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delete B. White
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ALDERSON REPORTING
(202) 628-9300
440 FIRST STREET, N.W.
WASHINGTON, D.C. 20001

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
SUBCOMMITTEE ON PROGRAM FOR QUALIFICATION OF
SAFETY RELATED EQUIPMENT

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Room 1046
1717 H Street, N.W.
Washington, D.C.

Tuesday, March 15, 1983

The Advisory Committee on Reactor Safeguards Subcommittee on the Program for Qualification of Safety Related Equipment met, pursuant to notice, at 8:35 a.m., Jesse C. Ebersole, Acting Chairman, presiding.

ACRS MEMBERS PRESENT:
JESSE C. EBERSOLE
DAVID A. WARD

ACRS CONSULTANTS:
T. PICKEL
I. CATTON
W. LIPINSKI

DESIGNATED FEDERAL EMPLOYEE:
ANTHONY J. CAPPUCCI

ALSO PRESENT:
VINCE NOONAN
NIEL SMITH
PETER YANEV
T. Y. CHANG
G. BAGCHI
R. LA GRANGE
BILL MORRIS
MR. AGGARWAL
MR. ANDERSON

P R O C E E D I N G S

MR. EBERSOLE: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on the Program for Qualification of Safety Related Equipment.

I am Jesse Ebersole, Acting Subcommittee Chairman. The other ACRS member today is David Ward. We also have in attendance ACRS consultants Ivan Catton, Walt Lipinski and T. Pickel.

For your information, Jerry Ray had a mild heart attack and he will be out for about six weeks or so. He is doing very well at the hospital somewhere near Pittsburgh.

The purpose of the meeting is to discuss the overall status of the NRC's equipment qualification program, using seismic experience data for seismic qualification, USI A-46, Issue 21, and C-1, and the research program on plant aging.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act. Mr. Anthony Cappucci is the Designated Federal Employee for the 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 February 23rd, 1983 and March 3rd, 1983.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. It is requested that each speaker first identify himself or herself and speak with sufficient clarity and volume so that he or she can be readily heard.

We have received no written comments from members of the public. We have received no requests for time to make staements from members of the public.

We will now have a few comments here from the table. I guess I will lead off with that.

In reading the material here on this topic I note that the Commissioners have elected to eliminate equipment which is said to be in a mild environment from environmental considerations. I want to go on the record and have the Staff respond to a problem, I think, which is generic to the business. It is this:

I guess I have mentioned it before but I now have some bitter evidence that it is with us. In some of the SEP studies that we have had, some plant owners, at least one I know of and maybe others, have found a somewhat subtle effect on the mild environment equipment when they began to look at those lines from any source which could deliver a steaming component of fluid flow and create from an ordinary mild environment, like this room, a turkish bath type of an environment, which is really not harsh; it is rather pleasant, but it is devastating to open-type electrical equipment which starts at a base temperature of something like 70 degrees and acts as the recipient of a condensing process.

The steam runs off and, as you well know, seeks all corners. It goes right through the ventilated enclosures of electrical apparatus, switches, contacts, the switch ports, consoles, whatever, with the end result of condensing on the terminal boards and contacts of all that equipment.

The Staff, in looking at these steam breaks, if the steam break has a radionuclide component, never does anything but look at the radiological consequences of this at the site boundary. They never look at the real effects of this, which is short-circuiting of equipment at the terminal boards of critically needed electrical functions.

They run up with a dose calculation and quickly conclude there is no consequence when there may be substantial consequence. I am quite certain I could find equipment rooms within which I could put a small boiler and literally stop everything in it in short order. I think that is a gross shortcoming of the present program not to look at this.

Some newer plants, by the way, are using NEMA type enclosures, which are watertight, to stop this. Some of the older plants, although it is not required, are actually boxing and sealing some of their older equipment.

Now that is my only comment on the package we are going to look at this morning, but I would like to have it on the record and have you all look into this matter and see whether I am wrong or not.

Any other comments from the table here on this line before we jump into this program? Yes, sir?

MR. CATTON: Are the current steam generator problems considered to be aging problems, the flow vibration?

MR. NOONAN: Shall I use a mike?

THE REPORTER: Yes, sir.

MR. NOONAN: My name is Vince Noonan. I am with the Division of Engineering, NRR.

The question you asked about the steam generators, with respect to a component piece of equipment, the steam generators are not necessarily treated in the same manner that we do other components.

The aging question: Yes, I guess you could say it is an aging question. It is a continuous buildup of byproducts inside the generator that causes the intergranular stress corrosion cracking to the tubes and so forth, which usually occurs over a period of time, depending on how well the water chemistry is controlled. So aging is partly there.

I would say the chemistry, the secondary side water chemistry is a very important part of that. You can have some plants that have been running for a fair length of time that had practically no problems with tubes, and yet we see plants that have been recently licensed in the past decade that have a number of problems with tubes.

MR. CATTON: I was kind of interested in flow vibration because I have recollections of when we did an LER study here of all kinds of pumps that had to have welds ground out and so forth as a result of fatigue and vibration that resulted from flow. It seems to me that is an aging problem and you do have a valve and pump part of your program and I really did not see anything directly related to this.

MR. NOONAN: I guess when it comes to flow vibrations on the steam generators it has always been considered, at least as long as I have been here. We have always talked about the flow-induced vibrations in steam generators and it never has appeared to be a major problem.

There are methods to restrain the top of the tube bundle, particularly in the Westinghouse plants, for this kind of problem. I cannot really say that I have ever seen a specific problem related to vibration from steam generators.

MR. EBERSOLE: Pardon me. I was under the impression that aging did not include fatigue, it did not include erosion --

MR. NOONAN: No, not in that sense.

MR. EBERSOLE: -- it did not include bearing wearout --

MR. CATTON: Then that answers the question.

MR. EBERSOLE: -- or a host of other things which are normal products of use; that "aging" had a sort of discrete meaning in which time itself was the main parameter.

MR. NOONAN: I think that is what I was referring to. It does not really come under the normal way we treat aging in this environmental program. "Environmental qualification" is not the same thing as what you would call the aging process on the steam generator.

MR. CATTON: I see where your famous incident occurred.

MR. EBERSOLE: Oh, yes; breakers.

(Laughter.)

MR. CATTON: I was just going to ask if the lubricant did not lubricate.

MR. EBERSOLE: That was a wearout.

MR. LIPINSKI: You mean on the breakers?

MR. CATTON: Didn't they get stuck or something because of the lubricant?

MR. EBERSOLE: Yes. You are referring to the two DB-50 Salem breakers sticking coincidentally?

MR. CATTON: Yes. Is there a part of your environmental program directed toward finding out what happens to --

MR. NOONAN: We are investigating both the Salem failures right now, and we are also involved in the problems that occurred at San Onofre over the weekend.

MR. CATTON: Is there anything in place now --

MR. NOONAN: Yes.

MR. CATTON: -- that would look at lubricants?

MR. NOONAN: There is a program that we have started as of now --

MR. EBERSOLE: I guess on lubricants, you would look at aging of lubricants, if they get tacky or something like that.

MR. NOONAN: We have both the Franklin Research Center and Brookhaven National Labs involved in looking at the lubricants, both from the standpoint of corrosion, hardening, any kind of detrimental effect we might find on these breakers. That effort just started.

MR. CATTON: I have heard Jesse describe that incident at least ten times, if not more.

MR. LIPINSKI: Could you elaborate on San Onofre?

MR. NOONAN: San Onofre ran some tests. It will be part of our Commission briefing this afternoon to the Commission. But there were some tests run on the third of March and also on the eighth of March in both units 2 and 3. This is very preliminary. I do not have all the facts yet because people just came back this morning that were out there over the weekend.

There were a total of four of these under-voltage trip attachments that supposedly failed. These are not the same type of attachments that are in Salem. They are a GE type of an under-voltage called an AKA-2-25 I believe is the number. I am not sure of that nomenclature. It is a similar type of device, but it is not the same device.

MR. EBERSOLE: Was it lubricated?

MR. NOONAN: It had been lubricated. It had been following a maintenance procedure, from what I am told. I was told it was a GE type of representative that goes to the plant on a periodic basis -- I am not sure exactly what that time period is yet -- but I was told that this GE sort of technician would maintain the breakers. They maintain the trip devices. There had been a lubricant used on these.

MR. EBERSOLE: I think the aging of lubricants would be a legitimate part of this program because I notice there are no particularly critical environments on lubricants for the critical machines, and certainly nothing about looking at them at X months and see the degree of tackiness and whether it is changing to glue or not, Ivan.

MR. CATTON: Or plastic.

MR. NOONAN: In Salem no lubricants were used other than the solvents. There were some solvents used, but no lubricants.

MR. EBERSOLE: Well, right; but Westinghouse had told the company to use lubricants.

MR. NOONAN: That is right.

MR. EBERSOLE: But the thrust of this whole thing -- by the way, the Salem case now has been augmented by the SONGS case. There is a critical matter there that I think we should all look at.

My understanding is that the SONGS breakers employed the magnetic kicker, called the shunt trip, coincidentally with the under-voltage trip, which is intrinsically less reliable than the magnetic kicker, except for the power supply reliability.

The thesis was that they had a sort of diverse in-place automatic trip, but they really had to rely from the safety viewpoint on the under-voltage component. They use these things unfortunately coincidently, and when they tested them they never broke the two components apart.

It is analogous to having a trailer behind you and finding you are pulling on the safety chain when the ball has long since failed.

MR. NOONAN: That is right.

MR. EBERSOLE: And they did not know that they were riding on the voltage-applied kicker to the shunt trip. In short, they had blinded their failure, which in a way is worse than the Salem trip. They had put a blinder over it and did not know that their UV trips were not working.

MR. LIPINSKI: That is an illustration of incomplete testing.

MR. EBERSOLE: Right. It was an absence or breakdown of the component parts of the process.

MR. LIPINSKI: But the whole procedure for testing evidently had not been examined properly.

MR. EBERSOLE: True. Right. I mean, it is kind of a gross --

MR. NOONAN: I think in these cases, and I pointed out the recent ones, the same thing happened. The shunt coil actually tripped the breaker --

MR. EBERSOLE: All right.

MR. NOONAN: -- but they were looking at the under-voltage trip that sort of got hung up.

MR. WARD: Jesse, could I go back to your comment about concern about a steam environment on electrical equipment? My impression is that this program is addressing that. The environmental qualification program is addressing that. Could you elaborate? Perhaps the Staff will say something.

MR. EBERSOLE: Will you be saying something about this?

MR. NOONAN: I can briefly address it right now, if you would like me to.

MR. EBERSOLE: Why don't we go ahead, Mr. Noonan.

MR. WARD: Is that an issue that is not being addressed by the program? Or is it being addressed?

MR. NOONAN: Main steam line breaks are addressed.

MR. WARD: Yes.

MR. NOONAN: We look at intermediate steam lines or low energy type lines.

MR. EBERSOLE: Impulse lines?

MR. NOONAN: They are not part of the program. I think that is what Dr. Ebersole meant.

MR. EBERSOLE: Or even the interim period within which you have a steam discharge and then you are intercepted. It might be quite competent of entering critical spaces and saturating the environment and leading to condensation short-out of equipment.

MR. NOONAN: There is a contention right now at Perry that involves steam erosion of elbows and there is some safety-related equipment located on the particular lines we are talking about. These are intermediate steam lines. They are not normally covered under the EQ program because they consider these so-called "mild environments."

Now in answering this contention, we are suggesting that we generically include the so-called -- what you would call the intermediate steam line breaks or steam erosion problems into the EQ program to determine how we should progress from this point on.

MR. :ATTON: His instrument line could do that, too.

MR. EBERSOLE: Oh, an instrument line can do it; or in the interval during which a valve is closing you can get a shot of steam that will do it.

Well, general purpose enclosures frequently are ventilated in fact to let the heat out. They are cheaper because they do not have a heat confinement problem. You just buy them automatically. They invite the condensation flow path. The terminal boards are not protected and you have got it made to a short-circuit to ground.

I think the clearances to ground are sometimes as little as 1/16th of an inch and a little dust on it and you have got it made for a short circuit enhanced by the moisture pickup; so everything stops.

Mr. Noonan, just to make it formal, let's turn this meeting over to you. It says here you have an hour to discuss the equipment qualification program status. So the meeting is yours

MR. NOONAN: Would you prefer me to use the vugraph?

MR. EBERSOLE: I would, please. I believe everybody would. I believe you are going to say something about the matter of the part of the program called the "long term capability of hermetic seals" as part of your discussion here.

MR. NOONAN: Yes, I want to talk about that very briefly.

(Slide.)

I think this morning what I would like to do here is basically go through a status report of the equipment qualification plan, talk both about the electrical and the mechanical equipment, and how our present program plan addresses these items and what sort of time schedule we are talking about here as a result of a number of these issues.

The first vugraph that I will present here basically talks about the equipment program plan. In here there are a number of issues that we plan for this program plan to accomplish by the time we complete it. We are talking about a time span basically between now and about March of '85, about a three-year period of time, to what I would call put the environmental qualification program in place and have it implemented.

The first bullet talks about the environmental qualification of electrical equipment. Basically, right now we are working on completing the reviews and the appropriate corrective actions of the operating license submittals. These are being done on a case-by-case basis. We look at both the -- in this particular program, although I say electrical, it also includes the mechanical equipment, selected parts of the mechanical equipment. I've got a slide later on that will address just how this program is treated.

The second slide addresses what I just mentioned about the mechanical equipment. What we are trying to do right now is establish a little better data base as to how mechanical equipment should be treated in the long term from an environmental qualification standpoint, not seismic, strictly environmental I am talking about there.

We thought that by this time next year, by February of 1983, we would have a position in place on how we want to treat the environmental qualification of all mechanical equipment, not only for the OLs that are coming along, but also if it's needed to backfit into the operating reactors. At this point in time there is no program to backfit, but it is part of the thing that we will be addressing.

Seismic qualification of both electrical and mechanical equipment is basically being done on the OLs. It is being treated both electrically and mechanically, and the program is pretty much in place.

Later on this afternoon, or today I think you will be hearing about the A-46 program. Mr. Anderson will be addressing that. That program basically should just be about completed about the middle of this year, but in order for us to be totally complete and finalized, by this time next year. We put into our schedule what we call the spring of fiscal '84, our 1983 -- excuse me -- yes, 1984, to look at this in this particular program.

We have also been addressing the survivability of equipment exposed to hydrogen burn. As you know, there is a rule being written on this. We have made our comments.

To date we are in a position basically now where we treat the hydrogen burn question in conjunction with our normal review of the environmental qualification program. It does not necessarily take a special type of review.

We have been finding, since we first started this program back in about 1980 to this point in time, we have been finding that pretty much of the equipment, if not all, is basically covered by the high energy line breaks and the LOCA.

Accreditation program: There has been a proposed rule on this one. I don't think it has moved very far. We are talking to the industry about the industry developing their own program on accreditation of laboratories. I will give you my own personal opinion. I think that is where it belongs, is with the industry and not necessarily with the Nuclear Regulatory Commission.

(Slide.)

One of the main things that we plan to do this year -- and I would like to have this one in place by the August-September time period -- is a procedure between NRR and I&E where we now start transferring the lead responsibility for these plants over to the regions. By that I mean that I would start basically with the reactors that we have recently approved for operating licenses, the OLs, the near-term OLs who have just been licensed.

We would start with those particular plants and start transferring the lead responsibility over to I&E, with our particular branch, NRR, being in more of a backup role and supportive role of the I&E function.

Those plants have full SERs written on them. All the issues have been addressed, both the environmental issues and the seismic issues. I think they are the most complete package as far as this whole program is concerned. So that would be the first stage.

The second stage would then be to develop a procedure for transferring over the operating reactors. That is somewhat not as clean, because basically we will not be ready to start talking about the seismic question on operating reactors until about this time next year.

The environmental program for the operating reactors, which I will address in a few minutes, is basically coming to a completion as far as all of the work that is being done by Franklin Research Center. By the end of this month all of the technical evaluation reports will have been finalized and we will have all of the SERs done within the first week of April, and I would guess by the middle of April all of the complete 71 plants should have their SERs, their technical evaluation reports, submitted to the Licensees.

At this particular point in time I believe we only have 9 plants left to go. That says we have submitted 62 safety evaluations to the Division of Licensing, and I believe they have submitted on the street to the Licensees, around 57. So there are about 5 behind us right now and that's because we just sent them over.

As you know, there was the rule on the equipment important to safety, which was affirmed by the Commission on January the 6th, 1983. It became effective on February 22th of 1983. At this point in time we are not anticipating any more rules regarding the equipment qualification area. We think we can handle it within the present framework of our organization. We do not feel there is a need to go into any further rulemaking.

Regulatory Guides 1.89, 1.100 and 1.131 will be talked about. In fact, Dr. Aggarwal will be talking about 1.89. We do have some slides to show you about the research programs that are presently being carried on, and also the standards that are being worked on.

The bottom one talks very generally about some of the research program. I would like to hold that and address that towards the end of this thing. We have people here from Research who can talk about that directly.

MR. EBERSOLE: Mr. Noonan, this matter of regional transfer of what you say here of responsibility is a little disturbing because it suggests there is no central responsibilities, or there may be insufficient central responsibility. Could you comment on the benefits and also the ill effects of this transfer to regions of this matter of environmental qualification?

In my own view, I think it's throwing things to the field with a certain degree of loss of degree of knowledge as to what's going on. I guess what I am going to ask is: How do you here in Washington anticipate knowing in fact what is going on in the regions?

MR. NOONAN: Right now, like I said, I'm in the process of trying to develop these procedures. But that particular concern will be addressed in the procedures. I would hopefully try to reach an agreement with the regions that in each case where there is a question involving the environmental qualification, the NRR people are at least brought in for consultation.

MR. EBERSOLE: Yes, but the problem there is, with the scope of responsibility given to the region, the decision as to whether you should be brought in at all or not is theirs.

MR. NOONAN: Yes, sir.

MR. EBERSOLE: Therefore, if they elect not to bring you in in the marginal case -- and there are great degrees of freedom in making these decisions -- that in fact you will never hear about the fact that there was an issue.

MR. NOONAN: That's correct.

MR. EBERSOLE: And I think that's a major problem.

Does anyone else want to comment on the regionalization problem as a generic proposal in a specific sense?

(No response.)

MR. EBERSOLE: Well, I'd like to go on record that I think we need more --

MR. NOONAN: I understand your comments, sir, and I am sensitive to that comment. Right now with the regionalization aspect within NRC, there is this type of action going on and we will be prepared to discuss this with you later when I have the procedures in place.

MR. EBERSOLE: I really think it's going to be a step backwards in the context of understanding what's going on, and we will be removing to a greater degree of ignorance.

MR. NOONAN: I understand.

MR. CATTON: Jesse, is this where they're going to move the people out to the various regions?

MR. EBERSOLE: Yes, this is a part of it.

MR. CATTON: And it becomes an I&E function?

MR. EBERSOLE: Yes.

MR. WARD: No, it's not an I&E function.

MR. CATTON: But they become --

MR. EBERSOLE: -- regional directors to determine in essence whether or not there is an issue.

MR. CATTON: I see.

MR. NOONAN: That does not necessarily mean my staff --

MR. CATTON: I would be very much concerned if they somehow came under the direction of Inspection & Enforcement, because that's strictly an audit function.

To me audit functions --

MR. WARD: The regions are not under the I&E office.

MR. EBERSOLE: They have expanded the regions to include a --

MR. WARD: A year and a half ago.

MR. EBERSOLE: It's a very subtle process.

MR. CATTON: Okay.

MR. WARD: This is an issue that was discussed quite a bit at the last full Committee meeting.

MR. CATTON: From my limited view of I&E, it still looks the same.

MR. EBERSOLE: Okay.

MR. WARD: And you may have a good point.

MR. CATTON: My exposure is different.

I have a little different question.

MR. EBERSOLE: Yes, sir.

MR. CATTON: I may be missing something, but I think the processes that equipment have to survive are transient, and to me this means that you have to worry about heat transfer, heat transfer coefficients, and that leads me to believe that flow is important.

There is a section here on accreditation of testing laboratories. As far as I can tell, what the laboratories are going to do is just to stick it in one of these big ovens at temperature and humidity. That is not the same unless you are looking at very long times where heat transfer does not matter, where you are really going to soak through the equipment. If it is short things like for the LOCA or maybe even the steam line break, which means thermal time constants are the same order as the duration of the period you are interested in, you have to do something else.

I don't see it anywhere in here. Maybe I'm just missing it.

MR. NOONAN: I think what I have not flagged here, there is a research program being presently worked on that is to determine what you call the chamber effects for the hydrogen problem.

MR. CATTON: I'm not necessarily referring to the hydrogen problem; just the LOCA, where you have temperature rises and falls, and it's over a period of minutes or maybe an hour or so.

MR. NOONAN: Let me ask Bob LaGrange to address that. Would you comment on that, Bob?

Bob LaGrange is the Section Leader for the Environmental Section and he has been following the program in detail.

MR. CATTON: I'm staying away from flow vibration, which I think is also important during this period of time.

MR. LA GRANGE: Technically, the LOCA profiles are extended for a period of time that allows the equipment to reach the same temperature as the temperature profiles.

MR. CATTON: So the rate that it heats up and so forth is not important?

MR. LA GRANGE: I wouldn't think so, no.

MR. CATTON: Okay. That answers the question. If it is not important, it does not need to be considered.

Another thing I do not see in here: I understand from reading through the report on the meeting that was in Bethesda last year, that there is a synergistic effect between radiation and thermal effects. In reading through your list of items here, I don't see any mention of that.

MR. NOONAN: Bob?

MR. CATTON: Is it hidden away somewhere, too? What are the laboratories you are accrediting going to do about this?

MR. NOONAN: Mr. LaGrange can talk to that.

MR. LA GRANGE: Is the question in the context of lab accreditation?

MR. CATTON: If you were going to accredit labs to "bless" the various kinds of equipment that are going to be put into nuclear power plants, then that laboratory should be able to do the testing as required.

From your workshop -- I'm not sure if it was your workshop, but Minogue was the key speaker at it; I assume it was -- there were several papers in there that point out that the combination of radiation and thermal is worse than either one alone, and that you do not just add the effects.

So that tells me that somewhere you have got to do some testing where you do both simultaneously, either that or you have to have some damn good theory to back it up; and I don't see it anywhere.

MR. AGGARWAL: Bob, let me address that question, if I may.

MR. LA GRANGE: Okay.

MR. AGGARWAL: The workshop that you are referring to on nuclear power plant aging, was done under the Nuclear Research Office. With regard to the direct answer to your direct question --

MR. CATTON: Just for the record, it's NUREG/CP-0036.

MR. AGGARWAL: That is correct.

MR. CATTON: It was a meeting on August 4th and 5th, 1982, in Bethesda.

MR. AGGARWAL: That is correct. The further rule which has been issued requires that the synergistic effects should be considered. Regulatory Guide 1.89 when issued, if any known synergistic effect is there, it will be included and the Licensees will be required to qualify equipment for those effects.

We are aware of the Sandia reports and also the paper presented, and this information will be reflected in the Regulatory Guide 1.89 when issued as a final guide.

MR. CATTON: The last part of the question I was asking had to do with the accreditation of the testing laboratories. If radiation and thermal effects are to be treated simultaneously, then you have to I guess check to make sure the laboratories have the proper radiation source and so forth.

MR. AGGARWAL: Let's separate that issue into two parts. The issue of accreditation of testing labs, to the best of my knowledge the Commission has made no decision at this time. So we could spend a lot of time going into all possibilities, but that won't serve any purpose.

With regard to the program plan, even if the accreditation takes place, the NRC should be and will be looking into the program plan, and will ensure that the requirements of the rule are satisfied.

MR. CATTON: Which means including the synergistic effects as necessary?

MR. AGGARWAL: That is correct.

MR. CATTON: Okay. Thank you.

MR. NOONAN: Let me just comment a little further on that. Synergistic effects are a requirement. The Licensee must consider them, whether they're temperature, radiation, or whatever, the Licensee must consider synergistic effects. My staff looks at that particular one, and the work being done by Franklin Research has also been -- that's been a particular detail they have been highlighting in their technical evaluation reports.

Accreditation of the laboratory is not a question. I think what you're concerned about is: Is the lab capable of running those kinds of tests?

MR. CATTON: That's right.

MR. NOONAN: I'm saying that we're working with the industry right now to develop what we call an accreditation program, and have the industry make sure that they monitor their own test laboratories to see that these tests are conducted properly, and not have the NRC necessarily do that type of function.

There is a Commission action on this thing that has not taken place. If that occurs, then that will change our position on this. At this point in time we are basically working with the industry.

(Slide.)

I would like to talk a little bit about the equipment qualification and the environmental aspects of the so-called safety-related equipment that we have been doing to date on that equipment located in a harsh environment. Basically we talk about the NTOLs, which are under SRP 3.11 and NUREG-0588. We talk about the ORs which are set forth in the DOR guidelines. Then I talk again a little bit about the procedure on the transfer of I&E.

Excuse me for a second. Bob, do you have a copy of the Franklin technical evaluation reports?

(Pause.)

What you see here is basically typical of what we call the Franklin technical evaluation reports. It usually comes in a set of two or three volumes, depending on the utility. This particular one here is Zion, Zion Unit 1. There is a similar set for Zion Unit 2 and, like I said, in some cases it could be down to one volume and it could be as many as three volumes, depending on the magnitude of the comments that were made on a particular plant.

The Franklin people have basically gone through and in detail on the operating reactors have looked at just about every test report they could get their hands on. There's a section here we call section 4, which basically breaks up the equipment and talks about that equipment that is qualified, equipment that still needs further documentation; we have a category that we call equipment not qualified, where we have some piece of test data in our hands that shows that there has been a test deficiency identified with that equipment. There is another category in here basically where documentation was never made available to us, no type of documentation.

MR. EBERSOLE: Mr. Noonan?

MR. NOONAN: So we had the various categories.

On equipment that is considered not qualified, as soon as that is identified to us, we basically identify it to the Division of Licensing and they approach the Licensee and ask for an explanation on this piece of equipment, including the justification for continued operation. It is usually done on a system basis if there's a redundant system involved, or on some of the aging questions it's not of immediate concern as of right now; but in all cases it is resolved in one way or another. Either the plant will replace the equipment or they do provide us a justification which may be a schedule for replacement for some time later.

As we finalize these last set of technical evaluation reports, we plan to meet with the various Licensees -- they have requested such a meeting -- and go over these reports and discuss any kind of discrepancies that they might have found that they feel should be picked up at this point in time.

Effectively, though, by about the middle of May these technical evaluations will be really what I would call "closed out" by an SER saying: Okay, now here is the status of the plant. It tells you what equipment you have to go out and qualify or provide additional documentation on, and you now have to the second refueling after March of '83 or March of '85, depending, under Rule 50.49.

So really after May, all the operating plants now will basically fall under the rule for implementation of equipment qualification.

MR. EBERSOLE: Mr. Noonan, may I comment on this area? I have read lots of these things. What I fail to find anywhere as one goes through the types of equipment, pieces of equipment, is an assessment or a question even of why is this piece of equipment in a hostile environment. It seems to be an accepted fact of life -- the analogy I draw is, we would review a concrete airplane, if one of the industry members brought it in to us, and we would not even ask why it was not made out of aluminum.

Would it be an appropriate thing to do at the very outset to say, why does this sit here where it is in a potentially hostile environment when it could be perhaps easily lifted away from here and then not become a massive research program that will probably exceed the cost of investment in the equipment itself?

MR. NOONAN: Part of the charter that we gave Frank was not to even look at that particular question.

MR. EBERSOLE: Who is looking at it?

MR. NOONAN: The Staff never looked at it from the standpoint of why a particular piece of equipment is located in that environment. It seemed to me that based on economics that if an operator had a piece of equipment located in a harsh environment and he can move that to a different environment, it would be to his benefit to do so.

MR. EBERSOLE: Do you invite him to do so?

MR. NOONAN: Would I invite him to do so?

MR. EBERSOLE: Yes.

MR. NOONAN: Clearly I would.

MR. EBERSOLE: So that is a part of the evaluative process?

MR. NOONAN: It is a part, but it is sort of a subtle part. In other words, we do not necessarily question him on why does he have that particular piece of equipment in there. I think it would come up under the question of, if he said that he had to do something, some large-scale type of test, to get this piece of equipment qualified. Clearly we would approach him on why it has to be there and why can't it be moved.

MR. EBERSOLE: Oh, fine. That's what I wanted to hear you say. Thank you.

(Slide.)

MR. NOONAN: I have talked a little bit about the environmental qualification of safety-related mechanical equipment. The program we have to date right now is what I referred to as the Shoreham program. This is a program provided by Shoreham on mechanical equipment that was submitted to the Staff.

The Staff liked the program, basically thought the program covered in detail the kind of things we were concerned about, and basically has accepted this program for the short term. We are approaching other utilities that are in the so-called NTOL chain to adapt what the

Shoreham people are doing in their program.

As you can see here, we basically look at what we call the sensitive materials, the non-metalics, the seals, the gaskets, the lubricants. It is not a program to take large pieces of mechanical equipment and throw them in test chambers. It's a program mainly to look at the piece of equipment to determine the parts of that piece of equipment that are sensitive to the types of environment we are talking about and then run a test on those types of things.

This is what I talked about as the data base on the plants that we have looked at so far, and the plants we will continue to look at until this time next year. I think once we have a little better feel on this, we would then be prepared to make a recommendation as to whether this program should be increased, and also whether it should be backfitted into the operating reactors.

(Slide.)

I might mention there is a research program on mechanical equipment, and again, there will be a slide a little later on that. I talk about the seismic and dynamic qualification of safety-related electrical and mechanical equipment. Basically this is the program as it now stands today.

We used Section 3.10 to look at the NTOLs. The review is done by the EQ Branch. The acceptance criteria is basically the same as we have been using over the past years. We are not looking at any operating reactors. The decision was made deliberately not to do anything on the operating reactors until completion of A-46.

You will be hearing about the status of A-46 a little later on today, so I won't necessarily go into that particular aspect. The operating reactor program is hinged very tightly to that schedule.

(Slide)

Very briefly I would like to bring up the new rule that was effective the 22nd of February, 1983, 10 CFR Part 50.49. The title of the rule is called Equipment Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants.

There are basically three paragraphs of the rule that I would like to highlight and some problems we are now having with the implementation of this rule.

(Slide)

Paragraph (b) defines "equipment important to safety." I will read the exact words out of the rule. Paragaraph (b) basically talks about electrical equipment important to safety covered by Section (b) of the rule itself. Paragraph 1 talks about safety-related equipment. Paragraph 2 talks about nonsafety-related equipment. We say, "On the postulated environmental conditions it could present satisfactory accomplishments of safety functions.

Paragraph 3 talks about the post-accident monitoring equipment, Reg Guide 1.97 equipment. As you know, basically the work we have done to date has been on safety-related equipment. All of the technical evaluation reports for the operating reactors and all of the work we have done on the NTOLs has addressed only safety-related equipment.

The post-accident monitoring equipment was to be handled on a case-by-case plant-specific schedule, and there was no -- other than the work done by some of the branches in DSI, was there any look at the component level of nonsafety-related equipment. There was a system look to make sure that the various nonsafety systems couldn't impact safety systems, but there has been no real work done on the nonsafety equipment at the component level.

We are now charged with that responsibility, starting with McGuire Unit 2. Basically it comes into effect with this rule. We are talking to the DSI people, Dr. Mattson and his people, as to how we will start to implement a review of this particular area.

I point this one out particularly because I think it is going to be a very difficult area to do a review on. For the older plants, information is going to be hard to come by. For the newer plants, those plants that have what you call master equipment lists, we can probably work from those. But if the master equipment list does not exist, it will take some work in developing that particular list of equipment.

It has to be brought off the Q List. Since the Q List addresses basically only systems, I would say there is a large effort of work involved going from the Q List to what you call the master equipment list. Some of the newer plants have it. In particular I could talk about Salem, too, since we have been talking about the circuit breaker problems.

We have looked at the Salem 1 and 2 equipment lists. It was developed basically after Salem 2 was licensed, or at the time Salem 2 was licensed. It is a master equipment list for both plants. Even in that list when we got to the breakers, breakers were not on the master equipment list. The system was on the Q List. The breakers were not on the master equipment list.

When you go through the procedures, you see that the procedures, if they were followed correctly, should lead you to believe that that piece of equipment should have been on that master equipment list. The licensee said it was an oversight. I have a tendency to agree with him, but like in all things when you find this kind of thing, you are never sure.

So there is an investigative effort being carried on by the Staff now in the Salem incident to look at this master equipment list in more detail to make sure it is complete. Plants that do not have this list, it will be very difficult to do this kind of review. In particular, we recently came through the Shoreham hearings where this issue was raised.

There is no standard review plan covering this. There has never been an implementation plan for this particular paragraph ever set down on paper by the Staff. That needs to be done, and that is basically in process right now.

Mr. Volmer, who is my division director, sent a letter to Dr. Mattson. Basically it requested the two divisions to sit down and start developing a procedure for how this type of review would be handled Again, we will basically be starting on McGuire Unit 2 with the Shoreham plant also being included in this review.

An example of some of the problems we will have in this area, in the Shoreham application the Licensee has stated they he has no equipment that falls into this category. He gives some very general reasons why this is. It is basically because of the way he classifies equipment and the way his design procedures are, et cetera. It does not necessarily go into the methods of how he made that determination that there is no equipment in that category.

So when you have a utility telling you there is nothing in that category, we have to go back with him, ask him how he made that determination, and that process is now involved. There was a clarification letter sent to all the reactors in regards to paragraph (b)(2) saying that when they responded in the new rule, the May 20th response required for the operating reactors, that they specifically address that paragraph.

I think I will find that the responses will be varied. I am sure we will be talking to the utilities about this particular paragraph.

Paragraph (g) basically requires the operating licensees to respond to the rule by May 20th. They have to, number one, talk about the paragraph, what I call paragaraph (b), which is the safety-related and nonsafety-related, and the post-accident monitoring equipment, and also talked about a schedule and how they will plan to meet the March 1985 date when all equipment must be qualified.

Paragraph (i) is basically for the operating licenses. At this point in time now, all operating licenses must address the rule and provide a justification for interim operation as defined by paragraph (i). There are five specific elements in that paragraph that give guidance as to what should be addressed for interim operation, and that is being required prior to licensing.

MR. EBERSOLE: I think the highlights of the rule should include the exclusionary aspects of, for instance, the mild environment problem.

MR. AGGERWAL: Mr. Chairman, I intend to highlight for the benefit of the subcommittee the changes in the final rule compared to what was presented in the last meeting.

MR. EBERSOLE: Thank you.

MR. AGGERWAL: I will also cover the issue of the mild environment for the benefit of the new members.

MR. NOONAN: Basically what Dr. Aggarwal has said, the rule does not cover mild environments.

MR. EBERSOLE: Yes.

MR. NOONAN: It is in the statement of considerations to the rule. Right now we are basically going to rely upon Reg Guide 1.89 to talk about mild environments.

MR. EBERSOLE: All right.

MR. NOONAN: I would like to just basically put up some of the research work that is being done. We have people here from Research who can address these particular programs if you would like to get into the details.

(Slide.)

Here we have environmental qualification of electrical equipment. It is a fiscal year 1983-84 research plan. It lists basically five areas of research that is to be carried on.

If you would like to hear more, I think Mr. Farmer from Research is prepared to address any details you might have on this area.

MR. EBERSOLE: I think we have time to do that.

MR. NOONAN: Would you like to come on up here and discuss that?

MR. FARMER: Do you want me to speak from up at the platform?

MR. EBERSOLE: Yes, please.

(Slide.)

MR. FARMER: This is an outline of some of the key areas we were examining in our research program. It is a very broad program. We are covering in effect all aspects of the equipment qualification, starting with the source term and environment, and examining the conditions that one would set up for the qualification based on identifying environments in plants and identifying radiation levels.

Then we are looking at all the steps in the process of qualification, including the aging and the LOCA accident qualification test. I have a slide or a Vu-graph which deals with some of the current highlights. I think this might tell you where this aspect of the research stands.

(Slide)

One of our programs was with the French, in which we are taking a large cross-section of materials used in electrical equipment, basically elastomers and polymers, the degradable materials that go into the cable insulants, the cable jackets, the terminal blocks and other parts of electrical equipment, including gaskets and seals.

We have structured a program with the French in which we are doing the aging research. We are looking at synergism and radiation dose rate effects on all these large number of materials. We are varying the sequence, taking specimens and doing thermal aging before radiation, radiation before thermal, and doing them simultaneously. We are doing both low and high dose rate aging.

Then the specimens, after they have gone through this aging sequence in the facilities at Sandia, are all shipped to France, and they will be tested in a LOCA test chamber at Soqualay (phonetic) in the CESSAR.

Currently the status of this program is that all of the specimens have gone through the Sandia aging and the last of them are expected to be shipped by the end of this month. The LOCA simulation tests will start July of 1983 in France, and we will be through with that program as far as testing is concerned by July of 1984.

So we are expecting to have a fairly broad-based set of data on synergism and dose rate effects for electrical materials by late 1984, early 1985.

This is some work that preceded this that was finished up recently. We have been doing some work at

Sandia in which we have taken materials and conducted synergism and dose rate studies on these. These were materials that were stripped from cables such as the cross-link polyolathyene, ethylenepropylene, polyethylene. We did these same type of tests of varying the sequence in which you age them and looking at how they degrade when subjected to the steam and pressure of a LOCA.

We also took, besides the material specimens, and ran some cables through the same sequence. The cables were cross-linked polyolethyene purchased from mill runs of safety-grade cables from two manufacturers and we subjected them to the type of tests that we are talking about when you say synergism and dose rates should be considered.

That is, we took initially material specimens from the cables, ran synergistic tests, found the most conservative conditions, and then ran a functional test of the entire cable loaded electrically through the aging and through the LOCA qualification sequence.

MR. WARD: Could I ask you a question about the cables? I understand cables are a unique problem and that the composition of cables, the insulating materials, is very variable with a wide range of possibilities. How have you dealt with that problem?

Just a lot of samples? Do you think you have it pretty well characterized or what?

MR. FARMER: Usually we have purchased the cable, like in this case of the mill run, we had of course cables selectively taken off of a number of feet of the cable. There was not too much variation in that case between the behavior of the specimens. We have encountered the problem you have discussed in terms of mill runs from different suppliers or different manufacturers. You find that the formulation and processing of these polymers or elastomers doesn't, even though it may be the same basic compound by identifying name, it will have some variation between them.

So you do have that concern that you must go back really and look at a particular manufacturers cable materials specifically in order to know how they are going to behave.

MR. WARD: Do you think the research program you have here is going to have characterized the envelope of possibilities for insulating materials?

MR. FARMER: Our intent is that we will look at what basically represents a typical cross-section of materials. We will not have examined all of them. Hopefully, we will have covered the different types of organic chains that are used principally in elastomers or polymers. It will provide a base by which you can judge generally the questions of synergism and dose rate effects.

Some compounds don't exhibit them very much. EPR, for example which is used extensively, does not seem according to our tests to show much synergism or dose rate effect. Things like polyethylene and PVC, which are gradually being phased out of nuclear plants, show very strong effects, very radical effects. So it is not uniform. The behavior of materials is not uniform. It varies by composition.

All I can say in answer to you is we are going to cover what we think is a representative cross-section of materials, but at that point we are contemplating in about 1985 stopping; and at that point if there are materials introduced into the technology or into the business, I think it will remain industry's problem to examine this question.

MR. EBERSOLE: May I throw out a case in point I remember from some years back? Batelle Laboratories was testing the critical solenoid-operated valving which executes the semi-automatic blowdown, a critical function of the boilers.

MR. FARMER: Yes.

MR. EBERSOLE: Their first testing revealed a number of shortcomings. It failed and it failed, so they changed the recipes and configuration and eventually produced in the laboratory a little device, a system which in fact passed the test.

Then when there was the problem of reproducibility of that en masse, so to speak, out in the industry -- and I, for one, never had much faith in the fact that that synthesized product was so reproduced -- and the reason is basically the product, the recipes, the plastics and the insulation is proprietary. It is a black box. Yet it is used for type test work.

Now how do you feel about the reliability of type testing proprietary materials like this which may, in fact, change in their constituent makeup as well as the baking process and 14 dozen other things that may influence the environmental resistivity of such apparatus?

MR. FARMER: I think you have to almost test it specifically. We have ran into the same problem on EPR. We took samples, which again were proprietary, where the manufacturer would only tell us the 20-or-so chemicals that were used in the formulation. We made up sheets based on known industrial specifications, and we got different results on sheets coming out of the Sandia

Labs.

MR. EBERSOLE: When you come up with a problem like this, isn't it appropriate to say I have a possible problem here I must so identify it and have another kind of fix besides this one, which is no solution at all, this matter of trying to do what you are doing but acknowledging in the end that you can't; you will not know the environmental resistivity of equipment which is subject to such variabilities?

MR. FARMER: I think we are seeing the trends. All I am saying is that I think that we are categorizing trends. There are distinct trends. The variations that you are discussing, which are one of variation between manufacturers formulating the same compound, or variations between mill runs, are usually much smaller than the trends that you see in the difference in behavior between, let us say, polyethylene and cross-linked polyolathyene or EPR.

So what we are doing is characterizing the boundaries. Now it still remains the problem and the job of the supplier who is selling that product to examine his own product and demonstrate how its behavior is.

MR. EBERSOLE: And you will require that demonstration?

MR. FARMER: I would expect Licensing will demand that demonstration in the qualification data.

MR. EBERSOLE: You would "expect" it. Is there anyone here who will say that it will be so required?

MR. NOONAN: Yes.

MR. EBERSOLE: Do you have any comment on this, Mr. Noonan?

MR. NOONAN: I would like to have Mr. LaGrange address that.

MR. LA GRANGE: I have a comment. Typically when we review the results of testing performed on any piece of equipment, we look for a tie between the test report and the specific piece of equipment. The person who makes that connection is the manufacturer. So we are looking for, prior to our accepting the qualification of a specific piece of equipment, what we also try and verify is that the testing that was done is applicable to the equipment that was purchased.

MR. EBERSOLE: Do you put any constraints on future modifications to the material of the equipment without future tests? How do you constrain him to reproducibility as he makes spare parts and puts in equipment as it ages?

MR. LA GRANGE: I would say that if he makes a major change, he would have to retest that material or equipment he is manufacturing. If it is a minor change, typically I would say that would fall under a QA-type program where they would have to examine the changes and perform an analysis to show that the changes that have been made do not result in an unqualified specimen.

MR. EBERSOLE: Thank you.

MR. FARMER: Going on down, we are doing some work on the assessment of methodologies in national standards. I mentioned with regard to the synergism that we did take two manufacturers' mill runs of cross-linked polyalthyene cabling and did an extensive dose rate test which has been recorded. We currently have under test a set of seven Asco solenoid valves. Five of these were artificially aged. Two of them were procured from Asco, which had been aged for approximately four years on the shelf.

So we were making comparisons between the natural and artificial aging techniques. We also ran those plus an unaged valve through a seismic test at NTS recently, and all of the valves passed successfully. So far we have not seen any significant difference in behavior between natural aging, artificial aging and unaged valves insofar as seismic behavior is performed.

This has significance in terms of this

question of should equipment in a mild environment be seismically qualified in an aged condition, or as industry has proposed, is seismically testing unaged equipment adequate? So far the data we have for that equipment we have tested is that equipment seems to give the same results on unaged as aged.

MR. WARD: Let's see. What has been tested there, a solenoid valve?

MR. FARMER: Seven of them. They were mounted on a shaker table.

MR. WARD: Does that include the cabling for the valves? One thing that you might expect is that after a cable is aged, it becomes embrittled and it is more likely to fail, I guess, during a seismic event.

MR. FARMER: We did not have a long length of aged cable on it. The pigtail on the solenoid coil did go through the aging process, but that is a fairly short section in the pipe attachment to the solenoid. The long cable connecting that was new cable.

MR. EBERSOLE: What do you mean by aged, by the way, in years actually?

MR. FARMER: Actually these were aged the equivalent of four years.

MR. EBERSOLE: How long will they be used?

MR. FARMER: Asco recommends changing out the coils, the elastomers, every four years.

MR. EBERSOLE: Okay.

MR. FARMER: And on that basis we did them for four years. Now it is some pretty severe aging. The reason is, number one, that we aged coils based on an energized state since some of the coils must be energized to perform their safety function. Two, we did one thing that the industry has not done; that is, this 50 degree or so hot spot in about three locations in that coil where elastomers are located.

Industry has generally ignored the temperature of the hot spot in their aging. They are claiming seven or eight years aging. It is probably much lower because of that hot spot. We aged taking into account the hot spot. So we gave it a much more severe aging condition. That was thermally.

Also, in terms of radiation we saw about 40 or 50 megarads of radiation. This was done only to the artificially aged valves. The naturally aged valves were just seen on the shelf aging in an energized state.

MR. WARD: Excuse me. You said something that surprised me. The four-year lifetime for certain solenoid valves in service?

MR. FARMER: This is the elastomeric components. The coil itself, which of course has the electrical windings insulated, and the elastomer seats where the valve seats. At the end of four years they don't throw away the metallic body or the housing; they just disassemble it, replace the elastomeric seat and put in a new coil.

MR. EBERSOLE: Is this typical of such materials? Is there sort of an integrated picture you can give us of how frequently you have to change out these elastomers and similar materials?

MR. FARMER: For seats it is usually relatively short. Many times --

MR. EBERSOLE: What about coils?

MR. FARMER: Pardon me?

MR. EBERSOLE: What about coils?

MR. FARMER: For coils it varies. It is the same situation typical of motors. Very frequently there is no requirement that those be changed.

MR. EBERSOLE: Ever changed?

MR. FARMER: Yes. In this case it is a relatively inexpensive item that can be readily changed.

MR. EBERSOLE: On that particular score, is there a sort of an integral treatment of when you do and when you do not change out, you know, analogous to when you break down an airplane engine?

MR. FARMER: There is normally with any of the equipment supplied a scheduled maintenance, a time at which the manufacturer recommends the parts be replaced. As I mentioned here, Asco has recommended every four years replacing elastomeric parts of the coil.

MR. EBERSOLE: When the manufacturer makes that recommendation, does he know the level of responsibility the equipment is carrying? Or is it just a general recommendation? In short, does he know the level of importance?

MR. FARMER: In the case of Asco, I would say they knew it because they have been intimately involved with Westinghouse and others involved in qualifying these valves for nuclear plants, on their own. They have done this independently.

MR. EBERSOLE: But that is not the general case, or is it?

MR. FARMER: I would say where it is safety-related equipment, generally the manufacturers are all aware of the importance and provide maintenance specifications accordingly. Nonsafety-related equipment, I would not know.

Right now the valves are at Isometics going through the 150 megarad simulation of the loss-of-coolant accident radiation level. They will then go back to Franklin in April and be put in one of their big steam test chambers. So far, none of the seven valves have exhibited any major anomalies. They are getting a little more sluggish, indicating that there may be some deterioration going on, but none of these particular seven have failed as yet.

The last two items I wanted to mention very briefly. One is we are doing some accident failure mode tests. We are actually doing them in conjunction with an assessment of national standards for qualifying particular components. We are working with a list that the Equipment Qualification Branch asked us to test. We did some pressure switches, which have been completed. We are now in the process of running some RTDs, or we will be in another week.

The last item is an item which came about recently when some of the Haddam Neck batteries failed. They were, if I remember correctly, around 12 years or something like that of age. A couple of the cells went out. Both I&E and NRR asked us to look at this issue of the fragility of batteries to common mode failures as they age. Generally now batteries remain in the plant 15 years or thereabouts and are removed normally just when you start having cells going out.

There is concern that the buildup of material on the plates would make them very susceptible to a seismic failure in the aged condition, that is, after they have gone through many chargings and dischargings and rechargings and have deteriorated.

What we are attempting to do now is get ahold of some batteries of various age removed from nuclear plants and run some seismic tests on them. We are working partially in conjunction with Ontario Hydro, who are taking some batteries out of some of their heavy water power plants, which have -- well, I think the first batch coming out is about five years, and they have some with ten years of use on them coming out in June, and they are going to run tests on those batteries, and we meanwhile are trying through Sandia to obtain batteries from some of our U.S. nuclear plants to run parallel tests.

MR. EBERSOLE: Are you talking about tests on individual cells, and in particular on --

MR. FARMER: Well, it will probably be about three cells.

MR. EBERSOLE: It is really on the plate, the particular function of the plates and whether the material is loose or not?

