NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

IN THE MATTER OF:

SUBCOMMITTEE MEETING

on

EMERGENCY CORE COOLING SYSTEMS

Place - Washington, D. C.

Date - Wednesday, 20 June 1979 Pages 260 - 462

Telephone:
(202) 347-3700

ACE - FEDERAL REPORTERS, INC.

Official Reporters

444 North Capitol Street
Washington, D.C. 20001

NATIONWIDE COVERAGE - DAILY

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

WEDNESDAY, 20 JUNE 1979

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING

on

EMERGENCY CORE COOLING SYSTEMS

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

Wednesday, 20 June 1979

The ACRS Subcommittee on Emergency Core Cooling Systems met, pursuant to adjournment, at 8:30 a.m., Dr. Milton S. Plesset, chairman of the subcommittee, presiding.

PRESENT:

DR. MILTON S. PLESSET, Chairman of the Subcommittee

MR. JESSE EBERSOLE, Member

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DR. PLESSET: Let's begin. We have a rather full day, but of necessity it is going to be a short day, because some of us have to leave by 3:30. That is the good news.

Now the bad news: We are going to be succinct both in our questions and our comments. I have asked the Staff to be likewise.

Before we begin I thought I would say a few words to you. What we are concerned about today is the fact that the ACRS must make a report to the Commissioners in July regarding the research budget; and this, I am sure, will also go to the Congress, even though we prepare another report due in December.

We have already prepared two reports. Let me tell you what kind of reaction they have gotten. In the preparation of the bill in the House Committee, which has oversight on the finances of the NRC, they made some comments in the bill.

There are some specific criticisms of the ACRS in the bill. That is unusual. Let me read it to you. They want to propose three changes to increase the utility of the ACRS report as follows:

One, they are asking ACRS to prepare its report in accordance with a schedule that permits it to be used by the Commission in preparation of the fiscal year 1981 authorization request. That we are doing, hopefully. The

Commissioners would consider the budget in July.

Two, prepare a clear statement of research priorities, including specification of projects the ACRS believes should be added to or dropped from the Commission's research program. That is a very specific request.

Three, include discussion of the specific manner in which the Commission's reactor safety research projects are expected to affect the Commission's reactor regulations. That is a little less clear.

You can see what some of our problems are. It may very well be that the ACRS reports of the past two years have been more concerned with form than substance.

Now we have to try to reverse that and pay more attention to the substance and less attention to the form.

I mention these things to you because we look to you for help in considering the budget and the items, and direction of the safety research program.

I think that Mr. Murley of the Staff will certainly help us get as much of this in this short day as possible.

Do any of our consultants want to make comments on our task? I don't know if we can do it all today, but we will try.

We will have to transmit to the full committee our views regarding the budget, as well as the research program, which is the more important thing for us to be concerned with, rather than just the dollars.

So you will wait until after the presentations to make comments. Hopefully we can complete all the presentations before 3:00 o'clock. I think that is when we will have to adjourn; 3:30 is as late as we can stay, and we need some time for discussion.

I would like if we could finish by 2:30 or 2:45.

PROF. THEOFANOUS: In view of the time limitation, could I suggest we let the speakers speak without interruptions so we get the train of thought, and then maybe after a particular segment, ask questions, instead of breaking in all the time?

DR. PLESSET: That is a good idea. It will certainly help.

I also asked Tom Murley to have his people be succinct and not go into any particular amount of background material. We are pretty familiar with the facilities and fairly familiar with the programs that are involved with those facilities. We can save a lot of time that way.

Any other comment?

I think that is a good suggestion. I hope the Staff will make note of that. We will try to cooperate for a change and let them speak without too much harassment and interruption.

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I guess we can proceed, Tom. Do you want to comment?

MR. MURLEY: Yes. Okay, this will be the first time we have really gone into detail on budgetary material with the Committee.

I had intended in my introductory talk to tell you what the material is all about and lead you through it. I will do that.

Also Dr. Plesset has asked that I take a little time to explain what is in the fiscal 1980 supplementary request that we will be requesting of the Commission, probably within a month.

First I think I need to go over some introductory remarks. We a reexamining our program in light of the Three Mile Island accident.

We have already made some changes in the program. The semiscale tests have been run on TMI type simulations.

The LOFT program has been changed. We have conducted hydrogen experiments and will be conducting more.

And there was a change in emphasis in our Code D program. We are tarting to accelerate transient codes.

You recall last year we had the research staff with the support primarily of the Idaho National Engineering Laboratory staff. I conducted a survey of reactor safety

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research needs.

(Slide.)

I will just quickly reiterate what these were. There was widespread agreement that licensing evaluation models be conservative with regard to large LOCA.

The current programs were addressing the small scale model research needs, but further large scale tests were neded for both PWRs and BWRs.

We have started the large 3D program, and it is now going at high speed. Gary Bennett will talk about that later.

We have since started BWR countercurrent flow limiting research programs at Lynn, Massachusetts. That is also large scale in conjunction with EPRI and GE; and I believe Al Serkiz intended to cover some of that.

Also there was widespread agreement in the community and ACRS that more emphasis should be placed on non-LOCA research. We started to do that, as a matter of fact.

(Slide.)

We went to the Commission. This budget chart is taken from last year's Commission presentation. We showed that the LCOA-ECCS program would start down after fiscal 1980 and continue down.

Indeed, the whole light water reactor program would

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start down in fiscal 1980. That has been our plan up until the TMI accident.

I think we have learned that there are quite a few areas we haven't been addressing adequately, and we intend to do that.

As a result, we foresee the following impact on our program: in fact, it will not peak in fiscal 1980, but will peak in 1981 and take a large jump, and start down at roughly about the same rate.

I have shown three budgets here. The dark lines are the old lines from last year. For information, the 1978 and 1979 figures include part of DOE's funding for LOFT. You recall they had to pay to finish the construction of it. It was all part of safety research in a way, so I am including this to show the trends.

We are going in with a supplement to our 1980 budget. If we get that, then the budget increase will start off in 1980 at a much higher rate than what we have previously asked for, and still will peak in 1981 and come down.

If we don't get a budget supplement in 1980, then it will take a much sharper rise in 1981.

I should explain that this budgetary supplement will get us into areas where we will start looking at accidents that go beyond design basis accidents. Particularly, we will

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be looking at what we call degraded plant conditions.

By and large we have assumed that we have taken the Appendix K assumptions that may be loss of offsite power, but the ECC systems work.

When you get into transients and small LOCAs, where the time scales can extend out into hours, there is a lot of opportunity for operator intervention. That can sometimes negate the emergency cooling system.

Likewise we will be looking at multiple failures of equipment. We intend to be doing more exploratory research.

We will be looking at real plants. We will be looking at trying to apply the lessons of WASH-1400 to real plants, and how they would stack up against the various accident scenarios in WASH-1400.

We are looking into possibly some simple methods for making quick calculations. We don't have firm ideas on that yet. I throw it out as an indication that we are thinking along these lines.

I have asked to se if we can get even a small computer in research so we could experiment with some small programs ourselves to see if it makes sense to do quick calculations. I think we can, of the kind Carl Michelson does, for example.

So those are the general areas we will be moving into.

Dr. Plesset wanted me to talk about the fiscal 1980 supplement.

(Slide.)

This was presented to the Full Committee about a month ago. Most of you weren't here, so I will go over this.

We will be asking for abc.it $29.8 million above our regular request in 1980. It is broken down into six categories. I will go over each category in a little more detail.

This may change slightly. Sol Levine is still working on the papers, but there will be major changes.

(Slide.)

The first area, better understanding of transients and small LOCAs. We see an urgent need to modify and check our codes to improve their capability to handle transients, natural circulation and small LOCAs.

This includes a fair amount of money just for running the codes to examine the transients.

We plan to upg:ade SEMISCALE by adding a secondary system and a secondary steam generator so we can look at plant transients.

We are tentatively planning to upgrade the TLTA facility to study BWR transients and small LOCAs. We need to modify LOFT so we can accelerate the small LOCA tests. It

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will require some addition hardware that we hadn't planned on until another year or two; but now we intend to accelerate it.

Don McPherson will talk about this later.

We have separate effects, and thermal hydraulic tests. Also, Al Serkiz will talk about how they will be modified.

We intend to do some studies of cooling several damages cores, like what may exist in TMI today, for example, or possibly looking at other types of core damage and see that, in fact, we can cool those.

We intend to look at the release and transport of fission produced from damaged fuel that may get much hotter than 2200 degrees, up to 3000 or 4000 degrees Fahrenheit.

. A major item is to establish a data bank for each operating reactor that will allow us to do calculations immediately. Once we learn there is an accident or an event at some plant, we intend to have codes available and a data bank, including an operating deck for each reactor. Probably this will be done at National Labs.

(Slide.)

The second area of extreme importance is enhanced operator capability. This is the second item. Logically it should be first. We have to develop the instrumentation needs that should be brought into the control room so the operators know the status of the plant.

The most obvious is liquid level in the reactor vessel. We think we have experience along those lines that can help commercial plants.

There is a lot more, too. We should systematically go through each plant or each type of plant and find out what kind of instrumentation is needed to measure the parameters that have to go into the control room.

We then will look at control room displays, and in particular what kind of diagnostic systems the operator should have available to him.

I don't believe we mentioned it last time, but there is an excellent prototype system that is existing on the Halden reactor. Halden is a small test reactor in Norway where they have a diagnostic system. It is in a small room next to the control room. It has three CRT displays.

It is not really the palnt operator -- it is one of the operations staff -- can sit at the displays. It interrogates the plant computer. It doesn't control the plant. It draws data out of the plant computer and analyzes it.

For example, the thermocouple readings at TMI could have been displayed continuously and systematically on the CRT displays in this room I mentioned.

We are looking very seriously at installing such a syste on LOFT so that we can get experience ourselves. LOFT is an operating reactor. It is, I think, uniquely geared to this kind of a system, so we can get some operating experience.

The Germans are so impressed with this system at Halden that they are moving toward installing it on the Groven-Rhinefeld reactor in Bavaria. It is a PWR built by KWU, and Prof. Berkhauffer in Germany is very impressed with this system. I think they are moving toward possibly installing it on most of their plants in Germany, though that is a bit premature to say that now.

The third item is a task to identify the data transmission requirements and review the accident response procedures of the NRC itself. We should have more information available to us in the incident response center.

We are looking at, do we need out own computer, what kind of display steps, and so forth.

MR. EBERSOLE: ESF means engineered safety features. If you go to any SAR you will find ESFs are limited to definition of machinery and equipment that mitigates LOCAs. It doesn't include the critical auxiliary feedwater pump.

Therefore, it is obligatory to center the scope of what is called ESF until all elements of the plant that cope with the after heat removal problem after trip without the condensor. That is a point of beginning.

MR. MURLEY: This is shorthand. We agree with that.

(Slide.)

Plant response under accident conditions. You recall in TMI we had quite a lack of understanding of what condition the reactor was in; but also there was a question of was there a hydrogen bubble, how big? Was there oxygen, how much? And a lot depended of not knowing the extent of boiling, if there was any; we didn't know the coolant chemistry, and so forth.

We intend to undertake some tests to examine what the coolant chemistry could be under fuel failure conditions, and better ways of sampling that at high pressure.

We expect to look at hydrogen behavior, how it is generated, its transport through the system. And clearly we will have to look at probably each reactor, because removing hydrogen from the — the pressurizer surge line on a B&W plant is different from Westinghouse plants, so the behavior of hydrogen gas would be different getting out if the pressurizer relief valve went. We have to look at each of those.

We will do effects of hydrogen explosions. We won't do explosion research ourselves, but we should catalog

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the information available. There is a wide range of information available. It was not readily accessible to the NRC on short notice.

We will have to look at the response of plant equipment and structures to accident conditions. Here we mean things like the hydrogen pressure spike. What could that do to equipment in containment? What could it do to the containment itself? What does the containment spray system -- sodium hydroxide -- do to equipment in containment? What does prolonged exposure to radiation do to cabling and equipment? So forth.

A lot of this equipment was not designed to withstand the water and radiation levels at TMI. In fact, some of it didn't.

We intend to look at -- this means maintaining containment integrity under fuel melt conditions.

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We should go beyond the TMI accident itself and take a look at if we were to get large masses of molten fuel, what could be done to mitigate the consequences. We have programs along these lines. This is meant to augment that.

Finally, we need to do benchmark testing of structural and piping system analysis codes. We spent a lot of time and thought put into what we call verifying codes. That was always our large LOCA codes.

We have done nothing with regard to our structural piping system analysis codes. It has shown up in seismic plant shutdown. We have to start doing that in a systematic way for these codes as well.

(Slide.)

Finally, I believe there should be a comprehensive postmortem examination and plant recovery. This should not be primarily the government's responsibility. We have had discussions with EPRI, DOE, and with the utilities and there will be another meeting next week at EPRI.

My understanding is that they intend to take the lead on the postmortem of the TMI plant. Nevertheless, we believe we should be an integral partner to that activity and, in fact, will have to do some of the examinations ourselves, we believe.

We expect to take some damaged fuel when it comes

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out probably to — we are looking seriously at the hot shop at the test area north in Idaho out near LOFT that was initially built for the aircraft nuclear propulsion project. It was recently upgraded. It will be a first class facility. We think that is a logical place to examine some of the fuel. We believe we should go in and measure the fission product chemistry and plate-out data. What kind of fission products and where are they plated out in TMI?

Finally, we want to look at some of the safety-related equipment, cabling, instruments, that kind of thing in the plant and from that help us establish some requalification criteria. If the utility plans to take TMI back to power someday, we clearly have to have some criteria under which we will allow the plant to operate.

We think we need research in those areas.

(Slide.)

Two more. One is risk assessment. I am not the best one to talk about it. I will summarize it for you. When we presented it to the Committee the last time, we only had $300,000 here. We ought to be fed up, and we agree. So we have beefed it up. We need $1.4 million to go into detail looking at the event trees of accidents. This should be kind of the intellectual guide answer to our research program on looking at various accident scenarios, at least the ones coming out of WASH-14 and any others we

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can think of, and then that will allow us to examine with our codes i` much more detail those various scenarios. We expect a larger program on human error rates and the impact of human errors on risk.

We have to beef up our failure data analysis effort. The total there is $3.1 million.

(Slide.)

With regard to improved reactor safety, this is a different budget category. That is why it's broken out separately, the same as for risk assessment. We need to look at improved containment concepts. Here we mean vented containments primarily and we intend to look at how we might backfit vented concepts into existing containments. We will look at improved safety systems for coping with accidents. These are things like residual heat removal systems that can operate higher than 400 psi, better decay heat remove systems, that kind of thing.

And value/impact methodology is really aimed at if we are looking at backfitting reactors, we know there is a high economic cost with that, and we have to have some better methods for quantifying the benefits.

That summa .zes the fiscal '80 supplement. We sent down copies of the Commission Staff Paper. It's discussed in more detail there.

I would suggest you refer to that for more details.

Now I would like to shift gears into our fiscal 1981 budget submission. This is what is new to the Committee. There is a formal procedure that we have to go through. We have sent down to the Committee our zero base budgeting documentation. For the Office of Research, it's this thick. It's almost impenetrable to a beginner, so let me try to summarize it for you.

DR. PLESSET: Tom, let's see if we have any comments on the supplement. I think that would be a suitable point to do that, before we get into the 1981. Let's have succinct, pointed comments or questions. Ivan, you look as though you are ready.

MR. CATTON: I made a lot of notes here. Just one thing, better understanding of transient to small LOCA events, that seems like a lot of money. I would need more detail. That seems like a lot of money to spend in an area where work has been oging on for some time.

MR. MURLEY: Let me discuss that with you at the break. I have a sub-breakdown on that, but I don't have it at hand here.

DR. PLESSET: Does that include a lot of analytic work?

MR. MURLEY: Yes.

DR. PLESSET: Mostly analytical work, or does it include special work?

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MR. CATTON: Would you put the second slide back up? Better understanding of transient and small LOCA accidents.

(Slide.)

The bottom two items look new. Coolability of several damaged cores and establishing of the data bank. I assume the data bank is so you have -- if you were going to run RELAP, it would be set up and ready to go for a specific plant, that is what that means?

MR. MURLEY: Yes.

MR. CATTON: It's the ones from that point up that I would have some reservations about. I guess I would need to see more before I could be more specific.

MR. MURLEY: I would suggest a starting point would be the discussion in the Staff paper -- the Commission paper. Unless you have something specific, I don't know how to respond.

A large part of it has to do with hardware. $3 million and 2.2, $1 million, this really is hardware to do transient tests.

MR. CATTON: Are you referring to --

DR. PLESSET: Here is a paper headed "Research FY '80 Supplemental Budget Information."

MR. CATTON: I got so many yesterday --

MR. MURLEY: Bring my copy up from the table,

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will you, Bill? Thanks.

DR. PLESSET: This was prepared for the Commissioners by Sol Levine. What you might do is look at it all, then ask your question again. Is that all right? Can we come back to it, Tom?

MR. MURLEY: Yes.

MR. CATTON: The first item, it's not clear to me what modifications must be made. I have been led to believe for the most part the codes do reasonably well in handling the small LOCA.

MR. MURLEY: It's more than that. TRAC, for example, does not have a secondary system in it. If we will deal with transients that originate in the secondary system, and most of them do, we have to put that in and we have to put in control features.

We will be looking at RETRAN which is a very old version of RELAP but has good control features in it. There is an IRT code we purchased from Combustion and is up at Brookhaven. We need to beef that up.

We are shifitng away from the large LOCA emphasis. When we do that, you need a lot more capability in your codes.

MR. CATTON: A different kind of capability.

MR. MURLEY: That's right. But it takes time and money to do that. We are saying that that is about $1.7

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million. A full secondary system with associated trips and controls would be added. Noncondensable gas model. RETRAN and IRT will be modified to meet the immediate licensing needs.

MR. CATTON: Now you have three.

MR. MURLEY: We will incorporate COBRA into TRAC. That will allows us to do more detail core analysis. I think COBRA really needs -- if you want to look at details of cores, you need that kind of detail. That doesn't have a system capability.

MR. CATTON: Let me give to you some of the feedback I have been getting listening to people talk about analysis. You get the feeling that it's a quasi-static process and can almost do the classification by hand. This was confirmed by some of the people with the Licensing Staff who were here a few days ago at the Full Committee meeting. That question was asked them directly. How well can you make classifications without a computer? A person indicated they could do reasonably well on the back of an envelope.

Look at Michelson's analysis, which was done using maybe a hand calculator — I was going to say slide rule but that's --

DR. PLESSET: That's obsolete.

(Laughter.)

MR. CATTON: From the point of view of putting

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together a system to look at a plant as a system, which means you all have the steam generators and pumps and everything and the various controls built into the system, is important. I am not sure that if I were doing it, I would want to hang all that on a code like TRAC that has a level of sophistication that is just not needed as far as I can tell, at least for the beginning part of the accident.

Now if you get down to the case near the bottom where you are interested in what happens after you have damaged the core, that is another ballgame.

MR. MURLEY: Let me respond. As I said, there are classifications that can be done simply, and we intend to do those and find out the range of applicability of those classifications. We have to have the capability to do those on short notice.

I don't think you can rely on them unless they they have been tested against something bigger. To shut off our advanced code development or say that you don't need to look at these even quasi-steady state accidents -- there was boiling going on. so in order to examine that you need a code that has two-phase capability. You have to look for subtle things in these accidents.

MR. SHUMWAY: I wanted to agree with [illegible]ey only because with hand classifications you can do an overall gross mass and energy balance on the system, but if you want

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to know about the two-phase distribution of liquid in the reactor, which you must know if you are going to assess whether or not you have DNB and heat-up, you need more sophistication than you can have with hand classifications.

MR. CATTON: I hope I wasn't implying you would do it all by hand. It's just that --

MR. MURLEY: You were questioning why we need money. That is at the root of it. I am telling you that until now we have been going very fast with our efforts focused on the large LOCA analysis. We have to shift gears a bit and put a lot more emphasis on a broader range of codes than we have been. That includes TRAC, RETRAN, IRT and COBRA.

MR. CATTON: I thought RETRAN was an EPRI code.

MR. MURLEY: Yes. It was developed by Energy, Inc. under EPRI's sponsorship. We either have it or will have it and will be using it as wel as the Idaho and Brookhaven.

MR. CATTON: Where does the SSC code fit in?

MR. MURLEY: That is a liquid metals systems code developed by Brookhaven. We have asked them to look at if they could modify that to look at water reactors. It's not a simple modification. You have to take out the sodium, take out the secondary system, two-phase

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capability and so forth.

If that can be done, we may put some effort into that. Now it's limited to a scoping analysis of what can be done. It's a good liquid metal systems code.

MR. CATTON: Also a good systems code.

MR. MURLEY: Yes.

MR. CATTON: I guess I am speaking from ignorance, but it seems to me that that would be a good direction to go. Water hydrology is very much like sodium. The heat transfer part, you have to worry about.

MR. MURLEY: There a lot of differences when you get in details. Steam generator models are different. It has no pressurizer, no two-phase capability. We have to look at those. I have accounted for $1.7 million of the 3.1. The other is analysis of PWR and BWR transients. This is to use the codes looking at these various scenarios.

This is where a large part of the learning will come.

MR. CATTON: 1.7 and 1.4?

MR. MURLEY: 1.7 was to accelerate the transient codes. 1.4 was to use them and to analyze the range of transients that we identify preliminarily through the fault tree and event tree analysis.

MR. EBERSOLE: I think we are saying you are going to depart from strictly large LOCA analysis and extend

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studies out to small LOCA and cascades o: various sorts that threaten the afte: heat removal process. Up to now you have been comfortable in lumping BWRs and PWRs into the same bucket, because they have the same potential for large LOCAs.

Now it's essenti. as you broaden your scope to put them in separate camps and look on a relativistic basis for the portents of getting into trouble with these particular models.

In the first sentence you talk about natural circulation and small LOCA accidents in PWRs and BWRs. It looks like mixing tomatoes and oranges and apples in this category.

BWRs have phase change for heat transfer. They have a neat system to cause a small break in their SAR design. They short-circuit a lct of the problems which the BWR can't. I am syaing it will be a branching package, once you get down to this area, where you will inevitably see striking differences in accident potential betwee them which should be called out.

MR. SULLIVAN: I looked at your last item in the budget on this slide and you are establishing a data bank at $.4 million. Isn't that low? There are ov r 50 operating plants now. To put together that many decks for that amount of money in th. detail you need for looking

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at the secondary side, I would question whether you could do that with this or not.

MR. MURLEY: It probably will take more. On the other hand I am not sure we can do everything in one year. That is somewhere around seven people full-time. I don't know whether we can double that or triple that.

DR. PLESSET: It's a matter of people that determines a lot of those numbers that you have.

MR. MURLEY: Yes. We have factored in -- this is not everybody's wish list thrown together and compiled. This had a fair amount of management review in RSR and has been cut about half from what was originally requested.

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PROF. THEOFANOUS: I want to make sure I understand you correctly. In the first list, you are asking a question of understanding the small LOCAs.

Then in the fourth of fifth list you talk about the improved risk assessment, the 1.4 million is for actually carrying out the risk assessment, actually carrying out the —

MR. MURLEY: Excuse me. Part of this is also what I would call better understanding.

PROF. THEOFANOUS: I wanted to make sure. I believe most of the understanding now will come from that and not from going there and tagging on things. We have a lack of understanding.

MR. MURLEY: I understand what you are saying. You can only get so much understanding from an event tree. You can identify accident scenarios, but you don't know how the reactor will respond to those.

Let us suppose you postulate the kind of event that led to TMI, namely a feedwater transient where this and that were valved out, and the high pressure injection system was on and off for certain amounts of time.

Postulating those on an event tree wouldn't tell you what the plant will do. You need calculations. It will be an interrelating effect between the calculations and the event trees. I agree with you.

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PROF. THEOFANOUS: I agree with that. I want to see where the calculations are. That is the crucial aspect. That is where most of the understanding comes from.

MR. MURLEY: This is to identify scenarios that we will then look at in the $3.1 million item, and result in better understanding.

PROF. THEOFANOUS: So the calculations will be carried out under the 3.1 million?

MR. MURLEY: Yes. It could well be we have to go back in and look at a new set of event trees. It may lead to a state of the reactor that hadn't been anticipated when the analysts were developing event trees.

PROF. THEOFANOUS: Fine. You are close to what I was saying in our last meeting.

I still want to express a concern that I feel if I consider the two activities together, 3.1 plus 1.4, that makes 4.5; and I still feel this is disproportionate to all the other kinds of money being spent in this budget, and in particular in the present budget as far as leading to this understanding that is crucial.

MR. MURLEY: Would it help if I told you, I don't know that we can even spend that much on this kind of thing? I will tell you why.

It takes a certain kind of person and certain kinds of people. That represents so many people at $70,000 per man.

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PROF. CATTON: Twenty some odd.

MR. MURLEY: We don't have those in the agency.

PROF. THEOFANOUS: Where is the computer time? I thought it was in there.

MR. MURLEY: That is virtually all people. The 3.5 includes a fair amount of computer time but, together, we are talking about probably 40 or 50 people on top of our existing programs.

PROF. CATTON: You can't belive that second item, analysis of human error, rates out, because that will determine the first item. You are really talking about $5.7 million in this package. Without the second, the first becomes meaningless.

PROF. THEOFANOUS: I think if you tink of that in terms of on top of your present programs, it becomes difficult. The people you have to draw on to put in this activity must be people who are very familiar with accidents and already have been very much involved in this.

MR. MURLEY: That is a good point. Let me address that.

PROF. THEOFANOUS: A lot of shifting has to take place.

DR. PLESSET: Address it briefly, Tom.

(Laughter.)

MR. MURLEY: I don't want you to get the idea, which

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you could do, that we should spend this $40 million but cut $40 million out of our other programs.

Some of the people who are working on our existing program -- say SEMISCALE and LOFT -- it is very good. We hope to draw on some of those for this highly important work.

