NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SUBCOMMITTEE MEETING

on

EXTREME EXTERNAL PHENOMENA

Place - Washington, D. C.

Date - Wednesday, 11 July 1979

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Wednesday, 11 July 1979

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING

on

EXTREME EXTERNAL PHENOMENA

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

Wednesday, 11 July 1979

The ACRS Subcommmittee on Extreme External Phenomena met, pursuant to notice, at 8:30 a.m., Dr. David Okrent, chairman of the subcommittee, presiding.

BEFORE:

DR. DAVID OKRENT, Chairman of the Subcommittee

DR. PAUL SHEWMON, Member

MR. MYER BENDER, Member

MR. HAROLD ETHERINGTON, Member

DR. DADE MOELLER, Member

DR. CHET SIESS, Member

584 126

P R O C E E D I N G S

DR. SHEWMON: Let's get started. We can discuss what we need to before the staff finds their way through the traffic.

This is a continuation of the meeting yesterday with our distinguished visitors. I am not sure whether Igne or Savio is our designated federal employee. Have you decided?

DR. SAVIO: Both.

(Laughter.)

MR. BENDER: They are each half.

(Laughter.)

DR. SAVIO: No comment.

DR. SHEWMON: One thing that we might point out is that, in view of the -- I hadn't seen the schedule before I got here, and I have asked the people who are going to talk about feedwater line cracks -- that is, the thing that was at D.C. Cooke, to come down and talk about it at 11:00 o'clock or 11:30, in hopes that we could compress some of this schedule and get that in somewhat earlier.

I guess I some resent having what started out as a simple Metal Components Subcommittee two-day meeting all rammed into one day yesterday.

Be that as it may, I think that is all the general comments I have. Is there any other discussion?

I guess the staff is here and getting organized. Why don't you go ahead, Larry?

DR. SHAO: Okay.

(Slide.)

DR. SHAO: Good morning. My name is Larry Shao. I am the Assistant Director for General Reactor Safety Research.

Today we are going to present to you the research program in the three branches: the Structural Engineering Research Branch, the Mechanical Engineering Research Branch, and the Site Safety Research Branch.

Most of the programs in these three branches are under the purview of the Subcommittee on Extreme External Phenomena. However, some of the programs in the Mechanical Engineering Branch are under the purview of the Subcommittee on Metal Components, and some of the site safety research programs fall within the scope of the Subcommittee on Radiological Effects and Site Evaluation.

Since SSMRP is a sizable program, it takes a long time to cover and we will not discuss this today. SSMRP is Seismic Safety Modeling Research Program. However, we will set up a separate meeting for you for this program in the near future.

For the Structural Engineering Branch, Mr. Bagchi will discuss the needs and priorities of research programs other than SSMRP. Jim Richardson will discuss the needs and priorities of mechanical engineering research programs other than SSMRP.

Per your instructions, we will not discuss all of the programs in the Site Safety Research Branch. Jerry Harbour will confine his discussions to programs on recurrent interval earthquakes at reactor sites.

(Slide.)

We request a total budget for fiscal year '81 of a total of $19.9 million: $6.0 million for the Structural Engineering Research Branch, $7.4 million for the Mechanical Engineering Research Branch, and $6.5 million for the Site Safety Research Branch.

The Site Safety Research Branch has been around a long time and has always been headed by Dr. Jerry Harbour. The Structural Engineering Research Branch and the Mechanical Engineering Research Branch are quite new. They were formed about a year ago.

Mainly in the last few years there have been a lot of problems related to structural and mechanical engineering. I would like to show you some problems related to these areas.

(Slide.)

We have the BWR feedwater nozzle cracks in the BWR vessel. We always have pump and valve problems all the time. We have BWR pipe crack problems, mainly in the primary system. And lately we have pipe cracks in PWR secondary systems. In the last few weeks, we have been looking at about 17 plants.

Out of 17, 10 had cracks in the feedwater lines. These 10 plants are all Westinghouse plants.

And yesterday we heard Three Mile Island 1 had cracks in a lot of other lines. They looked at about 860 welds and they found indication of 180 -- they have indication on 180 welds, Three Mile Island 1, the secondary systems. This is a B&W plant.

Later on the NRC staff will cover the pipe cracks in the feedwater line.

We also have problems with snubbers. Either it would not work during the accident condition or sometimes the snubber got stuck during the normal operating conditions. One is a mechanical snubber, the other is a hydraulic snubber. Both types of snubbers have problems.

We have steam generator tube cracking all the time. We have denting problems, a denting problem, and also corrosion. Recently we had a lot of seismic problems. Humboldt Bay was shot down. GETR was shut down. Diablo Canyon never operated. Trojan was shut down for years because of the problems in the seismic analysis in the control building.

We have a systematic evaluation program. We are looking at the 11 oldest plants for the seismic analysis. It was designed by the very old criteria. Some were designed to the Uniform Building Code.

Recently we have shut down five plants because of computer errors in the absolute sum, the algebraic summation.

Another thing is we have a petition from the Union of Concerned Scientists that requests us to reanalyze all of the plants within 120 days. We haven't answered this petition yet.

I would like to talk about recent I&E bulletins.

(Slide.)

We have five bulletins in the structural-mechanical reas. These all happened in the last few months.

The first bulletin is IE 79-02. It is called base plate flexibility and anchor bolts. A lot of plants, the anchor bolts don't meet specifications. They cannot resist the design loads that they are supposed to. As a matter of fact, we don't know whether we ought allow North Anna to come up for operation, depending on the base plate conditions.

We have 79-04. It is a valve problem. The valve has a certain weight, 600-700 pounds. In the calculation, they all used 200 or 300 pounds. So all of the seismic calculations are not really right. That happened to most of the plants, too.

And we have 79-07, with use of algebraic sum for model responses on seismic analysis from the five-plant shutdown. The first five plants were designed by Stone & Webster: Surry 1 and 2, Fitzpatrick, Maine Yankee and Beaver Valley. After we looked at the problem, we found another 20 plants have the same kinds of problems. So we sent out a bulletin to ask for the status of these plants.

79-13 is the cracking of primary system -- it mainly is the feedwater line piping cracking, the one I will talk about, out of the 17 plants, that 10 plants had cracking in feedwater lines. And this bulletin was issued about two weeks ago, two to three weeks ago, and this bulletin asks for inspection within 90 days.

The last bulletin is 79-14. It was issued last week, the as-built problem. A lot of the supports are supposed to be there and are not there, and many are in the wrong location and may be in the wrong orientations. That happened in every plant. Within 120 days, every plant has come down for inspections to measure, to assure they can resist the seismic loadings.

So all of these bulletins have happened within the last few months. They really involve almost all of the plants, all of the operating plants.

DR. SHEWMON: Are you suggesting that if we had doubled the last year's mechanical and engineering research budget, they wouldn't have happened? Or just where are we getting to?

DR. SHAO: I don't think it would not have happened. It maybe would have been minimized. The trouble is this: In the past, there has not been any research in mechanical engineering or structural engineering. There has been a lot of emphasis on LOCA and ECCS and thermohydraulics. That is why the two branches were formed about a year ago. These two are very new branches. They were formed in 1978.

We just initiated some of the programs.

MR. BENDER: Looking at that list out there and the previous listing -- you don't have to put it up --

(Slide.)

MR. BENDER: I think I would not conclude that the research program would have provided any information that would have resolved those matters, if the research program, as I see it, is the one that you are talking about. In fact, most of those things are just plain mistakes in inspection and design.

I can't quite visualize why a research program is needed to address them.

DR. SHAO: Let me make an example why we think it can be helpful. For instance, the GETR or even Humboldt Bay that was shut down. We really don't know what is the seismic margin. If we know what kind of conservatism is in this building, then maybe we would take a different stand. Like GETR, they said the G load is .8 or .1. If we put it at the G load, maybe it is only .6 G and maybe the structure has more resistance or less resistance. We don't know.

MR. BENDER: I don't know why the regulatory staff needs to spend its time analyzing installations that are designed by somebody else, owned by somebody else, and whose responsibility belongs to somebody else.

DR. SHAO: But that happens with every program.

MR. BENDER: GETR and Humboldt Bay were designed long before the regulatory staff even understood the significance of seismic design. You couldn't cure that with research efforts today. And I just don't understand why you are making that argument.

DR. SHAO: Like Diablo Canyon, I understand there is a lot of trouble with damping values -- 7 percent, 5 percent, 6 percent. I think by some testing you know whether it is 7 percent or 10 percent.

MR. BENDER: That's fine, and I don't want to prolong this argument very much. But that discussion has been going on for several years as well. The thrust of the effort you have described in the program as I have seen it is not like to make the information any more usable. But we will hear about it later.

MR. BAGCHI: I can make a comment.

DR. OKRENT: What they were asked not to discuss was the seismic tectonic investigation program. But anything that is in the engineering area related to seismics, they are supposed to discuss, except the SSMRP.

DR. SIESS: That's what I thought it said here, "other than that included under the SSMRP." But some of the questions Larry has been addressing are clearly going to be answered when and if the SSMRP program is completed. Whether 5 percent or 7 percent makes any difference is one of the questions in the SSMRP program.

DR. OKRENT: I don't know if he will answer it, then.

DR. SIESS: I am not sure it is NRC's job to decide which it is. It is NRC's job to find out what is important and either tell the applicant to assume a conservative value or provide the information to justify a less conservative value.

There are millions and millions of dollars of seismic research going on in the country right now, and NRC can't hope to do all of it.

DR. SHAO: I know.

MR. BAGCHI: Excuse me. Let me introduce myself. My name is Bagchi. I am in the structural engineering, the branch chief.

I would like to address one of the questions that Dr. Bender raised, and that is, why should the regulatory staff address some of these issues, why not the licensee. The systematic evaluation program is one example where the licensees have been very slow to come up with any kind of information. That is primarily because these people have a license and the owners have the -- the proof is on the staff. We have to make the analysis. We have to make a determination as to why this is unsafe or needs some modification.

I think that is why the staff needs to look at it much more closely than for a new plant.

DR. OKRENT: Excuse me. I have to offer a comment in this area. It is now about 13 years that the ACRS recommended that the staff initiate a systematic review plan, and you are now starting to do it. It doesn't have to be done the way it is being done.

The Commission, for example, could pass a regulation which required that every ten years the applicant reviewed his plant and came in with justification for why it was acceptable that the plant run another ten years, and the onus would then be on the applicant to show that whatever the condition was, the degradation and so forth, whatever the new knowledge was, that the plant was adequate in this regard.

e-1

DR. SIESS: They don't have to make a regulation. All they have to do is issue a show cause order, which they did, and shut down the plants until they show cause. The Commission has the tool. The Commission has used it.

And with another ten years of research, particularly on SSMRP, the staff might be in a position to look at plants like those that they issued the show cause order on, where they found a, quote, "mistake," quote, in a computer code and decide whether it is substantive or not and whether the plant needs to be shut down. They have got the mechanism right now.

They don't have to do research to know whether there is a problem.

DR. SHAO: It is a very interesting subject that Mr. Bender raised. Let me make an example. There is a computer code problem, the recent five-plant shutdown. The NRC doesn't have any computer code capability. We don't have a code to check. So we have to come up with some codes to even check the licensees'.

They say theirs is perfect, but we want to do some checking. We cannot check it. We have never had the research to come up with the computer code.

Lately we asked Brooknaven to do some.

MR. BENDER: I am sure Dr. Shewmon is anxious to get along with the substance. What I said was premature. I really was just trying to make the point that this doesn't represent a reason for doing research, because most of it describes engineering mistakes. There probably are some good reasons for doing research, and why don't you tell us about the research and then we will make our own judgments about it.

DR. SHAO: Sure.

DR. SHEWMON: Fine.

DR. SHAO: Any more questions?

DR. SHEWMON: I would like to get into somewhat more detail the discussion of budget on this first slide you had, but that perhaps can be done --

DR. SHAO: That will be covered by each branch.

DR. SHEWMON: Fine, thank you.

DR. SHAO: Thank you.

MR. RICHARDSON: Good morning. I am Jim Richardson, Chief of the Mechanical Engineering Research Branch.

I would like to go over briefly what I will talk about.

(Slide.)

I would like to present to you our overall budget. We have the mechanical engineering research broken into three principal areas, which are entitled dynamic analysis program, mechanical components program and codes and standards program.

What I would like to do is present each of those programs and the projects that make up those programs and give you a very brief overview of the budget, the objectives of the program and what we feel is the need for the program.

In the hard copies that are being handed out to you, there are a great deal many more slides than what I am going to show today. Some of them will serve as backup in case you do have questions, and might be supplemental information for you to look at either today or later.

After I have presented the budget of the projects and their needs, at the end of my presentation I would like to present to you what I feel are the priorities that we have established for these programs.

(Slide.)

The mechanical research budget for '79, the current year, is $1.6 million, broken up in the three areas as shown. In FY '80, we are budgeted for $3.8 million; and in FY '81 we have requested a budget level of $7.4 million.

I would note that the $7.4 million and the $3.8 million include a suppleme tal budget request as a result of Three Mile Island and the five-plant shutdown, and we will discuss those as we go along.

(Slide.)

The three areas again, principal areas the Mechanical Engineering Branch budget is broken into are: the dynamic analysis area, mechanical components, codes and standards.

(Slide.)

I will take each of those individually. The first area we will look at is the area of dynamic analysis. It is made up of six projects: the SSMRP, which we will not discuss in detail today; the PARET program; load combinations; our involvement with the HDR reactor in Germany; and non-linear systems modeling.

In this area, our 1979 budget, our current budget, is about $1.3 million, most of which is taken up with the SSMRP. And in FY '80 we are going to $2.1 million, and again, the majority of that money is the SSMRP. And finally, in FY '81, we are requesting a budget level of $3.5 million, of which $2 million is SSMRP.

The next biggest item would be load combinations, at $500,000. And the other programs are $200,000 and $300,000.

(Slide.)

I will just put a slide up very briefly on the SSMRP. We are planning to brief the ACRS Subcommittee some time in the September time frame, and where we will give you a detailed presentation of what is happening on that program.

DR. OKRENT: Why don't you skip the discussion of the SSMRP, just omit it.

MR. RICHARDSON: Fine.

(Slide.)

I would like to discuss the PARET program. PARET is an acronym for parameter analysis technique. We are operating on a budget of $165,000 this year, and over the next two years we would like to spend something on the order of $400,000. This is an ongoing program involving Lawrence Livermore as a prime contractor, with three subcontractors, including Agbabian, Anco and Structural Measurement Systems.

The objectives of this program are to determine by testing -- we can determine modal shapes, modal damping and modal frequencies of operating reactors. We feel by development of this program, which is basically a systems identification code, that we will be able to go into operating reactors and, by controlling the input by an impulse load or a simple shaker test, we can verify the analysis assumptions that were made on systems.

For instance, I can go into an operating plant, mount a couple of transducers and hit it with an impulse load, and very quickly, in a matter of a few minutes, determine mode shapes, frequencies, and compare them with the analysis that was made, and it would give me a very quick indication as to the as-built condition of the plant versus its design.

I can also -- we are exploring using PARET for damage assessment. We might be able to detect damage if we had gotten a baseline signature of a structure, and after an accident come back in and look at the mode shapes, frequencies and damping values after an accident, and determine if the structure has sustained any damage.

DR. OKRENT: What would be different here with regard to the behavior characteristics of the reactor before an earthquake from the existing methodologies? There are people who go around nd shake reactors and measure modal frequencies or something, and I guess damping at very low values. I don't know what that means.

What would be different about this?

MR. RICHARDSON: Well, we have not developed as such a systems identification technique. That has already existed. It is the application of this to nuclear power plants. One of our tasks is to develop a testing technique in nuclear power plants. That is our principal thrust of this program this year.

DR. OKRENT: It seems to me that there exist methods -- correct me if I am wrong -- and the problem I have had in the past, I have been unable to get the staff to get the various licensees to make such measurements. In other words, I suggested to the licensees and to the staff, wouldn't it be useful to be able to go in and see if what the measured frequencies are what you calculated. I haven't seen the staff require that licensees do this, even.

MR. RICHARDSON: We would hope, as a result of this program, that working with the licensing staff, that they would be convinced that this is a viable method and would impose this on the applicant.

DR. OKRENT: Are you telling me there is not a viable method now?

MR. RICHARDSON: There may be a viable method. I don't think we have explored the application of that method to nuclear power plants and looked at things like the threshold, how low a damping value can you measure and extrapolate to larger values, what are the testing techniques you would use.

DR. SIESS: Why would you have to convince the licensing staff? Didn't they request this research?

MR. RICHARDSON: Yes. I think it is a matter of convincing them we have gotten results that they can use.

DR. SIESS: In their request for research, did they indicate what their objectives were, so that you would know when you reached them?

MR. RICHARDSON: The objectives are to develop a testing technique to use a systems identificat code, and to explore using this systems identification code in verifying analytical techniques. We feel we will meet those objectives and we will transmit those to the licensing staff. They are working with us in monitoring the contract, and we are in frequent communication with them. So when the program is complete, we would hope that they would be in agreement with the results and be able to employ them.

DR. SIESS: When you say "validate analytical techniques," I assume that means elastic analysis?

MR. RICHARDSON: For this part of the program, yes. We have not gone into the inelastic.

DR. SIESS: It would be nice if we could be sure that plants would never go in the inelastic range.

MR. RICHARDSON: When I say "verify analytical techniques," I guess I primarily mean verify that the as-built condition is as it was assumed in the analysis: Are the supports in the correct position? Have I assumed the correct support --

DR. SIESS: You don't need a computer program to verify the as-built condition. You do that by going out and checking it.

MR. RICHARDSON: Yes, and this might be a way to preclude walking through it. It is a double check to make sure.

DR. SIESS: I think you are ten miles off base if you think a computer program is going to tell you anything about -- it may tell you something about the as-built response as compared to the assumed response for the particular input you put into it, for the elastic conditions. But I don't think that is going to get you very far to be sure that the nuclear plant is safe under an earthquake.

DR. ZUDANS: How would this supplement, complement or differ from pre-service inspection, where you are supposed to shake all of the systems and check them already?

MR. RICHARDSON: I don't believe in pre-service inspection you do shake all of the systems.

MR. BOSNAK: Dr. Shewmon, if I can make a comment. On Diablo Canyon, the applicant did do some of these measurements. They went in with shakers and measured the mode shapes and actual frequencies of several of the components that they felt were critical, to check the analysis. And they did find there were problems.

DR. OKRENT: But they did it with an existing technique.

MR. BOSNAK: That's correct.

DR. OKRENT: And San Onofre 1 was shaken before.

I am tryinc ..o understand what you are trying to develop h... on't go away, Bob.

MR. BENDER: Could I try this -- this kind of observation, to see if this is an interpretation of what you are saying? If you develop a computer code that can analyze the stresses in the system and you can do a certain number of measurements using shakers in the plant and measure some deformations or stresses or strains, whatever it is you want to measure, and can compare them with the computer computation, the computer might be able to feed back to you that if this is the stress you are reading, something must be wrong. It may be able to interpret.

But the problem is that there is a support in the wrong place -- it would have to be a pretty smart computer. But I gather that is the argument you are trying to make.

MR. RICHARDSON: Yes. With the systems identification technique, I am basically measuring frequencies, mode shapes and damping. And I have predicted those in the design, and they should match fairly well with my measured values. And if they do not match, I know that I have mislocated a support, my support stiffnesses may be wrong, or there is something I have to explore.

MR. BENDER: There isn't anything wrong with doing it. We can do it now without the computer code. But the computer may be able to do it faster, and it may be able to do it with more precision than we can do it now.

MR. RICHARDSON: What we feel our mission is is to provide the licensing staff with a simplified technique that they can use to either perform the tests themselves or use the program to monitor tests performed by the applicant.

DR. ZUDANS: What is this computer program supposed to do?

MR. RICHARDSON: It will predict, from the output response due to a measured impulse -- it will predict and measure the frequencies, the mode shapes and damping of a structural system such as a piping system.

DR. ZUDANS: It is really a data processing system. You would collect the data, process the data and derive from your impulse loadings the different locations of what the system functions are.

MR. RICHARDSON: Commonly known as systems identification.

DR. ZUDANS: This has nothing to do with the analysis.

DR. SHEWMON: I am confused as to what we are talking about. Are we talking about a computer code you want to develop or a widget you go hang on systems, or can let someone go out, hang on a system and check on a plant?

MR. RICHARDSON: The PARET program is, one, a computer program, and, two, a test procedure.

DR. SHEWMON: The widgets you can buy off the shelf?

MR. RICHARDSON: The widgets you can buy, accelerometers, strain gauges, transducers.

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584 147

Well, have we heard enough? Can we move on to the next topic?

DR. OKRENT: I have a question with regard to the latter part of the objectives. Do you seriously think you can assess damage in a way that is sufficiently definitive? In other words, you would be able to make a measurement to say that there isn't enough damage to worry about. You can run. Or there is so much damage you are going to have to shut down for a year and go in and find out which specification or --

MR. RICHARDSON: There is another program toward the end of my presentation which addresses that specifically where we would like to explore this further, but we don't know. We have had some experts tell us that they think, yes, it can be used to measure rather small damage levels in a structure.

DR. OKRENT: I think you can see differences if differences are there. That is not the question. It is the question of interpreting what you see in a regulatory context that (a) it is safe enough and that you don't have to do anything else, or (b) you have to shut down because of these measurements, but we don't know really what is causing these changes in signals.

MR. RICHARDSON: That would certainly take some research. We would have to establish thresholds and do some

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correlations between damage and --

DR. SHAO: I would not depend on this program to say whether you shut down or start up, but I think from this indication at least you have to do some detailed inspection. It tells you that. From this computer output, I don't think I would depend on this.

DR. SHEWMON: I am sure no one will. Let's go on. We will be back to this before we are done.

MR. RICHARDSON: The next project is load combination.

(Slide.)

We are requesting a budget in FY '81 of one half million dollars, and we are budgeting in FY '80 at $300,000. This is another program we have at Lawrence Livermore. It is presently identified as a part of the SSMRP, but it also has additional benefits from an SSMRP. That is why we identified it as a separate project.

We have Science Applications, Inc., involved with the program as a subcontractor and John Stevenson as a consultant. We will probably be getting a few other --

MR. BENDER: What is the product of this going to be?

MR. RICHARDSON: I will get to that. The objectives of this program are to assess the contribution to safety and costs incurred due to the requirement to design

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for simultaneous large LOCA and earthquakes.

(Slide.)

Currently, the regulation states that for the primary system that you must add the loads from a large LOCA along with the SSE, and for some operating plants this has produced a real hardship in the resulting asymmetric blow down load on the reactor supports. We are taking a look at that criteria.

Is it necessary to add the LOCA and the SSE loads, as a first part of this project. We think that this criteria may be imposing an ultra-stiff design that may not be necessary in the reactor support system and the primary system. And this program might result in revised design criteria.

DR. SHEWMON: The argument would be basically on the basis of probabilities?

MR. RICHARDSON: Yes. There are three tasks to this program. The first task is we are looking at the cost benefits of -- if this regulation were modified, would it result in a substantial savings in the design? We suspect that, yes, it would. We are not spending very much money to do that.

The principal task is involved in looking at the probability of an earthquake causing a LOCA. We feel that if we can show that that probability is small enough that

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it would be reasonable to decouple the LOCA from the SSE. We are taking this from a probablistic point of view. We are looking at the most probable crack distribution -- the probability of having a certain size crack, the probability of detecting that crack, and the probability of that crack growing, and from that, make a determination from the load distribution as to what the probability is of an earthquake causing a large LOCA in the primary system.

Another task that is related to this is that -- that is what you might classify as comibination of events. We are also looking at, once you have given that events occur simultaneously, how do you combine their responses?

So we are also looking at the proper way to combine responses.

DR. SHEWMON: You have SAI's opinion written to you two different times when they were paid for by user groups who sent it in and Noonan wasn't convinced buy it for reasons I can't reproduce now.

MR. RICHARDSON: Primarily because of the data base.

DR. SHEWMON: Do you think you will get anything different, or how would this be different from what you have already?

MR. RICHARDSON: The difference is we will be developing a data base which was not there in the submittals

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by the applicant — a materials data base.

DR. SHEWMON: Are you doing anything with the Metal and Materials Group?

DR. SHAO: The main problem is there is not enough data on toughness. There was not enough mat rial toughness data. We have a separate program on material toughness. Pedro is working on it, and there isn't time for the material toughness input into this program.

By the way, there will be a detailed presentation of this research program in the afternoon.

MR. BENDER: I expect to hear more about this today, but I wanted to ask one thing about your probabolistic approach.

You are going to determine whether probablisticly it is appropriate to combine the loads or not, and that's fine. Are you going to determine probablisticly whether you can make the combination in a rational way and be sure the result is usable?

MR. RICHARDSON: I would certainly hope so.