MR. FARMER: What we are trying to do, we will mount the three cells on a shaker table and subject them to G loadings that are typical of the response spectra in the portion of the building where the batteries are located, and we will be measuring current continuously and voltage continuously, and we will see whether the cells short out or fail and in what mode they do fail.

MR. EBERSOLE: It is interesting that you should mention this. There was an LER not too long ago that reflected I think what is a more or less generic concern. It was a spontaneous cracking of the containers, the lids and the vessel proper. It suggested that certainly aging would make this worse, that the initial brittle condition was such that whereas an individual cell might pass the seismic test, if you bolted several of them together, which you do of course, and it depends on whether you use rigid copper bars or braid, you then created in the actual battery system rather than in the cell a situation of stress levels which tended to spontaneously crack the cells irrespective of any seismic input, which also suggested that you would have a totality of failure if you had a seismic input, even if you strapped the whole battery group to the wall. You would just break the cells.

This may or may not be a component of aging. It depends upon what the containers are made of. Are you looking at the containers?

MR. FARMER: Yes. These would be with the containers. They are generally blaxon or some fairly highly durable plastic which is used in a lot of these containers.

MR. EBERSOLE: I wish you would look at this aspect of whether or not the spontaneous incident there of failure sort of forecast a general failure under seismic input.

MR. FARMER: I will be glad to. I am glad you brought it up because we are aware of the case cracking, but generally it had been along the sides and leaking.

MR. EBERSOLE: My impression is that if a case fails and the electrolite runs out, the resistivity of that cell will go up and it may be very easily now a source now of a fire or other nasty things.

MR. FARMER: We will test the complete cell and plates. We are also looking at the question of whether we should put in the seismically-designed support stands, or whether we will just take the response spectra at the base of the battery and duplicate it.

MR. WARD: I can see where equipment manufacturers might be reluctant to furnish samples of their equipment for these exploratory tests, and that they could end up getting bad press for early failures under some extreme conditions or something.

Is this a problem in the program?

MR. FARMER: It is a major problem.

MR. WARD: It is?

MR. FARMER: It is in fact the delaying problem that has delayed us months in trying to accomplish things. There are some suppliers who will have stonewalled us repeatedly on the supply of any equipment at all, for that very reason, that as they view it, if it fails they have nothing to gain; if it passes, fine, they knew it was going to pass anyway.

So they feel that there is no benefit. So it is a struggle. Even the utilities who we have gone to and asked -- Will you let us even buy equipment? -- have generally dragged their feet and been very reluctant to sell us equipment. So that is really the major problem we have in trying to get these tests off on a timely schedule.

MR. EBERSOLE: You mean you have to go and beg them to give you this stuff? You just can't issue an order that you want three samples?

MR. FARMER: If NRR chose to. But up until now, the Agency has not elected to use its clout to force anybody to provide this equipment. So we have had to do it on a gratis, cooperative basis.

MR. EBERSOLE: That sounds too close to EPA.

(Laughter.)

MR. WARD: The pieces of equipment are not just commercially available to your testing contractors? Is that the problem?

MR. FARMER: Even when they are commercially available, we have trouble buying them. For example, we wanted to order some cable, and because of the tests that we were referring to back here, the cable manufacturer decided that our data was causing him agonies. So we tried for six months him to take the order. They finally took the order and then kept sending us letters saying "all our mill runs are committed but we will put you on the list for two years from now."

You know, there are any number of ways of legally precluding your getting the equipment in a timely fashion.

MR. WARD: I guess it is understandable to some extent from the manufacturer's standpoint. Your research program is not trying to qualify individual pieces of equipment or types of cable or anything.

MR. FARMER: No, we specifically cannot qualify equipment for industry and we make that clear.

MR. WARD: There is not any way to report the results anonymously?

MR. FARMER: We have offered to do that. Our attorney, of course, has always said that if intervenors elect to come in and demand, that he is skeptical that we could protect the name of the supplier, and they realize that if push came to shove, that the name would come out. But we have attempted to maintain the anonymity of the suppliers where he has requested us to do so.

MR. BAGCHI: May I make a comment? May I make a comment on what the Regulatory Staff is doing?

MR. EBERSOLE: Please.

MR. BAGCHI: My name is Guton Bagchi. I am with the Equipment Qualification Branch, Section Leader for Seismic and Dynamic Loads.

We have recently looked at a number of LERs on battery failures. There is an I&E information notice going out. If it is judged to be a significant problem, it could become an I&E bulletin.

The problem that Bill was discussing regarding the older batteries, that has an older design. The current battery designs are indeed looked at and qualified with aged battery cells. Typically it is set up with the leads and busses that are representative of the batteries in the plant and are absolutely tested on a shaketable.

There have been instances of accelerated aging having failed the battery cells and so forth, and the Staff has refused to accept those kinds of batteries. I will give you examples of the kinds of plants, but I would like to leave you with the impression that there is something being done, and if it is really a common-mode kind of a problem of significant safety, it will be looked at.

MR. EBERSOLE: Thank you.

By the way, in that aspect, if one begins to develop a lack of faith in the batteries, it is a minor not impossible matter, in my view, to provide self-contained energetic sources of DC power, a few, certainly less than 100 kilowatts. I won't define the power level. But a minor amount of DC power supply can be supplied with engine-driven equipment stabilized for operation without the presence of the batteries and easily get over the short-term failure of the batteries because of lack of storage or the lack of confidence in their ability to pass the auxiliary requirements.

In short there could be a DC source discretely supplied, just as we supply AC, at very small capacities in a relative sense, engine-driven DC power supplies. It is just a problem in ideology that we have now in not providing such a source.

MR. CATTON: It might even be cheaper than batteries.

MR. EBERSOLE: Oh, yes, but not as reliable.

MR. NOONAN: That was basically the discussion of the research program for the electrical equipment. I would like to make a comment a little bit on the aging question. We talk about aging, and we have talked about it for years, as to how do you age equipment. Do you do it by analysis, do you do it by test, do you naturally age it, artificially age it, et cetera. I suspect the aging question will be with us as a controversial subject for some years to go.

My personal belief is in the area of preventive maintenance and surveillance the aging work done by Research can help us establish what we think are the life spans are or when equipment should be looked at, when equipment should be replaced, or the various parts of equipment should be replaced.

I personally do not believe we can ever see a piece of equipment that is good for 40 years. I think that is being naive. I think there is a definite, finite life for all equipment, and I would hope that our program one of these days could get to the point where we can intelligently have a very good maintenance and surveillance program in place to sort of avoid the question of aging so that we do not run into aging problems.

MR. EBERSOLE: Mr. Noonan, are you telling me that you think a four-year life is just too short?

MR. NOONAN: I'm sorry, sir?

MR. EBERSOLE: Are you saying a four-year life of a component you believe is not long enough?

MR. NOONAN: I said 40-year life. I don't think there is anything for 40 years. Four years, yes. I can see four years.

MR. EBERSOLE: Are you agreeable to having to replace things at four-year intervals?

MR. NOONAN: I am agreeable to having to replace things at intervals we think are proper, whether it is four years or three years or five years. I don't really know the numbers to the answer to that question.

I am just saying I believe there is a finite period of time a piece of equipment is capable of operating. I think after the time period, whatever it is, there should be a preventive maintenance program put in place so that certain parts are replaced and the thing brought back up to a certain standard that you would like to have in that plant.

I would hate to think that I am working at the end of my four-year program when I have say a high energy line break or a LOCA or so forth. So it should be some period of time. I'm not sure what that period of time is.

MR. EBERSOLE: Not too short.

MR. NOONAN: Not too short. Not too long, either. One thing we talked about a little bit earlier I would like to briefly comment on is the question on the --

MR. WARD: Before you go on, I would like to ask you a question on a particular point. You mentioned that some elastomers that are relatively easy to replace in equipment might be replaced after a few years. But are there indications that there might have to be major replacements of cables in a power plant before the 40-year, whatever, end of life of the plants? What about the SEP plants that are being reviewed now? Are cables indicated to be a problem there? Is Research indicating that cables will not last as long as the reactor pressure vessel?

MR. NOONAN: I would almost say that the cables won't last as long as the reactor pressure vessel. Bob, would you care to comment on that as to the length of life of cables? Is there any indication that cables are a problem or any requirement to replace cables?

MR. LA GRANGE: I don't know if Bill Farmer has any information that would disagree with what I am about to say, but I do not believe anyone so far is proposing to replace any cables before 40 years. We have a problem with a particular manufacturer that is used in a particular plant right now. He is retesting that cable. We have yet to determine whether that cable is qualified.

Typically cable is going to remain in the plants for 40 years. As Vince mentioned earlier, we put a lot of emphasis and rely heavily on maintenance surveillance to tell us whether or not what we thought was going to last 40 years will indeed last that long.

MR. EBERSOLE: What about penetrations?

MR. LA GRANGE: Penetrations I don't know off the top of my head. I don't believe there are any that are qualified for less than 40 years at this point.

MR. LIPINSKI: I have a question. That would imply that these are the general cables that you would find in a fossil-fired plant, but there are specific cables, like the ionization chamber connections, where do you do have some radiation to consider, the cables that go to the rod drives on the top of the vessels that might be in a milder radiation environment. I think if the cables are not in a radiation environment, then what you are saying is probably true. If they do encounter any irradiation over the 40 years, can you still make that statement?

MR. LA GRANGE: Typically cable inside containment is tested to a couple hundred megarads. I'm not talking about cables in a mild environment. I am talking about the cables inside containment.

MR. LIPINSKI: In the last 40 years?

MR. LA GRANGE: Based on test results, that shows they can perform their electrical function after being irradiated to those levels and after going through a LOCA.

MR. LIPINSKI: This includes the ionization chamber cabling, the connectors and cabling to the ionization chambers?

MR. LA GRANGE: I don't know specifically about those cables, but I have not seen any cables yet that people were replacing in less than 40 years.

MR. LIPINSKI: Well, we haven't had a plant run for 40 years. I have had to change some cables out because of the radiation on the ionization chambers.

MR. AGGERWAL: Dr. Lipinski, as you are aware, in many, many plants we have ongoing qualification. It is too early at this time to know whether or not a cable will survive 40 years of life.

MR. LIPINSKI: That is why I'm asking him to qualify his statement about a blanket 40 years without any qualification because these cables that are exposed to radiation, I doubt they are going to survive for 40 years.

MR. AGGERWAL: I agree.

MR. NOONAN: Please understand that one thing we have done, right now we have run tests. The tests indicate that the cable is good for 40 years. I was indicating that the Staff should -- at least it is my intention that the Staff will work very hard on the maintenance and surveillance program to tell us when those cables are starting to deteriorate, whether it is 10 years, or whether it is 20 years, or whether it is 40 years.

That program right now is in place. We have worked very hard to put something in place for the near-term OL licensees. We have not done too much in that area for the operating reactors.

MR. EBERSOLE: Walter, are you thinking about unfortunately a chamber trips or active electric pulse trips? Are you thinking about the loss of a flux trip because of a sudden exposure to something like steam and the inability then to meet a fast flux rise? After the reactor has tripped, then the show is over. Are you thinking about something prior to that?

MR. LIPINSKI: It is not a question of -- well, there is also that possibility. But given the fact that these cables are in place and they deteriorate, you can develop shorts and opens as a function of time. If you have a complete testing program, as in the case of these breakers that we talked about that had incomplete testing, if you have complete testing you will verify that these channels are available when you need them. If the testing is incomplete, you will not verify it.

Let me give you a case in hand where we got some real-time data very early when CP5 first went into operation. We used Teflon because of its nice electrical properties right on the ionization chamber fittings. After we ran awhile we started getting faults. We weren't getting the right resistances, and the question was, "what's happening?" When we pulled those chambers and dismantled them, that Teflon came out as a powder. It went in as a solid but under irradiation it went into a powder form, which indicated that you didn't want to use Teflon in a high radiation environment.

MR. EBERSOLE: Mr. Noonan, I have to reflect back on the battery question. I have an input here. I was always impressed with the old World War II German and American battery-driven submarines taking depth charges the way they did and continued to run. Do you have any way of extrapolating that experience into the seismic capacity of batteries? I mean that was truly impressive to me that the shock loads could be taken by batteries critical to the propulsion of plants of those ancient old machines.

MR. WARD: It was in the movies, anyway.

[Laughter]

MR. NOONAN: The only comment I could make on that is that a lot of that data has been lost. It would be very difficult to retrieve. Personally I came out of aerospace. A number of years, 16 years, I spent in aerospace. One of the questions we had was basically on the same line where we put the certain critical components in the submarines or the large warships, the shock impact from explosives, depth charges, whatever.

A lot of that data even as late as 1970, 1971, we couldn't find it any more. It did not exist. The Navy ran a lot of tests. They used to have what they called the old barge test. They stuck them out there and they put pieces of equipment on the barge and they set off depth charges under the barge. Then they went in and they measured -- these are the old pen methods for the old shock spectrum type techniques they used to talk about. But for all that old equipment that was World War II equipment, effectively that has all been replaced by new test data or whatever.

MR. EBERSOLE: Are we committed to lead acid cells on these big batteries?

MR. NOONAN: Gouton?

MR. BAGCHI: I missed the question.

MR. EBERSOLE: Are these all lead acid cells?

MR. BAGCHI: They do have some newer designs, but basically we are talking about lead acid cells.

MR. EBERSOLE: I have another note that there is a lot of even current data on the newer-type batteries in helicopters, which is subject to impact and shock, which is another military application that evidently has some information available about performance under heavy shock conditions.

MR. BAGCHI: We do have data on those batteries. They are qualified on shaketables. So for the newer design, we know how they behave. On the older design, let me give you one data point. There was a test performed by Ontario Hydro. Apparently during the seismic tests, parts of the cells sloughed off. The cells cracked and essentially did not perform under that kind of seismic loading, so we really need some data points as to how far these batteries could go and still perform satisfactorily under seismic conditions after the seismic loading.

MR. EBERSOLE: Go ahead.

MR. NOONAN: I would like to just talk about this last slide very briefly here. As I mentioned, the mechanical equipment, the seismic portions are basically being treated today using the methods established in Standard Review Plan 3.10 and IEEE Document 3.44. There is a research program that has been identified for mechanical equipment qualification. If you would like to hear the details of it, Mr. Campbell is here to address that. If not, I can proceed on.

MR. EBERSOLE: How long would that take? I am trying to run to schedule here. Say ten minutes?

MR. NOONAN: I am getting the signal. About five minutes.

MR. AGGERWAL: I think I have 15 minutes of my time, I don't know how many. They can have that increment.

MR. EBERSOLE: Could we have five minutes on this topic?

MR. CAMPBELL: My name is Campbell. I am with the Mechanical Structural Engineering Branch in the Office of Research.

We have recently initiated a mechanical equipment qualification program through Idaho National Engineering Lab. We are attempting to assess initially some of the aging and degradation phenomena for mechanical equipment. We do not expect there to be any significant environmental effects on the hard metal components. There is some indication that if soft metal, "pot metal," is used there are problems, but we do not believe we have that problem.

Similarly to the environmental, is there a need for pre-aging on the non-metalic components such as the gasketing material and that? We are going to do some initial testing on containment purge and vent valves. This is in support of the containment integrity program and in support of valve operability.

We have some work going on concerning EPRI safety valve tests, monitoring those to find out whether or not the computer programs that they are developing will be adequate for general usage. The characterization of in situ dynamic loads has not been completed. We hope to do some work in that area to properly characterize those loads.

One of the big problems in mechanical equipment qualification is what some people call either scaling or modeling or extrapolation: Once I have tested this widget of four inches, do I have to qualify a whole family by testing each and every size, or can I go to six inches, or eight inches, or 28 inches?

In some of the areas people would like to do qualification by analysis only. Current NRC policy on this is very limited and is only done in certain areas. One area where it is done by analysis only is where structural integrity is the primary factor we are looking for. Operability, it's very difficult to do qualification by analysis only.

The bottom item here, the review of the output of the PRA's to relatively rank equipment to be addressed. Thousands of pieces of equipment out in the plant, some of them if they fail they are a never-mind, but they are safety-related relatively to other items. Some are more important.

We hope to find through the use of some of the PRA's, if they can become fine structured enough, that they will identify which are the equipments and then we can identify which ones are the ones that are sensitive and insensitive to the challenge, and work on the big contributors that are sensitive to the challenge, instead of wasting time on one that is a never-mind, that is very, very strong.

We are looking to evaluate the adequacy of available industry voluntary standards. Currently there are not too many of those available. We do have one that is out currently endorsed. It's the 278.1 on safety-related valves. It has been endorsed by the reg guide, but with the reg guide endorsement it has not been invoked on any plant at all because the implementation section says it will be endorsed for plants who are docketed after a certain date. There has been no plant totally docketed since that date.

We have in printing now with ASME B-1641, and that will be out, we hope, this month. I think we will have the same problem with that that we do for the previous standard 278.1 getting it effective on the plant.

The bottom standards from here down all relate to pumps broken down as pump assemblies. The total assembly as the pump, this is the part that has the impeller driving mechanism shaft seal assemblies, motor drivers, turbine-drivers and the motor frames. The other four standards up in this area (indicating) are all related to valves, either two for production testing and two for functional testing.

(Slide.)

So unless there are some questions, we will try to move on.

MR. EBERSOLE: Let me ask you a question about what is in 278.9, function of operation of self-operated check valves. In looking at one of the more recent plants, I noted with great interest the fact that the main feedwater reverse flow checks on boilers have been equipped with hydraulic dampers. They were not put on for no reason at all. They flag an ancient issue, and it is a generic one.

Are these valves in fact designed and tested against faulted conditions such as would exist if you had a gross upstream failure of that pipe and subjected those valves to the very high accelerated loads that would come from reverse flow from an 1100 pound system?

MR. CAMPBELL: I can't answer that question.

Can you answer that, possibly, Gouton? Massive flow challenge to the check valve on a boiler?

MR. BAGCHI: Qualification by analysis in most cases, but very few pass with full flow.

MR. EBERSOLE: Is that based on the postulation that you have a gross full circumferential failure of the feedwater pipe upstream of the valve?

MR. BAGCHI: I don't recall any such analysis myself. Check valves in the past have not been looked at in any great detail. Now we are looking at check valves, and most of the qualifications that I recall are by analysis.

MR. EBERSOLE: That being the case, can you characterize the standing level of risk that we have in this aspect if we were to put this in the PRA picture? What is the probability that a valve will disintegrate upon the occurrence of an upstream line failure?

MR. CAMPBELL: I can't answer that question. We are just starting with these valve standards. They have not been addressed, and I am not --

MR. EBERSOLE: You understand the problem?

MR. CAMPBELL: Yes, I understand it totally.

MR. EBERSOLE: Well, an extrapolation of that, if I go to valves in general, I have seen little evidence of actual functional flow testing against the emergency loads they might face, which would exhibit a performance requirement with margin that they would function.

Can you make a comment about the present status of improving the level of knowledge we have about these valves meeting their dynamic requirements under faulted conditions?

MR. CAMPBELL: We do intend to look into this for the active check valves.

MR. EBERSOLE: I'm talking now about the other kinds of valves, the motor-driven.

MR. CAMPBELL: We hope to look into that on part of the equipment qualification program, for example MSIV's, the challenge that could come to them if there is a rupture.

MR. EBERSOLE: Now let me talk about an aging problem in this connection. Over the 40-year life of the plant, you hope you will never see an emergency. So what you do is, you idle these valves back and forth. They sort of have a bistable mode of operation. They are either open or shut or they don't at all. They are operating unloaded. There are no current measures taken of the margin to function, the overcoming operational friction in th system without the emergency load presence.

As the valves degrade in time, and then accordingly with these other aspects of aging, how do you know at the end of X years you can do what you might have done on day one?

MR. CAMPBELL: I believe we have incorporated some margin testing in the work done for valve operators. Much of the research is yet to be done on the overall effects under the nuclear plant aging program, which is just getting started.

MR. EBERSOLE: How did they get at the margin? It would seem to me they would have to put a pony brake on the valve shaft or something to see whether they could deliver the torques.

MR. CAMPBELL: I believe they have done some torque testing of that kind. I have not witnessed it myself.

MR. EBERSOLE: Thank you.

Are there any other questions?

MR. WARD: Mr. Campbell, on your previous chart you talked about assigning some priority to the research program based on the output of PRA's. That seems like a reasonable approach. In essence, that gives you another Q list for a plant, another level of almost sort of the graded QA approach.

There is a branch or a part of the NRR organization that is struggling with finding some better approach with graded QA. Are you interacting with them on this?

MR. CAMPBELL: Yes, we are. We have seen the output of one of those programs from INEL. There is another program through another organization, I believe, that is being done at Sandia.

What I am speaking of here is not a ranking, not based upon the QA type documentation that has been required, but the output from such things -- like one gentleman mentioned the ASEP programs. What is coming out of the ASEP programs, what are the big contributors to risk scenarios there? Then looking at the sensitivity of those.

If you were to take a Q list which possibly could be arranged alphabetically, okay, all this -- or your Q list might be done by system or something like that, but we hope we can get a ranking based upon the contribution of that component or that system to the accident scenario.

MR. WARD: Right. But hopefully some day people will make up Q lists with that sort of intelligent input, but that is what I am asking.

MR. CAMPBELL: To the best of my knowledge, Q lists are -- everything ranks the same. It's either Q or non-Q.

We hope to have some kind of ranking from this. From what we have seen with the studies coming out, there will be a little more on seismic in the ASEP program and they will have some capability of doing that.

MR. WARD: I guess what I am suggesting is, your work sounds like it would be a valuable input to the people who are trying to develop graded QA definitions.

MR. CAMPBELL: We are taking it as an output from the PRA's. We are not running our own PRA's, and we are making sure that this information is shared with the I&E office who has the primary responsibility now for one of the graded QA programs. I'm not sure who has the lead on the Sandia program, which office it is in now. I believe it is in NRR.

MR. WARD: Thank you.

MR. CATTON: This is a little bit along the line with your concerns. It turns out that they can show that there is an increased chance of failure of check valves with distance, as distance between a bend in the check valve is decreased, because of recirculating eddies and so forth that are as a result of the bend.

Is this coming anywhere in your -- do you have functional qualification of self-operated check valves?

MR. CAMPBELL: It may.

MR. CATTON: Is that the mechanical end of it? Does NRC say that you must have check valves more than so many diameters downstream of a bend, and if it's closer you have to do something different?

MR. CAMPBELL: I cannot answer the question as to what Licensing requires about the upstream conditions relative to check valves. The phenomena is known. At present we are not down to the fine structuring level of the equipment qualification research program to identify the upstream distance of a check valve.

MR. CATTON: If you are doing functional testing, the vibration frequencies and their amplitudes would be a function of that distance.

MR. CAMPBELL: Yes.

MR. NOONAN: That basically concludes our presentation on the equipment qualification status. If you have any questions, I'd be glad to entertain them at this time. If not, we'll have Mr. Aggarwal.

MR. EBERSOLE: Thank you. I think we'll have Mr. Aggarwal at this time give his presentation.

MR. AGGARWAL: Good morning, Mr. Chairman.

As you are aware, a final rule in the area of environmental qualification of electric equipment was published in the Federal Register on January 21st, 1983, and became effective on February 22, 1983. This effective rule is somewhat different from what we have presented to you before this Subcommittee in 1982.

What I propose to do is, I would like to highlight some of the major differences so that there is a proper understanding of the final rule.

(Slide.)

First of all, the title of this rule is "Important to Safety," and I will discuss explicitly as to what is covered by this rule. As you will notice from paragraph A of this rule, this rule applies to all nuclear power plants -- operating, pending OL, or future OL.

(Slide.)

The next issue is now of the scope. As you will notice, according to General design criteria 4 the entire pie is considered important to safety.

MR. WARD: Could you -- maybe you could stand back and use the big pointer there.

MR. AGGARWAL: The entire pie is considered to be important to safety. This rule explicitly covers this part of the pie (Indicating). There should not be any misunderstanding about it. We are very explicit in the rule that the rule covers the safety-related equipment which the NRC believes to be class 1E equipment.

In addition to this, it also covers certain non-class 1E equipment whose failure could prevent the satisfactory accomplishment of safety functions. Also, it covers certain post-accident monitoring equipment.

The rule explicitly states that these are the category 1 and category 2 equipment, as defined in Regulatory Guide 1.97, Revision 2, so that there should not any more be any misunderstanding with regard to the scope. We recognize these are equipment important to safety.

MR. WARD: Satish, could you explain, let's see, if there is equipment, your part A there of equipment whose failure could prevent accomplishment of safety functions. Why isn't that simply class 1E?

MR. AGGARWAL: There are a few requirements for class 1E. It must meet redundancy.

MR. WARD: Why isn't it required if its failure will prevent accomplishment of a safety function? Why isn't that equipment required to be class 1E?

MR. AGGARWAL: Don Sullivan intends to answer that question.

MR. SULLIVAN: I am Don Sullivan, Office of Research. Class 1E is defined as equipment which is important -- that is, it provides a particular function. That's how it's defined, as opposed to something that itself did not provide a function but caused failure effects. I hope my point is clear.

MR. LIPINSKI: No.

MR. SULLIVAN: Class 1E would be something that makes a pump move, an electric pump for core injection, things like that. Non-class 1E would be like an associated circuit whose failure, by virtue of it being attached to a classd 1E bus, would cause that to fail on an associated circuit maybe to the coffee pot, to use a facetious example.

So it's the way it's defined. Class 1 is important of itself and the other stuff, if it's not important to the coffee pot but it could fail, we call it an associated circuit. But then it must meet all the class 1E requirements, like qualification.

MR. AGGARWAL: I think, Dr. Ward, I think your basic question is what is class 1E? What is not class 1E?

MR. WARD: I think I understand. That's good. Thank you.

MR. AGGARWAL: In conclusion, this is a part of the pie which is covered by this rule. NRC is looking into a graded approach and the possibility to find the equipment covered in this part of the pie. We will come to some conclusions as to what the requirements will be. It will be subjected to a value impact analysis and hopefully will be before you in the future.

(Slide.)

MR. AGGARWAL: This rule for the first time defines safety-related equipment and also provides the basis of a design basis event. I will not repeat the requirement. Basically, the point I wanted to point out is, the rule explicitly states what we meant by safety-related equipment and what the design basis event means.

In the preamble to the rule it is made clear that the NRC considers at this time that Class 1E equipment from the electrical point of view is equivalent to the safety-related equipment.

(Slide.)

As I stated earlier, the rule is very explicit as to what is covered in addition to safety-related equipment, namely paragraph 2 and 3. I have attended several meetings of the IEEE and there seems to be some confusion with regard to what it means, what equipment is covered under paragraph 2.

I propose to respond to those questions in Regulatory Guide 1.89. I would like to give you my thinking at this time. I personally feel that it is naive of a Licensee to come in and say they don't know what it means. Reg Guide 1.75 covering associated circuits was issued many years ago and is used by NRC in its licensing process, and that is covered there.

In addition to this, I agreed upon providing at least three typical examples in Regulatory Guide 1.89 to indicate what kind of equipment is covered by paragraph 2. Now, it should be noted that it is plant-specific and it is the Licensee's responsibility to determine what equipment falls into this category.

MR. EBERSOLE: Before you leave that, I'm having some difficulty here identifying equipment which could prevent satisfactory accomlishment of safety functions as being non-safety-related. This is non-safety-related equipment whose failure could prevent the satisfactory accomplishment of safety functions? That is a piece of doubletalk I can't quite swallow yet.

MR. SULLIVAN: That's the coffee pot.

MR. EBERSOLE: Well, if the coffee pot can prevent me from scramming the plant I'm going to identify it as a piece of safety equipment.

MR. SULLIVAN: It's the way these definitions have evolved.

MR. EBERSOLE: Well, let me ask as a case in point, will the coffee pot be tech spec and will it have a degree of operational control and inspection and testing to validate that it will continue to be whatever it was to start with?

MR. SULLIVAN: It will not be tech spec'ed to function as a coffee pot. It will be qualified to meet the accident requirements of not shorting out, and not be subject to the Regulatory Guide 1.75. It must be kept away from division B circuits. If indeed it is mixed in with division A circuits, it has to meet the separation and qualification requirements.

It does not have to meet any tech spec requirements on its functioning as a coffee pot. I will grant, it is a form of safety-related in that if it would fail it would be a non-safety -- it would cause a hazard. But we simply defined as safety-related or class 1 electrical, as that which has an important function in itself. All else is considered an associated circuit, but it must meet the requirements so as not to cause a problem.

MR. EBERSOLE: Did you have a comment?

MR. AGGARWAL: In my handout I have included three examples. One of them I will just cite here. Others I will let you provide some comments if you may. We intend to include these examples in Regulatory Guide 1.89 and we will bring them to the Subcommittee to review the final guide.

(Slide.)

This is an example of what I consider falling under paragraph 2 of the rule. In some cases, the electrical control system for a pump, for example a charging pump or an ECCS pump, will include termination commands on loss of lubrication oil pressure or low suction pressure. These features are not safety-related, but are provided for equipment protection.

Failure of these features would defeat the safety-related function, therefore they must be environmentally qualified.

MR. EBERSOLE: Well, insofar as environmental qualification goes, fine. What about other aspects of qualification?

What these are are supportive features of a safety feature. In here it is an interlock or a termination command on loss of oil pressure. It stops that function.

MR. AGGARWAL: That is correct. The statement I made, that equipment must be environmentally qualified as to what the design requirements should be, that particular requirement should come out of another division. I am only concerned with what equipment should be environmentally qualified.

MR. EBERSOLE: What about the seismic?

MR. AGGARWAL: I will address that issue.

MR. EBERSOLE: All right, go ahead.

(Slide.)

MR. AGGARWAL: Another point I would like to point out as far as the EQ rule is concerned, we're only concerned with the accidents. The design basis accident at this time, we are talking about a LOCA and the steam line breaks.

Accordingly, in 1.89 we will make similar statements in the final effective guide.

MR. EBERSOLE: Satish, let me see if I can understand something here. We're talking about the positive aspects of qualifying something environmentally. What we are not talking about are the other aspects of qualifying this equipment. We seem to park certain equipment in the safety-related category, which is lower than the safety category, and then turn right around and say, but we are going to environmentally qualify this as though it was safety-related.

What I am getting around to, if I had reduced a qualification to safety-related and then upgraded it, so to speak, with environmental qualification, that leaves a void in the qualification process about other aspects of qualification, not environmental because you've just fixed that.

So to the extent we're just limiting our discussion to environmental qualifications, you have cured a problem. To the extent that we have run the qualification of equipment down in the broader context, we have generated a problem. And I do not think we should ignore that.

MR. AGGARWAL: No, there is no intention of ignoring that. What I am stating to you, sir, is what is expected is the design requirement that you know of in your technical specification, you should state what those qualification requirements are. The national standards for qualifying those equipments will take care of that problem.

MR. EBERSOLE: Let me go back to the first example -- and I might have been out -- which was the steam generator overflow.

MR. AGGARWAL: I didn't present that because that is one of the controversial examples, as I said.

MR. EBERSOLE: That's why I'm going to pick it.

MR. AGGARWAL: Okay. Fine.

MR. CATTON: Then I'd like you to pick 3.

MR. EBERSOLE: The reason I'm going to pick this is, as you know, we're having a big flap with CE about keeping feedwater going. One aspect of keeping feedwater going is to consider in the case of the AC power failure case we will always have turbine-driven feedwater.

MR. AGGARWAL: That's correct.

MR. EBERSOLE: Turbine-driven feedwater is dependent on the high level control of the steam generators as well as other matters. If one loses the high level control because of lack of safety qualifications of that function, you will drown the aux feedwater system in its own output and run then into a condition where it -- although you've got too much water now, later on you will have no turbine pump.

MR. AGGARWAL: That's correct.

MR. EBERSOLE: So I would take issue with the thesis that the turbine generator overfill can be categorized to a lower than safety level protective feature. Now environmentally you just fixed it, you said you're going to make it work. I am talking about redundancy, tech spec'ing, QA in general, et cetera.

Is there anyone here who can talk to that?

MR. AGGARWAL: That issue comes under Dr. Mattson's office and I don't think there's anyone from that office here. As I said, that office is responsible for defining or determining what constitutes class 1E equipment or safety-related equipment. That is the starting point for the EQP.

In principle, as a technically knowledgeable person, I'm inclined to agree with you that some of this equipment which is not heretofore classified as non-safety-related possibly falls in the category of safety-related equipment.

MR. EBERSOLE: I think the lube oil system in a diesel generator is safety-related.

MR. AGGARWAL: That is correct. I mean, it is again a matter of opinion. It has not been so determined by NRC before.

MR. NOONAN: Dr. Ebersole, I would like to comment on this particular thing. In my previous discussion I said this category EQ is going to cause a lot of problems both for the Staff and the Licensees.

MR. EBERSOLE: I can believe it.

MR. NOONAN: We have talked about this particular category. There is some opinion, both by Staff and Licensees, that a plant could have nothing in that category or could at most have a minimum amount of equipment in that category, because of some of the things you just mentioned, particularly in this example here.

Clearly this example here could be nonexistent as far as the non-safety-related aspects.

MR. EBERSOLE: On the other hand, it could be non-1E equipment. I take the case in point where we did regulate the offsite power structures to diminish the challenge rate to the diesel plants. It was a non-1E set of equipment and the less it had to be regulated, it reduced the challenge rate. I don't see any problem with that.

Are there any comments on this?

MR. CATTON: If you look at example 3, I think it is even clearer.

MR. EBERSOLE: We haven't gotten that far yet.

MR. CATTON: He talked about 2, but I want to go to 3. If I don't have a heat exchanger, I don't even have a system. I don't even have to go through a couple of steps like Jesse did. You lose that heat exchanger, you have lost it all.

I don't know how you can call that second loop non-safety. It is safety. That is your system that you are looking at.

MR. AGGARWAL: I'm not going to debate the issue here of what should be classified safety-related or what should not be. I think it's pointed out that it's an issue that has to be decided by the other division of licensing, namely Dr. Mattson's office.

MR. CATTON: Out of curiosity, what is the difference in the design of a safety-related heat exchanger and a non-safety-related heat exchanger?

MR. EBERSOLE: May I offer a possible answer to that? As I see this, the outboard the steam generator has been put in as a conservatism. Maybe the company wanted another one. It was his obligation in putting it in to either make it safety grade -- correct me if I go astray -- or to put the isolative function in the safety grade configuration. And he took the option to not make it safety grade, but to put the isolative function in safety grade.

MR. AGGARWAL: That is the correct conclusion.

All I am saying, if you do that, you exercise the option in that way, it must be environmentally qualified.

MR. EBERSOLE: I'm saying really, Ivan, that the first heat exchanger was judged to be an adequate heat exchanger in its own right.

MR. CATTON: But if the second one doesn't run you don't dump the heat from the first one.

MR. EBERSOLE: If the second one is not running -- I looked on the second one as augmenting the function of the first one.

MR. CATTON: When you look at these loops that's not the case, unless they draw their pictures differently. Your second one is dumping the heat somewhere else.

MR. EBERSOLE: Let's take the first one. I have lost the secondary of the first one, the cooling water. Now I need the second one. Or I wanted to deliberately cut it off.

MR. CATTON: You're looking at this as if both cools -- I don't know.

MR. EBERSOLE: I was looking at it as an additive context. Either one will do the job, but only one is safety grade.

MR. CATTON: Oh, okay, if that is the case.

MR. EBERSOLE: There needs to be some better wording here.

MR. AGGARWAL: I will work on it.

MR. CATTON: When I look at your loop here, I just assumed that the non-safety-related was cooling the water that was cooling the safety-related.

MR. AGGARWAL: I will add a few words to that effect.

MR. LIPINSKI: Do you have a particular system in mind for this illustration?

MR. AGGARWAL: No.

MR. LIPINSKI: Because it's not an RHR. On an RHR you don't have that safety-related heat exchanger up front. You only have the one behind.

MR. AGGARWAL: I will be prepared to answer that question when I come back to you with 1.89.

MR. EBERSOLE: Tom?

MR. PICKEL: Just a general comment in this regard. This goes back to the previous discussion on aging as well. It is not clear through the discussion this morning that the full range of failure modes have been looked at and considered in what needs to be evaluated in this aging process.

I assume that in the qualification that even if the source of failure were external to the equipment it should be evaluated. Is this true?

MR. AGGARWAL: That is correct. As the Licensee you have the responsibility to go back and look at your systems now and determine what equipment falls in that category. Vince highlighted that problem, that the utilities are having a problem. I made the statement earlier that I failed to understand why some of the Licensees are so naive. The concepts in Regulatory Guide 1.75 were known for years. Those fall under that category.

Now, the determination as to what equipment should be safety grade or what falls in that area is a determination to be made by Dr. Mattson's office. The Equipment Qualification Branch only implements that. But I will take your advice. I will polish some of these examples and make it clear what the functions of some of the components are.

MR. CATTON: When I first looked at your diagram I didn't read it right, but I do have this feeling about heat rejection. It seems to me if you're taking heat from one place and putting it into another, that if you get a break anywhere in that line you have lost the total function. So it seems to me that when you start talking about safety-related heat removal systems, it's got to be from source to sink or it just doesn't make sense.

I got a little carried away with this diagram. I realize this diagram is different, it's parallel. But that does not change my feelings about the heat rejection system.

MR. AGGARWAL: Thank you.

(Slide.)

This is telling the Licensees, we told you earlier in the rule that you have to prepare a list of equipment in those three categories, A, B, C, namely the safety-related equipment, the non-safety-related equipment, and also post-accident monitoring equipment. Now, within 90 days after the effective date of this rule you must divide that entire list into three parts. One list should tell me what has already been qualified or is being qualified. The second list should have a listing of equipment telling me what will be replaced. And the third list should be what is going to be tested.

Again, we want to bring an end to the qualification process by 1985 if we can, and that is the intention of this implementation. A plus B plus C, the total scope of the rule, divides the listing into three parts, and that should be submitted within 90 days after the rule becomes effective, which is May 22.

MR. CATTON: Just one more comment before I leave this. I visited a plant during the summer and was out near their service water pumps. The service water pumps supply the cooling to the heat exchangers, that supply the cooling to the reactor under a wide variety of circumstances.

It turns out those pumps get a little hot during the summer. What they do, they drag out the big portable fans. They stand about this high, they've got a big base on them, they swing back and forth to keep it cool. It was plugged into an outlet at the wall.

From what I see here, that system has to be environmentally qualified; is that correct?

MR. AGGARWAL: If what is expected, if you can design -- I'd like to come back to the definition of "mild environment." If the equipment is in a harsh environment, yes. You qualify to the environment the equipment is exposed to or expected to be exposed to. If you're in a mild environment --

MR. CATTON: So the system I saw was just fine?

MR. AGGARWAL: I they equipment was in a mild environment I don't see anything wrong with it. If the transformer got warm you just turn on the fans. There's nothing wrong with that. You know it, you are designing it, and you can accept it up to that design limit.

If the tempe.ature goes over a certain limit you require the qualification.

MR. CATTON: I personally find that unacceptable.

MR. AGGARWAL: Unacceptable?

MR. CATTON: Yes.

MR. AGGARWAL: Would you tell me a little more information as to the equipment in the mild environment?

MR. C TTON: Certainly it probably meets all the written requirements. I just think it's damn foolish to have a system that behaves that way and have to drag out a fan that you can buy at the local hardware store to keep it cool. I think that's nonsense.

MR. AGGARWAL: I think it's a poor design.

MR. CATTON: I think it is, too.

MR. AGGARWAL: But from the qualification point of view, nothing is wrong.

MR. CATTON: That might be right, but that seems to be an awful narrow viewpoint of things.

MR. LIPINSKI: From the qualification standpoint, those pumps and motors are not qualified to operate for the ambient temperature you get in the summer, and it's underdesigned for ambient summer conditions.

MR. CATTON: That's right.

MR. AGGARWAL: It sounds more like a manufacturing defect in that case.

MR. LIPINSKI: Part of the specification says, when the room temperature goes up to 90 they're supposed to say, will the equipment survive based on what the room temperature is.

MR. AGGARWAL: That's correct.

MR. EBERSOLE: It seems to me there has to be some degree of qualification on this. That maneuver could be used to simply extend the life of the motors from what might have been 10 years to 15 years, because motors are degraded according to the integrated time and temperature. Therefore there could have been only a very mild safety implication.

On the other hand, if you go back in the meteorology and find the very hottest day you can mathematically forecast and take that as a base, like we do for floods and storms and all the other things we do, then we find that when the fans we've plugged into the coffee pot outlet didn't work that we had an ambient in which there would be short-term failure of the pumps, and we have a problem that fulfils all the items concerned, and I think one has to define this in a very sharp way, not a loose way.

MR. AGGARWAL: I agree with you. Let me make a different presentation of the same argument. The issue I am making here is that the problems you have in the design or in manufacturing you cannot resolve by qualification. As an engineer or a Licensee, it's your responsibility to know what environmental conditions are expected in that room.

MR. EBERSOLE: Well, yes, I can specify that ultimate environmental condition in that room using extrapolations from history.

MR. AGGARWAL: That is correct. Now, you specified 40 degrees. That is the normal expected temperature. Because of the loss of the ventilation system or some other region, you anticipate the temperature in the room will be 140 degrees. The equipment is located in a mild environment. It is my summation to you that if you have that requirement in your technical specification, then it is the obligation of the manufacturer to prove that equipment can perform under that design postulated condition.

This is a Q item and that's a requirement. I don't like to see 79.01 kind of summations to NRC for equipment located in a mild environment, but that equipment has to be qualified. But I don't want to see a ton of paperwork involved.

MR. EBERSOLE: I think your disclosure that we have equipment that has to drag in portable fans to be cooled -- we should document how many cases we have of this and examine them at the outermost end of the conditions they may have to face, and not just for the matter of extending the service life of the equipment, but during a meteorological condition that might be the worst we could expect.

MR. AGGARWAL: I didn't know any of those cases existed, but apparently there are a few cases.

MR. CATTON: I would be glad to give you the details at the break.

MR. AGGARWAL: I will have I&E to look at this.

MR. EBERSOLE: Does the Staff know of any broad practice of using supportive-type equipment to keep the ambient down? I've heard of it in whole stores and warehouses, but not in reactors.

MR. LA GRANGE: I am not aware of this situation existing in very many plants. This is news to me.

I would say that, along the lines of Mr. Lipinski here, that in this application the environment was not specified properly. If anybody has to use fans to keep these pumps going, I would be very concerned. I don't think it's a good idea.

MR. EBERSOLE: We better investigate this as a discrete topical matter.

MR. AGGARWAL: Thank you.

Finally, this qualification must be completed by March 31, '82, or March '85, whichever is earlier. The dates are keyed to the implementation after March of '82.

Finally, I would like to point out that this rule includes a grandfather clause which basically states that if you were qualifying equipment currently either under DOR guidelines or NUREG-0588, that requalification of that equipment is not required.

We do recognize the industry efforts, and there is no intention on the NRC's part at this time to ask for requalification.

(Slide.)

This is something new that was added at the Commission briefing time. What the rule is now saying is that replacement parts shall be upgraded according to this rule unless there is some reason to the contrary. In the preamble of this rule we have stated that some regions will be included in Regulatory Guide 1.89. It is the Staff's intention at this time to include some of the typical examples in the Regulatory Guide 1.89 as to what will be acceptable.

One of the acceptable examples that comes to mind is if you have a piece of equipment which has previously qualified either under the DOR guidelines or NUREG-0588 and you have it in your stock prior to the effective date of this rule, then you should be able to replace it as and when needed. Again, we recognize the industry's -- if you have the equipment, surely you can, but if you do not and you have to modify it, then it must be upgraded.

MR. LIPINSKI: Could we go back to (K), the previous slide?

MR. AGGARWAL: Surely.

(Slide.)

MR. LIPINSKI: If I were to interpret this literally, I would come to the conclusion that the new requirements are more stringent than the old requirements; but if you have gone through the procedure specified here, then you do not have to reconsider it. To me, that implies that there is possibly some equipment that would not pass according to the current specifications.

MR. AGGARWAL: Are you debating the issue of whether the current requirements are more regressive compared to the DOR guidelines?

MR. LIPINSKI: Compared to the specifications in the old guidelines.

MR. AGGARWAL: That may be true. Let me make a qualifying statement. NUREG-0588 has two categories, Catetory 1 and Category 2. It is the Staff's view that the Catego-- 1 requirements are equal to IEEE 3.23-'74 and are reflected in the final rule. The Category 2 requirements are not equivalent to the 1974 requirement;

however, the rule does grandfather the plants that do not have to upgrade the equipment unless they go in the replacement cycle.

MR. LIPINSKI: If I literally interpret this, then, that means that there are some plants out there that will have equipment that is not qualified to the same standards as this rule requires for the newer plants?

MR. AGGARWAL: I would say your interpretation is correct. However, you have to keep in mind what I am saying is different. Look what you have done already. You do not have to requalify it. When you go into the replacement cycle you have to meet the requirement of this rule, which is more rigorous.

MR. LIPINSKI: That does not appear in here, though. You have to go look at further documents to get that information.

MR. AGGARWAL: That is correct, but I think this is common knowledge among licensees now. As I said, the grandfather clause was worked out after our first briefing with the commissioners, and was possibly consistent with the demands or requests and presentations made by the industry.

Yes, sir?

MR. EBERSOLE: I was just going to say, you could not very quickly comment on what were the important differences, could you?

MR. AGGARWAL: I can, but I am sure that would generate many more questions. So if you would like, I am willing to, but --

MR. EBERSOLE: No, let's not get into it.

MR. AGGARWAL: The issue has been debated --

MR. EBERSOLE: What Walt is getting around to is he wants to know just what are the plants that do not have to qualify under the new rule? What is the difference?

MR. AGGARWAL: Well, for example, just off the top of my head, the 1971 requirements of IEEE 3.23, radiation aging can be done by analysis only because in those days we did not know too much about it, and we do not want those plants to be totally shut off because of that reason. At newer plants we will not accept any such thing. So this is a point an example.

MR. EBERSOLE: The problem is to understand the degree to which safety is enhanced by the new provisions or the reverse of that.

MR. LIPINSKI: Taking that particular case, if a particular plant had done an analysis based on the materials they had in the plant, but after that some experimental data was obtained to invalidate those early analyses, effectively they ignore the new information and say we meet the requirements? Because under my analysis it said I was qualified.

MR. AGGARWAL: No, sir, no, sir. The moment we have that knowledge we will go back to the licensee and tell them to fix it now. This is a normal procedure for an I&E bulletin in any case.

MR. EBERSOLE: So there will be a compartive examination of the differences to see whether they are of material consequence?

MR. AGGARWAL: No, sir, I did not say that. I said if I know of the failures, then I will go back and tell them to fix it. If I don't know, possibly I cannot do anything about it.

MR. NOONAN: Dr. Ebersole, may I please comment on this?

MR. EBERSOLE: Yes.

MR. NOONAN: I would like for the record to state that those plants that have been qualified to the DOR guidelines are no less safe than the plants that are required to follow the latest criteria. Basically, what we are looking at is a difference in the methodology of qualifying to certain environments. Like we said earlier, take for example the aging question. We allow the operating plants to qualify by analysis, and later on more tests are required. There still is probably some analysis allowed in certain cases.

In the effort undergone by Franklin, as new information comes in to us it is highlighted. If we find out that a certain plant did something a certain way and we have new information on that, we have a way of cross-checking that and assuring ourselves that that information is brought out and the plants are notified. So I really do not have the concern of the criteria, the latest criteria versus the oldest criteria.

I would say for the record that the plants designed by the DOR guidelines are just as safe as the ones we are now qualifying. We are using better procedures, better techniques and the state-of-the-art has advanced. Clearly, when there is a deficiency it is noted. If we find a deficiency, it becomes that and all plants are notified of that.

MR. AGGARWAL: Now a similar case could arise that let's say the plant is a NTOL, which is a category 2 plant under NUREG-0588. Let us argue they are testing a transmitter. Suppose that fails. Then all the applicants throughout the country have to upgrade it or replace it, whatever the case may be. That is a separate issue. A similar thing applies whenever you discover anything that has failed, either based on certain data or the experimental research, as the case may be.

Finally, I would like to move to, if I could, the mild environment and possibly try to put that thing to bed.

MR. EBERSOLE: Let me at this point call a 10-minute break. Since it is a discrete place and I think we should, and we will come back to this.

MR. AGGARWAL: Okay. Thank you.

(A short recess was taken.)

MR. EBERSOLE: Gentlemen, as you all know, we are running a little behind, like 40 minutes, so we need to expedite to the extent that all of the participants can so do. Carry on.