But they will have to be replaced, because we still have to carry out the SEMISCALE and LOFT programs. Don't get the idea that it is either this or the other. We think we can do both.

PROF. THEOFANOUS: Another small point.

I am seeing a tremendous shift, basically going on from what is called a large LOCA to a small LOCA. We must recognize they are all LOCAs. In spite of the tremendous amount of money spent for large LOCAs, I don't think we have at this time the kind of understanding we were sent out to get years ago when these plans were made.

I would hate to see that at this point just because an accident happened coming from a small LOCA, we forget about the large ones and put all our efforts to the extremely small ones.

This kind of activity you are talking about, better understanding, ought to be done with a view of the whole spectrum. There are also intermediate LOCAs with their own problems and difficulties in terms of complexities. The

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operator again has to know which way the accident is going.

In order to provide this kind of indication, we have to have a better understanding ourselves of what is happening in order to project, for example, instrument readings to what is happening in the system.

The conclusion then -- I suggest this activity of constructing event trees and accident scenarios, I would suggest this be viewed as a total effort with a view to addressing the whole LOCA.

By LOCA, I mean any kind of sequence that leads to losing your coolant from the reactor system.

MR. EBERSOLE: Including those that don't start with a LOCA at all, like a battery failure, for instance; a universal failure, which will inevitably lead to some kind of LOCA.

DR. PLESSET: Yes. You will have that kind of thing in your study, I believe.

MR. MURLEY: Definitely.

MR. EBERSOLE: It is a little wrong to call them a LOCA at the outset. It might be somebody demineralizing --

MR. MURLEY: Transient can include a wide range of things.

MR. ZUDANS: I have a few comments.

Risk assessment. I can't separate item 1 and 2 in my own mind. I would like to think it is possible to

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constructing event trees where elements are human error, not just equipment fairlure rates; and for that reason I think that this is probably the most important part of your additional program, to put some very experienced, bright people to work to really study -- even by Monte Carlo -- everything that possibly could happen.

You must think in terms of here, under these conditions, if something bad can happen, it will. If an error can be made, it will be made.

What are the consequences then? We talked about it yesterday quite a bit. I think a case like TMI fell in between the cracks, and the question is really: How many more such cracks exist in current systems?

My feeling is these two items are the most important ones in your program, and maybe are underestimated. I don't know. I am not expert in this field; but I feel you should join these two items if possible.

PROF. THEOFANOUS: Maybe a better question to ask is: What is the projection? With this kind of budget allocation, when do you hope to have the answers we are talking about? One year, two, five, ten?

DR. PLESSET: That is a painful question. You don't have to answer that one.

(Laughter.)

MR. MURLEY: I would hope we could start having some

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insights, let's say, within a year.

PROF. THEOFANOUS: When do you hope to have sufficient insight to claim we have completed this? I think that is what you are talking about when you talk about cracks.

MR. MURLEY: I don't know what completeness means.

PROF. THEOFANOUS: I don't mean it in the sense of 100 percent; but what would you consider sufficient completement to prevent similar things happening like TMI?

MR. MURLEY: I can't answer that.

MR. ZUDANS: I think we have it today.

DR. PLESSET: That is a good point. I let Tom off the hook. Maybe next year we will come back and he will give us the answer.

PROF THEOFANOUS: I think it is a very important question.

DR. PLESSET: I agree, but I think it is — let him think about it.

PROF. THEOFANOUS: I can't have an opinion on the budget unless I know how close the budget is bringing me to where I want to go. If it will be ten years, that is something else from six months.

MR. MURLEY: Tell me where you want to go. I view this as an exercise in looking under rocks and poking into corners and looking for accidents that we have never looked at

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before, and hardly even thought about.

I am telling you I think we can be looking under rocks within a year. I don't know how many rocks there are, so I have no idea of the scope of the job and when we will have looked under every one. I am not sure it is even definable.

DR. PLESSET: I think we ought to go into the 1981 budget discussion.

MR. ZUDANS: Could I finish another comment? Very short one. I think in your improved reactor safety area, I would recommend that you could have a systematic review of all interconnected systems with the idea in mind that regardless of how they are isolated from each other, the --

MR. MURLEY: There is a generic safety item called systems interactions. We're probably going to take over responsibility for that from NRC.

Right now it is under Steve Hanaur's task force on safety items. We are negotiating to take that over, and will look at that carefully with the risk assessment group.

MR. ZUDANS: I am pleased to hear you know about Halden; and I also know you went out there; is that correct?

MR. MURLEY: Yes.

MR. EBERSOLE: Dr. Zudans' point here, you said interconnected systems. If you just look at schematics and

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see the steps in that light we never see the environmental connections which are never put on drawings.

Therefore, interaction setps must include the environmental aspects.

MR. ZUDANS: My biggest concern is you seem to have power plants where there is no information on neutral zones at all. There are a series of valves between two different energy steps, and you don't know what happens in between.

There is not enough instrumentation to tell is it a disaster if I open this here because the previous valve already leaked?

Primary coolant leaks through RHR because the guy tried to open it and it wouldn't open, so he cranks it open by hand and blows up the RHR system because the other valve had leaked.

I think a big aspect on this particular item is some kind of instrumentation in the neutral zone, whatever you call it.

DR. PLESSET: Fiscal 1981.

MR. MURLEY: The fiscal 1981 budget, I really won't go over it in detail. I intend to provide a Rosetta Stone that will allow you to understand the various levels in our budget..

To do that, I picked the code D budget.

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(Slide.)

These were provided -- we call them the delta charts. What it is is we list each budget area like code D, break it into two or three or sometimes eight or nine subcomponents.

In this case we have steps codes, component codes, an area called assessment and applications.

We then show what is the fiscal 1980 level in the President's budget that is now before the Congerss, and what we are requesting in fiscal 1981.

Now a key point to note here is because of the notion of a fiscal 1980 supplement, this has very much complicated our budget lives. This assumes we don't get the 1980 supplement, so that the $8.9 million code D is without a supplement, and the $14.4 million is what we need in 1981, assuming we don't get a supplement in 1980.

One of the innovations of President Carter, as you probably know, is the zero base budgeting concept. In that concept we have to list several potential levels of our budget.

(Slide.

This year we have four. They are titled: the minimum budget, the current budget, the requested budget, and the amended budget.

The minimum program is intended to mean what is the minimum level below which the program loses its integrity and you really can't accomplish your functions. I don't want to go over this.

It is just to tell you the next chart that says fiscal 1981 minimum is what we believe in the code D area is the minimum integrity program.

Moving up from that level we show a chart going from the minimum to the current, and the difference between them.

(Slide.)

Giving what is in the base for a minimum program, we then add $1.76 million in the various areas, and it tells you what you buy or what in this case Congress would buy or get for $1.8 million; what the nation gets.

(Slide.)

Similarly, the next chart shows how we move from the current budget. I should say current is defined to mean more or less our current program. What does it cost to keep the current program going without major reductions or major increases? In that case our assessment is that it takes about $11 million a year to keep the current program going in code D.

(Slide.)

Now the next one is what are we requesting? We are requesting a sizable figure, as you can see, $3.4 million

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increase. All of this assumes we get no increase in fiscal 1980.

(Slide.)

The last chart is a new innovation that says, what happens if in fact we get the fiscal 1980 increase? How much do we need in fiscal 1981?

In this case this clearly shows we don't need as much increase, although the totals are about the same. If we were to get our amended budget, the $3.1 million that I had a dialogue with Ivan Catton about is included in the $12.4 million.

If we got that, the fiscal 1981 budget would be somewhat different than if we didn't get it. That is all this chart is intended to show. Anyone going through the budget in detail, this will allow you to work your way through it.

DR. PLESSET: Tom, does that pretty much complete your presentation?

Could you give us some indication of priorities? You rememer that little criticism the ACRS reports had that said we didn't indicate priorities; you haven't either, so you are in the same boat as we are. That's good company, I would say.

(Laughter.)

MR. MURLEY: I would rather not do that standing up

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here. I would like to -- could we write to you?

DR. PLESSET: That would be fine. I don't want you to take it lightly.

Also on the supplement, unless they all -- they could be of similar priority. That is a legitimate, possible statement. I think it would be very helpful if we could have some kind of indication, and I think it would help both you and us.

MR. MURLEY: I will do that, and we will send it down. It will probably be a week or so.

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DR. PLESSET: Fine. Any other brief comment before we let Tom go? We kept him longer than he scheduled himself, but I think it was very helpful.

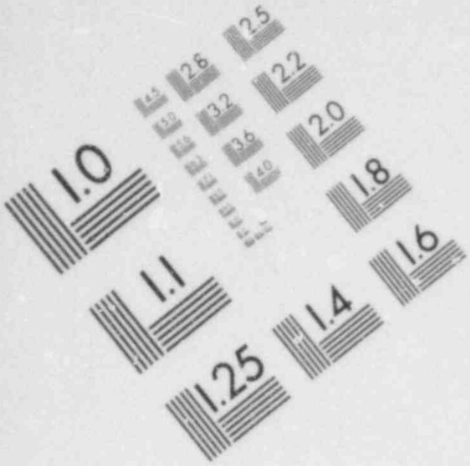
MR. MURLEY: I asked my staff to cut their presentations down, so I hope it will make up for my extra time.

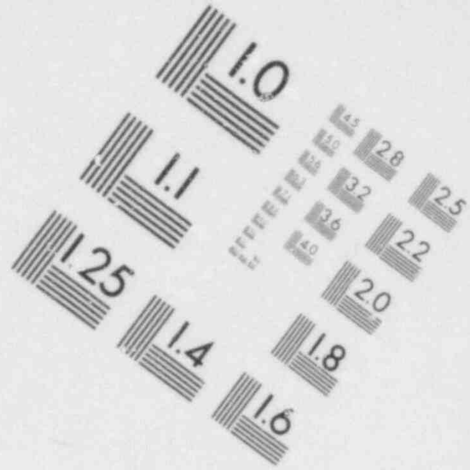
MR. ZUDANS: I would like to ask one brief question before you leave.

Your plans currently are to simply take over a system like Halden has and apply it to LOFT, or do you plan to work out your own, or recommend the utilities do their own monitoring systems that are computerized, not necessarily called CRTs, but just a screen type of information that kind of keeps in pace with actual reactor state, and continues to display what the state is?

If the operators makes any action, it indicates whether he is doing right or wrong; also makes reference to technical specifications and new procedures that might be built into such software -- in other words, an aid to the operator, not to control the plant but monitor and provide information.

MR. MURLEY: Let me make a [illegible] and then I will respond directly to your question. I was at Halden last October. I led a research team there. I was very much impressed with it.





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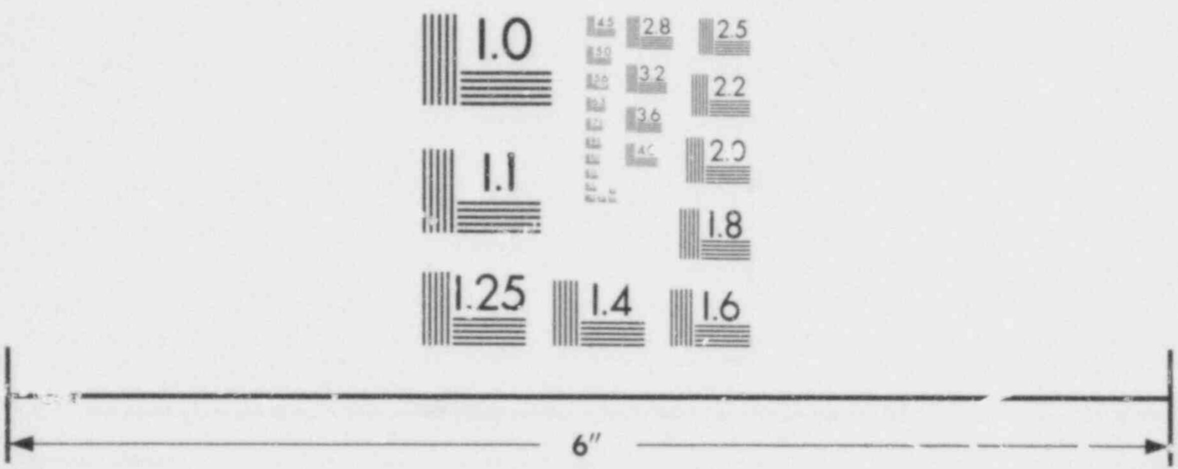

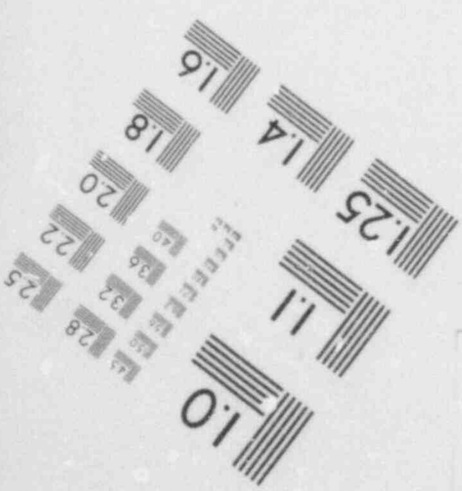

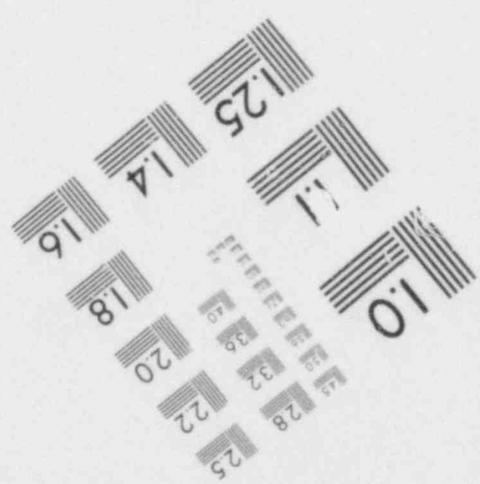

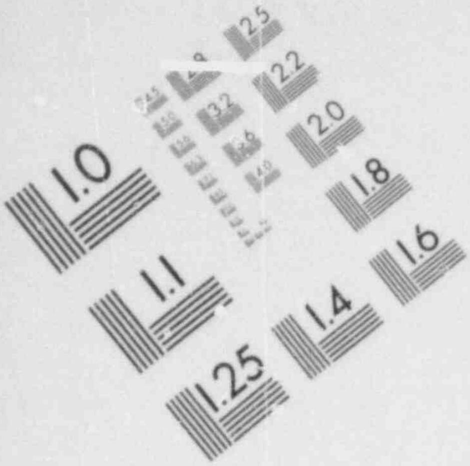

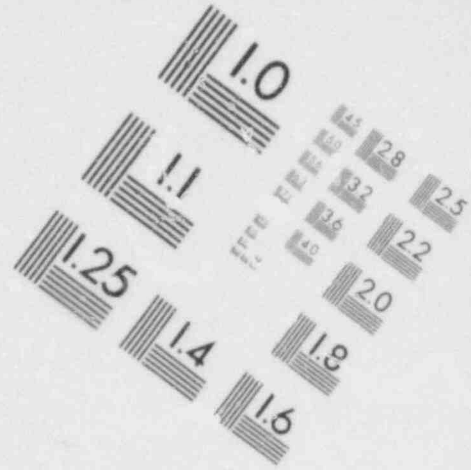

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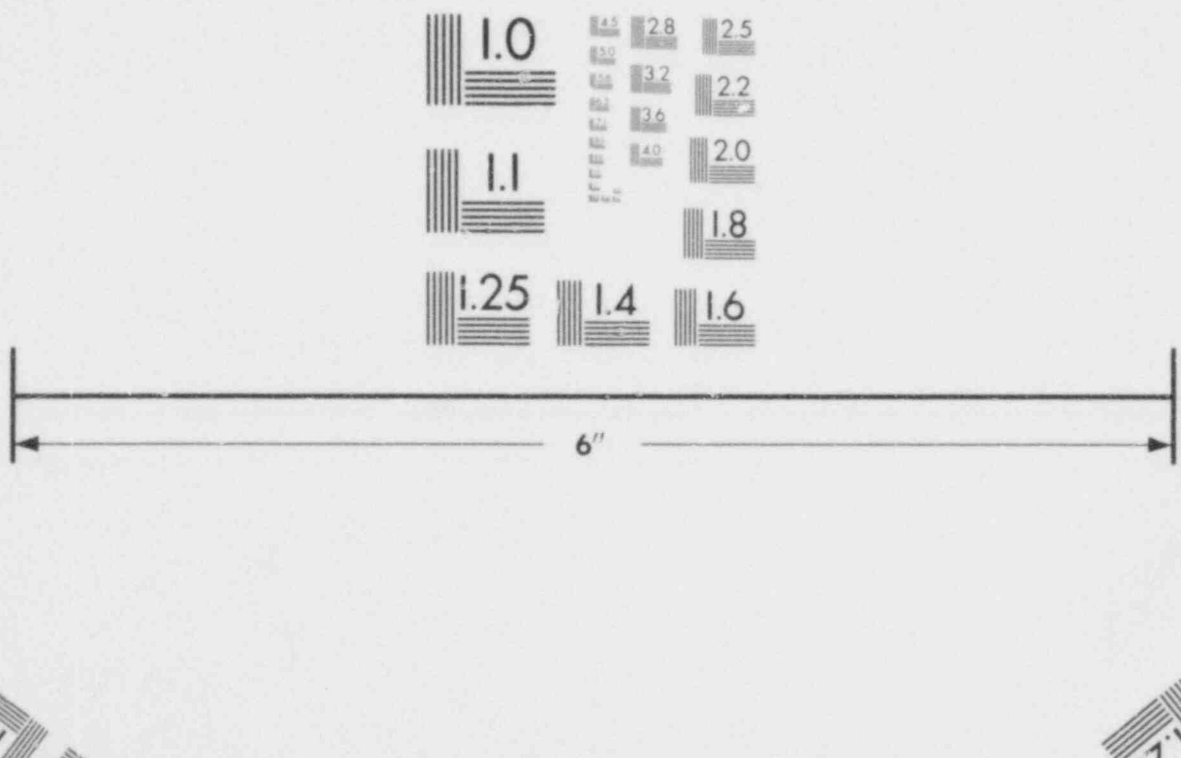

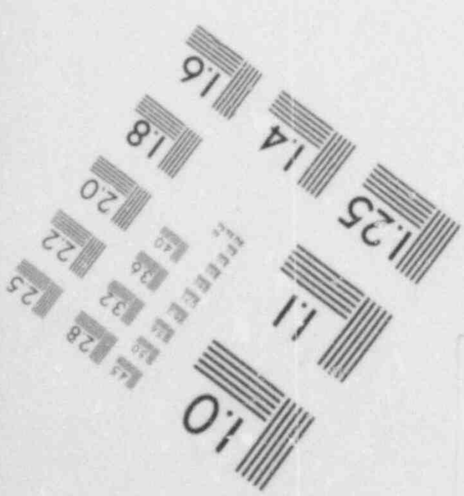

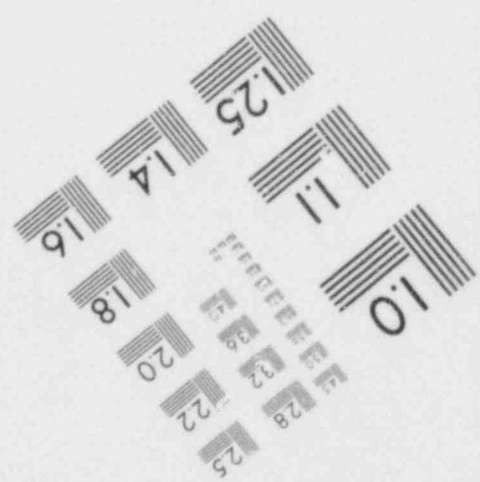

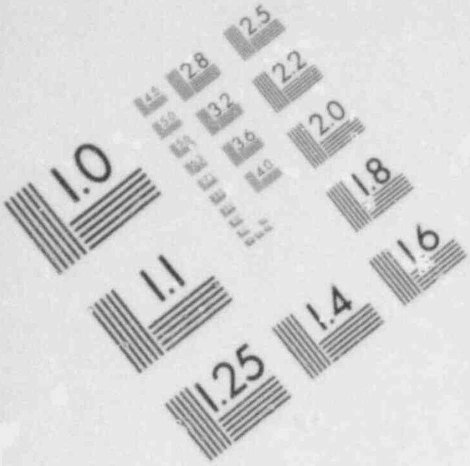

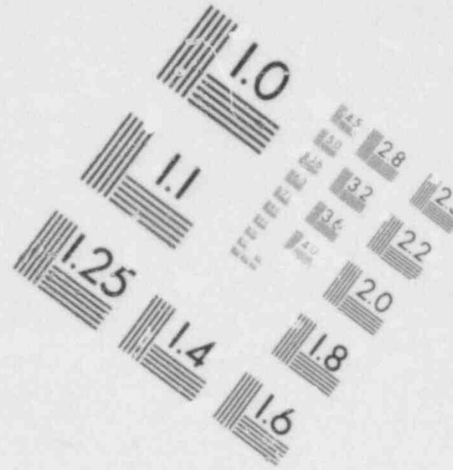

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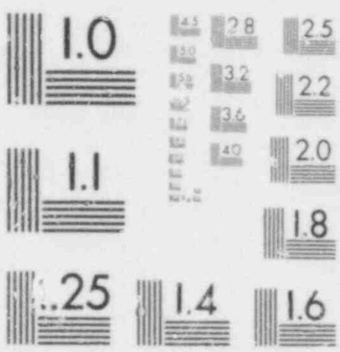

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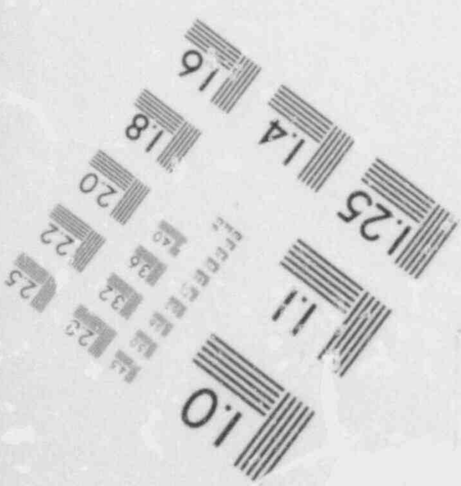

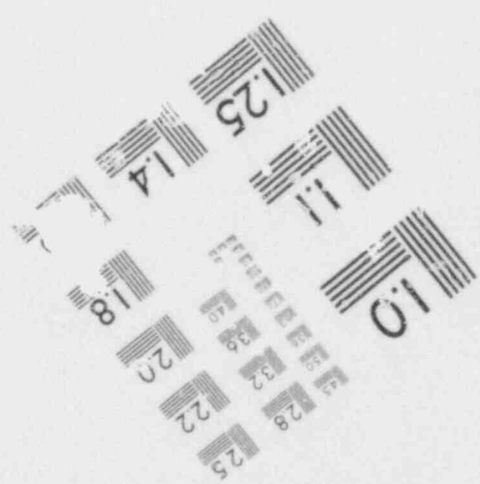

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I sent the LOFT project manager over also to take a look at it. One of the systems engineers at Idaho went with him. They came back and said that the system is very useful, and we could implement it, we believe. We are looking at it.

But they said it is not a great advance in the state of the art at all. We routinely do that in refinery operations in this country.

But the nuclear industry, in terms of control and display and diagnostics, is a generation behind a lot of other industries.

So the key thing -- this was Dick Kauffman. He said not that they made break-throughs, but simply that they did it. You can see it.

My own view is that the utility -- the German utility would never consider such a thing unless they had an example to go to and see how it worked on a test reactor.

That is my thought as well. Until we put it some place and demonstraet it and beat the bugs out of it in our country, it will be very difficult to get some operators to rely on it or even think about that.

My first thought is we would put in pretty much the same system they have at Halden. They have been working on it since about 1971, so they have put a lot of time and thought

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into it, and ironed a lot of bugs out.

MR. ZUDANS: Okay.

MR. GARLID: I would like to ask a brief question.

In your fiscal 1980 supplemental budget, you had categories. Fiscal 1981 you have different categories. How do those two fit together? Are those under the fiscal 1980 mostly under systems engineering?

MR. MURLEY: The fiscal 1980 supplemental -- oh, dear.

MR. GARLID: You have a totally different breakdown.

MR. MURLEY: We did that for a reason. I guess I will have to take the 1980 supplement figures and put them into our budget breakdown, because they are in different budget breakdowns.

I will tell you the problem we had. When we talked with the Licensing Staff we sent them over saying here is our research needs, and here is how we think we ought to be going as a supplemental in fiscal 1980.

They were broken down according to the old budget categories: systems engineering, LOFT, code, so forther. Frankly, the reaction was, this is more of the same old stuff. There is no new thinking here, just you are upgrading SEMISCALE and LOFT. Big deal.

The point is, it completely lost the logic involved. There is a logic. That is why I presented it this way, as a

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logic pattern and not a budget category. But I will do that.

DR. PLESSET: Thank you, Tom.

I guess we can -- yes, Dr. Wu.

PROF. WU: I have a brief question.

In the research I heard about the current work, is it moving towards a direction to develop some of the simplified but basic research on the transient with problems such as flushdown of steamwater or headwater interface, liquid jet into the steam and also a bubble flow and so forth?

Those are made more elementary, but each with a very specific physical understanding. This type of problem seems to be valuable towards a physical understanding of some of the more systems approach programs.

It looks like quite a bit of work has been taken on or carried out by KWU, and I wonder what is the priority in future programs of this type of problem?

MR. MURLEY: We have had for a long time a number of small programs heading towards a basic understanding of phenomena. We needed that for the large LOCA code as well. I don't see much change in those programs.

PROF. WU: Will there be an increased level of activity planned for 1980 and 1981?

MR. MURLEY: We planned on it.