MR. BENDER: How? That doesn't show up in the program as such as a part of the effort, and my impression from the WASH-1400 study, which showed that on the devices which were designed for seismic loading, something like 20 percent were designed erroneously. From the recent experiences we have had with plants up to now that showed

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a large part of the plant is designed erroneously, you would have to assume that there are going to be lots of mistakes in any seismic design. I wonder how you are going to deal with that aspect of it, if you have reached the conclusion that you must design and design two loads.

MR. RICHARDSON: I guess you are asking the question of construction errors.

MR. BENDER: Design errors, loading errors, and assumptions about the properties of materials that you have no way of confirming.

MR. RICHARDSON: We have as a task within the SSMRP a task to try to get a handle on construction errors and how to handle them.

MR. BENDER: I am not arguing with the availability of a task. I am addressing the question of the ability to perform the task. I wonder if the little bit of effort you have assigned to this thing will give you any information that is useful.

MR. RICHARDSON: I think for the little bit of money we do have, we do feel that this is a modest effort that we might be able to get a handle on the bounding values — how large an uncertainty can we put on construction errors, design errors, quality assurance.

We would hope to get some bounding values on the uncertainties associated with those parameters. It may turn out that they are very large.

MR. BENDER: The only criticism that was valid about the WASH-1400 study was that the bounding values were not well founded. I think that is going to be the result of this.

DR. SHEWMON: Can we postpone until this afternoon, extent will we get into that this afternoon?

DR. ZUDANS: I assume that you are fully familiar with what GE and Westinghouse submitted in this area.

MR. RICHARDSON: Yes.

DR. ZUDANS: And the SAI also. The way I remember the studies they made, the problem was condition -- stress conditions of particular components. It was a skeleton type of model. And also the real conclusion is not to assume combination of responses, but to think about much broader concepts.

How do you combine the inputs? How do you interface the inputs? You have to look for margins. You can't end with elastic analysis. And the only way you can combine responses is inelastically.

I don't know what you can do other than maybe better analyze submittals by these two companies that have already proposed some loads of combinations of responses. Is there any look at the major problems of combining the inputs with the understanding that you want to get the

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margins, and for that, you cannot use elastic analysis.

MR. O'BRIEN: I think we should know that the way we surpass present analysis is that we do have nonlinear fracture mechanics involved here. We do have a statistical distribution on floor sizes. We are assessing the inputs of in-service inspection and late raid detection on the probability of a joint LOCA and SSE.

We are looking at indirect methods of seismically inducing LOCA, something which nobody has done so far. So I think -- these are the criticisms or some of the criticisms that Vince Noonan did have and is the basis for the present study. He did not accept it for certain reasons. He tolds us what those reasons were, and now we are performing a new study to satisfy his concerns.

DR. ZUDANS: You are looking at just a partial piece of the bigger problem -- load combinations -- or maybe this is the details of the program.

MR. O'BRIEN: I am going to speak about a half hour this afternoon.

MR. ETHERINGTON: So far I haven't seen any basis for a supplementary budget as a result of Three Mile.

MR. RICHARDSON: We didn't ask for any supplementary budget in this area.

MR. ETHERINGTON: You will develop that as you go along, will you?

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MR. RICHARDSON: Yes.

DR. OKRENT: Three short points. When you are doing your data study, I think I would like to see what people get when they sort of go year by year. In other words, what conclusions would they have drawn with the data at the end of 1977, the data at the end of '78, at the end of '79? Are there changes as a result of this -- marked changes? I have in mind a big perturbation at Duane Arnold, which had it not occurred, it might have left things looking very differently.

That is one thing I think -- and the point that Mr. Bender mentioned about design errors. He mentioned it in a different way -- construction errors. But how that gets into your evaluation, if it is not there, as far as I am concerned, the evaluation is rather academic.

The second thing is you mentioned the primary system, but a moment ago, we heard that in PWRs you are having quite a bit of cracking in the secondary systems. And you may need, as part of this, to think about whether, what is known about secondary system behavior in earthquakes and what is being done in the licensing process, match, and maybe you should talk to the licensing people and see what is being done in this regard to see what is assumed.

The third point -- it is my impression that there are some recent experiments in Japan where they flex pipe

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like in an earthquake, and they found whether or not the piping was pressurized had a rather considerable effect on the piping behavior. In fact, when it was pressurized, they got rupture in relatively few cycles.

I don't mean a guillotine rupture but rupture of the pipe where you would not have predicted it, let's say, or would not have seen it unpressurized. So let me just mention those things.

MR. RICHARDSON: Thank you.

DR. SHENMON: Can we go on now?

(Slide.)

MR. RICHARDSON: The next errors are involvement with the HDR. The HDR is a decommissioned reactor in West Germany that saw a few years service, and then was shut down. The Germans have embarked on a rather extensive research program using this reactor to look at some thermal hydrolic behavior and alsc structural behavior involving the use of explosives, snap-back tests, and shaker tests of the reactor building and the components inside the reactor.

You might note, of course, that we don't have any full scale test facilities in the United States, and this is a rare — we though a rare opportunity to become involved in some rather significant tests going on in Germany.

As a result of our contacts with the West Germans, they have asked us to, indeed, become involved in the

584 157

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program to the point of making some pre-test predicitions with some tests that are involved -- that will be conducted this fall.

There will be some moderately high explosive tests this fall that should produce a few tenths of a G response at the reactor building. We will be making a soil structure interaction analysis of building response prediction and taking a look at the feedwater pipe to make some pre-test predictions. We will also have the opportunity to look at the behavior of some of our predictive codes, some of our soil structure interaction codes, and building response codes, and piping codes.

This particular budget in my branch has to do with the response prediction of th BWR -- of the feedwater system at the HDR facility. This will be an ongoing program lasting over many years, and we are spending abou $70,000 this year and next year, and we are requesting an increase in '81 to about 300K to become much more involved in the HDR program.

(Slide.)

We think the need for this is based on a rare opportunity to become involved in full-scale testing. The HDR does have non-linear supports and it gives us an opportunity to verify some of our existing codes.

DR. SHEWMON: Does non-linear support mean snubber?

MR. RICHARDSON: No. Non-linear spring type hangers.

DR. SHEWMON: All right.

MR. RICHARDSON: They do have snubbers, I believe, also.

(Slide.)

Going along with this, we felt that there is a need to have some representation at the HDR site. And so we have issued a request for proposal to represent us at the HDR facility during the test period.

This RFP is currently on the street and we should receive proposals within a week or so.

We feel that this will provide us with on-site evaluation. They will be able to give us an assessment of the test results very quickly and recommend further involvement. The contractor would visit the Lawrence Livermore laboratory, become familiar with our assessment program, understand our research need(,(and then represent us in West Germany during this test time and serve as eyes and

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ears for us.

MR. BENDER: What are the Germans putting into the program?

MR. RICHARDSON: About $5 million. It is about a $5 million program, exclusive, of course, of the cost of the facility.

(Slide.)

Our next program is entitled "Non-linear Systems Modelling." This, again, is an ongoing program at the University of California under Professor Masri. We are currently spending $135,000 this year and are budgeted for about $150,000 in FY '80, and are requesting a budget of about $200,000 in FY '81.

This is a program that will provide analytical and experimental studies of dynamic responses of nuclear plant mechanical equipment to determine the effects of non-linear system modelling of the ability to predict structural response.

This is a study carried on by Professor Masri that will provide us some methodology for giving us bounding values for responses for licensing staff in the form of design curves, that when an applicant comes in with a pump or a valve under seismic conditions, the staff would be able to look at their responses and determine whether they are valid or not.

DR. ZUDANS: What is non-linear about this?

MR. RICHARDSON: Both geometric non-linearities and material non-linearities.

DR. ZUDANS: What would you in this assessment use for loading?

MR. RICHARDSON: Seismic loading, primarily.

I think in looking at first principles, I think once the technique is developed, you can use any dynamic input. It doesn't have to be seismic -- any time, history, response spectra input.

DR. SHEWMON: Is this a finite element code, a set of equations, or what?

MR. RICHARDSON: Parts of it are finite element. But it is primarily a set of equations in the form of a computer program that will predict response values.

DR. ZUDANS: What does it differ with or what will it differ with from codes such as DINA, MARK, ANSR, which have all of these capabilities?

MR. RICHARDSON: Simpler, a quicker analysis and although we will provide to the staff the code, we don't envision that that in itself will be the useful product. The useful product would be things like design curves which we have developed and some bounding values on things like scaling. They would go out and test a particular pump or valve. How far can I scale that to larger valves and still consider it to

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be valid.

DR. ZUDANS: I do not disagree with your objective. I think the objective is clear, but I have a pretty grave doubt that you can achieve the objective by this or any other method.

MR. RICHARDSON: We have had a fair degree of success on some very simple models.

DR. ZUDANS: What do you call success? Non-linear beam? That is not a success. That is what you discussed last time.

MR. RICHARDSON: No. We have gone now to testing some valves, small 4-inch valves, and have made some predictions of those small valves quite successfully.

DR. SHEWMON: What does a prediction mean?

MR. RICHARDSON: A prediction is given an input, a theoretical input, what are the responses of key elements within the component?

And then we go out on a shaker table and verify.

DR. SHEWMON: Does that mean that it is plastically deformed, or how much does it elastically deform?

MR. RICHARDSON: Generally, it is elastic deformation but non-linear, such as gaps.

MR. BENDER: I guess that I am more confused than ever about this business. I was trying to envision what kind of valves you could test on a shaker table and what kind of deformations you could confirm as being inelastic. My little bit of knowledge of valve design suggests that very little of it is designed on an inelastic basis.

MR. RICHARDSON: I don't think any is designed on an inelastic basis.

MR. BENDER: What is a non-linear system modelling supposed to do? It deals with inelastic behavior.

MR. RICHARDSON: Inelastic material behavior, but more important, geometric non-linearities like gaps across valve stems and motor operators.

What we are attempting to do is to provide the staff and the Office of Standards some handle on developing qualification criteria.

How do you qualify pumps and valves for seismic environment?

MR. BENDER: Are you saying how to predict how a pendulum moves as a function of --

MR. RICHARDSON: That is --

MR. BENDER: That is about all I can see you are trying to do.

MR. RICHARDSON: There is a simple pendulum movement involved, but there are also many other structures involved with it. So it is not just a simple pendulum.

DR. OKRENT: What is inadequate, in your opinion, about the current method of qualification?

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MR. RICHARDSON: I don't think there is a good correlation between test and analysis. We currently allow a combination of test and analysis of pumps and valves, and I don't think that there is a good correlation between the analysis and the tests.

I think the tests may be too simplistic in just doing synocoidal sweeps and finding resonances.

DR. OKRENT: Could you make the same statement about the qualification of electronic equipment?

MR. RICHARDSON: I would and I will. We have another program that addresses that.

DR. ZUDANS: Then the objective of the non-linear would not be a continual type of analysis, but more components coupled in non-linear fashion.

So it is different than a continuum code than it would be, in your opinion, worthy objectives as set up now, able, in fact, to predict tests.

Let's say you run a wild test. You input certain response spectra, some random type of excitation. Would it be able to proceed in the calculation with that input?

MR. RICHARDSON: Yes. But I think the objective and the need is to make an assessment of the qualification criteria of pumps and valves.

MR. ANDERSON: I am chief of structures and components standards branch. We have been working with the

ASME for several years in trying to develop a standard for qualification of valves.

One of the problems in that standard is how much scaling can be done? If they test a 12-inch valve, can they say, now we don't have to test a 14-inch valve which is geometrically similar.

Can we jump to a 16-inch valve, an 18-inch valve? We don't have the capacity to test anything of that size right now.

We faced the problem of substantial non-linearities gaps, rattling of components inside of valves. And we had little or no basis to justify any allowable scaling. And so standards initially requested this program to give us some guidance on where we might draw the line on allowable scaling in qualification tests.

DR. OKRENT: The Japanese, if I understand correctly, have gone to large shaker tables. Have they, A, found information on scaling? And B, have they found it cheaper to build a large shaker table than to try to do the analysis and scale up? And have they found maybe more definitive measurements?

MR. ANDERSON: I am not talking just about shaker tables. In this case, one qualification test I witnessed that might be considered a reasonably valid test consisted of blowing 2 million pounds per hour of steam through an 8-inch valve simulating a pipe break just beyond that valve while they shook the valve in two directions and tried to close it and had the piping forces exerted on the valve, dynamic and static piping forces. And tried to close the valve under these conditions.

It is not a simple shaker table test, and if we talk about test facilities, I think we ought to talk sometimes about the capacities to blow huge amounts of steam through pressurized components at the same time that we are shaking them and bending them and operating them.

MR. BENDER: Bill, given that the tests are not as meaningful as you would like, what reason is there to believe that the analytical modelling approach, as described here, will be any better without a very large amount of physical testing to confirm the model?

MR. ANDERSON: They are doing some physical testing. But I think, if anything, we will come out with a place where we can draw the line and say to the industry, this level of scaling is not acceptable.

We may get a negative result which will be accepted.

DR. ZUDANS: Will this methodology include thermohydraulics as a part of the system?

MR. RICHARDSON: As an input?

DR. ZUDANS: No, as a part of the model. The flow will be affected by motions in the wall and the wall will

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effect -- no.

DR. ZUDANS: Then it represents reality anyway.

DR. SHEWMON: If we can't do the answer yet, the question is how should we start, not whether we will do everything.

DR. ZUDANS: My feeling is what is really missing -- and I agree with you -- what is really missing is the capability to look at the system behavior, where mechanical components inte: ct with the hydraulic aspects of the system.

This is why the relief valves pop open prematurely, because they are pressurized travelling back and forth.

This is what is missing. And if you would say that if the non-linear program is developed as a part of that major piece, that eventually it will be a systems type of a look at non-linear aspects.

I would sav that it is a beautiful program.

MR. ANDERSON: This is the very first step we tried to take, and that is, can somebody going to a shaker table say we have tested a 12-inch valve on this shaker table. We know its dynamic characteristics. We can then predict on this same geometric scaling what the characteristics would be for a 14- or 16-inch valve.

We didn't feel that we could accept that quite that readily and this is just the first step in trying to start to draw some conclusions in that area. We haven't begun to solve

584 167

the big problem.

DR. SHEWMON: Dade?

MR. BENDER: On point. I think nobody disagrees with your comment, Bill. But the problem that concerns me about this whole program and why I am so critical of it is it is a very long-range program. You are dealing with it in bits and pieces and it doesn't seem to have any end-point that would really have actual use in the licensing process or that would give anyone great confidence that we know more about the system reliability and its response to these various phenomena than we do today, because it is all based on exercising a computer.

I have become appalled with the uselessness of computers. They just give you a lot of data but not much analytical result.

MR. RICHARDSON: Our 1981 program in this project is primarily aimed at model verification by test. And that is why the big jump in money up to $200,000.

That, of course, is very modest, but it is a start into the test verification phase of it.

MR. BENDER: Ten times $200,000 won't buy you much of a test in the context in which we are talking.

MR. RICHARDSON: I agre[illegible] [illegible]t is a start and it is a long-range program. We do no[illegible] [illegible] that we will have definitive answers within [illegible] y[illegible] o[illegible] tw[illegible] We are hoping that

584 168

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after a visit to Japan, that we will be able to perhaps cooperatively enter into some test programs with the Japanese, take advantage of what they have done, perhaps furnish to them some pre-test predictions using some of our codes.

Take advantage of things like that.

DR. SHEWMON: Dade, did you have a question?

DR. MOELLER: Yes. My question tied into what -- to the remarks that the speaker just made.

I had understood that through the ACRS visit to Japan this spring, that we were going to have a rather detailed report on their shaker table experiments and what they are learning and so forth.

Do we have a report or was that covered?

DR. SHEWMON: I am not sure that was visited. The staff program got cancelled. And the only people that went from our place was Lawroski and Plesset, and they were more local-oriented.

DR. SHAO: The seismic group was supposed to go to Japan in April. Because of Three Mile Island, the trip was cancelled and is rescheduled for October.

DR. OKRENT: I made some negative comments on specific things we heard, and I will make some more. But let me suggest to this subcommittee that in a sense a role they can play if they don't like what they are hearing is to try to think of what would be a better program, because I think there is not much doubt that there are lots of problems with pipes and valves and so forth and so on. And certainly, in some other areas of research programs we are proposing to the staff that they do sutdies with a different emphasis than they were proposing, and I think it is not unreasonable, if we have all of this talent around the table, that people come up with some positive suggestions as well as negative ones.

MR. RICHARDSON: They would be most welcome.

MR. ETHERINGTON: I would like to ask for clarification on the preceding item, the HDR. Literally, hot steam reactor. Doesn't it have a name? What kind of an animal is this? Is it a boiling water reactor? Is it a nuclear reactor?

MR. RICHARDSON: It is a decommissioned BWR, located near Frankfurt, outside of Frankfurt, a few miles. And it was in operation, I believe, about three years and then decommissioned.

DR. ZUDANS: I would respond to David's suggestion. I would recommend that this program be considered in a different context, coupled with some hydraulics program, such as RELAP 4 and add the elements of nonlinear behavior of bodies, check valves, disks, and other things, so you can in fact analyze the dynamic system the way it fits in the power plant.

So, maybe what you are doing now in this strictly mechanical aspect is not a loss, just lack of completeness.

DR. SHEWMON: Thank you.

MR. RICHARDSON: Our next major area is mechanical components, and it is composed of five projects: snubbers, pump and valve operability, component seismic qualification, advanced seismic design, advanced seismic restrainers.

We had a very modest effort which started in 1979, $50,000 in FY '80. We are budgeted for $850,000. And in FY '81, $1.8 million.

I might point out that part of this FY '80 and '81 budget includes a supplemental budget on pump and valve operability. We have requested incremental funding of $300,000 of the $600,000, I believe $300,000 of it is supplemental. Of the $900,000, $600,000 is supplemental.

(Slide.)

The first project is snubbers. We are anticipating -- we have started -- we are going to start a program this year. we have not got it started yet -- with a budget of about $50,000, and this will increase to about $150,000 in FY '80 and about $300,000 in FY '81.

We do not have a contractor on board yet. We are in the process of selecting the contractor. So, I can't comment any more on that.

(Slide.)

The objectives are to evaluate the existing criteria for use of mechanical and hydraulic snubbers on nuclear piping system components and to establish some analytical and experimental characterization of snubber and restraint device performance which will be used to yield higher plant piping systems reliability.

From this program, we would anticipate the development of technical specifications regarding the qualification of snubbers, to update the standard review plan regarding snubbers, to support the regulatory guides on qualification and application and in-service inspection, and develop topical reports in support of proposed regulatory guides.

The need we see is that there have been many snubber failures in the field. We feel that this program will assess the design and application of snubbers and get a better feel for how a snubber behaves and what the regulations should be, and finally to assess the qualification and inspection requirements and come up with better ones.

DR. SIESS: I can't understand a word of what those needs mean. I understand the first ones. There have been many snubber failures. But I don't know what the definition of "snubber failure" is.

MR. RICHARDSON: A snubber failure, that is when it doesn't perform its job. That could be a lock-up.

DR. SIESS: You mean in a test?

MR. RICHARDSON: Either in a test --

DR. SIESS: We haven't had an earthquake --

MR. RICHARDSON: -- Or in normal operations.

DR. SIESS: You have had failures in normal operations?

MR. RICHARDSON: Yes. We have had them freeze.

DR. SIESS: What does the second item mean?

MR. RICHARDSON: We feel if we are going to understand snubbers, we have to make an assessment of the design and how they are applied.

DR. SIESS: What do you mean by "understand snubbers"? How they are built?

MR. RICHARDSON: How they are built, how they are used, how they are tested, how they are qualified.

DR. SIESS: This disturbs me greatly, because the staff has been requiring them and has been approving plants with snubbers for quite some time. And when I say "with snubbers," I mean with hundreds of snubbers. And you mean they don't understand why they are asking for snubbers in plants? Or why applicants are putting them in?

MR. RICHARDSON: I am sure they understand to the best of their ability right now. We feel that we need additional insights.

DR. SIESS: I don't understand. I thought I understood why snubbers were there: to keep the pipe from moving during an earthquake and to let it move during temperature movements.

MR. RICHARDSON: Yes.

DR. SHAO: A lot of the problems with --

DR. SIESS: There are a lot of problems with snubbers that are failing in one way or another: failing in a test or, as you say, failing in service. We haven't had one fail under an earthquake yet, that I know of.

I understand problems about failure rates, and we have asked questions about the consequences of a snubber failure, and there was a study made for us by an applicant -- not by research -- on Diablo Canyon.

But I am trying to find out what is the knowledge that the staff needs to regulate nuclear plants as far as snubbers are concerned.

MR. RICHARDSON: I think the primary thrust of it is: do we really understand and really believe that the qualification and inspection tests required for snubbers, are they adequate?

DR. SIESS: Are you worried about failure rate?

MR. RICHARDSON: Yes.

DR. SIESS: It seems that is a question for the probabilistic assessment branch or for reliability plant analysis rather than a mechanical type study.

MR. RICHARDSON: But if we can devise qualification tests that will reduce that failure rate, we will have achieved success.

DR. SIESS: Why don't you simply decide what failure rate you want, specify it, and let the industry devise the tests to meet your failure rate?

MR. ANDERSON: Could I speak to this, Jim?

MR. RICHARDSON: Yes.

DR. SIESS: Anybody who can answer it.

MR. ANDERSON: This snubber research was requested by Standards, again. We are faced with --

DR. SIESS: Are you speaking for Standards now?

MR. ANDERSON: I am speaking as a person who helped write the research request.

DR. SIESS: From Standards?

MR. ANDERSON: From Standards.

Our concern was: We are trying to write a regulatory guide on snubber qualification. We anticipate writing another regulatory guide on design assumptions to be used in application of snubbers. And we will be supplementing present tech spec requirements, maybe with another reg guide on inspection of snubbers.

We find several problems: that snubbers are reported to have failed because the fluid leaked out. That is one type of failure that says the snubber is inoperable. We find others where they took the snubber off, put it on test, and the snubber was specified as having a bleed rate of maybe in the range of 20 to 40 inches per minute or inches per hour, a number like that. It fell outside that specification, it is defined as having failed.

We find no basis for saying it needed to be anywhere within 20 to 40 in the first place. We don't see where that comes into the analysis. We don't see in any of the analytical efforts how this would be defined as a failure. It was outside the manufacturer's specifications and, therefore, defined as a failure.

What we feel we need is an analytical study which looks in great detail at the nonlinear characteristics of the snubber and modeling as closely as possible those things which are defined as part of a snubber operation, what is the lock-up rate. The lock-up rate is within a given range, is it adequate or can it be 10 times that range and still be adequate or must it be much, much finer.

DR. SIESS: Those are very good questions, but I thought it was the responsibility of the applicant to state the design bases and criteria for his plant and to justify them, and not the responsibility of the NRC to come up with design bases.

MR. ANDERSON: We do not intend to come up with a design basis.

DR. SIESS: You mentioned "design assumptions."

MR. ANDERSON: Assumptions for use in design.

DR. SIESS: And by "design assumption," you mean something like the Appendix K assumptions for LOCA?

MR. ANDERSON: Possibly something like that. What I am thinking is that we may require that they have a specific type of model, mechanical or mathematical model, for the snubber in a piping analysis, in order for them to specify the snubber and specify the qualification requirements for that snubber. And then we can also go from there to qualification requirements and to inspection requirements.

DR. SIESS: Does this cover both hydraulic snubbers and mechanical snubbers?

MR. RICHARDSON: Yes, it does.

DR. SIESS: Have you had the same problem with both, or just when you got started?

MR. RICHARDSON: Yes. The same types of problems.

DR. SIESS: Failures? Same kinds of failures with both?

MR. RICHARDSON: Both locked up.

Bill, you can probably address that better than I can.

DR. SIESS: I haven't seen an LER on a mechanical snubber failure. I have seen hundreds on hydraulic, and I just wondered.

584 177

DR. SHAO: There are a few on mechanical snubber failures list.

MR. ANDERSON: I understand all of -- all of the mechanical snubbers, or many of the mechanical snubbers, in FFTF are being replaced.

MR. BOSNAK: Yesterday, I think, we mentioned that we had a technical assistance contract on a snubber sensitivity work. This will be completed this fall, and a lot of the questions that Dr. Siess has raised are going to be answered.

There was a paper published just a few weeks ago, and it was given at the San Francisco Congress on pressure vessels and piping by our contractor. This was ETEC. And the kinds of data, the sensitivity data, that you need for snubber parameters are what have been developed. We have been in contact with Research, that they shouldn't reinvent the wheel when they go into this program.

As I understand this program, this is snubbers in tandem.

DR. SHEWMON: Why don't you handle that internally?

Thank you very much.

Harold, you had a question?

MR. ETHERINGTON: Yes.

I would like to ask about the criteria for a supplemental request. I had assumed that it was to resolve problems that have been identified in the Three Mile Island accident.

Here are some of these items -- in fact, all except the valves and perhaps the pumps seem to be using Three Mile Island as an excuse.

MR. RICHARDSON: No. I beg your pardon. The only supplemental request we came in on was for pumps and valves, not for snubbers.