MR. AGGARWAL: Thank you.

Finally, in the rulemaking process, as was pointed out earlier, that the equipment located in the mild environment is not covered by this rule. That does not mean that there are no requirements for the equipment in the mild environment.

We propose to include a requirement in Regulatory Guide 1.89, but I do want to make one point clear. Qualification is the verification of the design. It is up to you, the general licensee or designer, to postulate the environmental condition for a given location for that plant specific. I never said that I subscribed to the idea that there should be fans and they should be cooling the pumps or the motors.

The issue I am making here, you as the licensee have the obligation to define the environmental conditions for that equipment. If you determine they are in a mild environment, then put those requirements in the technical specification. Then the burden rests with the manufacturer.

MR. EBERSOLE: If I am the licensee, and I define it as mild, and that is the end of what I say, what do you as the regulatory function do to examine the accuracy of my statement that it is mild?

MR. AGGARWAL: It is class 1E equipment, QA item. The inspectors have every obligation to go and look into it. As I pointed out, we are not asking for any submittal to the NRC for any verification for the equipment located in the mild environment.

Bob, did you want to supplement?

MR. LA GRANGE: When we review an applicant's submittal, we look for the environments that they are specifying for this equipment. We ask them how they define mild environment, and why they are excluding equipment that is, for instance, 10^{-4th} rads. If you define the mild environment 10^{-4th} rads, we say we do not buy that. We want to see a submittal on anything that will be intended to the fourth or above. Any piece of electronics, we want him to tell us generically why that equipment will work in any environment, and typically we use a cutoff of 10^{3rd} rads for electronics. We don't take a look at a submittal at face value and say this must be everything in the mild environment.

MR. EBERSOLE: Let me take a case in point brought up by one of the consultants, I forget which.

By and large, the aux feedwater pump has only been recognized in recent years as a critical function in the plants, and now it is safety grade. It is absolutely required for the PWR's that don't have feed and bleed.

Typically, these pumps are thrown into one room, which includes a turbine driven pump associated with two motor driven pumps. The fact you take a case where I have steam pressure to the turbine driven pump and I carry steam pressure up to that point into the room. I have a steam pressure line break. I am postulating carrying steam pressure into the room as a continuous matter. You don't have to do that, but in many plants you may do it.

If I have a steam line break in that room, I have lost the function of the turbine pump. I throw the plant into disarray because of other effects of the steam line break. At the same time, if the electric driven pumps are in that room and there are switchboards or switch gears which may be isolated switches to furnish these two electric-driven motor-driven pumps are of general purpose character, non-NEMA-4, then they are the kind of things that will become shorted out as a result of the steam environment and one has no feedwater at all.

MR. LA GRANGE: If you pick up an applicant's program now, you will see the auxiliary feedwater pump motors in their program. We don't care about the pumps where the break occurred, because there is no reason to qualify the pumps lost. Anything in that area must be included in the program. The environment must be defined, and the equipment qualified for that environment.

MR. EBERSOLE: Does that apply to any room where I have a positive pressure water system in excess of, say, 250 degrees Fahrenheit?

MR. AGGARWAL: Let me interrupt here. The moment you talk about a steam pipeline, I can postulate a failure of it, and the equipment in that room is no longer in the mild environment, and you are in a harsh environment and must qualify the equipment according to the rule.

MR. EBERSOLE: What if the failure is due to a radiator system using steam heat?

MR. AGGARWAL: It is the accident, and the accident is no longer in the mild environment.

MR. EBERSOLE: Do you believe equipments in mild environments now are looked at in the context of the steaming atmospheres I am talking about?

MR. AGGARWAL: They should be.

MR. EBERSOLE: But are they?

MR. AGGARWAL: I am concerned with places like the control room and places like this. This is where we are trying to give the relief. The cases like you are describing, the licensees should know about it and design it that way. If there is a steam line in that room, there is no question in my mind that the equipment is located in a harsh environment, and that environment results from an accident, and therefore must be accounted for.

MR. EBERSOLE: I suggest you make a few discrete investigations in this area, because I don't think you are going to find things that have been identified as harsh environments.

MR. AGGARWAL: I will bring these things to the I&E inspectors' attention.

MR. CATTON: I don't think it is I&E inspectors. It should be the NRR, the licensing people. Both. And include instrument lines in that, too, because under high pressure they could spit out a lot of steam.

MR. AGGARWAL: That is right. Now, at this time let me turn it over to the two Regulatory Guides, namely, 1.89 and 1.100. I would basically point out to you that Regulatory Guide 1.89 was issued for public comment some time last year. At that time, we had not issued the final rule. The guide is based on IEEE 323 1974. However, we are aware of the fact that IEE 323 1983 will be available very soon. As a matter of fact, it was approved by NSAC last week. The final draft is due, and we will see IEEE 323 1983 available.

The NRC staff has participated in the development of the standard. I am a member of the FD2 committee. Don Sullivan is on NPAC. However, all the requiremnts that are there are not totally consistent with the final rulemaking or the current NRC thinking. Therefore, there will be some exceptions that will be taken by Regulatory Guide 1.89.

Now, the staff has looked at the comments which are provided by the public. There are a lot of comments. All I want to do at this time is make you aware of these issues so you are mentally prepared to discuss those issues when I come back with the guide. Number One is the source term. This is one issue which had been addressed. A maximum number of the comments are in this area. Let me give you a little background about this issue.

Following the accident at Three Mile Island, the staff had concluded that the thorough examination of source term exemptions for equipment qualification was warranted. It is recognized, however, that the TMI 2 accident represented only one of a number of possible accident sequences that could lead to a release of fission products and the mix of fission products released could vary substantially.

The staff felt at that time, which was last year, that there should be a modification of the TID source term indicated by the TMI 2 experience, and it may be important at this time to include a fission release, and the regulatory position in the Regulatory Guide 1.89 was revised to propose the release of 50 percent of the core cesium activity inventory.

The Regulatory Guide was issued for public comment, and as I pointed out, numerous comments are in this area.

MR. EBERSOLE: Is this leading to an environmental qualification effort?

MR. AGGARWAL: Probably, and it applies to equipment qualification now. It is my view at this time it is basically a narrow staff definition, because we still have to go to the CRGR and receive his comments before we come to the Subcommittee. Currently we are working on the resolution of public comments. Once we complete that task, we will go to him, the subcommittee of the CRGR.

Now, going back to why I am concerned with this comment, I believe that we should not leave the resolution of this complicated issue, namely, the source term, as applies to the nuclear power plant equipment qualification. It should also be noted that there is a grandfather clause in the final rule that tells you that if you are qualifying the equipment either under the DOR guidelines or NUREG-0588, that requalification is not required. What it brings to us is, look, those people will not depend for any guidance at this time on the Regulatory Guide 1.89. They are going to do what is in the NUREG-0588, which is basically the TID source term.

Therefore, the industry is asking that the staff should go back and reaffirm the position previously taken by the NRC until we have a definite position in the source term developed by another office of NRC, or we know something better in that area.

It is my thinking at this time to go back to the TID source term until further development for another simple reason, that if anyone ever reviews 1.89, it will be in terms of the replacement parts because they have to be upgraded, and we are still talking about some time frame.

So this is my first approach with regard to source term.

MR. EBERSOLE: Let me tell you what I am

hearing. I would say that you leave the TID in place with respect to radiation damage and then let it be a margin. That we don't look at source term for other biological reasons is another matter, but you are telling me that it may be in fact an effort that is present to diminish the source term in the context of diminishing the environmental --

MR. AGGARWAL: I am not saying anything but what I told you, sir. There is a program for what will be the outcome of the program in a separate office within the NRC, which I feel you are aware of, under Bob Bernero, which is responsible for this issue.

MR. EBERSOLE: Okay.

MR. AGGARWAL: All I have said is, equipment qualification should not be the lead runner in this issue.

Now I would turn to the second issue, which is the margin and one requirement. Basically, the problem was, whenever you have the LOCA environmental conditions determined for a given piece of equipment at a location in the plant, you have some analytical approaches and analytical margin taken.

The rule now requires that you will account for margins in addition to the analytical margins to account for test instrument errors and production variations, unless they can be justified, and the industry seems to agree with us.

I may point out at this time that recently I had a meeting with the AIF and some of the issues were discussed. We find that there is total agreement with the industry and ourselves at this time. With reference to one of the requirements, it had been a requirement here before that some equipment had been required to perform its safety function only for a short time, within a short time period into the event, and the requirement was that you shall qualify that piece of equipment for a minimum of one hour in excess of the time assumed in the accident analysis.

I seem to take a position at this time that unless a time margin of less than one hour can be justified, so if you can come back with some good arguments that I do not need to run the test for one hour, then that is fine.

The next item was aging. There was a concern from the industry that the reference to qualified life should be totally dropped because we do not know how to determine qualified life for a given piece of equipment. This, by the way, will be a subject matter for discussion in one of the IEEE meetings of the Nuclear Plant Society which is scheduled some time later this year, the issue being how do you really assess qualified life.

Therefore, the staff has decided to drop the reference to qualified life. What we are saying is, the predesignated life, if you think the cable has ten years of life for the time being, then at the end of ten years if you can show me by ongoing qualification methods that indeed the life is 20 years, I will buy that argument, but I am not taking that position at this time, that the life is 40 years.

Again, the burden remains with the utility to come and tell me what the life is.

The next item was the mild environment. People are concerned in the industry as to what the requirement will be. There is a very key issue here which is before the industry at this time. I do not think we have the answers yet. When I come back to 1.100 with respect to seismic requirements, I will briefly address that issue, but as far as I am concerned, with regard to the mild environment, the position is plain and clear that normal QC requirements are sufficient to meet the requirement of this rule or Regulatory Guide 1.89.

Now, as we discussed earlier, if this is a defined deficiency or a manufacturing defect, that would be a different issue altogether.

The next issue was replacement parts. I briefly addressed that issue earlier, and pointed out that Regulatory Guide 1.89 will provide some reason to the contrary. One of the reasons I point it out is, if you happen to have qualified equipment in your warehouse, then you can use it. We are providing some other sound reasons.

For example, the replacement of the equipment will take extensive delays in production of the basic operation of the plant. Namely, you are replacing a motor that failed. Now you cannot get it for three years. You are constrained by the time. We are saying that is a sound reason. Other reasons will be covered in 1.89.

Finally, Issue Number 6 was on sequence testing, which is one of my very favorite subjects, which I have discussed with you previously. Here, industry had been taking two separate prototypes in most of the equipment for most of the plants. One piece of eqiupment, they will go through the environmental testing. The other piece, they will go for seismic qualification, and they both independently met the requirement. So, we concluded that this is satisfactory.

Until recently, this fact was not recognized by the industry or IEEE for that matter. IEEE in 1983 has taken a step backward. They are saying, if you can justify that a single prototype is not required, namely, that you do the aging, then you do the seismic, then the environmental testing on a single prototype, then you can take any test sequence which you can justify.

The staff position at this time is that for operating plants, we do not want to impose any such requirement, because we do not have any technical basis. Now, for near-term operating plants I think that issue remains open, and I do not intend to address that issue in Regulatory Guide 1.89, and postpone it to 1.100. By that time we will have some more knowledge.

Now, fianlly, the Regulatory Guide 1.100, all I know, there are three very important issues at this time. The Number One issue is the pre-aging. This was briefly addressed by Vince Noonan and also came out in the discussion by some member of the subcommittee.

The problem I have, I heard both parts of the story in different professional meetings. Part of industry is telling me that, hell, it makes no damn difference, and of course when I go to the testing labs, they tell me another story, and I think I understand the reason.

EPRI has said in New York that there are some equipments which must be pre-aged prior to seismic testing. I seem to agree with that kind of conclusion at that time. It makes sense to me. All equipment may not be susceptible to pre-aging, but some of them may be. This is an issue where the staff has not taken a final position at that time. It will be addressed in Regulatory Guide 1.100.

I just want you to share my frustration, if I may, at this time in the area of equipment qualification and the regulatory processes thereof.

Finally, whether or not IEEE 344 1975, which is currently under revision under Subcommittee 2, I have made an official suggestion to IEEE that let us do something now and save millions of dollars to the industry.

The suggestion I have made to them is whether or not IEEE 323 -- pardon me, IEEE 344 '75 be extended to include mechanical equipment, because it is common knowledge today that many, many manufacturers of the industry are now qualifyin~ the equipment under a different standard.

The issue I have is that if they can extend it, then possibly we can include a similar requirement in Reggulatory Guide 1.100. Somehow I do not believe

ASME is not very receptive to it. I am pursuing this issue with the IEEE as well as the ASME, but the results will be known sometime in the near future.

The final issue here includes a dynamic requirement. So far, the title of the standard and the guide has been seismic. The position I have made is, there should be seismic and dynamic requirements for the electrical and the mechanical equipment. As I said, at this time in the working group level I think it is going to take some time. We in research have a program also to address the issue of pre-aging, whether it is for all equipment or some equipment, and we will have to see.

This concludes my presentation in providing you the status of the regulatory area at this time.

I have two very short comments to make in addition to what came out of earlier comments by some other members. There is quite good communication now between the staff and the region. I have been directed by the EOD, and I am providing now a presentation to all the five regions. The inspectors are called in, and they are being explained what the rules mean, what the requirements are.

Again, it is a dialogue, a conversation, a continuing dialogue between us and the region. So we are always looking for some method, for a way of improving communications in the staff members.

Finally, I would like to point out the purpose of the meeting was not finding out how aging should be done. Unfortunately, the mistaken view in the industry is that when you talk about aging in terms of qualification, it means the same thing for normal aging in the plant. They are two different issues.

That seminar, which was held under my chairmanship, the purpose of that seminar was to find out where the NRC should be using the taxpayers' dollars in performing the research in the aging problem, not how do you do the aging in the accelerated aging or matters of aging in a test lab.

We were looking for the unexpected that you don't know about. For example, the steam generator tubes and so forth. So, there are two different purposes in plant aging, and I believe this afternoon you will hear a presentation on that issue.

Thank you. If there are any questions, I will be happy to answer them.

MR. EBERSOLE: Thank you.

MR. WARD: I have one. On the region question, do you have experts -- are there experts on these equipment qualification issues in each of the regions?

MR. AGGARWAL: That is a very loaded question. I think I really cannot make that determination. All I know is that in some of the regions they do have offices in the so-called equipment qualification. I don't think all offices are equally strong, but some are on the staff. Again, this is based on my knowledge that I have gathered from my meetings there, but I don't think there is any plan at this time to do anything before 1985.

By that time, I hope the issue of qualification will be all over.

MR. CATTON: I would just like to make a comment on that. One thing I have noticed is that I&E is good at performing an audit function. Some of the people they have working for them are very good, but it has been my observation that frequently they are not engineers, and that if I&E is going to take over a lot of these activities, you are going to have to have a damn good training program to educate them, which means continuing workshops with I&E.

Is this part of your plan?

MR. AGGARWAL: I am not sure what it is part of. All I know, I was told this is one of the first rules for many years that have come out from the Commission, and there have been different interpretations. I think the Commission and the EDO felt it was necessary to provide some in-depth information to our inspectors in different offices in different regions.

MR. CATTON: Going that route, someone is going to have to take on a lot of responsibility for education.

MR. AGGARWAL: I am inclined to agree. Again, this is a management decision.

MR. WARD: (Presiding) Walt?

MR. LIPINSKI: One of the ingredients of the program are the laboratories which are qualified to do the environmental testing. One point, the IEEE used to be the organization that was going to go around and certify or qualify, whatever the term was, the testing laboratories. Where does that stand right there? IEEE was reluctant to be the responsible group for the laboratory accreditation.

MR. AGGARWAL: I will explain my personal views to the best of my knowledge. They are in no way a reflection of Mr. Fraley. The two Commissioners that voted, again, you will see the proposed rule. It has not gone to a final stage yet. It was supposed to be released for public comment. Two Commissioners were in favor, and two Commissioners were opposed to it. The fifth Commissioner had a somewhat mild, if I may say so, version of his own ideas which he tried to negotiate with the other Commissioners.

All I can tell you at this time is that the Commissioners have not made a decision as to what they intend to do.

With regard to IEEE, they are very much upset. They feel this is a breach of contract, and they have very strong feelings about that.

MR. LIPINSKI: So that is still an issue as to how these laboratories get certified in being able to carry out the qualification?

MR. AGGARWAL: This is under Commission consideration.

MR. LA GRANGE: I have one quick comment, just to clarify the record a little bit, on the recommended test sequence of 323 1974, plants recently licensed and plants being licensed are testing the same piece of equipment through the entire test sequence. We intend -- it is NRR's position at this time that that test sequence be specified in 1.89.

MR. AGGARWAL: Any other question or comment?

MR. WARD: Any other questions?

(No response.)

MR. WARD: Thank you, Mr. Aggarwal.

Mr. Noonan, you wanted to take a couple of minutes before the next topic?

MR. NOONAN: Very quickly, I would like to talk about this Item C-1 that is identified on the schedule. As of yesterday, this would be the first time we saw this particular item. We saw basically the Equipment Qualification Branch. I think it is assigned improperly, if that is correct.

We take as one of our jobs to tell the licensee that he has to have a maintenance surveillance program in effect per Reg. Guide 1.33. We do not basically follow up on the maintenance program to see how it is implemented. This is usually a function of the region. I will have to go out and find out how this got assigned.

What I would basically like to do is ask to put it in a hold pattern right now so I can go back and find out how it was assigned to EQB.

MR. WARD: Well, of course, assurance of long-term capability could be by inspection, or it could be insistence on some requirement in the design and construction of the piece of equipment.

MR. NOONAN: The way I read this particular thing, it would say that a seal becomes defective as a result of personnel maintenance. When equipment is qualified, we see that it is properly maintained and properly assembled. The way I interpret this particular item, this is long term over the years maintenance done on this equipment. Are there proper maintenance procedures, and how are they implemented so that the maintenance people cannot by some error cause damage to seals?

MR. WARD: So you are saying generic item C-1 is directed toward that rather than deterioration or degradation in service?

MR. NOONAN: Yes.

MR. WARD: Okay. Thank you. We have the option now of going on with the next item on the agenda, which is the use of seismic experience data, or taking our lunch break at the present time. I guess I favor taking the lunch break, anticipating that we might run on the long side this afternoon, beyond 4:00 or 4:15. Do our presenters have a problem with that? Let's see. Mr. Smith, is that all right with you?

MR. SMITH: That is fine.

MR. WARD: You can talk as well after lunch as before lunch?

MR. SMITH: Yes.

MR. WARD: Let's take a break then until five minutes before 1:00.

(Whereupon, at 11:55 a.m., the Committee was recessed, to reconvene at 12:55 p.m. of the same day.)

AFTERNOON SESSION

MR. EBERSOLE: Gentlemen, let's continue at whatever point we left off, and remember, we are behind.

MR. SMITH: Yes.

MR. EBERSOLE: Think about the man on the Federal Express ad.

MR. SMITH: Well, if it is just my presentation, it will be.

(Slide.)

MR. SMITH: Our organization for today, we will split it into basically three parts. I will provide a quick, brief background. My name is Niel Smith. I am chairman of the Seismic Qualification Utilities Group, and I work for Commonwealth Edison. Peter Yanev, EQE's president, Earthquake Engineering president, will be providing the main body of today's talk, and then I will come back and sum up, a few very brief comments. They will be more in the line of the speed I am going through right now.

(Slide.)

MR. SMITH: This group was formed as a result of some SEP concerns concerning seismic fragility. Just how do we know equipment is seismically qualified, or that it will in fact perform its function during an earthquake? Based on some information that we had seen where -- you hear a lot about major damage in earthquakes. You think of them as being relatively bad. It turns out news reports and stuff focus on damage. Non-damage, non-events are not reported.

So when we look beyond the very basic lines of the damage we saw at major industrial facilities, they seem to stand up well during earthquakes. We didn't know how well, but there is some history there, and we thought we had not in fact really looked at that history in any detail.

(Slide.)

MR. SMITH: So we formed this utility group. The purpose of this utility group which we started out with as a pilot project -- that is all we have done today is a pilot program. We have not done a complete and total program, but we had a number of things that we wanted to look at.

As I said earlier, it appeared that the industrial equipment survived earthquakes quite well, and that it has an intrinsic design for whatever reason, whether it is to withstand normal working loads or in one case the switch gear manufacturer says, I ship it to you, it has to withstand shipping, and that is far heavier than the stuff that has gone forth in the actual loading of the equipment in the plant.

So, the equipment is designed for a lot of loads besides seismic. When you look at it just in terms of seismic and how it performed during the seismic events, it appears to perform extremely well. Peter will talk about the details of this program. So, the main purposes of the pilot program are outlined up here.

As I said before, there is a lot of earthquake experience data out there, except it has never been catalogued. The damage has been, but when things go right, engineers say, well, what I have done is right. I will just continue doing what I have done. If your power plant does not fall down and it works, you say, okay, I can continue to do that. There is not this inquiry board as to why it did work. You know what you have done works, so you continue on.

So, we had to look beyond what was actually in the literature. We had to start creating our own literature base, and we have in fact started on that program. We had to, because of the quantity of equipment that would be available to look at, we limited ourselves to only six classes of equipment, rather than looking at the full broad scope, and we did that so we could get through a pilot program to see whether or not this in fact could be done. It was just done for that reason, to set a limited scope to do the work.

Then we looked at both nuclear plants and non-nuclear plants to see if the equipment in the plants was basically the same. Prior to about 1970, when the seismic criteria started to come into play, IEEE 344 1971, I believe, was the first one, the manufacturers had basically made the same equipment for industrial facilities as at power plants. You will see pictures. The model numbers were the same. They came from the same factories. It was basically the same equipment.

Some of the equipment we looked at in the conventional plants was upwards of 40 and 50 years old, and went through the 1971 San Fernando earthquake, so we looked at a relatively substantial earthquake body of data.

So then we asked, was there a problem when you looked at it in, say, power transformers that you just never experienced a failure, so why should you spend the time and the effort to spend a lot of effort showing that it is seismically qualified when there is just no reason at all to suspect that there is any problem with the piece of equipment. Yes?

MR. WARD: Are piping and structures part of this program?

MR. SMITH: Not at this point.

(Slide.)

MR. SMITH: So, the basic goals of our program were, one, to develop a historical data base and show how the equipment performed during and after seismic strong earthquakes. Then, we wanted to show that the equipment found in nuclear power plants was really quite similar to equipment found in the non-nuclear power plants.

We just looked at power plants, but again, the data base, if we wanted to expand it, includes most heavy industrial facilities. You have the petrochemical industry, steel mills, and other major industrial -- you know, where they design their structure and they design the equipment that goes in that structure.

Then, we wanted to determine whether there was sufficient data to conclude that transformers, for example, switch gear, that if you look at enough pieces and you find no damage, that it is not worth looking any further. You just stop. You say, the switch gear, because of these other inherent design features, are in fact okay.

Then, to develop a methodology for using the data we collect, for those items where in fact we know we have some failures, but let's say it occurs if you are about seven-tenths of a G ground motion and it is an amplified spectra of maybe five or six G's up in the building, that at that point you begin to see some failures. At this point you want to use this as screening data.

Well, maybe a west coast plant would worry about it, but you would say, gee, this type of equipment is good to extremely high levels, and therefore on an east coast plant it is not really a meaningful exercise. All it is is an exercise on paper, and you do not want to go through paper for the sake of paper.

By doing this, we focus our attention on those areas that in fact have some seismic questions. Rather than shotgunning it and hitting the whole broad range of all equipment, we will focus in on those few pieces that do not pass our screening. Then we can do something about those individual items.

Based on what we heard and saw from our preliminary review, we decided to go forward with this program. The results, however, surprised us, in that we basically have found no pieces of equipment in our pilot study that would cause us to question its seismic capability. It appears that the seismic question, at least to an east coaster like me, is overstated, and that the seismic concerns that we all have -- being from Chicago, the ground does not move under my feet -- and the thought of it bothered me, don't appear to be as real or as major as we thought.

One of the major goals of this program is, is there or is there not a real seismic problem. We are fast coming to the conclusion that the seismic question is not as big a question as we had originally anticipated.

So, with that, I would like to turn it over to Peter.

MR. LIPINSKI: Before you do, I have a publication in living color with about 100 illustrations of damage to electrical equipment in different earthquake areas. Now, in some of these cases, they illustrate that the transformer was not mounted to the concrete base, it was just set on it, and when the earthquake event came, it toppled the transformer onto the ground. The insulator on the top of the transformer, even if the transformer was properly mounted, they cracked.

MR. SMITH: I am not saying there is no problem. We looked at equipment within power plant structures. We went to Sylmar. It was a $50 million facility roughly, when it was two. Two or three months after it was finished, it took about $25 million or $30 million worth of damage. Most of that damage occurred in the switch yard. The capacitor banks were mounted on columns, ceramic columns. You had a relatively high load that was cantilevered, and the things broke.

The high tension bushings on the large transformers often broke because they were not properly supported. I grant you that once -- if you do not consider seismic loads at all in your structures, that in fact you will have damage.

When they did the post mortem on Sylmar, they put the stuff right back where they got it from. They anchored the equipment. They changed the mounting configurations, and now feel that the system in fact will stick together during an earthquake even though you still have ceramics and things like that.

The Japanese in some of their earthquakes bolted their equipment down very rigidly, and the large insulators in fact broke. That is the nice thing about using mother nature. The shake table in fact will find all the weak points or the weakest points in your system.

By taking that experience data and looking at it, you can then iterate that back into our plants and our designs, and we can learn from that.

MR. LIPINSKI: Repeat the statement you made earlier. You found no damage.

MR. SMITH: For the six classes of equipment we found inside the power plant.

MR. LIPINSKI: That is the qualification.

MR. SMITH: Yes, sir.

MR. LIPINSKI: What about the axis of excitation for the particular equipment you looked at versus how it was oriented within the structure?

MR. SMITH: I am not addressing that. Peter will address that.

MR. LIPINSKI: You look for one piece for a particular event, and you draw one particular equipment.

MR. SMITH: Peter will address that question.

MR. EBERSOLE: One difference between the nuclear plant versus all the other industrial plants, I guess it is the salient difference, is that a nuclear plant must continue to function to remove heat and maintain a thermal profile from the center of the outside on down to a heat sink.

Lots of industrial plants can shut down. You can go fix them, start them up again. Is what you say true in the context that they never experience an interruption in continuity of processes? Or did they in fact shut down and you found things were not too badly hurt?

MR. SMITH: I will let Peter address that in one of the slides in his talk. The answer to your question is yes in both cases. In some cases, we did not have an interruption of service. In some cases we did. Quite often the plants tripped on loss of load, not because of the earthquake.

MR. EBERSOLE: On the other side of the coin, since you make it look so favorable, I recall early on, many years ago, we were looking at the diesel plants and discovered they had a fire protection system, and the fire protection system was non-safety grade. What it did was close the diesels out and then flood them with CO_2. It was done with a rate of rise of pressure of thermal detecting devices and so forth.

In the little box which was non-seismic, non-safety grade, which controlled the process of closing the diesel plants in order to flood them with CO_2, there was found an array of mercury switches.

MR. SMITH: A lot of plants have had them, and a lot of plants have had them removed.

MR. EBERSOLE: You know the rest.

MR. SMITH: Yes. That is why I am saying when you take the earthquake experience data and you look at what has happened, you can determine where your weak spots are and then concentrate your efforts on those weak spots rather than making a thought process of what could go wrong. You are actually concentrating on those areas that in fact are weak.

That is the whole point of our exercise, to look at the real world, find out what the real world is trying to tell us. Then, based on that, make appropriate engineering judgments, and that is really what I think engineers have done in the past, looked at the date base, they have seen what has happened, and then they have tried to design for what really happens.

MR. EBERSOLE: The other thing I want to mention is what I think is the extreme delicacy of design. In a seismic mode, the plant is composed of two daisy chains, the redundant configuration of equipment, very long daisy chains, mechanical, thermal, hydraulic, electrical, you name it. One only needs a coincident failure of one of these in one train and one in another, whether one is mechanical or another electrical, whether one journal fails, one relay. You have had it.

MR. SMITH: In the long-term portions of this program, we are in fact addressing that type of question.

MR. EBERSOLE: It is a very delicate system when you look at it in that context.

MR. SMITH: In one way they are delicate, but in another way -- and it may be your seismic trip you want.

MR. EBERSOLE: Say that again?

MR. SMITH: It may be the seismic trip you'd like. If it was in the RPS system, or something like that, you could live with it.

MR. EBERSOLE: I don't worry about the trip; it's the continuity of the heat removal.

MR. SMITH: You would worry about it for the primary system boundary. You would worry about it for the containment boundaries. There are some systems you would worry about it very much. You would worry about it for keeping your system flows running, things like that.

But it is a system analysis at that point. It is not the whole plant.

MR. CATTON: When you did this study --

MR. SMITH: Pilot study.

MR. CATTON: Whatever it is.

MR. SMITH: We don't pretend to have all the answers.

MR. CATTON: One thing I noticed about the particular earthquake that you referred to is that block walls that were north-south fell down. Block walls that were east-west stood up.

MR. SMITH: Let me let Peter address that.

MR. CATTON: Fireplaces that were on this side of the building feel on their neighbbors. Fireplaces that were on the west side stayed there.

MR. YANEV: Before you keep going, let me show my slides.

MR. RICHARDSON: Mr. Chairman, could I ask a question before we go on?

MR. EBERSOLE: Yes.

MR. RICHARDSON: My name is Jim Richardson, with the Office of Research.

I think this resource that is being developed is a valuable one. It is a unique resource that we need to take advantage of. One question that has bothered me continually that I would like you to address is that many of the west coast plants have SSE levels of something like six-tenths of a G peak ground motion. East coast plants may be up to .2 G. These are very, very strong earthquakes, far beyond what we have experienced even in the San Fernando earthquake of 1971.

I guess my question is, how are you correlating the fragility level of equipment that has survived a nominal earthquake and extrapolate that to say that we have some assurance that that piece of equipment is in fact going to operate at the SSE level?

MR. SMITH: For the west coast earthquake, I am not sure we are making that extrapolation. For the east coast plant, the ground spectra, the unamplified ground spectra generally envelops the amplified floor response spectra for the areas of interest within the east coast nuclear plants.

MR. YANEV: I think the answer is, we collected all the data we could in the time we had. We are going to apply it to as wide a range of plants as we can. If the data is not high enough in ground motion to apply to specific plant sizes in California or other places in the world, that is the way it is. The data is not strong enough.

MR. YANEV: I am Yuri Yanev. I am with EQ, Incorporated, in San Francisco. I have been in earthquake analysis and design and earthquake-chasing, which is part of it, for the last about 14 years or so. I talk quite often on the subject of earthquakes. About half of our business is with conventional facilities in California. Many of them are industrial facilities handling toxic materials, toxic systems, high population buildings, so that a lot of our effort is in that direction. Safety-related is an entirely different viewpoint.

I will try to bring some of that experience in for you to understand my -- the nature of the research we conducted. I always also like to start with just a few illustrations of the effects of earthquakes I have witnessed personally. Unfortunately, we did not plan to make a presentation such as this, and I only have three or four slides of the kind I would like to show.

(Slide)

First I would like to start most of my talk from California with this picture because this is what most people conceive earthquakes to be like. This is the Golden Gate Bridge, this is a brick building built just before the Civil War. Now, I was involved in the analysis of the Golden Gate Bridge through the University of California at Berkeley.

The analysis shows some very different results, but this is what the popular press prefers to show. This is the impression people have. This is too often the impression engineers have. Ft. Point in the corner survived the 1906 earthquake. I have yet to see vortexes such as this occurring in the ocean, et cetera.

(Slide)

Another fault I see in the press, and I have been to a lot of earthquakes the press covered, we always see the worst. There is one collapse in the earthquake. That is all you see in the press. The impression is buildings collapse. I have been to places such as Managua, Nicaragua, where it was somewhere between 5,000 and 10,000 deaths. I was there a few days after the earthquake. It is a vivid experience I will never forget.

I would like to show you a couple of the examples there. This is the main traces of the fault right here. There are several other traces. This is the main trace. The four-unit power plant was located 200 meters away from it. The acceleration from the earthquake that was recorded was at the Esso refinery a few miles away from the fault, which was .4 g. Our guess for the actual acceleration here, magnitude 6.5, was about 50 to 75 percent g, easily.

I was employed right out of school then at Bechtel Power Corporation in San Francisco. I raised a lot of noise and was sent to review the effects of the earthquake specifically to learn how we could apply this experience to nuclear power plants. That was my first real exposure to a very destructive earthquake: as I said, 5,000 to 10,000 casualties, several thousand destroyed buildings.

(Slide)

MR. WARD: You are going to be talking about the percent g.

MR. YANEV: Peak ground acceleration.

MR. WARD: What does that mean? Is that at the low frequency? If I look at a spectra --

MR. YANEV: At whatever frequency it occurs, it is really the zero period acceleration at the tail end of a typical spectrum. It is the SSE definition in essence. It does not have a smooth curve because it is a real earthquake.

MR. WARD: In general when you are quoting a peak ground acceleration, you mean at zero period acceleration.

MR. YANEV: Right. This is what I will be talking about. I will be citing in almost all cases in the rest of the slides the ground accleration without any amplification to account for the structures and so on. We did not have the time or the funding in this phase to take a look at it. In fact, we didn't think we needed it because of the results.

Anyway, this structure was located across the street a few yards down from the four-loop power plant in Managua. It was totally destroyed. There were many like it in the vicinity. As I said, I saw quite a few casualties, deaths in these buildings immediately after the earthquake. So to me it is a very real thing. So the comments I make later will not be taken lightly.

(Slide)

Ths is an aerial view of the power plant. Partly there is the Unit 4 there, the newest one, which was built -- it is a German plant. Here is a collapsed building. Here is a collapsed building. The building I showed you is in the corner. This is the power plant.

I didn't bring the pictures last night from San Francisco. I had many more, several hundred.

(Slide)

This is one of the units. This is the only picture I had of the power plant. I looked at a lot of equipment. I believe I have photographs of almost everything that happened that was damaged and not. Very little happened at the plant. Very little happened. That data is partly recorded. We may go back, depending on the political environment, and look at that plant. It is still there.

MR. LIPINSKI: What were the design specifications for that plant?

MR. YANEV: This is not one of our data base plants. I would rather not comment on this and come back to the California plant. I believe it was something on the order of maybe 10 percent g. design, but I have not reviewed it recently to be certain of that.

MR. EBERSOLE: Did the plant continue to roll?

MR. YANEV: No. They had problems. They had a structural failure of the turbine petal base. They lost the battery racks. The batteries fell off and broke. That ruined some of the emergency system. The oil flow quit. Some of the pumps, it ground the pumps out. It ground the bearings of the turbine out so they were out for quite a while.

MR. EBERSOLE: Did the big oil tanks fail in your earlier picture?

MR. YANEV: You are stretching my -- I don't believe so, but I can show you other plants.

(Slide)

I will be talking about a couple of other plants. I thought I would show you what they looked like. In fact, I will wait. I will show this in the proper context later. I would be more than pleased to come back and show you literally hundreds or several thousand photographs of what I am talking about later. We have quite a lot of data.

(Slide)

What you saw was the Managua earthquake. Myself and a couple of the engineers who worked on this project in my office have visited the earthquakes. I believe there are about 17. I have gone to San Fernando and will be talking about that, 6.5 magnitude. Managua I went to twice. There were two there. One was 6.3 and 5.8. Another was Point Magu in northern Italy, Isu Peninsula.

The delegation from the United States to review the effect on the Fukishima Nuclear Power Plant and some of the other power facilities. This is magnitude 7.4. That is large by California standards. Then there are others we will hear about, Imperial Valley, 6.6. I will concentrate my comments on some of the strong earthquakes here in California.

MR. WARD: What was the Charleston earthquake of 1886 magnitude?

MR. YANEV: If I remember right, it is on the order of 7. It might be a little higher than that. I don't remember the number. There is no record -- I am not a geologist. I should stop there.

MR. LIPINSKI: How about the one in New Madrid?

MR. YANEV: The guesses are rather wide, but not merely approaching Sandia or bigger, magnitude 8. We don't know because there were not records, but the effects are strong. My interpretation of the data and of the tables that have put together, typically it is somewhere between one of the stronger earthquakes I have seen and the San Francisco event of 1906.

MR. WARD: And that was what?

MR. YANEV: To frame the sizes we are talking about, San Francisco, 8.25, faulting involved of 300 or so miles. New Madrid might have been high 7's, low 8's, something like that. The San Fernando earthquake was about 6.5, similar to Managua where you had 10,000 casualties. The El Centro earthquake of 1940, the one we always used for the analysis, was in the high 6's, around 7. So the really destructive earthquakes are typically above 6, with casualties depending on which part of the world you are in, of course.

MR. CATTON: When you give a number like 6.5 or 7.4, does that tell the whole story? My recollection of the San Fernando earthquake was it was one hell of a jerk in one direction.

MR. YANEV: It was a hell of a jerk in all directions, and it was stronger in one component than the other. We have reviewed all the data. It is published in our report. It was a strong earthquake in both directions. It was not a jerk. It was a 15 second motion with a rather wide spectrum.

MR. CATTON: It could be that one's perceptions are different depending on where one was relative to the earthquake. I live in the San Fernando Valley, and my fireplace moved in a given direction but water was sloshed out of the pool in one direction. Everything may have been a little off angle.

I visited Sylmar with the L.A. Police Department. I saw the direction things fell down. It seems to me that just saying 6.5 does not tell the whole story.

MR. YANEV: No, there is a lot more. The duration --

MR. CATTON: The first big jolt from that point on as far as surface motion was concerned that you could feel was trivial.

MR. YANEV: That is correct. Magnitude gives you a size of the energy released.

MR. CATTON: So when you say that was 6.5, was it the first peak that was 6.5?

MR. YANEV: Magnitude is determined on the basis of the record. This is completely off the topic. I'm not a seismologist.

MR. CATTON: I'm not either but an engineer told me I would understand it.

MR. YANEV: It is an approximate measure based on fault instruments of the total energy released by the event. You may look at it as an integral over the slippage plane in the whole energy released. You can equate it to the tons of TNT explosion.

MR. CATTON: So it's an integrated number.

MR. YANEV: Yes.

MR. CATTON: So if you have a big jolt that tails off, the integrated amount really doesn't tell the whole story. Okay, I understand. Thank you.

MR. YANEV: When I get to the specific sites, we have looked at a lot of spectra. If you are interested in the spectral content of the earthquake and where the power lays, we could illustrate some of them. Now, just a little bit of the experience in addressing some of the data involved in nuclear qualification work in several plants.

Currently, to a large degree what we do in California is concentrate on the upgrade of existing equipment systems and industrial facilities, especially hazardous systems. We address hundreds of equipment items. You have to get to them quickly and prevent damage from both a safety point of view and a business interruption for a company.

Some of the work is -- currently, for example, we are looking at Disneyland and strengthening the equipment there. It is sophisticated equipment, if you have seen how it operates.

(Slide)

Neal touched a little bit on the background that we had before we started the project, but we are all aware that the industrial equipment has to be designed to withstand certain dynamic loads because it is operating under a dynamic environment. For example, pumps are shaking much of the time. So that the equipment by its nature has some strength.

Earthquake experience, my personal and that of many others, indicates that major equipment failure is rare when the equipment is anchored, when it is protected against earthquakes. What we wanted to do, of course, is look beyond the documented experience because, as I said, we tended to concentrate on the failures, we don't concentrate on the successes. So we now need to frame the successes within the failures or vice-versa.

[Slide]

I will repeat very quickly the goals before I proceed to these slides. We had four goals. In our conclusions I will come back to the four goals. They are very simple. The first is to develop a historical data base on the performance of equipment, what really happens in strong earthquakes. We have a limited sample only.

The next one is to show whether the equipment in the plants that have survived the earthquakes is similar to the nuclear power plant equipment. As Neal indicated, we knew before that a lot of the earlier plants have equipment that is off-the-shelf type equipment similar to what is in conventional plants, and I will illustrate a few of those examples.

Then we had two other purposes. One was to determine whether data from the real earthquakes might be sufficient to indicate that certain classes of equipment -- vertical pumps or horizontal pumps for eastern United States plants that are located in the eastern United States plants -- whether the data we can collect is sufficient to say rather comfortably there is no problem, there is no need for the detailed types of qualification we are all engaged in. This is on the basis of the class of equipment.

Can I say we have never had a pump failure in an earthquake and therefore there is no reason to continue spending incredible hours analyzing and testing those pumps. Along the same lines, we came back and asked, can we pick out separate equipment items and envelope them with the experience we have from the real earthquakes?

In effect can we say that the earthquake test spectrum envelopes the required response spectrum for the plant?

MR. PICKEL: Question, please, sir. In looking at that data, are you looking at the earthquake motion at the point of the equipment? Are you taking into account the attenuation that may occur in these plants as compared to the nuclear plants?

MR. YANEV: Due to the limitations in time, primarily we concentrated on collecting data at ground level. We concentrated on collecting the free field data that we can reasonably assume would have occurred at the base of the plant with a rather large amount of equipment base.

For the nuclear plants, we looked at the spectra, the motion predicted at the location of the item itself, wherever that happened to be. I will come back to that.

MR. PICKEL: Do you plan to look at the effect of, say, the fact that non-nuclear plants may be built with more flexibility or greater damping characteristics?

MR. YANEV: The next proper step is to take a look at how we can hold the spectra we're using to account for the amplifications in the various structures that experience the earthquake. We have attempted to be here, so we did not deceive ourselves on a pilot basis, we attempted to be extremely conservative and limit our look to the ground motion and use only that as our experience data at this time, analyzing the structures.

And some of these structures would have amplified very significantly the motion. That is the next logical step.

MR. PICKEL: It could have gone the other way, also.

MR. YANEV: Yes. No assumptions were made there.

(Slide.)

The methods used in the pilot study were rather simple. We have the nuclear plant data, which is the analysis testing data, and we have what I call the data base plants or the experience plants data. What we wanted to do is to view the records in facilities which have experienced strong earthquakes, select some representative plants to examine in detail, select some equipment with these plants, and collect the necessary data to give us some comparison for nuclear equipment.

We did the same thing for the nuclear equipment. We reviewed the kinds of equipment from here that were applicable here, picked a few categories, concentrated on those. We selected them for nuclear plants, visited them -- most of our work was actually in the field -- to collect data, and we did some limited in situ testing in both the nuclear plants and the conventional plants, to collect the data in here and then compare all that together, in essence trying to say, here is a real life earthquake. The earthquake caused great motion that's required for that similar piece of equipment in, say, that Palisades plant.

It is the idea to come close and compare apples and apples as much as possible. Then in essence what we are saying, if you keep getting envelopes of the data for specific eastern plants, and we have a good indication for qualification, we really had a large choice to make here of equipment items.

(Slide.)

We tried to concentrate on where the more common items were in the nuclear plants and what people felt were the most sensitive items of the equipment that would suffer damage.

We used seven categories of classes of equipment. These would be: motor control centers, electrical 480-volt switch gear, 2.4 to 4 KV switch gear, the motor-operated valves, the valves and the operators, the air-operated valves, then horizontal and vertical pumps including the motors.

In total, we probably talked to in excess of 10,000 people in the field for the nuclear power plants to get a feeling for the comparisons. For photographing and testing in the field, we went to the Dresden 3 plant. It is an SEP plant which has a new SSE criteria, anchored to 0.2 g using regulatory guide spectra.

We also looked at Calvert Cliffs 1 and 2, concentrated on 1, Baltimore Gas & Electric, and the Pilgram plant. These have ground criteria based on the old Housner curves, so they are lower than the current criteria.

(Slide.)

We had rather large samples of earthquakes we could go back to and collect data and see what we could get. Here is the listing. You have a table of 15 various earthquakes, different magnitudes.

As I indicated before, we could go to Managua, we could go to some of the Japanese and Italian. As we first did the data survey, we determined to make a few visits to determine if we had enough data at this time to stay in southern California and have very strong earthquake and appropriate data.

So we limited ourselves to only a very small portion of the possibly available data. This would be as of a year and a half ago.

(Slide.)

I am trying to zero in on the process we went through and how the selection was made. We went through several facilities in a lot of detail. We looked at 14. Of those we selected even fewer for our testing and field collection of data.

In the San Fernando earthquake we found that there were a number of power plants and other electrical installations that experienced peak ground acceleration, again between about .2 and at least one-half of g. The Sylmar converter station, I'll discuss that.

We have in one case a record was taken of the Saugus substation. This is all the same earthquake, San Fernando Valley and the area around the hills.

The other area we looked at was at Point Magu. This collapsed a few brick buildings. It did not collapse any more, but we looked at that.

The Santa Barbara earthquake caused quite a lot of damage in Santa Barbara and the University of California campus. There was a substation, but the record instrument was right at the substation. A lot of electrical equipment; literally hundreds of the type of relays you see in power plants was instrumented, so we had the record right there again.

The Imperial Valley, this is the first earthquake the profession has really gone out and looked at. The Nuclear Regulatory Commission sent a team. We went back and tried to collect a lot of additional data to complement the NRC work. Again, there we have a good record.

Near the El Centra steam plant, perhaps 100 yards from the plant, half a g earthquake. In the vertical direction, this particular event had .8 g acceleration, 80 percent of gravity.

So it was asked earlier the question about records. It's possibly applicable everywhere in the world.

So this is where we had a choice for just southern California alone. To give you an idea of how that fits within the tectonic framework of California, the blue line is the coast, San Francisco Bay is up here, Los Angeles Basin is down here. The black line is the San Andreas Fault.

The San Fernando earthquake was here, in the northern end of the San Fernando Valley above Los Angeles. The Santa Barbara and Point Magu was in here, Santa Barbara was here, close to Los Angeles. The El Centro was down here on an Imperial fault which is a branch of the San Andreas fault.

We have data on others. We have looked at that. We know what happened. I'm not reporting that data because we did not do the detailed type of analysis we did for what I am reporting.

(Slide.)

First for the San Fernando event. Here's a rough sketch of the area. Downtown Los Angeles is here, this is the San Fernando Valley, this is the main trace of the fault that caused the earthquake. This is where the ground broke.

The blue dots indicate places where accelerometers were placed. We have very high quality strong motion data. This is primarily the data, a very great part of the data on which Reg Guide 1.60, the design spectra for nuclear power plants, is the record we're using.

There was a record of 1-1/4 g here. Typically these records are between .2 and .3 g at the outskirts of the valley.

The Holiday Inn is a famous case. A lot of studies were done after the earthquake. There were records, an array of records throughout the building. The ground acceleration was 27 percent g. What the profession did --

MR. WARD: It was what?

MR. YANEV: 27 percent, one component. I forget the vertical, 15, 20 percent.

What I am citing is the peaks of the three components. There's a directionality to the motion, but it's not 100 percent one, zero the other.

MR. CATTON: What about further out to the west? Would the two mountain ranges have --

MR. YANEV: There are records outside of what

I'm showing you.

MR. CATTON: I'm wondering if it would become more directional because of the valley floor on either side.

MR. YANEV: I don't know.

MR. CATTON: I have trouble imagining the Santa Monica Mountains doing much of anything.

MR. YANEV: That's an extension of the portion uplifted by the earthquake. In that case I have no idea.

MR. CATTON: I live a little bit, just about where the edge of that map is. I live right about in the middle.

MR. YANEV: There are evidently several people here that have been through it. One of the representatives of the utility went through it.

What we saw in the press -- what I went to photograph was the Sylmar converter station. This is where the equipment was damaged. This is the Sylmar station. This is the distance from the fault. The assumed acceleration, because we do not have a record right there, is at least a half a g. It's probably more like 75 percent.

We assume 50 percent. That's been accepted by the NRC unofficially in our correspondence.

There was a Rinaldi receiving station here, several other substations around. There was damage from the large transformers tipping over, breaking. This is well documented. We have it all.

We felt there was our data bank. We went there and while we were there we asked if there had been any power plants in the valley that experienced the earthquake. I have in my office about four or five feet of literature on the San Fernando earthquake and several hundred photographs.

In all of the literature there was one mention, a small paragraph, of a power plant going through the earthquake. Nothing happened, so they dismissed it. This was the USGS, Research Engineering Institute, everything. They all went there, they all looked at it. There was a power plant nobody really bothered to report on, except for LADWP, Los Angeles Department of Water and Power.

We looked at it. It turned out the Valley Steam Plant, four units, is located less than three miles from the fault. The estimated ground acceleration at that site is .4 g. The duration of the motion is 15 seconds, of the strong motion.

That would give us a much stronger type of a record than is used for the typical analysis and design of a nuclear plant east of the Rockies, much higher. That piqued our attention.