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MR. SERKIZ: Some of those questions you are asking are development and support, where we go after basic phenomena to start the buildings blocks that come up. I will cover some of that.

MR. ZUDANS: I would like to add one more thought. I will forget it otherwise.

Could I give thought to the following idea: We need larger and larger scale test results, really, to be certain about analytical tools and otherwise. How about thinking for the future about instruments on existing facilities or new ones to be bu lt to such an extent that sho certain transients occur, you can collect the data?

There have been several such small LOCAs like TMI, none of which had adequate instrumentation to use the results as test results.

My feeling is there is no better facility than a commercial reactor for doing these tests. Some of the tests could be run on your actual reactors without damage to the plant, to study the response.

MR. MURLEY: That is a good point. I forgot to mention in the analysis of transients item, the $3.1 million we were discussing, we have some plans to analyze the tra .ients that have been run on purpose in reactors, like the Peach Bottom transient.

And we have talked with Roger Matson, and he has in

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mind possibly asking much more of that from the licensing people. And if that is the case, we will specify at least minimum instrumentation so we can analyze the problem.

MR. ZUDANS: You can put in the instruments and sit back and wait. It will happen sooner or later.

PROF. CATTON: That is not a pleasant thought.

DOE does this, by the way. In some of the solar energy installations, they actually instrumented them at government expense. The person with the unit supplies the data to DOE.

I think what you are [illegible]gesting is something similar.

MR. ZUDANS: Exactly.

PROF. CATTON: RSR supplies the instrumentation and the facility feeds back the data when they get it. That would probably be a minimal expense.

MR. MURLEY: Good thought.

DR. PLESSET: We have to go on, Tom. I imagine you concur with our proceeding.

MR. MURLEY: Yes, thank you.

XXXX DR. PLESSET: All right.

PRESENTATION OF AL SERKIZ.

MR. SERKIZ: I recognize that the time has slipped by; and the package I have prepared as handout material gives you considerably more information than I plan on showing on

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the viewgraph machine.

I think it would be worthwhile to set the stage -- is this coming through? I guess it is.

(Slide.)

Let me set the stage in terms of the specific research areas that fall under the cognizance of the separate effects research plan. I will also show you a few slides to try to put the budget picture back in some perspective.

A point was brought up about confusion. This is the supplemental budget focused in certain particular subelements. There is a budget unit called systems engineering which carries both separate effects research programs as well as research support branch, 2D/3D, and so on.

The specific programs I will ad..ess from the budgetary and reprogramming and reevaluation viewpoint will be the SEMISCALE program, which you are familiar with, and I will give you some information and insight into the types of transient simulations that were run on a SEMISCALE facility in support of TMI.

I will take you through the BD and RF heat transfer programs. You are aware of the BD hear transfer program at ORNL, the program at General Electric at San Jose.

We are recommending upgrading this specific facility so it does a better job of simulating the BWR machine.

Next is a new program we have recently entered into, a second program with General Electric and EPRI. This is the Lynn facility looking at the upper plenum spray interactions and countercurrent flow limitations.

The Flecth Seaset program at Westinghouse looks at RF phenomena both in separate effects and in a simulated system.

The question was asked, where do we go for getting information, perhaps on fundamentals and basics? I will speak to these two categories first. Gary Bennett will discuss 2D/3D. When I come back on I will speak to model D.

It is under this that we have basic programs under way at universities such at M.I.T.; and Peter Griffith at R.P.I. under Dick Leahy; John Chen at Lehigh, where we are addressing what is happening locally and how can we better understand it.

These are small programs as opposed to facility; this is an integral facility which gives systems effects. These are facilities which have control boundary conditions where we try to simulate the system by separate effects.

In addition, there is another category we fund called technical support. This particular category has been used in the past and will be used again to address advanced instrumentation and advanced techniques that might be

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applicable to the type of scenario we saw in TMI.

(Slide.)

With respect to the levels of funding being applied to the diffarent categories shown here, this is a breakdown of the fiscal 1979 funding level that is being applied to these five categories.

The SEMISCALE program is roughly a $6 million program; and I will discuss specifically -- I will discuss with you a reoriented SEMISCALE program which is being designed to handle questions that need to be addressed now, and to become basically a PWR system type simulator.

This includes the addition of a secondary loop or secondary loops, because we want to model both an A and B loop, and go into a configuration representative of the correct steam generators, and so on.

The BD and RF heat transfer programs are about a $7 million effort. These will be coming down some, perhaps maintaining a constant level, as we make use of the same facilities to carry out experiments that are relative to the small break type of plant transients natural circulation boil-off, and so on.

I will not speak too much to the ECC bypass. This was discussed over the last three years. our intention is to phase out of small programs.

In model D and technical support, we are looking at

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where will we reorient or direct effort.

In terms of the overall systems engineering decision unit, OMB, separate effects research branch, $17 million, roughly speaking, roughly hal. a total budget unit as administered.

(Slide.)

With the excellent hindsight provided by TMI-2, we are quite busy. We are reviewing all our programs to be sure we address both TMI-2 type lessons learned plus scenarios perhaps that before were thought to be just war games.

We indicated to you last year we are deemphasizing large LOCA research. The intent was to complete large LOCA research and go on to other areas even moreso.

We do plan of utilizing existing facilities or modifying them or upgrading them so we can minimize expenditure of capital funds to come back in and address this question.

There re new research requirements being identified and we are working closely with NRC Staff. We are rethinking our fiscal 1980 effort.

I will show you specific examples later where we are redirecting effort.

We are requesting selective fiscal 1980 and 1981 budget supplements. Two particular categories Tom mentioned

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is upgrade on SEMISCALE and the two-loop test apparatus for BWR research.

The point was made that the PWR and BWR machines are two distinct machines. I agree.

We have now three facilities in the country that can be system simulators: LOFT is a nuclear simulator; the SEMISCALE system, when upgraded; the TLTA system at General Electric at San Jose has this potential.

We don't have facilities that people can turn to to run t is type of scenario, "what if" type scenarios. Both the SEMISCALE and GE facility at San Jose give us that potential.

(Slide.)

With respect to the type of dollars that we are talking about in the fiscal 1980 and 81 budget requirements, this is a display. It is in your packet.

With respect to the SEMISCALE system, the presidential budget Tom referred to was shown at the $6.7 million level. The upgrade on SEMISCALE to put in the secondary system, get once through and U-tube generators, estimated at $3-1/2 million; total requirement, if there was no supplemental in fiscal 1980, of $10.2 million. If we had the 1980 supplement, then the budget requirement in 1981 obviously would come down.

A similar type of budget display can be presented

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for BD and RF hear transfer. There are $3 million identified here. $2 million of this I will tag as required to make the TLTA -- extend it, upgrading it to better represent the BWR internals and BWR system to carry this to an off design, non-LOCA type simulator.

There is $1 million shown that would be devoted to utilizing existing programs such as Flecht Seaset to run natural circulation and boil-off experiments, we well as run some boil-off experiments in the BD hear transfer facility at Oak Ridge.

In fact, they did use bundle 1 at Oak Ridge on the BD heat transfer program in conjunction with the noise diagnostics people upon request from NRC during the TMI incident to see if they could use this noise diagnostics to ascertain whether you went into dry-out. They utilized bundle 1. This was on call.

The results looked like favorable research should be applied there. The results were favorable and people are talking about picking up the instrumentation aspect at noise diagnostics to look at it further.

We are piggy-backing on any and all our facilities for this type of research.

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ECC bypass, you can see is phasing out. Essentially, fiscal '81 we will be done with it. Small scale. Model development is shown here and is shown to actually come down because of the emphasis on utilizing the system codes. Technical support is being redirected primarily to get into instrumentation and diagnostics. With that instrumentation again to address the TMI type questions or supplement current instrumentation in the reactor system.

For example, how do we know the real liquid level in the reactor core?

(Slide.)

Let me just sort of take you back a few months in SEMISCALE and bring you up to whre we stand. Less than a half year ago SEMISCALE was set up in programmatic fashion to conduct UHI experiments. There is the S-06-7 experiment which indicated downcomer voiding and oscilato y behavior, mass depreciation, et cetera.

This mass depletion phenomena has been studied in follow-up experiments and the best we understand from the data, the excessive heat from the downcomer walls led to voiding associated with core back flow and high core steaming rat s.

SEMISCALE is being revised, or the facility is being upgraded with a new type of insulation material.

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It's a honeycomb — evacuated honeycomb type used in the aerospace industry. In effect the results of utilizing that type of insulation will be to negate or prevent future breakdown of thermal insulation. Dr. Tong was out to the SEMISCALE project last year and he was party to some results of thermal conductivity or conductance tests and the new insulation they have has a value of one-tenth of the prior.

In effect the SEMISCALE facility will be modified to insulate it from a mismatch of surface area to volume ratio effects.

As I indicated SEMISCALE was about the only facility we had in the country, or perhaps the world, that we could turn to in support efforts of the TMI incident. Within two days of the TMI incident they were running gas bubble venting experiments. In effect, they were using the SEMISCALE facility as a similarity to see if they could work a bubble out of the system.

In addition, they then utilized the facility to see if there could be a transient similarity of the type -- to simulate the type of transient that TMI experienced.

There has always been a lot of discussion associated with SEMISCALE and atypicality and mismatch and surface area to volume ratios, one dimensionality, et cetera. I would like to show you one curve -- I don't

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propose to go into details -- which is an illstrative curve of what was done with an existing facility to address the question: what happens if the operator does keep his eyes on the pressurized level? Can we use this type of facility?

(Slide.)

Here is an experimental run. There is a time scale consistent with the TMI accident. The pressurizer level was kept. Thre was bleeding from the accumulator.

You can see the core level starting to oscilate, drop, decrease.. If the core level was not monitored or other type of instrumentation not used, the operator would have said he had a full pressurizer level. The test was terminated here on a safety cut-off not to burn off valves. There is a quick report being prepared on a series of these experiments and it's targeted for issuance in early July.

I will be sure that the Committee does get copies of that. It's a very informative report. There was a lot of work done by the project. As a result of this type of experiment, it led us to the conclusion that that facility does warrant an upgrade, a significant upgrade.

I will talk briefly here to the type of upgrades we are proposing for the SEMISCALE facility. That program is currently under redirection to go and carry out the following:

(Slide.)

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We are moving small break testing up. What we are planning to do is run small break testing in the July through August time frame of this nature. We are in a HI configuration.

The upper plenum is a UHI configuration. We will run small break transients that allow a loss-of-primary coolant at a rate equal to or about that of high present injection system below and above.

The primary purpose of this is to get a series of runs that small break codes can be tested against.

We will rerun the SO-67 test with new insulation to establish conclusively, if possible, whether indeed it was a hot wall effect or something else. That will be tucked in here.

Right now the SEMISCALE project is putting together a list of feedwater transients. These are in preliminary stages. I would describe it: you have a turbine trip and then you have the the type of scenario either that TMI had and the SEMISCAKE people are looking at the type of scenario of how might we set up experiments where we deliberately introduce operator effects. The operator does something in the scenario. Since it's not fully thought out, I would rather not comment.

The schedule here would be we would run these in the late fall-early wintertime frame.

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Now at the same time that we are redirecting here, not shown on this slide -- rather than go through a lot of slides, we are in the process of asking those people to start on a preliminary system design and take a look at procurement activities that would be required to, one, upgrade the SEMISCALE facility to have secondary systems.

By this I mean closed loop secondaries, two independent secondaries. In effect go to a 4 by 2 configuration like the BW plant. We want to be able to have the capability with an upgraded SEMISCALE to have two independent secondary loops so we can look at transients of the type you have gas pockets formed, either slash or secondary loop, and have a system dump capability in the secondary loops with the cross. Have something which will allow us to st up in hardware a 4 by 2 BW type configuration. Closed loop secondary.

Right now the SEMISCALE facility as on-line has a scale PWR type steam genertor,but it's a U tube.

There is another U tube steam system generator on order, and this, I think, is slated for delivery somewhere next spring.

Our intention is to have both ones through and U type steam generators to upgrade the primary system to include both a reactor type scale pump on both of the primary loops, to install the internal wall insulation,

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so that we get away from this hot wall effect, and the MOD2 configuration is the one where we have two external downcomers. In effect we are setting up a one-demensional 2 by 4 loop.

MR. EBERSOLE: Will you rig for secondary blowdown?

MR. SERKIZ: Yes, sir.

MR. EBERSOLE: That will cause a discharge of UHI even though there is no break in the primary loop.

MR. SERKIZ: Yes, sir. Let me put a different slide on here and talk from this.

(Slide.)

The schedule, as best the Idaho people can tell us now this is the reason for the preliminary planning stage. I got this material over the weekend sent back to me. We will go into a design phase and experimental planning phase here. We can, with the system as configured and feeding into it steam generators and upgrading the secondary sysem, start conducting the type of experiments that you alluded to here, in that we are configured up basically in a Westinghouse configuration here.

We would start running these type of experiments on a preliminary planning fashion or, let's say, the first round to see the type of effects that are experienced.

What we are doing, I guess the best way I should answer that question: we are working with the people in

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the probabilistic analysis business with the licensing people to develop a set of transients or off-normal operation, so we can early on in upgrading experiments do those which are felt to have the highest probability of the most severe consequences.

We have not worked our way through that. We will have that put together in late summer.

I might stop here, if there are questions on the SEMISCALE before I move off this.

DR. PLESSET: Yes. Let's see if there is any discussion on the SEMISCALE points that you have presented. Ivan?

MR. CATTON: There has been some comment about the natural circulation part of the multidimensional effects in the core, and particularly one of the reasons for coupling COBRA To TRAC is because of the multidimensional characteristics.

Would you care to comment on this?

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MR. SERKIZ: The semi-scale will not be the vehicle to look at these multidimensional effects. The effects you refer to, the Japanese facilities, which have larger core assemblies, a particularly cylindrical core, also a capability to run limited transients and some system type transients.

The people on the 2D/3D project are in the process of thinking through what could be done with those facilities. I guess I would answer the question very cleanly:

We are not able to model on the semi-scale facility those effects, nor do we intend to. We will try to get some information of that type. Perhaps Garry might comment later.

I know we have discussed possibly using the cylindrical test facility in Japan to get that information, or some of that type of information.

DR. PLESSET: That is a bit of a frail support. It is a low pressure facility. It won't stand any pressure. It is a quite limited use altogether.

MR. SERKIZ: If you are looking for high pressure effects -- the question was raised from the multidimensional effects. We can use that facility to get multidimensional effect information. We will not get the pressure effect information out of that.

DR. PLESSET: The question is: How useful will it be toward the questions Catton has raised?

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MR. SERK' : If the question is directed more specifically as to the impact on the code, I am going to let a code man answer that one.

PROF. CATTON: Let me rephrase it. If the 2D/3D effects are important in the small break, and I have been led to believe -- I don't know that I agree they are, but I have been led to believe they are -- of what use is SEMISCALE in the small break? If they are not important, that question sort of goes away.

. While you are there, I would quote out of one of your documents. The Japanese 2000 rug -- I put SEMISCALE and FLECHT in the same arena for many reasons -- by providing additional information.

However, the limited Japanese program will not be sufficient to replace FLECHT in the opinion of both PMG and NRR Staff. What does that mean? How limited is the Japanese test?

MR. SERKIZ: It is a difficult question because you introduced three facilities. Does your question address FLECHT, 2D/3D, or SEMISCALE? On SEMISCALE you can handle multidimensional effects.

DR. PLESSET: It is a one-dimensional --

PROF. CATTON: How important are the multi-dimensional effects?

MR. SERKIZ: In what respect?

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PROF. CATTON: In small breaks.

MR. SERKIZ: Lou, would you care to answer that question?

Garry?

MR. BENNETT: On the large breaks we know it is important. I will defer for the small break analysis.

MR. SHOTKIN: Shotkin of NRC.

I agree with Ivan that there probably are some multidimensional effects in the small break. One of the main effects --

DR. PLESSET: He heard there were. He didn't say so. You think there are.

MR. SHOTKIN: There could be. One of the main effects we want to follow in the small break is how the level goes down in the system during the small break. I think that is primarily one-dimensional. SEMISCALE should give us all the information we need on that.

MR. SERKIZ: In terms of liquid inventory levels and that type of information, I guess the evidence that I would offer is the type of transients that have been run to try to simulate the TMI accident. There has been considerable discussion whether you could even control a one-dimensional atypical system.

Evidently they met with reasonable amounts of success. They feel very confident of being able to use this

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facility, not as a demonstration PWR full scale, but -- I will use the term assimulator, hardware simulator facility where one could test out various scenarios.

Without a secondary system, we can't do it.

PROF. THEOFANOUS: Going back to Lou, has anybody given thought to the differences present in the primary system SEMISCALE from those you might find in a full scale LWR? That is the question crucial to levels and so on.

I would like to raise the question that somebody should look into that.

DR. PLESSET: That is one reason to use at all. The question is how it relates to the full scale, you mean.

PROF. THEOFANOUS: That's right. Its clear differences would be present.

MR. SHOTKIN: Could I answer that question in terms of looking at core uncovery rather than just looking at small breaks? That is what we are interested in. Core uncovery could be due to small breaks or due to a small break in a pipe or valve opening.

In this case, the core uncovery has a presssure effect. It has multidimensional effects. There we want to coordinate all our facilities, including the 2D/3D facilities, that could look at multidimensional effects under core uncovery situations, SEMISCALE which could look at the present effect as the core starts to uncover.

PROF. THEOFANOUS: I agree with you. I asked the question in terms of not only core uncovery, but two-phase distribution within the primary system.

It is interesting to know what is in hot leg and what is the composition or percent of vapor in the inlet to the pressurizer.

When they are different, one would expect different behavior and different feedback from the pressurizer. This kind of question.

If you look at only the core uncovery itself separately, then I --

MR. SHOTKIN: We don't have any one facility where we could look at all effects at the same time. We could look at pressure effects at some facilities, multi-dimensional effects at others. We must try to integrate them using codes and engineering judgment.

DR. PLESSET: Isn't it unfortunate the core test facility was designed the way it was? Before it was built, it might have been made to stand some reasonable pressures. How did it happen that it wouldn't? It is too late now, but I am curious how it happened that way.

MR. SHOTKIN: The scenario the world community has been analyzing for the past several years has been the large break LOCA. The biggest uncertainty was in the reflood portion of that. We understood pretty much the conditions where our uncertainties were. Those were at low pressure.

The system had depressurized and we are wondering how fast the ECC liquid after refill gets up into the core. That is low pressure.

DR. PLESSET: There were other uncertainties. Is there an early quench, for example? What is the effect of the externally-mounted thermocouples, which could be quite significant and might affect the interpretation of the LOFT results unless we have information to the contrary?

There have been a lot of measurements of the effect of little bumps on things like fuel rods having a big impact on cooling. These are other things.

Where will they be studied? The test facility would have been fine if not misdesigned. How come that happened?

Say in a word why.

MR. SHOTKIN: It is a -- it was originally called large scale RF test facility.

DR. PLESSET: We should label it that always in our minds?

MR. SHOTKIN: No. We can try to redirect the program to look at some core uncovery tests that might give us information on multidimensional effects.

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Dr. Tong is over in Germany next week to discuss with the Germans and Japanese how to redirect those facilities. He is taking with him staff ideas on that.

DR. PLESSET: It would be a neat trick, but unless he is a genious, I don't see how he can do it. You didn't tell me how it happened.

Oh, it was a refill facility.

MR. SHOTKIN: Reflood.

DR. PLESSET: You are trying to make it into something different, more than that.

MR. SHOTKIN: That's right.

MR. MC PHERSON: I am Dr. McPherson.

The facility that you are discussing in Japan was designed by the Japanese prior to our entering into discussions with them on the cooperative work.

Nevertheless, yes, it is a reflood experiment. But I did want to say a few things around the question you have been asking.

The LOFT core is 83 percent of the diameter of the cylindrical core test in Japan and consequently constitutes essentially almost the same amount of 3D necessary that that facility does.

However, we are unable to make the detailed measurements that that facility does. The tests we have run to date in LOFT have given us high confidence in our

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understanding of what is going on in the core.

Nevertheless, those which we do have, have been very helpful in supporting our understanding of the thermal hydraulics.

Finally,re surface mounted thermocouples, we have eight different programs ongoing now in support of that question. Some in reactors, some out reactor. That is, using electrical heaters. Even some electrical heaters in reactors.

We believe the entire test series will give us a complete picture of where and when those experimental thermocouples do have an effect. We know they do sometimes. We know they don't sometimes.

We are trying to draw the boundaries.

DR. PLESSET: We need to take a break.

[Recess.]

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DR. PLESSET: All right, let's reconvene.

We were having some discussion regarding SEMISCALE. We weren't quite completed. Mr. Ebersole wanted to comment. Then we will throw it open.

MR. EBERSOLE: In our past world where we thought the large LOCA was the principal and nrly only area of jeopardy to core colling after trip, we put a number of safeguards to help that conditions. The UHI system is one.

Looking at these in their mitigating capabilities to help out, we overlook the accident potential of these systems. Among those is UHI, the capacity to disrupt core cooling capacity.

This was approximately a 30-to-1 ratio of call-ups for needed functions of UHI to inadvertent call-ups; a 30-to-1 probability we would rather not be called up.

The effect is to potentially invite the discharge of nitrogen into the sealed primary loop.

The failure criterion faces problems like vertex formation in the accumulator, difficulties in measuring level, activating valves that must close under dynamic heads.

It is critical to realize in considering the new accident set, to consider the accident potential of the old LOCA mitigating functions, notably UHI itself.

MR. SERKIZ: I accept your points, Dr. Ebersole; and

I will feed that back to the project in their program planning.

We talked about looking more specifically at the noncondensible effects in the small break scenarios. With respect to UHI I heard similar comments from other people. We are all running very rapidly right now to learn as quickly as we can to construct what should be looked at first.

PROF. THEOFANOUS: Is it correct to get the implication from what you say that you look at the upgrading of SEMISCALE as the facility to sort out the systems effects for small breaks?

MR. SERKIZ: We are looking at SEMISCALE as the primary facility besides LOFT in the United States to look at small break effects.

Lew indicated a while ago Dr. Tong will be in Germany talking with the German Federal Republic and the Japanese.

We are looking also at utilizing other facilities like PKL. We have -- PKL does now have a secondary system, a better secondary system in place.

We will be looking at that also to see if those facilities, in a cooperative fashion with the Germans or the Japanese, could not run small break tests or PWR type transients to give us information sooner.

PROF. THEOFANOUS: You don't envision any new facilities starting from scratch?

MR. SERKIZ: Not at the present time.

MR. MICHELSON: Along the same lines that Jesse Ebersole was elucidating on, It is also important to consider the situation wherein largers breaks are changed to smaller breaks, or in some cases changed to no break at all.

Depending on the point in time this occurs you could get interesting core cooling problems. The most obvious case in point is the boiling water reactor, wherein you isolate the pump isolation valves and between the valves you end up at low pressure momentarily with low inventory, but an immediate repressurization without the ability to supply large amounts of water.

There are other cases wherein perhaps the isolation -- the break is downstream of an isolation valve. You go to close it and it doesn't fully close. The large break now changed to a small break.

These kinds of situations don't appear necessarily unrealistic in the real world. Maybe you could indicate for a moment your views for such situations.

MR. SERKIZ: Let me respond to the point you brought up on BWRs, which in themselves give you that potential for this intermix.

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We will carry out this summer in conjunction with the upgrading of the TLTA putting together this type of scenario and seeing what it would take in a facility to have the cpability.

The reason I am not in a position to do other than show you a list on some of these types of transients, saying those are the most important -- there has been a lot of discussion already going on as to what is important.

Also, I would make the point brought up earlier by someone about why don't we run these tests in large plants. Some of our BWRs lately have been running some of these tests for us.

The BWR is a different animal. I look at it as that type of machine and the PWR another one.

We are working with the probabilistics analysis people analyzing these. A lot more of these scenarios are being developed as possibly for real versus the single failure criteria.

MR. MICHELSON: Of course, these can occur with just postulating a single operator action or failure. When you look at the pressurized water reactor, one should not overlook those plants with loop isolation valves. There are a few in the country.

They have this striking potential to change break sizes quickly under circumstances in which the core may not be able to usually recover.

MR. SERKIZ: This is a reason we want to maintain in SEMISCALE two independent secondary loops, so we can have that tyne of simulation capability.

MR. EBERSOLE: Not only do thes have those valves, but have operator instructions to try to stop the leak.

DR. PLESSET: Would you go on to your next part, Al?

MR. SERKIZ: Yes.

(Slide.)

I would like to very quickly take you through these four programs, concentrating primarily, to give you an insight on our thinking, in upgrading the TLTA, and giving you information in general.

When carrying our buget category here, these four programs appear. We have a level of effort at INEL that we utilize their staff towork with us and interact with the contractors.

The reason for this is these three programs are cooperative programs, and they do involve, in the case of the BWR, obviously General Electric; in this case, Westinghouse.

The budget di[illegible]ution that we have for those programs is as follows.

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(Slide.)

The budget distribution in fiscal 1979 is shown here. The reason for these programs coming down lower than Oak Ridge is, recognize the NRC share of the industry cooperative programs ranges somewhere between 38 to 42 percent.

What we are doing here is funding part of the total program cost. That information is in our handouts.

(Slide.)

The program at Oak Ridge terms the PWR blowdown heat transfer program is displayed here. We have concluded the bundle 1 experiments, and we are in the process of installing, within a week as best I can determine from the people at Oak Ridge, we wil have installed bundle 3, which has considerably more internal thermocouple and two phase flow monitoring instrumentation.

I put this up, and I want you to note we are getting out of a large LOCA program. This is slated and is being managed by Oak Ridge to conclude in fiscal 1982. Fiscal 1980 is the year where we will conduct the round-off experiments on bundle 3. The information and experiments are in that package you have.

We utilize fiscal 1981 to analyze the data and essentially close down the facility and issue final reports and analyses in fiscal 1982. As an example, I would show you

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one graph.