MR. ETHERINGTON: I see. You have an asterisk at the top.

MR. RICHARDSON: Yes. The only program that is involved in that is pumps and valves.

MR. ETHERINGTON: So, the criterion is to resolve specific problems that were identified in Three Mile Island.

MR. RICHARDSON: Our supplemental includes Three Mile Island and the five-plant shutdown.

MR. ETHERINGTON: Yes. But --

MR. RICHARDSON: It is linked to one of those two problems.

DR. SHEWMON: Mr. Richardson, this is dragging on at a snail's pace. Not your fault entirely. Could you scope a little bit? You are halfway through this handout.

MR. RICHARDSON: What I suggest is that I just quickly flip through and give a word or two on the projects.

DR. SHEWMON: I am not sure we will let you, but let's back up. You had a slide there with pump and valve operability, and the rest was seismic. Is there yet another comparable group to that figure right there?

(Slide.)

How many more do you have, projects, that you are going to try to talk about?

MR. RICHARDSON: I was quickly going to go through these five projects, and then I have some four projects under codes and standards.

DR. OKRENT: Let's take pump and valve operability.

(Slide.)

MR. RICHARDSON: This is a program that we hope to get started in FY '80, and we have budgeted 600K. Part of that is a supplemental request, a good share of it, more than 300K supplemental. And in FY '81, that would go to 900K.

(Slide.)

The objective is to develop acceptance criteria and methods for qualification, supported by a technical parametric data base of safety-related pump and valve operability problems. The results would be to predict the reliability of pumps and valves to perform their designed safety functions. We see the need arising from a need to assess the operability assurance in extreme environments. There have been pumps and valves fail. There are many existing pumps and valves that are not qualified for currently identified service conditions. They were qualified under conditions that were thought to exist when the plant was built. Those conditions have subsequently changed.

The question arises: How reliable are pumps and valves in these newly defined extreme environments? We think we need to get a handle on how reliable are these pumps; what sort of qualification tests should we be requiring, both of old plants and new plants.

MR. BENDER: Did TMI introduce any new extreme environments?

MR. RICHARDSON: I believe yes. I believe you could say maybe some new environments for at least pumps.

MR. BENDER: Someday, but not now, it would be useful to have that explained.

MR. RICHARDSON: I can't today get into it.

MR. BENDER: Sometime.

DR. OKRENT: I am interested in knowing why the NRC should undertake what looks to me like an expensive program, because we see $2-1/2 million by '82, and that is not the end of the program, I have to assume. And it seems to me there are so many different kinds of valves that exist, the ones you are doing may not be the ones on three-quarters of the plants, or whatever.

If you have questions concerning valves, for example, or pumps in existing plants with regard to whether when they were built something was inadequate or you learned something now, why is that not handled via the licensing arena? And if you think that they are currently being qualified improperly or there are doubts in this regard, again, why don't the licensing people have the licensee show that things are being done correctly? It is not clear to me why the NRC needs to test some specific valves when it is, in the first place, not going to be, I think, possible to test them all. And I don't know why you need to test any at the moment.

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MR. RICHARDSON: I don't think our job is to qualify specific valves, specific patented pumps and valves, to operate in a nuclear plant. However, I do believe we need to be in a position to ask the right questions, to impose reasonable qualification criteria on the applicant -- to what levels do we demand that they qualify their pumps and valves. We just feel that our qualification standards right now are not adequate, and we would try to get on a generic basis a handle on what are the right questions to ask the applicant and to confirm -- to be in a position to do some confirmatory validation of his claims.

DR. OKRENT: Are we throug with that, or at least have enough to make our comments?

DR. SHEWMON: What I would like to have the Committee do is, there is a handout which you have with you here. It is called "Extreme External Phenomena Subcommittee Meeting." If you would look on the last page of it, you will find someplace between one and two dozen topics that are in the Mechanical Engineering Research Branch. We could be here all day at this pace.

What I would like to urge is that we look at those titles, and either by way of sudden increase or above some level, pick the ones we are particularly interested in having talked about. We are down to about the middle of the page, to "Pump and Valve Operability." "Benchmark for

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Applied Mechanical Computer Codes" is the biggest one. "Design of Steel Energy Absorbing Restrainers" has the biggest percentage increase.

Pick your criteria, but I would like not to hear every one of these, if we can avoid it.

MR. BENDER: Mr. Chairman, I suggest we delete the rest of this just because we don't have time to hear it in any kind of substantive way, if we are going to cover any other part of the agenda. We have probably heard enough of this, even though I am guilty of using up a fair amount of the time.

DR. SHEWMON: Harold, what is your feeling?

MR. ETHERINGTON: Somewhat mixed. I agree with Mike that we have an awful lot to cover here. On the other hand, it is only by hearing some of these things and asking questions that we are in a position to hear whether a program is worthwhile or not. I think we have bitten off a little more than we can chew today.

MR. RICHARDSON: I have given you as a supplemental handout that's, I believe, a detailed project description for each of these programs that are beyond what I have on viewgraphs, and they go into more depth in describing the individual projects, and I hope that that might be useful to you.

DR. SHAO: I would like to make a general

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statement. All of our programs in the structural mechanical area are requested mainly in those parts of standards. Some of the programs have been requested for many years. Mainly, we don't have any research facility to do this. And also you may see like a bit percentage change in the Fiscal Year '81, mainly because the program is new.

And when you start on zero, the next change -- anything from zero to any number is infinity.

MR. RICHARDSON: Many times in our initial programs we spend the first year scoping and doing some sensitivity --

DR. SHAO: It is very difficult for -- to see such increases in percentage, and you say, "Why such a change in percentage", and it is mainly because the first year is mainly the scoping and the next year we want to do something.

DR. ZUDANS: How does the advanced seismic design differ from SSMRP?

MR. RICHARDSON: The advanced seismic design is looking at new, improved seismic design concepts -- specifically, seismic isolation and attenuation of seismic loads.

DR. SHEWMON: Dave, would you care to comment on the motion?

DR. OKRENT: According to the agenda that was

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prepared, originally we were going to discuss this plus structural until 11:15. I assume that is still in the plan.

DR. SHEWMON: No.

DR. OKRENT: No?

DR. SHEWMON: I was trying to compress things because we are putting in the feedwater line crack at 11:00 or 11:30, and we have some assurance from Shao that this would only take half an hour -- which is part of his usual optimism, I think.

(Laughter.)

DR. OKRENT: What is the agenda plan?

DR. SHEWMON: I was hoping we could be done with this by 10:00, instead of 10:30. At this point, if we go on at the rate we are going, it will be 2:30.

DR. OKRENT: There is a section on mechanical and there is a section on structural, and so far we have only picked up mechanical. Again, my question is: are we going to 11:15 with the mechanical plus structural?

DR. SHEWMON: No. I would like to be done with the mechanical now. I would like to be done with the structural in half an hour after that. I am trying to pick up half an hour on this presentation, and we are losing an hour.

DR. OKRENT: In fact, I would suggest that we give the mechanical and structural programs, again, until 11:15

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and delete other topics from the extreme external phenomena area.

DR. SHEWMON: No. Mechanical and structural is 11:00. Why do you say 11:15?

DR. OKRENT: Well, I think primarily because they each have alot of separate tasks shown, and I think in order to comment on them at least -- do you want to have a couple ofm minutes discussion on each one? This was the purpose of having the Subcommittee meeting, and I guess we joined with yours because we thought you were interested in hearing these topics. And I think that there are questions coming from members of the Metal Components meeting.

But if we don't have discussions I think it will be hard, and this is proposed to grow into a rather large program, and furthermore, the Budget Review Group doesn't agree with the rate of growth, for example. And I think the ACRS comment here is of some interest.

DR. SHEWMON: I agree with all of those good things. My question was: can we be more selective in what we hear?

DR. OKRENT: I am willing to pick out things where -- in fact I indicated in a memo the areas -- based on my reading of the tasks where I thought more discussion or justification was warranted. I did that with regard to both mechanical and structural.

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DR. SHEWMON: Can we get that and talk only about the ones you have checked? I really want to be done with this in 15 minutes, and then we can go on to structural and chew out of their time if you want to.

DR. OKRENT: Well, energy absorbing restrainers, that was one topic that there was some question on, and I see Siess is not here. He was wondering why NRC was proposing to do this. It seemed like it was a development kind of thing, so I can be specific in that way if you like.

MR. RICHARDSON: It is development. However, we felt that it has the possibility or replacing snubbers, and we felt that we would like to get involved in it to the point of proving or disproving the feasibility of the concept and not getting into the development of a patentable device where we would be in the awkward position of being asked to license a device that we had developed ourselves.

MR. BENDER: DOE has been sponsoring this thing for two or three years, as I understand it. What developed a suddenly compelling interest on the part of NRC?

MR. RICHARDSON: The NRC has been involved in it in the form of -- in an advisory capacity. I have served on the Advisory Board for that project. DOE came to use and asked us if we would enter into joint funding of this project for the next year. They have some funding problems, and we felt it was an appropriate place for us to get into

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where at the feasibility stage to look at how feasible this concept is, and can it, indeed, replace snubbers.

MR. BENDER: NRC doesn't have any funding problems, I take it.

MR. RICHARDSON: NRC. Yes.

MR. BENDER: Why try to solve DOE's funding problems?

MR. RICHARDSON: We are not trying to solve DOE's funding problem. We feel it is a project we should be involved in — that we need to get involved in and assert our views and how we feel the program ought to be run. We can't do that by sitting on an advisory panel.

DR. OKRENT: Let's move along. Now, "Benchmark for Applied Mechanic Computer Codes" is a big item. Could you tell us why you think it is both important and effective, as you are proposing to do it?

(Slide.)

I think one or two minutes' worth is good here. "Benchmark for Applied Mechanic Computer Codes."

MR. RICHARDSON: We feel that the Commission needs to develop a level of confidence in the structural mechanical computer code area. We propose to provide that confidence by setting up a series of benchmark standard problems to be run with existing codes. We also propose to the staff their own independent computer code checking

584 189

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capability -- not that we would develop brand new computer codes, but we would take existing computer codes and benchmark them, define their limits, their limitations, where they can and cannot be used, and provide to the staff modeling techniques so that they can run independent checks on an audit basis if they wish of computer outputs submitted to them by the applicant.

DR. OKRENT: Does it take $3 million do you think to get the appropriate staff capability with regard to computer codes and having the staff test them enough so they understand how they work and what their weaknesses and strengths are?

MR. RICHARDSON: Yes. Because we forsee the only way we are going to have confidence in benchmarking is by experimental verification.

DR. SHAO: I would like to say something on this. On the computer code in the structural mechanical area, I think NRC is ten years behind as far as comparing the structural mechanical area and the thermal hydrolics area. In the thermal hydrolics area they have been working on the computer code for the last ten years, and they are still working on it. The trouble is whenever people -- NRC -- checks detailed calculations on thermal hydrolics, by the time they finish the loading and giving it to the structural mechanical people, we are assuming everything is right.

584 190

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because we have no capability to check it. So it is a balanced review as far as NRC is concerned. In the thermal hydrolics area, they check every detail, and then they are still finding mistakes in the computer code. By the time they give it to the mechanical and structural people, we have no capability to review this, and we are just assuming that all of the codes used by industry are right.

DR. OKRENT: Larry, I am interested in the staff having some ability to analyze these things. I think that is reasonable.

I am not so convinced myself that you need to do experiments, for example, and I am trying to understand what the distribution of money is between getting the ability to do your own analyses and thinking that you understand what these codes do and so forth and how much of this money is in experiments, and why you have to do experiments.

I would like to separate. Let's assume for a moment that there is some basis for the staff having an ability to analyze for seismic design, if they need an ability to design for LOCA. Let's not argue in that area.

Now what else do you need to do beyond that, and how much of this money goes beyond getting your own in-house ability?

DR. SHAO: We try to use existing available codes and try to use them and to qualify them, but for certain areas maybe we have trouble. We feel the computer code is deficient, and we may do some experiments but would try to avoid that as much as we can.

DR. OKRENT: You haven't told me how this money is divided though, because I asked originally, do you need all of this just to get the analytic capability without an experimental program, and the answer --

MR. RICHARDSON: I would say when we first sat down and laid this budget out, it was about 50-50 with experimental versus developing.

DR. SHAO: Experimental is very expensive.

DR. ZUDANS: I think, Larry, there is some misunderstanding. At least the way I understood the program when it was first discussed, there are plenty of experiments in existence where you can exercise the program you select as a, let's say, a program that you engage others in. That is the only program you really have to check against this.

I understood the problem is the fact that most applicants' computer codes in the applied mechanics area are proprietary codes. You have to accept the results -- numbers in, numbers out. Now the benchmark, I would understand, is a very important thing to be such that it would exercise those black boxes in such a way that you would gain some confidence as to which numbers you can believe, or which ranges of parameters you can believe those

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numbers. That means the tests you can pick from nonlinear dynamics programs, or you can take tests from many, many other things that you already have included in these things.

So I don't see any reason for any experimental work here, but I see definite reasons for benchmark problems in the sense that it will allow the staff to exercise the black boxes so that they gain some confidence as to how credible the numbers that are coming out in terms of the input parameters.

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DR. OKRENT: I don't see any reason for those boxes to remain as far as the staff is concerned because they can say that we have to see what is in the code and we will keep it proprietary.

DR. ZUDANS: Even if you would disclose the black boxes, I don't know whether it would cost more money to learn --

DR. OKRENT: There are two separate questions. And the staff has, in fact -- they have the ability to review it and they think it is important. They should ask to see what is in the codes because we are unwilling to accept a black box analysis in an area of my own interest, for example.

If bench-mark calculations are worth doing, how much money does it take to develop the necessary, let's say, specifications for bench-mark problems.

The staff is going to ask the various industrial groups to do them and presuming they will run them with their own code.

I am trying to see, is this kind of money -- namely, $3 million over two years -- do you need that much for this kind of a program if you do not do your own experiments?

MR. ZUDANS: If you do not do your own experiments, I would say not needed. I haven't heard the breakdown, so I don't know.

MR. RICHARDSON: As I said, I would judge that about half of that money would be for experiments. That would sound like a very cheap experimental program.

However, we are anticipating that we would be looking at past experiments. We would be piggy-backing a lot of ongoing experiments such as the LOFT program, the HDR, and perhaps the Japanese programs.

We would hope to do a lot of piggy-packing.

DR. SHAO: There are lots of programs we have to look into. There are many different programs we have worked on. I appreciate that Dr. Zudans knows about this.

DR. ZUDANS: I think it is true that you can review the program in the (inaudible). It still, in my opinion, needs to be exercised, the input parameter so we can identify the limitations.

There is no way any mind can go through those listings and precisely identify what the program will do under specific conditions.

DR. SHEWMON: Let's shift.

DR. OKRENT: One other new program -- assessment of nuclear power structure system componets, subsequent severe accidental and environmental events.

You show 300K, 500K, 900K, from FY '80 to '82.

(Slide.)

DR. OKRENT: I am curious as to whether you think you can develop something that will really be able to assess this

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damage by the kinds of approaches you are talking about.

Is this really pretty far out research?

MR. RICHARDSON: I think it is marginal. And I think we would spend a few dollars early determining the feasibility. Does this hold out promise?

We feel it is an area that ought to be addressed. However, we do not see the solution. We do not -- we are not prepared to promise that we would have it, but we would propose to spend a small amount of money early in the program to assess the feasibility.

DR. OKRENT: It is shown as a rather substantial program.

MR. RICHARDSON: Yes. I am anticipating that in order to budget out into '81, in order to perform some feasibility studies early, and it turns out that there is promise, I must have money identified.

DR. OKRENT: I suggest you show this as one of the activities you are going to do in this program in foreign reearch. You might talk to the Japanese who are thinking about the problems and see if you can develop some ideas that have a chance.

I don't have any others.

MR. RICHARDSON: On the last page of your viewgraph, the suggested priorities, that is the last one.

DR. SHEWMON: Put it on.

584 196

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(Slide.)

DR. SHEWMON: I want to ask about your ASME code assessment exercise. Everybody on the staff, SSS codes, and everybody, if they want to, has representatives who sit on these codes.

Can you explain to me -- you are going to solve all of the corrosion problems that B&W has, which doesn't impress me highly, but go ahead.

MR. RICHARDSON: But we feel that there are several areas of the SME codes that are not adequately addressed currently.

Among those are buckling of shelves, fatigue of Class 2 and 3 components, corrosion, and dynamic behavior of components.

The ASME code is primarily a static code and the allowables are based on static allowables. It doesn't really address the dynamic environment.

We feel that there is a need to go in and look at how the code is handling some of these areas and work with the code in coming up with better requirements.

DR. SHEWMON: This is for travel expense, to go to meetings, or what?

MR. RICHARDSON: No. We would probably hire a Contractor to go in and look at the effects of performing fatigue analysis on secondary systems. Is there a need? How many instances of fatigue cracks in Class II systems have there been and what are the consequences?

Is there a need for requiring a fatigue analysis of Class II systems?

DR. ZUDANS: Jim, I know of the difficulties in the ASME code because of lack of funding and lack of volunteers to support such development.

The code normally uses what exists in the literature or what the industry voluntarily offers in doing additional analysis.

Now if this funding is designated for that purpose, I would wholeheartedly endorse it because, really, the code lacks the funding. They have no way of resolving a simple question like buckling of -- for internal pressure. For pressure vessels, they develop curves in one range and when they go into another range where the buckling starts, no industry wants to analyze this because it is a fairly expensive deal.

And there are no tests that would tell when those things happen.

So I think that this type of support for code groups, if it is intended that way, would be very welcome.

DR. SHEWMON: Thank you. Are there any other questions, then?

MR. BENDER: Have you discussed these activities with

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the PVRC?

MR. RICHARDSON: No.

MR. BENDER: Do you plan to?

MR. RICHARDSON: Yes.

MR. BENDER: It seems to me that would be appropriate.

DR. SHAO: I have discussed with the code people. They say Section 3 is great. But I say, how come it is so great that there are pipes cracking all over the place?

I think we should bring operating experience into the code. I think the code should wake up, too. If they are failing, they are cracking. The code is not performing its function.

MR. BENDER: I am not debating that point.

DR. SHAO: We have talked to the code people, and they don't want to make any changes until we force them.

DR. SHEWMON: Most of the piping codes come from the environmental effects and the ASME mechanical engineers are famous for avoiding that question as far as they can.

So you may not be going to the right place, or you may have to drag them in.

DR. SHAO: I think — they don't worry about environmental conditions. I think that has to be considered. These are the things that are causing the cracking.

DR. SHEWMON: Thank you very much. Do you have a list of all of the projects that you have in your branch?

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DR. BAGCHI: Yes, I have two things. I have a listing of projects, which is a handout, and I have a budget sheet attached to the very end.

DR. SHEWMON: Why don't we skip to the very end?

DR. BAGCHI: I also have a handout from a little presentation.

DR. SHEWMON: We have that. Let's talk about the areas you would most like to talk to us about, or where we would most like to hear comments.

The seismic safety margins, is that part of this LLL program?

DR. BAGCHI: That is part of the LLL program, but it addresses the structural elements as well as structural interactions part of the building response part.

DR. SHEWMON: As far as what gets put off --.

DR. OKRENT: No. That is separate from the SSMRP and I think it needs to be stressed here.

DR. ZUDANS: I would be interested in hearing on containment safety margins, on containment buckling.

DR. SHEWMON: Any other candidates that people are particularly interested in?

DR. OKRENT: I think the ductility under impact loads should be heard to evaluate the concepts, the last one --

DR. SHEWMON: Can we leave out the technical assistance?

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DR. OKRENT: Yes, I think that is sort of something that --

DR. BAGCHI: You are looking at this slide?

(Slide.)

DR. OKRENT: Let's start with the first one.

DR. BAGCHI: The first one, seismic safety margins. What I have attempted to do here is put down some very brief descriptions of the objectives and then go through the research and the needs for this particular project, since that is what I feel you want to hear.

The detailed description of each project task is provided in the other handout.

(Slide.)

This is part of the LLL program, mechanical engineering discussion. And this will be heard in greater detail later on during the meeting with ACRS.

DR. OKRENT: Is this part of the overall funding or is this separate from the current funding?

DR. BAGCHI: The funding level is separate.

DR. SHAO: This is part of SSMRP.

DR. BAGCHI: This is part of the total SSMRP.

DR. SHAO: Don't discuss it today.

DR. OKRENT: Don't discuss it if it is part of the SSMRP.

DR. SHEWMON: Why don't we go to containment safety margins, then.

DR. BAGCHI: Okay. Unfortunately, there was too much on the slide. But this is safety margins for containments. The objective is to develop reliable methods for predicting ultimate capacities and failure modes of containment building, investigate the behavior under combined earthquake and internal pressure. Evaluate effects of large penetrations on ultimate capacity and leak-tight integrity. And determine effects of hydrogen explosion on internals of containment structure. And bench-mark predictive methods rather than proof-test a particular containment type.

I ought to add here that the TMI latest supplemental budget is included in this program. That shows up as the item where I talk about hydrogen explosion and its effect on internals of the containment structure.

In terms of needs for this project, we, as of yet, do not have reliable estimates of failure loads. The industry codes, based on experience of conventional structures that are functionally and geometrically quite different from the containment pipes that we are building --

Three Mile Island and Maine Yankee types of situations really indicate the need for an estimate of ultimate capacity end-failure mode.

DR. OKRENT: What was the Maine Yankee situation?

DR. BAGCHI: The seismic load went up by a factor

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of -- it was perceived that the seismic load went up by a factor of 4. And if we had fairly good estimates of the ultimate margin, seismic safety margin for the containment, the staff would have been able to make a judgment regarding the time period involved.

DR. SHAO: Let me say a little bit about Maine Yankee.

Maine Yankee is one of the five plants that was shut down. That was the first plant. That was backed up a few weeks ago. During the review, the seismologists say that Maine Yankee was designed for a G value of .1. And if you use the present criteria, the G value had to be jacked up from .1 to .2 -- between .3 and .20. And the only Reason that we let them back up, because we felt that it was conservatism different components.

I think we feel that there is some conservatism in containment structures, but he doesn't know how much -- whether it is 2.5 or 4.0.

If it is 4.0, it is maybe a different story. 2.5, may be a different story. I think he wants to use Maine Yankee as an example that sometimes you want to know the margin for different component structures so that you can decide whether the plant can be shut down or should start up.

MR. BENDER: Is this all safety margin or seismic?

DR. SHAO: This is safety margin for seismic loading.

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MR. BENDER: Only.

DR. SHAO: I'm sorry. For pressure and seismic both.

MR. BENDER: And temperature?

DR. SHAO: The containment -- usually you don't see too much temperature. So mostly it is the pressure and the seismic.

MR. BENDER: There is a design temperature associated with the containment.

DR. SHAO: Yes.

MR. BENDER: Pressure associated with seismic load, I wanted to find out if all were being dealt with.

DR. SHAO: The reason we have this program is usually there is a lot of civil structure like bridges, beams, frames. There is a lot of testing. Containment is a different animal. So far, nobody has really tested any containment to failure.

DR. BAGCHI: There are efforts in Japan, Brazil, Canada, all but the United States.

DR. ZUDANS: A couple of questions. Does this involve an analytical program?

DR. BAGCHI: It is really bench-marking the analytical codes that will predict the failure margin.

DR. ZUDANS: Are you considering all failure modes, including buckling, in all types of containment, including concrete, free standing steel, et cetera?

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DR. BAGCHI: I was addressing the steel containment in a separate item, which shows up in this list as buckling of steel containment. But I am addressing containments of other types, pre-stressed as well as concrete.

DR. ZUDANS: The buckling of steel containment is not under the seismic test?

DR. BAGCHI: Not under this particular program.

DR. ZUDANS: Is that the same program that was presented by DSS to us yesterday?

DR. BAGCHI: This program supplements the DSS program by developing the data base that the DSS program does not address and dynamic asymetric pressure effects on buckling.

DR. ZUDANS: Now is the objective of this program also to establish a design criteria for such structures with respect to different failure modes, or only to bench-mark industry techniques as to how they are designed?

DR. BAGCHI: Those are byproducts that would come as the program develops. It depends on how well the analytical capabilities predict the failure modes and ultimate capacities.

DR. ZUDANS: It is not clear to me whether this program will resolve the outstanding problem that I consider exists; namely, the incapability of the state of the art techniques to predict buckling failure modes accurately for real structures.

If it is directed to the real solution of that

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particular objective, I'd like to endorse it, if it is of any importance.

If it doesn't, then I question why is it done?

DR. BAGCHI: One of the aspects of the buckling program is to review analytical methods and how well you can predict in the failure modes.

DR. ZUDANS: That was done by Weingarten. And the conclusion is that the state of the art has been stagnant since 1965.

DR. BAGCHI: It concluded other things, too. There is no data base for predicing the knock-down factors.

DR. ZUDANS: So the data base for knock-down factors exists for three specific types of stress.