We found, going away from the fault, the Burbank plant, power plant, was located here, six or seven units lined up right next to each other from the 1940's to the 1970's. A lot of data. Thousands of pieces of equipment all together.

Well, from there we found out, the Glendale power plant. There's Glendale, another six units. They're small units, but these units sitting here -- now we're getting to about seven miles from the fault. The peak ground acceleration for similar ground conditions is .3 g.

To be consistent, we pulled away pretty far, all the way to Pasadena with a four-unit power plant -- these were not reported in the literature until now -- with .2 g. So suddenly we are looking at a transect in one direction away from the fault that gives the gradation of the ground motion of about 20 units, 17 or whatever it is units, power units. And we spent a lot of time and looked at the specific items of equipment that I mentioned.

We also survey i a lot of it. Someone today made a comment on batttery wrecks. I happen to have a slide of battery wrecks. I'll show you battery wrecks.

The point is, suddenly we have this wealth of data that for the first time we are addressing in some detail. What is important to point out is, the operators of the plants always keep logs of what is done in the plants. When they have an earthquake they have a log of that earthquake.

We have collected that data. It's in the reports. We know step by step, minute by minute, in some cases almost second by second, what happened to these facilities. We don't know all the details of the system performance, but we know what that system basically did, where they tripped, stayed on line, what was damaged, what wasn't damaged. We'll give you the highlights of that.

(Slide.)

The other earthquake is the El Centro event, the Imperial Valley with the El Centro plant that you have sent the team to. The power plant is located here. This is the fault, the Imperial Fault. It's part of the San Andreas system of faults.

Here are the scales, so we are talking about three miles from the fault. The peak ground equivalent SSE here is a half g horizontal, .8 g vertical at the plant. So I will be reporting today on that, too.

(Slide.)

The first and natural thing to do is to look at the spectral content of the earthquakes, what made up the ground motion and how can we reflect that to our plants, the nuclear plants. The way we design the plant is with response spectrum. We go back to the response spectrum from the real earthquake. What this shows is two of the better earthquakes we have.

On this side I am showing the three components. So this takes care of the directionality question. The north-south, this is a red line at the Sylmar Converter Station. This is a record taken nearby that we have transformed for that site at .5 g. It's not taken at the site. It's a good approximation on the conservative side of what happened. This is the north-south component, east-west, and the vertical.

This is the Dresden 3 three-field SSE. This is the definition.

When comparing exactly in this case apples with apples, the earthquake envelopes in its entire range of interest to us, maybe with a little exception here at the design basis earthquake for the current level SSE at .2 g.

This is the older design spectra. At Pilgram and Calvert Cliffs we have an envelope of a factor of several of the ground motion. In fact, at this point here we have a .5 g conservatively. This is about .12 g, I believe, so we have a factor of four right in here.

The majority of equipment lies in this range, from about let's say 10 hertz to here. So the majority of the equipment we're interested in is in this portion of the curve where the big envelope is, because equipment by its nature is rather stiff. So we're talking about very strong earthquakes.

It really doesn't matter which component in this case. They are both very high. One is higher than the other, yes.

Here is the El Centro plant again, with the El Centro earthquake compared to those three same design basis earthquakes for Dresden, Pilgrim and Calvert Cliffs. Again, we have a very high specdtrum and a large envelope above. So if one wanted to address later on the safety factors, there is some data to do that.

This is interesting here for the vertical direction. This is a .8 g. It really envelopes -- I don't have a vertical spectrum for Dresden shown.

(Slide.)

To give you a better perspective of what happened, yesterday I was able to Xerox at least a few of the -- I'll be talking about the Sylmar Converter

Station, what happened at Sylmar. This is what happened to the bridges around the Sylmar Converter Station. Almost all the bridges in the immediate vicinity of the station were collapsed. We in California learned a lot about seismic design from bridges in a hurry.

The Sylmar Converter Station, a lot of the equipment I'm concerned about is right here. I think this is the fence right here, just below (Indicating). So we are in the heart of the worst damage from the San Fernando earthquake.

MR. EBERSOLE: How do I know those aren't bad bridges?

MR. YANEV: They were obviously not good bridges.

MR. EBERSOLE: Below standards.

MR. YANEV: Cal-Tran is a very good agency. they did the best work in the country on bridges for earthquakes. Obviously, the design was inadequate for the earthquake, obviously.

We have learned a lot. We learned a lot from that earthquake. I think this is the object of my entire research. I am trying to see what we can learn from what we collected. We learned about bridges, so we went back and fixed them or are fixing them.

We have different criteria. We've been doing this for buildings for 50 years in California. I've been doing it for only 13, but we've been doing it. Every time there's a lesson, we go in. If it's successful, we often keep the criteria where it is, or maybe decrease it. We've done that, too.

The interesting thing about equipment to a large degree, the reason for the lack of interest in equipment is because it's actually done rather well except when it is not anchored. Otherwise we would have been chasing it and looking at it just for non-nuclear purposes alone.

We have been fixing elevators in California because elevators fail.

(Slide.)

Somebody brought up block walls. This is an illustration on block walls. This is a failure across from Sylmar. There was a liquefaction problem with the land there. It just wrecked a whole bunch of buildings. This is across from our equipment. In fact, the landslide hit against the Sylmar Converter Station and partially damaged the equipment itself. So we also had an impactive load, that nobody can probably determine, from this liquefaction at the site.

These are obviously not properly designed structures for the foundation failures.

(Slide.)

Okay, now we're going into Sylmar. Sylmar was the biggest nightmare ever faced by the Los Angeles Department of Water and Power. It was on the order of $30 million. That was worth $50 million before the quake. I'm not sure of the numbers, but this is approximate numbers.

We have transformers, capacitor racks, all over the ground. Most of the failures here occurred because either the equipment was not anchored or the bolts were too small for the loads it saw. Over here a lot of the equipment was supported on porcelain; it broke.

I have experience now with a very good structural design of steel supports of equipment. In the Sandii earthquake we had a 100 percent survival of the structural steel and you had a very high percentage of breakage of the porcelain. So that's another way you handle porcelain. Maybe we should hang it, maybe we should have isolation supports on it. There are different methodologies for different equipment.

We did not address this equipment at all. We know we have problems with porcelain.

(Slide.)

Going inside the Sylmar Converter Station, if you went after the earthquake you would have seen this. This is the control room with a suspended ceiling. The entire suspended ceiling fell, almost as a unit. It injured, I believe, a couple of operators.

The equipment we're interested in is right behind. In fact, the suspended ceiling, like this one, fell on the control equipment, a lot of it containing General Electric relays we find in power plants. I'm asking the question, what happened to those. That was the purpose of our study.

This station is crammed full of electrical control gear -- motor control switch gear, relays exactly the type you see in Dresden and probably in many others.

What did we learn there? We learned for this equipment -- this is probably the most important point I have to make. This is the cleaning up process here. They've removed this so you can see this equipment.

The same equipment is obviously anchored improperly. Inside the station, this is not heavy duty yard-type switching equipment or converting equipment.

(Slide.)

Most of the equipment was designed, was anchored to a criteria. I'll discuss that. A few items I left out: construction errors, oversight, forgetfulness, whatever.

Here was an unanchored switch gear. This was the 4 KV type, a very large aspect ratio, low center of gravity. It's not likely to tip over. It slipped. It was held back, probably by the cables. The cables probably held it back.

The gear itself was not damaged. It was functional after the earthquake. Obviously, the station was out.

Here are cabinets with terminal blocks and relays inside. They were not properly anchored. They jumped their support and moved. The best we can figure is the overhead cable trays and other connections, conduit connections, held them in place so they didn't tip over.

There were several spare cabinets stored in the basement on their side. Most of those fell over, giving you an idea of the forces involved. So there was some damage inside.

(Slide.)

The equipment itself inside. Again, I apologize. I have many, many good photographs of the equipment. This is the actual equipment. These pictures were taken last year. This is GE 40 volt switch gear, undamaged by the earthquake functionally.

We don't know what happened in the earthquake. We have not pursued that. We do know from the operators of the facility they turned on the switch later and the gear operated. There was no damage to the gear itself.

This is other 4 KV switch gear now, very typical. It's the same as in the Dresden plant. Half a g, maybe 75 percent g motion, with the spectrum you saw. There was no damage to the switch gear either. There were no loose relays, there were no broken plates, there were no broken bolts.

There were some Unitrol motor control centers. The building has three floors, so you have a big strong amplification. We have not evaluated that yet. But they're just tiered up the building. We can obviously get very strong amplified motion when we do that analysis.

An additional GE motor control center. This is the GE 7700. That's what you call the '57 Chevy of the industry. About the only plants I haven't seen it in is in Mexico, Germany and Japan.

This is what the equipment did. Now, that's a question I had a lot, as to why do we not see damage inside this equipment. Typically, if you have a relay like one of these, the relay may weigh, or the switch may weigh, from 2 pounds to 20 pounds.

If we just for our purpose assume 10 g's, which is an incredible force for an earthquake, 20 pounds at 10 g's is 200 pounds. You have two screws holding it. Say an eighth of an inch. Obviously, you have a very large safety factor. We should not expect the damage if you sat down and thought a little bit about the forces involved, what that equipment is built to take before you even consider an earthquake.

Again, the Los Angeles Department of Water and Power and California Edison have looked at every earthquake and they have been affected by quite a few. If they had massive failures of that equipment in past earthquakes, we can forget the nuclear industry. It would have pursued that to make sure that they were buying today was at least protected.

I made a presentation to both of them after my Japan trip, where I saw a lot of Japanese Toshiba large transformers. Southern California Edison had the same transformers in their yards in some of their conventional facilities. They immediately met with me to collect all the data from me they could, to find out what they could do about their equipment.

These are large investment items, like a half a million apiece. So we do have that concern in

California to do something about it, that we just don't let it happen again as much as we can.

(Slide.)

I would like to quickly go through a few slides to give you a perspective of some of the equipment I have with me. This is the El Centro plant that I talked about, four units, vintage from 1940-somewhere to 1968.

(Slide.)

Most of the equipment in here has never been changed. We went there to look at seismic, but we obviously have a lot of non-seismic data that we've raised questions on earlier today. Looking at that plant for a distance, one really could not see that there was an earthquake.

There were collapsed buildings new by, new buildings, one major new building. We analyzed that new building. We know why it collapsed.

There was some damage here also.

(Slide.)

This is the real eye-opener to me in California. This is the Valley Steam Plant. This is a four-unit power plant four miles from a very strong earthquake, three miles from some of the heaviest damage suffered in California since 1906.

This picture was taken last year. This is the way the plant was built. This is the way it looked during the earthquake, after the earthquake, and this is the way it looks today. Nothing substantial was done to the plant after the earthquake, because the damage was inconsequential to a large degree.

This is not the usual perception that people and most engineers engaged in seismic analysis have of what happens in facilities, and I'll talk about the criteria this was designed to.

MR. WARD: Are those steel stacks?

MR. YANEV: Concrete in this case. At El Centro I believe they were steel. This is the power plant that went to .4 g ground motion, sustained 15 seconds. It's about double the Dresden design basis. It is double almost all plants in the United States.

Obviously, the Los Angeles Department of Water and Power is doing something right outside the nuclear area.

(Slide.)

Here are the samples of equipment I'll be talking about. This is one of the units. You see pumps. You've got pumps lined up, dozens of them. Statistical samples? They have them. Nobody bothered to look because nothing happened.

These are typical motors. We have them in all plants. This is slightly older. This is vintage 1955. They have electrical connections like the ones you were talking about. At the time of the earthquake they were 16 years old, some of them were 40 years old in other plants.

We are testing this without looking at the real data.

(Slide.)

Here is an example of a 1952 40-volt switch gear. This is typical of the equipment you see in the nuclear plants. What's very interesting now, some of the comments were made earlier, the equipment was inside steel cubicles outside the plant. The inside ovens in Los Angeles, because temperatures were maybe 250, 300 degrees, you have a lot of data other than seismic.

(Slide.)

Here is a comparison to give you a visual representation. It's by no means a full representation. We have thousands of items. Here is the 7700 G motor control center. This is the '57 Chevy of the industry in conventional facilities. This is the Zion plant, not very different vintage from Sylmar, early seventies both.

The arrangement of the components, of the equipment, is different, but it's the same equipment for all practical purposes. The details are different, but it is the same hardware.

The same way down here. The Burbank power plant, the .3 g versus the equipment at Pilgrim. The paint is different, some details are different. It is the same Unitrol equipment.

(Slide.)

Here is the El Centro plant, the half a g. The earthquake is about four times the SSE for Pilgrim, same equipment. Additional from Glendale, from Dresden; same basic equipment.

The models in some cases vary, in some cases they're the same, depending on vintage again.

(Slide.)

Horizontal pumps. We looked at many of them. Here are typical examples. These are feedwater pumps. I think those were mentioned earlier today. Here's a Glendale feedwater pump.

There's only a few manufacturers of this: Gould, U.S. Pump, Worthington Pump, three or four. You see them all the time in California in the conventional plants. You see them at Dresden, everywhere else. Same pumps, different vintage.

This is a comparison of the two between

Glendale, Dresden, Burbank and Zion. Several of them wind up, so you have a statistical sample of the pumps, not just one. In fact, if you mixed the pictures together I wouldn't be able to tell which is which, except I would look for the seismic support in the nuclear plants. I could always tell that. Those are not seen in the other ones, as I've indicated.

Valves. Hundreds of valves in the conventional plants.

(Slide.)

These are air-operated valves, different configurations, every conceivable size pipe from a 1-1/2 inch line all the way to, we see the size of this valve, this is like a 14, 18-inch line. Here's a Burbank valve. Here is practically the same valve, the same valve at Calvert Cliffs. Here are a couple of ones. Take a look at the lines they're mounted to -- really flexible. You can go in there and move them several inches by hand.

This is El Centro, half a g earthquake. This is upping the structure now. This is Crystal River, a similar valve on a similar pipe size, whatever.

It's very interesting about the air-operated valves. That's probably the best example. You may have huge safety factors, because you see these all the way up the steel structures all the way to the top. They're pretty high structures. So I would expect we would have some sizable amplifications.

Then we have the flexible lines and we have the flexible valves, if they're flexible. So if we use nuclear-type analysis we can build what I consider to be incredible accelerations.

MR. EBERSOLE: Recalling the Rancho Seco case, do you recall that fluorescent tubes stay within their brackets, or does the whole shebang fall down on top of the operators?

MR. YANEV: I do not know the details of the Rancho Seco situation.

MR. EBERSOLE: It was one lightbulb. I'm talking about the fluorescent tubes plugged into the standard fluorescent fixtures.

MR. YANEV: I'm unaware of the fluorescent tubes coming out. There are many cases where the whole light fixture comes down if it's not properly anchored. I don't know about Rancho Seco.

MR. EBERSOLE: As I understand it, if it's properly anchored, the question comes in, do the tubes come down.

MR. YANEV: I could go back to a lot of plants and find out what happened. Generally in my experience, I have been to a lot of rooms that had the fixtures; the bulbs do not come out.

(Slide.)

And I couldn't resist it. This morning I was hearing about battery racks. I've seen at least 50 battery racks. Here's a half a g battery rack. They were 1969, 1979, and 1942, 27, 30-year old battery racks. They change the batteries every, is it, 15 years or so. I asked those questions -- not I; we did. We asked the question you were asking today about the connections.

They had rigid connections, they had flexible connections between the batteries. Some of them have spacers, some do not have spacers. None of them had damage when they were properly anchored and supported. I can show you a lot of pictures of battery racks that fell over because they were not anchored.

But when they had anchored battery racks, they had wood, they had steel, they had braced, they had unbraced, we had half a g, we had .4 g ground acceleration, and the racks did not fall, they did not explode.

Is the question, really the question to ask, does the test case necessarily simulate reality? That's another question I always ask.

MR. EBERSOLE: Were they connected to the rigid coupler bars?

MR. YANEV: Yes. In fact, most of them I believe were. We have a lot of photographs of that. I didn't happen to bring them with me. We did not concentrate on battery racks, or batteries, I should say, the whole system.

I would be more than pleased to come back and show you one or more thousand slides of various equipment, any time you want. I would also be pleased to tour you through some of these plants to show you the real equipment that was there during the earthquake. It's still there today.

MR. LIPINSKI: With each one of your slides you would have to have an appropriate number for the axis of acceleration. Just showing the slide --

MR. YANEV: I will now attempt in the rest of the discussion to address that question for you, to the degree of time we have at this time.

(Slide.)

The first question is, what was the criteria designed to. The first misconception is that in California we do earthquake protection to everything. We do not. We only put it where it's needed, and we often don't put it where it's needed, like the failures that we see.

But the criteria, what you will be seeing or have seen already, for steel structures, typically they're designed to .2 g static load by the UBC and no more. So some of the plants you will see we've designed with less, but this was the most, .2 g static.

Concrete structures, the current UBC code, what we examined was about 13 percent g alone static forces. If you want to equate this to an SSE you might cut it in half with equivalent SSE numbers.

Equipment anchorage, the most critical thing. We do nothing in California -- we did nothing at that time to protect the equipment itself other than anchorage. That's a very important point. There was nothing done to the equipment to protect it seismically other than you nail it down to the floor so it does not move and tear its lines out or tip over. That's all the criteria we have used, .2 g applied at the center of gravity of the equipment.

MR. WARD: You say that's roughly equivalent to a ten percent SSE? Is that what you said?

MR. YANEV: Yes, without amplification on the floors. This is equipment located throughout the building. We do it for everywhere.

MR. WARD: Because it's at the center of

gravity?

MR. YANEV: Yes, that's why we do the dynamic analysis in fact.

So again, .2 g static force for tipping over the equipment and horizontal displacement. No seismic protection at all of internal components, et cetera.

Piping that comes into it typically in California has had no seismic design criteria, zero seismic forces considered for the design of piping systems. In the plants you saw so far there was not a single failure of a pressurized pipe of any size.

MR. WARD: This program you're talking about has not really addressed piping. This is the first time you've talked about piping. That's of considerable interest, though.

Is there a parallel activity going on examining experience with piping, and structures, for that matter?

MR. YANEV: I am unaware of a similar activity in the United States. We are engaged in a similar activity outside the United States.

MR. WARD: You are?

MR. YANEV: Yes.

MR. WARD: There have been some reports, but they are not real comprehensive.

MR. YANEV: If you review our report in detail, you'll see that we did not specifically go to collect that data for the purposes of this work.

MR. PICKEL: Question. There is a school of thought that says that maybe the fact that you are designing these structures to lower limits may not be all bad, that by virtue of that if they see higher g loadings that there can be some yielding, some failure of structures, so there isn't attenuation of earthquake motion that gets to critical equipment.

In looking at these facilities did you see any of that? Would you expect any of that to occur?

MR. YANEV: You're asking me for a personal opinion and I'll give you a personal opinion. We have relied on analyses to give us all the answers and testing lately. We have not relied on experience, which is the point of this.

Experience tells us that flexibility is a desirable feature in many cases, many situations. Especially, if we have no failures when you have relatively flexible systems, why bother to introduce more unknowns if there is no failure of that equipment consistently?

The problems we have as analysts is our computer are --I'm being forced to design by the computer numbers. I have a difficult time justifying what I do as a designer based on analysis when I go in the field and see what happened.

That may be a somewhat circuitous answer, but --

MR. WARD: I think the point Tom raises is, how applicable is this experience that you're cataloguing, when you have piping systems and so forth that have flexible designs, when it's applied to nuclear plants, where designs are more rigid?

MR. YANEV: This is where the dynamics of the situation enter. We tested the equipment, compared the dynamics of the equipment to the plant. Half of our data base is very rigid connections. In those cases, in fact, the loads coming from the flexible piping and so on, from the pump, would be greater than you would expect on a nuclear power plant where the pipe is much more rigidly designed.

So you would have both cases. You would have much higher loads due to the flexibility, and lower loads due to the flexibility. We recognize this. This is why dynamic experience and experience with the analysis really helps.

MR. EBERSOLE: Let me ask you a question about -- we use air for control systems quite a bit. This is very often driven by silica gel or whatever, which normally sets under gravitational influence in cans of some sort. One can argue that this seismic event will levitate it and it will be lifted up in the air streams and run out and virtually instantaneously pollute certain critical equipment that's not designed to accept the silica gel or whatever.

Did you find any place where the air systems failed to function, where they had dryers?

MR. YANEV: We did not look at air systems for this purpose. We have records of everything that did fail. In one case we had -- I wish I had someone from the company here with me that looked at that in detail. It's in the report that you have.

There is one case where we had an air line break for some reason. The conventional plants were gold mines of air-operated equipment, because they are older.

MR. EBERSOLE: I didn't say the air line broke. I said it went out and caused a common injury.

MR. YANEV: I'm unaware of a case like that. I did not pursue the question to a great degree.

(Slide.)

Before I go to the specific equipment item I would like to tell you what the systems did. That's an interesting question. Before we ask to review each tree, let's review the forrest. This is the crux of what happened in this earthquake. This is based on interviews, and some of the people here from the staff were present during some of our questioning of the operators of these plants. These numbers are based on records we obtained from the plants. They're now in the public domain for you to review. There's more data we can collect when it's determined it is wise for us to do so.

(Slide.)

What I will show you is the following. Let's use the El Centro steam plant as our first example. I will list each plant in this. The El Centro plant is here, four units, vintage 48 1968. Half a g. Here are the megawatt sizes. The megawatts don't reflect the size of the structure necessarily.

The Valley steam plant in Los Angeles, four units, 1954-55 vintage, bigger units, .4g. The Burbank plant, you have two facilities there; a total of I gather 7 units. The vintage here is from the 1940s, World War II. I don't know if they had submarine batteries but they might have some used ones. 1940s through 1958. They have 7 units, 35 percent g.

The Glendale plant, further away now. We have 1941 through 1964. This is a good one to see vintage lined up. Pasadena, 4 units at 20 percent g. 1949 to 1955.

What I would like to summarize is how the system operated. In this column you will see the important damage. At Sylmar we had extensive multi-million dollar substation equipment damage. We had very little if any consequential damage inside the equipment that was of interest. For the 7 categories of equipment I will address very little, if any.

Obviously, the station lost power. The place, as we call it, went dead, so we don't know from operability what happened. We do know when we brought it back up what happened. Did it come online or not. The other things that can happen at a plant -- one is the plant goes completely dead. So in essence, you lose operability data. You can retrieve some of it back by what did not happen to the equipment in the plant, but you lose some data when the plant goes completely dead.

The next thing the plant can do that is better is to trip offline. We have a grid disturbance. This happened in Los Angeles. The frequency of entire grid series in Los Angeles dropped by a hertz, I believe. It took the plants off the grid and kept them on steam online for what they call hotel power, house power, for internal power. But then the plant remains operational.

The best thing that can happen is an entry in the log of the operator saying we had an earthquake and nothing happened. This is what happen if they remain on line. These are the three gross possibilities for the entire plant system. So the data here assume a half a g more. We have certain structural data. We can retrieve certain operability data. We didn't try to do it.

The next plant was the El Centro plant where you have four units. What is very interesting is there are some erroneous reports in the literature; two of the four plants were online at the time of the earthquake. One lost power completely and the plant itself went dead for whatever reasons. One of the units stayed online through a half g earthquake. It continued to operate through the half g earthquake. This is the entire system of the plant.

Let's go to the Valley plant. We had four units there, of which two were online at the time of the earthquake. Units 3 and 4 were online at the moment of the earthquake the plants operate. That's an interesting example. One unit tripped due to a relay, we believe, unit switchgear. It tripped the plant. That one went out; no lights.

They were so excited about the earthquake it took them half an hour, the operators, to find out Unit 3 was online during the earthquake after the earthquake and continued to operate through the earthquake. Half an hour after the earthquake they took the unit offline because they were concerned about damage to the unit that they had not looked at yet. So they took that unit offline and brought it back online later, both units.

The next one, going down the acceleration level, is Burbank where we have seven units, of which four were operating. Now we see an interesting picture at Burbank. What we see at Burbank is two units stayed online, tripped offline but stayed operating inside, and two of them stayed online and continued to supply power to the city during and after the earthquake.

This is 35 percent g ground acceleration. This is an SSE of 35 percent. There is no plant east of the Rockies that has this kind of a design basis to stay within the system operating and making steam .2g design. Finally, going to Glendale and Pasadena, we throw in an additional five units that were operating, three at 30 percent, two at 20 percent; they all remained online during the earthquake and after the earthquake; all of them.

Now what happened here was interesting. At Glendale they were getting power from Bonaville. Cheap winter hydropower. They were getting it from Sylmar. Sylmar cut off; L.A. lost power. There was a call to the City of Glendale. It was separate from the L.A. system to provide power. Glendale tied into the L.A. system; the big surge of power pulled the plant offline immediately. There was too much of a demand for power, the plant couldn't supply it so the protective relays took it back offline. We have the incidents that happened and activities of the operators that we have recorded to some good degree.

MR. WARD: I am surprised that of those stations that lost power -- were some of them able to restarted immediately without any --

MR. YANEV: Most restarted within a few minutes to a few hours. I think one plant took a couple of days. We have all the data in the report. I don't recall all of it now.

MR. WARD: You brought up one point that might be of interest, I guess, to the NRC. The behavior of the operating crew during an earthquake can be of interest. I wonder if there are any data on that.

MR. YANEV: One nice thing we found about utilities in southern California is that the longevity of the people on the jobs is very good.

MR. WARD: None of them have ever been killed in earthquakes?

MR. YANEV: At least half the operators at the time of the earthquake were still there. We had stories about people being locked up in the toilet who couldn't get out. Operators injured taking a shower in the morning, then running to the station and so on to see what happened.

MR. EBERSOLE: The vintage of your plant --

MR. WARD: I guess the point is is there any indication that operators were or were not able to take any critical actions with the plant immediately through the course of the earthquake or immediately after?

MR. YANEV: You have to understand earthquake motion. For the 15 seconds of earthquake motion close to the fault, they're pretty strong. In some earthquakes there are records where people cannot walk during an earthquake in California; they are on their seats trying to figure out what hit them and they can't get up. So those effects we can collect. We can interview individual operators to find out exactly what data there is. None of them were killed, as we said. None were seriously injured.

MR. CATTON: Didn't one of the operators at Sylmar just leave? It's rumored, but -- and would not return. And if I had lived in their --

MR. EBERSOLE: If I looked at that plant, the vintage, -- are you maybe not comparing a DC3 to a DC10?

MR. YANEV: No. It is not that different. It seems not that much difference between the equipment. It pretty much looks the same today.

MR. EBERSOLE: The same margin of performance?

MR. YANEV: I would hope with what we're doing now, we are adding seismic loads to our design considerations that presumably were not considered in the design of this equipment. So I'm assuming that what we're doing is increasing safety. The question this raises is, is it necessary; are we wasting our money, and I think there's a very good possibility for that.

MR. EBERSOLE: Was it covered with conservatism much more adequately in this case? How do you know?

MR. YANEV: I have not examined the issue that way.

MR. EBERSOLE: It seems to be in the area of cutting margins, as you get smarter you say you are able to cut them.

MR. CATTON: Regulation gives you something to avoid thinking.

(Slide.)

MR. YANEV: To give us a basis for comparing, we felt not only was it necessary to take pictures and data on the pieces of equipment that make up the equipment, but we decided to test pretty hefty numbers of these to develop the -- to give us a margin of how comfortable we felt in our comparison. We are extending it to bring in the critical parameter. What is the frequency, what is the motion.

What we did was test it, using the same procedure exactly. However accurate is the same procedure? We tested 200 items in the field. About half and half in the nuclear plants and similar equipment in the conventional plants. Just to give one example -- we have these in the report for each type of equipment. This happens to be the response frequencies of 480 volt motor control centers. These are the whole cabinets we tested. Each square on this graph represents one bank of cabinets. There may be many control centers in it, but it's one bank, one row of cabinets tied together.

This is a vertical scale of number of units we tested. The horizontal scale is a frequency of 2. If you fell between 15 and 18 hertz, here is one question:

How are the dynamics? Is the system similar dynamically? The nuclear equipment fell between 8 and 18 hertz. All the cabinets we tested. This is not to say they wouldn't fall outside. This is what we tested, the limited sample. We got exactly the same range as the conventional plant, meaning the dynamic behavior characteristic of the equipment is rather similar if you look at the gross dynamic properties of that structure. The same range.

We looked at the internals a little bit like that, too, and we found similar trends. We are comfortable in our belief that the vintage of the equipment we are looking at is very similar to early seventies and earlier vintage nuclear equipment of the type we examined.

MR. WARD: I bet the piping would be different.

MR. YANEV: The piping is different. The supports are similar.

(Slide.)

We did some statistical data collection. We didn't want a sample of one; we wanted a sample as big as possible within the limitations of the time we had. What I will do, I will show you two examples we have done for all the categories.

This is the motor control center. At the 50 percent ground acceleration, these are two facilities, Sylmar and El Centro. We found a total of 24 banks of motor control centers. They contained a total of 350 control starters. This is what you don't want to trip in an earthquake because it might trip a pump. You don't want to be online or do the opposite. So for a half g, this is the acceleration of the ground. This is not the amplified acceleration. A lot of that equipment is up in the structure, so I'm keeping just at that.

Exactly zero of these were damaged or were not functional after the earthquake. Don't forget, some of these continued to operate through the earthquake at a half a g. We have examples at El Centro.

The same way when we go down to .4 g, we bring in our data bank. We bring in the Valley plant, .4 g now. So we're adding 16 more cabinet banks at Valley, so now we have a total of 40 cabinet banks and 550 controller that survived .4g or more, just going down the line to build up the statistical sample. We wind up when you get to .35 a total of 650 major components, 800, 850.

So our data bank shows just about none of these were damaged in any way structurally by the earthquake. None. In other words, there was something about the way they were designed when they were anchored properly, so they didn't fall over.

It caused them to all survive structurally. Quite a few of them operated during the earthquake. Some tripped during the earthquake. We did that for every category.

I will show one more, which is the pumps, two more. Again, we have our ground acceleration levels and the cumulative distribution of data. This is horizontal pumps.

(Slide.)

We have pumps and motors and the piping attached to it and the coupling, et cetera. We actually have 250 horizontal pumps. We had about 160 vertical pumps of various sizes, small, large, typical sizes we see in a nuclear power plant. We did try to get a distribution of size. They have good distribution.

I think when you get to the very largest nuclear pumps, it's because of the megawatts involved, you have larger pumps. And we don't have data on some sites. Maybe we never will from these kind of plants.

No damage to any of it, the motors, the pumps. Now, the wiring in some of these motors is undoubtedly 30 or 40 years old on some of them. The data is in that motor.

MR. EBERSOLE: Were any of these vertical pumps the long pendant pumps with the bowl about 35 or

40 feet below?

MR. YANEV: They were very long. The data are still there, so we can look at that.

(Slide.)

Now here is the summary of the salient categories, not counting motors as being a category. They really should be there, too; eight, really. Here is each class of equipment, category of equipment.

Now, for electrical we have cabinets. In the cabinets we have the pieces of gear we're interested in, the major ones, the switch gear or the control. We separate the two columns. What we have is a total of 2555 pieces of equipment that we looked at. You can throw in another 300 or so cabinets.

So let's say we have 3,000 pieces of equipment. We documented of this equipment one failure, an air-operated valve in the El Centro plant was damaged. What happened in that case, the line was, I believe, a one and a half inch line, very flexible. You can move it several inches by hand. The valve operator was sticking straight up, the diaphragm about an inch away from a steel column. The steel column was dented, the diaphragm of the valve was dented, the yoke was sheered.

It was an impactive failure due to multiple impacts. So that is not an earthquake failure from an inertial standpoint. If the pipes were stiffer or the column was further, they wouldn't have had the damage.

Anyway, this I did not expect. I've seen a lot of damage from earthquakes. I've seen equipment damaged. Apparently it was usually unsupported or not supported properly, and unanchored. When the equipment was anchored to criteria of .2 g or whatever was done in those cases, maybe less, the failure rate was zero. We did not expect that.

That set us back at least two months. Now what do we do? We had promised the owners group that we would look at the critical parameters that control behavior in an earthquake. Well, apparently in earthquakes there are no critical parameters structurally to cause damage. The earthquakes are not strong enough, as we saw them here, the earthquakes we reviewed.

That was an eye-opener. We suspected we had a strong case. We did not know how strong it was until we collected the data.

As I have indicated, there is a lot more data out there. We can go and make sure that what we're saying extends to some big earthquakes like the Japanese, or some shorter events that would be more like eastern events, that are less strong than the ones we've been looking at.

I consistently find people who find this hard to believe. I did when I saw it, but this is the raw data, and that's the reason we have not done more in California.

Now, how far we should go here is a question --

MR. PICKEL: Have there been any similar studies made by other people in, for example, the petrochemical industry?

MR. YANEV: The petrochemical people have a different problem. Right now they're asking us for the data. They have had testing done on fractionating towers, the normal procedure we do in the nuclear industry. They have different problems. So they're worried about different things.

I have visited several petrochemical facilities in Japan, in Managua, in California -- not in California -- after the strong earthquakes, and I could have shown you a lot of pictures of that, too.

MR. PICKEL: Their experience is similar?

MR. YANEV: My experience with their facilities was the same. Managua was .4 g at the refinery. I have about a hundred slides of it. I made the report for the American engineering community on the performance of that facility. That is available. It is a U.S.-owned facility. It's Esso. You could go look at it easily.

It was designed in California. Dr. Housner was involved in that. It was retrofitted because it was involved in a previous earthquake.

(Slide.)

Okay, I gave you the big picture. Now, to show you how we compared a few individual items before we made our conclusions. We wanted to compare one pump to one pump, one motor control to one motor control, one valve to one valve.

We don't want to do that. What we want to do in this program is wind up with the conclusion that motors and pumps in combination, that combination does not warrant equipment qualification because the experience does not warrant the work. And our data indicates that the earthquake experience is very high. So that is our first goal.

We can show you individual cases, perhaps, one to one, one to one, how in fact we qualified using that data, because it isn't a shake table, it's the real shake table. I'm piling all this on top of each other. That's not the earthquake. Keep that in mind, please.

This is more credible data because it's the real data. We are not simulating. We have the mechanisms involved in the shake table that are not that accurate. This is the real time history.

MR. LIPINSKI: Do you have a data base to compare an item of equipment that came out of the shake table to draw the same conclusion?

MR. YANEV: We are proposing to do a limited study of that, yes, because that is also earthquake-like data. We have not done that at this stage.

MR. LIPINSKI: When you take the data on the shake table you get more complete data. Here you're using extrapolations and estimates to draw your conclusion.

MR. YANEV: That is correct, you get more complete data, but it is based on an analytical input.

MR. LIPINSKI: If you were Japanese would I get the same viewpoint, or are they still qualifying all their equipment individually for all their plants?

MR. YANEV: I would prefer to leave the Japanese out, because we're dealing with different size earthquakes there. What we're doing in California should be similar to what the Japanese do, but that's a different issue.

For one to one, we obviously would compare the equipment dimensions to be sure they're the same, test both items in the field to get a technique for dynamic testing, if the technique is not correct, at least it's consistent. So we're comparing the same thing, that we believe is very good. check the motion response data that we get in the field to be sure that it falls within the expected ranges for the type of equipment.

For the motor controls, they were between 8 and 18 hertz. We hope the random equipment we took falls in that range. Are we getting about what we expect? Yes, we were?

Check the flow response spectra for the nuclear equipment against the response spectrum we have from the earthquake. If the response spectrum envelopes the required spectrum for the nuclear equipment, we have a qualification case, we have an IEEE-344 case on our hands. It's not quite as controlled as we would like to by Wiley Labs, but the plant was running and it stayed running.

So there's a lot of credibility and we can select items to look at like that, and we did that. Here is an example of how we collected the data. The report has a lot of data. There are a couple hundred items like this. This is a typical data collection sheet with pictures behind it. You already saw some of it.

What happens? This happens to be what I picked. I picked Dresden Unit 3 just to show you, exactly the same for the earthquake. Okay, this is a 480 volt motor control center at 39-3 in Unit 3. Here are three floor spectra. We did that for the earthquake. We have the same spectra for the site where the equipment is, but we usually only have the ground structure.

In this case we picked out three frequencies. the components were inside here: here is the anchorage, tack welds to an embedded baseplate. We took this data and stuck it next to the same data for the conventional plant. This happens to be the Sylmar Converter Station. We have eight units, basically the same equipment as a nuclear unit.

That survived the earthquake. Here they are. We can match your equipment. For example, we have the directionality, facing northeast and southwest. Mr. Catton raises the question about directionality. What we do is orient them from our comparison so we can pick up the strong component with the cabinets.

The function is the control pumps. We control the pumps and valves for rectifier cooling. There are many such systems at Sylmar. This controls the various

Class 1 systems at Dresden. Cabinets, at Sylmar they were usually four cubicles wide. The specific arrangement of the starter unit varies from cabinet to cabinet.

In this case the cabinet is six cubicles wide, slightly wider, but the individual dimensions are the same. I forgot to mention they are both a GE 7700 line series. This happens to be a 1970 vintage; at Dresden it happens to be a 1971 vintage. There is no reason to believe that the manufacturer did anything different between the two years, but I personally did not check that.

The components, what we have here is primarily General Electric CR-106 magnetic contactor. This is the one we felt, if anything would have a tendency to trip, that would be it. We find that we have a CR-106 here. We have in this case another one, CR-105, but they are arranged differently.

Anchorage in this particular case, the bottom channel of the cabinet is tack welded to a baseplate embedded in the concrete. At Dresden the bottom channel is tack welded to an embedded baseplate, so the same thing. I'm sure the size of the welds were different. There were no failures.

Applicable response spectra. Here we took the

Pacomia dam. The range of interest, the response spectra about doubled, as I showed before at Sylmar versus Dresden, without amplification being considered for the conventional plants. In this case what we did was took the highest motor control center in the plant and compared it against the ground motion in Sylmar, and we still enveloped it from Sylmar. That's how strong the motion is, the highest in the nuclear versus the ground motion at Sylmar.

The frequency of equipment is 18 hertz with a margin on both sides.

MR. LIPINSKI: Let's go back to that. You showed us the spectra for Dresden 3 and the equipment was tested to the spectra?

Go back to the response spectra for Dresden. We do not know that the Dresden equipment would not stand up if it were to be tested to the spectra.

MR. YANEV: I'm pretty confident --

MR. SMITH: The spectrum that Peter showed you was the amplified flow response spectra as determined through the SEP program, which is a relatively recent spectra. That indicated what that piece of equipment would see, and that is how this program got started, because rather than going into detailed qualification efforts for all the electrical equipment within the plant, we said there has got to be a better way to get to that question than actually testing the equipment.

MR. LIPINSKI: So now we see a spectra that the equipment is supposed to survive, but now you have not shown me a spectra that envelopes the spectra. You are giving me words and I'm trying to draw a mental picture as to how that is supposed to lay on --

MR. YANEV: I'll give you a mental picture. I didn't show it up to keep things simple, but I'll go ahead and do it.

(Slide.)

This is the highest Dresden motor control center. It is the same manufacturer model, basically, as Sylmar. We did not have spectrum at the location of the motor control system. We took one 19 feet above it. The spectrum we have below has a very similar shape, but it's below. We were conservative.

So what we did is, we went 19 feet above the highest and took that spectra in the plant. We tested it, and our primary frequency is right here. This is where we're interested. We had some torsion, which we think we've not done all the analysis now --

MR. LIPINSKI: What are these curves? You lost me.

MR. YANEV: This is the response spectra gave to a test lab to test.

MR. LIPINSKI: At Dresden 3?

MR. YANEV: Yes. This is -- there are three curves on this one.

(Slide.)

The blue -- this is a vertical component, so please forget the blue line. These are the two horizontal spectra, the blue the two directions, versus Dresden. This is the frequency we're interested in right here. We have a factor of about --

MR. WARD: The blue are horizontal where?

MR. YANEV: Sylmar. 19 feet above the highest MCC at Dresden, so that would qualify --

MR. WARD: For the SSE at Dresden?

MR. YANEV: The reason I didn't want it is that's irrelevant.

MR. WARD: You don't have any equipment at Dresden?

MR. YANEV: I'm talking about MCC only.

MR. LIPINSKI: Why just the one frequency of the frequency spectra? I have a resonancy around 7 hertz and you're saying the motor control centers won't see that?

MR. YANEV: Yes, it does, but it does not respond to it. This is what it responds to. This is resonance right here. This is the one that's going to damage it if anything will. That is standard dynamic analysis.

MR. LIPINSKI: How have you concluded that with respect to that particular piece of equipment?

MR. YANEV: What we have concluded is, if we had taken the Dresden, the Dresden equipment is similar to the Sylmar equipment, the Sylmar equipment was exposed --

MR. LIPINSKI: Hold it. You have not tested this equipment. Therefore I don't know where you draw the conclusion about its resonance characteristics.

MR. SMITH: Excuse me. We did an in situ test of the motor control system to determine its resonance frequencies. We didn't go through a full shake table test. There was a test done to determine the frequencies.

MR. LIPINSKI: In situ? How'd you do that?

MR. YANEV: That is a straightforward procedure.

MR. LIPINSKI: That's the point I missed, as to why you're emphasizing that particular frequency. You didn't have test data to establish it.

MR. YANEV: I perhaps have not made myself clear. We have collected the critical dynamic data that we would get out of an analysis or a test of that equipment. We will need to know the resonance frequency of the equipment, because that is where your damage should occur. That is what we wanted to compare.

We know where the nuclear equipment item sits on the floor spectrum now. We had this wide spectrum from zero to 33 hertz to infinity. We need to know where it falls in the spectrum. That's what you do on the shake table.

We pinpoint the frequency. It happens to be about here. This is the area where we check our -- this is the test response spectrum, in essence, and this is the required response spectrum.

MR. LIPINSKI: And there are no harmonic relationships saying that if you determine 16 is critical half that frequency is not critical as well?

MR. YANEV: There are a variety of other harmonics that come into play. The bottom line is, that's what I'm interested in as an analyst and a test operator.

MR. LIPINSKI: If I look at 16, a harmonic of 16 is 8 and 8 where the peak is at.

MR. YANEV: Right, but that's not where the equipment is. This is a consistent test with the methodology we use for an IEEE 344. We're doing it the same except going through an earthquake and comparing it to a similar piece that is in a nuclear plant.

What I'm saying is, I feel very comfortable with the Dresden equipment sitting at Sylmar during the earthquake.

MR. WARD: But if you have some critical equipment at Dresden that has a resonant frequency of 4 or 5 hertz, you have to look to some other experience other than Sylmar to qualify that.

MR. YANEV: Not necessarily. This is not the amplified spectrum at Sylmar. If I jack this up through the building I may be off the scale on the blowup. But I didn't do that. I'm just using the ground. That's how strong the data is for the equipment we're looking at.

MR. CATTON: The equipment wasn't damaged. I'm sure if they wanted to they could go back and do it. They have equipment that was not damaged. So if they needed it, they would go back and do the analysis to show that it was higher.

MR. WARD: Yes.

MR. YANEV: We didn't do it because we felt this was a strong enough case, if I understand you properly. We did a lot of comparisons like that and we have a lot more data.

MR. CATTON: I had a lot of damage to my house.

MR. YANEV: The 1971 earthquake led me to write a book on homeowners. It was a best-seller in California shortly after, and for engineers, too.

(Slide.)

In fact, that's sort of my favorite topic. That is not where the business is in California, however.

What we'll do is very quickly run through some of the fine points. You have them in front of you. I won't bore you with the details. I will just touch the highlights of what we concluded from the limited data that we looked at. It is limited. We have a lot more we could look at if we found it necessary.

The goal is to develop -- the first goal I mentioned was to develop a historical data base on the performance of equipment. I think I've proven my case here. There's plenty of it. All we need to do is go collect it, and I'm sure we'll get plenty more in the future coming from California. I hope it comes from Los Angeles and not San Francisco, that's all.

(Slide.)

Goal two was to show that much of the equipment investigated which has experienced strong earthquakes is similar enough to nuclear power plant equipment to draw some good conclusions from it. We found -- and you can see that in our data, and we have a lot more data we have not published on other types of equipment -- that typically we have only a few major equipment manufacturers that produce the equipment. For example, for the electrical heavy gear we have Unitrol, ITE, you have Westinghouse, GE, Square-D.

A few of them, particularly Westinghouse and GE, supply most of the equipment. So it's kind of like the fault in California. We are dealing with the same equipment.

There is little observable difference in general between the measured dynamic response frequencies when we tested in nuclear plants and conventional plants. That is very easy and convenient to prove by reviewing the test reports, which have that data for the nuclear qualified equipment.

The implications of the limited amount of data we have is we are dealing with equipment that has the same dynamic characteristics, typically. The pumps have the same frequencies, roughly. The motor control centers have the same frequencies. The switch gear have the same frequency, the range.

What we have seen is there are no generic differences other than age between the equipment. They basically function in the same manner. A pump is a pump. There are about three or four different kinds of pumps defined in the plants and they are the same. The age is the only difference that we have seen.

So as a conclusion, certain types of mechanical and electrical equipment found in nuclear power plants are very different in configuration, function, manufacture, mounting and so on for nuclear plants.

For the battery racks, coming into the batteries, the most popular battery rack in California is Exite. It happens to be, as far as I know, the most popular one in nuclear power plants.

Goal three was to determine whether actual earthquake data was sufficient to conclude that seismic qualification of certain classes of equipment by conventional methods is not necessary on pumps, motors, motor control centers, switch gears, et cetera.

(Slide.)

Excluding some unanchored equipment and the one air-operated valve due to impact, on the data we used no failures were reported on any of the seven types of equipment. Our report has failures in certain things that we did not cover, like tanks, like heat exchangers, and so forth. There are some things that we haven't examined because we just picked the seven we picked.

With the possible exception of the eletrical relays, there is no evidence of malfunction of the reviewed equipment during the earthquakes. We did not pursue operability to the same degree we pursued structural. For one thing, we expected structural failures, which we did not get.

With the possible exception of electrical relays, the data indicates we don't know the reasons. We have one plant we know of at .2 g that was stripped, outside of our data base, by a relay that was replaced afterwards by Southern California Edison. The estimated ground response spectra from several California earthquakes and the conventional power plants enveloped by them envelope many of the floor response spectra in nuclear power plants, including the amplified spectra.

So we have very good equivalent test data. The most interesting finding is that the conventional plants continue to operate during and after the earthquake. Whenever the acceleration was about 30, 35 percent or less, they continue to operate. So there is a wealth of operability data.

So the general conclusion of our pilot is, there is a very strong indication that we are wasting our money carrying out the detailed seismic qualification of certain types of equipment. This is raw data. It's available for anyone else to review. Failure is not a common occurrence. The risk to failure is not anything like what we seem to be making out of it.

Again, I really want to stress, I was in a city with 10,000 casualties. I am not taking lightly what I'm saying. I have seen what happens to people when a building comes down on them, maybe hundreds at a time. And I am responsible in Silicon Valley.

The fourth goal was to develop a methodology to show on a one to one basis that we could use this data to show that in effect we are qualifying to an IEEE 344 criteria. That last example is an example of the methodology.

In other words, if we determine that certain classes of equipment do not require qualification, but certainly we have a lot of failures we might want to qualify, then we can use individual examples like this to qualify.

(Slide.)

After I am involved in a job I like to be able to summarize in a couple of sentences, just a simple conclusion to leave you with. There are two things we're concerned with in equipment and earthquakes: structural survival and operability. What our data indicates is very simple. It appears that earthquakes much stronger than eastern United States design earthquakes for nuclear power plants are incapable of causing structural damage to the type of equipment we reviewed when it is properly anchored.

It is also apparent that the operability of that equipment is not usually compromised at sites with an SSE of about .3, .35 g. Those are two kind of startling conclusions out of this.

That is the end of what I had prepared, and I would love to answer questions.

MR. EBERSOLE: Let's go to Diablo Canyon.

MR. YANEV: I was vice president of Lewis & Associates for several years. We have not attempted to apply the information to Diablo. This is not why we collected it. It obviously has implications for Diablo. I would rather not comment on that.

I am interested on plants east of the Rockies for this discussion.

MR. EBERSOLE: Thank you.

Let me remind everybody again about our schedule. I'm sure the participants have that in mind.

MR. LIPINSKI: On those cabinets you're showing the east-west, north-south excitations, what about the vertical?

MR. YANEV: I did not have --

MR. SMITH: We did not have a vertical response spectra for Dresden. The way we came up with the vertical was to use two-thirds of the horizontal.

