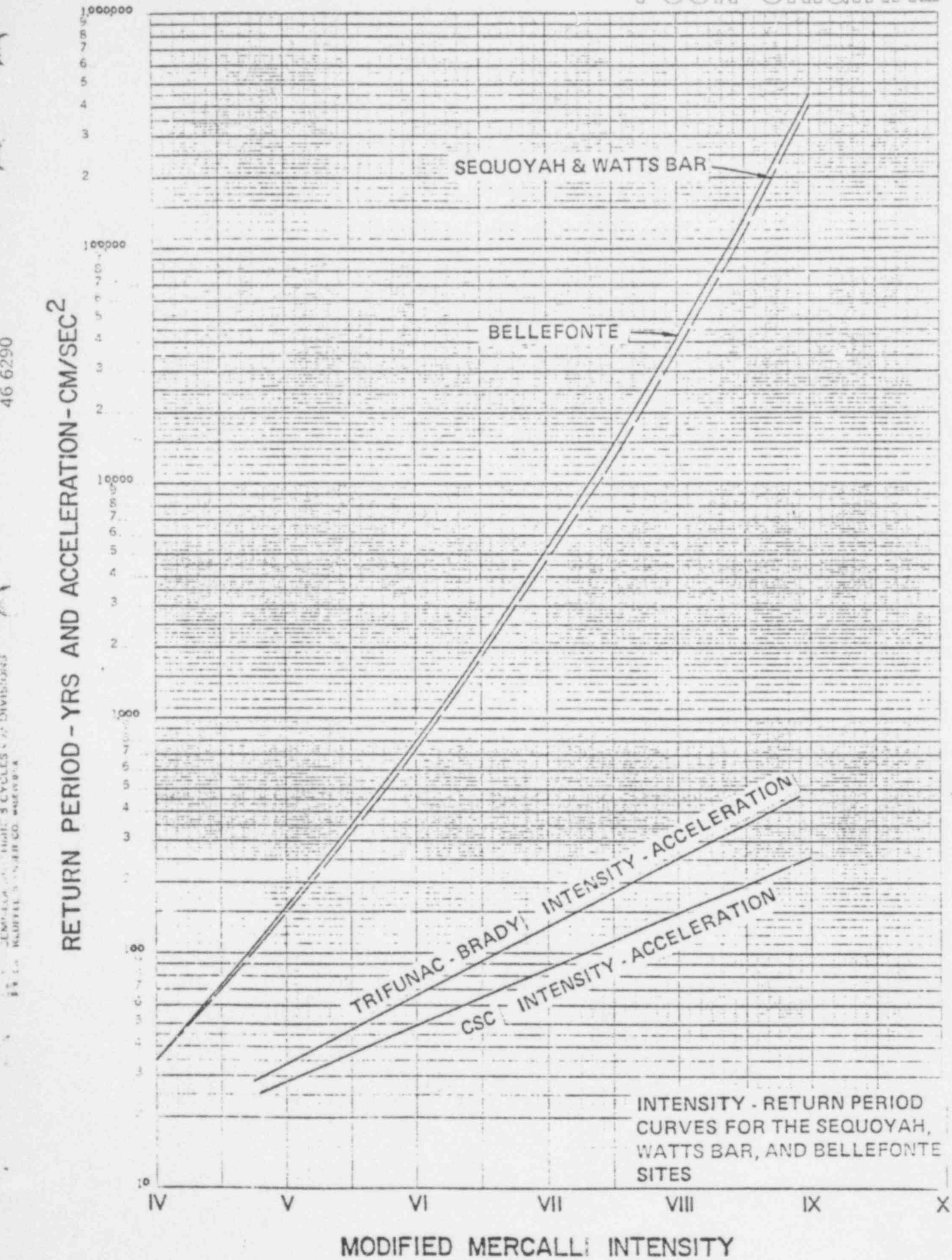


FIGURE Q5-1

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