Now if your model, this model that you want to make would produce one more point on combined loads for knock-down factors, it would be a magnificent program. If you don't plan to include that, I am wondering whether -- what is it that you want to do?

DR. BAGCHI: This program has not been started yet.

DR. ZUDANS: I understand. It is intended to supplement the DSS program.

My feeling is that you and DSS should really sit down and establish what is really missing in the state of the art of containment design with respect to different failure modes and maybe come up with a single program that would respond to real needs.

DR. BAGCHI: There was intent on our part, but these are internal things that perhaps we --

DR. SHAO: I think the containment for symmetrical loadings, we can predict the failure mode very easily, the ice condensors. And then you have to worry about the failure modes, how do they behave? And nobody really knows.

DR. ZUDANS: No disagreement with that.

DR. BAGCHI: I think that states all I want.

DR. OKRENT: What is not clear to me about this is in view of the multiplicity of containment types and then a bigger factor of variations on penetration design and so forth because each utility wants it different or each AE does it differently, or so forth.

So as far as I can tell on penetration design and so forth, there are very many big differences. How are you going to get information that handles the non-axisymmetric system?

How much money are you talking about to really do something so that if I were to come up to you and say, I am interested in these five containments, and I won't tell you which they are before you do the program, you will be able to tell me what the failure pressure is within a factor of 20 percent.

DR. BAGCHI: We feel that by benchmarking the analytical programs, we should be able for new candidate containment times -- we should be able to come up with that objective.

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DR. SHAO: What we would like to do is do a couple of testings and do a lot of analysis and do some correlations between analysis with the vendor programs, and based on the analysis of the experimental programs. We cannot test every type of containment, but most are shell-type structures. Most are concrete, reinforced concrete on the outside, liner on the inside. And they have certain characteristics.

We have done testing on the pre-tested concrete and we did some testing and some analysis and we tried to correlate. That is the intention.

DR. BAGCHI: The state of the art is in such disarray right now that we cannot, with any kind of certainty, say whether the containment will fail in -- whether it will fail with combined repressurization or some other mode, or whether it will fail in the area of penetration.

DR. OKRENT: I can't tell if this problem is as difficult as the problem of computing what happens to a fast reactor core after it melts because there are so many different variants.

In other words, are you starting something that you really can't --

DR. BAGCHI: I am simply saying that the civil engineers have tested for a long time. Some are shell types of structures; some are massive, usually employed in the nuclear industry where we have very little test data. And we

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are trying to do something from -- at the very ground floor.

DR. ZUDANS: There is one failure mode that the industry has not addressed adequately. That is the buckling failure mode. It is associated with real factors. No one knows that the real factors look like.

DR. OKRENT: Should the NRC be doing these kinds of tests. And if so, which ones and why?

DR. ZUDANS: I would give my opinion. My opinion is that if NRC is to either accept or reject an applicant design on the basis of some calculation, NRC should have some way of telling whether the method used by the applicant is conservative or not.

Now if that requires NRC doing some experiments to get the calculations or involving some computer program, I think it makes sense if industry is not doing that because industry right now is used to the plant, that NRC takes the position they will review on a case-by-case basis.

So if someone comes with a program, NRC doesn't know anything better than to say, okay, it looks fine. As compared to your analysis, it sounds reasonable. That is how they are accepted. But nobody knows where the real failure point is.

DR. BAGCHI: The question has to be addressed by several answers.

DR. SHAO: Can Professor Siess say something?

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DR. SIESS: Not on that subject.

DR. BAGCHI: Safety margins for containment.

DR. ZUDANS: The rest of the safety margins are analytically done without further program development.

DR. SIESS: I know something about the structural safety, but I don't really think that that is what we are concerned with.

We are interested in the ability of the containment to contain the fission products, which is a question of leaking. I don't know whether leaking is likely to precede significant structural failure or follow it at some much later point.

I think if you are thinking of the structure itself and not the penetrations, that you don't need a whole lot of research to predict structural failure with a lot better accuracy than you can predict fuel failure for the large LOCA, the 2200 degrees, or whatever it is.

You probably don't need that much margin.

But if you are going to try to predict when it will leak, I think you have got a real problem because -- and I don't think that you are going to do it with any kind of analytical program or any kind of a test program you can make.

DR. BENDER: It is not obvious to me that this program is aimed at trying to find out whether containment will leak or not.

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DR. SIESS: That is why the containment is there.

MR. BENDER: I understand this. But the proposal here is to do something in terms of structural response.

DR. BAGCHI: We have done specimen testing and we found that after the concrete cracks surveillance, the stiffness goes down by a factor of 10 or greater. That raises additional questions whether or not we want to impose additional constraints on the liner deformation.

This is all tied into the leak-tight integrity.

DR. SIESS: But the liner integrity has been based in the past on rather local deformation conditions. It has got to be much more ductile than concrete, even at one-tenth its stiffness.

DR. ZUDANS: As far as other aspects other than the buckling failure mode, I have no comments. My only comments pertain to the buckling.

DR. SHEWMON: May we go on, unresolved as this is?

DR. OKRENT: Benchmark of structural codes. Could you tell us briefly what it is you want to do there?

(Slide.)

DR. BAGCHI: This is as a result of the five-plant shutdown indicated in our supplemental FY '80 budget. And as you will please note, we have requested 400K for FY '80 and an additional 400K in FY '81.

DR. OKRENT: This is the Main Yankee kind of question?

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DR. BAGCHI: Trying to resolve somewhat similar questions. Not particiuarly Maine Yankee per se, but to provide the staff with tools to address questions that may come down with other operating plants.

DR. SHAO: The benchmark is the same.

DR. OKRENT: Could we go on, then, unless subcommittee members have a question?

In the water hammer area, I have one question. It seems that you are proposing something, but I couldn't see any sign of interaction between what you were reviewing and what the thermohydraulics people might think were at the places at which you might get water hammer under various designs conditions.

And have you, in fact, coordinated this?

DR. SHAO: The water hammer, we are doing not only structural but thermohydraulics. The main reason is this task action plan A-1, which is water hammer for everybody.

It is my responsibility.

In this particular area of water hammer, we are handling structural and thermohydraulics, too.

DR. OKRENT: It doesn't seem to show in the write-up.

DR. BAGSHI: It shows up in the needs area. We say methods needed to realistically evaluate water hammer events in operating plants. This is not currently covered by A-1.

That would be a thermohydraulic evaluation, load

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assessment, including --

DR. OKRENT: I didn't think you, in fact, in the structural group had people who would be assessing what kind of loads you get from water hammer.

DR. BAGCHI: That is because of our strengths and weaknesses. Our staff strength happens to be in this area.

DR. SHAO: Mr. Burger is a hydraulic expert.

DR. ZUDANS: Are you planning to, in fact, perform water hammer analysis in this context?

DR. BAGCHI: Analysis --

DR. ZUDANS: With respect to the boundaries?

DR. BAGCHI: This program has not been scoped out in detail. I will refer that question back to --

MR. BURGER: What is the question?

DR. ZUDANS: Are you going to consider flexible boundaries in this water hammer analysis? Do you plan to do water hammer analysis?

MR. BURGER: Yes, we plan to do water hammer analysis.

DR. ZUDANS: Will you consider structures interaction with the flexible boundaries or rigid boundaries?

MR. BURGER: At this point in time, probably not fluid-structure interactions. It isn't planned just yet.

DR. ZUDANS: Rigid boundaries is the answer?

DR. BAGCHI: Let me try to interpose one thing here. We are trying to evaluate the realistic effects of water hammer

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on operating plants. We don't have the luxury to bound water hammer loading on a system.

So I would say that wherever they are flexible, we have to consider that.

MR. BURGER: Yes. Basically, what we intend to do is establish calculational methods for the various types of initiating mechanisms.

DR. SHAO: That would include the fluid structure action.

DR. ZUDANS: And then you go in the pipes. It makes a big difference whether you say the pipe can expand with the pressure or not.

However, maybe if you are looking for conservative answers, you would not have to worry that much about that secondary aspect.

MR. BURGER: We would like very much to be able to use the -- what you are talking about.

I am not sure at this time if we will be able to, if the codes are able to.

DR. ZUDANS: You have identified some code you plan to use in this work?

MR. BURGER: They are not verified codes. We can use RELAP for some of the transient effects, hydraulic transients and possibly another for the structural, direct structural damage.

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Some codes don't exist right now to handle the condensation-induced water hammer. We may have to modify some.

So on and so forth.

DR. ZUDANS: Since the work has not been started, I think it is a good time to really plan it very carefully, not just start with something that is only temporary as a fix, something that in the future allows you to have something that you can rely on. And that means consider the flexibility of systems, to begin with.

MR. BURGER: That is very desirable.

DR. BAGCHI: One remark. Chuck is the project manager for A-1 also. So this coordination will be very effective.

MR. BENDER: The NRC had some work that was done by Criare in this area. Is this a departure from this or is that an extension of it?

DR. SHAO: We go beyond that.

DR. BAGCHI: You're talking about the Criare work. There is the upper-bound estimate, but I didn't go into the realistic effects of water hammer.

MR. BENDER: That concluded they need a lot of experimental work before we could do anything.

I wondered whether you were thinking in terms of ignoring that advice and going ahead and generating some analytical procedures without it.

DR. BAGCHI: No. Chuck, did you hear the question?

MR. BURGER: I didn't understand it.

MR. BENDER: Let me repeat. I think when Criare looked at this problem, they concluded that in order to provide any kind of analytical approach, there would be a need to do some experiments.

MR. BURGER: That's correct.

MR. BENDER: Now I at the moment, I hear you saying that you are going to adopt some existing analytical procedures.

I want to know whether you plan to do experiments to confirm those. What is the approach?

MR. BURGER: We plan at this point in time to do the analytical approach in parallel with some testing. As you say, if we come up with analytical techniques that are not verified by testing to any satisfaction, they are generally worthless and we won't be able to use it.

So we do plan to do testing along with the analysis. And basically, what comes out, or arose out of TAP-A-1, will sort of guide the subsequent research.

One thing that has already come out of A-1 that was cancelled prior to research thinking it over was that substantial state of the art didn't exist for calculating the steam condensation-induced water hammer, which is probably the worst and most prominent case.

MR. BENDER: When does the experimental work start in this program?

DR. BAGCHI: It starts toward the end of FY '81 when we hope that FY '82 would be sufficient funds to handle these kinds of things.

Again, I would like to leave with you that I understand the licensing staff, particularly NRR's group working with Criare, have been coming in with the research request where they claim full-scale tests would be necessary for steam generator water hammer studies.

With these kinds of funds, obviously, we couldn't handle anything like that.

MR. BURGER: That goes back to the old question of trying to extrapolate two-phase flow.

MR. BENDER: Thank you.

MR. BURGER: We also hope to do some TMI-related research.

DR. BAGCHI: That was based on the ACRS recommendation Unfortunately, it got too late before it was included in our FY '80 supplement. So we don't have the FY '80 supplement for water hammer.

MR. BENDER: I don't see a great urgency to get started any faster than you are doing. The rate of progress will be slow.

DR. SHEWMON: Are there other items here that you would like to bring up?

DR. OKRENT: I think it might be worth the committee hearing about ductility under impactive loads.

DR. BAGCHI: The plea here is the same thing. We base our current judgment on the basis of the tests. We would like to develop this by the experimental programs. In terms of needs, this is research that would address the provisions of the Appendix C. I think there is an error here in the slide. It should say "Research addresses issues arising from provisions of Appendix C of ACI 39-76." The results will be applicable to all plants, and current provisions are based on these tests and not any realistic data.

MR. BENDER: What does the term "impactive load" mean?

DR. BAGCHI: Pipe whip loading, missile impact type loading. Internal missiles.

MR. BENDER: From what?

DR. BAGCHI: Internally generated rotary machines and the like. Turbine missiles.

DR. OKRENT: That's not internal. What internal missiles are large enough that you are concerned?

DR. BAGCHI: Perhaps I am off base to talk about internal missiles. What I had was problems related to turbine missiles interaction, particularly pipe whip analysis where you need to account for some ductility in the system, and we need to develop guidance in that area.

MR. BENDER: Are you saying you are assuming that ductility exists and you are uncertain as to whether that assumption is any good or that you need to know more quantitative information about the ductility? Which?

DR. BAGCHI: More quantities of information and making sure that the limitations that are currently existing that the -- the regulatory staff has a different view as opposed to the code, and it would resolve the differences and establish quantitative limits on ductility.

DR. SHEWMON: The EPRI people recently ran some tests out at -- in the southwest desert someplace. Are you familiar with these? It had to do with some licensing case where -- with regard to turbine missiles.

DR. BAGCHI: That is primarily to look at the exit velocity of the turbine missile, and the missile interaction has not been done, but the type of ductility experimentation we are going to do involves --

DR. SHEWMON: They did do experiments. I have seen pictures of them. And they talked about various orientations of steel that hit them.

DR. BAGCHI: I am not aware that they were addressing ductility, per se. They were addressing exit velocity of a turbine missile. I may be wrong.

DR. SHEWMON: Exit after the concrete or exit after the turbine house?

DR. BAGCHI: After the turbine house is what I have seen. Mayb. :hey have done something --

MR. COSTELLO: I am not aware that the EPRI tests have progressed to the phase at which they are doing impact of turbine fragments on barriers.

DR. SHEWMON: On concrete.

MR. COSTELLO: The tests I have seen relate to attempts to estimate the exit velocity from the turbine casing.

DR. SHEWMON: Thank you.

MR. BENDER: Sandia has done some penetration work that surely would be relevant to the point you are making. I gather what you are talking about in case of pipe whip is repeated impact on the slab. Is that what you mean?

DR. BAGCHI: It may or may not be. We are looking at very high velocity loading on a concrete slab and determining whether or not the failure is electrical --

MR. BENDER: You have to define not only the failure mode but the loading, and that means you have to assume some kind of pipe loading the slab in some form. I haven't heard much about that aspect of it so I am just presuming that you are assuming a piece of pipe whipping around, hitting the slab repeatedly as the steam moves it from one point to another. Is that what you are saying, or is it something else?

DR. BAGCHI: I did not have repeated impact in mind.

DR. SHAO: This means fast loading, much faster than earthquake.

DR. BAGCHI: And whether or not the piece of concrete blows up by shear failure and hits some of the safety system. We want to avoid that kind of a situation, nonductile failure.

DR. ZUDANS: But you talk about pipe whip, and, clearly, you may have a continued rebound, impact, rebound, and impact, and that is the mechanism that Mike is describing.

MR. BENDER: I just postulated it.

DR. OKRENT: How dependent would this be on what you assume was the rate at which the pipe broke and so forth, or the way in which it broke and so forth and so on? I am wondering whether, having done this experiment, these studies, whether you would really be significantly better off with regard to assessing the safety of the plant.

DR. BAGCHI: I think the data does not currently exist. We would be lucky to get ductility factors less than between 10 and 20.

DR. SIESS: How much do you know about the data that already exists? There have been many, many tests made on slabs under dynamic loading from blast. There have been a large number of tests made on slabs under impactive loadings from pipes and telephone poles and things of this sort. And you can't get anywhere from knowing that? Where are you starting?

The blast stuff, God knows, is how many yea's old. It tells you a lot about required ductility in terms of the input energy. The missile type studies have been extensive in Europe and in this country, and I have never seen them brought together anywhere. So, where are you starting on this?

DR. BAGCHI: We have to start with a review of the existing data. I don't believe that we have --

DR SHAO: I think the structures are different. Here in the nuclear structure, the shear wall type of structures and the impact loading is a combination --

DR. SIESS: The shear wall type of structure is not going to fail from the dynamically imposed shear. That is not what you are talking about. You are talking about a transverse loading on it. I have been looking at the work statement and I just can't see a good definition of the problem. It is a very broad definition of a problem. It [illegible] clear that there is a problem.

MR. COSTELLO: The major argument is about allowable ductility under transverse load.

DR. SIESS: On slabs.

MR. COSTELLO: On slabs. We intend to use as a starting point the [illegible]ment station work which has been, in the main, for --

DR. SIESS: That is a small fraction of what has been done on that.

MR. COSTELLO: There has also been stuff done by the naval engineering laboratory that I am aware of.

DR. SIESS: There is extensive work done at my university. I hope you know about that. There has been extensive work done in Sweden at the Swedish Fortifications Board. And then, it seems to me that somebody has to know the question, and I don't hear the question.

MR. COSTELLO: The question is: What is the allowable ductility one can use for two-way slabs of the kind that will expand the depth ratios that we encounter.

DR. SHAO: I would like to give one example. Yesterday, Jim Costello was asked to form the analysis in case the Skylab falls on a reactor plant. They were deciding whether or not they want to shut down all of the plants or not yesterday. They were really serious about shutting all of the plants down because of the Skylab impact.

DR. SIESS: It is not that much different than an airplane hitting it.

DR. SHAO: With the airplane, one is a soft missile, one is a hard missile.

DR. SIESS: It is not much that different than an airplane.

DR. BAGCHI: The work statement does not specifically state that we will review what has already been incorporated, that already exists. If you look at the modest amount of effort

584 224

involved here, that is about the only thing we can do in the first year.

DR. SIESS: It doesn't look like it is that modest. I am looking ahead.

DR. BAGCHI: As I went along, I wanted to say that we would incorporate your comments and make the work statement more specific to review the existing data.

DR. SIESS: What makes you think you have a problem?

DR. BAGCHI: We have disagreement between the regulatory staff and the code committee as to what is an acceptable limit for ductility.

DR. SIESS: Do you have any idea whether you are conservative enough now?

DR. BAGCHI: The staff thinks the code is not conservative.

DR. SIESS: What is the staff requiring?

MR. COSTELLO: We are holding out for a limit between five and 10. Industry seems to feel 10 to 20 will be reasonable.

DR. SHAO: They are even talking 30.

DR. BAGCHI: That is the main thrust, why we are pushing for this program.

DR. SHAO: It is mainly 349.

DR. SIESS: The staff feels if the ductility is greater than about five or 10, you can get into some secondary effects that could damage the plant?

DR. BAGCHI: Yes.

DR. SIESS: More than it was already damaged. You have had already something to impact it.

DR. BAGCHI: Yes.

DR. SIESS: To get to the five or 10, you have had a pipe break, and now you are worrying about if you try to utilize ductility of 20, that you might get scabbing that will knock out your ECCS system; is that the question?

DR. BAGCHI: Or produce such overall deformation that --

DR. SIESS: This would be for internal structures. It depends on what is on the other side of that wall; doesn't it?

DR. OKRENT: The thing I am concerned about, there are some plants where you hardly have any protection at all for pipe whip. Here you are concerned about for those where it is designed, whether the margin is enough. How do we resolve these considerable differences?

DR. BAGCHI: Operating plants would have to be reviewed in a systematic manner, and we just cannot stop working on the area of criteria.

DR. SIESS: On what basis does the staff feel -- let me put it this way: How confident do you feel, if you limit the ductility to five, you won't get into any trouble?

DR. BAGCHI: It is subject to opinion. 584 226

DR. SHAO: Depending on the connection --

DR. SIESS: There is one way to get research done without costing me anything. It's to put what I consider a conservative limit; somebody says 20 is fine; and I say five is all I will accept. Then it it is up to them to do the research to prove that 20 is acceptable.

Now, they might just decide, well, it is cheaper to settle on five than to do the research to establish 20. But if you are smart, you can set that limit such that you can give them a pretty good incentive to do the research.

DR. BAGCHI: This is similar to the seismic shear transfer.

DR. SIESS: Yes. And I have the same opinion. They should have done it, not us.

DR. BAGCHI: We are wondering if the operating plants could take the seismic loads.

DR. SIESS: But you have a mechanism for handli[illegible] that if you want to.

DR. SHEWMON: Can we leave them with that advice and go on?

DR. BAGCHI: The research we have done comes in very handy for Maine Yankee.

DR. SHAO: We would like to see some research results that can go higher than five or 10, especially the operating plants that Dr. Okrent --

DR. SIESS: I would, too, but I don't think it is necessary for us to do it.

DR. SHEWMON: Come on, Larry, let's quit.

DR. SIESS: I don't know how handy it has to be for Maine Yankee. I want it to be handy for the NRC.

DR. SHEWMON: Do you want to hear adequacy of codes and standards for concrete, Chet, or can we move on?

DR. SIESS: As near as I can tell, the adequacy of code and standards addresses the shear question that I have already discussed at some length in previous meetings as something I didn't really see the need for the NRC to do. But I don't want to pursue that any further.

DR. SHEWMON: Okay. Thank you.

DR. OKRENT: Mr. Subcommittee Chairman, I would like to suggest that we not cover any more points except those on which subcommittee members or consultants have specific questions, since we are running out of time, but that whenever that is done, at some time today, before they leave, those who have any opinions on pro or con on either items discussed or items not discussed in either the structural or mechanical area, write them out and give them to me. Okay? So that I have them. I will be in another meeting. Give them to Dick Savio. He will get them to me before I break to go to my other meeting this afternoon. Somehow I have to coalesce these things.

DR. SHAO: May I ask one question before we quit here. Is there any program that you want to mention that you haven't mentioned that you want us working on that we have not worked on?

DR. SHEWMON: We are overwhelmed with the things that you have.

DR. OKRENT: Are there others?

DR. SHAO: Are there others?

DR. OKRENT: That is a good question, but I am not sure you are going to get an answer at this time. It should be thought about. I tried to indicate that earlier.

(Slide.)

DR. BAGCHI: If I have your indulgence for one minute, I have prepared one slide where I analyze the increases in the budget from FY '80 to FY '81, and the deltas show on there.

DR. SIESS: That is your last slide on the package?

DR. BAGCHI: Yes. The biggest increases are in the seismic margin program. And what I indicated as technical assistance, we have been seeing more and more a transfer of this responsibility from NRR to RES. We need to have preparedness for something like that.

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DR. SHEWMON: All right. Thank you very much.

DR. SHEWMON: Mr. Harbour, we would like to hear a brief statement of where you are.

DR. HARBOUR: The eastern megalopolis extends from Washington to Boston.

DR. SIESS: Do you have the latest report on Skylab?

DR. HARBOUR: No.

(Laughter.)

MR. COSTELLO: The last I heard was 11:50 on --

DR. HARBOUR: On Eighth Street.

(Laughter.)

DR. HARBOUR: My name is Jerry Harbour. I am Chief of the Site Safety Research Branch in the Office of Research.

I am not quite sure what your questions -- or what questions you seek to have me answer. The agenda said that you were interested in earthquake recurrence intervals and what we were doing on that at specific sites.

DR. OKRENT: Can I pose it this way? There is a program which is quite extensive, in the seismic area, to get background information. There is a statement that you are going to do some kind of work on estimating what should be, let's say, a better basis for judging safe shutdown earthquake, however you want to state it. There is the SSMRP program.

What I would be interested in knowing is, do you have some kind of a focus in all of this, where you will try to have a basis for providing at Site X earthquake intensity versus recurrence interval for increasingly large earthquake intensities going beyond the SSE?

It is the kind of input you would need for an SSMRP program or risk evaluation program or trying to judge Maine Yankee, which was at .1 and maybe now you think -- this sort of thing.

DR. HARBOUR: This is inherent in the program. First of all, I would like to say the earthquake recurrence interval is simply the reciprocal of the earthquake hazard. That is, the annual hazard is the reciprocal of the recurrence interval for any particular given earthquake size and frequency at which it recurs.

Essentially, the entire NRC research program addresses seismic hazard on a national reduced to a regional, and to provide the capability for local, hazard assessment.

The second thing I would like to say, also, the NRC program is part of a much larger program in the federal geoscience community involving the Geological Survey and the National Science Foundation. One of the things we have tried to focus on in our research program is the capability for providing specific earthquake hazard estimates or earthquake hazard estimates at specific sites.

As far as the jurisdiction for doing this, the actual jurisdiction for providing this informatio lies within the licensing group. We are trying to provide the capability for them to do that, both in terms of the research results that have been provided and in terms of the expert consultants that we have working on these problems within the various regions.

(Slide.)

DR. OKRENT: I don't know what you mean when you said jurisdiction.

DR. HARBOUR: Responsibility.

DR. OKRENT: They have the responsibility for deciding what they think is a safe basis, let's say, with regard to seismic design. But I would assume that the research people would provide their best estimate on seismic hazard or recurrence, however you want to put it, and that in fact in 1980 you could provide one estimate, qualify it however you want, giving as big an uncertainty limit as you wish. In 1982 you might have -- my question is, are we going to have to wait until the end of your research program before we get this estimate, or do you have a target of providing a first estimate, let's say, in 1980, with whatever you think are the appropriate uncertainty levels, which you will update every couple of years?

DR. HARBOUR: We feel that the state of the art currently is such that we can provide an estimate of the earthquake hazard or the recurrence interval of earthquake sizes at any particular site at the present time, but with large and unknown uncertainty levels. And our effort really is an attempt to reduce those uncertainty levels through the different approaches that are shown on this viewgraph.

DR. OKRENT: Is there a plan to put out some of these estimates that you think you can now do for, let's say, at least public discussion?