MR. LIPINSKI: What about the response of the equipment? Generally these cabinets are in the vertical direction rather than the horizontal direction.

MR. YANEV: The motor control center we're looking at, it's not likely. The controller is supported as a cantilever against the diaphragm. We tested a lot of these. They were generally rather rigid.

So what we're going to do is pretty much put the static forces in. I understand your concern. We could address it. I will just give you an example.

MR. LIPINSKI: If we're going to draw conclusions, we have to look at this from all angles, the horizontal direction and vertical as well. I could have picked an example, I'm sorry I didn't, from the El Centro.

MR. YANEV: There were some similar switch gears there, I believe. A lot of what we did at the time was done because we felt this was what we had. We had better data later and that sort of thing.

MR. LIPINSKI: Somehow I'm not feeling too comfortable, because, given the requirement at Dresden and the envelope you have for your measured data, you show that you have covered the horizontal and the vertical motions and its envelope, then you can draw conclusions.

MR. SMITH: What we have done is we have run a pilot program. This program was not intended to cover all applications and to say conclusively that this is the answer, but rather to say, we have a methodology, we think that methodology will work, we think that we need additional information, we know we need additional information, and the data base needs to be expanded.

What we are demonstrating is that we think it can be done. Prior to this time nobody even attempted it. It is just a demonstration that this type of methodology will work.

MR. YANEV: In that specific case, if it is two-thirds then I suspect what I remember of the motion in the vertical direction is they should be about equal without any amplification to the structure. That's why I didn't bother with that too much.

If I went into structural amplification, it would really jump up. I'm comfortable with what I have. I could give additional data to prove my case, and I unfortunately picked not our best example.

MR. WARD: Do you get amplification in the vertical component in the structure typically?

MR. YANEV: Especially in that case, because this is a light steel structure which will probably be stiff in the vertical direction, but not nearly as stiff as a nuclear plant. So I would suspect I would get more amplification than I would get at a nuclear plant if I followed the same analytical procedure.

MR. CATTON: But neither one would be near the amplification of the horizontal, is that right?

MR. YANEV: Not usually, right.

MR. SMITH: Any other questions for Peter?

(No response.)

MR. SMITH: Being mindful of our schedule, I just have one slide to show. And I would like to offer once again, if you do not have a copy of our report -- we really have two reports. One is a very thin, about a 20-page report that summarizes all the work. Then the other one is a two-volume report that is about an inch and a half, two inches thick. And if you don't have them we'll see to it that you get them.

MR. WARD: We just got the first volume,

didn't we?

MR. CAPPUCCI: We got volume one, and doesn't Jesse have volume two?

MR. SMITH: Why don't I arrange to have the report sent over. The thin volume you can read and get the overview quickly. Then you can go to the bigger volumes to look at the details if you are interested.

The second thing, we'll make sure that Peter sends Mr. Catton his book on how a house is earthquake-proofed.

MR. CATTON: I just need to know what to do if my fireplace tore up the roof.

MR. CAPPUCCI: I would suggest you take the bricks down and put up some plywood.

MR. SMITH: As you know, you remember quite clearly what happened on that day in 1971 and what you were doing, and our operators apparently do, too. So if we wanted to go back and interview them, they were very good about what they were doing at the time that that earthquake hit. They were quite impressed with it.

MR. LIPINSKI: I'd like to refresh your memory. Within the last 15 years Chicago has been hit by two earthquakes. One of them cracked the ceiling in my home.

MR. SMITH: I live in Chicago.

MR. LIPINSKI: So do I.

MR. SMITH: I hate to say it, I don't remember either one of those earthquakes.

MR. LIPINSKI: One was centered in Rockford, Illinois, and the other came from the Missouri fault, in the Chicago area.

MR. SMITH: I'm not denying it. It may well have cracked your ceilings. It's just that I don't remember.

MR. YANEV: Commenting on that, in 1906 in San Francisco Caruso was standing in the same office, the Sheraton Palace Hotel. He was sleeping. He found himself flat on his seat, et cetera, unable to get up. This was in the fill area of the city, soft soils. The resonance of the structure, very strong motion on whatever floor he was up in the building.

Many people living in the hills at 5:00 o'clock in the morning where the earthquake occurred did not wake up from the earthquake, because in the rock it was perceived as a very different earthquake, perhaps similar to what you're describing here. There are a lot of differences in earthquakes. It is certainly something that we have to account for.

That's why we use the various curves. People perceive things differently in different locations, within a building, within a city, and within the area.

(Slide.)

MR. SMITH: I just want to make three basic points. The results of our pilot program surprised us. It indicates that the seismic problem for well-anchored power plant equipment in nuclear power plants is not the problem we thought it was when we went into this program.

As Peter said, he was going to come up and tell us what the critical parameters were and what we had to design for. And he said, hey, I don't got any. That came as a surprise to us.

So based on that result we are beginning to belie e at this point that the seismic issue is not the significant safety issue that it was perceived to be, that as a result of that, that if we continue on with this effort that we would be better off putting it in its proper perspective and spending our money on areas of higher safety significance.

This information is based on a relatively small sample of information. We aren't claiming today that this is the bottom line answer. But it is one of the first attempts to go out and look at how equipment has in fact performed during earthquakes, how it responds, and try to learn from the past and try to learn from that experience and attempt to fold it in to get more realistic treatment on the seismic area, rather than continuing to make the plants more stiff and more rigid and continuing to work on basically a theoretical level, trying to fold back in reality.

That is the real purpose of this program.

MR. EBERSOLE: I think if Dave Okrent was here he would take issue with you, because you are looking at the bottom end of the spectrum of earthquakes, not the real bit serious earthquakes.

MR. SMITH: If we had a real big serious earthquake we would be there looking at it.

MR. EBERSOLE: You mean on a probabilistic basis?

MR. YANEV: I have been to a 7-1/2 earthquake. They are not different, apparently. We have not done the detailed work here. I was in Japan a week after the earthquake. There was nothing there to point to very different conclusions.

MR. EBERSOLE: You have a program ongoing at very severe earthquakes, over and above this?

MR. YANEV: We did the best data we felt we could get without leaving California. Obviously, we can get other data. Magnitude is not the only thing you consider. It's the duration of the shaking, the acceleration of the shaking.

MR. EBERSOLE: Whatever.

MR. YANEV: The purposes of the data for an eastern earthquake, for most of the United States these earthquakes are stronger than what we're dealing with here. It is not a New Madrid earthquake, no. But it is a New Madrid earthquake if you get --

MR. SMITH: The purpose of the program was a pilot program to see whether it was a practical approach. If upon reaching this stage people say, yeah, that looks like a good idea, we endorse the idea, we think we should be going forward with the data collection in this effort, then the utilities would probably be willing to continue to support and fund this type of program.

But if everybody indicated that it was not a worthwhile program, that the information we were obtaining looked like it had no future, then of course we would stop the program. The scope was, we picked some earthquakes on a very localized area, because we could do it on a relatively expeditious basis. We recognized there were other large earthquakes around the world, and if we continued with the program we would in fact go and get that information.

MR. WARD: What is the status of the program now? Is this going to be evaluated? Has a decision been made to go ahead with an expanded program or not?

MR. SMITH: At this point, no. We have talked to the Staff about it. We brought it here so we could talk to you about it. In general, we are trying to get an idea of just where it is going.

Maybe Newt Anderson could give some idea from the Staff's point of view, but it's not a sure bet at this point that it will continue on.

MR. WARD: If the program is continued on, it seems to me that an analysis of the piping systems, the historical experience with the piping systems, would be very valuable. These have never been considered at all?

MR. SMITH: Not yet. This has basically been focused on equipment per se. We have not looked at piping systems. If we agree to expand the scope of work and to continue on, we are sure eventually to look at piping system systems and structures and everything else.

We are literally spending hundreds of millions of dollars per plant for seismic design. If we could bring it more back to reality, then we might be able to actually cut a lot of money out of the design and construction of the plant without jeopardizing anything in the way of safety, and in fact we may improve it because we will better understand the phenomenon.

MR. YANEV: I would like to make one comment along the same lines. I think good engineering involves analysis, it involves testing, it involves experience, and it involves judgment. In the earthquake area in nuclear, we have neglected experience, which is telling us a very different story from what analysis can tell us.

I would like to make our analysis backfit reality and not try to figure out how to make reality fit our analysis. This is really what we have to do, I believe.

MR. PICKEL: I guess I'd like to make a statement at this time. I think that this is a very important study. It shows, I think, that in the first place there is a lot of useful experience information that we need to make use of. It gives, I think, a very optimistic position with regard to what we may be able to do.

I think that there are a number of things it needs to be extended to, and I agree the piping area is one of them. I believe, though, that the statement of conclusions are too strong for the fact that you have in your own words a pilot study, limited data, a limited look. And to make those sweeping conclusions you may do it a disservice.

I guess I feel like it is something that needs to be used, but you need to evaluate your results at this time with some caution.

MR. EBERSOLE: Because of the data base.

MR. PICKEL: Because of the data base.

MR. SMITH: That's why we've always couched it, the conclusions are based on the pilot program and that's a limited set. We are not saying that all-conclusively. That is why the statement does in fact refer back to the pilot study, which we feel downgrades -- the sweeping conclusions are based on a limited set of data, but that limited set of data surprised us significantly because of almost the total lack of failures, and that in fact surprised us.

MR. YANEV: Mr. Pickel, you're also referring to the report. I think in the euphoria of completing the study we made the conclusions too strong. We have softened them in the handout you've gotten today. We've had a few months to think about it, also.

MR. CATTON: Having been there when that earthquake occurred, and the fact that they are applying it only to eastern power plants, there was a great deal of damage. That was one hell of a jolt. And if that

Sylmar plant, which was right next to the dam that failed, if the equipment survived I would have no problems with that equipment any more in the East.

MR. SMITH: That's what came as a surprise to us, the equipment inside.

MR. CATTON: I was there very quickly, because I had friends responsible for civil control in the area, and the switchyard was just devastated. It was like they dropped a bomb on it. The important equipment within that mass survived? I'm really surprised.

MR. SMITH: Like I said, we were very surprised also.

MR. YANEV: Sylmar was the eye-opener. You have a mangled yard and there's this equipment inside that by our analysis I could not show it survived. Yet, by looking at it nothing happened to it.

MR. CATTON: The bigger problem is really in the structural area.

MR. SMITH: Any other questions?

(No response.)

MR. EBERSOLE: Let me suggest we have a ten-minute break and contemplate how we're going to finish the rest of the session.

(Recess.)

MR. EBERSOLE: Gentlemen, let's return to the meeting.

Let me point out, we have under item 4, topic A, 30 minutes; topic B, 10. We have bypassed for the moment topic C, and then another 45 -- about an hour and a half or thereabouts.

Let me ask you to consolidate your presentations as best you can for the rest of the day, and we'll try to cut the questions. If we can go into the topic 4.A, please. Mr. Chang.

MR. CHANG: My name is T.Y. Chang. I'm with the Generic Issues Branch of the Division of Safety Technology, NRR. I am the task manager of unresolved safety issue A-46.

(Slide.)

The title of this unresolved safety issue is seismic qualification of equipment in operating plants. As the background, we know that the seismic qualification went through a lot of changes in the last ten years or so, both in the criteria and methods. The first standard that came out, being used widely by the industry for the seismic qualification of equipment, is IEEE-344. That came out in 1971.

Then in 1975 there was another revision of that standard that came out, and the update of this IEEE-3444 is quite extensive. The 1971 version in fact says that you can qualify it by using single axis and single frequency tests. The '75 version recommends the use of multi-axis and multi-frequency tests. You can use single frequency and single axis tests only if justifiable.

Recognizing that, then we can conclude that the equipment in the present existing plants, the seismic qualification of those equipment, the safety margin may vary a lot. That problem was recognized by the NRC and was designated as an unresolved safety issue in December 1980.

It is recognized that for those operating plants we should go back and reassess the qualification of the equipment in those existing plants. We have to ensure that both the structural integrity and the operability for those plants is in place. So in other words, structural integrity is addressed by resistance to seismically induced loads and operability is addressed by the performance of the safety functions.

To face this issue, it seems impractical to utilize the current seismic qualification method or criteria, trying to qualify the equipment, the existing equipment in the operating plants, even if someone is willing to go through all the tests on the equipment he may not be able to do so.

The first thing is that you may not be able to get similar identical equipment to test in the test lab. If you want to take the equipment out of the operating plant and try to test that, then you have down time, and that is very costly. If you want to ship the irradiated equipment to the lab, then that is very dangerous, too.

So we realize that some other means has to be thought up to tackle this problem.

(Slide.)

The objectives of this USI A-46 are the following. The first thing is trying to identify the seismic risk-sensitive equipment and systems in any operating plants. We do not want to impose a burden on all the utilities that they have to qualify every piece of equipment, even though it is not safety-related or if it is seismically hard. So we only want to concentrate on the seismic risk-sensitive systems and equipment, if we can.

The second objective is, once you have this list, then we go in there and try to assess the adequacy of the existing equipment in terms of seismic qualification. So this is already on a narrowed down list, that we try to assess the adequacy.

The third thing is, realizing that it is impractical to use the current qualification method and criteria, then we have to find alternative methods to qualify the equipment in the existing plants. If we find from this effort it is not seisically adequate, then, lastly, we have to develop seismic criteria for the alternative methods.

(Slide.)

In order to address the four objectives we mentioned, we try to address all the problems by five tasks. Number six is the documentation of the above five tasks.

The first task is to develop a minimum equipment list to be qualified. This is related to objective one.

The second task is trying to survey the existing seismic qualification methods and try to compare the older methods against the current methods and criteria, and trying to see how much credit we can give the older methods.

The third task is trying to develop methods of in situ testing to help to qualify equipment in the existing plants. Realizing that qualifying equipment in the lab for the existing plants is not practical, this is one experimental method that can give us some data by not going into the lab.

Task number four is related to the presentation we just heard, that is, trying to utilize the seismic qualification utilities group and their efforts.

Task number five is trying to develop guidelines for generic response spectra for any equipment in an existing nuclear power plant, because it is not practical to try to develop response spectra by using a full-fledged analysis, by going into the finite element model and the time history analysis. So we are hoping that there is some way we can construct generic response spectra for different floor levels for existing nuclear plants.

(Slide.)

Now, I talk about a status for each task. Task one is trying to develop the guidelines for generating minimum equipment list. This task is contracted to the Brookhaven National Lab. We received a draft report from them back in December of last year and the draft report was reviewed by the Staff. The following are the conclusions.

First, the minimum equipment lists obtained by their methods are highly plant and site-specific. What they did is to use some kind of PRA approach, using WASH-1400 logic, and then of course they added the external event of seismic loading. What the study established is a seismic PRA methodology that could be used to identify seismic risk sensitike equipment and systems.

Originally we were hoping that we could get something generic, but it turns out that this approach is highly plant-specific and site-specific.

The third conclusion we have is that we are -- we realize that there are several, actually I think five or so, existing plants that they are in the process of performing a PRA study, and by next year about 26 or so existing plants will have their PRA results. So, realizing that, the Staff is recommending to use the PRA as an option for utilities to arrive at the minimum equipment list.

We are not saying that this mandates that they have to use this method, but this is offered as an option.

Also, at the same time the Staff is considering other means of developing this minimum equipment list. One possible way is by using the failure mode and effects analysis.

(Slide.)

The second task is trying to compare existing seismic qualification methods. This task is contracted to Southwest Research Institute, and Research is taking the lead on this contract. The purpose of the contract is to survey qualification methods used in operating plants, compared with current requirements, and try to determine the importance of differences between the older methods and the current methods, and try to recommend acceptability of qualification methods used in the older plants. In other words, how much credit we can give the plants that are qualified to the older criteria and methods.

We received some partial reports back in October of last year and February of this year. The final report on this study will be coming in in March. According to what I have heard from Bill Campbell, we should be getting this final report any time now.

One point I would like to make is that this is part of the research program concerning seismic qualification. This is the portion that we think is useful for A-46. That is why we are trying to incorporate the result of their study in this task.

(Slide.)

Task number three is trying to address the in situ testing method. We are trying to find out the extent to which it can be used in existing equipment qualification in the current operating plants. We received a draft report of the study early this year. This study is being done by Idaho National Lab.

What the report tells us is that by using the in situ test it is a feasible method to assist equipment qualification in existing plants. However, the requirements and criteria for conducting the in situ tests will be coming shortly. We foresee it will come in April of '83.

Our conclusion in reviewing the report is that in situ tests by itself alone, we do not believe it can be used as an equipment qualification method. This is by virtue of the seismic -- the dynamic input level you can impart on the equipment. This in situ test by definition is a low level test, so there is no way you can excite equipment to the SSE level by using this kind of method.

MR. CATTON: When you say "in situ" --

MR. CHANG: The in situ impedance test.

MR. CATTON: That's not the California earthquake test?

MR. CHANG: No.

MR. CATTON: That's an in situ test.

MR. CHANG: Like using the shaker or the hammer to impact the equipment and trying to find out the response of the equipment. In that way we try to establish the dynamic characteristic of it.

MR. CATTON: Are you going to give us the Staff view of what we heard just a few moments ago?

MR. CHANG: Yes.

On the SQUG study, that is another quantification of our effort. Even though situ tests, as I mentioned, it is not feasible to qualify equipment by itself, however, we believe that in situ tests can be used to establish equipment dynamic characteristics, and this is an important factor in trying to establish similarities between equipment in the nuclear plant and equipment in the non-nuclear plant.

If we try to utilize the experience data base, then this is a very useful tool to establish in the laboratory with this equipment. We also believe that the in situ test method is useful to minimize analysis effort to generate RRS by determining dynamic characteristics yes.

They are proposing some way to utilize the mode, shapes and natural frequency obtained by using the in situ test in order to construct response spectra at the support point of the equipment. Normally what you would do is try to use the finite element method and try to go through a time history analysis to find a response spectrum at the level of interest, at the location of interest.

But by using in situ tests, if you have the knowledge of the mode, mode, shape, mode, natural frequency, then there is a way that you can generate our estimate not by using the finite element model.

(Slide.)

Okay. Task number four will address how we utilize the experience data base. This task was contracted to the Lawrence Livermore Lab. Their function is to try to study the feasibility of using this experience data.

We received their report and the feasibility is established by their report. Also, we reviewed the SQUG pilot program report last year and we have some comments on this report, on their approach.

MR. WARD: I know what the SQUG report says or what it's trying to say, but what does the Lawrence Livermore study show?

MR. CHANG: What Lawrence Livermore did, they categorized the concerns in 38 different categories, such as fragility, seismicity, and all those, and tried to attach an importance to each issue, reviewing the current criteria and reviewing the experience data. In other words, when they looked at the current criteria of IEEE 344 1975, they tried to attach the significance of those concerns being addressed by the current criteria from a level range of zero to five.

If they think fragility is addressed adequately in the current criteria, they may give it a number five, and so forth. Then at the end they tallied the total number from 30 concerns, and similarly they did the same thing for the experience data base method. They compared the total number, and it turns out they are very close, 55, 56. Both are around the same number.

So based on that they concluded that using the experience data base method is a feasible way because it addresses -- most of the concerns are addressed by the same weight compared to the current criteria. That is the kind of a study they did. It is a different approach compared to the SQUG feasibility study, but arrives at the same conclusion.

MR. WARD: It sounds more like it has arrived at the conclusion that a SQUG-type study has some validity.

MR. CHANG: That is the conclusion.

MR. WARD: That it has not been a parallel effort.

MR. CHANG: No, it's a separate study. But it is an independent confirmation by using a different approach.

Granted, the SQUG effort is a pilot program, the data base they have collected so far is limited. But based on what they have so far, it seems to be a feasible method.

Our comments on the SQUG efforts are the following. We believe that using experience data is probably the most viable alternative to using the current seismic qualification method. We, meaning the contractor and the Staff, have been following SQUG's work very carefully and will be following their work, will be continuing to follow their work closely.

MR. WARD: Is the NRC sharing in the funding of that work?

MR. CHANG: No. This is a separate effort on their part. The NRC is funding the effort of the work done by Lawrence Livermore.

MR. WARD: Yes.

MR. CHANG: The first thing is, we believe that for any seismic qualification anchorage has to be addressed. Adequate anchorage must be proved first.

This will be the first step.

Secondly, based upon the pilot program, the earthquake they have looked into, there are six earthquakes they have used to collect extensive data. Five are from the 1971 San Fernando earthquake and one is from the 1979 Imperial Valley earthquake. So all the data are collected from two earthquakes only.

It is recognized that different types of earthquakes may have different effects on some specific types of equipment. So we think that they should broaden their data base by including at least three separate and distinct earthquake histories for each group of similar equipment.

Also, the duration of the earthquake, the amplitude, and the frequency content should be varied in generating response spectra.

MR. EBERSOLE: May I ask a question? We are attempting to focus on the nuclear plant itself, and then the machine within it, and then the subassemblies within that. One aspect of earthquake potential that I have not heard much about which is a distinct problem with the nuclear business is the indirect effect on nuclear plants as a result of dam failures. Many of the plants are below substantial dams. I for one have not heard much of the equivalent discussion on details of ascertaining how reliable a dam is or is not in the same context we're looking at the nuclear plant. Yet the effect can be enormous.

For instance --

MR. CHANG: You are addressing a new field effect?

MR. EBERSOLE: Yes. This has not been addressed to dams very much.

MR. CATTON: It will benefit at 100 yards.

MR. CHANG: Not that I understand.

We have looked at in the case of boiling water reactors the hydrodynamic load effect. That is in a frequency range quite different from earthquake loading. In trying to qualify the NTOL plants, near-term operating license plants, that is considered in the qualification of equipment.

MR. EBERSOLE: I don't think you're listening to what I said. I'm looking at hydroelectric projects that are above the reactor plant and pose a threat to them as a result of dam failure due to seismic influence.

MR. CHANG: That would be similar to what you would get from a boiling water reactor, hydrodynamic loading effect. You are meeting a different frequency content from earthquake excitation.

MR. CATTON: I don't think you understand my question.

MR. EBERSOLE: If we take the Clinch River breeder --

MR. WARD: It's going to flood the reactor.

MR. EBERSOLE: The impact of the seismic effect is to overflow the reactor, to flood it.

MR. ANDERSON: Dr. Ebersole, I would like to address that. I'm Newton Anderson, NRC Staff.

We have a large crew of hydrologists who are concerned about the effects of all natural phenomena on dam sites, and from that consideration they developed the maximum probable flood.

I have not seen anything specifically with regard to an earthquake, regarding a dam, for instance, where it failed and put water in a power plant. However, I know that they do make those considerations. We have not considered it at all in this study.

MR. EBERSOLE: Okay, thank you.

(Slide.)

MR. CHANG: Comment number four we have on their study is that the definition of similarities needs to be refined. By "similarity" we do not mean you have to compare equipment by a common serial number, number by number. What we mean by "similarity" is that pieces of equipment are similar if they have similar dynamic characteristics, meaning that they have a similar mass distribution, a similar size, material configuration, and the same type of anchorage and the same type of restraints. That's what we mean by "similar."

If you can prove that, then we call the two pieces of equipment dynamically similar. Also, another aspect that should be addressed in similarity is the safety function of the two pieces of equipment should be similar.

MR. CATTON: Why does that have to be, if it's the same equipment? What does it matter what its function was as far as your test was concerned, the California earthquake versus something else?

MR. ANDERSON: Let me --

MR. CATTON: I think number four is very important, the similarity, because the model changes and whatever, they won't change the model number, but they decide, gee, they built it good enough, they're going to reduce something inside it.

MR. ANDERSON: We are concerned about the operability aspects in similarity, because we do not know what the requirements for functioning equipment in the data base plants were. In many cases we do not know whether it performed any function at all.

What we are concerned about in using this data base for nuclear plants is that the systems, many of them are required to function during the event or immediately following the event. We think we need to establish that we have a piece of equipment in a nuclear plant that has to perform some function immediately, where it would still be subjected to the strong motion, and we would like to know that the data base covers that mode of operation.

MR. CHANG: To address your question differently, we can look at the definition of equipment qualification, seismic qualification. It has to cover two aspects: One is the structural integrity, the other is functional capability or operability. So we want to establish that also.

MR. CATTON: I understand the reason. What I was concerned about is that you were going to point to a plant somewhere in California and say, gee, that piece of data doesn't count because it's not a nuclear plant or because it was not functional in some way or another that's really not relevant. I'd hate to see you throw out some data.

MR. CHANG: They should try to collect data on operability as well.

MR. CATTON: I'm sure it's nice if you've got that as well, but I would not want to see you throw out data just because a piece of equipment was in standby. You could look at it and see if it worked before and after and you could make sure it worked during. That's important.

MR. CHANG: When we reviewed that report, we noticed that some switch gear in the motor operating center that they opened during the earthquake. We want to make sure that the opening is not spurious. In other words, if it's in a nuclear power plant this may affect the safety function of the equipment itself.

MR. CATTON: If the earthquake causes it to do something it shouldn't, then to me that piece of equipment has failed the California test.

MR. CHANG: So far what the report tells us is, they concentrated on the response of the equipment, whether the anchor failed or not or whether the equipment is in tact or not. But the operability aspect is really not covered adequately, in our opinion.

MR. CATTON: Okay, I understand.

MR. EBERSOLE: Before we get too far away from my remark about the dam failure, I don't think there are many plants in the country whose safety is contingent on the preservation of the hydroelectric dams which are above them, and there are a few. I can remember some at

Duke Power. I don't know of any in TVA. I don't know of any others.

But in that small set, it seems to me that it would be appropriate that we examine in intensive detail and structure the current arguments about the infallibility of the dams, just as we are looking at the fine structure of the nuclear plants, because if the basis for dam integrity is in fact marginal then of course the safety of the whole plant is involved.

MR. CHANG: Yes.

Number six is the margin and fragility should be addressed in their study.

Number seven is, they used low level in situ tests in comparing equipment in the nuclear power plant and the non-nuclear power plant, trying to establish similarities. However, we believe that the in situ tests should be validated according to task three requirements. Task three, as I mentioned earlier, is related to in situ tests.

The final point is that we believe that they have collected so far just non-nuclear plants. We realize that there is a lot of information from the test lab when we try to qualify equipment in the current nuclear power plants, and we have all kinds of tests being done in the test labs trying to qualify them.

Because if you use the current criteria only a very limited amount of equipment can be qualified by analysis. The recommendation is to use in situ tests to qualify equipment.

So there is a wealth of information in the test labs regarding equipment being used inside nuclear power plants. So we urge them to try to pool the lab test data also to augment the non-nuclear experience data base.

(Slide.)

Task number five is trying to establish means to generate generic response spectra for an existing nuclear power plant's equipment. This is more or less like using experience information trying to envelope response spectra and by doing so hopefully that it can be applicable for a spectrum of nuclear power plants such that they do not have to go through the finite element and the time history analysis to generate the generate spectra.

We have received a draft report on this study. This study, by the way, is being done by Brookhaven National Lab also.

So far we have obtained proposed generic response spectra in the horizontal direction only. But the nuclear industry has been using an approach similar to this. We believe this approach is feasible.

MR. WARD: So that would be something parallel to the ground motion spectra that are used now, is that it? The general envelop for ground motion?

MR. CHANG: This is trying to generate the response spectrum for a piece of equipment in the existing nuclear power plants, okay.

MR. WARD: Yes.

MR. CHANG: Then you have to compare this with experience data. If this is enveloped by the experience data, we can say this equipment is qualified. We are trying to generate the loading that a piece of equipment will see in a nuclear power plant, an operating power plant.

Normally you would go through the finite element analysis and the time history study to prove the equipment has different responses throughout the plant, but we're hoping there is some kind of generic method to generate response spectra by not going into such sophisticated analysis and yet still be conservative.

MR. CATTON: Are plants like San Onofre or Diablo Canyon instrumented with seismometers or accelerometers?

MR. ANDERSON: Yes.

MR. CATTON: Are all the floors and so forth?

MR. ANDERSON: No.

MR. CATTON: Gee, we get enough earthquakes in California that you get your data in no time.

MR. CHANG: Yes.

(Laughter.)

(Slide.)

MR. CHANG: Let me show this first. I want to emphasize that we believe that by using the experience data base, it is the most viable way to qualify equipment in the existing operating plants. So our effort really is geared to this kind of approach.

This is a flow chart that we envision the alternative seismic qualification will be done by to qualify equipment in operating plants. The starting point is, we assume we have arrived at a list of minimum equipment. This is the starting point, so you do not have to start with the whole Q list.

Also, we assume here we have done the in situ test already, so we have that information from the in situ test. On the other hand, you have the experience data base coming in.

When you have those three pieces of information, the next is trying to compare the minimum equipment list with the data base list and trying to establish similarities by using the in situ test information.

MR. WARD: How has the minimum equipment list been established?

MR. CHANG: This is related to the task one activity. We are hoping that -- there are several ways to arrive at this list. One is being done by Brookhaven National Lab by using the PRA study, trying to consider the significance of equipment or systems together with the seismic hardness to arrive at the reduced list.

MR. WARD: Okay. I missed that in the first part of your presentation. Thank you.

MR. CHANG: So at this step you try to establish the similarity between a piece of equipment in the nuclear power plant and a piece of equipment from the data base or from the experience data base. But that is not the end of the qualification. Even if the similarity is established, however, if the loading does not envelope the experience data base we next have to come to compare the RRS for the piece of equipment in the nuclear plant with the experience data base spectra.

At this point you need to generate the RRS -- RRS meaning required response spectra -- for the piece of equipment in the nuclear power plant. There are several ways of doing it.

One way is, as I mentioned earlier, the in situ test offers a way of generating the response spectra. Or if we used the result of task five, if we can generate that generic response spectra at that location. Of course, there is always the alternative that if they want to go through the analysis to arrive at the site floor response spectra by doing a finite element in time history analysis, that is a way they can pick and choose also.

So there are a number of ways to arrive at the required response spectra for a piece of equipment in the nuclear power plants. Then you have to compare this with the experience spectra from the data base bank, and if the data base spectra envelopes the response spectra then you can say, yes, this piece of equipment is qualified.

If not, then there are several ways to qualify the equipment. Those are the possible ways:

One is trying to modify the equipment in order to provide similarity with the equipment from the experience data base. You may try to put on some restraint, beef it up, try to improve the dynamic characteristic of the equipment, in order to establish similarities with the piece of equipment in the data bank. Or you may decide to replace the piece that is already qualified.

Another method that is possible is trying to compare the qualification method for that piece of equipment with that of the older days. Then in task number two we will have some light shed on how much credibility we can give the older qualification methods.

So this is how we see it from the Staff's point of view, that equipment in operating plants can be qualified.

MR. EBERSOLE: Any questions?

(No response.)

MR. CHANG: Finally, there are some dates that this A-46 is tied to. We are to develop the position of the Staff by June of this year. It has to go through CRGR review by August of this year, then will come to public comment in September, then again, after the comment is incorporated in the final guidelines in the report, they have to go through approval by the CRGR again by March of next year, and the final issuance of the guidelines and requirements will be by April of 1984.

MR. LIPINSKI: I have a question. Earlier we heard about qualifying specific pieces of hardware. What about cable trays? That's one you list, but we didn't hear anything about them. How are they being handled?

MR. CHANG: Currently we are not going to include cable trays in the equipment qualification program in A-46. The scope of this A-46 is limited to mechanical and electrical equipment.

MR. LIPINSKI: Cable trays aren't electrical equipment? Where do they fall?

MR. CHANG: We are concentrating on active equipment.

MR. LIPINSKI: It doesn't do you any good for all these cabinets to survive and have all the cables come down.

MR. CHANG: It will be looked at, but this is not within the scope of this study. So with piping. Piping is not considered as equipment. Even in the current plant qualification, piping does not fall within the equipment qualification realm.

MR. LIPINSKI: If you walk into a cable spreading room and visualize that all that cabling comes down and rips itself loose, what do you have left?

MR. CHANG: That's agreed that that has to be looked at.

Newt, did you want to say something?

MR. ANDERSON: I don't know if I know to

answer that any better than you do, T.Y. There is no question that it has to be looked at and considered. We consider it a structural problem. I hope the structural people don't consider it an equipment problem.

The point I would make is, it is outside our scope at this time. We are not addressing the qualification of cable trays.

MR. CATTON: I would think that if you go scrambling around California power plants, you'd take a look at the cable trays and at least report on them.

MR. ANDERSON: Peter Yanev has left now. He has a number of pictures of cable trays. He tried to po nt out to you how weak the restraints were on the data base plants on the cable trays. He is always making that comparison.

MR. CATTON: It sounds like he's right.

MR. ANDERSON: He's probably right.

MR. EBERSOLE: Of all the equipment in a nuclear power plant, where I think the percentage of maximum load is contributed by the seismic event, it is probably the air heating and conditioning ducts, where there's virtually no load in operation. The load is a static load, then the main load is the seismic load, and probably the seismic load defines the design of this ductwork to a large extent, unlike high pressure piping.

Are you looking at the ductwork?

MR. ANDERSON: No. That's in the same category as the cable trays, where we very conveniently defined it outside of this problem. It is being addressed, but it is not a part of our program.

MR. EBERSOLE: Well, that's on the record.

Any other questions?

(No response.)

MR. EBERSOLE: Thank you, Mr. Chang.

I believe we have a brief discussion here of 82-21, vibration qualification of equipment, and then after that the aging question, and then that's the scope of our meeting.

Mr. Bagchi?

(Slide.)

MR. BAGCHI: My name is Gouton Bagchi. I work for the Equipment Qualification Branch. I have the section on seismic and dynamic qualification.

When I was looking for this definition of the issue 21, 82-21, it was some kind of a designation, I could not find out where it came from. I have tried to focus on the issue. In my mind it says this: accident-induced dynamic loads and other vibrations may have detrimental effects on the functional capability of safety-related equipment.

(Slide.)

Now, the resolution is in two parts. One addresses the plants that are under operating license review. The standard review plan, section 310, does incorporate other dynamic loads. I would point out that the hydrodynamic loads in boiling water reactors are something that we are specifically looking into.

We have also been focusing on other kinds of transients, like reactor closure, valve lifting loads, and things like that. So in our mind the question of other vibratory loads for plants under operating license review is being handled.

I wanted to focus on the research activity that we have under way. I guess our colleagues are not available. They have been charged with trying to define what normal plant vibration loading is like, maybe in terms of a response spectrum or something like that.

MR. CATTON: Would that then include flow-incuded vibration as well?

MR. BAGCHI: The idea is to look at the operating plants, look at the reactors, and actually instrument some of these things. By doing so, we include some of the flow-induced vibration loads. There are specific instances where they have used valves, for example, for flow control purposes, for which it was not designed, and you are going to get into some unusual vibration problems.

MR. CATTON: I just brought this up because if you look in the LER indexing on vibration and you pull a series of the reports, as soon as you look into them you will see that a majority of them are flow-induced. This is all the way from problems with the diesels to pumps and everything else.

To miss that, if you were looking for the types of vibrations in a plant that you had to consider, you better not overlook the flow.

MR. BAGCHI: Indeed, we plan to look at that. Two sources, mainly vibration from operating machineries, and also flow-induced vibration. There is a recent example at Browns Ferry, where a valve completely fell off. Yes, we are mindful of those kind of things.

Now, with regard to the operating plants, here I feel the best we could do is address other dynamic loads in the context of general design criteria number 2, to the extent they're combined with seismic.

MR. EBERSOLE: Even before you do that, whether or not you combine with seismic there is a standing problem. I mentioned earlier reverse flow in the check valves. What is the intended progress in that matter? I don't personally believe those check valves will survive.

MR. BAGCHI: There have been failures of check valves in the BWR containment, for example. I think we would have to be mindful of the experiences we learned from these plants.

MR. EBERSOLE: But you don't have experience in pipe breaks of the caliber we're talking about, and you'll never get them.

MR. BAGCHI: I really don't want to put it into the same hopper as vibration loads.

MR. EBERSOLE: This is the root thing I'm talking about, the dynamic loads per se. I'm trying to get to some point of resolution as to what progress we're making on the root problem, the dynamic load problem, on valves such as that.

MR. BAGCHI: I guess we're getting to it slowly. We have to be mindful of the experiences that we gather from these operating plants.

You may be aware of the purge and the vent valves for the containment. These were not initially designed to close against accident pressure. Now, I think we have a pretty good handle on it.

MR. EBERSOLE: That problem started in 1968.

MR. BAGCHI: Well, the time frame I cannot give you any indication of.

MR. PICKEL: A question.

MR. BAGCHI: That's all I had to say.

MR. PICKEL: I am not sure I understand the statement on operating plants. The thing that's confusing me is, I guess in my mind I visualize the other dynamic loads, much like Dr. Catton mentioned here, of being a large number of cycle loads that you might get from flow-induced vibrations or mechanical equipment vibrations, what have you, so that the failures in general will be more generally fatigue type failures, aren't they, and low amplitude failures, as opposed to the kind of things you are likely to get from seismic?

MR. BAGCHI: No. I was saying that in the general design criteria number 2 there is one statement that says that seismic should be combined with other dynamic loads. It is in that context that I was using this.

MR. PICKEL: That's what I was looking for. But the failure modes could be, that you would be concerned with, would be much different than they would normally be in seismic.

MR. BAGCHI: An operating plant that has gone through a numbe of years of operation at least has seen a lot of vibratory loads, and equipment modification and plant servicing has ironed out much of the problems, in my mind, of low order vibratory loads.

But the big loads, impulsive kinds of loads as a result of rapid flow conditions, those are the sorts of things we would look for in the combination of loads.

MR. EBERSOLE: All right. Any questions?

(No response.)

MR. EBERSOLE: Our final topic for the day is the matter of the status of the research for plant aging, and it is Bill Morris.

MR. MORRIS: Well, it was the objective to come here today to give you a preliminary report on the status of the new program that we are initiating, to put it in the context of other programs that are going on at NRC and outside the agency, to try to give you an idea of what our objectives are and what our concept is of the aging program, and to tell you also what near-term activities we are initiating so that we can get this program moving.

(Slide.)

These topics that I intended to cover today, I will try to get through them as quickly as possible to finish. I wanted to tell you something about the background of how we got into this subject, to tell you what the objectives of the program are, to give you our scope of the program, the preliminary activities, how we would manage it, what kind of review would be going on for the program, what we anticipate the products would be and how they would be applied, and some of the schedule that we anticipate.

(Slide.)

Within the last few years, in reviewing our Office of Research long-range research plan we have had comments from NRR that suggested that we initiate a comprehensive aging research program. It never was entirely clear just what that meant, although we did have suggestions in the terminology used by Harold Denton when he spoke about this subject.

I believe, although I was not involved during the last year, there have been discussions with the ACRS or this Subcommittee in which this subject was broached. One of the suggestions made was, one way to get a start on this was to have a workshop where some of the representatives of industry came together. Some of you have a copy of the proceedings of that workshop, which was held last August.

A number of written papers and oral

presentations were given at the workshop. That was presented as a NUREG, published in November of 1982. We have reviewed the proceedings of the workshop. One comment I would have about it is that to some extent that workshop focused rather narrowly on the problem of aging and many of the participants were looking at equipment qualification. They were experienced in equipment qualification and they had a workshop to some extent on equipment qualification.

Our view of this program is somewhat broader than that. It's an attempt to answer a somewhat broader question, is our approach to it.

Just to give you an idea of the various activities that are going on that we believe are examples of aging.

(Slide.)

You will note that if you looked at the long-range research program published by the Office of Research, there are a number of activities that go on looking at vessels and how they are affected by the neutron bombardment, looking at piping, what kinds of corrosion, stress corrosion, may be going on in the piping, looking at subjects like nondestructive examination to try to examine equipment during the life of the plant without taking it apart and destroying it.

Electrical equipment qualification, and mechanical equipment qualification, the subjects you heard about earlier today, are related to aging, because there is clearly a question of how equipment will respond in an accident after it has been aged for some number of years.

The steam generators and certain of the problems associated with steam generators would probably be generally classified as aging-type problems, and there are others I have mentioned here that I would imagine you could put under the general category of aging-related research and investigation.

Now, taking that into account, that there are others, I decided to add a little statistics picture.

(Slide.)

This includes many of these: again, steam generators, vessels, dynamic and seismic qualification of equipment, mechanical and electrical equipment, environmental qualification of electrical and mechanical equipment, piping, nondestructive examination, in-service inspection, et cetera.

These various activities are not entirely related to aging. Surely steam generator problems are not all aging-related. There are some inherent design problems that may be part of the reason we have trouble with steam generators, and vessel problems aren't entirely all aging-related.

What we are trying to do is to generate a program that takes into account the various activities that are going on already in these areas and any other activities I may not have named here yet, and ask the question -- and answer the question, hopefully -- of what other kind of aging-related effects could occur to the equipment at a plant, to its structures, over the anticipated 40 years of life.

So the objecetive here is to try to essentially fill in the gaps left here by the ongoing programs and try to anticipate aging effects before they become problems, trying to identify what kind of aging effects are going to occur and figure out in advance what we should be doing about them.

We envision that there are certain categories of activities that will be useful in this regard. What comes to mind early is, one of the things you will have to look at here is surveillance and maintenance inspection, and that is a continuing effort that should go on through the life of a plant.

So a large part of what we anticipate we will be looking at is how those kinds of activities and other activities I will address will be important in addressing this question of aging. We're not strictly looking at electrical and mechanical components. We think we should be looking at this from a fairly broad perspective, and especially at the beginning to take as broad a perspective as we can, to try to anticipate all aging phenomena that could be important, including structures.

We even go so far as to consider the possibility that, as aging of plants progresses, there will be secondary effects and questions that will come up: How well are we able, with the limited number of plant operators and maintenance personnel, able to withstand occupational exposures of those people it will have to take? How will we deal with the question of replacement parts?

Many of these questions ultimately will have to be answered by the industry. What we're trying to do in our research is think forward, think ahead, to try to anticipate what kinds of things we ought to be doing down the road.

I do not want to indicate that all the activities that are going on are strictly going on in the NRC. There is a lot of perspective we will gain and have already begun to gain from looking at programs that are going on in industries outside the NRC.

(Slide.)

The nuclear industry in particular, as represented by EPRI and INPO, have programs we believe will teach us something about aging phenomena at nuclear plants. The military has had to grapple with this kind of question, because they have to procure, design equipment that will function for some period of time with some high reliability, and they have had to deal with the same question.

The Department of Energy has had to do the same thing. Particularly, I'm thinking here of the Department of Energy reactors, such as those at Hanford and Savannah River. I don't recall exactly how old the Hanford plants are, but the Savannah plants are nearly 30 years old now.

They have faced this problem and have had to contend with it, and are familiar with a document that has been generated pertaining to the Savannah River reactors that addresses just this question: How will they take the 30-year-old reactors and what will they do to those to allow them to operate those into the twenty-first century?

So we figure that there are lessons to be learned outside the NRC-related research. The space program, the communications industry, have also had to face this question. The question again is not strictly that of preparing equipment and becoming sure that equipment that has to function in the face of an containment will be qualified, but looking at all kinds of equipment in mild environments and otherwise.

(Slide.)

Let me just go ahead and say what we think our objectives are. What we are going to try to do is to identify previously unanticipated aging effects that have the potential to degrade reactor safety and to generate information useful in contending with those effects before they case problems.

We think that because of the nature of this activity that we will have to be able to understand the various other ongoing aging-related research within the NRC, and we believe that there will be some effort involved in this overall program to establish priorities and schedules and appropriate interfaces for all the new and ongong aging-related research within the NRC. That includes those activities I&E had before.

So we will try to take a comprehensive look at the whole aging picture as we proceed with this effort to identify new problems that we have not focused on as yet. This will also include the establishment of interfaces with the ongoing programs outside the NRC, EPRI, INPO. If there are other programs that we can take advantage of and for which there are mutual benefits, we will try to establish interfaces there, also.

(Slide.)

One more time. The scope of the program will be broad at first. We do not want to put blinders on. We don't want to neglect an area that could be important. As we proceed, we hope to be focusing on areas within the broad scope of things that are important. That is really the challenge before us: How do we start from a fairly generally-conceived program and move forward to begin to develop a focus on the real problems, to try to figure out what they may be?

We have talked about the various laboratories and potential contractors are various factors that have to be considered.

(Slide.)

As we try to narrow down the kinds of things we should be doing, we've thought of at least six categories of general topics of research that we'll probably be thinking about.

First, we have to have a systematic approach to identify important aging effects. How will we figure out what are the important aging effects 10 or 20 years down the road? What can one do to determine what they may be and to anticipate those problems?

Clearly, if the effect is already known and has had a lot of attention spent on it, we don't need to redo that, so we won't be duplicating efforts. If we develop an identification with a set of aging effects that we believe need to be considered, we will have to address the question, in a period of certainly decreasing resources for all research activities and certainly all other kinds of expenditures, how will we distribute our resources? What will be the important elements to attend to?

I think you have heard, at one time or another even today, various approaches that are being developed which the NRC is trying to establish with a priority ranking for allocation of resources in paying attention to various activities.

They will be the kind of activities involved. They will use the probabilistic risk assessment methodologies, folded in with judgments about the relative importance of various effects, competing factors, and I believe that's what we will also be doing.

We will probably be taking advantage of any capability that is developed along these lines for application in other areas of the NRC, and will piggyback on top of those programs. But we do believe it's something we will have to face.

We believe, again, that whatever the aging effects are, that the main thrust of the whole effort will ultimately be a monitoring by surveillance and detection of the ongoing progression of whatever aging effects may exist. I think in general I believe that that is going to be the main thrust of the way the program will develop. Surveillance, maintenance, inspection will probably be the key words for dealing with this problem.

Eventually, there may have to be replacement and replacement schedules, repair, and this area certainly will involve a large participation with the industry, because we do not intend to tell anyone how he would go about setting up a fair maintenance schedule. We just want to begin to generate the kind of information we believe the industry will want to focus on in terms of preparing their own programs.

One of the questions I think you have heard discussed today is, how does one make a judgment that equipment will be able to survive a certain period of time, given that there are potential aging mechanisms that occur for that equipment?

You know about the so-called iraneous theory that attempts to develop by accelerated aging techniques a basis for concluding that equipment will have an extended life beyond the time of its accelerated aging preparation. That is typically used for environmental qualification of electrical equipment and has been used for some time.

One would question the extent to which this kind of technique could be applied to other pieces of equipment that are not necessarily going to see a big LOCA or a heavy steam environment during an accident or even an earthquake necessarily, but that are going to have to survive 40 years or 20 or 5, whatever the period is.

One of the things we believe we will be looking at is the general theoretical background that would allow one to make these kinds of conclusions. We think some more effort needs to be given to that subject.

Finally, one of the activities we will have to engage in is the integration of the aging research work that is going on. We will have to integrate with what other NRC programs are doing, take advantage of the equipment qualification activities, the mechanical equipment qualification activities.

In addition, we will have to integrate with the outside programs to indicate that there are clear interfaces and advantages taken with regard to those programs.

What I am doing is, in the interest of completion here, I will just go on and speak to essentially one more area that I think might be of some interest. That is the question of what we are going to do in the near term to systematically identify what kind of aging effects we will look at.

We thought what we needed to do -- I think the key word here is we believe we will try to learn from the experience that has already occurred, and try to extrapolate from that experience to what may occur in the future. And some of the activities that we have thought of that would be useful for that purpose are the following kinds of things.

First, we believe the idea of workshops is a pretty good idea, where you convene a number of specialists and experts, get together to share their experience and thinking. What we would like to do is, rather than a workshop like the one we had last summer, is to have a series of workshops that are somewhat more focused and for which the participants come prepared to give us a better, more clearly delineated benefit of their experience and background.

So what we're trying to do is convene groups of people who know the mechanical systems, the mechanical equipment at the plant, get them together, and have them tell what experiences they have had, what they would suggest is the way mechanical equipment will behave during an extended life.

Those groups would hopefully include people involved in the design of the equipment, in the operation of the equipment. They will know what the equipment is constructed like, they will know what its environment will be. They will have some experience from their activities at some nuclear plant as to what has been happening to that kind of equipment.

Another workshop would involve electrical specialists, another perhaps structural. All of these would have an infusion of enough depth that you could get a fairly good cross-section of what is going on.

We believe there should be a survey of operating plant experience. Let me just say what that means to us right now. It's sort of an easy step to say, we ought to examine LER's. That's one of the things we think we ought to do. There have been examinations of LER's in the past. They have been gone over at various levels.

We think we would like to put a slightly different slant on that. We would like to examine the LER data base to see if anyone can determine from the LER's that have been presented in the past any indication of trends for the future, in particular those that would be related to this aging question that we are trying to address.