(Slide.)

This is bundle 1 that came out of the Oak Ridge facility. That was designed for something like 14 or 15 powered blowdowns. It has undergone 34 blowdowns.

You will note the heater rods, electrical rods are pretty straight. It looks in good shape. On this particular bundle, once we concluded bundle 1 tests, we ran boiler tests. We have a high degree of confidence in Oak Ridge designing and fabricating bundles with his survivability probability.

To show you that the program is in the process of concluding its final round of testing and going out of business -- people will be put on something else.

(Slide.)

With respect to the BWR research conducted in RSR, our programs in terms of experiments are concentrated at two facilities: TLTA which you have seen, the program at Lynn, Massachusetts, I will show you photographs of equipment and facilities up there.

I just want to use one offshoot slide you don't have just to discuss with you what we plan on doing.

(Slide.)

If you recall, the TLTA inception back in 1972 was a single bundle facility. The jet pumps didn't have the

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correct height. It was a simulation facility to model the blowdown phase of a BWR.

Since that time the program hsa been augmented as you see here. It has been a jury rig add-on, et cetera. We have come through a set of experiments that we had in mind for that facility, and the time has been long overdue that the facility should be upgraded so we have a better representation of what that facility should have in hardware for BWR LOCA testing.

(Slide.)

I emphasize this because when you call it a small or intermediate break, it is LOCA testing. I would focus up the TLTA to you this morning two ways. One, we want to upgrade it to conclude our LOCA testing. I will show you a schedule going with this.

We want capability to run blowdown through reflood. We plan on installing three bundles to have parallel bundle effects. We will upgrade the internals to have full height scaling on the jet pumps, a better steam separator, improved bypass and volume distribution and scaling, and also have the capability to run small break tests.

I will show you a slide that I didn't have prepared to include in your package.

(Slide.)

Schematically, what we have here is this snows where

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we intend to be in an upgraded TLTA.

With respect to that same consideration and redirection, what we plan on doing is also looking, and we are looking, at what I term here a TLTA extension. It may not be a TLTA extension. It may be a combination of TLTA and utilizing the Atlas facilities at General Electric at San Jose.

These are BWR transients being looked at in terms of scenarios and events. We should be through that phase by roughly September to see what sort of ..tentions are on TLTA or a combination of Atlas and TLTA.

In Tom's slide we showed supplemental deltas of three or three and a half for SEMISCALE in fiscal 1980, and something on the order of $3 million in a blowdown and reflood heat transfer are back-of-the-envelop type estimates now to go into an extension to look at transients that are off normal operation, but without neutronics feedback. It is on the order of $2 million.

All I can say is we are actively interacting with the NRC Staff. Points of view are being expressed. Maybe we shouldn't do this in small facilities. Maybe we should instead analyze more closely the BWR transients we had already.

I am giving you very current thinkging. We hope to come up with the highest probability associated with these,

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and do an ordering, and we would be in a position to report to you where we stand on that.

In terms of budget cycle requesting supplemental budgets and so on, we feel we need a BWR type facility to start looking at some of these type of transients. What I would like to do is show you a few color slides and some background slides on the West Lynn facility of General Electric.

(Slide.)

In that facility what we are doing is looking at what happens in the upper plenum, the upper core plate tie structure. This is just an overview on that particular facility.

That facility is now in operation, and the NRC contract interactions with both EPRI and GE have been concluded in the past month.

This, for example, is the sector bundle that is being -- sector simulator bundle being utilized in the West Lynn facility.

(Slide.)

I think you are familiar with the assemblies: the handling handles, boxes, channels, so on; full scale raid use, 30-degree sector.

GE is, I believe, scheduled to conclude their BWR-6 type tests at the end of July. That data will be made

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available to us as part of this triparty program. I would guess that would be available to us this fall.

The program that goes with that, I will show you in overlay form.

(Slide.)

This is in your package that I provided you. It is a program that the core spray distribution testing will continue into fiscal 1980; single heated electrical bundle testing at the San Jose. We will continue both -- we come out of here with the BWR-6 testing, and go into BWR-4.

We also have scheduled 360 degree, roughly a third or half scale diameter tests; the analytical support.

Of course, t program now is projecting into a four year cycle beyond fiscal 1979 with this type of funding distribution.

This particular program, the numbers shown here are NRC costs, and are 40 percent of the estimated operating cost. What we have through these cooperative programs is a reduced budget requirements on the NRC.

Perhaps I should stop here on the BWR programs. We have a new one. I can come back with supplemental slides and take questions on the GE programs.

DR. PLESSET: Let's do that. Maybe there will be no questions.

MR. SERKIZ: We could get back on schedule.

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DR. PLESSET: Hopefully.

MR. SERKIZ: Okay.

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Let me just give you a brief overview on another triparty program on Flecht Seaset.

(Slide.)

This is the program at Westinghouse, Pittsburgh, indicated earlier. We are looking at bundle separate effects, steam generator separate effects, upper plenum, ultimately tying these components and separate effects type of experiments into a system effects test.

We have both the 161 rod bundle and 21 rod bundle. We run both flow blockage and without flow blockage. The schedule that goes with it -- perhaps this would be the point to concentrate the discussion on or talk from.

(Slide.)

Our unblocked bundle tests are nearly concluded. I think August, the 161 rod unblocked bundle test will be concluded. We are putting together a 21 rod bundle for flow blockage tests. We would run those tests on 161 rod bundle.

Steam generator separate effects tests, that will be concluded in the same time frame, early fall. We have an upper plenum where the upper plenum is a scaled upper plenum that has the type of geometry representative of a PWR.

The upper plenum geometry, steam generator and bundles will be coupled into a system effects type of system

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that would be run out in this time frame.

The level of funding associated with this program is as shown here. Again the cost to NRC is 42 percent.

PROF. CATTON: I have seen Flecht, TLTA, SEMISCALE and the reflood tests. I am having trouble trying to figure out where they fit into the big picture, and what the contribution of each is.

I get the 'eeling in looking at what you are presenting -- for example under Flecht, systems effects test, scaled 2-loop PWR utilizing components and so forth, what is being done at these other facilities that couldn't all be done at SEMISCALE, for example? Why do you have to have the Flecht system as well as the SEMISCALE?

Can some of the TLTA -- could they, for example, be folded into SEMISCALE? Could the Oak Ridge program be folded into SEMISCALE? Would this yeild a more efficient system or more effective use of the dollars?

MR. SERKIZ: Many questions. Let me try to come back through them.

First, SEMISCALE is an integral systems facility that allows you to go from high pressure to low pressure through a LOCA transient. It has its current limitations: perhaps not noticeable being the core region dimensionality effects and limited bundle representation, for lack of a better term.

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With respect to the Oak Ridge program, as I indicated on the earlier slide, that is essential concluded over the next several years.

Bundle 3 was put there so we could get LOCA information so we could determine two phase flow mixture distribution during these transients and in effect conclude the type of data base that was needed to come up with the heat transfer correlations and put that question to bed.

It is a highly instrumented bundle. We are not concentrating on time CHF. That was beat to death the last few years. That is a PWR type bundle; TLTA is a BWR type bundle.

Can I fold SEMISCALE and TLTA into one? No. BWR and PWR are different animals. I have two facilities. One I alr[illegible] have on line, principally designed to be a PWR. I hav[illegible] BWR facility which I am saying needs upgrading so we have a parallel channel effect, the correct height scaling on jet pumps, more representative geometry, et cetera.

In terms of cost effectiveness to the government, the cooperative program cost the government out of a total of some 38 percent.

If I tried to cram everything into one facility, I start driving myself to something I recall trying to defend here a year ago called a multipurpose test facility. I am trying to deal with facilities on line with minimum cost

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investment to investigate the two principal type reactors.

The Flecht Seaset program was designed prior to TMI to handle reflood, handle -- primarily look at flow blockage effects. This was the reason for the 21 rod bundle.

This was done in close coordination with the NRR people. We wanted to look at local flow blockage effects. If you are modeling the thermal hydraulics, these bundles are instrumented.

It is a program built upon a building block of separate effects, and taking the same equipment available in the program and tying it together into a low pressure system effects facility.

I can give you an example. We already used, for example -- we got some data -- I will come back to this slide for discussion purposes.

(Slide.)

We have, for example, just move testing around, and we have run steam cooling tests, and preliminary analysis shows better cooling than the current model.

Loren, did you tell me 50 percent enhancement?

MR. THOMPSON: Yes.

MR. SERKIZ: We have a high temperature capability. I stress this point with Flecht Seaset. I am jumping between facilities here. We have different facilities and are trying

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to do the most in each.

Flecht Seaset has a testing capability of up to 2300 degrees Fahrenheit. To test reflood conditions — this is even more important when you look at perhaps starved flow or boil-off, where you are looking for data in a region where fuel clad damage can start occurring.

We have simulated fuel pin designed or bundles with a testing capability up to 2300 degrees Fahrenheit.

A question came up, why can't we do this in other facilities? Different facilities cover different aspects. What we are doing here is trying to do the most with existing facilities, include our LOCA related research, certainly concentrating more on the small LOCA than the large LOCA, but certainly conclude those program particular aspects, and then redirect programs either in as is condition -- in other words, use the facility or something else, like we could potentially use the Oak Ridge bundle for boil-off and natural circulation tests in the bundle.

Okay? We haven't thought that far. We haven't planned that. I think it would clutter up this type of meeting to give you four examples and get into that type of discussion.

Let me stop and go back to the question.

MR. MURLEY: Are you close to the end? We are way behind.

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MR. SERKIZ: I would like to. I don't know if I answered your question. These facilities have their own capabilities as they stand.

PROF. CATTON: I guess a better answer would have been a single viewgraph showing the flow of information from the facilities to your goal.

I will have to read the transcript. I got lost in what you were saying. It was too much too fast.

I want to ask one more thing. We had a report a year ago about views on the blowdown heat transfer, and what was felt to be needed to be done in that area.

Paul didn't feel much more needed to be done. There were concerns about electrical heating. I see continued use of facilities with electric heating and expansion of facilities with electric heating.

Just a single comment on that will end it.

MR. SERKIZ: If the question is being raised in terms of can an electrical heater simulate the thermal hydraulic boundary conditions or simulate the fuel bundle, all of these electrical heaters have been designed keeping that in mind.

PROF. CATTON: I have not seen that. There were questions raised about things like gap conductance and the lack of it, particular having to do with reflood.

MR. SERKIZ: With respect to reflood?

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PROF. CATTON: In particular with respect to reflood, quenching.

MR. SERKIZ: In the TLTA upgrade this is a key design question. It will be factored into the heater design plus the programming of power to the heater to try to get the simulation.

PROF. CATTON: I understood there was a study in this area going on.

MR. SERKIZ: If you can give me a specific, I can try to answer the question. I would draw your attention to the las three Oak Ridge quarterlies and several topicals. I would be happy to send them to you.

On the bundle 3, considerable care was given to avoid perturbances of thermocouple installation, programming of the heater power, et cetera.

DR. PLESSET: Let me comment about now upgrading TLTA, which might have been concluded from Ivan's remark.

He didn't mean it, I am sure. Outside NRC there is a lot of comment about the disproportionate amount of money going into BWR problems as compared to PWR problems. I don't know if you heard this.

MR. SERKIZ: I heard it expressed different ways, yes.

(Laughter.)

DR. PLESSET: But the idea is that. You are aware

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of this sentiment?

MR. SERKIZ: Yes, I am. I will be very candid with the group here. We are looking very strongly at what research, particular non-LOCA rm(mizkh,((ho)ll(e address in a BWR transient.

I don't have a clean answer for you. One of the slides is the type of thing we are looking at. The NRR views. Obviously there are vendor views.

In a cooperative program we have the benefit of interacting with the vendor and NRR and our own staff.

MR. EBERSOLE: I would call out at this time in the spirit of trying to make this integral and cover those gaps that will embarrass us later that if we look at the whole picture here and look at the accident sets you spoke about and the various regimes and cooling problems, there is one distinct gap.

We are considering the ractivity control problem in the ATWS program; this is anticipated transient without scram.

I will say there is a blank spot in our consideration in looking at unanticipated transients without scram, notably with respect to the BWR. When we get some kind of flood loss in the PWR, wo reflood with highly borated water, and in the interval we are voiding we have the reactivity problem at hand.

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A BWR refloods with cool, clean water. Therefore, it is an absolute requirements that the rods get in a BWR type reactor before starting the reflood process. There is no mechanism which will jeopardize insertion of those rods, one postulates, but there are.

Noticeable among them is the stubborn aspects of the designers to continue to put the drive control insert and exhaust tubes in direct line of the muzzle of the blast from LOCAs inside the dry well.

This brings an interface problem up wherein one must argue whether or not you are going to get the rods in, having suffered damage in the rats nest of tubes immediately adjacent to LOCA effects.

I am not sure but what there isn't a mechanism which will preclude getting some of the rods in, if not many, for the reason that you closed or damaged this tube set.

I won't go into detail beyond that, but it was dismissed so far by superficial handwaving type arguments which don't hold today.

MR. SERKIZ: Let me make one comment on one of your early comments, the nuclear feedback effects which are very prevalent in the BWR.

I accept your point about looking more closely at the BWR ATWS situation. This is unanticipated. LOCA is — the point I was trying to make is one of the significant

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points of disagreement now, is should we invest in a further extension of a facility to study these type of transients where we would have extreme difficulty modeling these nuclear feedback effects with electrically heated bundles?

MR. EBERSOLE: I am thinking about it more crudely. Can you asses without going that far to the point of acknowledging or dismissing the potential for intercepting rod insertion in BWR?

MR. SERKIZ: I don't know; but I will bring that point back to the people I deal with.

MR. EBERSOLE: Okay.

PROF. CATTON: I would like to finish up the comment about electrical rods.

There has been some special work comparing Flecht heater rods with those filled with simulated fuel. There are differences between the two. The repeated use of Flecht gives you highly oxidized pins, which changes some of the reflood characteristics.

Where is all this leading us to? What meaning do the Flecht results have? How much more of that data should we collect? I will leave it at that.

DR. PLESSET: I think I would make one last comment before you go on to the next topic. We are running behind. I want to emphasize Jessie Ebersole's point, which is really a hydromechanical question.

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MR. SERKIZ: I will feed that back to people like Warren Minners and the people at GE.

DR. PLESSET: This is important. It was discussed at several reviews of BWR plants, this kind of question.

MR. SERKIZ: I will bring the message back.

I would like to take a break for myself and let Gary Bennett present the 2D/3D program, and then we can see how the time situation is.

I will cover model D and the technical support. Perhaps covering the model D, since there was interest raised here, it might be appropriate to go through it.

DR. PLESSET: To help us, we might leave out the discussion of small scale ECC bypass. Just ask Tom to assign a priority to it.

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MR. BENNETT: The next part of the presentation is a discussion of the refill and reflood program.

In the interest of time I thought I could mention I intend to skip over a number of the viewgraphs in the handout.

(Slide.)

The 2D/3D program is an interational cooperative program with the Japanese and Federal Republic of Germany. It was set up to cover such phenomena as steam binding which might occur in a pressurized water reaction given a LOCA, flow distribution effects within the core, flow hydrodynamics both in the downcomer and upper plenum, and we are now looking into questions such as core uncover and national circulation.

I would like ot briefly describe the facilities involved in the 2D/3D program.

(Slide.)

In Germany we have the PKL facility. This is not formally a part of the 2D/3D program. However, because we have been testing out instrumentation, we are getting a lot of information out of it. That is a full height facility with 3-loop capability.

Now the facility which is being built in Germany as part of the formal 2D/3D agreement is the upper plenum test facility which is a full-scale vessel and will be a

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a full-scale markup of the upper plenum 360 degrees with the downcomer. In Japan we have the cylindrical test facility which is 2000 electrical rods, full height core, with a system effects -- it has four loops. Also in Japan we have the slab core test facility. 2000 rods. Full height. The interesting thing is that it's full radius. A full radial slice. The U.S. contribution includes development of advanced instrumentation for these facilities and analytical work at Los Alamos using TRAC.

Through the program we hope to be able to develop information and understanding modeling large breaks, small breaks, natural circulation and core uncover. Also indicated ECC penetration, steam binding and flow blockage.

(Slide.)

The accomplishment so far in fiscal year 1979 includes completion of construction of the cylindrical core test facility in Japan and a number of shakedown tests have already been run on the cylindrical test facility.

The preliminary design of the slab core test facility had been completed. We hope to have that operational in early 1981.

The air water loop tests in Idaho have been completed on the instruments which they are provided. We have already completed installation of a number of the

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instruments in the cylindrical core test facility and PKL. TRAC calculations have been run on PWs as part of the program and to identify test facility design.

(Slide.)

Dr. Plesset mentined in the opening the effect of the different programs on licensing. I indicated on this viewgraph some of the effects we think the 3D program will address the steam binding effect and its influence on temperature.

Downcover behavior and effectiveness of different ECC systems. We intend to look at small breaks and natural circulation discussed in the various facilities. Because these are larger scale than what we have felt within some areas, this will help us in the computer code checkout and extrapolation to a full sized pressurized water reactor.

(Slide.)

We have been looking into what we can do to address questions which have come out of TMI. Dr. Tong is going to be in Germany the end of the month-long with Mr. Farmer, program manager, to discuss with the Germans and Japanese how we might appropriately move the direction of these programs to address other concerns such as small break tests, natural circulation tests, block bundle tests and core uncover tests.

We are working on this now to explore how we can incorporate this into the existing schedule and get additional information at a larger scale.

(Slide.)

The budget is broken out here. I have in the handout additional information on the work scope of the principal laboratories. The good news is our budget is going down in 1981. The 1980 budget currentlyunder Congressional review is $15.8 million. In 1981 it goes down to $12 million. We are not involved in the 1980 supplemental for the 2D/3D program. The labs developed, Idaho is developing pieces for facilities. Oak Ridge is developing advanced instrumentation to get thickness measurements, and so forth. Los Alamos is providing the analytical support to tie the various facilities together and eventually scale them to large-size plants.

In addition they are providing stereo lenses, basically periscopes, for looking at these fields. We have a number of support groups helping us who are involved in preparation of specs and general technical support.

So the program peaks in 1980. The budget currently being considered by Congress starts down beginning in 1981.

I think from the schedule charts which you have you can see the technical reason for it.

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(Slide.)

Most of the activity starts in this period. Because a large part of our instrumentation has to be delivered in 1979-1980 periond, that is when we expect our peak funding, and then we will start ramping down. A lot of the instrumentation will be in place.

As we move out to 1982 to 1984, it will be preliminarily analytical support on the part of the U.S.

The cylindrical core test facility is currently undergoing shakedown tests and the slab core will undergo shakedown tests in 1981. This indicates the need the labs have for providing support to the Japanese program.

(Slide.)

Similarly, you can see the German program. PKL is not formally a part of the 2D/3D program.

However we are using it to test out our instrumentation. We are getting information from PKL.

The principal German facility here. Here is our schedule. Most of the instrumentation we need to be delivered in 1981.

Now the handout has work scopes for Idaho and Oak Ridge and Los Alamos. I have viewgraphs on those. if you want to discuss them.

But that in a very brief nutshell is the 2D/3D program, and I am happy to report that we are on schedule.

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The Japanese and Germans are on schedule. The U.S. program is on schedule.

DR. PLESSET: Thanks very much. That is on schedule. We aren't. Let's have brief questions on the program.

MR. CATTON: Could you refer me to a document somewhere that would give the details of these various programs? What do you expect to get out of the Japanese program, what measurements and runs will be made?

Then you can avoid using up the time of the Subcommittee.

MR. BENNETT: We have several documents. We have a paper presented in Japan by Dr. Soo which describes instrumentation. We have a baseline document. I can get you copies of those.

MR. CATTON: I am particularly interested in the physical processes we will know about after the test is run.

MR. BENNETT: We will send you copies.

DR. PLESSET: Let me make one comment here. There has been a lot of emphasis put on instrumentation which will be adapted to operating light water reactors, particularly as a result of TMI-2. You have a large instrumentation development program in addition to the instruments we think of right off, level indicators and b

maybe improved pressure temperature instruments, and instrumentation to follow the course of an accident.

Now could your program make contributions as to those problems? I am speaking now of things we can put into present type reactors, as well as new ones.

So there is a special requirement here that is quite different from the instruments you had developed for a research program. These things have to have life, requirements and reliability requirements. Quite different from research instruments. It would be very helpful in this large program if some work could be done in that area.

MR. BENNETT: We do think that there will be some spin-off both from this program and others that will be helpful.

DR. PLESSET: I want more than spin-off. I want a real hard effort. In some sense I would be less interested in some of the instruments you developed for this program than I am in the instruments that might come out of it for LWRs in the near future.

MR. BENNETT: Dr. Sc talks to various people about the possibility of using some of these instruments. One question is always: can we get the utilities to use some of the things tht come out of these programs?

DR. PLESSET: There are other ways of getting the

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utilities to use them, if they are really good instruments.

DR. SOO: About instrumentation, we do have -- up to now the ones we are having are for the research type. I would point out --

DR. PLESSET: We aren't criticizing.

DR. SOO: We fully appreciate that point. Research type is not always applicable to the power plant. But there are some external ones that we used, unobtrusive ones, that could be applied. We are going through very detailed reviews and we have submitted a memo to Dr. Tong on our recommendations.

In Idaho they have a so-called commercial plan allication and that is second run. In July when we have all instrumentatopms going through the third total review, we will have another halfday review on which instrumentation could be applied for the power plant and which condition. We are going through this review.

Among all the ones we have, there are quite a few externally applied, such as gamma beam and so forth, we can apply to the power plant too.

MR. EBERSOLE: Consider the specific differences between the B&W design and Westinghouse. I think we will find we will be able to reobtain solid liquid systems on B&W type design, because of the efficiency of the venting process.

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On the other hand, we won't find that capability on the inverted U tube steam generators and may well be approaching an admission after violent arguments about it, that we may have to face permanent loss of natural circulation on these types of steam generators.

All is not lost if that is so, if we can cool by evaporative reflux condensation in the steam generators.

Do you have such a program accommodating the use of borated water in that process?

MR. BENNETT: As a matter of fact, we have been talking about the possibility of the reflux boiler.

Dr. Tong has been talking about it in-house. We plan to discuss it with the Germans and Japanese.

MR. EBERSOLE: I didn't see it.

MR. BENNETT: I skipped over that quickly.

MR. SULLIVAN: Gar, could you draw a scenario between the FLECHT-SET program and this 3D program in terms of the REFLOOD? We see lot of similar type of work being done for both.

MR. BENNETT: The question there is more one of scale. The 3D program allows us to look at additional multidimensional effects. FLECHT allows us to focus on intrabundle effects. Both are important.

We need to address both. The programs will be complementary. The people running them are down the hall

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from each other.

Westinghouse has been involved in reviewing the direction we are going in the 3D program. I think the two compliment each other in terms of scale.

MR. CATTON: What kind of effects do you expect to see in the Japanese tests?

MR. BENNETT: It have been postulated you may have flow going one direction vertically and down elsewhere. Chimney effect. Oh, you are talking about recirculation?

MR. CATTON: No. I asked a question.

MR. BENNETT: You are talking about the original scope with the REFLOD.

MR. CATTON: What kind of 3-dimensional effects do you expect to see?

MR. BENNETT: There may be cross flow. There may be a chimney effect. Flows going up in one location of the core and coming down somewhere else.

MR. CATTON: Water up, water down. Recirculation of the water below the quench rod, is that what you are saying?

MR. BENNETT: It may be.

MR. CATTON: Is that what the chimney effect is?

MR. BENNETT: No. You have a flow one way and another potential flow pattern elsewhere. Or you could have flow, you know --

MR. CATTON: Would recirculation below the

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quench -- I thought you meant the water would geyser up in the middle and there would be steam on both sides of it. That is not what you mean?

MR. BENNETT: No. Stan, you look like you were about to say something.

MR. FAB: Stan Fabic. The way I understand chimney effect --

DR. PLESSET: The mike isn't on.

MR. FAB: Okay. We may have a situation where we are generating a lot of steam in the central part where we have higher peaking factors and may be getting water coming down from the upper plenum around the periphery.

So you have a fall back around the periphery. We have steam going up in the hot channels. That is one form of chimney effect. And we have observed even in one-dimensional test facilities situations where flow is coming from above while the steam is coming from below in the same channel above the quench rod.

DR. PLESSET: Any other comment? It is a big program and I would think you might have some opinions with regard to -- yes?

MR. ZUDANS: I like to come back to the question Ivan asked before. I had a chance to think about it. Does RSR have some summary sheet that shows all the information that you looking to obtain from different programs and then indicating from which of your facilities such information is expected to come?

In other words, an overview picture. We have been asking the questions all the time. We don't quite know what they expect to get from one precisely. There could be duplication. That was a good question.

I would like to see such information on a large sheet or maybe two sheets.

DR. PLESSET: You might get a papyrus role.

[Laughter.]

PROF. CATTON: I would even buy three, but three inches of paper is a bit too much.

MR. BENNETT: Over the years we have put together different charts.

For example, there is one which Dr. Tong shows quite often which shows scale and different phenomena plotted against it.

MR. ZUDANS: That would put us back in shape to understand what we are talking about.

DR. PLESSET: Thank you.

Al, we are back to you.

MR. BENNETT: One thing I might mention. Since we are not covering technical support, I asked Andy Bates to pass out the research support branch of the technical support activity and that will be coming around for you to look at.

DR. PLESSET: Fine.

MR. SERKIZ: What I would like to do is quickly go through two categories.

[Slide.]

One called Model D.. That was primarily because the question was raised where do we address basic phenomena. I will give you examples. We have a funding subcategory in separate effects research branch we call Model D.

In those particular programs we do have research going on at universities and at some national labs using people that have developed an expertise and are acknowledged to have good credentials.

We use their data to develop basic correlations or basic models.

[Slide.]