DR. HARBOUR: As an example of this Maine Yankee, it came up there and at Connecticut Yankee, and the information we provided -- we provided information to the regulatory staff on both of these and provided them with consultants, and they have come up with estimates.

You are talking about a formal methodology?

DR. OKRENT: I think in fact it would be useful, a discussion on earthquake recurrence interval and so forth, if it were done in a semi-academic atmosphere, to the extent possible, and if in fact based on this rather extensive program that you have; if you were to put out such estimates at a suitable number of sites, that this could be a focus of discussion.

People could say, this looks good, or, for the following reasons, in this area you are much too large or much too small on one number or another. And what you are proposing, that on a case by case basis you can get assistance of the regulatory staff.

I am saying there is another way of helping knowledge along which is independent.

DR. HARBOUR: One of the things we will be coming up with will be, for example, frequency-magnitude curves for various areas of earthquake occurrence or source regions. I think this addresses the kinds of things you are talking about, and that will be forthcoming.

DR. OKRENT: Let's leave it, at least a strong personal interest in seeing something out. We have seen sort of studies by other groups, nothing by the NRC's program.

DR. HARBOUR: A lot of what you might have seen from the other people's research may actually have been NRC-supported as well.

DR. OKRENT: That's possible.

Could I ask why is there a need for the tsunamis?

DR. HARBOUR: The program on tsunamis is completed as of this fiscal year.

DR. OKRENT: One other question. There is some work on floods that is going on in this office. There is some work on floods that is going on in the Probabilistic Assessment.

DR. HARBOUR: That is correct.

DR. OKRENT: Is there coordination?

DR. HARBOUR: Very close coordination.

DR. OKRENT: One other question. There is considerable amount of effort on meteorology. Could you tell us why that is important, and is it a high priority item, and why?

DR. HARBOUR: I think it is a moderately high priority item. The need for the research, as we see it, is that many models exist, almost any or all of which are acceptable. There is a question of verifying the various parameters within the models through large-scale field experiments.

DR. OKRENT: These are models to be used for what?

DR. HARBOUR: Atmospheric dispersion under accident meteorology conditions in terms of accidental releases.

DR. OKRENT: For DBA safety analysis reports?

DR. HARBOUR: That is one part of it. The other is for the event of accidents that go beyond the estimated releases from DBA.

DR. OKRENT: Tell me more about how you think this research would apply to that. It is not clear to me.

DR. HARBOUR: For example, if there is an accidental release of some magnitude, first of all you need to know the source term. At Three Mile Island, the source term was back-calculated from the meteorological conditions to determine what was released and how much was released. In order to perform that kind of back-calculation, it is necessary then to know where the plume is, know where your measurements, where your concentration measurements are taken within the plume, and you need the meteorology information to provide you with this. In order to predict out to 25 miles what the concentrations are going to be, you have to know what allowances are for the horizontal spread, for meander along the ground, and the amount of diffusion in the vertical, which in the past has not been measurable in field experiment.

And there is a new technique using ground base -- to provide concentration measurements in the vertical, which can greatly refine the programs and greatly increase their chances of success in predicting concentrations at greater distances, out to like say 25 or 30 miles.

DR. OKRENT: I am not clear whether you are talking about a postmortem on an event, which is what the Three Mile Island situation is, if I understand correctly, or trying to, in the heat of an accident trying to predict what is going to happen. Or is this supposed to be predictive?

DR. HARBOUR: In the accident situation, something similar to Three Mile Island except with significant releases, we would like to develop or -- develop the minimum requirements for meteorological and radiological monitoring networks to -- and determine the kinds of ground and fixed ground and mobile monitoring instruments that are necessary to make the decisions concerning the possible evacuation and to where and in what direction.

DR. OKRENT: I would think that wasn't something you would need meteorological research for. You don't know what the weather is going to be, anyway.

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DR. HARBOUR: You do not know what the weather is going to be, but once the accident is under way you know what the accident conditions are, and you need to have the satisfactory understanding of dispersion under those weather conditions to predict an hour in advance or two hours in advance or longer.

DR. MOELLER: What did TMI show that you lacked?

DR. HARBOUR: TMI showed, first of all, that we lacked a good response system, and it was one which was put together ad hoc, which involved one of our investigators, among others, with the NOAA teams, who sat on an ad hoc basis and predicted ahead of time what was going to -- what concentrations were going to be.

DR. MOELLER: It takes research to improve this response?

DR. HARBOUR: It takes research to improve the prediction capabilities under a variety of terrains and a variety of meteorological conditions.

DR. MOELLER: How is your work tied into ARAC?

DR. HARBOUR: Our work is not tied into ARAC, and our view of ARAC was rather pessimistic as a result of the TMI accident, primarily because of the response time. And even with accurate predictions coming in from -- or calculations coming in from a distant site, it is still necessary to have the individuals on the site who understand the local meteorological conditions at that time, to make the human judgments based on those calculations, to provide the advice to people at the site who need the information.

MR. BENDER: What is ARAC?

DR. HARBOUR: Atmospheric release advisory capability. It is a large bank of computers which propose to store meteorological as well as source term information, centralized at Lawrence Livermore Laboratory and connectable by telephone lines to any field site, any reactor site, at which time their capabilities would be required. Local people can tie into it and they can get answers.

But there is a 40-minute delay between their input, their response and the processing of the information and delivering it back to the site.

MR. BENDER: Are you saying that you need to develop a capability to do something in a lot less time than 40 minutes?

DR. HARBOUR: A lot less time than 40 minutes, and do it locally.

DR. MOELLER: Does NRC currently have a financial input to ARAC? Do you support it?

DR. HARBOUR: The Site Safety Research does not. It is possible that Probabilistic Analysis does.

DR. MOELLER: And a couple of quick questions. You aren't doing a whole lot in hydrology. Why? I can understand some of the meteorology effort, but if core melt occurred you would certainly want to know something about where it went, and you are not addressing that.

DR. HARBOUR: As far as core melt under -- ground water transport under core melt conditions, there are a lot of available methods. I think the state of the art is such that delay coefficients of the ground due to the ion exchange in the ground -- we know that the sump water is likely to be the predominant source of contamination. We know roughly, fairly accurately, what the contamination, the predicted contaminants would be within that water. Existing two and three-dimensional groundwater flow --

DR. MOELLER: So you say that the data are in better shape there?

DR. HARBOUR: Right.

DR. MOELLER: Why do the waste management people keep calling for research?

DR. HARBOUR: I cannot answer that question.

DR. MOELLER: Maybe you should give them all of these data that you have.

DR. HARBOUR: They have the information. As a matter of fact, most of the information was developed through the waste management program research back in the 1960s.

MR. ETHERINGTON: Could we have predicted with any confidence the results of a melt-through in Three Mile Island?

DR. HARBOUR: The groundwater consequences of a e-10

melt-through? Not without -- it would have been possible, certainly, and the information are available, the data are available, the models are available. And it could have been done, I think, with considerable accuracy.

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DR. OKRENT: You are going to do micro meteorological studies in research? Or just what would you do if you got the money that you are asking for in FY '80 and '81?

DR. HARBOUR: We would perform large-scale field tests over a variety of terrains, of the two terrain types that encompass most of the plants, which are coastal, either ocean coastal or large inland body of water coastal, and river valley terrains, and under a variety of atmospheric conditions which influence dispersion of contaminants in the atmosphere.

DR. SHEWMON: Thank you very much.

As I mentioned earlier, and partly because of consultants, I would like to move discussion of status of feedwater line cracks up at this point in the agenda. That still leaves the question of when we have our executive session to discuss what goes on. Or do you want one for that? Could we do that from 12:15 on or something?

DR. OKRENT: What I would like to do is suggest that you schedule that executive session whenever it is convenient for making sure you haven't lost too many of the people that are appropriate, and then get the benefit of that.

DR. SHEWMON: All right.

DR. OKRENT: Thank you.

DR. SHEWMON: Thank you.

DR. MOELLER: Could I ask I hope a quick question? I keep reading about the Earthquake Hazards Reduction Act of

1977, which supposedly has lots of money associated with it. Does NRC benefit from that in terms of supporting your research?

DR. HARBOUR: We are fairly closely coordinated with the USGS and the NSF, who receive funding under that Act. We attempt to see to it that work which meets NRC mission requirements is accomplished. Much of it is accomplished by the other agencies, but the majority of it is the basis of our program, the remainder, in order to assure that the NRC mission requirements are met.

DR. MOELLER: Thank you.

DR. SHEWMON: At this point in the agenda we shift to a discussion of status of feedwater line cracks. Are you presenting that, too?

DR. SHAO: Yes.

MR. HERMAN: I am with the Engineering Branch of DOR. We are going to try and bring you up to date on the feedwater line cracking problem.

On May the 20th this year, D.C. Cook Unit 2 reported leaking circumferential cracks in the 16-inch main feedwater line near the steam generators. At that time they brought the unit down and radiographed the balance of the feedwater lines on that unit, and also took a look at Unit 1, where they also discovered they had some cracking.

On May the 25th, NRR sent a letter to all PWR licensees informing them of the D.C. Cook failures and requesting specific information on feedwater system design, fabrication, inspection and operating histories. At the same time, the Office of Inspection and Enforcement requested PWR licensees that were in current outages to immediately conduct volumetric examinations of certain feedwater piping welds.

As a result of the above actions, several of the licensees with Westinghouse PWRs reported cracking at the nozzle-to-piping welds.

On June the 25th, after the initial cracking was found, I&E issued a bulletin requesting all facilities with Westinghouse and CE steam generators to complete specified inspection programs within 90 days.

(Slide.)

This slide is basically the results of the inspections, of the inspections which have been performed to date. As you can see, three facilities other than Westinghouse plants were examined: Crystal River Unit 2, Calvert Cliffs Unit 1, and Davis Besse 1. That constitutes the list of facilities in which no cracking has been found in the transition from the nozzle to the piping.

In addition to the list we have here, we found this morning that Ginna also has some cracking in the same area. North Anna Unit has a question as to whether or not they had cracks or some discontinuities that were in the welds originally.

I think I would like to go on next and present a summary of the preliminary metallurgical analysis which has been performed to date. The units on the top -- D.C. Cook Unit 2 had through-wall cracking, and they basically discovered their problem by the leak detection methods.

These facilities, from the results of the preliminary analysis, have similar looking failures. The failures are rather flat. In some cases there is clear evidence of marks. There has also been evidence of fatigue striations on some of the --

DR. SHEWMON: What is the difference between a beach mark and a fatigue striation?

MR. HERMAN: A beach mark is a macro indication which indicates stops and starts in a fatigue-type failure, and the fatigue striation is indicative of perhaps the individual loads that would propagate --

DR. SHEWMON: One is the individual cycle, the other is the --

MR. HERMAN: More the stops and starts and failures.

Most of the work done to date so far has been by Westinghouse, and they have tentatively identified the mode of fracture in these units as corrosion-assisted fatigue. They are straight transgranular and there is not a great deal of oxidation associated with the cracking.

San Onofre and Point Beach have generally much more shallow cracks. They tend to be much more branchy and filled with oxide, and they look like they were probably stable cracks that have been there for a longer period of time.

I think we don't have a clear picture to date as to what the initiating mechanism is for the cracking. Most of the construction graphs have been reviewed and appear to be reasonably -- well, it appears that they are free of cracks at that stage.

Some of the things that are suspected as contributing factors to either initiating or driving the cracks are original fabrication defects -- these may be associated with heat treating -- pipe vibrations, environmental effects, thermal stresses, and improper pipe restraints.

DR. SHEWMON: When you say a fabrication defect, you mean there were cracks there?

MR. HERMAN: There may have been some cracking.

In the case of Diablo Canyon, which is not on this list, they had a problem with -- which was identified by the licensee -- and the mode of failure in that case was supposed to be cracking associated with the welding with the cycle, with the preheat cycle and with the postweld stress relief. There is a question on some people's minds as to whether or not that might be an initiating mechanism for the other ones.

MR. ETHERINGTON: When there are simple transgranular cracks, why do you conclude that they are corrosion-assisted? Did you say some of them are transgranular?

MR. HERMAN: Most of them were transgranular. The macro appearance of the cracks is rather flat. It is very typical-looking of fatigue failure, and there is some evidence that there is assistance by corrosion.

MR. ETHERINGTON: Is that conclusive?

MR. HERMAN: These are tentative analyses at this time.

DR. SHEWMON: You get that out of the fact that you can't explain them with the stresses you know about without that?

MR. HERMAN: I think we will get to that a little further on.

DR. SHEWMON: All right.

(Slide.)

DR. SHEWMON: One thing before we leave that. You didn't really say anything about whether there was a particular axis or orientation or part of the wall --

MR. HERMAN: I will get to it in this slide.

DR. SHEWMON: Okay.

MR. HERMAN: In the deeper failures, the one I showed up on the top that are being called corrosion-assisted fatigue, the fracture appearances are more or less elliptical. I don't remember the exact locations, but they are like at two locations across from each other and they are localized. The deepest cracks are localized at some area on the pipe, and they are elliptical in nature.

It looks like there might be some kind of bending associated with the crack. In most of the cases, the cracks -- the original fabrication -- in this case there was a backing ring on here, very shallow cracks underneath that area. But there is a counter bore on the -- in this case it was an elbow, in which there is stress concentration here. This is counter bored to align the thicker-fitting section with the nozzle transition piece.

And in all cases, on the top the primary crack had been running out of this corner at the top, which is where you would expect it to be coming (Indicating). As I said, the -- in the Cook case, the cracks were through the wall. They were basically elliptical, with some shallow cracking around the balance of the piping in the Cook case.

DR. CORTEN: Are those secondary?

MR. HERMAN: Yes, in some cases some slight indications up in this area. But nothing that was as deep as these cracks in the area where the nozzle was.

DR. ZUDANS: You also had cracks in the nozzle?

MR. HERMAN: There were some slight cracks in the nozzle, which were circumferentially around them, shallow.

(Slide.)

As a postmortem to the failures, the as-built configurations were analyzed with regard to pressure dead weight and thermal expansion to the original codes. Additional analyses were done looking at thermal transients such as through-wall bending stresses and thermal stresses due to local geometric discontinuities.

The results of all the analyses were that the normal operating stresses were under code allowables and the ones outside the code requirements were rather low.

DR. CORTEN: The ones that were outside of the code requirements?

MR. HERMAN: Yes. These were additional analyses performed that were not required by the code.

DR. CORTEN: They are not beyond the code allowable.

MR. HERMAN: No.

DR. SHAO: So far, the stress analysis consists of pressure loading, the general thermal loading and the local thermal loading. Possibly there is vibration loading, but nobody knows whether there is such a loading or not. There may be additional loading that is missing here. We don't know.

DR. SHEWMON: If I stay with that for a minute, though, I saw one reasonably complete analysis of this, which I thought came from PG&E. Is that San Onofre?

MR. HERMAN: Yes.

DR. SHEWMON: One of the things that struck me was that all of these pressure dead weight and maybe thermal expansions were trivial. But as they got down to, let's say, the thermal expansion and one of the other thermals, and then they said, these come out 60 and involve 90,000 psi, but --

MR. HERMAN: No, I don't think they are anywhere at levels that high.

DR. SHEWMON: He then went on and said that, given that, the code says it ought to be good for 1,000 cycles, and so it still meets the code.

MR. BENDER: I think that has to do with the way in which the piping is analyzed.

Tom, you know a little bit about that.

DR. PICKEL: On the secondary stresses, like the thermal transients, where they are self-relieving, the elastic analysis would let you go to stresses that are considerably above the yield stress of the material. And 60,000, the stress is not an unreasonable stress for the very low cycles in the code fatigue curves.

It is sort of a fictitious typ stress.

DR. SHAO: The 60,000-90,000 is not really a stress measure. It is pseudo-elastic stress, essentially the measure of strain.

DR. ZUDANS: It is not a question of what it is a measurement of. I am interested in knowing what was the load source that gave this --

MR. HERMAN: I think we will --

MR. BENDER: Thermal expansion. Cycling in the sense that every time the feedwater chemical changes, you get a different expansion on the pipe.

DR. PICKEL: And as the gentleman said, it is really a calculation of strain with the stress being interpreted as -- from the calculated strains.

DR. SHAO: I would like to make two comments on this slide. As far as the calculations show, everything is under allowable. But there are two possibilities that the calculation doesn't cover.

The one possibility is maybe there is additional loading that nobody knows, whether a vibration loading, water hammer loading, whatever, which has not been calculated. Another possibility is they use an ASME code fatigue curve. Because of corrosion, maybe the fatigue curve isn't right. They used an ASME fatigue curve that shows everything is okay, but maybe it isn't okay, because after operating for a couple of years the fatigue strength of the material may be different.

The two possibilities that are not covered by the stress analysis are these.

DR. SHEWMON: If there is an environmental effect and you are going into a plastic strain, then it becomes easier for me to think that maybe, if I hear about a dead weight of

5,000 psi stress, then I have a lot of trouble with that.

DR. PENSE: Yesterday in the discussion of this, the striation spacing was quoted for us and it is small. So I doubt we are talking about very large stresses. So it has got to be many cycles of low stress type. Therefore, I don't think it can be a low cycle fatigue phenomenon.

DR. SHEWMON: It was a high cycle on that one. But he is also talking about his beach marks or whatever, and we are advised it implies that there are other sorts of things.

DR. PENSE: There were those particular groups of cycles. You may have a large number of very high cycle fatigue striations, and then you have some reason why the plant shuts down or for some other reason, the fatigue ceases. That leaves a macroscopic beach mark. That does not imply that there was a large stress cycle.

Then the plant starts up again, and that has been marked more or less by corrosion. And then you start again and you get another whole batch. That does not imply there was a large stress cycle.

I think that the indication was yesterday, we have got to be talking about vibrational or high-cycle fatigue.

MR. HERMAN: I would like to make one comment on that. The striation spacings we are seeing on surfaces that have been fairly heavily -- well, have had some oxidation on them. They also happen to be on the same order of magnitude as the perlite, fractured perlite. I don't know how much stock we can put in the fatigue striation spacing right now.

DR. CORTEN: The fatigue striation spacing doesn't eliminate some major cycles that start at cracks and then propagate with the minor cycles.

MR. HERMAN: I think the other thing is the initiation of the outer part of the fracture, where the initiation would have taken place. Those are reasonably obliterated on the fracture surfaces. You really can't get very much on the initiating cracks.

MR. ETHERINGTON: The normal thicknesses of the pipe, is the steel stronger in the vessel?

MR. HERMAN: It is 106 steel in the nozzle and I think it is 508, Class 2 in the fittings.

MR. ETHERINGTON: What would that mean in a real s[illegible]se on tensile strength?

MR. HERMAN: It would be somewhat higher.

DR. SHAO: I think it is about the same.

MR. HERMAN: Maybe a little higher.

MR. ETHERINGTON: We would have to try to account for it occurring in the pipe rather than in the nozzle always.

DR. SHEWMON: I think I would check Larry's figures. I thought I looked up something different.

DR. SHAO: They use the same fatigue curve.

DR. SHEWMON: They are not very much different.

One was 106.

MR. HERMAN: And the other was 508, Class 2.

DR. SHAO: 106 is piping and 508 is forging.

MR. ETHERINGTON: The micro shows a strong structure --

MR. HERMAN: What set do you have?

DR. SHEWMON: We will wait for yours. Go ahead.

MR. HERMAN: I have got the originals of the Westinghouse material on all plants. I was going to get into short-term corrective actions that are happening. The crack components are being removed, in most cases taking the elbows out, the reducers out, whatever the areas that happen to be cracked, and they are being replaced.

The transition sections going from the fitting to the nozzle -- let's say their design is being somewhat improved in terms of their being raised. The tapers are being more gentle and measures are being taken to reduce the stress concentrations.

Grinding or other repairs are being performed in the areas where there is shallow cracking to remove those. The total repair, upon its completion, is being radiographed aft-- after the repair and after the final heat treating, to assure that, at least within the detections of the RT, that there are no fabrication defects in the area.

Also, a UT baseline is being performed. Also, a test program is being established for Cook and Robinson at this time where acceleration, displacement and temperature are being measured. The long-term fixes as of right now are to perform a test program using the data obtained and subsequent analyses to establish cause of failure and the cause of the initiation; and modify the piping systems if it is required.

(Slide.)

The lines are being instrumented here in the areas of the elbows, circumferentially, with accelerometers, strain gauges, thermocouples. There is displacement transducers and accelerometers on the line, and there is going to be an effort to establish any thermal transients that occur, any vibrations, any gross movement in the pipe.

I think the other thing is that there hasn't been any evidence on any of the restraints, where the pipes have been cut loose, that there has been any undue amount of residual stresses in the lines, and they haven't been dropped particularly much when they have been cut loose. There haven't been any damaged restraints or supports, or it has been minimal, at least. So that hasn't appeared to be a problem.

MR. BENDER: Is that configuration you have got up there -- is that what all of them are, or is that just D.C. Cook?

MR. HERMAN: This is Cook. This is reasonably typical of the ones that have the deeper cracks. They come out from the nozzles to either reducer and go into an elbow.

MR. BENDER: What is the dimension from the elbow at the top to the elbow at the bottom, the vertical runs?

MR. HERMAN: I don't remember, 14 or 15 feet.

MR. BENDER: So the flux has to do with whatever is involved in moving that vertical line up some amount; is that right? It would be nice to see all of the attachments so you can see where the constraints are.

MR. ETHERINGTON: Do the cracks always occur in the same place, always underneath, or in the same area?

MR. HERMAN: The cracking that has occurred--what we are characterizing are the deeper cracks. They have been in the region where there is a suction change or at the end of a counter bore, in the area where the fitting thickens.

DR. SHAO: They always occur at high stress concentration areas.

MR. ETHERINGTON: 12:00 o'clock, 6:00 o'clock, or what?

MR. HERMAN: They haven't necessarily all been in the same place.

DR. ZUDANS: Could you point out --

DR. SHEWMON: Let's get his comment here.

MR. KLECKER: Herman has set the picture for where most of the cracking has occurred. It has generally been in a region close to the nozzle, not always in the weld. Right here sometimes in here. But in the cases that Bob mentioned, where the cracking has been most severe, the elbow has been reasonably close to the nozzle, such that you do have the potential for thermal mixing when you are operating with, say, either aux feedwater during startup and shutdown, or at standby. In some cases, in particular on the Cook plant, their operation under those conditions was with on-off control, and the flow rate would be very small compared with nominal full flow rate at full power.

As a consequence, when the water is shut off you tend to get hot water accumulating in here from this conduction from the vessel itself. And then, when the water is turned on again, you have -- tend to be flushed back. We could visualize the potential for the cold water sweeping up due to the centrifugal forces acting on it.

And in the Cook case, the cracking has been in the top of the line. In a few other cases where this dimension here is further removed, say about four or five feet, we have found that as you come up you could get the water tending to cause -- the colder water tending to cause the cracking near the bottom of the line.

DR. SHEWMON: When you talk about it being on-off control, what is the frequency of that? Is that sort of once a day, or is that sort of once every ten seconds as they try to modulate their flow?

MR. HERMAN: I don't know that we ought to go jumping into the on-off control situation. A lot of these plants are using a continuous makeup, either from aux feedwater or from electric-driven pumps, where they run at some rate. They have been steaming in the condenser during hot standby and they have basically a constant situation where they are bringing basically maybe 100 gallons a minute into makeup for what is being steamed off to the condenser. And we have cracking in those cases, too.

MR. KLECKER: But you wouldn't get stratification -- you would get stratification to some extent.

DR. SHEWMON: Can I still get an answer to my question?

MR. KLECKER: I believe during hot standby -- it would vary, of course, facility to facility. But we are talking on the order of ten minutes to a half hour, as the level drops in the steam generator and it has to be brought back up. It gives an opportunity for warm water to flow out into this area.

MR. BENDER: With regard to the strain gauge, can you be a little more explicit in saying where you are going to make the measurements?

MR. KLECKER: The strain gauges on the Cook facility, which is the one we have the details on at the moment, are located top and bottom and on the side at this location here and about in here. So they will encompass this entire elbow, as well as a few down lower on the other line.

MR. BENDER: Are they accelerometers or strain gauges?

MR. KLECKER: Both. Strain gauges, thermocouples up here, as well as an accelerometer, which of course tends to monitor the vibration of the steam generator itself, as contrasted to one --

MR. BENDER: Is that testing in the present configuration or the proposed?

MR. KLECKER: Present.

MR. BENDER: We will be able to see actually what is happening?

MR. HERMAN: The accelerometers are going to be back at the bottom of the vertical droppage.

DR. SHAO: This loading you are talking about is already occurring?

MR. KLECKER: No, not the one I am talking about. The one that is included in the analysis at the moment is taking into account the effect of the differential thicknesses in the walls here.

DR. SHAO: How come this one is not included in the analysis.

MR. KLECKER: That is difficult to do. First of all, we are still speculating on the mechanisms here. One can only visualize what might be happening. Hopefully, with the thermocouple installation --

DR. SHAO: But with the ten minutes every cycle, there is a lot of similar fatigue.