In that same category, we think there are programs that have already been established in looking at plant maintenance request records. Surveys have already been done of plant maintenance requests, and I believe if we go back and relook at those surveys that have already been done with a new slant, we'll ask the question of, what will that tell us about what kind of aging effects would occur in the future. There may be some benefit to that.

Mind you, these are essentially feasibility studies that we are going to be doing in this fiscal year, that would tell us how effective these kinds of techniques would be in trying to project what important aging effects would be considered.

Other experience may be the results of non-destructive examination tests that have been done at plants. Another activity we believe will be useful is a survey of aged facilities. Here what we are talking about is perhaps sending some teams of investigators to interview the operators of aged facilities similar to LWR's, maybe even including some old LWR's.

Particularly we're thinking about the Hanford and the Savannah River reactors. We would like to establish communications with the people who have been operating those reactors, and sit down and talk to them in hopefully enough length and breadth to understand what's been going on there and what they believe are the things people should watch out for.

There are similar communications facilities, fossil fuel power plants, that may have some lessons to teach us, and military establishments, to the extent we can get access to that information. We have not gotten it well mapped out yet just what the procedure will be and how we're going to do this and what the plants are, but we think there is some benefit to be gained from that.

In addition, there are some plants that are being decommissioned or may be facing decommissioning, and we think there may be some information to be gleaned from those kinds of plants by appropriate examination or investigation of what's happened in those plants. We believe we would like to go back even this early and make a survey of the kind of aging mechanisms we should be anticipating for pertinent materials.

You heard today that there are -- there is already a data base that pertains to the kinds of equipment that are used in electrical equipment, and a somewhat smaller data base related to mechanical equipment. I'm talking about now particular the polymers or composite materials that were used in pumps, electrical installation seals, et cetera.

We think we would like to sort of do a comprehensive survey of that, but we would consider extending it beyond these kinds of equipment to perhaps structures and ask the question, are there other aging mechanisms that could occur for other structures that would be of concern over the 40-year life of that structure, that have not fully been explored yet? Just because they have not been seen to date doesn't mean we don't have to think about 20 years down the road.

So those are activities that we are starting this year, and they are being started on a relatively small scale, and we will re-examine those as time progresses to see if they are giving us the kind of information we are looking for.

What I have essentially done is show what's on a number of slides here. You can examine those slides if you want to and remind yourself of what we are talking about.

Just to give you an idea of how we would proceed with the review and management of the program -- I have no idea what I meant by "DE" there. I cannot remember any more. The management of the program is the Office of Research, Division of Engineering and Technology, and for no particular reason in the Electrical Engineering Branch. This is a fairly general kind of a program. There is no one particular place that you would naturally find to put it, and the system shows that the Electrical Engineering Branch will be looking at this program.

(Slide.)

We won't be doing all the work, certainly, but we will be sort of the focal point for the work as this program continues. If there are clearly mechanical effects and mechanical engineering type questions that come up or structural questions, the spinoff studies would be directed to those particular branches or sections of the agency.

They of course would do an intensive review of what we come up with. We will be talking to NRR. There again, there is no particular place in NRR that we can go to accomplish all the things we're doing, and we'll probably be talking with the appropriate branches across the board.

We believe that Inspection and Enforcement is another potentially interested arm of the agency that may find some use for what we are doing. I will mention that again in a minute.

We certainly will hopefully be coming to the ACRS to exchange views with various Subcommittees, and I imagine this one will be the principal one, with the hope that we will not only be letting you know early on what we are doing, but to hopefully get some feedback from you regarding the way we're going.

As I understand it, there is some interest in getting an exchange of views early in the development of a program, so that we won't get locked into something going down the road without having had the benefit of the kind of exchange we might expect with various ACRS Subcommittees.

We anticipate that we will establish a special review panel that will help us guide the whole program. Here we would want to get senior and experienced people who have a broad perspective to help tell us how we should be running this program. We will be looking for the kind of people who should be doing that to help us with the regular meetings of that panel, to talk with the various contracts that will be involved in the program.

We will be looking for a lead contractor and hope to name a lead contractor within a few months. That contractor would integrate various elements of the program, although they might be not doing everything, but they would certainly be putting it together, particularly as it develops in the subsequent years. We don't believe that we can complete this job in a year. We can only begin to try to approach it in this fiscal year, but this program will continue for several years assuming that it appears to be effective.

(Slide.)

Well, the products we perceive are the identification of likely aging effects, evaluating the safety significance of these effects, identification of methods to detect important aging effects, identification of methods to mitigate the aging effects, evaluation of viability of predicting service life of equipment susceptible to aging, and an integration of various aging research activities internal to NRC and external programs as well.

(Slide.)

The application would be to anticipate important aging effects, to take appropriate actions before problems develop, or to perhaps instigate appropriate actions before problems develop. We certainly wouldn't take the action ourselves.

Another thing I've been thinking of lately is, I believe that this may be important for the future of the Inspection and Enforcement activity. Although we have not established a formal agreement with I&E yet as to how we might be able to give them some benefits from this program, we think if you think about what that office has got to do and what the regions are going to have to do, they are going to have to face the question of what will be happening at nuclear plants for the rest of their lives. Maybe they might want to focus their inspection schedules and resources in directions that would be likely to show aging effects occurring. That maybe a way that they would choose to do their job better.

We think there may be some potential commercial benefits from this program in the sense of whatever we may learn from aging effects on safety-related equipment will probably have application keeping plants on line, keeping them up to their expected 40-year life, and perhaps would even be beneficial for establishing a basis of going beyond the anticipated 40-year life.

So even though that wouldn't be our direct intent, we can't help but believe there would be some spinoff benefits along those lines.

Well, that is the general thrust of what we're trying to do. If you have any suggestions as to specifics you think we ought to be doing, we would certainly appreciate getting those views.

MR. EBERSOLE: Any comments for Bill on this matter?

MR. PICKEL: One comment, I guess, or a question. From the discussion this morning I gathered that the aging, the definition of aging here, excluded some things like wear and fatigue, what have you. It would appear that when you go to look at some of this data, particularly if you go to mechanical equipment, it is going to be extremely difficult to separate time effects only from those kinds of phenomena, the wear, creep fatigue, the vibration damage, corrosion and what have you.

It looks like it would be worthwhile at least doing the same thing we mentioned a while ago, while you're out there getting that data to at least find out all you can about those effects, too, because you are going to have that problem of separating the effects to get what you are looking for.

MR. MORRIS: I'm not sure we have quite the narrow view of aging that has been discussed this morning. I think what our approach would be, if we discover anything that seems interesting, what we will do is look to see whether it's being addressed somewhere and if it's not we will probably try to surface that and try to explain what we saw, so that someone somewhere could take advantage of that information and do whatever is appropriate about it.

We would not try to be so precise about what our definition is of aging or what it's not, although we are not going out to, I guess the word would be, witch hunt. We just want to understand the phenomena that are going on. If we come across something, we certainly will not neglect something because it did not fit a predefined category of aging.

MR. EBERSOLE: Any further questions?

(No response.)

MR. EBERSOLE: Thank you, Bill.

Well, that concludes our meeting. I would like our consultants to join everybody here to turn in to Tony some kind of contributions toward a composite letter we might present to the full Committee in May.

We have such a crushed schedule in April that we cannot do anything about this then, but we do want to pick the salient features of today's program, compile it, and see if we have something to say to the full Committee. I think we do, one notable thing being, do we in fact endorse this pilot program of looking at generic performance of seismic equipment, equipment under seismic circumstances.

MR. CATTON: I think that is one of the more rational things I've heard.

MR. WARD: Jesse, I really think the full Committee ought to hear some kind of summary on that.

MR. EBERSOLE: Right. I am informed that the April meeting is so jammed that we are looking forward to doing that in May.

MR. WARD: Okay.

MR. EBERSOLE: Along with a letter of some sort that we will suggest that the full Committee endorse.

Are there any other comments?

MR. CATTON: I think the business of the harsh and mild environment is important, and I don't see it being addressed anywhere. It's almost as though it's being deliberately pushed to the side.

MR. EBERSOLE: I am fearful that the

owner-operators look at mild environments in just that context and do not pursue the circumstances under which they may become not really harsh, but harmful.

MR. CATTON: That's right. I think the word "mild" is what does it. If it's mild, who cares?

MR. EBERSOLE: Right.

On the matter of aging, on the very point of the aging problem, I think one can look at the elastomers on the diesel engines that ceased to be elastomers after a few years at temperature and therefore were subject to vibration breakage.

Turkey Point has I think some very good points about their looking at the aging problems of the cables, which are alternately subject to being dry for long periods, then when a hurricane rolls in all of a sudden they're wet. I thought they were quite conservative. They used the things the Romans used, like lead jackets, under which they had elastomers at very high grade. But I'm not sure this is the rationale that is employed even for critical cabling inside containment subject to LOCA effects and environmental effects.

MR. CATTON: I guess the other area is the response of equipment to normal plant vibration. I think what they are doing is kind of incomplete, that, you know, the LER's point to this over and over again.

I think it was made clear here that this is not a part of anything that they are doing. I think somewhere that needs to be addressed.

Then there is the argument that you shake down a plant and after a while all those problems go away. That's nonsense, you find, because it became a problem. It's just that maybe we've been fortunate that when they found it it was not a serious problem.

MR. EBERSOLE: If you will incorporate this in a one or two-page comment.

MR. CATTON: I certainly plan to.

MR. EBERSOLE: And if everybody else would, also.

I appreciate everybody coming in today and the quality of the presentations. The meeting is adjourned.

(Whereupon, at 5:08 p.m., the Subcommittee was adjourned.)

* * *

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

____

in the matter of: ACRS/Subcommittee on Program for Qualification of Safety Related Equipment

Date of Proceeding: March 15, 1983

Docket Number: ____________________

Place of Proceeding: Washington, D. C.

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

Jane N. Beach

Official Reporter (Typed)

Jane N. Beach

Official Reporter (Signature)

Briefing Of The ACRS Subcommittee On Equipment Qualification

Status Of Equipment Qualification Program

Vincent S. Noonan
March 15, 1983

T2

EQUIPMENT QUALIFICATION PROGRAM PLAN

SHOULD ACCOMPLISH

- ENVIRONMENTAL QUALIFICATION OF ELECTRICAL EQUIPMENT--COMPLETE REVIEW AND ESTABLISH APPROPRIATE CORRECTIVE ACTIONS; CONTINUE REVIEW OF OL SUBMITTALS.

- ENVIRONMENTAL QUALIFICATION OF MECHANICAL EQUIPMENT--CONTINUE REVIEW OF OL SUBMITTALS, ESTABLISH DATA BASE AND COMPLETE SURVEY OF QUALIFICATION BASES, BASED ON SURVEY RESULTS ESTABLISH PROCEDURES AND CRITERIA FOR REVIEW OF VERY LIMITED ITEMS FOR OR'S IF REQUIRED.

- SEISMIC QUALIFICATION OF ELECTRICAL AND MECHANICAL EQUIPMENT--CONTINUE REVIEW OF OL APPLICATIONS, UNDER USI A-46 ESTABLISH PROCEDURES AND CRITERIA FOR ADEQUACY OF EQUIPMENT IN OR'S, INITIATE REVIEW FOR OR'S IF REQUIRED.

- SURVIVABILITY OF EQUIPMENT EXPOSED TO HYDROGEN-BURN ENVIRONMENT--REVIEW INDUSTRY TEST PROGRAMS AND SURVEY AVAILABLE INFORMATION TO ESTABLISH THE LICENSING BASIS FOR EQUIPMENT IN OR AND OL PLANTS.

- ACCREDITATION OF TESTING LABORATORIES--WORK CLOSELY WITH INDUSTRY TO ESTABLISH PROCEDURES AND CRITERIA GOVERNING ALL THE KEY TASKS OF THE EQUIPMENT QUALIFICATION TESTING PROCESS.

EQUIPMENT QUALIFICATION PROGRAM PLAN (CONT'D)

- DEVELOP PROCEDURES WITH I&E TO TRANSFER RESPONSIBILITY OF ISSUES RELATED TO QUALIFICATION OF ELECTRICAL AND MECHANICAL EQUIPMENT IN ORs FOR ENVIRONMENTAL AND SEISMIC AND DYNAMIC CONDITIONS.

- EQUIPMENT QUALIFICATION REGULATION--RULE ISSUED ON ELECTRICAL EQUIPMENT (1/6/83), NO OTHER RULE ON EQUIPMENT QUALIFICATION ANTICIPATED, SEISMIC QUALIFICATION OF EQUIPMENT IN ORs AND ENVIRONMENTAL QUALIFICATION OF MECHANICAL EQUIPMENT IN ORs TO BE IMPLEMENTED AS RESOLUTION OF GENERIC ISSUES IF REQUIRED.

- REGULATORY GUIDES--1.89, 1.100, AND 1.131 ON ELECTRICAL EQUIPMENT AND OTHER APPROPRIATE GUIDES ON ELECTRICAL AND MECHANICAL EQUIPMENT IN SUPPORT OF USIA-46 AND ANY OTHER RELATED GENERIC ISSUE.

- EQUIPMENT QUALIFICATION METHODS AND TESTING--CONDUCT VERY LIMITED INDEPENDENT TESTING, PERFORM LIMITED CONFIRMATORY RESEARCH ON LIMITATIONS OF ACCELERATED AGING METHODS, RADIATION DOSE RATE EFFECTS, SEISMIC AND DYNAMIC TESTING METHODS INCLUDING THE EFFECTS OF AGING AND OTHER DYNAMIC LOADS.

REVIEW ACTIVITY ON EQUIPMENT QUALIFICATION

COMPLETE EQUIPMENT QUALIFICATION REVIEW CONSISTS OF:

I. Environmental Qualification of Safety-Related Electrical Equipment Located in a Harsh Environment

- Acceptance criteria for NTOLs specified in SRP Section 3.11, primarily NUREG-0588 (as set forth by the Commission).

- Acceptance criteria for ORs are the DOR Guidelines (as set forth by the Commission).

- Develop procedure by August 1983 for transferring responsibility for this issue for ORs to IE.

II. Environmental Qualification of Safety-Related Mechanical Equipment Located in a Harsh Environment

- Current review for NTOLs is limited to reviewing applicant's bases for claiming compliance with GDC-4 and evaluating documentation demonstrating such compliance for three pieces of equipment. This documentation review consists of an evaluation of the acceptability of materials sensitive to environmental effects, i.e., nonmetallics. Examples are seals, gaskets, lubricants, fluids for hydraulic systems and diaphragms.

- Collect a data base from the NTOL reviews over the next year. A decision relative to implementing any requirements for ORs will then be made, based on the data base collected, and established.

III. Seismic and Dynamic Qualification of Safety-Related Electrical and Mechanical Equipment

- Acceptance criteria specified in SRP Section 3.10.

- EQB reviews and acceptance criteria used are essentially identical to the reviews performed and acceptance criteria used by MEB prior to creation of the EQB.

- No ORs currently being reviewed. A decision relative to ORs will be made following resolution of USI A-46.

Rule: 10 CFR Part 50.49

Environmental Qualification Of Electric Equipment Important To Safety For Nuclear Power Plants

High Lights Of The Rule

- 50.49(b)1 Electric Equipment Important To Safety
- 50.49(b)2 Non Safety Related Electric Equipment
- 50.49(b)3 Certain Post-Accident Monitoring Equipment
- 50.49(g) Holders Of Operating License
- 50.49(i) Applicants For Operating License

ENVIRONMENTAL QUALIFICATION OF ELECTRICAL EQUIPMENT

FY 83/84 RESEARCH PLAN

1. AGING MECHANISMS AND ACCELERATED AGING METHODOLOGIES FOR MATERIALS

2. DOSE RATE EFFECTS

3. ADEQUACY OF RADIATION SIMULATION

4. COMPLETION OF WORK ON IMPORTANCE OF OXYGEN DURING LOCA SIMULATION

5. ASSESSMENT OF METHODOLOGIES, INCLUDING TEST SEQUENCE, GIVEN IN THE IEEE STANDARDS FOR GENERAL QUALIFICATION AND THE QUALIFICATION OF SPECIFIC COMPONENTS, SUCH AS CABLES, PENETRATIONS, MOTORS, AND BATTERIES, AND THE DEVELOPMENT OF A METHODOLOGY FOR QUALIFYING POST-ACCIDENT RADIATION MONITORING EQUIPMENT

Noonan
T3

STATUS OF

ELECTRICAL EQUIPMENT QUALIFICATION RESEARCH

- o VULNERABILITY OF SAFETY RELATED POLYMERS TO AGING AND ACCIDENT SEQUENCE
  - AGING OF SPECIMENS AT SANDIA COMPLETE
  - LOCA SIMULATION IN FRENCH CEA CESAR FACILITY TO START JULY 1983
- o SYNERGISM AND RADIATION AGING DOSE RATE TESTS OF CABLE MATERIALS (XLPO, EPP, PE, PVC) COMPLETE
- o ASSESSMENT OF METHODOLOGIES IN NATIONAL STANDARDS
  - ASCO SOLENOID VALVES (NATURAL & ARTIFICIALLY AGED) COMPLETED SEISMIC TESTING (2/83) IN LOCA RADIATION SIMULATION PHASE (IEEE 382)
  - XLPO CABLE AGING DOSE RATE TESTS COMPLETE (IEEE 383)
- o ACCIDENT FAILURE MODES OF SELECTED EQUIPMENT
  - PRESSURE SWITCHES COMPLETED
  - RTD'S START MARCH 1983
- o AGING RESEARCH
  - SEISMIC FRAGILITY TEST OF NATURALLY AGED BATTERIES PLANNED IN 1983

MECHANICAL EQUIPMENT QUALIFICATION

- ASSESS AGING AND DEGRADATION PHENOMENA
- IDENTIFY PRE-AGING REQUIREMENTS
- EVALUATION OF EXISTING AND PROPOSED METHODS FOR ENVIRONMENTAL QUALIFICATION
- INITIAL TESTING OF CONTAINMENT VENT AND PURGE VALVES
- EVALUATION OF RESULTS FROM EPRI SAFETY VALVE TEST PROGRAM
- ASSESS "IN SITU" DYNAMIC LOADS IMPOSED ON EQUIPMENT AND DETERMINE IF QUALIFICATION PROCEDURES PROPERLY CHARACTERIZE THESE LOADS
- IDENTIFY THE EXTRAPOLATION METHODOLOGY (SCALING RULES) CURRENTLY IN USE FOR DYNAMIC QUALIFICATION AND VALIDATE OR IDENTIFY DEFICIENCIES
- EVALUATE THE CURRENT LIMITATIONS ON DYNAMIC QUALIFICATION BY ANALYSIS ONLY WHEN COMPARED WITH QUALIFICATION BY TEST OR COMBINATIONS OF TEST & ANALYSIS
- EVALUATE THE ADEQUACY OF AVAILABLE VOLUNTARY STANDARDS
- REVIEW THE OUTPUT OF PRAs (PROBABILITY RISK ASSESSMENTS) TO RELATIVELY RANK EQUIPMENT TO BE ADDRESSED

ELECTRICAL EQUIPMENT

STANDARDS, RULES AND REGULATORY GUIDE DEVELOPMENT

FY 83-84

1) FINAL RULE: ENVIRONMENTAL QUALIFICATION OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS

2)(A) IEEE 323: STANDARD FOR QUALIFYING CLASS 1E EQUIPMENT FOR NUCLEAR POWER GENERATING STATIONS

(B) REGULATORY GUIDE 1.89: QUALIFICATION OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS (CURRENTLY BEING REVISED - ENDORSES IEEE 323)

3)(A) IEEE 344: RECOMMENDED PRACTICE FOR SEISMIC QUALIFICATION OF CLASS 1E EQUIPMENT FOR NUCLEAR POWER PLANTS

(B) REGULATORY GUIDE 1.100: SEISMIC QUALIFICATION OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS (INITIATE REVISION 3RD QUARTER FY 83. ENDORSES IEEE 344)

4)(A) IEEE 383: STANDARD FOR TYPE TEST OF CLASS 1E CABLES FOR NUCLEAR POWER GENERATING STATIONS

(B) REGULATORY GUIDE 1.131: QUALIFICATION OF ELECTRIC CABLES FOR NUCLEAR POWER PLANTS (INITIATE REVISION JANUARY 1983. ENDORSES IEEE 383)

5)(A) IEEE 572: STANDARD FOR QUALIFICATION OF CLASS 1E CABLE CONNECTIONS (CONNECTORS) FOR NUCLEAR POWER GENERATING STATIONS

(B) REGULATORY GUIDE (UNNUMBERED): QUALIFICATION OF CABLE CONNECTORS IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS. TO BE INITIATED 3RD QUARTER FY 83. ENDORSES IEEE 572

6)(A) IEEE 317: STANDARD FOR ELECTRIC PENETRATION ASSEMBLIES IN CONTAINMENT STRUCTURES FOR NUCLEAR POWER GENERATING STATIONS

(B) REGULATORY GUIDE 1.63: ELECTRIC PENETRATION ASSEMBLIES IN CONTAINMENT STRUCTURES FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS (INITIATE REVISION 4TH QUARTER FY 84. ENDORSES IEEE 317)

7) STANDARD REVIEW PLAN: ASSIST NRR IN DEVELOPING REVISIONS

ADDITIONAL IEEE QUALIFICATION STANDARDS DEVELOPED

AND UNDER DEVELOPMENT

8) IEEE 550: STANDARD FOR QUALIFYING CLASS 1E BATTERY CHARGERS AND STATIC INVERTERS FOR NUCLEAR POWER GENERATING STATIONS

9) IEEE 649: STANDARD FOR QUALIFYING CLASS 1E MOTOR CONTROL CENTERS FOR NUCLEAR POWER GENERATING STATIONS

10) IEEE 334: STANDARD FOR TYPE TESTS OF CONTINUOUS DUTY CLASS 1E MOTORS FOR NUCLEAR POWER GENERATING STATIONS

11) IEEE 535: QUALIFICATION OF CLASS 1E LEAD STORAGE BATTERIES FOR NUCLEAR POWER GENERATING STATIONS

12) IEEE 382: STANDARD FOR QUALIFICATION OF SAFETY RELATED VALVE OPERATORS

13) IEEE P638: GUIDE FOR QUALIFICATION OF CLASS 1E TRANSFORMERS FOR NUCLEAR POWER GENERATING STATIONS (INITIAL VERSION UNDER DEVELOPMENT)

14) IEEE P744: SEISMIC QUALIFICATION OF SWITCHGEAR (INITIAL VERSION UNDER DEVELOPMENT)

15) IEEE P798: QUALIFICATION OF RELAYS AND ASSOCIATED DEVICES AS USED IN NUCLEAR POWER PLANTS (INITIAL VERSION UNDER DEVELOPMENT)

MECHANICAL STANDARDS

ENDORSED: N 278.1-1975, SELF-OPERATED & POWER OPERATED SAFETY RELATED VALVES, FUNCTIONAL SPECIFICATION STANDARD - REGULATORY GUIDE

IN PRINTING: B16.41-1983, FUNCTIONAL QUALIFICATION REQUIREMENTS FOR POWER OPERATED ACTIVE VALVE ASSEMBLIES FOR NUCLEAR POWER PLANTS (FORMERLY N 278.2.4)

IN PREPARATION: N 278.2.3, FUNCTIONAL QUALIFICATION FOR POWER OPERATED AND SPRING LOADED PRESSURE RELIEF VALVES

N 278.2.?, PRODUCTION TESTING OF POWER-OPERATED SAFETY RELATED ACTIVE VALVE ASSEMBLIES

N 278.2.?, PRODUCTION TESTING OF SPRING-LOADED PRESSURE RELIEF VALVE

N 278.2.7, FUNCTIONAL QUALIFICATION OF SELF-OPERATED CHECK VALVES

QNPE-1, STANDARD FOR QUALIFICATION OF ASME CLASS 2 & 3 PUMP ASSEMBLIES FOR SAFETY SYSTEMS SERVICE - GENERAL REQUIREMENTS

QNPE-2, STANDARD FOR QUALIFICATION OF ASME CLASS 2 & 3 PUMPS FOR SAFETY SYSTEMS SERVICE

QNPE-3, STANDARD FOR QUALIFICATION OF SHAFT SEAL ASSEMBLIES OF ASME CODE CLASS 2 & 3 PUMP ASSEMBLIES FOR SAFETY SYSTEMS SERVICE

QNPE-4, STANDARD FOR QUALIFICATION OF MOTOR DRIVERS OF ASME CODE CLASS 2 & 3 PUMP ASSEMBLIES FOR SAFETY SYSTEMS SERVICE

QNPE-5, STANDARD FOR QUALIFICATION OF TURBINE DRIVERS OF ASME CODE CLASS 2 & 3 PUMP ASSEMBLIES FOR SAFETY SYSTEMS SERVICE

QNPE-7, REACTOR COOLANT MOTOR FRAMES

PRESENTATION BY

SATISH K. AGGARWAL

U.S. NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555

(301) 443-5946

ACRS SUBCOMMITTEE ON THE PROGRAM FOR

QUALIFICATION OF SAFETY RELATED EQUIPMENT

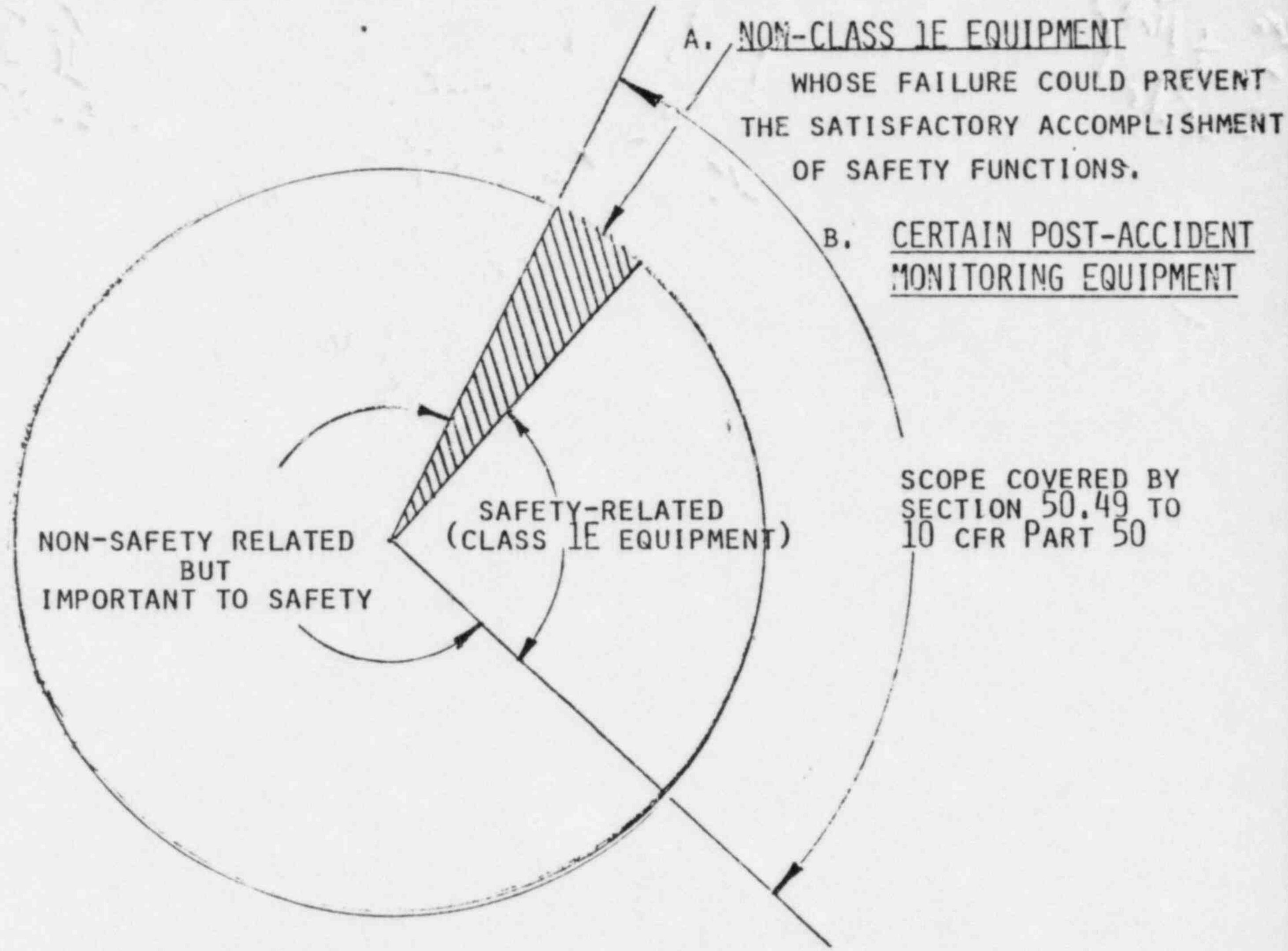
WASHINGTON, D.C.
MARCH 15, 1983

T6

§50.49 ENVIRONMENTAL QUALIFICATION OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS

(A) EACH HOLDER OF OR EACH APPLICANT FOR A LICENSE TO OPERATE A NUCLEAR POWER PLANT SHALL ESTABLISH A PROGRAM FOR QUALIFYING THE ELECTRIC EQUIPMENT DEFINED IN PARAGRAPH (B) OF THIS SECTION.

SAFETY CLASSIFICATION



IMPORTANT TO SAFETY
(ENTIRE CIRCLE)

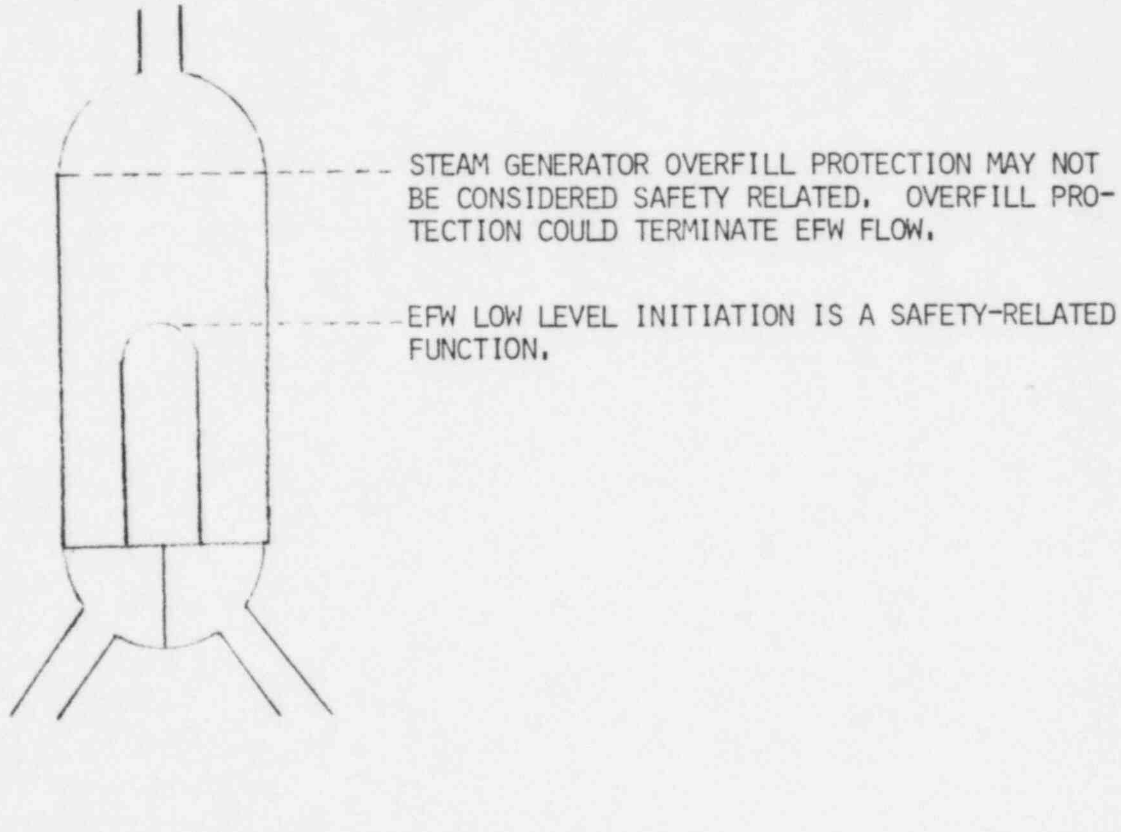
(1) SAFETY-RELATED ELECTRIC EQUIPMENT: THIS EQUIPMENT IS THAT RELIED UPON TO REMAIN FUNCTIONAL DURING AND FOLLOWING DESIGN BASIS EVENTS TO ENSURE (I) THE INTEGRITY OF THE REACTOR COOLANT PRESSURE BOUNDARY, (II) THE CAPABILITY TO SHUT DOWN THE REACTOR AND MAINTAIN IT IN A SAFE SHUTDOWN CONDITION, AND (III) THE CAPABILITY TO PREVENT OR MITIGATE THE CONSEQUENCES OF ACCIDENTS THAT COULD RESULT IN POTENTIAL OFFSITE EXPOSURES COMPARABLE TO THE 10 CFR PART 100 GUIDELINES. DESIGN BASIS EVENTS ARE DEFINED AS CONDITIONS OF NORMAL OPERATION, INCLUDING ANTICIPATED OPERATIONAL OCCURRENCES, DESIGN BASIS ACCIDENTS; EXTERNAL EVENTS; AND NATURAL PHENOMENA FOR WHICH THE PLANT MUST BE DESIGNED TO ENSURE FUNCTIONS (I) THROUGH (III) OF THIS PARAGRAPH.

(2) NONSAFETY-RELATED ELECTRIC EQUIPMENT WHOSE FAILURE UNDER POSTULATED ENVIRONMENTAL CONDITIONS COULD PREVENT SATISFACTORY ACCOMPLISHMENT OF SAFETY FUNCTIONS SPECIFIED IN PARAGRAPH (B)(1) OF THIS SECTION BY THE SAFETY-RELATED EQUIPMENT.

(3) CERTAIN POST-ACCIDENT MONITORING EQUIPMENT.

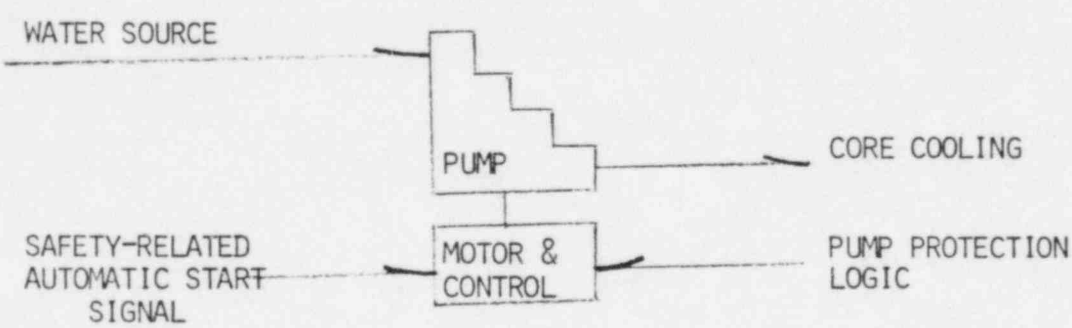
EXAMPLE #1

THE INJECTION OF EMERGENCY FEEDWATER (EFW) FOR PWR'S AND HIGH PRESSURE COOLANT INJECTION (HPCI) FOR BWR'S ARE SAFETY-RELATED FUNCTIONS. THE EFW SYSTEM AND THE HPCI SYSTEM ARE INITIATED UPON DETECTION OF LOW WATER LEVEL. AUTOMATIC TERMINATION OF THESE SYSTEMS UPON DETECTION OF HIGH WATER LEVEL MAY ALSO BE PROVIDED. THE HIGH LEVEL TRIP IN SOME CASES HAS BEEN CONSIDERED AN EQUIPMENT PROTECTION DEVICE. HOWEVER, THE INADVERTENT TERMINATION OF EFW OR HPCI DUE TO MISOPERATION OF THE LEVEL SENSING EQUIPMENT WHEN SUBJECTED TO A HARSH ENVIRONMENT COULD DEFEAT THE SAFETY-RELATED INJECTION FUNCTION. THUS, THE ELECTRIC EQUIPMENT ASSOCIATED WITH AUTOMATIC INJECTION TERMINATION MUST BE ENVIRONMENTALLY QUALIFIED.



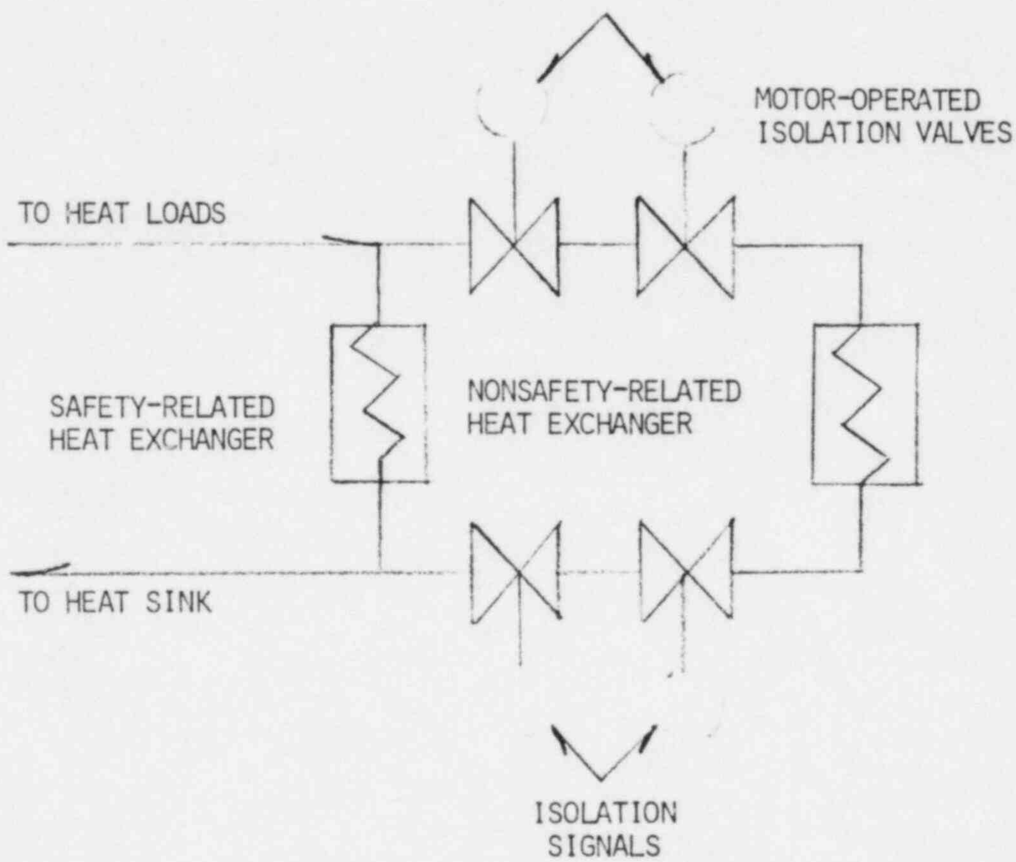
EXAMPLE #2

IN SOME CASES, THE ELECTRICAL CONTROL SYSTEM FOR A PUMP, FOR EXAMPLE A CHARGING PUMP OR AN ECCS PUMP, WILL INCLUDE TERMINATION COMMANDS ON LOSS OF LUBRICATION OIL PRESSURE OR LOW SUCTION PRESSURE. THESE FEATURES ARE NOT SAFETY RELATED, BUT ARE PROVIDED FOR EQUIPMENT PROTECTION. FAILURE OF THESE FEATURES WOULD DEFEAT THE SAFETY-RELATED FUNCTION. THEREFORE, THEY MUST BE ENVIRONMENTALLY QUALIFIED.



EXAMPLE #3

A SAFETY-RELATED FLUID SYSTEM MAY HAVE NONSAFETY-RELATED PORTIONS OF THE SYSTEM THAT ARE ISOLATED FROM THE SAFETY-RELATED PORTIONS OF THE SYSTEM UPON THE GENERATION OF A SAFETY FEATURES ACTUATION SIGNAL. ISOLATION MAY BE PERFORMED BY MOTOR-OPERATED VALVES. THESE VALVES AND VALVE OPERATORS MUST BE ENVIRONMENTALLY QUALIFIED.



(D) THE APPLICANT OR LICENSEE SHALL PREPARE A LIST OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY COVERED BY THIS SECTION. IN ADDITION, THE APPLICANT OR LICENSEE SHALL INCLUDE THE FOLLOWING INFORMATION FOR THIS ELECTRIC EQUIPMENT IMPORTANT TO SAFETY IN A QUALIFICATION FILE:

(1) THE PERFORMANCE SPECIFICATIONS UNDER CONDITIONS EXISTING DURING AND FOLLOWING DESIGN BASIS ACCIDENTS.

(2) THE VOLTAGE, FREQUENCY, LOAD AND OTHER ELECTRICAL CHARACTERISTICS FOR WHICH THE PERFORMANCE SPECIFIED IN ACCORDANCE WITH PARAGRAPH (D)(1) OF THIS SECTION CAN BE ENSURED.

(3) THE ENVIRONMENTAL CONDITIONS, INCLUDING TEMPERATURE, PRESSURE, HUMIDITY, RADIATION, CHEMICALS, AND SUBMERGENCE AT THE LOCATION WHERE THE EQUIPMENT MUST PERFORM AS SPECIFIED IN ACCORDANCE WITH PARAGRAPHS (D)(1) AND (2) OF THIS SECTION.

(G) EACH HOLDER OF AN OPERATING LICENSE ISSUED PRIOR TO THE EFFECTIVE DATE OF THIS AMENDMENT SHALL, BY A DATE 90 DAYS AFTER THE EFFECTIVE DATE OF THIS AMENDMENT, IDENTIFY THE ELECTRIC EQUIPMENT IMPORTANT TO SAFETY WITHIN THE SCOPE OF THIS SECTION ALREADY QUALIFIED AND SUBMIT A SCHEDULE FOR EITHER THE QUALIFICATION TO THE PROVISIONS OF THIS SECTION OR FOR THE REPLACEMENT OF THE REMAINING ELECTRIC EQUIPMENT IMPORTANT TO SAFETY WITHIN THE SCOPE OF THIS SECTION. THIS SCHEDULE MUST ESTABLISH A GOAL OF FINAL ENVIRONMENTAL QUALIFICATION OF THE ELECTRIC EQUIPMENT WITHIN THE SCOPE OF THIS SECITON BY THE END OF THE SECOND REFUELING OUTAGE AFTER MARCH 31, 1982 OR BY MARCH 31, 1985, WHICHEVER IS EARLIER.

(K) APPLICANTS FOR AND HOLDERS OF OPERATING LICENSES ARE NOT REQUIRED TO REQUALIFY ELECTRIC EQUIPMENT IMPORTANT TO SAFETY IN ACCORDANCE WITH THE PROVISIONS OF THIS SECTION IF THE NUCLEAR REGULATORY COMMISSION HAS PREVIOUSLY REQUIRED QUALIFICATION OF THAT EQUIPMENT IN ACCORDANCE WITH "GUIDELINES FOR EVALUATING ENVIRONMENTAL QUALIFICATION OF CLASS 1E ELECTRICAL EQUIPMENT IN OPERATING REACTORS," NOVEMBER 1979 (DOR GUIDELINES), OR NUREG-0588 (FOR COMMENT VERSION), "INTERIM STAFF POSITION ON ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT."

(1) REPLACEMENT EQUIPMENT SHALL BE QUALIFIED IN ACCORDANCE WITH THE PROVISIONS OF THIS SECTION UNLESS THERE ARE SOUND REASONS TO THE CONTRARY.

BRIEF BACKGROUND -- N.P. SMITH

DETAILS OF PILOT PROGRAM -- P.I. YANEV

CONCLUSIONS -- N.P. SMITH

T10

GOALS OF THE PILOT PROGRAM

- Develop a historical data base on the performance of equipment in power plants during and after strong earthquakes.
- Show that much of the equipment in those plants is similar to equipment found in nuclear power plants.
- Determine whether data from actual earthquakes are sufficient to conclude that seismic qualification by conventional methods is not necessary for certain classes of equipment.
- Develop a methodology for using earthquake data to evaluate the necessity for seismic qualification of specific items of equipment by conventional methods.

OVERALL CONCLUSIONS

- RESULTS OF THE PILOT PROGRAM INDICATE THERE IS NO SEISMIC PROBLEM FOR PROPERLY ANCHORED EQUIPMENT IN TYPICAL NUCLEAR PLANTS.

- BASED ON THE RESULTS OF THE PILOT PROGRAM, WE DO NOT BELIEVE THE SEISMIC ISSUE IS A SIGNIFICANT SAFETY ISSUE.

- DOCUMENTATION OF THE SEISMIC QUALIFICATION OF EXISTING EQUIPMENT DOES NOT WARRANT EXPENDITURES OF SIGNIFICANT RESOURCES WHICH COULD BE BETTER SPENT ON MORE IMPORTANT ISSUES.

SEISMIC QUALIFICATION UTILITY GROUP
MEMBERS

BALTIMORE GAS & ELECTRIC COMPANY
BOSTON EDISON COMPANY
COMMONWEALTH EDISON COMPANY
CONSOLIDATED EDISON COMPANY
CONSUMERS POWER COMPANY
DETROIT EDISON COMPANY
DUKE POWER COMPANY
FLORIDA POWER CORPORATION
GPU NUCLEAR CORPORATION
NEBRASKA PUBLIC POWER DISTRICT
NORTHERN STATES POWER COMPANY
PENNSYLVANIA POWER & LIGHT COMPANY
ROCHESTER GAS & ELECTRIC COMPANY
SOUTHERN CALIFORNIA EDISON COMPANY
TOLEDO EDISON COMPANY
YANKEE ATOMIC ELECTRIC COMPANY

EARTHQUAKE INVESTIGATIONS

EQE's engineers have visited more than seventeen earthquake areas throughout the world. In some cases we were able to arrive on the same day as the event. This experience is particularly valuable because it imparts a sense of the impending reality on our work. The more important earthquakes that we have personally surveyed in the field are:

1971 San Fernando, California (M6.5)
1972 Managua, Nicaragua (M6.3)
1973 Point Mugu (Oxnard), California (M5.9)
1973 Managua, Nicaragua (M5.8)
1975 Lice, Turkey (M6.8)
1976 Friuli, Northern Italy (M6.5)
1978 Izu Peninsula, Japan (M6.7)
1978 Miyagi-Ken-oki, Sendai, Japan (M7.4)
1978 Santa Barbara, California (M5.1)
1978 Bishop, California (M5.8)
1979 Gilroy, California (M5.5)
1979 Imperial Valley, California (M6.6)
1980 Livermore, California (M5.5 and M5.8)
1980 San Luis Obispo County, California (M4.6)
1980 Mammoth Mountain, California (M6.5, 6.5 and 6.7)
1980 Eureka, California (M7.0)
1981 Brawley, California (M5.6)

We have published several reports on these earthquakes and have conducted extensive post-event analyses.

1981 AND 1982 SEISMIC EQUIPMENT QUALIFICATION EXPERIENCE

Nuclear Utility Clients

Consumers Power Company

Walkdowns and in-situ testing, Big Rock Point Plant
Crane analyses, Big Rock Point Plant

Pacific Gas and Electric Company

In-situ testing, Humboldt Bay Unit 3

Yankee Atomic Electric Company

Walkdown, evaluation, in-situ testing, and qualification of Yankee Rowe Plant safety-related equipment

Lawrence Livermore National Laboratory

Fragility evaluation, in-situ testing of El Centro Steam Plant, Unit 4

Systematic Evaluation Program (SEP) Owners Group

Set up program for seismic qualification using actual earthquake experience

Seismic Qualification Utilities Group (SQUG)

Major equipment qualification study on effects of past earthquakes on power plant equipment

Conventional Clients - Seismic Equipment Evaluation and Strengthening

The Aerospace Corporation, El Segundo, California
Amdahl Corporation, Sunnyvale, California
American Automobile Association (AAA), San Francisco, California
Burke Industries, San Jose, California
City of Palo Alto, California
Federal Emergency Management Agency, Washington, D.C.
The Folger Coffee Company, South San Francisco, California
Freemark Abbey Winery, St. Helena, California
Grove Valve & Regulator Co., Oakland, California
Intel Corporation, Santa Clara, California
Kelly-Moore Paint Company, San Carlos, California
MCA Inc., Universal City, California
National Science Foundation, Washington, D.C.
The North Face, Berkeley, California
Raychem Corporation, Menlo Park, California
TRW Inc., Redondo Beach, California
Transamerica Corporation, San Francisco, California
Zilog, Campbell, California

BACKGROUND

- INDUSTRIAL EQUIPMENT IS DESIGNED TO WITHSTAND DYNAMIC LOADS ASSOCIATED WITH NORMAL OPERATION.
- EARTHQUAKE EXPERIENCE INDICATES THAT MAJOR EQUIPMENT FAILURE IS RARE.
- LOOK BEYOND DOCUMENTED EXPERIENCE OF EQUIPMENT SURVIVING EARTHQUAKES.
- SELECT A FEW EXAMPLES OF EQUIPMENT USED IN NUCLEAR POWER PLANTS AND EVALUATE THE EXPERIENCE OF THAT EQUIPMENT DURING AND AFTER STRONG EARTHQUAKES.