The programs we currently have underway in fiscal 1979 -- these we had for several years-- I think many of the

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persons sitting around the table are familiar with them -- we have at ANL transient heat transfer modeling. Under ?ob Hendry and some of his personnel.

At Brookhaven we have Owen Jones and his people looking at nonequilibrium phase change.

We utilize a variety of staff at INEL to work in developing and benchmarking the heat transfer correlations and verification.

John Chen at Lehigh, looking at nonequilibrium heat transfer.

Peter Griffith working with us in reflood thermal hydraulics.

Prof. Bancroft at Northwest University looking at condensation phenomena to come up with right models to model condensation rates.

Dick Haley doing LWR safety research as a category we carry.

Channel instabilities. Basic research on two-phase flow.

We have Dr. Lee at Stony Brook University in Long Island looking at droplet entrainment between what would be fuel rod type assemblies.

We had work going on at the University of Washington to come up an understanding of two-phase flow regimes.

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The point I would make here, what we are doing here is many of these studies have been basic studies that have concentrated on the large LOCA.

All these programs are currently being discussed with the principal versus an NR staff and others to see where we can redirect the level of expertise and thinking into non-large LOCA.

[Slide.]

Some examples of this, of the specific activities that are carried out.

At MIT under Peter Griffith, he more recently is looking at natural circulation between hot and cold regions in a bundle using 2 x 6 rod sections. Studying how liquid moves between them.

He looked at steam generator modeling during reflood, using a 4U tube steam generator. Studying flow regimes as a function of air and liquid velocities.

He did lots of work in gravity feed reflood oscillations.

[Slide.]

Dick Haley at RPI has been working on these areas. Two-phase flow instrumentation looking at void fraction, distribution within budnles, phase separation and distribution, parallel channel effects.

He completed a loop and is testing to look at steam

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binding in BWR type fuel assembly geometries. Has a parametric test series planned.

[Slide.]

At Lehigh we have John Chen. John looked at direct measurement in nonequality. Improved correlations of post-CHF heat transfer. Worked on development of film probes for measurement of liquid film thickness.

Dr. Lee at Stoneybrook has been studying droplet flow, work tied in with the 2D/3D tie plate geometry. Looking at effect of grid spacers on low and blockages on droplet distributions.

[Slide.]

Hendry at ANL is coming up with a best estimate model for transient CHF. Their report is scheduled the end of this fiscal year.

Also coming up with subchannel analysis for a two fluid model of transient two-phase flow.

Prof. Bancroft at Northwest University is doing parametric studies looking at condensation in horizontal and vertical steam water flow type geometries.

Also getting into looking at plenum pool hold-up experiments. He would like to do work with holography to be able to discern the nature and distribution of two-phase flow type regimes.

The point I am making here is we utilize these types of personnel that have the qualifications to look at the fundamentals.

Our intent would be to continue utilizing them, but perhaps redirecting them to look at problems more clearly identified now than they might have been several years ago.

We have another category called technical support.

[Slide.]

This again derives exactly from that, it provided technical support to other programs. Some of the advanced instrumentation, the film probes being used, for example, in the 2D/3D program three years ago were looked at under small effort in different places under technical support.

In that way they also assisted the model D work.

The people we have working in those areas, or labs we have working there are in the handout I provided.

[Slide.]

We have, for example, at ORNL always maintained an advance two-phase instrumentation effort. We utilized under technical support, support on other programs, staff at ANL are able to utilize libraries, et cetera, in heat transfer studies and coordination.

We carry under technical support the INEL data bank where we keep a central repository on test data from SEMISCALE, LOFT, all of the programs ultimately are designed to put the

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data in a data bank here.

At Oak Ridge they have a measured data repository keyed specifically to the blowdown heat transfer program. These two are interrelated.

Sandia has worked about a year and a half and will in another year conclude their work on a pulsed neutron generator which is a tool in conjunction with the ANL work, Paul Keeler at Argonne on two-phase flow tracers will be able to come up with a system where we can pulse a two-phase flow mixture and use it for calibration of instrumentation.

I believe the plans are to have it available for the LOFT instrumentation in about a year.

For example, Sandia, this particular program has met its goals of coming up with being able to deliver the required pulsing level and the frequency. This next fiscal year, fiscal 1980, will have several units put together, one of which would go out to the LOFT project. Our intent is to maintain about the same level of effort in technical support and in Model D.

[Slide.]

Some examples which are in the handout, I will simply key on them. You can read them at your convenience.

I mentioned earlier we have the development of pulsed neutron generators at S· dia. We met our goals in May. We are expecting delivery of the units for use by people with two-phase flow facilities in June of 1980.

I would like to give you an insight into our thinking as to where we would redirect some effort in these areas.

[Slide.]

These particular slides are intended to convey that message. Currently ANL has been looking at transition and film boiling, heat transfer, oscillations on reflood. We feel there is a need to reorient some of this activity to pull together a data base for natural convection and natural circulation heat transfer with steam and in two-phase flow mixtures.

Jones and his people have been looking at flashing vapor nonequilibrium at Brookhaven. We are talking with them to look more closely ato solubility of noncondensibles and discharge break flows with noncondensibles in them.

We are interacting actively with these people. Our target is by the end of August to have developed a reoriented program at about that level of effort.

The reason we say at about that level of effort, we are drawing on fixed people, numbers of people, and simply asking them to apply their expertise to other areas.

The INEL heat transfer, correlations and assessment, we plan on using them to put together research information letter on rewetting, work on core uncovery models,

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we would postpone the post-CHF work.

The data bank is in a preliminary state.

Can we use the in-place equipment to look at setting up a direct data link between NRC and power plants? We are looking at that. We are in a very preliminary phase there. I have run through those rather quickly.

Our current level of effort, as I indicated early on in the slide -- let me come back to those areas.

[Slide.]

I would anticipate we would have to maintain a level of effort on this order over the next two-three years.

Questions?

MR. EBERSOLE: One question:

In this small break category, we are in search of heat sinks primarily to cope with the problem. The heat sinks are two in conext: the break itself and transfer to the secondary side.

Are we in need of additional knowledge about the mass volume and energy transport characteristics of orifices such as broken down relief valves or a better understanding about the relationship between mass, volume, and Btu transport through these orifices?

Furthermore, are we in need of new knowledge on the performance of boilers under reduced pressure with much smaller transfer surfaces than they would normally have?

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MR. SERKIZ: With respect to your first two questions, that is a need for more or better information on the flow characteristics or capability to predict them through relief valves, the answer is yes.

Owen Jones, for example, has been doing work on nonequilibrium flow in converging,diverging sections.

Owen was in about a month ago and we specifically said, okay, you are coming up with promising results on being able to model that. What if you extended that work to the type of geometries representative through the internal zone relief valves?

This, to me, represents a natural extension of something that is already underway. Not primarily from the viewpoint to go out and test valves, but to utilize Jones and his people where they are meeting with success in being able to tie nonequilibrium two-phase flow models with the data they are getting -- a simple experiment of converging and diverging nozzles.

The information has been coming out in quarterlies. Look at what the internals of a relief valve look like. How can we design simple analytical approaches and simple models to get that uncertainty down?

Yes, we need more information there. With respect to experiments for that type of relief valve, that's another ball game.

You can always test these valves and so on and go back to a topsy-turvy world arguing is this the way to approach it?

With respect to the PWRs, I don't know if people are looking at that specific question that closely. I would take that message back.

PROF. CATTON: In redirecting particularly the university programs, are you having any problem with the sole sourcing of that work? Or do you have to go for bid?

MR. SERKIZ: It is our intent wherever possible to go out on competitive bid. The mandates have been laid on us from a variety of sectors. I don't feel that the universities are at all inhibited or prohibited from competing competitively.

Our plans are to, within this next calendar year, to focus up our research needs in terms of the model D or the fundamentals and go out on RFP for it.

DR. PLESSET: How would you evaluate Professor A from Professor B?

[Laughter.]

This is an interesting point.

MR. SERKIZ: It would be based on credentials and the program he submits.

[Laughter.]

MR. ZUDANS: All of your current programs really go to people, not to institutions.

DR. PLESSET: There is a legal problem he is concerned with. In getting these contracts placed.

MR. SERKIZ: I think if we have a work scope that is well defined and we know what our end objectives are, there are maybe three elements one considers:

One certainly are the personnel proposed, which are an important factor.

The second is what comes along with it in some cases on available facility and support.

The third being demonstration of some sort on being able to meet your commitments.

I think that is a fairly straightforward --

DR. PLESSET: That might limit you to people with whom you have already been working and would make it more difficult for new blood to get into it.

MR. SERKIZ: No, because the RFP would be an open RFP.

DR. PLESSET: How would you get a demonstration of being able to meet commitments that are required if you had no previous experience with that university?

MR. SERKIZ: What normally happens with offerers that are bidding is they provide examples of performance on related programs. That is one way. That is a factor that can be used.

We are not trying to limit new blood. We are encouraging new blood by that process, and new thinking.

DR. PLESSET: I see your difficulty and hear the words.

PROF. THEOFANOUS: I see abrupt changes here in direction of many of those programs, and wonder whether you can tell us the implication. Either you were doing things before that weren't valuable and, therefore, you quit them; or you feel that you have to go with the fashion of the times.

Tell us more about this. What is the implication?

MR. SERKIZ: The implication is the obvious one that was hammered around here as well as discussions related to TMI. All of a sudden we are that much smarter because it happened.

The redirection is twofold, or multifold. In many instances here the personnel we have been utilizing have come in and said we shouldn't be working on this, but we should be working here.

PROF. THEOFANOUS: What happens to the other things they were working on?

MR. SERIKIZ: We are concluding --

PROF. THEOFANOUS: So they weren't needed in the first place.

I am concerned because obviously if there was a program in place, a lot of thought went into that. Let me take an example here.

The nonequilibrium change studies. I know these people have been working on improvement of the probes and parametric studies for a number of years. Investment went into that. I am sure you must have given a lot of thought to investing this money.

Suddenly I wonder what happens to this.

MR. SERKIZ: It is not turned off.

PROF. THEOFANOUS: That is what it says.

MR. SERKIZ: It was scheduled for completion this fiscal year, mid to three-quarters through the next fiscal year. We want Owen and his people to conclude that work and report on it. He has both model D work in it as well as the Carson with the experimental data.

We want that concluded and reported. That is a two and a half to three year effort. He was running into a natural conclusion in fiscal 1980, anyway.

PROF. THEOFANOUS: I haven't seen results yet. It is hard to believe they will conclude without results.

MR. SERKIZ: I will send you the quarterly reports.

PROF. THEOFANOUS: I receive them, but haven't seen any results from that yet. Up until a few months ago they were developing the optical probe.

MR. SOO: The first batch came out.

MR. SERKIZ: I will send you the last two

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quarterly reports.

PROF. THEOFANOUS: I have them. Thank you. I have the reports already.

PROF. CATTON: I hope a topical is coming out on that.

MR. SOO: Yes, it is.

MR. SERKIZ: A topical will come out covering its own program.

PROF. CATTON: The quarterly reports were a bit terse.

MR. SERKIZ: Some contractors write terse reports and others write verbose reports.

PROF. CATTON: Some write none.

MR. SERKIZ: Yes, and I don't care to discuss that here.

[Laughter.]

DR. PLESSET: Thank you all. You helped us get through this. We do have another topic which I think everybody would appreciate a very brief presentation.

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MR. MC PHERSON: I am Don McPherson.

I wanted to answer a question raised earlier about the application of instrumentation to commercial plants.

We did have such a meeting last week. We called together representatives of all five vendors at EPRI together with asking EPRI to invite utilities so that we might discuss the possible implication of instrumentation we have developed in the LOFT program and other programs related to ECCS work at INEL.

During that meeting we asked the vendors and utilities to discuss those instruments which they had heard about during a week colloquium on instrumentation which they felt might be useful to their operations and off-normal operations.

If I may summarize the response was generally somewhat pessimistic from my point of view. The vendors tended to find a number of reasons why it would not be very useful to put any of our instruments into their plants principally because of the life testing that would be necessary for these instruments.

In fact, the LOFT instrumentation meets pretty well the same specifications in most cases as commercial plants do.

Consequently, there really is not any significant problem there. Following the meeting we had a more optimistic reply which I guess is typical of such meetings where utilities and vendors are asked to speak openly and, in fact, there was a suggestion that they would be interested in seeing some of our instruments on their plants.

We suggested that we might be able to offer such instruments to fund the application of those instruments to their plants for checking out the usefulness of them.

I just mention that in passing. I found that especially interesting and pleasant. Okay?

[Slide:]

I will move right along in this presentation because I do want to get to your interest, namely where the funding in 1981 will be applied and especially related to small breaks and off-normal transients.

Very briefly, the achievements to date:

We have completed our power range testing. We issued a research information letter on all non-nuclear tests done in the L-1 series.

We performed the first two nuclear loss-of-coolant experiments in the large break series, one in December and one in May.

On May 31, we performed an isothermal small break loss-of-coolant experiment with the object of providing sufficient data for us to plan small break test series.

This data was locked up and is due to be released tomorrow. The purpose of locking it up was to terminate prediction of that test as a significantly urgent test by our RELAP and TRAC codes.

We are pulling out the central fuel assembly for replacement in preparation for upcoming experiments.

[Slide.]

This is a good time to break in between the past and future by telling you about new focus that we have arrived at through discussions with the regulatory arm of NRC, together with utilities and vendors.

The focus now is going towards that of studying system response to off-normal conditions, to natural perturbations such as opening and closing of relief valves or injection -- high pressure injection, for example. And the response to operator intervention such as purposely closing high pressure injection system, for example.

Another area of this focus is small break and transient codes in specific areas as opposed to the entire codes where I think the general feeling expressed here earlier was that our small break and transient codes aren't that bad.

However, in certain areas where we get the system filled with steam or a mixture of steam and noncondensible gases, there certainly are questions about how good our codes are.

It is those specific areas which we leave it to licensing, our own code people, to point out where we intend to address the focus of our experiments.

We will also study means of recovering from uncontrolled situations, from small breaks whose flows may be larger or smaller than the HPSI flow, for example, and where we might arrive at a quasi-steady state condition where the two flows are equal.

As a byproduct of this new focus, we see the following:

Assessment of conventional process instrumentation. We have already begun this work wherein we separate the information the operators learn from conventional process instruments in the LOFT reactor while it is having accident simulation and compare that with the special instrumentation which is much more in depth and gives us much more information.

Another byproduct is that this approach will provide us data for code assessment through the standard problem program. The standard problem has been put under LOFT funding responsibility and we are now more closely related to the standard problem and will be ensuring, I think, in this manner that the data we produce will be used more effectively in evaluation of an assessment of various codes.

Assurance and understanding to the regulatory staff,

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to the technical community and by participation of media personnel.

This will get to the public, we believe.

As a side comment, there is nothing quite so convincing as to sit in the LOFT control room or visitors' room and observe an experiment going on and see how the predictions compare with the measurements in real time.

[Slide.]

This is a messy slide, but I only want to use it as a demonstration that we are considering changing the LOFT nuclear program. The column on the left indicates our current program.

Theo, you will note we have not left out any tests in the program being considered, but we have rearranged them. Specifically those diagonal lines indicate that we are bringing small breaks up to the near future. We are not doing this lately.

We are studying the situation very carefully to ensure we can get meaningful data, that it will be useful for licensing, that we will be able to make the measurements we feel are necessary for our code assessment.

Inserted on the right-hand column you will see some L-6 tests. That is the series intended to study transients. We have always intended to study them. They hadn't been inserted in the current schedule because we knew we could insert them

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between major tests. That is the only reason they are not on the left column.

They were always supposed to be there. You will see we have those L-6 tests interspersed with the large black dots beside them. We have also added additional small break tests, the L-0001, for example, and the other is down the column with plus signs beside them indicate additional small breaks.

Fiscal years are indicated and you will see it simply tried to indicate to you we have rearranged the test series.

[Slide.]

Here is what we expect to achieve in 1980. Three small break loss-of-coolant experiments. That would be this here.

We perform a large break loss-of-coolant experiment, probably the L-25 experiment. The same as the past experiment, but with loss of offsite power. We would begin natural circulation testing and we would issue research information letters on the L-2-2 and L-2-3 and small break experiments.

The work on that is half completed now. We expect to have it out September or October.

[Slide.]

Achievements in 1980. This is what we would achieve with the current budget we are discussing.

We would complete the power ascension series, the L-2 series we have been doing up until now.

We would continue natural circulation testing, begin off-normal transient testing, and issue research information letters on the entire large break loss-of-coolant experiment series.

[Slide.]

I know you are not especially interested in knowing about how every dollar is spent in LOFT and I will very briefly run over that with the object of showing you the kinds of things the money goes into, and then address my 1981 budget in terms of the current level of spending to show you incrementals where we go up or down.

This list simply shows you the breakdown that we are using in our 189s on the LOFT program in 1980 and 1981.

I had this drawn up at INEL. We could have one program for 300 K at Hanford, so for a complete picture for the 1981 budget, you should add $300,000 to get $44.3 million in the right-hand column.

The following viewgraphs simply give breakdowns of each of these 189s.

[Slide.]

The program is shown here. Let me point out one line on this viewgraph, namely electrical nuclear heater rod comparison. The question was raised earlier. We have had this going on for one year now.

The object is to study all the data we have from electrical rods and nuclear rods, including the codes which are used to relate the two, and come up with this conclusion as to how valid the electrical rods are in simulating nuclear heaters and under what conditions.

Obviously under some conditions are better than under others.

Steady state, forced convection, obviously they will not be that much different, but transients during blowdown reflood, we expect differences and have seen differences.

A large part of this program running around $300,000 is in support of the IFA-511 experiment at Halden.

We are doing analysis on that test to support the work going on. It is a test in which we run electrical and nuclear heaters under the same conditions in the reactor and compare the results.

We will use the measured nuclear results to predict how we would operate the electrical rod if we wanted it to simulate what we saw the nuclear do and run the electrical under those conditions, and see how it matched up.

Possibly out of this task we will have some conclusions as to improved designs of electrical heaters or possibly some conclusions that under certain conditions one simply can't simulate nuclear heaters with electricals.

PROF. CATTON: Do you have any results on this study yet?

MR. MC PHERSON: Our report is due out in two months. There will be the report of the survey of all the electrical heater/nuclear heater comparisons that we have had done, and will include the codes which are used -- a critique on the code used to compare the two.

It will also list the programs underway, the intended way in which the results from those different programs will be used to come to some conclusions.

DR. PLESSET: I want to make a remark. Every minute you speak now takes a minute away from Fabic. I am sorry, that is the way it is.

PROF. CATTON: Would you see I get a copy of that report?

MR. MC PHERSON: Yes.

DR. PLESSET: Maybe you can accelerate a bit.

MR. MC PHERSON: I will simply suggest you leaf through the next six pages, because each of them is a breakdown of the various 189s and is intended to give you a view of the kind of work which each 189 includes.

Very briefly, the test reactors typically require about 20 million a year to operate without any analysis, without any fuel.

If you add those extra things we do in LOFT together on top of the $20 million, it comes out to a reasonable number. That is about all we can really address here.

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Let's try to look at increments.

(Slide.)

The 1978 budget, President's budget, was $40 million. On the second column from the left I am going down the intended President's budget. On the right-hand I am trying to give --

DR. PLESSET: President's intended budget.

(Laughter.)

MR. MC PHERSON: Our intention for the President's budget.

(Laughter.)

MR. MC PHERSON: So we compare 40 with 40 here. Obviously the President's budget was 40. We spent 40.

In 1979 the President's budget was 39.1, including the DOE funds. I am trying to give you the whole picture as opposed to a split.

We were required to purchase a portion of a special spares inventory out of the 1979 budget, leaving us with a relative budget this year of 73.2.

Let me go into the special spares a bit more. The total special spares inventory, which is different from normal spares, came to $3.7 million. It had been intended that the total special spares budget for LOFT be $5.7 million.

Out of the 1980 budget we have to complete the purchase of the special spares which are already in

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existence, and we have to increase the special spares inventory to bring it up to the full requirement.

In addition, in going over to NRC full support of LOFT in 1979 — through 1979 and now 1980, we have been required to go on a budget authority acccounting system as opposed to an oglibational budget accounting system, which means when you place an order you have to have as much money as is required to fulfill that order, whether you get the equipment or services this year or three years from now.

We have been required by DOE, who runds the program for us, to go on that system.

Now we can't do it this year with the 1980 budget. We had to go partially that way with $2 million assigned here. You will see later in 1981 we have an additional $3 million which gets us on to the BA budget.

If you consider that total of $5.8 million as an increment over what we have been funding subtracted from the 42.9, you end up with a relative budget for comparison of 37.1.

Now the 1980 budget has a supplemental that was referred to. And we included in the LOFT case hardware changes to accelerate small break and transient tests: the kind of thing there is lower the pump seal.

We also have instrumentation to commercial plants. I already alluded to that. That is an additional $2 million.

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If you subtract the 2 — and 5.8 from the 44.9, you have our relative budget of 39.1.

(Slide.)

We have our minimum and current budgets. We have a requested budget and supplemental budget. So I had to show these three different budgets from left to right in the right-hand column in terms of what would be accomplished.

I laid out in the left column the plans which I addressed in my second viewgraph. Then according to which of the budgets we are given, we would accomplish varying numbers of experiments.

So you can see with a minimum — and current, which we are combinnit in the LOFT case — we would accomplish, one, off normal transient; two, large breaks, which would complete the large break series.

One, off normal transient. The additional funds of $4 million would give us one additional test off normal transient, small break; and the supplemental would give us another small break.

(Slide.)

With that in mind, we go on to the 1981, and the same method I addressed the 1980 budget. The minimum and current request is shown at the top. The new responsibilities over what we are doing now would complete the change over to

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the budget authority accounting system. $2 million was in the 1980 budget; $3 million in the 1981 budget.

Now we have new facilities operations to take over. We have hot shops and hot cells which are being constructed and are going to be put into operation. We must fund the operation of them. We have not until now done that.

There is a two phase calibration facility which will have the capacity of calibrating our instruments, flow instruments up to the full -- essentially the full flows in full size pipes.

There is no such facility in existence that we know of in the world, and we badly need that facility. It is scheduled to be finished this spring, so we will be operating that facility then with 1981 money.

So that is the minimum. If you subtract that, you get $39 million. That is in 1981 dollars. This compares with the earlier numbers of, say, 37.1, without supplemental in 1980.

The requested budget has the additional $4 million over and above the new responsibilities in the minimum current. That is the top list. These are to increase special turn-around time by 25 percent.

That means doing one more test. Initiate instrument application to commercial plants in the event we don't get the supplement in 1980; and initiate operational

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fault diagnostics. That is the diagnostic computer work discussed earlier.

The flat $4 million added together with the $5.3 million, subtracted from the 48.3 gives us a relative budget of 39.

Finally the supplemental budget for 1981 would have an additional $1 million, and with that $1 million over and above what I already describe for the current level, we would have two TMI-2 related experiments, small off normal transient and small break.

We would continue the instrument application to commercial plants we will have begun in 1980 if we get the supplemental budget, and continue the operation of fault diagnostic work begun in 1980 if we get the supplemental.

That is the whole story. I am pleased to answer questions now.

DR. PLESSET: I think we will have to have a very brief discussion because of time, but we will definitely stop at 12:30.

You mentioned this instrumentation. I want to be sure my point was clear. I was not thinking of adapting instrumentation developed in the research program 2D/3D necessarily at all. I was thinking of a fresh approach to the instrumentation needs as had been expressed by ACRS and others from a new point of view, not taking an offshoot or spin-off or anything like that.

I was thinking only of what you were discussing, but using some of the funds in the 2D/3D program -- that's a large instrumentation program.

Now I think Mr. Ebersole has a comment in this general direction that he passed to Dr. Catton. He had to leave.

PROF. CATTON: Jessie indicated that he had not heard any mention of use of audio type detection devices, not like the second. It seems you could use various microphones; and pattern recognition is a very cheap type of instrumentation as ignoring it.

MR. MICHELSON: Yes and no. When I first came on LOFT I attempted to have a loose parts monitor installed, and for a variety of reasons it was not approved and is not on.

I have raised the question again. We anticipate -- we are discussing that now. We may put on a loose parts monitoring system.

In addition, we have just sent out a directive to augment our instruments in such a manner that we would have a subcooling temperature device which should be in operation on our next experiment.

So while we are going through our small break we would have the operators able to have this degree.

MR. BENNETT: In total programs, the diagnostic

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program. we have a loose parts monitoring system, and we aer looking into that.

PROF. CATTON: I wasn't referring just to loose parts. For example, recognition of the onset of boiling with an accoustic monitor.

MR. MC PHERSON: One of my programs is that of monitoring the noise on the neutron detectors. We have been looking at that data and have a man actively involved in it.

That is one area that comes under your --

PROF. CATTON: It is not visible in your program.

MR. MC PHERSON: I am sorry. My program is so extensive. I would like to speak for three days on it, but half an hour is all I had.

MR. LIPINSKI: Westinghouse had done work on accoustic monitoring several years back, their own in-house work. There are reports on those subjects.

PROF. CATTON: I don't see it as any part of the NRC instrumentation development program.

MR. MC PHERSON: We have some within the LOFT program.

PROF. CATTON: What about within the 3D program or some of the programs under Dr. Soo?

MR. SOO: We don't have ongoing, but we do plan to do more in that area. We do plan to look into that more. At current, we have not used that, mainly because when we use

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two phase, accoustics are always a problem.

We did look into Westinghouse. There is a problem involved in that.

MR. ZUDANS: I have a very simple question.

You flashed a slide showing considerations in reshuffling the nuclear development program. There was another piece of program discussed before, improved risk assessment, which will study differences in areas and event trees.

How flexible is your considered program to include some cracks they may find in the other program?

MR. MC PHERSON: As flexible as has been indicated. Strong efforts to change it in the past two months. There is -thing set in concrete. As long as we have the support of the community, ACRS, NRC, NRR, we are able to alter that program to the degree LOFT is capable of responding to questions.