MR. KLECKER: In addition to that, when you mix cold water with warm water, you are going to get local eddies.

DR. SHAO: Someone had to do some estimate, some judgment, including the calculation.

MR. KLECKER: It becomes complex. It is sort of related to the BWR where you get mixing of hot and cold water and tumbling of the water.

MR. ETHERINGTON: Here you are getting the cracks on the outside.

MR. HERMAN: No.

MR. KLECKER: Inside.

DR. SHAO: Inside.

MR. KLECKER: The crack is right here (Indicating).

MR. HERMAN: That is one of the ones they analyzed for Cook.

DR. ZUDANS: On your next slide, could you indicate where the restraints are placed?

MR. HERMAN: There are restraints, but only one or two snubbers on the line, and they are fixed at the generator and at the containment. There is not really much on the line.

DR. ZUDANS: No restraints?

MR. KLECKER: Not on this one shown here. It would extend this line out maybe about 10-12 feet, I believe. There are snubbers and a spring hanger.

DR. ZUDANS: Is there axial restraint on the horizontal portion as you go out?

MR. KLECKER: No, not on this.

MR. HERMAN: The lines are loosely supported.

DR. ZUDANS: Would it be possible for you, when you dispose of these instruments, to put it in this plane so that they would measure the steam nozzle motion in that direction; not transverse, this way (Indicating)? At the bottom of the elbow another displacement transducer to see if there is a relative motion of the steam generator relative to the rest of the pipe, which would not, maybe, be thermal effect but mechanical.

MR. HERMAN: There are hints by Westinghouse that there possibly might be some --

DR. ZUDANS: Yes, and that would induce the bending at the top of the elbow, and that is what you are looking for.

DR. SHAO: I am worried about mechanical loadings, but nobody can find out about mechanical loading.

DR. SHEWMON: Let's go on.

MR. HERMAN: One of the things I am putting up here are the NRR actions that are planned at this time. One is do an independent review of the work that is being done by the licensee, have an independent analysis performed by Brookhaven and Lawrence Livermore Labs to verify the mode of the failures.

In addition, I believe -- they would be done here -- the stress analyses review of the work of the licensees, have some independent analyses performed by INEL, plus the staff has done some work in stress analyses review, and have recommendations made on the test programs by Livermore.

They -- we are going to -- there are some other plants that may be interested in putting instrumentation on the lines. They are going to review currently what is being done on Cook and Robinson and the possible areas of measuring temperatures and stresses and accelerations, and perhaps come up with some either alternate recommendations or other instrumentation that might be better suited to getting some information on the problem.

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The responses to the May 25th letter, which are basically information on various designs, various facilities, in terms of feedwater line layout and the way the plants are operating, feedwater chemistry history, those things are going to be gone through. And then the consequences of the cracks. We are going to look at various things which might cause challenges to the pipe integrity, and also take a look at the piping structural integrity in terms of what is there for the material, and then systems effects, and then evaluate and then do corrective actions.

Any questions?

DR. SHEWMON: Do you have any idea why the DC 2 showed the :racks first, being quite similar to 1, I assume, and three o: four times as old?

MR. HERMAN: No. Of all of the facilities that has been around, it is an ice condenser plant.

DR. SHEWMON: Cook 1 and 2 are both ice condensers.

MR. HERMAN: The unit that had the through-wall cracking had the least service time, and I don't think that there is particularly any answer as to why it failed and the other one didn't.

DR. ZUDANS: Is it known for sure that it failed?

MR. HERMAN: No, it is not known that the cracking initiated first. What is known is that it leaked first and went through the wall. I don't know that we can say anything about initiation.

DR. SHEWMON: I would like to see the pictures you lifted off the Westinghouse people yesterday, but I am not sure that we should hold up the whole group for that.

Do you want to adjourn for lunch or start in on combination loads?

We will come back refreshed in an hour for combined loads.

(Whereupon, at 12:21 p.m., the meeting was recessed, to reconvene at 1:21 p.m. the same day.)

e-13

T-1

FY 1981 AMENDED BUDGET

($ IN MILLIONS)

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY

STRUCTURAL ENGINEERING RESEARCH BRANCH	$ 6.0
MECHANICAL ENGINEERING RESEARCH BRANCH	7.4
SITE SAFETY RESEARCH BRANCH	6.5
TOTAL PROGRAM SUPPORT	$ 19.9

584 263

AGENDA

MECHANICAL ENGINEERING RESEARCH BRANCH	NEEDS AND PRIORITIES OF RESEARCH PROGRAMS OTHER THAN SSMRP FOR THE SUBCOMMITTEE ON EXTREME EXTERNAL PHENOMENA AND METAL COMPONENTS
STRUCTURAL ENGINEERING RESEARCH BRANCH	NEEDS AND PRIORITIES OF RESEARCH PROGRAMS OTHER THAN SSMRP FOR THE SUBCOMMITTEE ON EXTREME EXTERNAL PHENOMENA
SITE SAFETY RESEARCH BRANCH	RECURRENCE INTERVALS FOR EARTHQUAKE AT REACTOR SITES

584 264

RECENT REACTOR PROBLEMS RELATED TO STRUCTURAL
AND MECHANICAL ENGINEERING

1. BWR FEEDWATER NOZZEL CRACKS
2. PUMP AND VALVE OPERABILITY
3. BWR PIPE CRACKS
4. PIPE CRACKS IN PWR SECONDARY SYSTEMS
5. SNUBBERS
6. STEAM GENERATOR TUBE CRACKING
7. SEISMIC PROBLEMS
    A. HUMBOLDT BAY 3
    B. GETR
    C. DIABLO CANYON (NOT YET OPERATING)
    D. TROJAN
    E. SYSTEMATIC EVALUATION PROGRAM (SEP)
    F. RECENT 5 PLANT SHUTDOWN
    G. RECENT I & E BULLETINS

584 265

RECENT I&E BULLETINS CONCERNING SEISMIC AND STRUCTURAL DESIGN ADEQUACY

79-02 - BASE PLATES FLEXIBILITY AND ANCHOR BOLTS

79-04 - IMPROPER SPECIFICATION OF CHECK VALVE WEIGHT

79-07 - USE OF ALGEBRAIC SUM FOR MODAL RESPONSES FROM SEISMIC ANALYSIS

79-13 - CRACKING OF PRIMARY SYSTEM PIPING

79-14 - VERIFICATION OF AS-BUILT PIPING SYSTEMS AND THEIR SUPPORTS

584 266

T-2 through T-7

ACRS SUBCOMMITTEES ON

EXTREME EXTERNAL PHENOMENA

AND

MATERIALS AND METAL COMPONENTS

<u>FY 1981 BUDGET</u>

MECHANICAL ENGINEERING RESEARCH BRANCH

J. E. RICHARDSON

CHIEF

584 267

MECHANICAL ENGINEERING RESEARCH BRANCH

FY 1981 BUDGET

AGENDA

1. OVERALL BUDGET
2. DYNAMIC ANALYSIS PROGRAM
3. MECHANICAL COMPONENTS PROGRAM
4. CODES AND STANDARDS PROGRAM
5. PRIORITIES

584 268

MECHANICAL ENGINEERING RESEARCH BRANCH

BUDGET

($ IN THOUDANDS)

	FY 79	FY* 80	FY* 81
DYNAMIC ANALYSIS	1586	2105	3500
MECHANICAL COMPONENTS	50	850	1750
CODES AND STANDARDS	0	885	2150
TOTALS	1636	3840	7400

* INCLUDES SUPPLEMENTAL REQUEST

MECHANICAL ENGINEERING RESEARCH BRANCH

DYNAMIC ANALYSIS

($ In Thousands)

	FY 79	FY 80	FY 81
SEISMIC SAFETY MARGINS RESEARCH PROGRAM	936	1505	2000
PARET	165	100	300
LOAD COMBINATIONS	-	300	500
HDR MECHANICAL COMP. ANAL.	-	-	300
HDR MONITOR	50	50	200
NONLINEAR SYSTEM MODELING	135	150	200
TOTALS	1286	2105	3500

SEISMIC SAFETY MARGINS

RESEARCH PROGRAM

(MECHANICAL ENGINEERING)

584 271

USER OFFICE: NRR

CONTRACTOR: LAWRENCE LIVERMORE LABORATORY (LLL)

FUNDING:

FY79 - $1236K

FY80 - $1505K

FY81 - $2000K

FIN NO.: A0126

PRINCIPAL INVESTIGATOR: P. D. SMITH

NRC MONITOR: J. E. RICHARDSON

SUBCONTRACTORS:
1. ENGINEERING DECISION ANALYSIS COMPANY
2. NSC/QUADREX
3. J. D. STEVENSON
4. U. C. BERKELEY
5. J. H. WIGGINS
6. UCLA
7. TERA CORPORATION
8. SCIENCE APPLICATIONS, INC.

SEISMIC SAFETY MARGINS RESEARCH PROGRAM

OBJECTIVES

- ESTIMATE THE CONSERVATISMS IN THE STANDARD REVIEW PLAN SEISMIC SAFETY REQUIREMENTS

- DEVELOP IMPROVED REQUIREMENTS

- DEVELOP METHODOLOGIES THAT REALISTICALLY ESTIMATE THE BEHAVIOR OF NUCLEAR POWER PLANTS DURING AN EARTHQUAKE

SEISMIC SAFETY MARGINS RESEARCH PROGRAM

584 273

APPROACH

PHASE I -
- CONSTRUCT SYSTEM AND COMPOENENT MODELS THAT DESCRIBE PLANT BEHAVIOR AND ACCOUNT FOR UNCERTAINTIES
- PERFORM SENSITIVITY STUDIES TO GAIN ENGINEERING INSIGHTS INTO SEISMIC SAFETY REQUIREMENTS
- DETERMINE PRIORITIES FOR PHASE II

PHASE II -
- ESTIMATE CONSERVATISMS IN THE STANDARD REVIEW PLAN
- REFINE AND IMPROVE METHODOLOGY

PHASE III-
- RECOMMEND CHANGES IN THE STANDARD REVIEW PLAN DETERMINISTIC SEISMIC SAFETY REQUIREMENTS

SEISMIC SAFETY MARGINS RESEARCH PROGRAM

SCHEDULE OF PHASE I MAJOR MILESTONES

6/79	Specify Computational Procedure
1/80	Develop Seismic Input
2/80	Fragility Description
3/80	Event/Fault Trees
4/80	Str & Mech. Meth.
5/80	Soil-Str Int.
6/80	Load Comb.
7/80	Complete Phase I

584 274

APPLICATION OF PARET TO OPERATING REACTORS

USER OFFICE: NRR/DOR/SEPB

CONTRACTOR: LAWRENCE LIVERMORE LABORATORY (LLL)

FUNDING: FY79 - $165K
FY80 - $100K
FY81 - $300K

FIN NO. A0128

PRINCIPAL INVESTIGATOR: H. J. WEAVER

NRC MONITOR: J. A. O'BRIEN

SUBCONTRACTORS:

1. AGBABIAN ASSOCIATES (DYNAMIC TESTING)
2. ANCO ENGINEERS INCORPORATED (DYNAMIC TESTING)
3. STRUCTURAL MEASUREMENT SYSTEMS (SYSTEMS IDENTIFICATION)

APPLICATION OF PARET TO OPERATING
REACTORS

OBJECTIVES: DETERMINE BY TESTING MODE SHAPES, MODAL DAMPING AND MODAL FREQUENCIES OF OPEATING REACTORS. DEVELOP MEANS OF EXTRAPOLATING LOW LEVEL TEST RESULTS TO HIGH LEVEL ENVIRONMENTS. DEVISE TECHNIQUES FOR ASSESSING DAMAGE SUBSEQUENT TO SEVERE ACCIDENT AND ENVIRONMENTAL EVENTS.

RESULTS: VERIFICATION OF ANALYSES TO DETECT DESIGN AND CONSTRUCTION ERRORS. PROCEDURES FOR REQUALIFYING PLANTS AFTER EXTREME EVENTS. METHODS FOR EVALUATING CONSERVATISM IN DYNAMIC LOAD COMPUTATIONS.

NEED:

1. ASSESS CONSERVATISMS IN DYNAMIC ANALYSIS
2. REQUALIFICATION
3. IDENTIFY CONSTRUCTION ERRORS

584 276

LOAD COMBINATIONS

USER OFFICE: NRR

CONTRACTOR: LAWRENCE LIVERMORE LABORATORY (LLL)

FUNDING: FY79 - $0K
FY80 - $300K
FY81 - $500K

FIN NO.: A-0133

PRINCIPAL INVESTIGATOR: C. K. CHOU

NRC MONITOR: J. A. O'BRIEN

SUBCONTRACTORS: (TENTATIVE)

1. SCIENCE APPLICATIONS INC. (FRACTURE MECHANICS)
2. JOHN STEVENSON/WOODWARD-CLYDE CONSULTANTS (ECONOMIC AND SAFETY CONSEQUENCES)
3. OTHERS TO BE SELECTED

584 277

LOAD COMBINATION

OBJECTIVES: TO ASSESS THE CONTRIBUTION TO SAFETY AND COSTS INCURRED DUE TO THE REQUIREMENT TO DESIGN FOR SIMULTANEOUS LARGE LOCA AND EARTHQUAKE. TO EVALUATE THE PROBABILITY OF SIMULTANEOUS LARGE LOCA PLUS EARTHQUAKE. TO RECOMMEND GENERIC TECHNIQUES AND STANDARDS FOR COMBINING DYNAMIC LOADS.

RESULTS: GUIDANCE ON CERTAIN EVENT COMBINATIONS AND RESPONSE COMBINATIONS.

NEED:
1. PRESENT CRITERIA REQUIRE STIFF DESIGN
2. POSSIBLE REVISION OF DESIGN CRITERIA

HDR MECHANICAL COMPONENT RESPONSE

ANALYSIS AND TESTING

USER OFFICE: NRR

CONTRACTOR: EG&G IDAHO, INC.

FUNDING: FY79 - $70K
FY80 - $70K
FY81 - $300K

FIN NO.: A-6285

PRINCIPAL INVESTIGATOR: R. C. GUENZLER

NRC MONITOR: J. A. O'BRIEN

SUBCONTRACTORS: NONE

584 279

HDR MECHANICAL COMPONENT RESPONSE

ANALYSIS AND TESTING

OBJECTIVES: TO SELECT DYNAMIC MODELS OF THE HDR RECIRCULATION LOOP SUITABLE FOR USE ON EG&G COMPUTERS, AND TO EXERCISE THESE MODELS TO PREDICT THE RESPONSE OF THE SYSTEM TO EXPLOSIVELY GENERATED GROUND SHAKING AND SHAKER TESTS.

RESULTS: COMPARISONS BETWEEN PRETEST PREDICTIONS AND TEST OBSERVATIONS OF PIPING SYSTEM RESPONSE UNDER SEISMIC TYPE ENVIRONMENTS.

NEED:

1. OPPORTUNITY FOR FULL SCALE TESTING
2. NONLINEAR SUPPORTS
3. VERIFY EXISTING CODES

NRC MONITOR FOR HEISSDAMPFREAKTOR

SEISMIC TESTS

USER OFFICE: NRR

CONTRACTOR: UNDESIGNATED, RFP BEING ISSUED

FUNDING: FY79 - $50K
FY80 - $50K
FY81 - $200K

FIN NO: B6755

PRINCIPAL INVESTIGATOR: UNDESIGNATED

NRC MONITOR: J. A. O'BRIEN

SUBCONTRACTORS: NONE, BUT THIS EFFORT FEEDS TWO OTHER HDR PROGRAMS FUNDED BY RES AT LLL AND INEL.

NRC MONITOR FOR HEISSDAMPFREAKTOR

SEISMIC TESTS

OBJECTIVES: ASSIST IN TEST PLANNING, OBTAIN DATA, INTERPRET FINDINGS, EXPLAIN TEST OBJECTIVES, MAKE RECOMMENDATIONS FOR EXPANDING OBJECTIVES AND ASSESSMENT OF TEST RESULTS.

RESULTS: IDENTIFICATION OF ANALYTICAL INADEQUACIES IN SEISMIC METHODOLOGY AND CONFIRMATION OF CONSERVATISMS.

NEED:
1. PROVIDE ON-SITE EVALUATION
2. ASSESS RESULTS
3. RECOMMEND FURTHER INVOLVEMENT

NONLINEAR SYSTEM MODELING

USER OFFICE: OSD

CONTRACTOR: U.S.C.

FUNDING: FY79 - $135K
FY80 - $150K
FY81 - $200K

FIN NO.: B-5976

PRINCIPAL INVESTIGATOR: S. F. MASRI

NRC MONITOR: D. D. REIFF

594 283

NONLINEAR SYSTEM MODELING

OBJECTIVES:

- ANALYTICAL AND EXPERIMENTAL STUDIES OF DYNAMIC RESPONSE OF NUCLEAR PLANT MECHANICAL EQUIPMENT

- DETERMINE EFFECTS OF NONLINEAR SYSTEM MODELING ON ABILITY TO PREDICT STRUCTURAL RESPONSE OF MECHANICAL COMPONENTS

NEED:
1. PROVIDE METHODOLOGY FOR BOUNDING RESPONSE FOR LICENSING STAFF
2. ASSESS LIMITS OF SCALING
3. ASSESSMENT OF SIMPLIFIED MODELING TECHNIQUES
4. PROVIDE BASIS FOR PUMP AND VALVE QUALIFICATION REQUIREMENTS

NONLINEAR SYSTEM MODELING

RESULTS:

- QUANTIFY DESIGN MARGIN OF SAFETY UNDER DYNAMIC LOADS
- DESIGN CURVES FOR COMPONENT RESPONSE
- COMPUTER CODE DEVELOPMENT/MATHEMATICAL MODELS
- GENERIC MECHANICAL COMPONENT RESPONSE TO SELECTED DYNAMIC ENVIRONMENTS

NONLINEAR SYSTEM MODELING

INPUT	→	SYSTEM	→	RESPONSE
EXCITATION CHARACTERISTICS		MODELING PARAMETERS		CALCULATION TECHNIQUES
SOIL/STRUCTURE INTERACTION		SYSTEM IDENTIFICATION		APPROXIMATE SOLUTIONS
		PHYSICAL MODEL		COMPUTER CODES
		NONLINEARITIES		SCALING LAWS
				TRANSFER FUNCTION
				PHASED INPUTS

NONLINEAR SYSTEM MODELING

APPROACH:

1. ANALYTICAL AND EXPERIMENTAL STUDIES OF NONLINEAR STUDIES
2. MATERIAL/MECHANICAL NONLINEARITY
3. SIMPLE PLANAR TWO DIMENSIONAL PIPING ANALYSIS CODE
4. DESIGN CHARTS FOR NONLINEAR VARIABILITY
5. SCALING LAWS/SYSTEM VARIABILITY
6. PHASED INPUTS/DYNAMIC RESPONSE
7. SIMPLIFIED VALVE TESTS/DYNAMIC RESPONSE DATA
8. SYSTEM IDENTIFICATION

PROBLEMS:

CURRENT FUNDING IMPACTS WORK TASKS AS FOLLOWS:

1. REDUCTION IN SYSTEM IDENTIFICATION STUDIES AND APPLICATIONS
2. ELIMINATES QUANTIFICATION OF UNCERTAINTY DUE TO VARIABILITY OF SYSTEM CHARACTERISTICS
3. ELIMINATES BEAM RESPONSES TO PROPAGATING BLAST LOADS

WILL REPLACE ADDITIONAL TASK AND ADD NEW TASK TO ESTABLISH VALIDITY RANGE FOR APPROXIMATE SEISMIC ANALYSIS TECHNIQUES

MECHANICAL ENGINEERING RESEARCH BRANCH

MECHANICAL COMPONENTS

($ In Thousands)

	FY 79	FY 80 *	FY 81 *
SNUBBERS	50	150	300
PUMP AND VALVE OPERABILITY	-	600	900
COMP. SEISMIC QUALIFICATION	-	100	250
ADVANCED SEISMIC DESIGN	-	-	100
ADVANCED SEISMIC RESTRAINERS	-	-	200
TOTALS	50	850	1750

* INCLUDES SUPPLEMENTAL REQUEST

584 288

21

SNUBBERS

USER OFFICE: OSD

CONTRACTOR: UNDES

FUNDING:

FY79 - $50K

FY80 - $150K

FY81 - $300K

FIN NO.: B-6603

PRINCIPAL INVESTIGATOR: UNDES

NRC MONITOR: D. D. REIFF

SNUBBERS

OBJECTIVES:

- TO EVALUATE EXISTING CRITERIA FOR USE OF MECHANICAL AND HYDRAULIC SNUBBERS ON NUCLEAR PIPING AND SYSTEM COMPONENTS AND PROVIDE SUPPORT FOR SNUBBER REGULATORY GUIDES
- TO ESTABLISH AN ANALYTICAL AND EXPERIMENTAL CHARACTERIZATION OF SNUBBER AND RESTRAINT DEVICE PERFORMANCE WHICH WILL BE USED TO YIELD HIGHER PLANT PIPING SYSTEMS RELIABILITY

584 220

RESULTS:

THE DATA BASE AND EVALUATIONS WILL BE USED TO:

- DEVELOP TECHNICAL SPECIFICATIONS
- REVISE THE STANDARD REVIEW PLAN
- SUPPORT THE REGULATORY GUIDES ON APPARATUS QUALIFICATION, APPLICATION AND IN-SERVICE INSPECTION
- TOPICAL REPORTS IN SUPPORT OF PROPOSED REGULATORY GUIDES

NEED:
1. MANY SNUBBER FAILURES
2. ASSESS DESIGN AND APPLICATION
3. ASSESS QUALIFICATION AND INSPECTION REQUIREMENTS

SNUBBERS

APPROACH:

- WORK PLAN
- ESTABLISH CRITERIA
- PARAMETERS FOR CRITERIA
- ANALYTICAL PROGRAM
- SCALE TEST PROGRAM
- USE OF LOFT

584 291

PROBLEMS:

IF FULL SIZE TESTING IS REQUIRED, ADDITIONAL FUNDS MAY BE REQUIRED

PUMP AND VALVE OPERABILITY

USER OFFICE: NRR

CONTRACTOR: UNDES

FUNDING:

FY79 - N/A
FY80 - $600K
FY81 - $900K

FIN NO.: B-6727

PRINCIPAL INVESTIGATOR: UNDES

NRC MONITOR: D. D. REIFF

584 292

PUMP AND VALVE OPERABILITY

OBJECTIVE:

- o DEVELOP ACCEPTANCE CRITERIA AND METHODS FOR QUALIFICATION (SUPPORTED BY A TECHNICAL PARAMETRIC DATA BASE) OF SAFETY RELATED PUMP AND VALVE OPERABILITY

RESULTS:

- o PREDICT (FOR NRC LICENSING POSITIONS) THE RELIABILITY OF PUMPS AND VALVES TO PERFORM THEIR DESIGNATED SAFETY FUNCTIONS.