GOALS OF THE PILOT PROGRAM

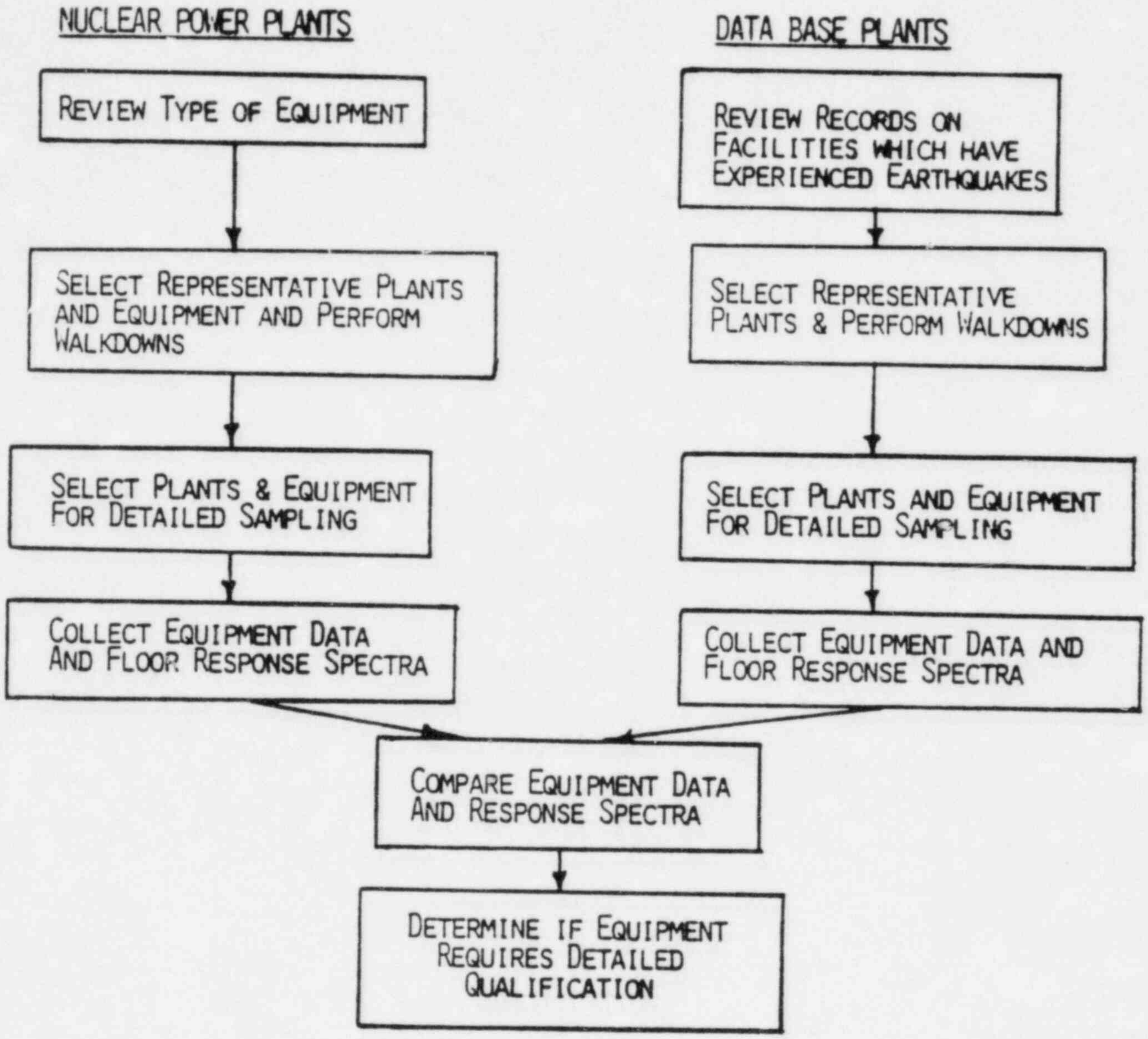
- DEVELOP A HISTORICAL DATA BASE ON THE PERFORMANCE OF EQUIPMENT IN POWER PLANTS DURING AND AFTER STRONG EARTHQUAKES.

- SHOW THAT MUCH OF THE EQUIPMENT IN THOSE PLANTS IS SIMILAR TO EQUIPMENT FOUND IN NUCLEAR POWER PLANTS.

- DETERMINE WHETHER DATA FROM ACTUAL EARTHQUAKES ARE SUFFICIENT TO CONCLUDE THAT SEISMIC QUALIFICATION BY CONVENTIONAL METHODS IS NOT NECESSARY FOR CERTAIN CLASSES OF EQUIPMENT.

- DEVELOP A METHODOLOGY FOR USING EARTHQUAKE DATA TO EVALUATE THE NECESSITY FOR SEISMIC QUALIFICATION OF SPECIFIC ITEMS OF EQUIPMENT BY CONVENTIONAL METHODS.

METHOD USED IN PILOT STUDY



EQUIPMENT SELECTION

- Equipment Selected:
  - Motor Control Centers
  - 480 Volt Switchgear
  - 2.4 to 4kV Switchgear
  - Motor-operated valves
  - Air-operated valves
  - Horizontal Pumps
  - Vertical Pumps

- Seven Nuclear Power Plants Visited - Three selected for equipment data collection:

PLANT	DESIGN BASIS SSE
- Dresden 3	0.2G
- Calvert Cliffs 1	0.15G
- Pilgrim	0.15G

SELECTED MAJOR EARTHQUAKES THAT HAVE AFFECTED
POWER AND INDUSTRIAL FACILITIES (Yanev, 1981)

Earthquake and Location	Year	Approximate Richter Magnitude	Recorded Peak Ground Acceleration (g)	Estimated Number of Ground Motion Records	Power Plant Units Affected
1. Eureka, CA	1980	7.0	0.15+	8	3
2. Imperial Valley, CA	1979	6.6	0.81+	50	4
3. Miyagi-Ken-oki, Japan	1978	7.4	0.40	100+	10+
4. Friuli, Italy	1976	6.5	0.30+	30+	?
5. Eureka, CA	1975	5.5	0.35	Several	3
6. Point Mugu, CA	1973	5.9	0.09	10+	2
7. Managua, Nicaragua	1972/3	6.2	0.60	4+	3
8. San Fernando, CA	1971	6.5	1.25	60+	20+
9. Caracas, Venezuela	1967	6.5		--	Several*
10. Seattle, Washington	1965	6.5	0.08	3	Several
11. Alaska	1964	8.4		--	7
12. Niigata, Japan	1964	7.5	0.18+	Several	Several
13. Chile	1960	8.5		None	Several
14. Kern County, CA	1952	7.7	0.13	5+	1
15. Long Beach, CA	1933	6.3	0.15+	Several	5

+ Indicates equal to or greater than the number shown.
* Actual number not determined.

EQE

SUMMARY OF DATA BASE PLANTS

& EARTHQUAKES

EARTHQUAKES	FACILITY	ESTIMATED PGA
SAN FERNANDO 1971	1. SYLMAR CONVERTER STATION	0.50 - 0.75**
	2. VALLEY STEAM PLANT	0.40**
	3. BURBANK POWER PLANT	0.35**
	4. GLENDALE POWER PLANT	0.30**
	5. PASADENA POWER PLANT	0.20**
	6. RINALDI RECEIVING	0.50**
	7. VINCENT SUBSTATION	0.20**
	8. SAUGUS SUBSTATION	0.39*
POINT MAGU 1973	9. ORMOND BEACH PLANT	0.20**
	10. SANTA CLARA SUBSTATION	0.10**
SANTA BARBARA 1978	11. GOLETA SUBSTATION	0.28*
	12. ELLWOOD PEAKER PLANT	0.30 - 0.40**
IMPERIAL VALLEY 1979	13. EL CENTRO STEAM PLANT	0.51*
	14. MAGMAMAX GEOTHERMAL PLANT	0.20 - 0.30**

BASED ON:

* RECORDED PEAK GROUND ACCELERATION - AT PLANT SITE

** LOCATED NEAR STRONG MOTION RECORDS

SANTA BARBARA EARTHQUAKE, 1978

Goleta Substation
Ellwood Peaker Plant

POINT MUGU EARTHQUAKE, 1973

Ormond Beach Plant
Santa Clara Substation

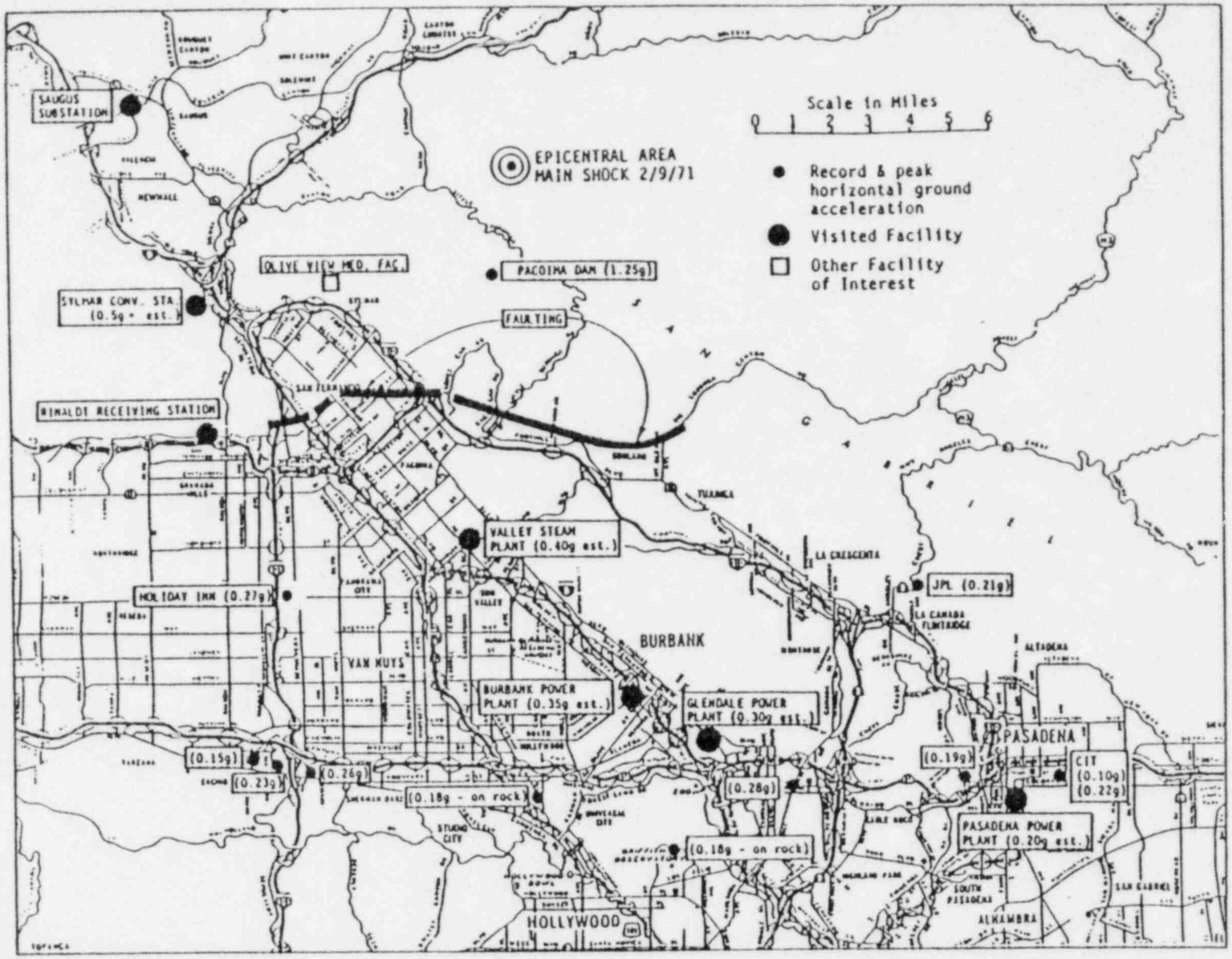
SAN FERNANDO EARTHQUAKE, 1971

Sylmar Converter Station
Valley Steam Plant
Burbank Power Plant
Glendale Power Plant
Pasadena Power Plant
San Fernando Power Plant
Rinaldi Receiving Station
Vincent Substation
Saugus Substation

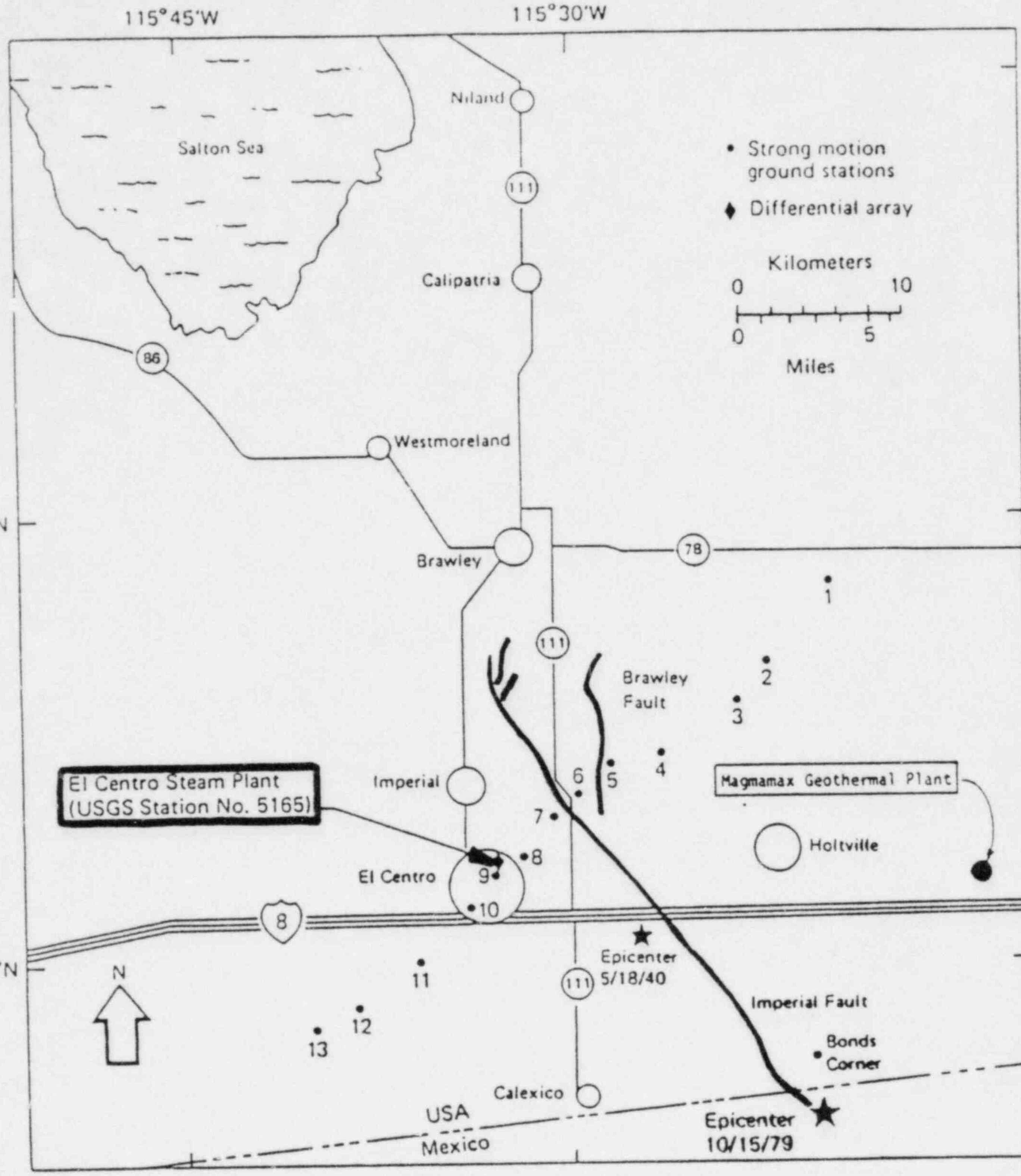
IMPERIAL VALLEY EARTHQUAKE, 1979

El Centro Steam Plant
Magmamax Geothermal Plant

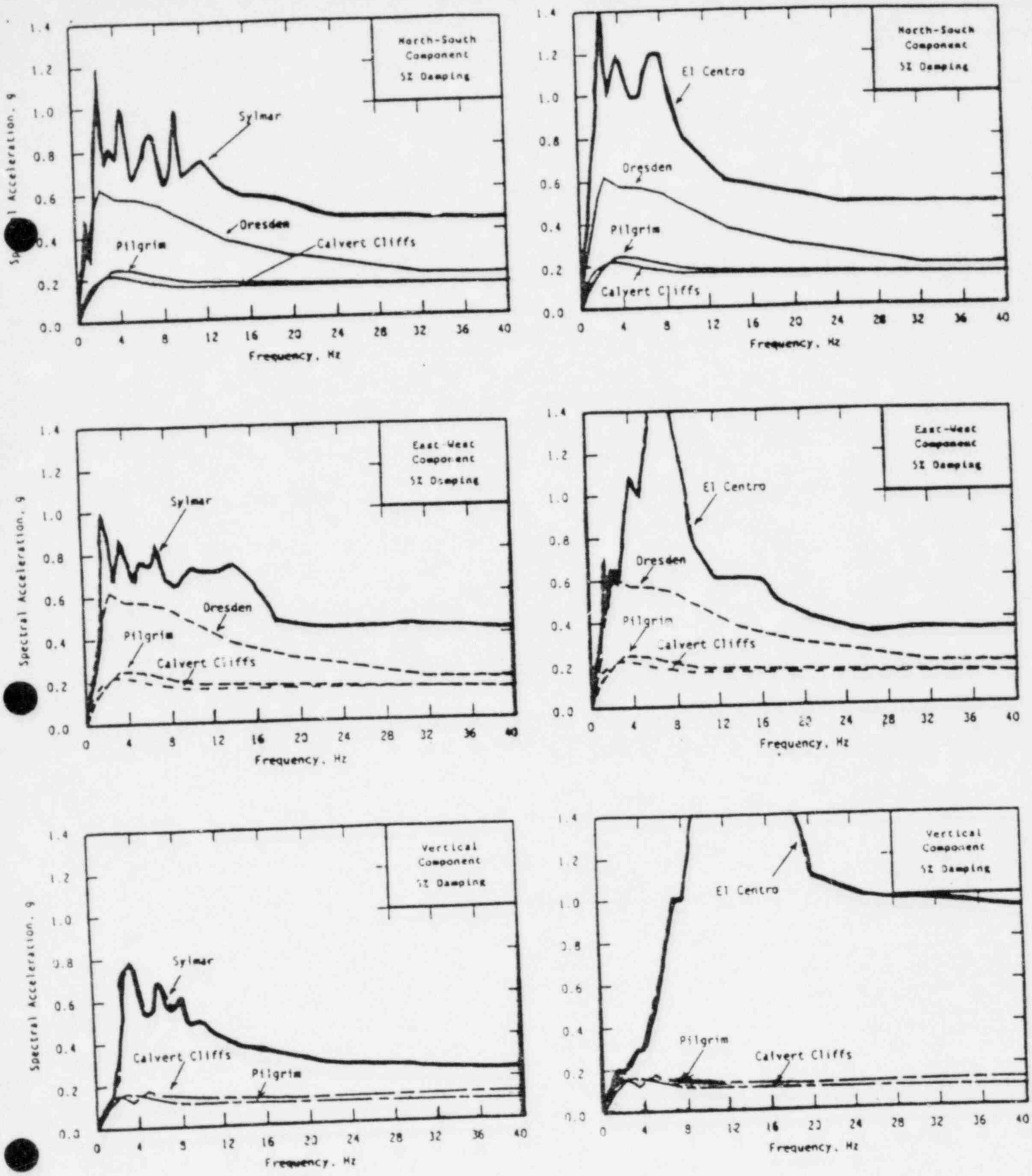
Generalized location of surveyed facilities listed in Table 2.



Location of San Fernando Valley power plants and other facilities with respect to the 1971 earthquake epicenter, fault, and nearby strong-motion accelerograph records.



Map of the Imperial Valley, California, showing the ruptured segments of the Imperial fault, and the El Centro Steam Plant and Magmamax Plant sites. Also shown is the strong motion array that straddles the fault.



Free field Sylmar Converter Station (San Fernando, 1971 event) and El Centro Steam Plant (1979 Imperial Valley event) ground spectra compared to three nuclear power plant SSE free field ground spectra.

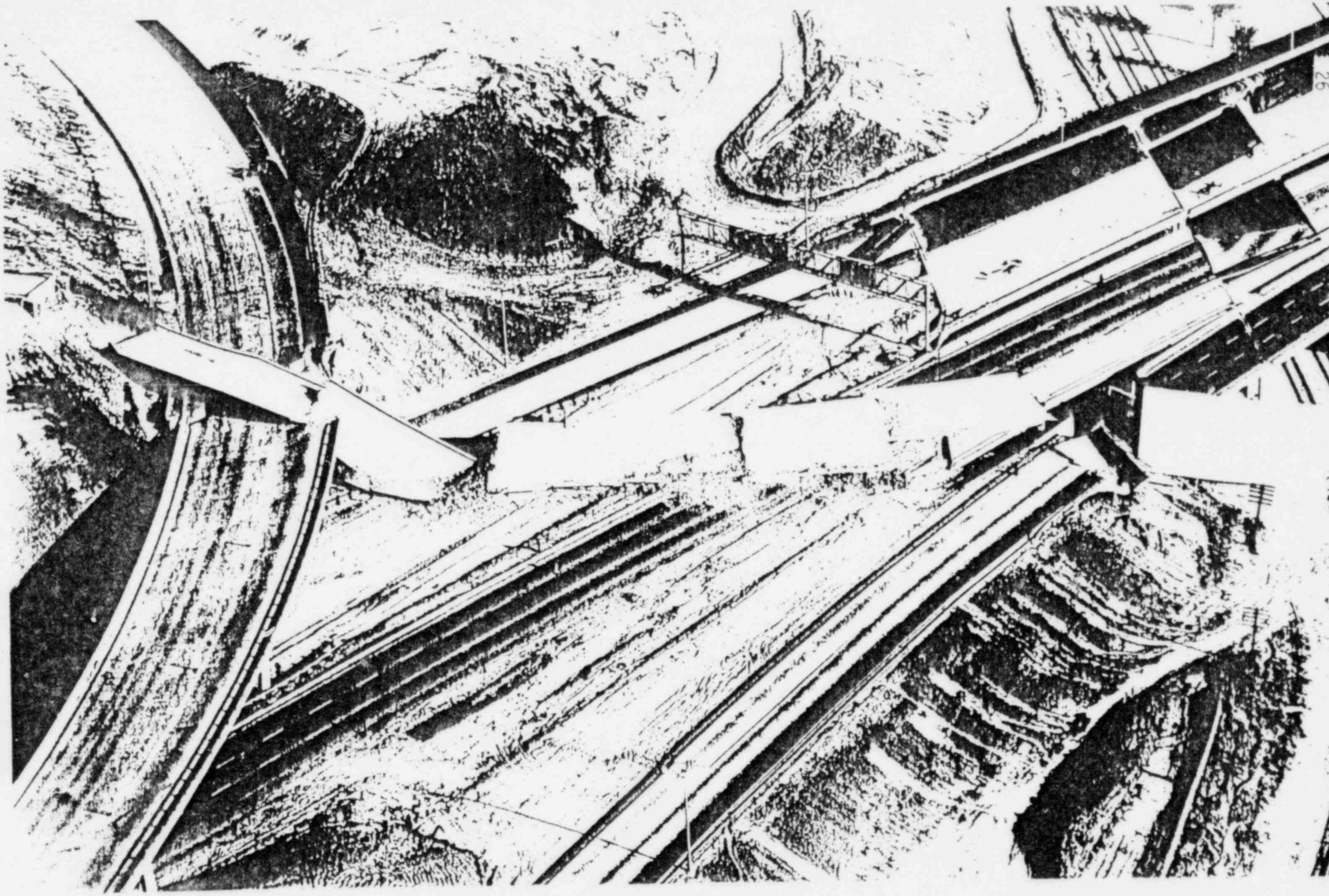


FIGURE 7: Damaged and collapsed interstate overpasses in San Fernando. The Sylmar Converter Station is located just outside of the photographed area (Los Angeles Time Photo).

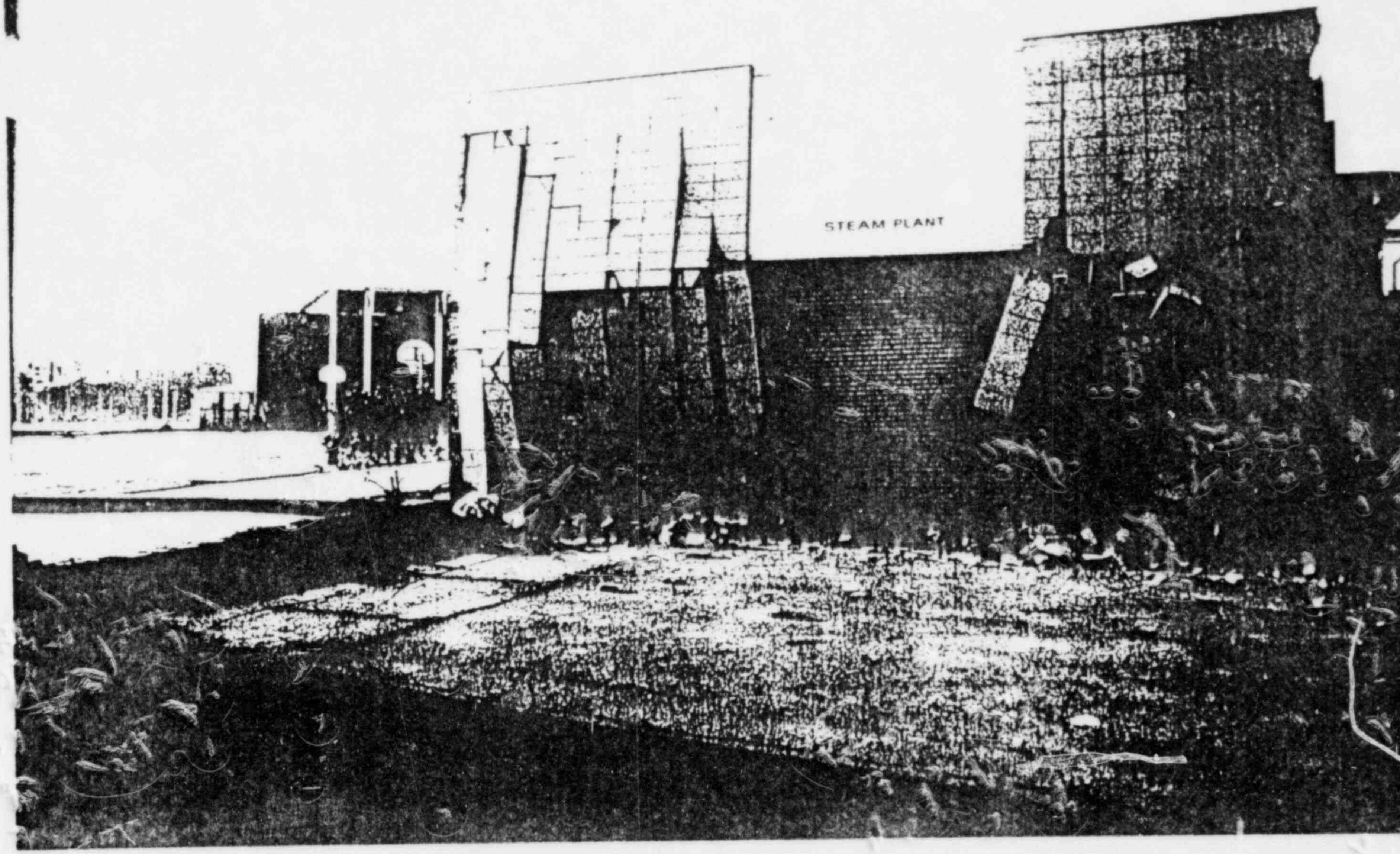
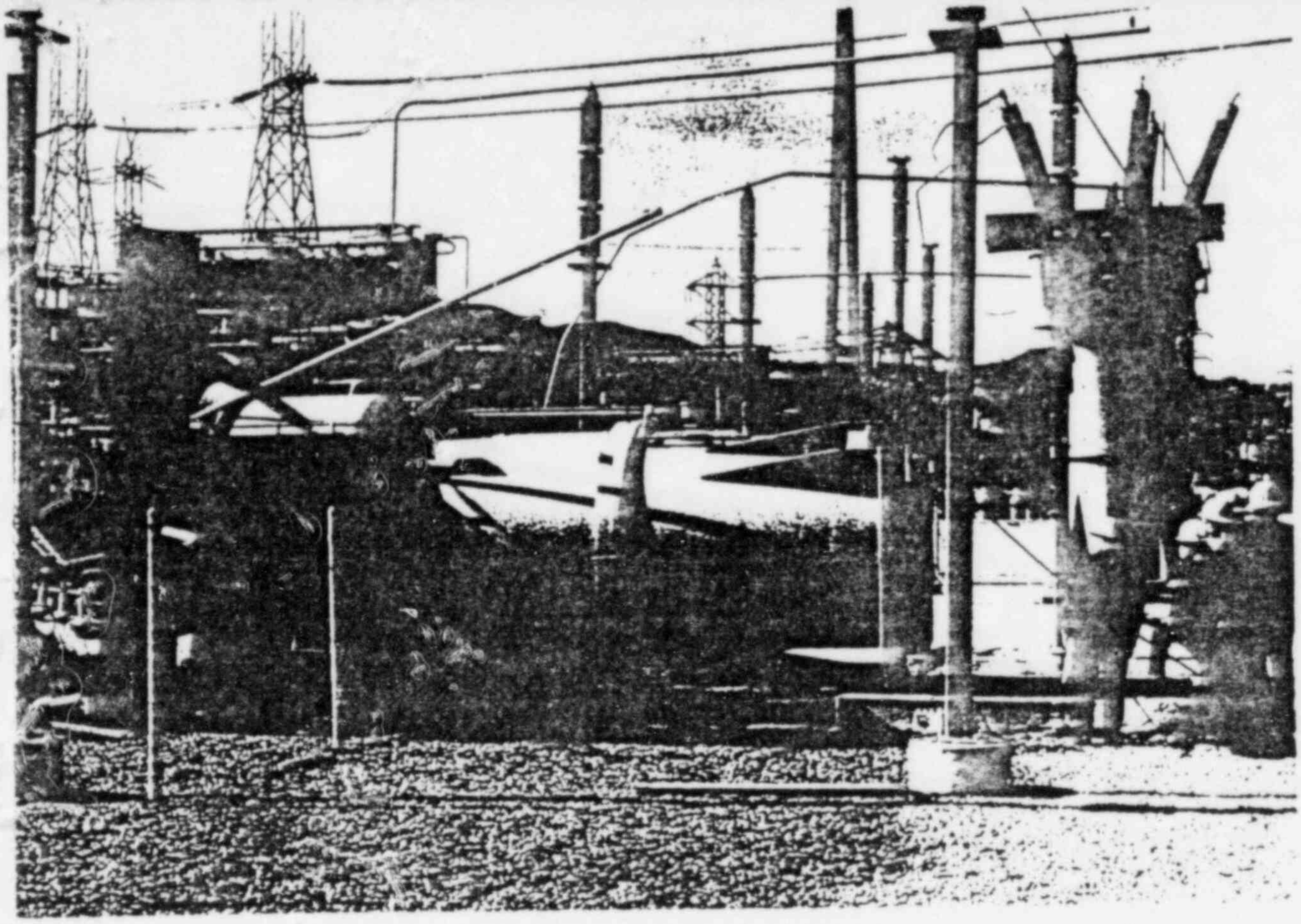


FIGURE 8: The damaged steam plant of the Los Angeles County Juvenile Facility, which is next to the Sylmar Converter Station.



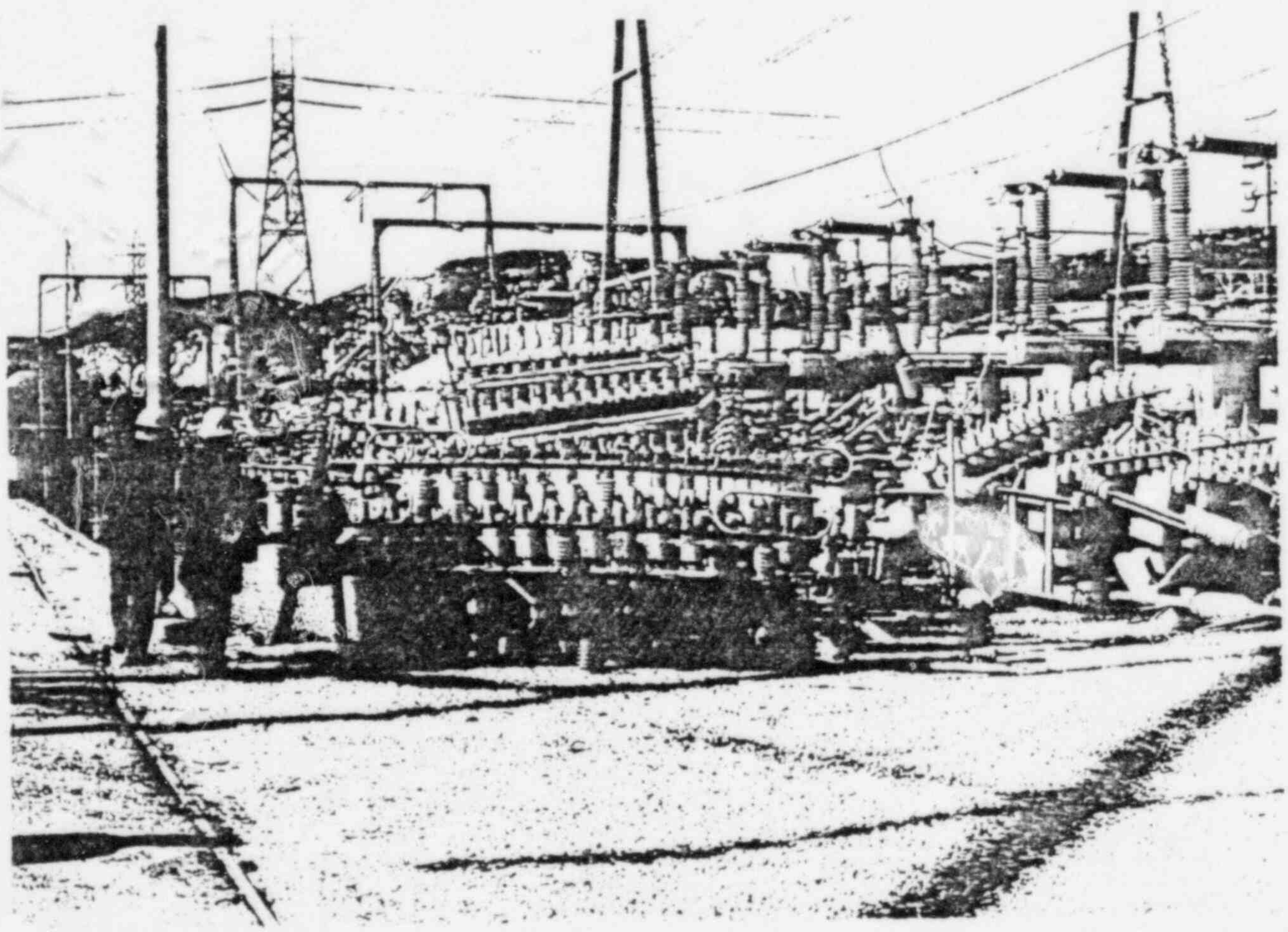


FIGURE 9: Typical damage to inadequately anchored electrical equipment at the Sylmar Converter Station.

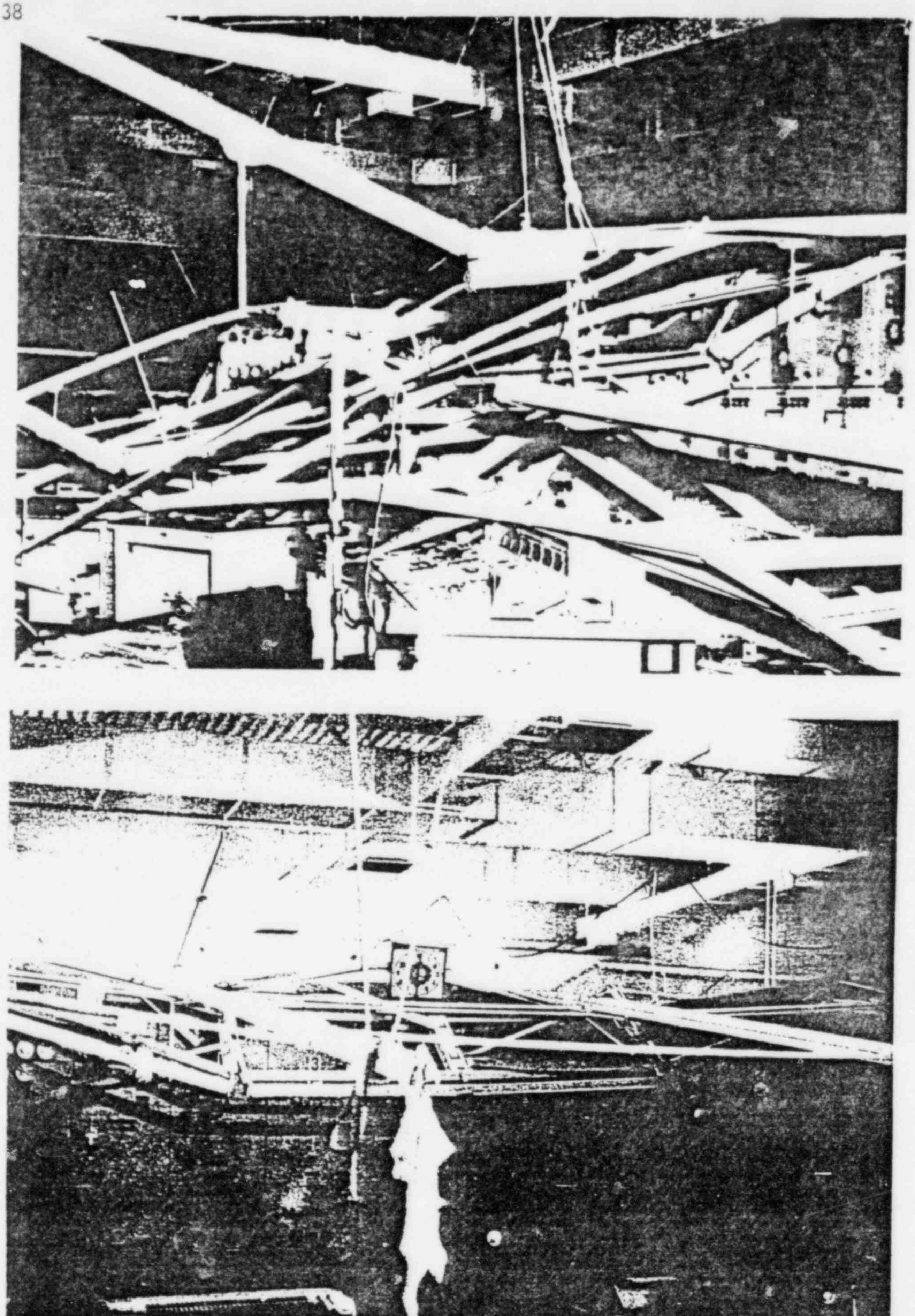
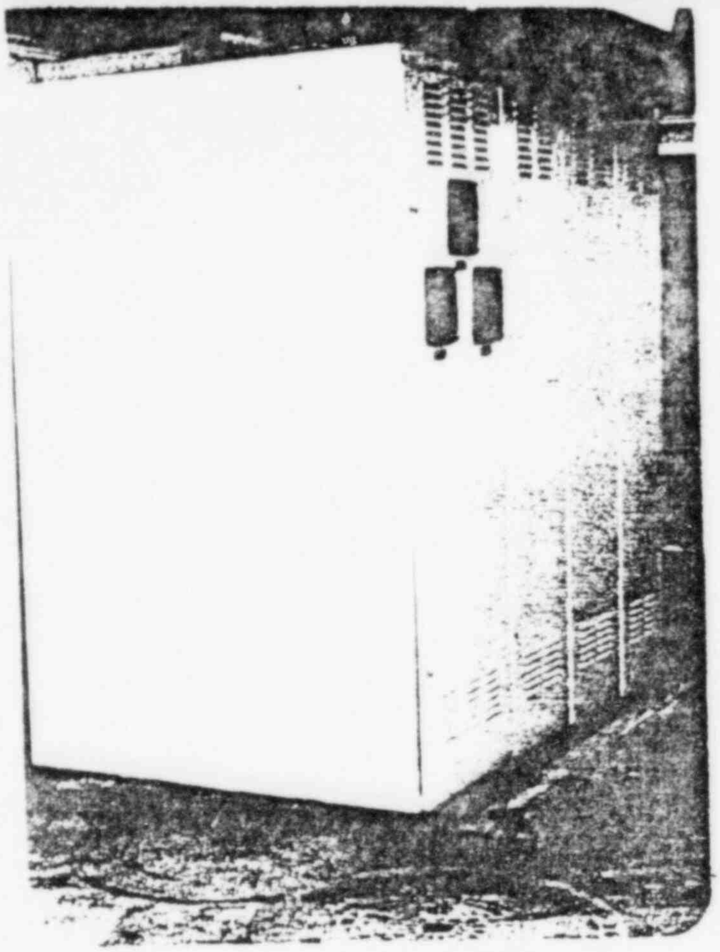
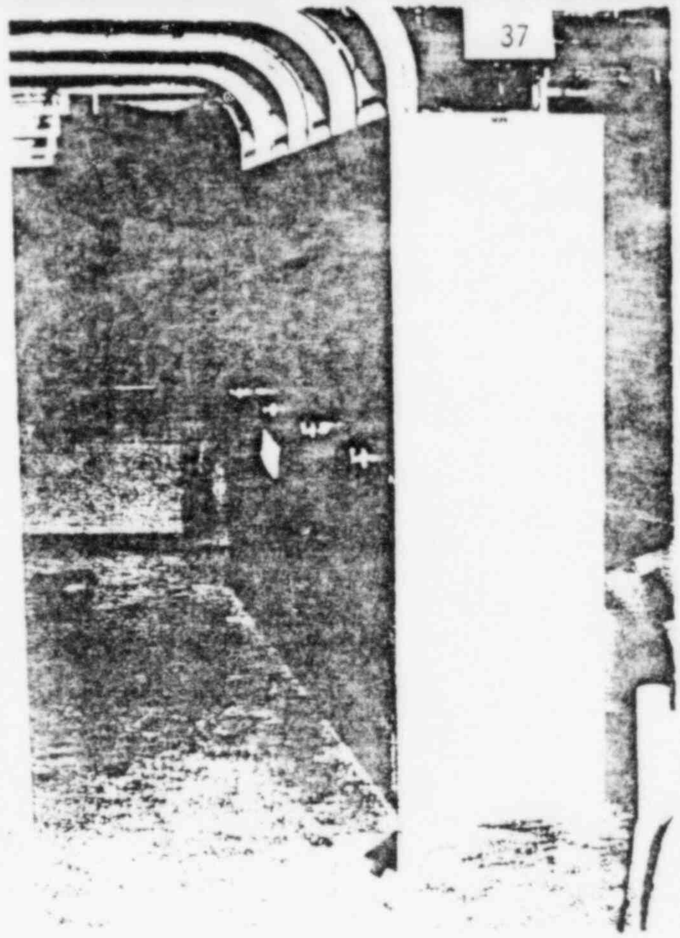


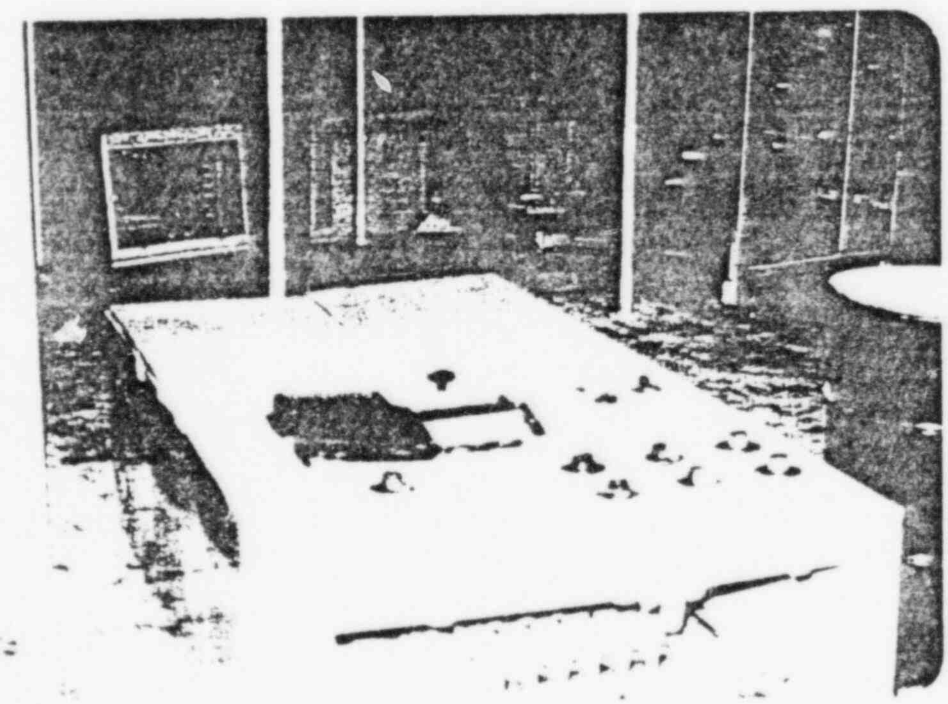
FIGURE 14: The collapsed ceiling of the control room of the Sylmar Converter Station.



Unanchored switchgear shifted a few inches off the leveling plates.

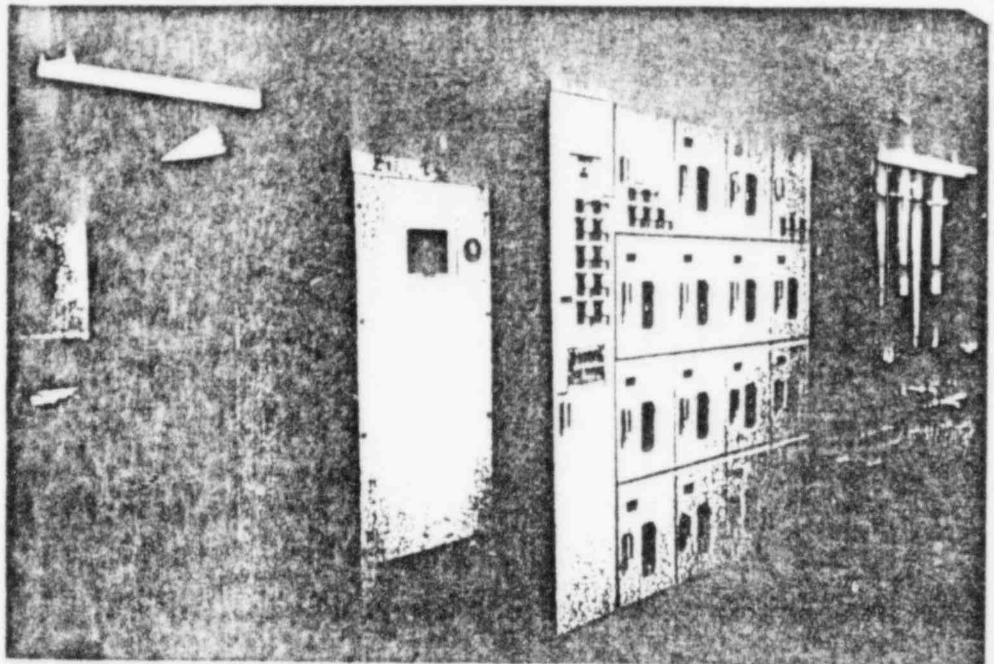


A cabinet with terminal blocks and relays was anchored with short screws. Only two threads were engaged and the cabinet broke loose and shifted.