PROF. WU: As a follow-up, I fully support this accounstic device. Perhaps in the piping flow, I am happy to hear from Dr. S.o that we have this direction.

I wonder if it might also be extended to the siting of the flow noise for the transient and the two phase type of situation. It can be very useful.

PROF. CATTON: And fairly cheap, which I think the commercial people will like.

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MR. SOO: We do plan to recommend that be put right by the safety valve and use that to tell whether we have flow or not.

MR. MC PHERSON: We are already learning a great deal about noise kind of information. Preliminary indications are that our ion chambers and self-powered neutron detectors do see the two phase flow down the downcomer and lot of level in the core.

MR. SHUMWAY: You are shifting to simulating the TMI type transients. One of the most difficult items to calculate on that transient is the water level as it comes down off the top of the core, the froth level, and uncover the core, and the heat transfer coefficients above this froth front which may be in the range of one or two English units. And RELAP now has a minimum of 5; but that can be changed, of course.

You have a short core in LOFT and the instrumentation has been arranged for the large breaks. What is being doing to eliminate these problems?

MR. MC PHERSON: We find our instrumentation is adequate to tell us when we hav a loss of level, decreased level over our instruments.

The clad thermocouples and the coolant thermocouples which are scattered through the core as well actually certainly indicate -- and our liquid level detector

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certainly give us a strong indication of where the water is, what condition it is in, what quality it has.

DR. PLESSET: Thank you.

We will recess for lunch now until 1:30.

(Whereupon, at 12:30 p.m. the meeting was recessed to reconvene at 1:30 p.m. this same day.)

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AFTERNOON SESSION [1:30 p.m.]

DR. PLESSET: I think we can go back into active session.

For this afternoon, Dr. Fabic will lead the discussion for the analysis development branch.

MR. FABIC: Mr. Chairman, I have two handouts. It is clear I have far too much material than I can present in any reasonable length of time.

I thought you may appreciate using it at your leisure later. I don't intend to cover it all.

In fact, I will play it by ear and after the first couple of viewgraphs I will ask you which ones you want to see.

DR. PLESSET: We will try not to have too many interruptions. At each segment of your talk, if you could stop, we could have questions then. That will make it more efficient, I think.

MR. FABIC: I am Stan Fabic, branch chief of Analysis Development, Reactor Safety Research Division.

[Slide.]

I thought it might be useful to very briefly go through the perspective that made us go the way we have been going for the last few years.

In 1972 we had RELAP available at Idaho. There was an advanced code developed at that time. In 1974 a fairly significant event happened. The American Physical Society

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study was conducted which recommended more physically based codes be developed. That prompted RES to take another view at code development and we decided to keep fixing up the code we had and develop advanced codes that do indeed have better physical bases.

The advanced code development was divided into two parts: detailed advanced codes and fast-running advanced codes.

We started off with development of the THOR code at Brookhaven as the fast-running code. Later on RELAP-5 came along.

In 1978 we had three candidates for fast-running. In December NRC management decided to develop the fast-running track at LASL.

INEL was going to take care o[illegible]rsation to BWR issues.

In March 1979 the first detailed version of TRAC, TRAC-P1A, was released to the public. In the same month we had the TMI-2 accident. The only consequence as f[illegible] as our present plans are concerned would be to accelerate the fast-running TRAC development that we already had in the plants.

What we are now hoping for is tha[illegible] the end of this calendar year there will be a first version of a fast-running TRAC applicable to PWR available.

By that I mean much faster running than RELAP, yet advanced.

[Slide.]

Now we have perceived unhappiness from various sources with number crunchers. Why do you have these large complex codes to look at phenomena like small breaks, TMI, so on.

I am saying that complex codes are unwieldy for extensive mapping of great variety of postulated accidents. Equipment malfunctions, operator actions, and so on.

Here I have two suggested courses of action which are in addition to the current plans to do all I just described a while ago. There are two possibilities.

Maybe we ought to do one or both. One is to take a good look at hybrid. We have been doing that very recently. It does look very feasible to have a good physically based code, one-dimensional, with nonequilibrium thermal hydraulics, plus noncondensible gas, with neutron kinetics thrown together.

In computational space they are faster than real time. So the operator can do a great number of studies in a very short time, s op the calculation in the middle, change the parameters, see what would the future course be if something happened.

Operator action, for example, or malfunction.

Now, the way we have scoped it out is that if you have, for example, 100 computational cells and each has five field equations to be solved and so on, all the necessary equations are presented by electronic circuits and can all be on a card.

So one card per cell, including the function generators for equational state. Each cell has its own. But that hardware has to be built. It would take four years maybe to build it. One year to prove everything works fine within the acceptable errors.

Then it would take a number of years to build the hardware. Dedicated hardware. That is a drawback.

On the other hand, this is really what NRC needs in the long run.

MR. LIPINSKI: Are you aware of the U.S. Army program to develop an advanced type computer? This goes back four years ago when we were developing the transient code for the Clinch River reactor.

They sent invitations to all government agencies to see if they wanted to participate in the program. Their plan at that time was to have three machines developed in parallel, Electronics Associates, Applied Dynamics and a company called Dentell Corp. in Denver. They were different because they proposed to develop special digital equipment to replace the conventional analog and solid state type equipment.

I think it was ERDA or AEC at that time, but the lead engineer I dealt with attended one of these meetings and recommended that -- we will call it DOE now -- not participate in the program. They wanted a contribution of $200,000 from the agency to become a full participating member.

I don't know that anybody ever contacted NRC to see if they had interest at that time. They had a three-year program. I don't know where it stands because I have not maintained any contact with these people.

MR. FABIC: I think this is useful information. We also had some experience -- Idaho had some experience with Trunk Associates a few years ago in the LOFT project, but I think they went around about it in a different way than we would do.

The hardware is developing at such a hard pace that three years ago the hardware is prehistoric compared to what you have today in the way of combining the effectiveness of digital circuits to switch and direct the flow of information between the elements.

The electronic speed of analog hardware, where you can solve all these equations simultaneously without numerical problems, without instability, with their own function generators, without switching back and forth to -- that is the way it used to be done. Not any more.

There is a great potential there on tap and it could be used.

MR. LIPINSKI: A fourth machine we looked at was ILIAC-4. 64 parallel digital processors. Except you have to write your own programs to fit that particular machine. That is another possibility.

That gives you the ability to solve equations in parallel at high speeds.

MR. ZUDANS: Additional comment. I am sure you are familiar with microprocessors and parallel processing. Computations are done --

MR. FABIC: We have done it faster.

MR. ZUDANS: The microprocessors now with circuits or digital --

MR. FABIC: They are digital processors. I talk about that on this side. Thank you. I will look into this. In parallel, we are looking at the visibility of developing very fast digital routines. I am not even talking codes. Routines. With intelligent shortcuts. Possibly in-house development using microprocessors.

I have an example here. I will leave a copy with you. I have done in my own spare time, I developed a natural circulation routine that solves the damaged core BW natural plant circulation in less than two seconds.

That may not be the most intelligent way to go about it, but this --

DR. PLESSET: Let me ask, would any one of the consultants like a copy? It is fairly thick.

All right. May we make copies?

MR. FABIC: Of course.

DR. PLESSET: Thank you.

MR. FABIC: That is the other part that we are now looking into of possibly doing something in-house where we can go to a lot of analysis in a simplified way, taking shortcuts where we think they are defensible, and looking at the type of accident phenomena that hasn't been looked at before.

Certainly in the case of small break or some of the non-LOCA transients, you can do a lot of things to simplify the analysis. We are aware of those and can take account of them.

[Slide.]

Now I have a lot of material that I could present.

[Slide.]

I am sure you don't want to hear it all. I would like to leave it to your discretion. If you can tell me which particular topic in this list would you like me to concentrate on.

Here, for example, I will be giving you a list of codes that have been completed. We are always being accused about plans and never achievements. We have done something. I can show you what we have done. I can show you what we are developing.

I don't think you are interested in where the bills will come.

I also have two viewgraphs that show which codes we have now in hand to address which generic issues, including TMI, and which codes will have, when we finish our business, to do the same job. That is this part.

Then I have on a few viewgraphs where we are applying these codes. Quite a few viewgraphs on code assessment. This may not be the time to go through it, but I can show you a copy on that.

One viewgraph on statistical studies, conclusion of some studies that was finished.

One viewgraph on budgets. Perhaps I ought to start with budgets because it is very short.

DR. PLESSET: I am sure we will see that, anyway.

MR. FABIC: After hearing the LOFT budget, this may come as a shock to you. This is small change.

[Slide.]

Okay, I broke it down into the following two categories:

Code development and code assessment and applications. I am showing here the SBB levels. Level 1 is the minimum level. The red line shows the supplementary FY '80 budget we asked for.

Here you see three levels and so on. You can see here the systems code development is going down at a fairly fast pace and will end up hopefully in 1984 with just maintenance activity.

The component codes are quite low, anyway. They will end up at just about the maintenance activity with one code we want to keep maintaining where we are learning about the start of two-phase flow -- we will do the best we can just to keep abreast.

DR. PLESSET: How do you justify your request for the supplement? Briefly.

MR. FABIC: Okay. The primary -- this one here?

DR. PLESSET: Yes.

MR. FABIC: Okay. The primary -- there are two categories. One is acceleration of the fast-running -- acceleration of development of the fast-running codes. That is a sizeable part. And then application of codes to analysis that just aren't being done. The thing someone ought to do with codes we have as well as codes that will be finished at the end of this year, we think we can use these advanced codes to look at the operating reactors, the issues that haven't been looked at yet.

swes

I think the code that we will have at the end of the year will be quite fast-running.

We can do quite a few analyses. We should spend the money in doing these analyses. These are the two main topics.

DR. PLESSET: Thank you.

MR. FABIC: Now I also -- yes, what we had to do in the fiscal 1980 budget is consider the case we have no supplement. How would we reorient current priorities because of TMI?

What we decided in that case is to take quite a lot of funds from the code assessment, independent assessment, and put it on accelerating development of fast-running codes.

What I also wanted to do with the supplement is to remove that -- I think we should strongly continue the code assessment program. We are learning a great deal from that activity. We shouldn't delay and push it aside.

Now the bottom part, you will see again various levels. The code assessment program is gaining in magnitude. It will reach some kind of plateau during 1981 to '83 and then we hope in 1985 we will not only have assessed codes, but we would have done a sufficient number of statistical studies to arrive at what we call marginal safety evaluation.

How safe are we with respect to some EM or Appendix K type criteria, for example?

That, I could talk in terms of a large break. Now we are emphasizing other kinds of accidents and we don't even know what -- well, having done this part, I wonder whether I ought to give you -- you will find that codes keep changing names all the time. So I will give you a new nomenclature after I show you this generic viewgraph which shows what codes exist today to address what phenomena.

[Slide.]

First column shows EM, licensing code. Best estimate and advanced best estimate.

Across the row you see headings large and intermediate break LOCA, PWR, BWR. Small break LOCA, the same. Steam line break only PWR. Anticipated transient without scram, both types of reactors. Other transients -- by that I mean none of those -- others that don't fall into this category.

There are quite a few. All right.

The EM codes that we -- green means we are finishing end of this calendar year. Black means it is available. It can be used already.

BWR we can address some -- do some EM calculation. Not yet verification. That will take time. But they are available.

IRT is a code that Brookhaven has bee improving for NRR and it has been designed to look at no LOCA, mild transients. It can do two-phase two but homogenous equilibrium without moment'um equation.

It can't do natural circulation. No phase separation so you can't look at small breaks, either.

ar12

RELAP-3B has been in existence in Brookhaven for some time for ATWS calculations. Both.

Again other transients, IRT is a possibility. Best estimate, we have RELAP-4 MOD6 in operation for some time. MOD7 coming downstream at the end of the year. We may or may not be able to do some LOCA calculation with BWR with that [illegible].

Small breaks, we think we will be able to do with MOD7 a variety of small breaks.

Steam line break, IRT, RELAP-4 MOD6.

RETRAN is a code developed for EPRI and we are getting it now under license from EPRI and will make it available at Brookhaven and Idaho. This code can be used for natural circulation studies in addition to some other codes.

Advanced codes, we have issued to public TRAC-P1A. That is a detailed code, slow running. And the fast version of TRAC we hope to have the end of this calendar year. I call it TRAC-PF1. P for PWR. F for fast.

RAMONA is a code we imported from Norway. Fairly advanced thermal hydraulics. Fast-running. Three-dimensional -- you can select -- neturon kinetics coupled. What we are doing with that code is making it applicable to U.S. PWR plants. It is possible -- I put a question mark because we don't have it yet, to put critical flow routine there so we can

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even do small breaks for BWRs using that code.

The purpose of this graph is to show we don't have many holes as to the capability of doing analysis. I am not claiming we have the best and most economical analysis, no. But we have the analyses technique.

MR. ZUDANS: Can any of these codes handle the entire primary and secondary system?

MR. FABIC: These are all systems codes. I think in the end we will have a different picture. Let me show you the new nomenclature we are trying to get familiar with, ourselves.

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(Slide.)

This shows something about the time we expect these versions. You see now there is a generic PWR and BWR version of TRAC. P stands for PWR. Each is now divided into detailed,((low running, 3-dimensional and fast running code. The black stands for the time when the code will be available at the contractor for NRC use but not released to public. Released to public is red. That is shown in red here.

So the end of this calendar year we expect tht the next detailed version of the PWR code called TRAC P D2 will be available to public and the first fast version will be available for NRC use.

The last code in this category is P D3. Known later on as B D3. That code will have not only thermohydraulics but also neutron kinetics coupled with 3-dimensional neutron kinetics.

If you really want to spend time with benchmarck classifications, you can with that version. The fast running versions PF2, that is the end of the fast running version line. Okay?

That will have the kinetics feedback. The first version will not have that. This one will have neutron kinetics one-dimensional feedback as well.

You cannot justify small LOCA but also anticipated

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transient without scram.

Now in the BWR sector here we are showing some detailed code availability, our best guess is today, and on the fast running version you will see the name Levy in brackets next to the code name. This is based on some discussions we had internally.

If Levy and his associates were involved extensively in helping out, we could meet those deadlines. What do we mean by fast running PWR code?

(Slide.)

That is the thing we have today. Maybe somebody would like to comment. Theis a geometrical representation. Not one-dimensional. It can be made so by choice of the user. But the plena, for example, will be one-dimensional.

The core, you could have 2-dimensional. You could use concentric annuli which do communicate radially.

The downcomer can be as detailed as it is today in the detaled code, or you can have completely one-dimensional. You can choose the amount of detail. We feel if you want to apply his code to large breaks in PWRs, it would make no sense to use one-dimensional.

This allows us to go when we want to go when we want to or a little bit more detailed.

MR. CATTON: You have the versatility to set the dimensionality in various parts independently?

MR. FABIC: Right. That is what I was trying to show here. Everything outside the vessel would be one thing. This the vessel.

MR. CATTON: You can select the downcomer --

MR. FABIC: We can have the downcomer 2D. It's only 2D. There is no definition cross thickness. 1D everything else.

MR. ZUDANS: What is the purpose of having downcomer 2D, when you connect to 1D?

MR. FABIC: It doesn't matter once it gets into the downcomer, but the penetration of liquid into the downcomer from the nozzles in the first place does very much depend on how you treat the downcomer.

MR. ZUDANS: Those are kind of boundary conditions. They will force it to readjust somewhat.

MR. FABIC: The boundary conditions from the lower plena will not be quite accurate but will still affect delivery of water. Isometrical downfall can be handled this way. One of the biggest problems that licensing people have with the applicants today is how to represent the downcomer with the one-dimensional codes they have. If you use one string or two, how you connect them. What do you get? How physical is it? This way I think we can be as complicated as we can afford and as simple as we want to be.

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MR. ZUDANS: I assume if you want to, you could make a couple of size two-dimensional on the reactor plenum as well.

MR. FABIC: We have detailed codes for that which we can benchmark simple things against. Let me at this stage show you this graph that talks about final systems codes. When we are through with all the development, we don't want to continue any further.

(Slide.)

This is the picture. It shows the fast running TRAC and detailed TRAC and BWR and PWR version with neutron kinetics and without. It will cover the whole spectrum. This bottom note shows what kinetics dimensionality will be contained in what codes. Shown in green is hybrid as a possibility for very, very fast running classifications which we haven't decided on, but it's a possibility. There is another possibility to do much simpler classifications, much simpler additional classifications with many shortcuts, which is not shown here at all. Instead of telling you which codes we have finished, which you can read in there, I have now the following options. It's up to your discretion which way I go. I could show you a couple of viewgraphs on comparisons of TRAC, on how we can go about doing the independent assessment. What key indicators we are looking for in a couple of comparisons. Or I could tell

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you the work we have done on the TMI accident scenario. It's up to you.

DR. PLESSET: What is your preference? We have to cut something out, I think.

MR. FABIC: It's too much material here.

DR. PLESSET: I think we want questions at this point.

MR. SULLIVAN: I know from your chart that at the end of calendar '80 you will be competed with the PWR versions of TRAC.

MR. FABIC: No.

MR. SULLIVAN: It says TRAC P3 --

MR. FABIC: Yes. That is the planned version. I am sure you will find this is not quite right from an investment. You want to improve and adjust. We might issue another update of the same code.

MR. SULLIVAN: Then on your slide it showed all the areas which the TRAC would be applied to. Do you think that is optimistic, to say that they would be through with that code to the extent that it would be an EM?

MR. FABIC: Very good question. I didn't want to bring a viewgraph I had prepared which shows from the beginning of development until today how applications changed, how the names changed and the dates changed, and it keeps going on. I don't think it serves much purpose. In view

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of all that and experience, you may be right that we are optimistic. I think in our game we have to be optimistic.

MR. SULLIVAN: I see that TRAC is scheduled to be a lot of things. I am not sure it's very realistic to think that roughly a year from now they will be through withe it, the PWR version.

MR. FABIC: I think there will be a PWR version with neutron kinetics a year from now. Okay? Whether that will be the last word and we are going to stop right there depends on what we learn from code assessment. If we find we have to improve physics, we will improve it without changing the name of the code. We keep doing assessment until the end of 1984, until the last 2D/3D experiments.

MR. ZUDANS: In these codes do you provide for operator actions?

MR. FABIC: Very good question. No. You will notice that my second viewgraph in the beginning, I said that a lot of people perceive these codes as number crunchers. You shove something in and eventually get something out, and you have to try to digest what it told you. Okay? You can't stop the classification midstream and change something in the middle and see what the consequences are. You can't change things in the middle. You do restarts, but that is again delays.

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MR. ZUDANS: There are other ways. You could preprogram.

MR. FABIC: You can do that too.

MR. ZUDANS: Preprogram options where you can have operator interactions which may result from the other studies they will do in the risk assessment. They might identify combinations at such and such time.

MR. FABIC: This we can do even today. We can tell when the valve will open and when some pumps will stop. We can do that now.

MR. ZUDANS: You want somebody to go stop it.

MR. FABIC: That we don't have. What we are, therefore, planning is -- remember that simple route even I talked about? These are ones where we will be on the microcomputer. We can stop the classification any time, change the parameters, see the change in the results as they are going being generate. The same thing you can do more efficiently with the hybrid. Much faster. You get a lot more information.

This is the way we ought to be going.

MR. ZUDANS: You reach a po t where you can do essentially real time classifications. Interactive is not unthinkable.

MR. FABIC: I agree.

PROF. THEOFANOUS: You talk about development and

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also quite a few graphs on assessment. Does application fall also under your responsibility?

MR. FABIC: Yes.

PROF. THEOFANOUS: I haven't seen anything in that area. Except for the TMI. I don't mean TMI application. I am talking about generic application.

MR. FABRIC: This a viewgraph that shows that we have ongoing code applications. The first is on TMI. I have the whole other sections.

(Slide.)

Then there is this viewgraph on applications.

(Slide.)

This shows first some TMI work at LASL. But then -- this is still TMI. There is another application. Okay. Here we go.

We have analytical support to the 2D/3D program. We have to do a lot of design classifications, as well as pretest, posttest predictions, many of these classifications scheduled. Here is the list of those. We will be conducting similar analytical support to the 2D/3D program and that will be done with the BWR version TRAC at INEL.

We will see a lot of these here. Looking at the operating reactors issues. Using these codes to look at the transients or accidents that we haven't be analyzing before, but to this detail we can do today.

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PROF. THEOFANOUS: I am interested in that part. Can you tell us what you are planning there? What is the extent of the program?

MR. FABIC: I don't have plans today. I can say: "Look, we foresee there will be so many hours of computer time, so many runs we might be doing. This much money I think I will need." Okay? From past experience. When we get requests urgent, tell me right now --

PROF. THEOFANOUS: Who will do the request?

MR. FABIC: For example, TMI came. We had to do all the changes at INEL. It cost us $200,000. They are not lengthy.

PROF. THEOFANOUS: My question is aimed at a slightly different target. What you tell me is helpful, but I want to know whether it's under your branch or any other branch under the Office of Research --

MR. FABIC: The funds are under my branch.

PROF. THEOFANOUS: Excuse me. Let me explain. Is your branch responsible or is it some other branch that is aiming at applying thes codes to learn something? will learn something? Who will be responsible for learning something?

MR. FABIC: Now I understand. We have in fact recently discussed this particular issue. We haven't been doing that in the past. We have decided to do it very

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seriously.

PROF. THEOFANOUS: Who?

MR. FABIC: Our branch. We will be developing --

PROF. THEOFANOUS: Where don't you show us plans?

MR. FABIC: The second slide showed in-house development of codes and applying them by people who develop them. I think only people who know what shortcuts are being made can intelligently apply them.

PROF. THEOFANOUS: I am talking about what you are talking about here.

MR. FABIC: The number crunchers will be asking our contractors to perform calculations per NRC specifications. We will tell them consider such and such plant with this and this boundary condition, such and such accident sequence. And they will come to us with the answers. We don't have those number cruncher machines.

MR. ZUDANS: I would like to hear about quantitative assessment.

DR. PLESSET: The independent assessment.

MR. ZUDANS: Whatever you are prepared to say.

DR. PLESSET: We will leave out the discussions of TMI. All right.

MR. FABIC: I am delighted. It's not a very good story.

DR. PLESSET: We will leave that out.

PROF. THEOFANOUS: I was going to vote the other way.

DR. PLESSET: We can have a show of hands. Who wants to hear about TMI?

PROF. THEOFANOUS: Maybe some --

MR. CATTON: Only one small part of TMI is of interest. That is near the point that the core dried out.

DR. PLESSET: I don't think they got to that. Did you get to the core dry-out regime?

MR. FABIC: No. But we have gone up to 110 minutes of the transient. We haven't seen the core dry-out. We think we know why. I could say a few words about it just very briefly. About why we think we haven't gotten this yet. We think we should have, but we didn't.

DR. PLESSET: Briefly then. We will talk a bit about the assessment program.

MR. FABIC: First or second?

DR. PLESSET: Do TMI now.

MR. FABIC: All right. I will skip a number of items which have to do with quite a few classifications that were in support of natural circulation studies and various aspects of the transient. NRR has been asking for all these classifications in the first place. We are reporting the results. What we are told by both labs doing these classifications -- this can be looked at partially as excuses -- is the fact that the number of boundary conditions you have to know to do the classification are not known.

(Slide.)

There have to be guesses made. When they make guesses, they find disagreement with data, so they change guesses. If you have enough of these to play around with, sooner or later you will get agreement. But I am warning you about it.

MR. CATTON: You are having the same problems as B&W have been having.

MR. FABIC: I must say it's true they are not well defined and you can put different assumptions and get different answers.

This is part of our weakness. I will talk about another one which is more of a technical weakness the way I see it.

(Slide.) That is our representation of B&W steam generator. I find that there is something called aspirator in the main feed line inlet which brings in the steam water mixture into the feedwater, the downcomer, to preheat it.

That didn't play any part in TMI, but it's not -- it may be important when we look at natural

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circulation. It's not in our codes.

MR. CATTON: Not in their codes either.

MR. FABIC: The other part which is connected with TMI has to do with the aux feedwater supply. My understanding is that this supply comes to some kind of header and sprays onto the tube bundle itself, onto the tubes, and there is a perforated baffle underneath which has a tendency to spread that liquid cross the whole tubes. Okay?

Therefore, then it will fall down through -- now I am not sure. It will fall down through annuli around the tubes or separate holes. That I haven't checked out yet.

MR. CATTON: I understand it wets pretty much the outer parts, but does not penetrate to the center.

MR. FABIC: That is my assumption too. I am showing it this way along this tubes. This is certainly not treated in either RELAP or TRAC. The heat transfer on the secondary side due to aux feedwater coming in I don't think is right. Okay?

This is probably the main reason why our comparisons so far are not very good.

MR. CATTON: How important do you think the aspect of the first 110 minutes is? Do you think it's important?

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MR. FABIC: Yes. Whether that is the one or something else. In TRAC classification we had the wrong flow rates for the feedwater. They have assumed that the aux feedwater flow rate is equal to the main feedwater flow rate. It should be about one-third. They told us in just weekend.

Here is the results of INEL analysis, using RELAP.

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PROF. CATTON: We heard yesterday how unimportant the steam generator is. I am kind of in agreement with you. I am pleased to see this.

MR. FABIC: I don't understand why they would say that.

PROF. CATTON: I didn't either.

MR. FABIC: Red is measurements in TMI. Green is the first calculation at INEL. Blue is the Latest calculation that shows here, after about 500 seconds — this is the first 20 minutes of the trans ent -- that the calculation doesn't predict the pressure dropping.

It is not dropping because of the wrong heat removal. There should have been more heat removal to drop the temperature. It should be saturation pressure here. Saturation pressure calcuated stays level; it should be dropping down.

We have seen a report. INEL told us what next steps they will take in trying to resolve that problem, one of them being look at the steam generator haet transfer in a better way.