NEED: 1. ASSESS OPERABILITY ASSURANCE IN EXTREME ENVIRONMENTS

2. EXISTING PUMPS AND VALVES NOT QUALIFIED FOR CURRENTLY IDENTIFIED SERVICE CONDITIONS

PUMP AND VALVE OPERABILITY

APPROACH:

- FAILURE ANALYSIS STUDIES
  (CAUSE/IMPACT - COMPONENT DEGRADATION)

- DEVELOP QUALIFICATION ACCEPTANCE CRITERIA

  INSPECTION TECHNIQUES
  TEST PROGRAM (LIMITS OF ANALYSIS, DESIGN MARGIN)

PROBLEMS:

UNDEFINED ENLARGED SCOPE OF SAFETY RELATED EQUIPMENT (TMI) MAY CHANGE ENVIRONMENTAL CONDITIONS AND LEVELS OF PERFORMANCE PARAMETERS FOR DESIGN MARGINS

SEISMIC QUALIFICATION OF NUCLEAR PLANT MECHANICAL AND ELECTRICAL EQUIPMENT

BUDGET: FY80 $ 100K
FY81 $250K

FIN NO.: B-6000

USER OFFICE: NRR

CONTRACTOR: UNDESIGNATED - RFP BEING ISSUED

PRINCIPAL INVESTIGATOR:

NRC MONITOR: J. J. BURNS

584 295

28

SEISMIC QUALIFICATION OF NUCLEAR PLANT MECHANICAL AND ELECTRICAL EQUIPMENT

584 296

OBJECTIVE:

- EVALUATE PAST AND PRESENT METHODS OF QUALIFYING SEISMIC EQUIPMENT
- DEVELOP GUIDELINES ON MODELING, ANALYSIS, AND TESTING TECHNIQUES, INCLUDING THE EFFECTS OF DEGRADATION AND OTHER NORMAL AND ACCIDENTAL CONDITIONS
- DEVELOP A PROCEDURE OF EXTRACTING FRAGILITY DATA FROM SEISMIC QUALIFICATION TESTS

RESULTS:

- DETERMINATION OF THE MOST SUITABLE METHODS OF QUALIFYING VARIOUS KINDS OF COMPONENTS
- CORRELATION OF QUALIFICATION METHODS WITH CURRENT CRITERIA
- RECOMMENDATIONS FOR IMPROVEMENT IN QUALIFICATION CRITERIA AND METHODS
- DEVELOP A SOURCE OF FRAGILITY DATA

NEED:
1. ASSESS CURRENT QUALIFICATION CRITERIA
2. ASSESS SCALING FACTORS
3. RELATE ANALYSIS TO QUALIFICATION TESTS

ADVANCED SEISMIC DESIGN

USER OFFICE: NRR

CONTRACTOR: UNDES

FUNDING:

FY80 - $0K
FY81 - $100K

FIN NO.: B-6732

PRINCIPAL INVESTIGATOR: UNDES

NRC MONITOR: J. A. O'BRIEN

584 297

30

ADVANCED SEISMIC DESIGN

584 298

OBJECTIVE:

DEVELOP IMPROVED CONCEPTS FOR DECOUPLING OR ISOLATING NUCLEAR POWER PLANT COMPONENTS FROM THE SEISMIC ENVIRONMENT

RESULTS:

DESCRIBE AND SET STANDARDS FOR DIFFERENT SEISMIC ISOLATION AND DECOUPLING SYSTEMS. IDENTIFY ADVANTAGES AND SHORTCOMINGS

NEED:
1. LICENSING PROBLEMS DUE TO SEISMIC ENVIRONMENT
2. PLANTS SHUTDOWN DUE TO SEISMIC DESIGN PROBLEMS
3. RETROFIT CAPABILITIES

ADVANCED SEISMIC RESTRAINERS

USER OFFICE: NRR

CONTRACTOR: U. C. BERKELEY

FUNDING:

FY81 - $200K ($400K FROM DOE)

PRINCIPAL INVESTIGATOR: V. ZACKAY

NRC MONITOR: J. E. RICHARDSON

SUBCONTRACTORS:
1. BATTELLE NORTHWEST LABORATORY
2. MASSACHUSETTS INSTITUTE OF TECHNOLOGY

584 229

ADVANCED SEISMIC RESTRAINERS

OBJECTIVES:

DEVELOP ANALYTIC PROGRAM TO CONFIRM VIABILITY OF ELASTIC-INELASTIC DEFORMATION OF RESTRAINER DEVICES TO CONTROL PIPING AND COMPONENT RESPONSES

DEVELOP SOLID-STATE RESTRAINERS

CONFIRM CONCEPT BY EXPERIMENT

RESULTS:

ANALYTICAL METHODOLOGY FOR PREDICTING COMPONENT AND DEVICE RESPONSE

PRELIMINARY DESIGN CONCEPT OF DEVICES

COST/SAFETY BENEFIT STUDY

NEED:
1. MANY SNUBBER FAILURES
2. EASY RETROFIT CAPABILITY
3. INCREASED RELIABILITY OVER SNUBBERS
4. GOOD FOR OTHER LOADS, (WATER HAMMER, ETC.)

584 300

MECHANICAL ENGINEERING RESEARCH BRANCH

CODES AND STANDARDS

($ IN THOUSANDS)

5804 301

	FY 79	FY 80 *	FY 81 *
ASME CODE ASSESSMENT	-	-	200
DAMAGE ASSESSMENT OF COMP.	-	300	500
VERIFICATION OF COMPUTER CODES	-	500	1000
PIPING BENCHMARKS	-	-	250
FOREIGN RESEARCH	-	85	200
TOTALS	0	885	2150

* INCLUDES SUPPLEMENTAL REQUEST

ASME CODE ASSESSMENT

BUDGET: FIN NO.: B-6729

FY79 - $0K
FY80 - $0K
FY81 - $200K

USER OFFICE: NRR

CONTRACTOR: UNDESIGNATED

PRINCIPAL INVESTIGATOR:

NRC MONITOR: J. J. BURNS

ASME CODE ASSESSMENT

OBJECTIVE:

- ASSESS CURRENT CODE RULES AND DETERMINE WHAT CODE RULES NEED TO BE MODIFIED, EXPANDED, OR ADDED. CONSIDERATION WILL BE GIVEN TO, BUT NOT LIMITED TO:

    - MATERIAL DEGRADATION AND CRACKING
    - COMPONENT DEGRADATION
    - IN-SERVICE INSPECTION TECHNIQUES
    - DYNAMIC BUCKLING
    - FATIGUE OF CLASS II COMPONENTS

RESULTS:

A RIL WILL BE PREPARED ON THE SHORTCOMINGS IN THE CODE AND A SET OF RECOMMENDED CODE CHANGES AND PERTINENT INFORMATION WILL BE PRESENTED TO THE ASME CODE COMMITTEE AND TO STANDARDS FOR POTENTIAL REGULATORY GUIDES

NEED: CODE DOES ADEQUATELY ADDRESS:
FATIGUE OF CLASS 2 PIPING
BUCKLING OF STEEL SHELLS
STRESS CORROSION

111

DAMAGE ASSESSMENT OF MECHANICAL COMPONENTS

USER OFFICE: NRR

CONTRACTOR: UNDES

FUNDING:
FY79 - $0K
FY80 - $300K
FY81 - $500K

FIN NO.: B-6753

PRINCIPAL INVESTIGATOR: UNDES

NRC MONITOR: J. A. O'BRIEN

DAMAGE ASSESSMENT OF MECHANICAL COMPONENTS

305

584

OBJECTIVE:

DEVELOP PROCEDURES OF HIGH RELIABILITY TO ASSESS LEVEL OF DAMAGE SUFFERED AND LOCATE REGIONS OF DAMAGE

RESULTS:

DETAILED METHODOLOGY AND PROCEDURES FOR RAPID DAMAGE ASSESSMENT OF NUCLEAR POWER PLANTS SUBJECTED TO SEVERE ENVIRONMENTAL AND ACCIDENT EVENTS

NEED:
1. NO EXISTING CRITERIA FOR RESTART AFTER ACCIDENT
2. NEED TO SUPPLEMENT CONVENTIONAL INSPECTION TECHNIQUES
3. MAY BE ABLE TO DETECT FAILURE TRENDS BEFORE ACCIDENT

BENCHMARKS FOR APPLIED MECHANICS COMPUTER CODES

USER OFFICE: NRR

CONTRACTOR: BNL
UNDES

FUNDING:

FY79 - $140K (RES)
FY80 - $500K
FY81 - $1250K

FIN NO.: B-6750

PRINCIPAL INVESTIGATOR: M. REICH
UNDES

NRC MONITOR: D. D. REIFF
J. J. BURNS
J. F. COSTELLO
M. HARTZMAN

584 306

BENCHMARKS FOR APPLIED MECHANICS COMPUTER CODES

OBJECTIVES:

DEVELOP AND EVALUATE BENCHMARK PROBLEM SOLUTIONS AND PHYSICAL TEST BENCHMARKS FOR EVALUATION AND VERIFICATION OF PIPING SYSTEM DESIGN AND ANALYSIS COMPUTER PROGRAMS

RESULTS:

- INCREASE CONFIDENCE IN EVALUATION OF STRUCTURAL INTEGRITY - ALL PLANTS, ALL DESIGN CONDITIONS
- VERIFY COMPUTER PROGRAMS - GENERATE CORRECT RESULTS AND DESIGN
- EXAMINED AND VERIFIED COMPUTER PROGRAMS USED IN DESIGN OF 5 PLANT SHUT DOWN

NEED:
1. PLANTS SHUTDOWN DUE TO CODE ERRORS
2. NEED TO SHOW THAT CODES ARE VALID
3. PROVIDE LICENSING STAFF WITH CAPABILITY TO INDEPENDENTLY VERIFY DESIGN INTEGRITY

MECHANICAL PIPING BENCHMARK PROBLEMS

APPROACH:

DEVELOPMENT OF PIPING BENCHMARK PROBLEMS

EVALUATION OF APPLICANT SOLUTIONS

MODIFICATION OF COMPUTER PROGRAMS

DEVELOPMENT OF NEW PROGRAMS WHERE NEEDED

- ANALYSIS BENCHMARK DEVELOPMENT
  - ELASTIC (CLASS 2 & 3)
  - CLASS 1 PIPING
  - INELASTIC (INCLUDES PIPE WHIP)
- PHYSICAL TEST BENCHMARK
  - SUBSYSTEM MODEL TESTS
  - REACTOR SYSTEM MODEL TESTS

PROBLEMS:

INADEQUATE FUNDING IN FY80 AND THEREAFTER TO ACCOMPLISH PHYSICAL TEST BENCHMARK DEVELOPMENT

PRIORITY TO INDEPENDENT CONFIRMATORY ANALYSES OF LICENSED PLANTS ON A NEEDED BASIS DELAYS GENERIC BENCHMARK PROGRAM

584 308

BENCHMARKS FOR APPLIED MECHANICS COMPUTER CODES

OBJECTIVES:

PROVIDE NRC THE CAPABILITY TO VERIFY PORTIONS OF THE DESIGN AND ANALYSIS OF NUCLEAR POWER PLANTS BY VERIFIED COMPUTER CODES

RESULTS:

1. VERIFIED LOGIC OF THE ALGORITHM USED TO PERFORM CALCULATIONS
2. VERIFIED MODEL OF SAFETY-RELATED STRUCTURAL AND MECHANICAL SYSTEM BEHAVIOR

BENCHMARK FOR APPLIED MECHANICS COMPUTER CODES

APPROACH:

DEVELOPMENT OF:

1. COMPUTER CODES
2. ANALYTIC BENCHMARKS
3. PHYSICAL TEST BENCHMARKS

PRIORITY TO STANDARD REVIEW PLAN (SRP) TASKS:

1. PLANT DESIGN FOR PROTECTION AGAINST POSTULATED PIPING FAILURES IN FLUID SYSTEMS OUTSIDE CONTAINMENT
3. SEISMIC DESIGN AND ANALYSIS
7. STEEL CONTAINMENT
9. SEISMIC CATEGORY I STRUCTURES

ADDRESS REMAINING APPLICABLE SRP TASKS

PROBLEMS:

1. COMMITMENT OF LARGE AMOUNT OF RESOURCES FOR CODE DEVELOPMENT AND MAINTENANCE

2. CODES IN PUBLIC DOMAIN MAY COMPROMISE INDEPENDENCE OF VERIFICATION

118

1/3

43

FOREIGN RESEARCH AND LICESNING PRACTICES
COORDINATOR FOR GRSR

USER OFFICE: OSD

CONTRACTOR: UNDESIGNATED, RFP BEING ISSUED

FUNDING: FY80 - $85K
FY81 - $200K

FIN NO. B6769

PRINCIPAL INVESTIGATOR: UNDESIGNATED

NRC MONITOR: J. A. O'BRIEN

SUBCONTRACTORS: UNDESIGNATED

584 311

FOREIGN RESEARCH AND LICENSING PRACTICES

COORDINATOR FOR GRSR

OBJECTIVES:
TO COMPILE, EVALUATE AND COMPARE FOREIGN RESEARCH AND LICENSING PRACTICE WITH U.S. RESEARCH AND LICENSING PRACTICE. TO INDICATE POTENTIAL AREAS OF JOINT VENTURE RESEARCH AND EVOLUTION OF FOREIGN PRACTICE AND STANDARDS.

RESULTS:
INTEGRATION OF FOREIGN RESULTS INTO U.S. PRACTICE. COOPERATION IN RESEARCH WHICH WILL AVOID NEEDLESS DUPLICATION AND SHARE CREATIVE TALENTS.

NEED:
1. AVOID DUPLICATION
2. SHARE CREATIVE TALENT AND EXPERIENCE
3. JOINT VENTURE RESEARCH

584 312

MECHANICAL ENGINEERING RESEARCH BRANCH

PROJECT PRIORITIES

RANK	PROJECT	FY 81	ACCUM $
1	SSMRP	2000	2000
2	LOAD COMBINATIONS	500	2500
3	VERIFICATION OF COMPUTER CODES	1000	3500
4	PIPING BENCHMARKS	250	3750
5	ASME CODE ASSESSMENT	200	3950
6	SNUBBERS	300	4250
7	PUMP AND VALVE OPERABILITY	900	5150
8	ADVANCED SEISMIC RESTRAINERS	200	5350
9	FOREIGN RESEARCH	200	5550
10	COMPONENT SEISMIC QUALIFICATION	250	5800
11	ADVANCED SEISMIC DESIGN	100	5900
12	HDR MECH. COMPONENT ANALYSIS	300	6200
13	HDR MONITOR	200	6400
14	NONLINEAR SYSTEM MODELING	200	6600
15	PARET	300	6900
16	DAMAGE ASSESSMENT OF COMPONENTS	500	7400

594 313

7 through 9

ACRS MEETING

EXTREME EXTERNAL PHENOMENA

SUBCOMMITTEE

JULY 11, 1979

FY1981 BUDGET FOR

STRUCTURAL ENGINEERING RESEARCH BRANCH

GOUTAM BAGCHI

BRANCH CHIEF

584 314

52

OUTLINE

GOALS

OBJECTIVES

PROGRAM CATEGORIES

PROGRAM MOTIVATION & PROJECT ELEMENTS

COST SUMMARY

GENERAL PRIORITIES

FY1981 PROJECT PRIORITIES

SUMMARY

584 315

GOALS

IMPROVE UNDERSTANDING OF REALISTIC BEHAVIOR

- LOADS
- RESPONSE
- ACCEPTANCE STANDARDS

IMPROVE DESIGN AND CONSTRUCTION QUALITY

- ROLE OF ERRORS
- TECHNIQUES FOR IMPROVEMENT
- SPECIAL CONSTRUCTION TECHNIQUES

IMPROVE SAFETY AND RELIABILITY

- IN-SERVICE INSPECTION REQUIREMENTS
- PREOPERATIONAL TESTING AND INSPECTION CRITERIA
- NEW CONCEPTS

RECOMMEND PROCEDURES, METHODS, AND CRITERIA

- REGULATIONS
- REGULATORY GUIDES
- LICENSING POSITIONS

584 316

OBJECTIVES

ASSESS STRUCTURAL BEHAVIOR

- ULTIMATE FAILURE MODES
- MARGINS OF SAFETY
- EFFECTS OF INTERNAL AND EXTERNAL PHENOMENA
- COMBINATION OF NORMAL AND ACCIDENT CONDITIONS

IMPROVE DESIGN & CONSTRUCTION QUALITY

- BENCHMARKING OF COMPUTER CODES
- DEVELOPMENT OF SIMPLIFIED CODES
- EVALUATION OF TECHNIQUES OF INSPECTION

IMPROVE DATA BASE

- SCALED EXPERIMENTS
- RESPONSE TO NATURAL PHENOMENA
- RESPONSE TO MAN INDUCED EVENTS
- DYNAMIC TESTING

PROVIDE INPUT TO

- SEISMIC DESIGN CRITERIA
- QUANTITATIVE GUIDANCE FOR GENERAL DESIGN CRITERION #2
- ADEQUACY OF DESIGN CODES AND STANDARDS

584 317

STRUCTURAL ENGINEERING RESEARCH BRANCH

PROGRAM BUDGET

AREAS OF RESEARCH	FY79	($1000) FY80	FY - 81 CUR	REQ	AUG
LOAD DEFINITION	0	$645	$800	$1000	$1000
RESPONSE PREDICTION	$790	$760	$1300	$2130	$2130
ACCEPTANCE AND PERFORMANCE CRITERIA	$190	$775	$1250	$1650	$1950
LICENSING SUPPORT	0	$ 95	$250	$720	$720
EVALUATION OF NEW CONCEPTS	0	0	0	$200	$200

58A 318

56

STRUCTURAL ENGINEERING RESEARCH BRANCH

LOAD DEFINITION PROGRAM

PROGRAM MOTIVATION

DEVELOP A BASIS FOR CHOOSING LOADS AND LOAD COMBINATIONS TO BE USED IN THE DESIGN OF NUCLEAR PLANT STRUCTURES UNDER NORMAL AND EXTREME CONDITIONS.

PROGRAM ELEMENTS

ENGINEERING CHARACTERIZATION OF SEISMIC INPUT

FLOOD HAZARDS AND FLOODING EFFECTS

WATER HAMMER EFFECTS

AIRCRAFT & TURBINE MISSILE IMPACT

LOAD COMBINATIONS

584 319

ENGINEERING CHARACTERIZATION OF SEISMIC INPUT

COST SUMMARY:
1. FY80 (PRES) - $150K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $200K

OBJECTIVES:

EQUIVALENT ENGINEERING INPUT FOR STRUCTURES AT FOUNDATION LEVELS

EFFECTS OF ROCKING AND TORSIONAL MOTION

CHARACTERIZATION OF NEARFIELD MOTION

PROJECT NEEDS:

DEVELOP A FORMAL PROCEDURE TO ESTABLISH SEISMIC INPUT NEAR SOURCE REGIONS

AN IMPORTANT ISSUE FOR PLANTS LIKE DIABLO CANYON, GETR

USEFUL FOR EXISTING PLANTS WHERE SEISMIC LEVELS MAY BE INCREASED PURELY ON SEISMOLOGICAL RECOMMENDATIONS

WATER HAMMER EFFECTS

COST SUMMARY:
1. FY80 (PRES) - $150K
2. FY81 (CUR) - $200K
3. FY81 (REQ) - $200K

OBJECTIVES:

EXAMINE CONDITIONS FOR OCCURRENCE

DETERMINE POTENTIAL SEVERITY OF PRESSURE PULSE

ASSESS THE LIKELIHOOD AND BEHAVIOR DURING VARIOUS WATER HAMMER EVENTS

PROJECT NEEDS:

NUMEROUS EVENTS AFFECTING PLANT SAFETY SYSTEMS

ALL PLANTS ARE AFFECTED

METHODS NEEDED TO REALISTICALLY EVALUATE WATER HAMMER EVENTS IN OPERATING PLANTS

FLOOD HAZARDS & FLOOD EFFECTS

COST SUMMARY:
1. FY80 (PRES) - $100K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $250K

(PROGRAM MANAGEMENT SHARED WITH SSRB)

OBJECTIVES:

DATA COLLECTION FOR STORM SURGE

EVALUATION OF PROBABILISTIC METHODS USEFUL FOR PREDICTING FLOOD HAZARDS DUE TO RIVER, COASTAL, OCEAN SURGE, SEICHE AND OTHER TYPES OF FLOODING

QUANTIFY FLOOD PROTECTION MARGINS

PROJECT NEEDS:

BASIC DATA NEEDED TO VERIFY ANALYTICAL MODELS FOR PREDICTING FLOOD WATER LEVELS

QUANTIFY CONSERVATISMS OF CURRENT DETERMINISTIC METHODS OF FLOOD PROTECTION DESIGN

QUANTIFY MARGINS OF FLOOD PROTECTION FOR PLANT STRUCTURES AND SYSTEMS

584 322

AIRCRAFT AND TURBINE MISSILE IMPACT

COST SUMMARY: 1. FY80 (PRES) - $100K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $150K

OBJECTIVES:

DEVELOP EXPERIMENTAL DATA ON AIRCRAFT IMPACT AND STRUCTURAL RESPONSE TO IT

UTILIZE EPRI TEST DATA TO IMPROVE TURBINE MISSILE AND BARRIER INTERACTION PREDICTION

PROJECT NEEDS:

AIRCRAFT IMPACT MAY GENERATE HIGH FREQUENCY VIBRATION OF IMPACTED STRUCTURES EXCEEDING THOSE DUE TO EARTHQUAKE

SOME OPERATING PLANTS MAY NEED REEVALUATION OF AIRCRAFT IMPACT HAZARDS

TURBINE MISSILE TESTS BY EPRI ARE NEARING COMPLETION, A PROGRAM TO ANALYZE THE TEST DATA WILL BE COST-EFFECTIVE TO NRC

51

LOAD COMBINATIONS

COST SUMMARY:
1. FY80 (PRES) - $145K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $200K

OBJECTIVES:

RECOMMEND METHODS FOR COMBINATION OF STRUCTURAL RESPONSES TO MULTIPLE TRANSIENTS

RECOMMEND LOAD COMBINATIONS TO ENSURE UNIFORM MARGINS OF SAFETY

RECOMMEND MINIMUM SETS OF LOAD COMBINATIONS

PROJECT NEEDS:

CURRENT DESIGN CODES CONTAIN LOADING COMBINATIONS THAT DO NOT ENSURE UNIFORMITY OF SAFETY MARGINS

SYSTEMATIC COMPARISON IS NECESSARY BETWEEN STRENGTH DESIGN METHODS AND ALLOWABLE STRESS METHODS

CRITERIA ARE SOUGHT FOR DESIGN OF PLANT STRUCTURES (BOTH EXISTING AND NEW PLANTS ARE INVOLVED)

584 324

62

STRUCTURAL ENGINEERING RESEARCH BRANCH

RESPONSE PREDICTION PROGRAM

PROGRAM MOTIVATION

ASSESS, AND IMPROVE UPON WHERE NECESSARY, THE METHODS USED TO PREDICT THE RESPONSE OF NUCLEAR PLANT STRUCTURES UNDER NORMAL AND EXTREME LOADS.

PROGRAM ELEMENTS

SEISMIC SAFETY MARGINS

DYNAMIC TESTING

RESPONSE PREDICTION CODES

BENCHMARKING OF STRUCTURAL CODES

584 325

SEISMIC SAFETY MARGINS PROGRAM

COST SUMMARY:
1. FY79 - $90K
2. FY80 (PRES) - $660K
3. FY81 (CUR) - $1280K
4. FY81 (REQ) - $1280K

OBJECTIVES:

QUANTIFY CONSERVATISMS IN SRP CRITERIA

DEVELOP IMPROVED SEISMIC DESIGN REQUIREMENTS

PROJECT NEEDS:

RAPIDLY CHANGING CRITERIA CALL FOR AN ASSESSMENT OF THE SIGNIFICANCE OF THESE CHANGES

CURRENT SHOW CAUSE ORDERS INVOLVE SEISMIC DESIGN CAPACITY OF OPERATING PLANTS

SEISMIC LOADING IS A COMMON INITIATOR TO TEST THE INTEGRITY OF THE ENTIRE PLANT SIMULTANEOUSLY

584 326

DYNAMIC TESTING

COST SUMMARY:
1. FY79 - $80K
2. FY80 (PRES) - $100K
3. FY81 (CUR) - $250K
4. FY81 (REQ) - $300K

OBJECTIVES:

PARTICIPATION IN HEISSDAMPFREAKTOR

PREOPERATIONAL TESTING OF CATEGORY I STRUCTURES

POST-EARTHQUAKE INSPECTION

PROJECT NEEDS:

OPPORTUNITY TO SHARE TEST DATA ON REACTOR BUILDING AND SSI BEHAVIOR DUE TO GROUND MOTION

DEVELOP PREOPERATIONAL TESTING CRITERIA

DEVELOP CONFIDENCE IN PLANT STRUCTURES DESIGN THROUGH CORRELATION OF TEST DATA WITH ANALYTICAL PREDICTION

DEVELOP POST-EARTHQUAKE INSPECTION CRITERIA WHERE NONE EXIST CURRENTLY

RESPONSE PREDICTION COMPUTER CODE

COST SUMMARY:
1. FY79 - \$50K
2. FY80 (PRES) - \$0
3. FY81 (CUR) - \$0
4. FY81 (REQ) - \$150K

OBJECTIVES:

DEVELOP SIMPLIFIED CODES TO ANALYZE STRUCTURAL RESPONSE TO IMPACTIVE LOADING

PROVIDE STAFF WITH A TOOL FOR PERFORMING RAPID CONFIRMATORY ANALYSIS

PROJECT NEEDS:

SIMPLIFIED ANALYTICAL TOOLS ARE NEEDED TO PERFORM INDEPENDENT VERIFICATION

SUFFICIENT TEST DATA ARE CURRENTLY AVAILABLE TO DEVELOP A RELIABLE ANALYTICAL CODE FOR COMPUTING STRUCTURAL RESPONSE TO IMPACTIVE LOADS

BENCHMARK OF STRUCTURAL CODES

COST SUMMARY:
1. FY80 (PRES) - $0
2. FY80 (SUPL) - $400K
3. FY81 (CUR) - $0
4. FY81 (REQ) - $400K
5. FY81 (AUG) - $400K

OBJECTIVES:

ESTABLISH STANDARD COMPUTER CODES WITH VERIFIED ALGORITHMS

DEVELOP UTILITY PACKAGES FOR SIMPLIFIED INPUT AND DISPLAY OF RESULTS

DEVELOP BENCHMARK PROBLEMS AND STANDARD SOLUTIONS TO VERIFY OTHER COMPUTER CODES

PROJECT NEEDS:

IMPROVE QUALITY OF DESIGN CALCULATIONS

NEED TO VERIFY DESIGN CALCULATIONS INDEPENDENTLY

584 329

STRUCTURAL ENGINEERING RESEARCH BRANCH

ACCEPTANCE & PERFORMANCE CRITERIA

PROGRAM MOTIVATION

ASSESS THE ADEQUACY OF THE CRITERIA IN USE TO ASSURE THE PUBLIC HEALTH AND SAFETY UNDER NORMAL AND EXTREME LOADINGS.