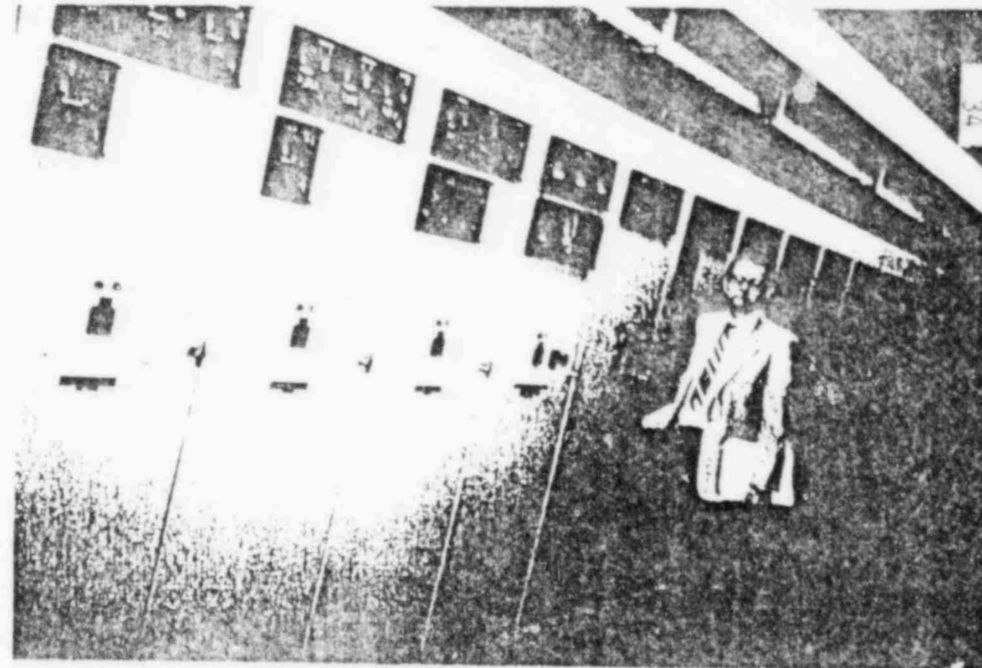


Unanchored and unsecured spare electrical cabinets fell and were heavily damaged.

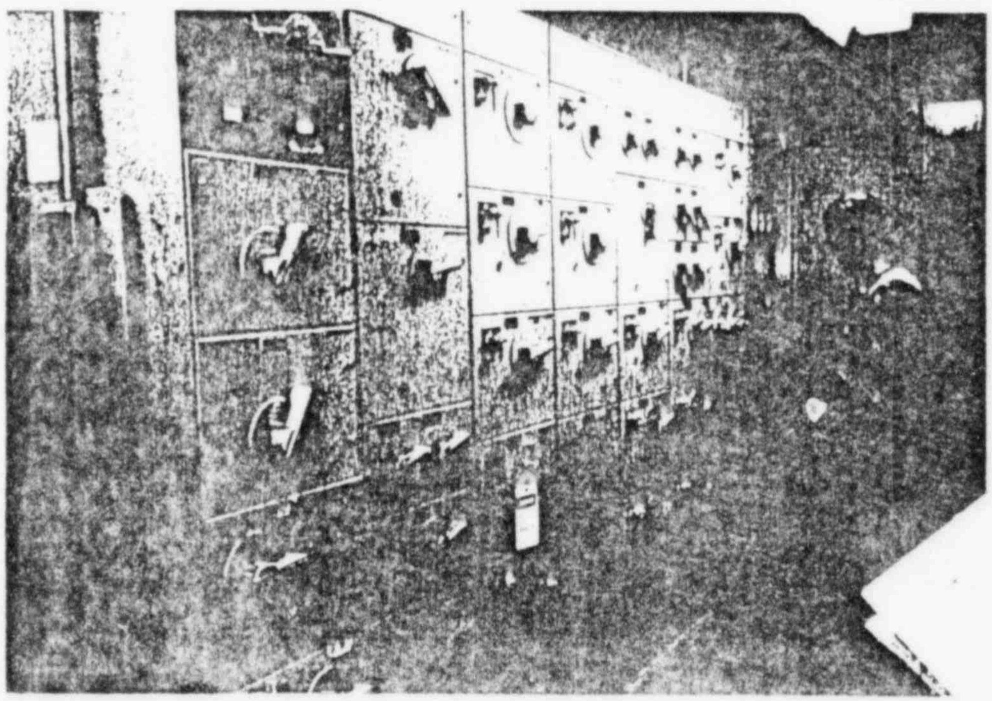
FIGURE 13: Damage at the Sylmar Converter Station (from Yanev 1973)



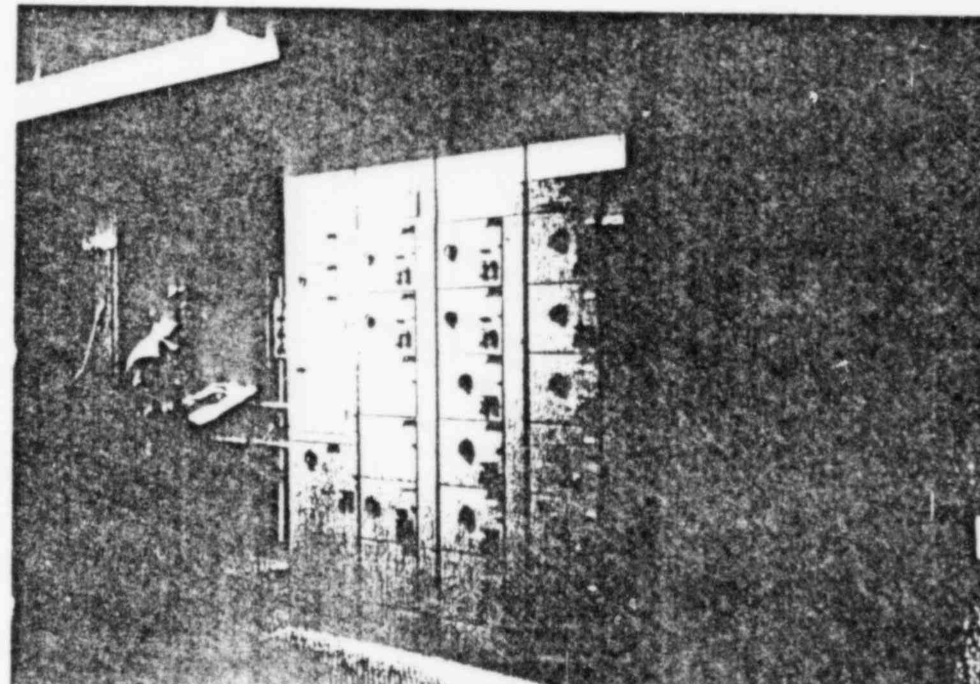
General Electric 480-V Switchgear



General Electric 4kV Switchgear



Unitrol Motor Control Centers



General Electric Motor Control Centers

FIGURE 11: Typical undamaged equipment, Sylmar Converter Station

TYPICAL SEISMIC CRITERIA OF DATA BASE PLANTS

. STEEL STRUCTURES

0.20G STATIC

. CONCRETE STRUCTURES

0.13G OR LESS STATIC

. EQUIPMENT ANCHORAGE

0.20G STATIC FORCE APPLIED AT C.G.; NO SEISMIC CONSIDERATIONS FOR STRUCTURAL INTEGRITY AND OPERABILITY

. PIPING

NO SEISMIC DESIGN CRITERIA

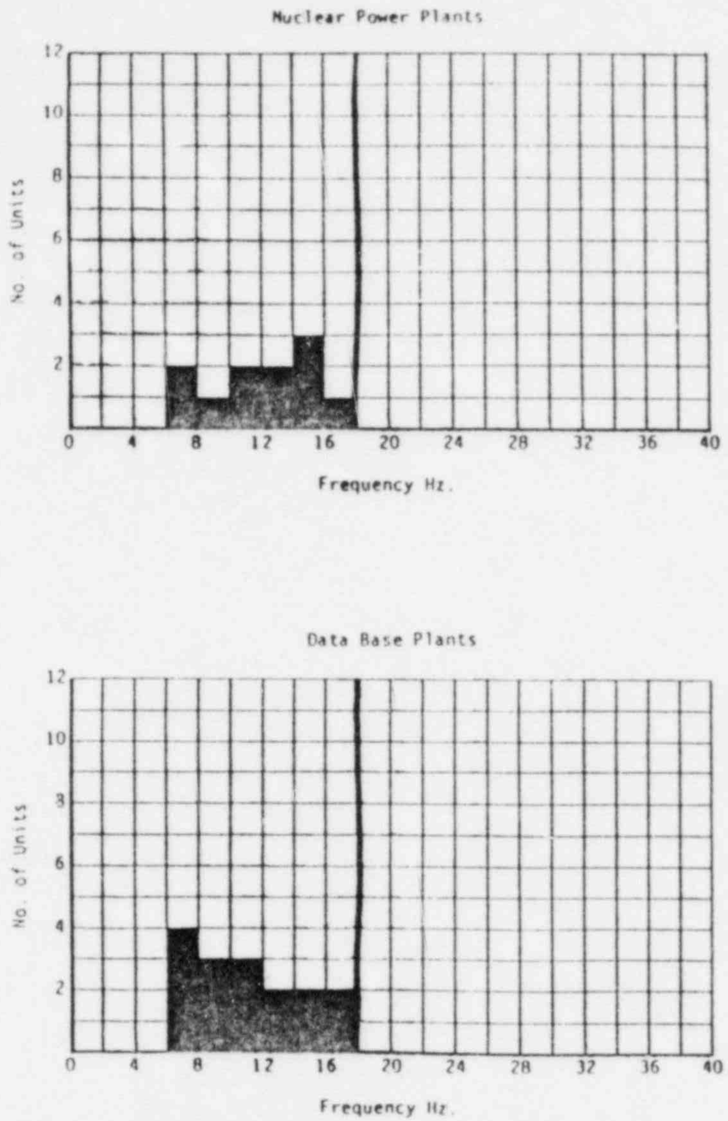
SUMMARY OF THE OVERALL PERFORMANCE OF THE DATA BASE PLANTS REVIEWED IN DETAIL

Power Plant and Unit	Size MW	Vintage	Peak Ground Acceleration (g)	Performance During Earthquake: Remained on Line	Tripped Off Line, But Still Operating	Lost Station Power	Summary of Equipment Damage
Sylmar Converter Station	1440	1970	0.50'	-	-	X	Extensive switchyard damage, unanchored cabinets slid or overturned. HVAC coolers broke isolation mounts.
El Centro:							
Unit 1*	20	1948	0.50				Broken cooling water lines.
Unit 2*	30	1952	0.50				Broken air-operated valve.
Unit 3	44	1957	0.50	-	X	-	Leakage from large oil tanks.
Unit 4	80	1968	0.50	-	-	X	Minor switchyard damage.
Valley:							
Unit 1	100	1954	0.40	-	-	X	Tube ruptures in condenser.
Unit 2*	100	1954	0.40				Minor switchyard damage.
Unit 3	160	1955	0.40	X	-	-	
Unit 4	160	1956	0.40	-	-	X	
Burbank							
Olive:							
Unit 1	44	1958	0.35	-	X	-	Broken pipe on demineralizer tank.
Unit 2	44	1961	0.35	-	X	-	
Magnolia:							
Unit 1*	10	1940s	0.35				Broken demineralizer piping.
Unit 2	10	1940s	0.35	X	-	-	Broken bolts on gantry crane.
Unit 3	20	1950s	0.35	X	-	-	Broken fuel oil gauge line.
Unit 4*	30	1950s	0.35				Leaks in 2-inch cooling water line.
Unit 5*	20	1968	0.35				
Glendale:							
Unit 1*	20	1941	0.30				Broken line of draft fan.
Unit 2*	20	1947	0.30				Broken line on demineralizer.
Unit 3	20	1953	0.30	X	-	-	
Unit 4	44	1959	0.30	X	-	-	
Unit 5	44	1964	0.30	X	-	-	
Pasadena:							
Unit 1	45	1955	0.20	X	-	-	Disconnected linkage on air-flow monitor
Unit 2**	45	1957	0.20				
Unit 3	71	1965	0.20	X	-	-	
Unit 4**	45	1949	0.20				

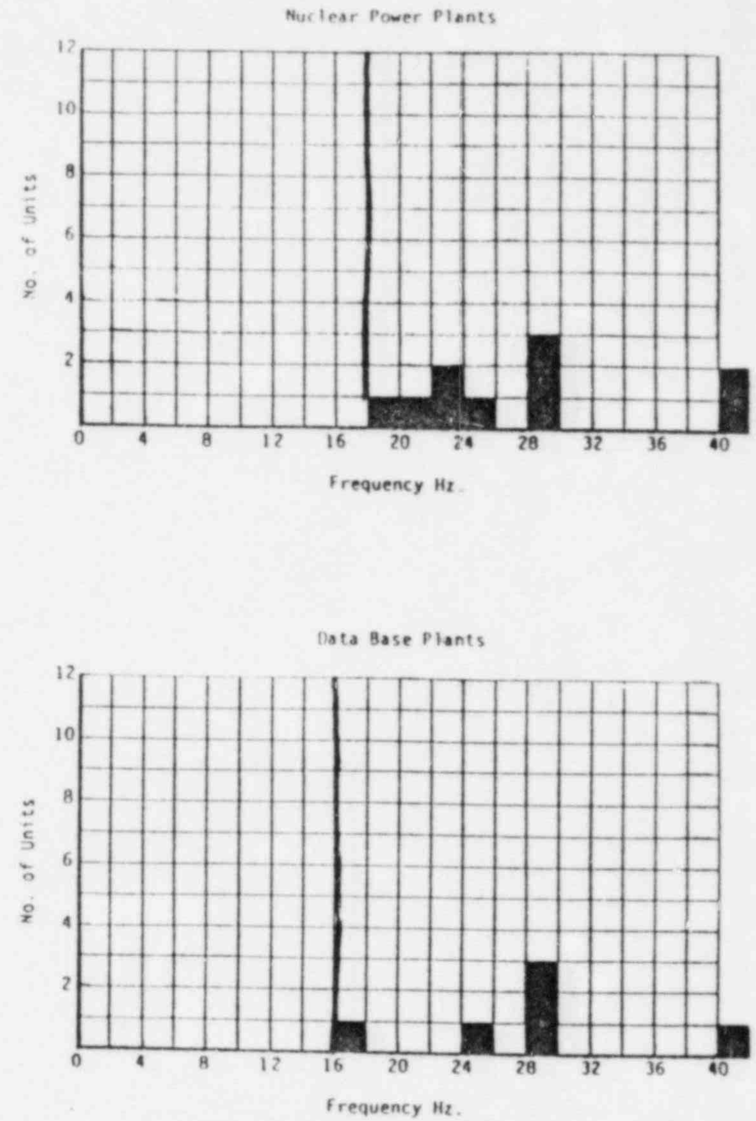
* Not operating at time of earthquake
** On hot standby at time of earthquake
' 0.50g or greater

EQE

T13



Distribution of the response frequencies of the transverse rocking mode of tested 480-V motor control centers.



Distribution of response frequencies for tested motor control center starter units.

MOTOR CONTROL CENTERS

PEAK GROUND ACCELERATION	NO. OF MOTOR CONTROL CENTERS EXCEEDING THIS PGA	NO. OF MOTOR CONTROL STARTERS EXCEEDING THIS PGA
0.50	24	350
0.40	40	550
0.35	46	650
0.30	64	800
0.20	67	850

PUMPS

Peak Ground Acceleration	Number of Horizontal Pumps Exceeding this PGA	Number of Vertical Pumps Exceeding this PGA
0.50	50	25
0.40	90	85
0.35	160	115
0.30	210	145
0.20	240	160

SUMMARY CONCLUSIONS

	Numbers of Pieces of Equipment Experiencing PGA in excess of 0.2g		Number of Pieces Of Equipment Damaged
Motor Control Center Cabinets	67		0
- Motor Control Starters		850	0
480 Volt Switchgear Cabinets	29		0
- 480 Volt Circuit Breakers		350	0
Metal Clad Switchgear Cabinets	185		0
- Door Mounted Relays		550	0
Motor-Operated Valves		45	0
Air-Operated Valves		370	1*
Horizontal Pumps		240	0
Vertical Pumps		160	0
	281	2,565	1*

* The valve damaged was the result of impacting with an adjacent girder.

METHODOLOGY FOR COMPARISONS

COMPARE NAME PLATE DATA AND EQUIPMENT DIMENSIONS

TEST BOTH ITEMS OF EQUIPMENT TO ESTABLISH LOWER RESPONSE FREQUENCIES AND MODE SHAPES

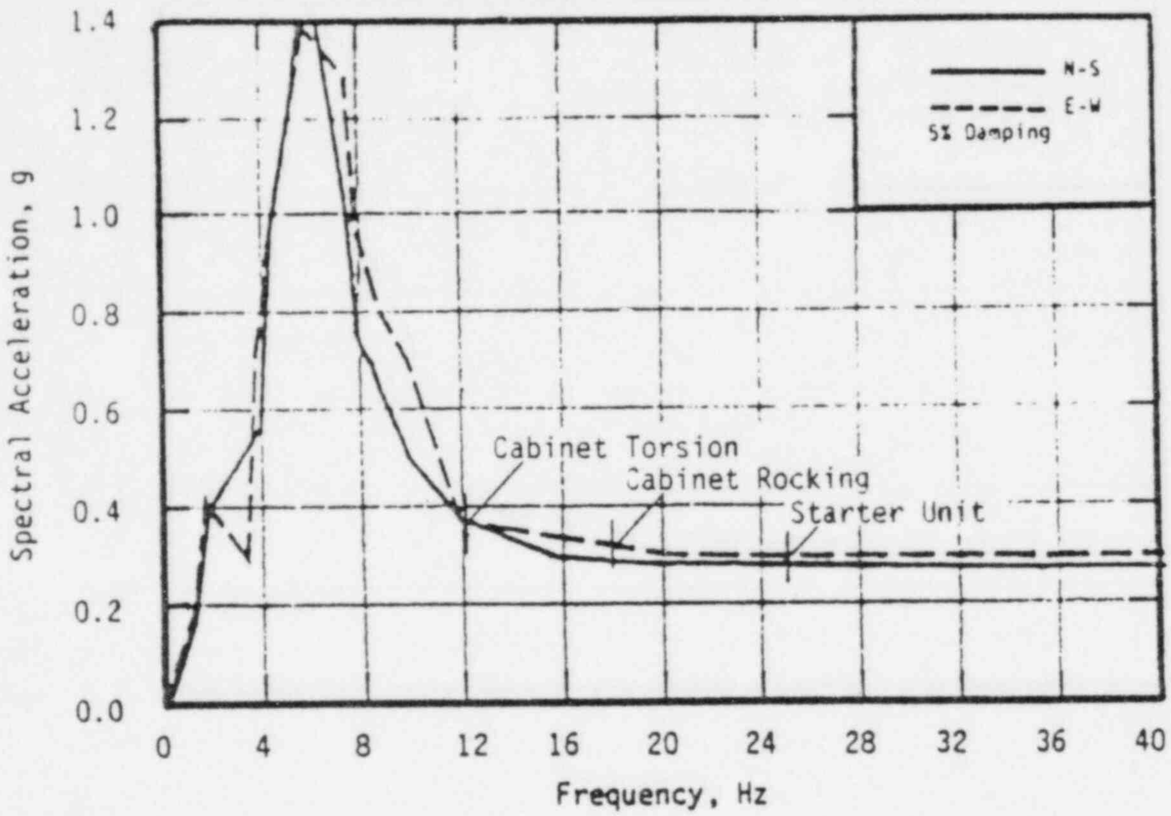
CHECK MEASURED RESPONSE DATA TO ASSURE THAT IT FALLS WITHIN THE EXPECTED RANGES FOR THE TYPE OF EQUIPMENT

CHECK TO ASSURE THAT THE DATA BASE FLOOR RESPONSE SPECTRA ENVELOPE THE NUCLEAR EQUIPMENT REQUIRED FLOOR RESPONSE SPECTRA

CHECK BY ANALYSIS TO ASSURE ADEQUATE ANCHORAGE OF THE NUCLEAR EQUIPMENT FOR THE REQUIRED SEISMIC LOADS

ITEM: 480 Volt Motor Control Center 39-3

PLANT: Dresden, Unit 3



Manufacturer: General Electric 7700 Line Series Vintage: 1970

Location: Reactor Building Elevation 570, facing east.

Function/System: Control of various class I mechanical systems.

Cabinet: Cabinet is six cubicles wide, 13 inches deep, containing only starter units of various sizes.

Components: GE starter units consisting of circuit breaker, control transformer, terminal block and GE magnetic contactors Type CR-106 or CR-105.

Anchorage: Tack welds to an embedded base plate; two per stack of cubicles along front and rear bottom channels.

Applicable Response Spectra: The calculated floor spectra for the Reactor Building, Elevation 589 are shown.

ITEM:	480 Volt Motor Control Center Cabinets 1VA-6VA, P3A & P4A (Eight Units)	480 Volt Motor Control Center 39-3
PLANT:	Sylmar Converter Station	Dresden Nuclear Plant, Unit 3
MANUFACTURER:	General Electric 7700 Line Series, 1970	General Electric 7700 Line Series, 1971
LOCATION:	Sylmar Converter Station basement, facing northeast and southwest	Reactor Building Elevation 570, facing east (grade is at Elevation 517.5)
FUNCTION/SYSTEM:	Control of pumps and valves for rectifier cooling systems	Control of various Class I mechanical systems
CABINET:	Each cabinet is four cubicles wide; the specific arrangement of starter units varies from cabinet to cabinet; they are otherwise very similar.	Cabinet is six cubicles wide. The cabinet contains starter units in cubicles of various sizes.
COMPONENTS:	A typical starter unit consists of a General Electric CR-106 magnetic contactor, a circuit breaker switch, a control transformer, on-off pushbuttons and a terminal block.	A typical starter unit consists of a General Electric CR-106 or CR-105 magnetic contactor, a circuit breaker switch, a control transformer, on-off pushbuttons, and a terminal block.
ANCHORAGE:	The bottom channel of the cabinet is tack welded to a baseplate embedded in the concrete floor. At least one cabinet was inadequately anchored at the time of the earthquake and slid a few inches.	The bottom channel is tack welded to an embedded baseplate, two welds at the base of each stack of cubicles, front and back.
APPLICABLE RESPONSE SPECTRA:	The records taken at Pacoima Dam are shown scaled to 40% of the measured amplitudes as a conservative estimate of the ground motion at Sylmar.	The calculated floor spectra for the Reactor Building, Elevation 589 are shown. Spectra at Elevation 570 were not generated.
EQUIPMENT STATUS DURING AND FOLLOWING THE EARTHQUAKE:	The MCCs were in operation at the time of the earthquake. No damage to either cabinet or components was reported. One cabinet slid a few inches due to lack of floor anchorage. Source: References 1, 10, 20, 25, 26, 27, 30 and 32 (Appendix A).	

Comparison of equipment data: eight MCCs from the Sylmar Converter Station and Dresden MCC 39-3

MAJOR CONCLUSIONS

GOAL 1

GOAL: DEVELOP A HISTORICAL DATA BASE ON THE PERFORMANCE OF EQUIPMENT IN CONVENTIONAL POWER PLANTS DURING AND AFTER STRONG EARTHQUAKES.

FINDINGS:

- SEVERAL POWER PLANTS AND OTHER INDUSTRIAL FACILITIES HAVE EXPERIENCED STRONG EARTHQUAKES EXCEEDING THE FREE FIELD SAFE-SHUTDOWN EARTHQUAKES REQUIRED FOR THE DESIGN OF MOST UNITED STATES NUCLEAR PLANTS.
- THE PLANTS RESPONDED WELL TO THE EARTHQUAKES AND USUALLY CONTINUED TO OPERATE OR WERE BACK ON LINE SHORTLY AFTER THE EARTHQUAKES.
- MANY OF THE FACILITIES WERE IN OPERATION AT THE TIME OF THE EARTHQUAKES; THUS THEIR EQUIPMENT WAS SUBJECTED TO NORMAL OPERATING LOADS IN ADDITION TO THE SEISMIC LOADS FROM THE EARTHQUAKES.
- WITH A FEW MINOR EXCEPTIONS, THE EQUIPMENT CONTAINED IN THE POWER FACILITIES WAS UNDAMAGED AND WAS FUNCTIONAL AFTER THE EARTHQUAKES. THE EQUIPMENT WAS NOT KNOWN TO BE MODIFIED BECAUSE OF THE EARTHQUAKES.
- SUFFICIENT DATA EXIST TO ESTIMATE THE SPECTRA EXPERIENCED BY THE PLANTS AND THEIR EQUIPMENT.
- THERE IS A LARGE, AVAILABLE DATA BASE, ONLY A PORTION OF WHICH WAS SAMPLED IN THIS STUDY, OF POWER PLANT EQUIPMENT THAT HAS BEEN SUBJECTED TO STRONG EARTHQUAKES.

CONCLUSION

THERE IS A LARGE BODY OF AVAILABLE DATA ON THE PERFORMANCE OF POWER PLANT EQUIPMENT IN STRONG EARTHQUAKES, INCLUDING BOTH MECHANICAL AND ELECTRICAL EQUIPMENT. MANY CONVENTIONAL POWER PLANTS AND INDUSTRIAL FACILITIES HAVE EXPERIENCED EARTHQUAKES THAT SUBJECTED THEIR EQUIPMENT TO SEISMIC ENVIRONMENTS EQUAL TO OR EXCEEDING SEISMIC LOADS ASSOCIATED WITH SAFE-SHUTDOWN EARTHQUAKES REQUIRED FOR THE DESIGN OF MOST NUCLEAR POWER PLANTS.

GOAL 2

GOAL: SHOW THAT MUCH OF THE EQUIPMENT INVESTIGATED, WHICH HAS EXPERIENCED STRONG EARTHQUAKES, IS SIMILAR TO EQUIPMENT FOUND IN NUCLEAR POWER PLANTS.

FINDINGS:

- A FEW MAJOR EQUIPMENT MANUFACTURERS SUPPLY MUCH OF THE EQUIPMENT FOR BOTH CONVENTIONAL AND NUCLEAR POWER PLANTS.
- THERE IS LITTLE OBSERVABLE DIFFERENCE BETWEEN THE MEASURED DYNAMIC RESPONSE FREQUENCIES OF EQUIPMENT IN NUCLEAR POWER PLANTS AND THOSE IN CONVENTIONAL PLANTS.
- THERE ARE NO GENERIC DIFFERENCES OTHER THAN AGE BETWEEN EQUIPMENT FOUND IN CONVENTIONAL AND NUCLEAR POWER PLANTS.

CONCLUSIONS:

CERTAIN TYPES OF MECHANICAL AND ELECTRICAL EQUIPMENT FOUND IN NUCLEAR POWER PLANTS ARE VERY SIMILAR IN CONFIGURATION, FUNCTION, MANUFACTURER, AND MODEL TO THE TYPES FOUND IN CONVENTIONAL PLANTS. MUCH OF THE EQUIPMENT IN NUCLEAR POWER PLANTS AND CONVENTIONAL POWER PLANTS IS THE SAME.

GOAL 3

GOAL: DETERMINE WHETHER ACTUAL EARTHQUAKE DATA ARE SUFFICIENT TO CONCLUDE THAT SEISMIC QUALIFICATION OF CERTAIN CLASSES OF EQUIPMENT BY CONVENTIONAL METHODS IS NOT NECESSARY.

FINDINGS:

- EXCLUDING SOME UNANCHORED EQUIPMENT AND ONE AIR-OPERATED VALVE, NO FAILURES WERE REPORTED IN ANY OF THE SEVEN TYPES OF EQUIPMENT ADDRESSED IN THIS STUDY.
- WITH THE POSSIBLE EXCEPTION OF ELECTRICAL RELAYS, THERE IS NO EVIDENCE OF MALFUNCTION OF THE REVIEWED EQUIPMENT DURING THE EARTHQUAKES.
- THE ESTIMATED GROUND-RESPONSE SPECTRA FROM SEVERAL CALIFORNIA EARTHQUAKES AND THE CONVENTIONAL POWER PLANTS AFFECTED BY THEM ENVELOPE THE FLOOR-RESPONSE SPECTRA FOR THE SAFE-SHUTDOWN EARTHQUAKES REQUIRED FOR NUCLEAR POWER PLANTS IN THE RANGES OF MOST EQUIPMENT RESPONSE FREQUENCIES.
- CONVENTIONAL PLANTS THAT WERE SUBJECTED TO EARTHQUAKES WITH PEAK GROUND ACCELERATION OF ABOUT 0.30G OR LOWER GENERALLY CONTINUED TO OPERATE THROUGHOUT THE EARTHQUAKES.

CONCLUSION:

SEISMIC QUALIFICATION OF NUCLEAR EQUIPMENT BY CONVENTIONAL METHODS DOES NOT APPEAR TO BE NECESSARY FOR THE CLASSES OF EQUIPMENT EVALUATED FOR MOST LEVELS OF SAFE-SHUTDOWN EARTHQUAKES.

GOAL 4

GOAL: DEVELOP A METHODOLOGY FOR THE USE OF ACTUAL EARTHQUAKE DATA TO DETERMINE WHETHER SEISMIC QUALIFICATION OF SPECIFIC ITEMS OF EQUIPMENT BY CONVENTIONAL METHODS IS NECESSARY.

FINDINGS:

- THE SEISMIC PERFORMANCE OF THE REVIEWED EQUIPMENT APPEARS TO BE INDEPENDENT FROM ANY OF THE FOLLOWING FACTORS:
  - AGE OF EQUIPMENT
  - YEARS OF SERVICE
  - MANUFACTURER AND MODEL
  - MOUNTING CONFIGURATION
  - DYNAMIC PROPERTIES
- THE METHODOLOGY USED IN THE PILOT PROGRAM TO EVALUATE CLASSES OF EQUIPMENT WOULD BE EQUALLY APPLICABLE TO SPECIFIC ITEMS OF EQUIPMENT.

CONCLUSION:

THE PILOT PROGRAM HAS DEMONSTRATED THE METHODOLOGY. THERE IS AN ABUNDANCE OF DATA THAT CAN BE USED TO IDENTIFY SPECIFIC ITEMS OF EQUIPMENT THAT DO NOT REQUIRE ADDITIONAL SEISMIC QUALIFICATION.

OVERALL SUMMARY

- WE HAVE SHOWN THAT THE STRUCTURAL INTEGRITY OF ANCHORED POWER PLANT EQUIPMENT AND COMPONENTS IS NOT COMPROMISED IN STRONG EARTHQUAKES OF UP TO 0.50G PEAK GROUND ACCELERATION.

- WE HAVE SHOWN THAT TYPICALLY POWER PLANT EQUIPMENT OPERABILITY IS NOT COMPROMISED IN STRONG EARTHQUAKES WITH PEAK GROUND ACCELERATIONS OF ABOUT 0.20G TO 0.30G.

STATIC

USI A-46

SEISMIC QUALIFICATION OF EQUIPMENT IN OPERATING PLANTS

BACKGROUND

- SEISMIC SAFETY MARGIN IN OPERATING PLANT EQUIPMENT MAY VARY CONSIDERABLY
- SEISMIC QUALIFICATION OF EQUIPMENT IN OPERATING PLANTS SHOULD BE REASSESSED AND REQUALIFIED (IF NECESSARY) TO ENSURE RESISTANCE TO SEISMICALLY INDUCED LOADS AND PERFORMANCE OF SAFETY FUNCTIONS
- NOT PRACTICAL TO SEISMICALLY QUALIFY OPERATING PLANT EQUIPMENT BY CURRENT CRITERIA AND METHODS
- TASK A-46 APPROVED AS USI BY NRC IN DECEMBER 1980
- SCHEDULED COMPLETION DATE IS APRIL 30, 1984

T16

OBJECTIVES

DEVELOP ALTERNATIVE METHODS, GUIDELINES AND ACCEPTANCE CRITERIA FOR SEISMIC EQUIPMENT QUALIFICATION IN OPERATING PLANTS

- IDENTIFY SEISMIC RISK SENSITIVE SYSTEMS AND EQUIPMENT
- ASSESS ADEQUACY OF EXISTING SEISMIC QUALIFICATION
- DEFINE ALTERNATIVE METHODS FOR QUALIFYING EQUIPMENT IF EXISTING SEISMIC QUALIFICATION IS INADEQUATE
- DEVELOP ACCEPTANCE CRITERIA FOR THE ALTERNATIVE METHODS

SCOPE

- TASK 1 - DEVELOP MINIMUM LIST OF EQUIPMENT TO BE QUALIFIED
- TASK 2 - SURVEY AND EVALUATE EQUIPMENT QUALIFICATION METHODS USED IN EXISTING PLANTS AND COMPARE WITH CURRENT METHODS
- TASK 3 - DEVELOP METHODS OF IN-SITU TESTING TO ASSIST IN QUALIFICATION OF EQUIPMENT
- TASK 4 - SEISMIC QUALIFICATION OF EQUIPMENT USING SEISMIC EXPERIENCE DATA BASE DEVELOPED BY SQUG
- TASK 5 - DEVELOP GUIDELINES FOR GENERATING GENERIC RESPONSE SPECTRA
- TASK 6 - DOCUMENT RESULTS OF TASK A-46 (INCLUDING VALUE/IMPACT ASSESSMENT)

STATUS

TASK 1:

- DEVELOP GUIDELINES FOR GENERATING MINIMUM EQUIPMENT LIST
- DRAFT REPORT RECEIVED IN DECEMBER 1982. REVIEW OF REPORT BY STAFF COMPLETED. STAFF REVIEW CONCLUSION -

  1. MINIMUM EQUIPMENT LISTS OBTAINED ARE HIGHLY PLANT AND SITE SPECIFIC
  2. REPORT DEVELOPS A SEISMIC PRA METHODOLOGY TO IDENTIFY SEISMIC RISK SENSITIVE EQUIPMENT
  3. STAFF WILL RECOMMEND PRA AS AN OPTION TO DEVELOP MINIMUM EQUIPMENT LIST
  4. STAFF IS CONSIDERING OTHER MEANS OF DEVELOPING MINIMUM EQUIPMENT LIST

STATUS (CONTINUED)

TASK 2:

- TO SURVEY QUALIFICATION METHODS USED IN OPERATING PLANTS, COMPARE WITH CURRENT REQUIREMENTS, DETERMINE IMPORTANCE OF DIFFERENCES, AND RECOMMEND ACCEPTABILITY OF QUALIFICATION METHODS
- PARTIAL REPORTS RECEIVED IN OCTOBER 1982 AND FEBRUARY 1983. FINAL REPORT DUE MARCH 1983.

STATUS (CONTINUED)

TASK 3:

- TO REVIEW EXISTING METHODS FOR IN-SITU TEST, ASSESS THE EXTENT IT CAN BE USED TO ASSIST IN QUALIFICATION OF EQUIPMENT IN OPERATING PLANTS
- DRAFT REPORT RECEIVED JANUARY 1983 AND REVIEWED BY STAFF. FEASIBILITY ESTABLISHED. REQUIREMENTS AND CRITERIA FOR CONDUCTING IN-SITU TEST TO BE PROVIDED BY APRIL 1983
- STAFF CONCLUSION -
  1. IN-SITU METHOD IS USEFUL FOR EQUIPMENT QUALIFICATION WHEN EMPLOYED IN CONJUNCTION WITH EXPERIENCE DATA BASE
  2. IN-SITU TEST CAN BE USED TO
     A. HELP ESTABLISHING EQUIPMENT SIMILARITY BY PROVIDING EQUIPMENT DYNAMIC CHARACTERISTICS
     B. MINIMIZE ANALYSIS EFFORT TO GENERATE RRS BY DETERMINING DYNAMIC CHARACTERISTICS
  3. IN-SITU TEST BY ITSELF ALONE CAN NOT BE USED AS A EQUIPMENT SEISMIC QUALIFICATION TOOL

STATUS (CONTINUED)

TASK 4:

- TO DETERMINE IF CORRELATION EXISTS BETWEEN EFFECTS OF SEISMIC EVENTS ON NON-NUCLEAR AND NUCLEAR PLANT EQUIPMENT, DETERMINE FEASIBILITY TO USE THIS CORRELATION, AND DEVELOP GUIDELINES FOR USE OF NON-NUCLEAR EXPERIENCE DATA
- STAFF ESTABLISHED FEASIBILITY OF USING EXPERIENCE DATA (LLNL STUDY)
- SQUG PILOT PROGRAM REPORT RECEIVED AND REVIEWED BY STAFF, DECEMBER 1982
- STAFF CONCLUSION -
  1. THE USE OF EXPERIENCE DATA IS THE MOST VIABLE ALTERNATIVE TO CURRENT QUALIFICATION REQUIREMENTS. CONTRACTOR AND STAFF FOLLOWED AND WILL CONTINUE TO FOLLOW THIS WORK CLOSELY
  2. ADEQUATE EQUIPMENT ANCHORAGE MUST BE PROVED FIRST
  3. A MINIMUM OF 3 SEPARATE AND DISTINCT EARTHQUAKE HISTORIES FOR EACH GROUP OF SIMILAR EQUIPMENT. A RANGE OF DURATION, AMPLITUDES AND FREQUENCY CONTENT DESIRABLE

STATUS (CONTINUED)

TASK 4:

4. DEFINITION OF SIMILARITY NEEDS TO BE REFINED
5. EQUIPMENT OPERABILITY MUST BE ADDRESSED DURING AND AFTER SEISMIC EVENTS
6. ADDRESS MARGIN AND FRAGILITY
7. LOW LEVEL IN-SITU TEST SHOULD BE VALIDATED ACCORDING TO TASK 3 REQUIREMENTS
8. SQUG SHOULD POOL LAB TEST DATA TO AUGMENT EXPERIENCE

STATUS (CONTINUED)

TASK 5:

- TO EVALUATE FEASIBILITY OF USING GENERIC ENVELOPES, RECOMMEND AND DEVELOP GENERIC FLOOR RESPONSE SPECTRA. ESTABLISH CRITERIA FOR EVALUATING GENERIC SPECTRA

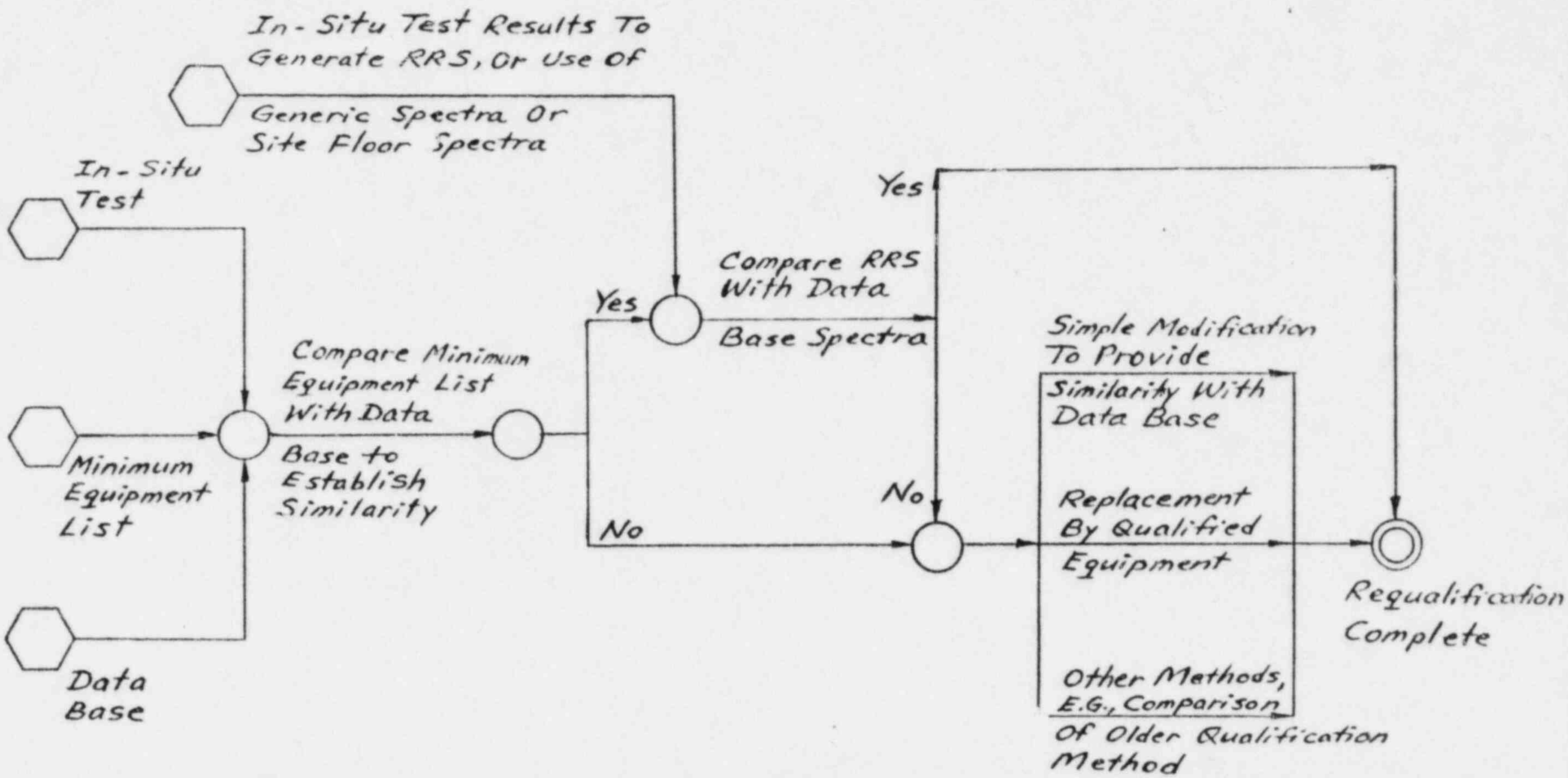
- DRAFT REPORT RECEIVED JANUARY 1983, PROVIDES GUIDELINES AND PROCEDURES TO DEVELOP GENERIC RESPONSE SPECTRA IN HORIZONTAL DIRECTION ONLY

SCHEDULE

- POSITION DEVELOPED BY JUNE 1983
- CRGR REVIEW BY AUGUST 1983
- PUBLIC COMMENT BY SEPTEMBER 1983
- FINAL PACKAGE TO CRGR BY MARCH 1984
- REQUIREMENTS AND GUIDELINES ISSUED BY APRIL 1984

ALTERNATIVE SEISMIC QUALIFICATION PROCEDURE

FOR USE WITH USI A-46 RESULT



Briefing Of The ACRS Subcommittee

On Equipment Qualification

Generic Item 82-21, "Vibration Qualification Of Equipment"

Goutam Bagchi
March 15, 1983

T20

Issue-21 Vibration Qualification Of Equipment

ISSUE: Accident-Induced Dynamic Loads And Other Vibrations May Have Detrimental Effects On Functional Capability Of Safety-Related Equipment.

ISSUE 21

RESOLUTION:

PLANTS UNDER OL REVIEW -

- SRP 3.10 INCORPORATES REQUIREMENTS FOR QUALIFICATION FOR OTHER DYNAMIC LOADS.
- EQUIPMENT QUALIFICATION RESEARCH PLAN WILL DEVELOP DETAILED GUIDANCE ON OTHER DYNAMIC LOADS.

OPERATING PLANTS -

- SEISMIC QUALIFICATION OF EQUIPMENT UNDER USI A-46 SHOULD LARGELY RESOLVE PROBLEMS FROM SIGNIFICANT DYNAMIC LOADS IN COMBINATION WITH SEISMIC LOADS WITHIN THE CONTEXT OF GDC #2.

STATUS REPORT ON NUCLEAR PLANT AGING RESEARCH

- o BACKGROUND
  - AGING WORKSHOP
  - ONGOING RELATED ACTIVITIES
- o OBJECTIVES
- o SCOPE
- o PRELIMINARY ACTIVITIES
- o MANAGEMENT/REVIEW
- o PRODUCTS
- o APPLICATIONS
- o SCHEDULE

T21

AGING WORKSHOP

- AUGUST 1982
- TWELVE WRITTEN PAPERS AND EIGHTEEN ORAL PRESENTATIONS
- NUREG/CP-0036 (NOVEMBER 1982)

EXAMPLES OF NRC AGING RELATED RESEARCH

- VESSELS
- PIPING
- NON-DESTRUCTIVE EXAMINATION
- ELECTRICAL EQUIPMENT QUALIFICATION
- MECHANICAL EQUIPMENT QUALIFICATION
- STEAM GENERATORS
- NUCLEAR PLANT AGING RESEARCH (NPAR)

RELEVANT RESEARCH/EXPERIENCE OUTSIDE NRC

- o INDUSTRY (EPRI, INPO)
- o MILITARY
- o DEPARTMENT OF ENERGY
- o SPACE PROGRAM
- o COMMUNICATIONS INDUSTRY

PROGRAM GOALS AND OBJECTIVES:

- IDENTIFY PREVIOUSLY UNANTICIPATED AGING EFFECTS WHICH HAVE THE POTENTIAL TO DEGRADE REACTOR SAFETY AND TO GENERATE INFORMATION USEFUL IN CONTENDING WITH THOSE EFFECTS BEFORE THEY CAUSE PROBLEMS.

- ESTABLISH PRIORITIES, SCHEDULES AND APPROPRIATE INTERFACES FOR ALL NEW AND ONGOING AGING RELATED RESEARCH WITHIN THE NRC.

- ESTABLISH APPROPRIATE INTERFACES WITH AGING RELATED RESEARCH PERFORMED OUTSIDE THE NRC.

SCOPE OF PLANT AGING RESEARCH PROGRAM

EFFECTS OF AGING ON

- DBE MITIGATING EQUIPMENT
- ACCIDENT PREVENTION EQUIPMENT
- EQUIPMENT WHICH COULD CAUSE ACCIDENTS OR TRANSIENTS
- HUMAN FACTORS
- OCCUPATIONAL DOSE
- OTHER

POSSIBLE CATEGORIES OF AGING RESEARCH

(FEASIBILITY STUDIES FY83-84)

- o SYSTEMATIC IDENTIFICATION OF AGING EFFECTS
- o RANKING IMPORTANCE OF AGING EFFECTS
- o DETECTION AND MONITORING OF AGING EFFECTS
- o MITIGATION OF AGING EFFECTS
- o SERVICE LIFE PREDICTION
- o INTEGRATION OF AGING RESEARCH

SYSTEMATIC IDENTIFICATION OF AGING EFFECTS

- DESIGN AND OPERATIONS SPECIALISTS WORKSHOPS
- SURVEY OF OPERATING PLANT EXPERIENCE
- SURVEY OF AGED FACILITIES
- SURVEY OF AGING MECHANISMS OF PERTINENT MATERIALS

PRODUCTS OF NPAR

- o IDENTIFICATION OF LIKELY AGING EFFECTS
- o EVALUATION OF SAFETY SIGNIFICANCE OF THESE EFFECTS
- o IDENTIFICATION OF METHODS TO DETECT IMPORTANT AGING EFFECTS
- o IDENTIFICATION OF METHODS TO MITIGATE AGING EFFECTS
- o EVALUATION OF VIABILITY OF PREDICTING SERVICE LIFE OF EQUIPMENT SUSCEPTIBLE TO AGING
- o INTEGRATION OF AGING RESEARCH
  - INTERNAL TO NRC
  - EXTERNAL

APPLICATION

- o ANTICIPATE IMPORTANT AGING EFFECTS AND TAKE APPROPRIATE ACTION BEFORE PROBLEMS DEVELOP
- o DEVELOP STRATEGIES FOR INSPECTION OF NUCLEAR PLANTS WHICH REFLECT POTENTIAL FOR AGING
- o COMMERCIAL

PROGRAM REVIEW AND MANAGEMENT

- MANAGEMENT RES/DET/EEB
  - DE
- REVIEW
  - NRR
  - IE
  - ACRS
  - SPECIAL PANEL