Here are the hot leg temperatures versus measure. Big discrepancy. Here it is. Not enough heat being removed by the steam generator. Temperature hanging ouit. The same thing on the code.

PROF. CATTON: Could it have been the brake flow

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that was a little out of whack?

MR. FABIC: Of course it could be. What we are not sure of there again is what was the -- when the valve stuck open, it stuck fully open or halfway open or three-quarters? What was the opening when the valve stuck open? We are not sure of that.

Even more important, however, is the fact that we don't know how to model that brake flow to that kind of valve from -- I don't think we will ever do that. We will put in some reasonable model which has a chance with appropriate multipliers that are empirical multipliers coming from mythical test data. Then you will have a chance to do a good job.

Right now we don't know what the multipliers are when the valve is discharging two phase mixture rather than single phase.

MR. ZUDANS: Could you make some judgment from the tanks that were filled in the basement and overflowed?

MR. FABIC: I will show you some of the calculations. I think that is a good point.

PROF. CATTON: It was early, though.

MR. ZUDANS: Twenty minutes. That would give you some indication what you discharged through that valve. This was early also.

MR. FABIC: Good point. I had no way to compare calculated discharge with measurements. That is a way.

MR. ZUDANS: At least for some time.

DR. PLESSET: But the valve had been leaking into that tank quite a bit before the accident; quite a long time. Yes. That is what the operator's testimony stated.

MR. ZUDANS: They still have level indication.

DR. PLESSET: So they could tell what happened after the accident began?

MR. ZUDANS: Yes.

DR. PLESSET: Oh, in that case that is something else.

MR. SULLIVAN: That is being done now.

DR. PLESSET: It is?

MR. SULLIVAN: Yes.

MR. FABIC: The last viewgraph has to do with Idaho calculations.

(Slide.)

This shows five calculations performed for a time period after twenty minutes. Various assumptions were made as to liquid levels in a steam generator where the HRP was on or off, and when the accumulator was on or off.

They all came with unacceptable conclusions. Like there is no core recovery at all or temperature length to 2400. That is surprising. So I think these were all bad starts.

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What Idaho finally decided is they would like to get a good calculation the first 20 minutes before they attempt anyfurther long-term time.

(Slide.)

Now, at LASL we only have the detailed code, trying to make this simpler. This shows you loops. I don't think this is very interesting.

(Slide.)

However, the vessel --

PROF. CATTON: If we will carry it very far -- would you put that slide back?

MR. FABIC: Don't look at the pressurizer.

PROF. CATTON: If you don't handle the candy cane right -- noding wouldn't do that.

MR. FABIC: What you see is each one of these segments is subdivided into mesh. There is a finer mesh going through. It doesn't mean only one control --

MR. SHOTKIN: In this calculation, that volume 11 is just one volume; but their calculation wouldn't be used for natural circulation studies.

This is just going to be used for the core uncovery at TMI, up to about 120 minutes. Let's say the first 3 hours, 180 minutes.

PROF. CATTON: Some of us believe core uncovery occurred at 120 minutes.

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MR. SHOTKIN: Up to core uncovery is two hours. Maybe they will extend another hour. For natural circulation they need the more detail Stan is talking about which wasn't in this calculation.

PROF. CATTON: The first pump went off at 70 minutes, the second at 110. You will have to stop at 110 minutes.

MR. FABIC: The reason we are doing this calculation is not to show when the core uncovers, but what went where and when after it uncovered.

Did we start accumulating scrap or in what part of the primary loop? We have to continue with the calculation until we find out where the inventories were going. We don't want to do 15 hours, but we should be finding out whether we were accumulating steam in the upper head or the candy cane, at what time, according to calculation.

MR. SULLIVAN: When the transient goes two phase, you will need more detail. It should be two phase much before that.

MR. FABIC: Yes.

(Slide.)

This is the vessel. It shows in the current version we are stuck with the fact that we have to have at least two circumferential definitions, all the way up and

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cown the vessel.

We are using the minimum that can be used with this kind of analysis.

Here is a good example of current restrictions with the code to describe the control of the relief valve.

(Slide.)

Here are the cells within the pressurizer itself. Then you have to use many fine cells to get the critical flow calculated from what we call first precipice, not using correlations and not using some other models which are compatible with the code.

There, of course, also we pay some penalty for that. In a fast running code we wil. go away from that constraint and adopt simple techniques to calculate critical flow to relief valves. However, we had fairly good success with that.

I just found yesterday calculation results that Brookhaven has done as part of an interest assessment using TRAC from their own clinical control studies, special studies, with fairly good comparisons as to pressure versus space; and I think they were surprised to see the first time we applied the code to something new it worked.

(Slide.)

In TMI, it didn't work. Here is the TMI TRAC comparison, pressure versus time for the first 110 minutes

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or so. These are minutes now, not seconds.

Red is data from TMI. Blue is TRAC calculations. I think here we are not sure how fast this dry-out of the secondary side really occurred. That could have changed the level in here of that first undershoot.

The second very fast decrease in pressure is attributed to instantaneous discharge of -- first the core models the auxiliary feedwater as being added at the bottom, not coming from the top. It is added instantaneously. When it comes on, it comes on full blast.

It probably didn't happen that way. There are valves that have to open over some time. You can get it in. They think this is the reason why it came down too fast.

Then in this period of 12 minute to 15 minutes, they used the 2 HPI pumps operations. Now they think there should have been only one. That is the reason why they have a fairly steep increase in pressure. They had one HPI pump after 50 minutes.

The fact that this drop here is too steep, the drop in pressure, is attributed to another code input error which says the auxiliary feedwater flow used in TRAC was equal to the main feedwater flow, which is about three times the amount that the auxiliary feedwater should have had.

That is the response for that. They don't want to keep defining this, but this is playing around. What they

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will do is repeat the calculation with corrections done from the time it reached this plateau, and go until complete, and beyond.

This early part doesn't play any role here. They will reach a start here and go to core recovery.

PROF. CATTON: Couldn't you maintain the evel in the steam generator at the point it was measured to be to separate whether your problem was with the primary or secondary sice?

MR. FABIC: Because the boundary condition like that is not available in the core. You can't separate a liquid level as a boundary condition. The liquid level is calculated by --

PROF. CATTON: The feeling we have been given in the past is that this was a relatively unimportant part. If you veered the heat transfer in the steam generator plus or minus 50 percent it yields very little change in the final results.

I got that from B&W yesterday. It may not be true, I understand.

MR. FABIC: The heat transfer coefficient plus this area.

MR. SULLIVAN: I agree with Ivan. B&W did indicate to us yesterday that -- I pointed out yesterday I thought it was. It looks like they are from even the TRAC

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calculations. I think Ivan is right. It should be pursued with B&W.

PROF. CATTON: The TRAC code runs could collect some of that out. If they input the measured secondary side conditions and things fell on line, maybe we would begin to separate the phenomena.

MR. SULLIVAN: I wish it was that easy. The secondary side is not numbered. Very little we are sure of, identically sure of at even the levels in the steam generator, there are questions about them, the measurements that are made, the ranges they were on, and when they switched ranges.

There is a lot of questions about what actually happened on the secondary side of the steam generator. It is not black and white.

MR. MICHELSON: How do you know what the auxiliary feedwater flow rate is, for instance? You know the level of the generator remained constant for long periods of time, like at ten inches. You know that auxiliary feedwater was coming in. But you don't know how much.

You know you are evaporating all that came in because the level remained constant. You don't know how much less than that might have been coming in.

PROF. CATTON: You know temperature and pressure.

MR. MICHELSON: But you don't know the mass that is

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involved.

MR. SULLIVAN: The only thing you can do is assume it was full flow.

MR. MICHELSON: You can tell on the back of an envelop it couldn't be that.

MR. SULLIVAN: That is what we did. The energy balances aren't very good.

DR. PLESSET: I don't want to spend the rest of our time on this, if we can avoid it.

One more comment.

PROF. THEOFANOUS: What about phase separation?

MR. FABIC: I want to tell you something about it right now.

(Slide.)

This is a breakthrough through the relief valve. It indicates, for example, high flows here and here. That is when we have a heavy fluid heating the well, either liquid or a very dense mixture.

A low flow is where you have steam or very low density.

The reason these density differences are there is because of the phase separation calculated inside the pressurizers. How good it is, we haven't yet --

PROF. THEOFANOUS: B&W told us ten days ago that they calculate and assume and think is reasonable that the

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system was completely homogenous.

MR. FABIC: I can't understand that.

PROF. THEOFANOUS: If that were, the TRAC results might be useful to them.

MR. FABIC: When we like them and believe in them, I think we will.

PROF. CATTON: They don't believe the steam generator is very important.

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DR. PLESSET: We can go to your next topic.

MR. FABIC: All right. I will be very brief.

DR. PLESSET: Is certainly worth some of the criticisms in some people's minds. That is good.

MR. FABIC: Later on you will see that I talk about qualitative and quantitative ways of assessing the code. I will not spend much time on qualitative at all, except to show you one plot that shows L-23 results of temperature profile along the hot rod as a function of time. What we show here in red is data and green is TRAC results using ILOEJE correlation.

(Slide.)

It shows the core is not doing bad. The flat temperatures are good. Final quench is here. Qualitatively, it's not that at all. Other words that are not hot rods are also -- for quantitiative assessment we can't use time -- there is no way to have these results digested in a format where you can extrapolate what you learn from different scale facilities.

I will briefly talk about integraters we are using here.

To describe present -- first of all, in using -- in assessing the code, integral test facilities, our primary purpose is to see how well do we represent dynamics of the system. The code. Is the feedback between component right?

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Rather than details of heat transfer. That is not very important. Other tests and those familiar -- integral test, dynamics of the whole system. That is presented by present time history. And the present time history itself could be characterized with certain types of occurrence. For example the time to empty the rods, no matter what the facility. The time for accumulators to come on. The time the pressure reaches one -- I will show you how we use these indicators. The other indicator is what is the inventory of fluid here? Here we show the time after reaching the minimum when you just start to refill, and -- there is a formula here like 10 percent above the minimum, or if you start with zero volume, then 10 percent -- time to reach that. Time until when you get the final core reflood started, you might have a number of oscillations, but the final core oscillation sustained REFLECHT started -- this is indicated with a double asterisk. I will show you one more viewgraph to indicate this.

(Slide.)

The time to get zero flow at the ore inlet after the first reversal, these are the times we can pick for different facilities. That indicates something about dynamics of flow inside the reactor vessel.

The next two may look like too much heat transfer oriented indicators. They are really not. All these

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quench cycles really tell us is that there is a flaw going on there. Bursts of flow are responsible for quenching. If we agree with the times of these quenchers, that means the hydraulics is also okay.

(Slide.)

Here I show time for the first and last quencher and time for second quencher, if it exists in the facility. In different facilities we only have one quencher, showing the last quencher. Of course, we are also showing the value of the peak clad temperature as the last indicator. Ten of them altogether, we thought that was enough.

Certainly you are supplemented here. We have great detail how well it does overall without quantitative band here.

(Slide.)

What we do with these indicators is plot them on a predicted versus measurement scatter plot. Everything lies on a 45-degree line. We will have uncertainties in prediction and in measurement that will explore sensitivity studies. When our crosses lie outside the 45-degree line, it means we have errors in the code or inadequacies in the formulation, errors in numerical analysis. Whatever.

We think that with such plots which have — this is all for one indicator. Everyone of these crosses is bw

crosses is for one of those ten indicators. But has different test facilities, different test conditions.

We might extrapolate the arrow for that into full scale. We have to come up with a criteria for what is acceptable. We don't have that. The last viewgraph here is to show you, instead of having only one indicator plotted on one graph, all we had so far on LOFT is enough inforamtion there, which is all the indicators for one graph for one tst.

(Slide.)

This shows that we are not doing badly. Green is the TRAC-PIA without ELOGI correlation.

Read is with the ELOGI correlation. It says without ELOGI we are way off on a quench. We don't predict first quench. Our last one is delayed.

With ELOGI it's much closer. It shows that all the other indicators I talked about are fairly good. Our peak clad temperatures are within a few degrees. That will be luck. We have to do a lot of that. On many experiments we qualified a plan which shows which tests or what facility we want to object, which measurements will be taken, where and what time. We have done this for PWR. We might have to change some of those, because we didn't consider the importance of these tests. We are changing some of our test facility plans. We have

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to change some of this here. That would be the end.

DR. PLESSET: Thank you, Stan.

We appreciate your condensing some very interesting things. Now we can have some questions.

MR. ZUDANS: Very quick question. In first shelf in TMI here, isn't that because they actually had HPI from 4 to 8 percent.

MR. FABIC: What happened before that time is very confused as to how many were actually on, whether there was one or two, and in what time period. I do have a paper that shows what they assume. Those assumptions are not the same as INEL's.

MR. ZUDANS: I was tickled by the remark you said: since these points are coming from different sized facilities, you may have a chance to extrapolate. In view of the fact you have facilities that are small scale —

MR. FABIC: No. You have some full scale.

MR. ZUDANS: TMI.

MR. FABIC: No. 2D/3D. Full scale upper plenum, downcomer, lower plena, full height core/full width core -- half width, but full-scale width.

There are four high-steam generators in the test facilities. Enough to get measurements. I think we have quite a few large-scale data. It will not be all wild extrapolation, no.

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MR. ZUDANS: Okay, as long as you have that kind of information.

MR. SULLIVAN: In the TRAC code it's almost conceivable to me the small break may be even harder to model than a large break. Surely the fluid dynamics are going to be easier. You shouldn't pass them by either. Now you are working with small delta Ps and the fluid dynamics will have to be very good. Separation will have to be good. I was thinking more in terms of the heat transfer from the system. It will be critical you get those right because the transients are so long and you are integrating them over such long periods of time.

MR. FABIC: Can I digress a bit to answer his point? Something I learned recently from experiments done at MIT with glass hardware. Looking at three loops in smaller scale briefly, air-water, okay?

That was the purpose of the experiment. They learned something else. They learned — may I take this off and go to the blackboard? If a steam generator represented before U tubes and they are nested inside each other, and add manifold supply inside, and they had now air-water mixture, droplets of water, coming from here.

If the flow rate is low enough as a natural circulation of the type Dr. Michelson looked at, reflux boiler, you find there is a very nonuniform distribution

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for fluid. In fact, two of them, there was no flow. Most of the flow was on this one and on this one. It was a lot of instability.

We can define a region of flow where there is instability in his equipment.

Now we have to seriously take a good look at that.

I don't know the consequences when you have many, many tubes, to the just four, but we have seen even in PWR tests with the Westinghouse steam generator there is a small distribution because of centrifugal action alone in the plant. What this will do to heat transfer, because if you were starting some regions of that bundle, the heat transfer, that would be different.

How will we handle that in fast running or slow running situations? We will have to look at that.

DR. PLESSET: Any other question or comment?

(No response.)

Evidently not.

Thank you very much. We will have a ten-minute break and come back and have a brief summarization.

I want to thank all the Staff for their presentation.

(Recess.)

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DR. PLESSET: What I thought we could do for the next 15 or 20 minutes is I will just go around the table and ask if you have comments you would like to direct to me regarding what we had presented today.

Why don't I start — who wants to lead off?

Harold.

MR. SULLIVAN: I forgot who made the presentation, but he showed SEMISCALE data for one of the transients run to simulate TMI. The SEMISCALE facility was to model the Trojan plant which is a Westinghouse plant.

And the pressurizer also stayed full in that -- during that experiment.

So not only it seems to be the U-tube in the B&W system, but also a Westinghouse plant may give a false indication of liquid level. I don't know whether that was brought up or not.

DR. PLESSET: I don't think it has; but I think in one of the bulletins to Westinghouse they were directed not to consider the pressurizer level as an indication of core covery at all times.

It is covered in that sense, but people still may not have a feeling it applies.

Why did it say full?

MR. SULLIVAN: I will pass the question along to our chief consultant on SEMISCALE.

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DR. PLESSET: That means Mr. Shumway.

MR. SHUMWAY: Magic.

(Laughter.)

MR. SHUMWAY: The opening of the system was at the top of the pressurizer, so the only way the pressurizer could drain was through countercurrent flow; and it did. That is all I know.

DR. PLESSET: But their relief valves are no different from those on -- not much different from B&W plants. You have the same kind of opening.

Right?

MR. SHUMWAY: We modeled that opening, that's right. B&W plant's pressurizer on TMI-2 stayed full, and also on SEMISCALE. The low pressure point of the system, except for the gravity head part, is at the top of the pressurizer.

The water can only get out by countercurrent flow against the steam that is being generated in the core, that is the high pressure point, that is trying to escape from the system through the break.

DR. PLESSET: I think that is a very pertinent observation to all we have been hearing.

Do you think that SEMISCALE is really going to give you a good handle on things like this? I guess you think it does.

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MR. SULLIVAN: I would think with that indication and that experimental result, if a code disagreed with it, I would like to know the difference between the two before I would stop an operator from taking that as the liquid level indicator.

Most of the indications I have gotten is that a Westinghouse pressurizer would empty during a small break.

DR. PLESSET: So the U-tube loop is not necessarily the fatal element. Is that what you are implying?

MR. SULLIVAN: Right.

And also I think that it would be worth NRC warning the utilities that own Westinghouse and Combustion plants that that did occur.

PROF. CATTON: That is a very small pipe you have, isn't it?

MR. SULLIVAN: Also a very small leak.

PROF. CATTON: The surge line is typically ten inches or larger.

MR. SHUMWAY: It is fairly big in TMI-2; and that line wouldn't drain the water.

PROF. CATTON: It was a loop seal there. If I had a straight vertical pipe --

MR. SHUMWAY: In SEMISCALE we didn't change the pressurizer. It is modeled after Westinghouse. But we did change the loop seal design. The surge line was changed, the

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TMI surge line.

DR. PLESSET: I didn't understand that last statement.

MR. SHUMWAY: The surge line in SEMISCALE was piped to match the loop seal in TMI-2.

DR. PLESSET: So it was not like a Westinghouse plant?

MR. SHUMWAY: It was like a Westinghouse in the volume, pressurizer volume.

DR. PLESSET: But it had a loop seal which Westinghouse plants don't have.

MR. SHUMWAY: Yes.

DR. PLESSET: That may be the way they would get out of that.

MR. SHUMWAY: It may be; but I don't think that is the key issue. I think that water would be in there if you didn't have the loop seal, personally.

PROF. CATTON: Even though the pipe is quite large.

MR. SHUMWAY: Yes.

DR. PLESSET: Now that is not stable. To try to maintain a column of water with steam pressure on the bottom --

PROF. CATTON: Ten inch diameter pipe.

DR. PLESSET: That is not stable. You can try it

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sometime.

PROF. CATTON: What was the size of your pipe?

MR. SHUMWAY: Quarter inch.

DR. PLESSET: That would be stabilized because of surface tension effects.

How hot was it? It is getting pretty small.

PROF. THEOFANOUS: Even a quarter of an inch? I don't think it would be small enough to make it stable.

DR. PLESSET: It is getting close to stability, yes.

PROF. CATTON: About an inch.

DR. PLESSET: I think that's right.

PROF. CATTON: The candy cane being 36 inches in diameter in the B&W plants, it would be damn tough to simulate in small scale like SEMISCALE. I am not sure it would have meaning.

DR. PLESSET: What is the pressurizer height in SEMISCALE in the model above that?

MR. SHUMWAY: Much lower than the TMI pressurizer.

DR. PLESSET: How high was it?

MR. SHUMWAY: About seven feet, compared to like forty feet.

DR. PLESSET: Seven feet of water column is what you are supporting.

MR. SHUMWAY: Something like that.

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PROF. CATTON: I used to use that method to bleed my brakes, and a quarter-inch pipe held the brake fluid w n no problem at all.

PROF. THEOFANOUS: Quarter-inch or three-quarter?

Fine. I thought three-quarters you said. I take it back. I am with you now.

DR. PLESSET: That may be really the difference.

MR. SHUMWAY: Between what and what?

DR. PLESSET: The fact that you had a pressurizer and it held up.

MR. SHUMWAY: They did the same thing in the drainage pipe.

PROF. CATTON: No.

MR. SHUMWAY: At TMI.

DR. PLESSET: Different reasons. It was a manometer seal and the pressure on the gas side was high enough to maintain a column. Certainly that high, or higher even.

But now --

MR. SHUMWAY: Wait a minute. Mass is going out that line.

DR. PLESSET: Right.

MR. SHUMWAY: Why wouldn't the water bleed back against the effluent out?

DR. PLESSET: Because it is held up by the loop

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seal?

MR. SHUMWAY: Are you sure it is not held up by countercurrent flow?

DR. PLESSET: It is a stable loop seal. I think I am right.

PROF. CATTON: That's right.

DR. PLESSET: The fact that you have steam bubbling through that loop isn't significant so far as supporting that column goes. If you have a U-tube, ten inches diameter or ten feet, or whatever, it can be supported if you have enough gas pressure. It is stable.

If you don't have that, if you have a straight column, and if it is then enough it can be held up by capillary, without the loop seal.

MR. ZUDANS: The loop seal goes like that in the pressurizers, correct?

DR. PLESSET: At B&W. That is the only one. The others are not a manometer type seal.

MR. ZUDANS: You could have one beginning at this end and go all the way up and hold it.

PROF. CATTON: Some have a rather long run, like 40 or 50 feet.

DR. PLESSET: I don't think it matters if it is truly level. It will run out.

Well, let's go on. Harold, do you have another

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Theo?

PROF. THEOFANOUS: I don't know exactly how to say this. I am very disappointed and disturbed with the response I see that the research is taking to the TMI-2 accident.

DR. PLESSET: Which part of the research?

PROF. THEOFANOUS: The focus in all of it. I don't see there — I think as a result of TMI-2 there are certain lessons we must have learned and certain actions we must take.

There are other urgent actions, I think, and I don't see leadership in taking any of those actions.

I pointed out some of those things in the letter I sent.

DR. PLESSET: You didn't give any priorities. You have to have priorities.

PROF. THEOFANOUS: I only discussed one topic in the letter.

DR. PLESSET: Which one is that? Let the other people hear.

PROF. THEOFANOUS: It is very difficult to say in a short time. The letter is two and a half pages. I would rather make reference to that.

If you want me to say in a nutshell, I feel that —

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again, something ' mentioned many times throughout meetings is that I don't feel we have paid enough attention to the accident analysis and accident sequences, not only for small LOCAs, but all LOCAs.

In order to — if we did our homework on that, probably TMI-2 might not have happened. The way to find out the kinds of cracks that are evidenced in what happened in TMI-2 is work through the accidents and work through the system interactions, study the results of the computer codes.

Stan mentioned the computer codes are there and they are available to be used. The problem is nobody is using them. They have been there for some time.

In order to use them effectively in that respect, you can't take a casual effort -- I don't want to accuse people in terms of casual efforts, but I am thinking of an order of magnitude of different consideration to that as being the focal point.

DR. PLESSET: Right. But I think we have to do this in an orderly way, separate it from the panic approach to a lot of activities as a result of TMI-2.

PROF. THEOFANOUS: That is the point. I see a lot of things coming out of TMI-2, and I don't see the systematic, orderly way of going through the accidents.

DR. PLESSET: They are not organized, right. I

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agree.

PROF. THEOFANOUS: All the activities, our response to TMI-2 ought to be organized. Starting from that. I describe we have several line of defense. One is prevention, mitigating, establishing consequences, and so on.

That really ought to be the order of priority of research. The way I read the Staff's proposals is they say, well, up to now we have been dealing with the two ends of it, design basis accidents. We have been ignoring the space in between.

I think that is putting it in the wrong focus. The order ought to be from preventing, next to the intermediate stage, next to class 9.

How you will put the threshold has to come from a more systematic study of the different accidents. That is why I keep saying that everything has to start from there. I don't see it happening, and I feel very disappointed with it.

DR. PLESSET: I think they are going to make an effort on the experimental side. I would like your response to the applicability of the program with the small break tests with LOFT and the small break sequences with SEMISCALE. That is on the experimental side.

Are you in agreement this is reasonable?

PROF. THEOFANOUS: No, I am not. I don't think it is the right place to start. It is good to think in terms of some LOFT small scale tests and SEMISCALE, though with quite a bit more reservation.

However, to what extent LOFT and SEMISCALE tests will give us the answers we want or the answers to understand how small breaks behave, that we have to think very hard in conjunction with the kind of studies and calculations I am talking about.

One approach would be to outline a number of tests. The facilities are there and there is nothing much we can do about that. We have to use the facilities that we have.

However, I think we ought to have some idea of whether those facilities are adequate or not, and in what respect are they inadequate, and see how we can cover ourselves if we find any inadequacies.

We will not know the answers to those questions unless we went through the calculations and through anything about those accidents.

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DR. PLESSET: I think you have a very good point. I would hate to see us arrive at some additional facility needs without real careful thinking. I am including 2D/3D as no facility to date which is really without serious criticism. I think you have a very good point and I think you are right. They are not approaching this problem in this way.

MR. ZUDANS: I remember when they discussed risk assessment. They insisted they would go back and set up a very extensive study where they would look for other cracks, so to speak.

That might affect all the programs, all the test setups. I insisted they join those two things. Human factors and event trees. I thought this program covered what you are addressing here. It may have to be made more specific.

PROF. THEOFANOUS: Let me respond to that. I am disappointed. I think this is a token. When this program was presented to the TMI-2 ten days ago, there was only $400,000 allocated to the activity. I raised serious doubts then and they increased it by a small factor. On the other hand we go to Stan and hear his whole program outlined, and he doesn't have anything to say about the subject that is crucial. He spent all his time on development, a lot of time and assessment and didn't say one

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word -- I asked the question about whether this was a possibility or not. He said he saw this as a possibility. But he had nothing to say about it. They should be doing those things already. Not planning three years from now.