PROGRAM ELEMENTS

SAFETY MARGINS FOR CONTAINMENTS

BUCKLING OF STEEL CONTAINMENTS

SAFETY MARGINS FOR CATEGORY I STRUCTURES

ADEQUACY OF CODES AND STANDARDS

DUCTILITY UNDER IMPACT

584 330

08

SAFETY MARGINS FOR CONTAINMENTS

COST SUMMARY:
1. FY80 (PRES) - $125K
2. FY80 (SUPL) - $325K
3. FY81 (CUR) - $500K
4. FY81 (REQ) - $500K
5. FY81 (AUG) - $800K

OBJECTIVES:

DEVELOP RELIABLE METHODS OF PREDICTING ULTIMATE CAPACITIES AND FAILURE MODES OF CONTAINMENT BUILDING

INVESTIGATE BEHAVIOR UNDER COMBINED EARTHQUAKE AND INTERNAL PRESSURE

EVALUATE EFFECTS OF LARGE PENETRATIONS ON ULTIMATE CAPACITY AND LEAK-TIGHT INTEGRITY

DETERMINE EFFECTS OF HYDROGEN EXPLOSION ON INTERNALS AND CONTAINMENT STRUCTURE

BENCHMARK PREDICTIVE METHODS RATHER THAN PROOF TEST, A PROTOTYPE

PROJECT NEEDS:

NO RELIABLE ESTIMATES OF FAILURE LOADS EXIST

INDUSTRY CODES BASED ON EXPERIENCE OF CONVENTIONAL STRUCTURES FUNCTIONALLY AND GEOMETRICALLY QUITE DIFFERENT FROM CONTAINMENT STRUCTURES

THREE MILE ISLAND AND MAINE YANKEE INDICATE A NEED FOR ESTIMATES OF ULTIMATE CAPACITY AND FAILURE MODE

584 331

57

BUCKLING OF STEEL CONTAINMENT

COST SUMMARY:

1. FY80 (PRES) - $130K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $200K

OBJECTIVES:

SUPPLEMENT DATA BASE FOR KNOCKDOWN FACTORS

DEVELOP DESIGN CRITERIA TO SUPPLEMENT ASME AND AISC REQUIREMENTS

ESTABLISH BUCKLING CONSIDERATIONS TO ACCOUNT FOR ASYMMETRIC PRESSURE TRANSIENTS AND SEISMIC EXCITATIONS

PROJECT NEEDS:

LARGE SCALE BUCKLING TEST DATA NOT AVAILABLE

ACCURATE RESULTS ARE NOT AVAILABLE FOR UNSYMMERTIC DYNAMIC PRESSURE

STEEL CONTAINMENTS ARE BECOMING MORE POPULAR DUE TO CHANGES IN LIMITS FOR POST-WELD HEAT TREATMENT REQUIREMENT

PROVIDE AN INDEPENDENT MEANS TO VERIFY BUCKLING DESIGN

584 332

70

SAFETY MARGINS FOR OTHER STRUCTURES

COST SUMMARY:
1. FY80 (PRES) - $150K
2. FY81 (CUR) - $150K
3. FY81 (REQ) - $250K

OBJECTIVES:

VERIFY PREDICTION OF ULTIMATE CAPACITY AND FAILURE MODE BY SCALED EXPERIMENTS

ESTABLISH DUCTILITY LIMITS FOR NONLINEAR SEISMIC RESPONSE

EVALUATE INFLUENCE OF NONLINEAR STRUCTURAL BEHAVIOR ON EQUIPMENT RESPONSE (PEAK BROADENING)

BENCHMARK PREDICTIVE METHODS RATHER THAN PROTOTYPE TESTING

PROJECT NEEDS:

DESIGN CRITERIA BASED ON EXPERIENCE OF CONVENTIONAL BEAM AND SLAB TESTS

HEAVY SHEAR WALL STRUCTURES MAY HAVE SIGNIFICANTLY DIFFERENT MARGINS TO FAILURE

GOOD ESTIMATES ARE NEEDED FOR SAFETY MARGINS IN SITUATIONS SIMILAR TO "TROJAN"

584 333

71

ADEQUACY OF CODES AND STANDARDS

COST SUMMARY:

1. FY79 - $190K
2. FY80 (PRES) - $270K
3. FY81 (CUR) - $300K
4. FY81 (REQ) - $300K

OBJECTIVES:

CONTINUATION OF EXPERIMENTAL VERIFICATION OF TANGENTIAL SHEAR EVALUATION

ALLOWABLE PERIPHERAL SHEAR WITH BIAXIAL TENSION

PROVISIONS FOR DUCTILE CONSTRUCTION REQUIREMENTS AND THEIR DESIRABILITY IN ACI 349-76

PROJECT NEEDS:

UNDER BIAXIAL TENSION AND SEISMIC SHEAR LATERAL STIFFNESS IS DRASTICALLY REDUCED

NEED TO DEVELOP PROPER DEFORMATION LIMITS TO ENSURE LEAK TIGHTNESS

DUCTILITY UNDER IMPACTIVE LOADS

COST SUMMARY:
1. FY80 (PRES) - \$100K
2. FY81 (CUR) - \$150K
3. FY81 (REQ) - \$200K

OBJECTIVE:

DEVELOP AND VERIFY METHODS TO PREDICT PERFORMANCE OF TWO-WAY SLABS UNDER IMPACTIVE LOADING

PROJECT NEEDS:

RESEARCH ADDRESSES ISSUES ARISING FROM PROVISIONS OF APPENDIXES OF ACI 349-76

RESULTS WILL BE APPLICABLE TO ALL PLANTS

CURRENT PROVISIONS BASED BEAM TESTS

EVALUATION OF NEW SAFETY CONCEPTS

COST SUMMARY: 1. FY80 (PRES) - $0
2. FY81 (CUR) - $200K
3. FY81 (REQ) - $200K

OBJECTIVES:

SEISMIC ISOLATION OF FOUNDATION MAT

CONTAINMENT MODIFICATION FOR PROTECTION AGAINST RAPID HYDROGEN BURNING AND CORE MELTING

PROJECT NEEDS:

BRANCH GOALS INCLUDE IMPROVED RELIABILITY AND SAFETY

A FEASIBILITY STUDY IS NEEDED TO IDENTIFY DESIRABLE DESIGN ALTERNATIVES FOR SAFETY IMPROVEMENTS

IN NUREG 0496, ACRS RECOMMENDED PURSUIT OF ALL RESEARCH PROJECTS UNDER IMPROVED SAFETY INCLUDING ADVANCED SEISMIC DESIGN

PRIORITIES OF RESEARCH PROGRAMS

GENERAL

MINIMUM LEVEL

CURRENT LEVEL

REQUESTED LEVEL

584 337

25

PRIORITIES OF FY 1981 PROJECTS	FUNDING LEVELS IN $1000 FY 79	FY 80 PRES	FY 81 CUR	FY 81 AUG	FY 1981 ACCUMULAT FUNDS
SEISMIC SAFETY MARGINS	790	660	1050	1280	1280
BENCHMARK OF STRUCTURAL CODES	0	400 (4)	0	400	1680
WATER HAMMER EFFECTS	0	150	200	200	1880
LOAD COMBINATIONS	0	145	150	200	2080
CONTAINMENT SAFETY MARGINS	0	325 (3)	500	800	2880
ADEQUACY OF CODES & STANDARDS	190	270	300	300	3180
SAFETY MARGINS - OTHER STRUCTURES	0	150	150	250	3430
DYNAMIC TESTING	0	100	250	300	3730
STEEL CONTAINMENT BUCKLING	0	130	150	200	3930
ENG. CHARACT. OF SEISMIC MOTION	0	150	150	200	4130
DUCTILITY UNDER IMPACT LOADING	0	100	150	200	4330
FLOOD HAZARDS & FLOOD EFFECTS (1)	0	100	150	250	4580
CONSULTING & TECH. ASSISTANCE	499 (2)	95	550	720	5300
DAMAGE ASSESSMENT OF STRUCTURES	0	120 (3)	0	200	5500
RESPONSE PREDICTION CODES	50 (4)	0	0	150	5650
AIRCRAFT & TURBINE MISSILE IMPACT	0	100	150	150	5800
EVALUATION OF NEW CONCEPTS	0	0	0	200	6000
TOTALS	1529	2995	3900	5700	

(1) MANAGEMENT SHARED WITH SSRB

(2) INCLUDES $170K FOR TAP A-1 AND $329K FOR TAP A-40

(3) FY80 SUPPLEMENTAL BUDGET

(4) SIMPLIFIED SSI CODE DEVELOPMENT

584 338

SUMMARY

- ANALYSIS OF INCREASES IN $1000 PROGRAMS

	FY 80 PRES	FY 81 REQ	Δ
SEISMIC SAFETY MARGINS	660	1280	620
TECHNICAL ASSISTANCE	95	720	625
CONT. SAFETY MARGINS	325	500	175
SAFETY MARGINS - OTHER STR.	150	250	100
DYNAMIC TESTING	100	300	200
DUCTILITY UNDER IMPACT LOAD	100	200	100
FLOOD HAZARDS & FLOOD EFFECTS	100	250	150
RESPONSE PREDICTION CODES	0	150	150
EVALUATION OF NEW CONCEPTS	0	150	150
TOTAL			2270

- CURRENT LICENSING PROBLEMS ARE IN STRUCTURAL AND SEISMIC ADEQUACY OF PLANTS NEED TO VERIFY ANALYTICAL PROCEDURES THROUGH SCALED EXPERIMENTAL RESULTS
- ESTIMATES OF FAILURE MODES & SAFETY MARGINS NEEDED FOR A BALANCED LICENSING DECISION
- SUBSTANTIAL BUDGET INCREASES ARE NECESSARY TO INITIATE PROGRAMS VITAL FOR LICENSING SUPPORT, RECTIFY A LACK OF FUNDING IN PRIOR YEARS, PRODUCE TIMELY RESULTS

584 339

22

G-10

PREDICTION OF EARTHQUAKE RECURRENCE INTERVALS
METHODS AND LIMITATIONS

STATISTICAL AND PROBABILISTIC

DETERMINISTIC/CLASSIC

GUMBELL

BAYESIAN

LIMITED BY: CONFIDENCE IN EXTRAPOLATION
(SHORTNESS AND INCOMPLETENESS OF DATA RECORD,
NON-STATIONARITY IN TIME AND SPACE)

GEOLOGICAL

STRATIGRAPHIC (OLDEST OR YOUNGEST FAULTED ROCKS)

GEOMORPHIC (SCARPS, SAGS, OFFSET STREAMS AND TERRACES)

DATABLE LIQUEFACTION FEATURES

LONG TERM FAULT DISPLACEMENT RATES

DATING OF MATERIALS IN FAULT PLANES

LIMITED BY: INCOMPLETENESS OF GEOLOGIC RECORD
ABSENCE OF DATABLE MATERIALS
NON-STATIONARITY IN TIME

584 340

PREDICTION OF EARTHQUAKE RECURRENCE INTERVALS
RESEARCH APPROACH

IMPROVE QUALITY AND QUANTITY OF DATA RECORD

EXAMINE ASSUMPTIONS OF STATISTICAL SEISMICITY METHODS

TRIAL APPLICATIONS OF CURRENT METHODS

COMPREHENSIVE STUDIES OF MAJOR EARTHQUAKE SOURCE AREAS

INVESTIGATE SPECIFIC FAULTS AND FAULT ZONES

DETAILED INVESTIGATIONS OF RECENT EPICENTERS

EXAMINE TECTONIC STRESS CONDITIONS

584 341

T-11,12

PROBLEM

MAY 20, 1979 - D. C. COOK UNIT REPORTED LEAKING CIRCUMFERENTIAL CRACKS IN 16" MAIN FEEDWATER LINE NEAR STEAM GENERATOR NOZZLE.

MAY 25, 1979 - LETTER SENT BY NRR TO ALL PWR LICENSEES INFORMING THEM OF D. C. COOK FAILURES AND REQUESTING SPECIFIC INFORMATION ON FEEDWATER SYSTEM DESIGN, FABRICATION, INSPECTION AND OPERATING HISTORIES. IE REQUESTED PWR LICENSEES IN CURRENT OUTAGES TO IMMEDIATELY CONDUCT VOLUMETRIC EXAMINATIONS OF CERTAIN FEEDWATER PIPING WELDS

AS A RESULT OF THE ABOVE ACTIONS, SEVERAL OTHER LICENSEES WITH WESTINGHOUSE PWR'S REPORTED CRACKING AT THE NOZZLE TO PIPING WELDS.

JUNE 25, 1979 - IE BULLETIN NO. 79-13 ISSUED REQUESTED ALL FACILITIES WITH WESTINGHOUSE AND CE STEAM GENERATORS TO COMPLETE SPECIFIED INSPECTION PROGRAM WITHIN 90 DAYS.

584 342

30

PWR FEEDWATER LINE INSPECTIONS
(NOZZLE TO PIPING)

PLANTS INSPECTED TO DATE	NOT CRACKED	CRACKED
TURKEY POINT 3 & 4	X	
FARLEY 1	X	
CRYSTAL RIVER UNIT 2 (B&W)	X	
ZION 1	X	
PRAIRIE ISLAND 1	X	
TROJAN	X	
INDIAN PT. 3	X	
CALVERT CLIFFS 1 (CE)	X	
DAVIS BESSE 1 (B&W)	X	
BEAVER VALLEY 1		X
SALEM 1		X
KEWAUNEE		X
H. B. ROBINSON 2		X
SURRY 1 & 2		X
SAN ONOFRE		X
D. C. COOK 1 & 2		X
PT. BEACH UNIT 2		X
NORTH ANNA UNIT 2		?

584 343

81

FACILITIES WITH PRELIMINARY METALLURGICAL ANALYSES

FACILITY	CRACK SEVERITY	TENTATIVE ANALYSES MODE OF FRACTURE
D. C. COOK UNIT 2	THROUGH WALL	CORROSION ASSISTED FATIGUE
D. C. COOK UNIT 1	DEEP CRACKING	"
H. B. ROBINSON UNIT 2	DEEP CRACKING	"
BEAVER VALLEY UNIT 1	DEEP CRACKING	"
KEWAUNEE	MODERATE CRACKING (.100 IN.)	"
SAN ONOFRE	MODERATE CRACKING (.090 IN MAX)	STRESS ASSISTED CORROSION
POINT BEACH UNIT 2	SLIGHT CRACKING (~.040 - 0.80 IN)	STRESS ASSISTED CORROSION

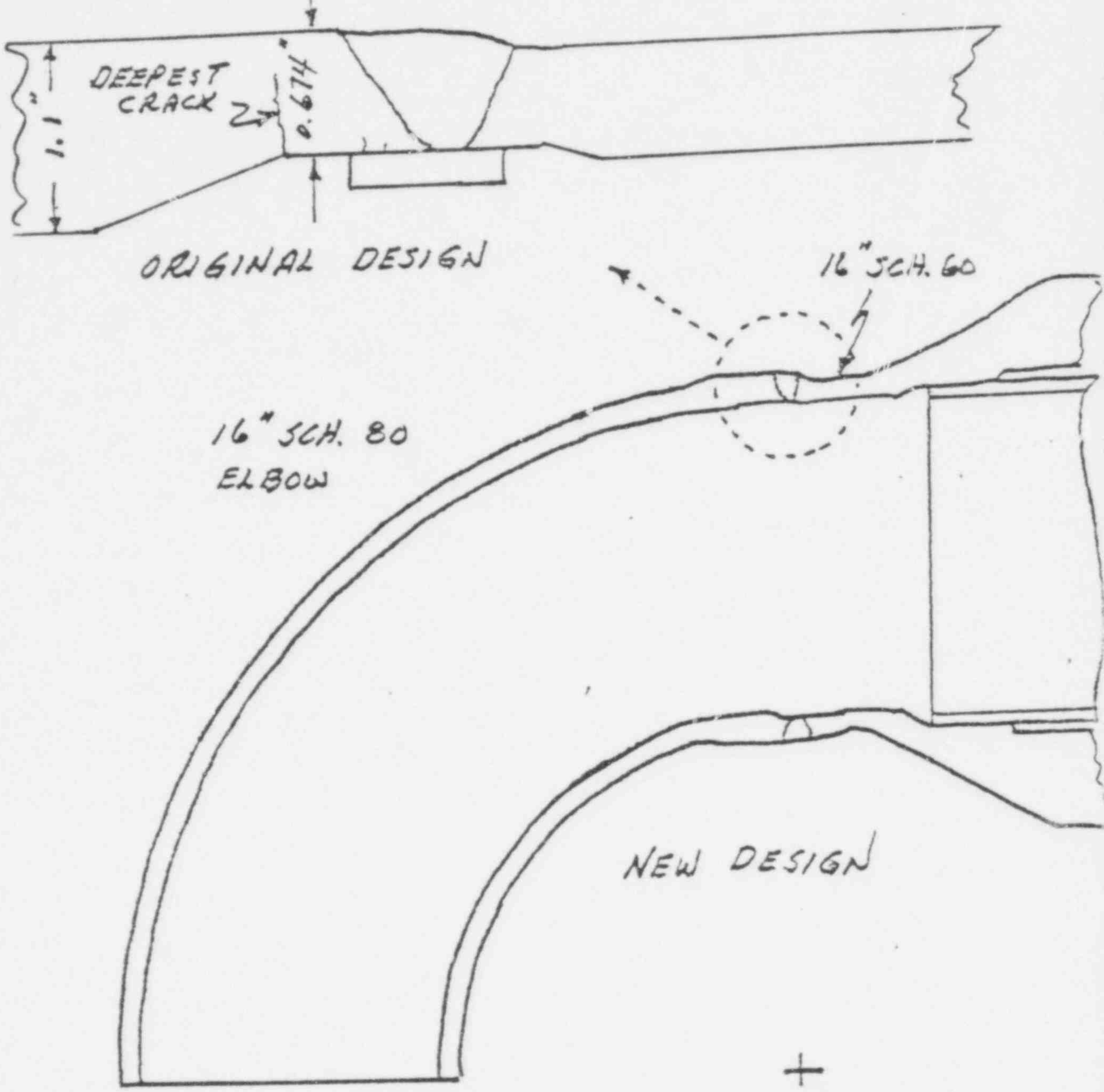
CAUSE OF CRACKING

CAUSE OF CRACKING NOT IDENTIFIED CURRENTLY.

CONTRIBUTING FACTORS SUSPECTED:

- ORIGINAL FABRICATION DEFECTS
- PIPE VIBRATION
- ENVIRONMENTAL EFFECTS
- THERMAL STRESSES
- IMPROPER PIPE RESTRAINTS

584 344



D. C. COOK NUCLEAR PLANT

584 345

PWR FEEDWATER PIPING STRESSES

NORMAL OPERATING STRESSES

- PRESSURE
- DEAD WEIGHT
- THERMAL EXPANSION
- THERMAL TRANSIENTS
  (THROUGH WALL THERMAL BENDING STRESSES AND
  THERMAL STRESSES DUE TO LOCAL GEOMETRIC
  . DISCONTINUITY)

ALL NORMAL OPERATING STRESSES WERE ANALYZED WITH AS BULIT CONDITIONS. THE STRESSES ARE UNDER THE CODE ALLOWABLES.

584 346

CORRECTIVE ACTIONS

SHORT TERM

REPLACE CRACKED COMPONENTS.

REDUCE STRESS CONCENTRATIONS.

REPAIR AN ASSOCIATED MINOR INDICATION.

VERIFY ADEQUACY OF ACTIONS BY RT AND UT FOLLOWING FABRICATION.

ESTABLISH TEST PROGRAM FOR ACCELERATION, DISPLACEMENT AND TEMPERATURE.

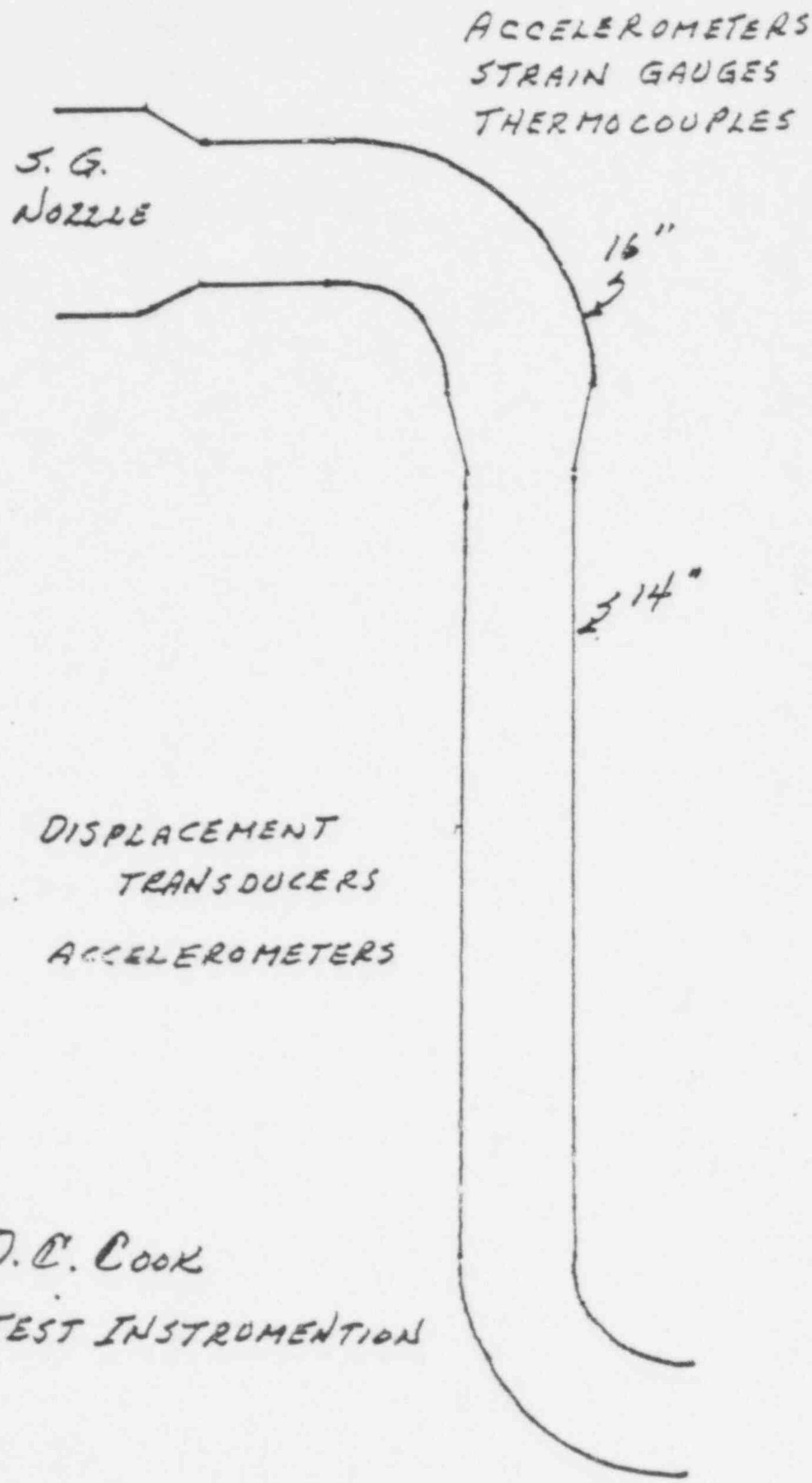
LONG TERM

PERFORM TEST PROGRAM USING DATA OBTAINED AND SUBSEQUENT ANALYSES TO ESTABLISH CAUSE OF FAILURE.

MODIFY PIPING SYSTEMS, IF REQUIRED.

584 347

85



D. C. Cook
F.W. TEST INSTROMENTION

584 348

NRR ACTIONS

ESTABLISH PWR FEEDWATER PIPE CRACKING ACTION PLAN

I. FAILURE INVESTIGATION - CAUSE OF CRACKING

A. CRACKING MODE, METALLURGICAL ASPECTS

: REVIEW LICENSEE WORK

: INDEPENDENT ANALYSIS BY BROOKHAVEN AND LAWRENCE LIVERMORE LABORATORIES

B. STRESS ANALYSIS

: REVIEW LICENSEE WORK

: INDEPENDENT ANALYSIS BY INEL

: REVIEW AND RECOMMENDATION ON TEST PROGRAMS BY LAWRENCE LIVERMORE LABS.

II. REVIEW PWR DESIGNS AND OPERATIONS

III. CONSEQUENCES OF CRACKS

A. POSSIBLE CHALLENGES TO PIPE INTEGRITY

B. PIPE STRUCTURAL INTEGRITY

C. SYSTEM EFFECTS

IV. EVALUATE REMEDIAL AND CORRECTIVE ACTIONS

584 349

87