MR. GARLID: I wanted to second what Theo was saying, but in a different sense. I think the arguments for what they are doing in modifying the experiments they have are reasonable and very persuasive that they can do some things. In a way it goes back to what Carl Michelson did, where he investigated something that according to him was pretty much on his own time and discouraged at the time and now that it turned out to be an event very pertinent to that investigation, reports are given a lot of attention. It seems to me what the Research Staff ought to do is someho orient the organization to encourage this kind of thing.

I don't see any of that in the fiscal '81 budget. Some items are mentioned in the fiscal '80 budget.

DR. PLESSET: Thank you. Now Ivan.

MR. CATTON: I think that the program that was mentioned, the risk assessment and so far it fills that gap.

I don't agree with Theo as far as it being a token effort. I don't think it is. I heard Roger Matson with his lessons learned group. He is paying a lot of

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attention to that area. Almost everybody we hear from is at least giving it lip service. I think it's too premature to say they won't do anything, unless you know them better than we. Maybe you do.

PROF. THEOFANOUS: I knew you would disagree with me, but since you did, let's take that further.

First of all, I think already they ought to be doing it. I don't see it anywhere.

Secondly, even ten days ago we heard that the budget allocated for this particular item was one-third of what you saw today. You saw it three times bigger because I was arguing with Sullivan on the TMI-2 subcommittee just ten days ago.

If people believe so much about it and if it was the focal point according to their own thinking, that ought to be there before in the first place.

What I am trying to say is that I like to see that the people are responsible for developing those plans, I like to see that somehow they become convinced themselves. Not do something because they hear somebody say something about it. This should be something that has to be done. Unless they become convinced, you will not have the appropriate leadership. This needs leadership. That is where I find fault. It's a matter of first convincing the people responsible for these activities in order to provide

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the right mechanism. The mechanism is not there yet. I guarantee that. It's there only for analysis. I used that word in my letter. There is no mechanism there for synthesis and a lot of cracks are present. TMI happened as a result of us not having enough time with the synthesis.

Some of us have been talking about this for years now. Even today there isn't a concerted effort to provide the synthesis in order to make sure no other cracks exist.

DR. PLESSET: Do they have the personnel to undertake this kind of synthesis?

PROF. THEOFANOUS: Absolutely.

DR. PLESSET: Where?

PROF. THEOFANOUS: All over the place. People in the National Labs.

DR. PLESSET: You mean outside NRC?

PROF. THEOFANOUS: Including NRC. Stan Fabic and Lou Shotkin. These people have been with these plants. Dr. Tong. They work with the plans. They know the systems. There are people on the Subcommittee. Carl Michelson, for example, knows the system.

They have to be bought together under some unified leadership to address this in a systematic down-to-earth fashion. Pragmatically, realistic and urgent as it is.

MR. SULLIVAN: I agree with Theo. It's going to

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take quite an effort. It will be a very painful effort, because I have only looked at systems in a very general way. When you start looking into them and looking at interaction of all the secondary steps, it will be a very painful process to go through and it's going to take quite a while to see what an operator can do to a plant and to make an accident either better or worse.

I am not sure I even understand what happened at TMI to make it better.

DR. PLESSET: Ivan, do you have another comment?

MR. CATTON: I forget it.

(Laughter.)

DR. PLESSET: Good.

PROF. THEOFANOUS: There are significant resources of people through the review groups that have been able to draw together people from all walks of life and different backgrounds. There are a lot of people in the National Labs that are very much involved in that. There is no question of lack of people.

DR. PLESSET: I just wanted to hear you say it. What you have to do is get some of this counsel to me within a few days, because what is being considered is a supplementary budget. The basis for it is, say, TMI-2. Otherwise they wouldn't have the audacity to propose such a thing.

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Ivan, you remembered what you wanted to say?

MR. CATTON: My view of what happened at TMI is a little different. I think what it gets down to is how a plant is adminstered. Some of us are on the LER subcommittee. Straightaway, you see LER is very nice. You learn a lot from them. But the route back to the plant was nonexistent. The people operating the plant didn't know about things like Davis-Besse, Oconee. They hardly knew about what went on in their own plant. I don't care how much research you do or how many smart people you have doing it. Unless something is done about that part, the rest doesn't make any difference.

Somehow that has to be straightened out.

MR. LIPINSKI: An automated plant.

MR. CATTON: Maybe that is the direction.

MR. LIPINSKI: The ultimate, if you eliminate the people, you end up with a totally automated plant. Having automated the plant I have to worry about the next level, the guy who keeps it working and automated.

DR. PLESSET: The maintenance man. Okay. Prof. Wu had a comment.

PROF. WU: I wanted to follow up a little longer along this line. I understand there is not much time and I don't know the situation, as well as Theo.

MR. PLESSET: Nobody does.

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PROF. WU: And I don't know I can say in the same meaning as you said about synthesis. But perhaps, in my own feeling, the safety of the nuclear reactor will be a very important issue for the future off this industry.

Surely we have a good case on hand from which we hope to learn as much as we can. So perhaps in this postmortem see if we can extend the scope a bit in the investigation and use the highest imagination as we can.

Already we have brought other than the engineering and technical side facets of the matter, should we concentrate on the human factors. Error in decisionmaking under very difficult circumstances.

Furthermore, look into into what way we can avoid the future hazardous situations and see if there is any design that can be improved. This would almost take a game theory type of approach. It's like playing chess.

There is no time and space to do the role of elimination approach, but to spot a few important areas where the engineering design plus the human operation can be carried on with the least possible doing of any hazardous situations such as the U tube type checks and so forth.

Even the mathematical approach of the dynamic programming. See if there is anything that indicated a mistake. What would be the consequences? Look to the improvement of the engineering design and avoid any possible

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abuse of operation. It may take a different work task force from what we have.

You already named good names of experts already familiar with the engine'ing side. I think it might take a bit broader scope to learn -- to enrich the lesson as we can. That is, on this TMI-2 case. Then if I may take a couple of more minutes, I want to talk about the future research program, and specially for some of those basic problems to enlarge the capability of the very sophisticated system codes, 2D/3D, and so on, phase transition, transient flow and others.

Now the possibility of the last example is an excellent one that Stan Fabic mentioned.

There is a flow instability and flow separation and so forth, secondary flow, and all this seems we can come to a very solid foundation and improve the understanding as we track some of these basic problems and study it in full.

In such cases, conservation of mass, momentum, energy, they might have a considerable departure from original assumptions based on which these system codes were developed. Once we learn some of the good lessons in these basic lessons in these basic problems they might have a very good utility in the future to improve the existing system code by saying if the flow separation and

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such is important, there might be an easier way, much more simplified, but on the physical basis, well-based assumptions, by putting some of the energy sink, in order to continue on a much more simplified basis in the system approach.

Then also along this line, see if it is worthwhile to keep a very close contact and collaboration with the efforts put in by the Japanese and the German team in what is developed in due course.

If these are the desirable ways to move, then the next thing is see if the budgetary matter is sufficient to inhance such a stepped up activity.

Thank you.

MR. ZUDANS: This pertains to the same subject of Theo. I want to really make it understood that in principle, I agree with Theo, except that my interpretation was they were going to pay attention to this subject. We asked very clearly. I think maybe we should take a position that any supplementary budget lead item would be this particular item, and any changes to a facility or design or analysis tools should be based on findings on this risk assessment. Looking for new cracks. Then there would be a good reason for it.

If TMI is interpreted in every which way by different groups in different fashions, everybody finds

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something he can do. There is no unified purpose. Unified purpose is in what Theo states. That, we could emphasize That is all.

DR. PLESSET: I think we have used up our time, unless there is some really excruciatingly important remark, I will consider the session adjourned.

Let me add one nonagenda item. Tom Murley suggested we have our next meeting in Idaho Falls. We usually do have a meeting there about once a year. What is the sentiment of our distinguished -- I know what those two would say.

(Laughter.)

PROF. THEOFANOUS: When are you thinking about?

DR. PLESSET: Sometime this year.

PROF. THEOFANOUS: August or July?

DR. PLESSET: July is too busy. Late summer.

PROF. THEOFANOUS: More like August.

MR. ZUDANS: Early September? I am not here in August. Not until the 9th, but then I am in Europe until the 31th.

PROF. THEOFANOUS: Combine it with a meeting in Seattle.

DR. PLESSET: What meeting?

MR. LIPINSKI: The 20th to the 24th is the International Fast Reactor Safety Meeting in Seattle.

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The week of August 28.

PROF. THEOFANOUS: If you can combine with that, it would be helpful.

DR. PLESSET: After that, to just follow it.

MR. LIPINSKI: The 27th.

DR. PLESSET: You might lose a meeting.

MR. ZUDANS: I would like not to loze it. I hope you won't be able to make up the schedule that quick.

(Laughter.)

DR. PLESSET: Thanks again. We will have to try to arrange this meeting well in advance.

(Whereupon at 3:00 p.m. the meeting was adjourned.)

el 4

SYSTEMS ENGINEERING

(THOUSANDS OF DOLLARS)

278 163

	FY 1980 (PRES.)	FY 1981 (REQ.)	Δ	
SEMISCALE	6,700	10,150	3,450	• FACILITY UPGRADE FOR SIMULATING PWR SLOW TRANSIENTS AND OFF-NORMAL OPER.; ALSO TMI-RELATED EXPTS. IN CURRENT CONFIGURATION
BD/RF HT	6,215	9,390	3,175	• TLTA UPGRADE FOR SIMULATING BWR OFF-NORMAL OPER. & SLOW TRANSIENTS; ALSO USE OF EXISTING FACILITIES FOR TMI-RELATED EXPTS.
3D	15,800	12,000	-3,800	
ECC BYPASS	900	900	-	
MODEL DEVELOPMENT	1,915	3,510	1,595	• CONDUCT CONTAINMENT INTERCOMPARTMENT FLOW TESTS.
(ADB)	(615)	(2,010)	(1,395)	• BROADEN DATA BASE FOR STEAM/WATER/GAS SEPARATION
(SERB)	(1,300)	(1,500)	(200)	• ADDITIONAL CONSULTING RELATED TO TMI PHENOMENA

SYSTEMS ENGINEERING (CONTD.)

(THOUSANDS OF DOLLARS)

	FY 1980 (PRES.)	FY 1981 (REQ.)	△	
OP. SAFETY	1,600	9,950	8,350	• FULL-SCALE REPLICATION FIRE TESTS • EXAMINE TMI CLASS IE SAFETY EQPT. • BROADEN NOISE DIAGNOSTIC WORK TO MORE PLANTS • PREPARE TEST FACILITY FOR SAFETY VALVE TESTS
TECH SUPT.	1,670	2,620	950	
(SERB)	(1,000)	(1,030)	(30)	
(RSB)	(670)	(1,590)	(920)	• FULL SUPPORT FOR CODE CENTER AND NSIC.
TOTAL	34,800	48,520	13,720	

278 164

1027

278 165

SYSTEMS ENGINEERING

FY 1981
MINIMUM PROGRAM
$32.1 MILLION

SEMISCALE	•	STRETCHOUT FACILITY UPGRADE BY 6-12 MONTHS. LIMITED TESTING.
BD/RF HT	•	CONTINUE PWR BDHT AND FLECHT-SEASET, AND BWR CCFL. TLTA EXTENSION LIMITED BY FUNDING CONSTRAINTS.
3-D	•	SUPPORT 3-D FLOW EXPERIMENTS IN GERMANY AND JAPAN - FABRICATE INSTRUMENTATION FOR UPPER PLENUM TEST FACILITY IN GERMANY AND SECOND TEST SERIES IN THE CYLINDRICAL CORE TEST FACILITY IN JAPAN. - PROCURE DATA ACQUISITION SYSTEM FOR UPPER PLENUM TEST FACILITY IN GERMANY - PERFORM PRE- AND POST-TEST ANALYSES FOR CYLINDRICAL CORE TEST FACILITY AND SLAB CORE TEST FACILITY IN JAPAN.
ECC BYPASS	•	TERMINATE SMALL SCALE BYPASS RESEARCH IN FY 1980
MODEL DEVELOPMENT	•	CONTINUE ONGOING EXPERIMENTS NEEDED FOR BASIC UNDERSTANDING OF STEAM/WATER INTERACTIONS AND FLOW-REGIME FORMATION.

<u>SYSTEMS ENGINEERING</u> (CONT'D.)

FY 1981

MINIMUM PROGRAM

278 166

OP. SAFETY	• PROVIDE FOR OPERATIONAL SAFETY RESEARCH TO - EVALUATE LOCA QUALIFICATION TESTING METHODOLOGY - EVALUATE FIRE PROTECTION MEASURES IN FULL-SCALE REPLICATED CABLE TRAY SYSTEMS
TECH SUPT.	
(SERB)	• PROVIDE DATA BANK AND INSTRUMENT DEVELOPMENT AT REDUCED LEVEL
(RSB)	• LIMITED SUPPORT FOR RELEASE OF COMPUTER CODES AND BARE MAINTENANCE OF NUCLEAR SAFETY INFORMATION CENTER

278 167

SYSTEMS ENGINEERING
(THOUSANDS OF DOLLARS)
FY 1981

	MIN.	CURRENT	Δ	
SEMISCALE	6,780	6,780	-	
BD/RF HT	6,890	6,890	-	
3D	12,000	12,000	-	
ECC BYPASS	-	900	900	• CONCLUDE REPORTS AND INTERACT WITH 2D/3D PROGRAM
MODEL DEVELOPMENT	2,140	2,140		
(ADB)	(730)	(730)	-	
(SERB)	(1,410)	(1,410)	-	

SYSTEMS ENGINEERING (CONT'D.)

(THOUSANDS OF DOLLARS)

FY 1981

	MIN.	CURRENT	△	
OP. SAFETY	2,570	2,850	280	• CONTINUE SIMULATOR STUDIES OF REACTOR OPERATOR RESPONSE.
TECH. SUPT.	1,720	1,910	190	• PROVIDE FOR LEVEL-OF-EFFORT ON PUBLIC RELEASE OF COMPUTER CODES AND NUCLEAR SAFETY INFORMATION CENTER
(SERB)	(800)	(800)	-	
(RSB)	(920)	(1,110)	(190)	
TOTAL	32,100	33,470	1,370	

278 168

SYSTEMS ENGINEERING

(THOUSANDS OF DOLLARS)

FY 1981

	CURRENT	REQ.	△	
SEMISCALE	6,780	10,150	3,370	• INSTALL SECONDARY LOOP, CONCLUDE UHI TESTS AND W OPERATIONAL TRANSIENT TESTS, COMMENCE UPGRADING TOTAL SYSTEM TO A 4x2 B&W CONFIGURATION WITH OTSG's.
BD/RF HT	6,890	9,390	2,500	• ANALYZE PWR-BDHT RESULTS, COMPLETE TLTA UPGRADE AND INITIATE TESTING, COMMENCE BWR-CCFL 30^{o} SECTOR SYSTEMS EFFECTS TESTING, COMMENCE FLECHT-SEASET SYSTEMS EFFECTS TESTING.
3D	12,000	12,000	-	
ECC BYPASS	900	900	-	

SYSTEMS ENGINEERING (CONT'D)

(THOUSANDS OF DOLLARS)

FY 1981

	CURRENT	REQ.	△	
MODEL DEVELOPMENT	2,140	3,510	1,370	
(ADB)	(730)	(2,010)	(1,280)	• CONDUCT CONTAINMENT INTER-COMPARTMENT FLOW TESTS • BROADEN DATA BASE FOR STEAM/WATER/GAS SEPARATION
(SERB)	(1,410)	(1,500)	(90)	• ADDITIONAL CONSULTING PHENOMENA RELATED TO TMI PHENOMENA
OP. SAFETY	2,850	9,950	7,100	• PROVIDE FOR POST-MORTEM OF CLASS IE SAFETY-RELATED EQUIPMENT FOR THREE MILE ISLAND • PROVIDE FOR UPGRADED REACTOR DIAGNOSTIC STUDY • INITIATE RESEARCH ON SAFETY VALVE BEHAVIOR

278 170

278 171

SYSTEMS ENGINEERING (CONT'D.)

(THOUSANDS OF DOLLARS)
FY 1981

	CURRENT	REQ.	△	
TECH SUPT.	1,910	2,620	710	
(SERB)	(800)	(1,030)	(230)	• INCREASED TMI-RELATED INSTRUMENT DEVELOPMENT
(RSR)	(1,110)	(1,590)	(480)	• PROVIDE FULL PUBLIC RELEASE OF NRC COMPUTER CODES AND COMPLETE DOCUMENTATION OF SAFETY DATA IN THE NUCLEAR SAFETY INFORMATION CENTER • START DEVELOPMENT OF COMPUTERIZED INFORMATION RETRIEVAL SYSTEM ON REACTOR SAFETY RESEARCH DATA
TOTAL	33,470	48,520	15,050	

SYSTEMS ENGINEERING

(THOUSANDS OF DOLLARS)

	FY 1980 AMEND.	FY 1981 AMEND.	Δ	
SEMISCALE	10,200	8,100	-2,100	• EQUIPMENT FOR SEMISCALE UPGRADE AND TLTA EXTENSION ORDERED IN FY 1980
BD/RF HT	9,215	8,400	- 815	
3D	15,800	12,000	-3,800	
ECC BYPASS	900	900	-	
MODEL DEVELOPMENT	1,915	3,530	1,615	
(ADB)	(615)	(2,030)	(1,415)	• CONDUCT CONTAINMENT INTER-COMPARTMENT FLOW TESTS
(SERB)	(1,300)	(1,500)	(200)	• BROADEN DATA BASE FOR STEAM/WATER/GAS SEPARATION
				• ADDITIONAL PHENOMENA RELATED TO TMI PHENOMENA

278 172

155

278 173

SYSTEMS ENGINEERING (CONT'D.)

(THOUSANDS OF DOLLARS)

	FY 1980 AMEND.	FY 1981 AMEND.	△	
OP. SAFETY	3,200	9,750	6,550	• FULL-SCALE REPLICATION FIRE TESTS • EXAMINE CLASS IE TMI SAFETY EQUIPMENT • CONTINUE UPGRADED REACTOR DIAGNOSTIC STUDY • CONDUCT RESEARCH ON SAFETY VALVE BEHAVIOR • PERFORM INITIAL TESTS ON SAFETY VALVES

SYSTEMS ENGINEERING (CONT'D.)

(THOUSANDS OF DOLLARS)

	FY 1980 AMEND.	FY 1981 AMEND.	△	
TECH SUPT.	1,670	2,620	950	• PROVIDE FULL PUBLIC RELEASE OF NRC COMPUTER CODES AND COMPLETE DOCUMENTATION OF SAFETY DATA IN THE NUCLEAR SAFETY INFORMATION CENTER. START DEVELOPMENT OF COMPUTERIZED INFORMATION RETRIEVAL SYSTEM ON REACTOR SAFETY RESEARCH DATA.
(SERB)	(1,000)	(1,030)	(30)	
(RSB)	(670)	(1,590)	(920)	
TOTAL	42,900	45,300	2,400	

278 174

157

LOFT

(Thousands of Dollars)

	FY 1980 (PRES.)	FY 1981 (REQ.)	Δ
PROGRAM PLANNING AND ANALYSIS	3,820	5,000	1,180
FUEL	7,460	8,300	840
OPERATIONS	8,450	8,900	450
INSTRUMENTATION	7,300	8,000	700
FACILITY SUPPORT	9,100	11,300	2,200
ENG. & PHYSICS	6,470	6,500	30
ADV. FUEL INSTR.	300	300	-
TOTAL	42,900	48,300	5,400

- ACCELERATE TEST PROGRAM BY 20%
- TEST INSTRUMENTATION AND DIAGNOSTIC COMPUTER
- CHANGE TO BUDGET-AUTHORITY ACCOUNTING (DOE REQUIREMENT)

278 176

LOFT

FY 1981

MINIMUM/CURRENT PROGRAM

$44.3 MILLION

L6-2	OFF-NORMAL TRANSIENT
L2-4	LARGE BREAK AT 16 KW/FT
L2-6	LARGE BREAK WITH PRESSURIZED FUEL
L6-3	OFF-NORMAL TRANSIENT

159

LOFT

(Thousands of Dollars)

	MIN/CURRENT	REQ.	Δ
PROGRAM PLANNING AND ANALYSIS	4,000	5,000	1,000
FUEL	8,300	8,300	-
OPERATIONS	8,600	8,900	300
INSTRUMENTATION	7,500	8,000	500
FACILITY SUPPORT	9,500	11,300	1,800
ENG. & PHYSICS	6,100	6,500	400
ADV. FUEL INSTR.	300	300	
TOTAL	44,300	48,300	4,000

- ACCELERATE TEST PROGRAM BY 20%
- INITIATE PROGRAM TO TEST
  - -INSTRUMENTATION AND
  - -DIAGNOSTIC COMPUTER

278 178

LOFT

(THOUSANDS OF DOLLARS)

	FY 1980 AMEND.	FY 1981 AMEND.	△
PROGRAM PLANNING AND ANALYSIS	3,820	5,000	1,180
FUEL	7,460	8,300	840
OPERATIONS	9,050	8,900	-150
INSTRUMENTATION	7,900	9,000	1,100
FACILITY SUPPORT	9,900	11,300	1,400
ENG. & PHYSICS	6,470	6,500	30
ADV. FUEL INSTR.	300	300	-
TOTAL	44,900	49,300	4,400

- ACCELERATE TEST PROGRAM BY 20%
- COMPLETE INSTALLATION OF DIAGNOSTIC COMPUTER INTO LOFT CONTROL ROOM
- CONTINUE EVALUATION OF ADVANCED INSTRUMENTATION FOR APPLICABILITY TO COMMERCIAL PLANTS

CODE DEVELOPMENT

(THOUSANDS OF DOLLARS)

278 179

	FY 1980 (PRES.)	FY 1981 (REQ.)	△	
SYSTEMS CODES	4,430	6,330	1,900	• EXPEDITE TRAC-BWR • ACCELERATE IRT AND RAMONA III • BEGIN HYBRID CODE
COMPONENT CODES	1,410	1,650	240	• EXPEDITE COBRA-TF CODE (HOT CHANNEL VERSION) AND TRAC/COBRA COUPLED VERSION FOR UHI SYSTEM ANALYSIS
TRAC ASSESSMENT AND APPLICATIONS	3,060	6,450	3,390	• RECOVER TRAC ASSESSMENT SCHEDULE LOST DURING FY 80 TO ACCOMMODATE TMI-RELATED PRIORITIES • STATISTICAL APPL. OF TRAC • TRAC APPLICATIONS TO OPERATING REACTORS • WRAP APPLICATIONS PER NRR SPECS. • DATA BANK ON POWER PLANTS
TOTAL	8,900	14,430	5,530	

278 180

CODE DEVELOPMENT

FY 1981

MINIMUM PROGRAM

$9.2 MILLION

SYSTEMS CODES	• UPDATE RAMONA III FOR BWR TRANSIENTS • DEVELOP FIRST VERSION OF TRAC FOR RIA • DEVELOP TRAC-B1 (FOR BWR LOCA) • ASSESS BEACON VS DATA ON INTERCOMPARTMENTAL FLOW
COMPONENT CODES	• APPLY BASIC TESTS TO DEVELOP LOCAL MODELS. • VERIFY HYDROELASTIC CODE USED FOR ANALYSIS OF SUBCOOLED BLOWDOWN LOADS ON CORE BARREL
TRAC ASSESSMENT AND APPLICATIONS	• ASSESS FIRST VERSION OF TRAC ATWS • ASSESS FAST-RUNNING VERSION OF TRAC-PWR BASED ON AVAILABLE DATA • APPLY TRAC-PWR TO LOFT AND TRAC-BWR AND -PWR TO LARGE SCALE REFLOOD TESTS • LIMITED APPLICATION TO CASES OF INTEREST TO NRR

278 181

CODE DEVELOPMENT

(THOUSANDS OF DOLLARS)

1981

	MIN	CURRENT	Δ	
SYSTEMS CODES	4,100	4,600	500	• ACCELERATE DEVELOPMENT OF FAST RUNNING TRAC • IMPROVE TRAC-BWR, IRT, AND RETRAN
COMPONENT CODES	1,120	1,550	430	• VERIFY TRAC/COBRA LINK
TRAC ASSESSMENT AND APPLICATIONS	4,000	4,850	850	• INCREASE TRAC ASSESSMENT (DEFERRED FROM FY 1980 DUE TO HIGHER PRIORITY TMI RELATED WORK) • SUPPORT TRAC USERS
TOTAL	9,220	11,000	1,780	

CODE DEVELOPMENT

(THOUSANDS OF DOLLARS)

1981

	CURRENT	REQ	Δ	
SYSTEMS CODES	4,600	6,330	1,730	• ACCELERATE IMPROVEMENT OF RAMONA III FOR BWR TRANSIENTS • EVALUATE "HYBRID" CONCEPT
COMPONENT CODES	1,550	1,650	100	• APPLY COBRA/TRAC LINK-UP TO SEMISCALE AND PWR-UHI ANALYSES
TRAC ASSESSMENT AND APPLICATIONS	4,850	6,450	1,600	• APPLY FAST RUNNING TRAC TO NON-DESIGN-BASIS ACCIDENTS. EVALUATE CONSEQUENCES OF ACCIDENTS THAT WERE NOT POSTULATED IN THE PAST. • START DEVELOPING DATA BANK ON COMMERCIAL NUCLEAR POWER PLANTS TO FACILITATE USE OF CODES TO ANALYZE SAFETY ISSUES ON SPECIFIC PLANTS
TOTAL	11,000	14,430	3,430	

278 182

278 183

CODE DEVELOPMENT

(THOUSANDS OF DOLLARS)

	FY 1980 AMEND	FY 1981 AMEND	Δ	
SYSTEMS CODES	6,130	6,330	200	• CONTINUE DEVELOPING VERY FAST RUNNING CODE FOR NON-DESIGN BASIS ACCIDENTS (POSSIBLY "HYBRID CONCEPT")
COMPONENT CODES	1,410	1,650	240	• ACCELERATE DEVELOPMENT OF COBRA HOT CHANNEL CODE (TO BE USED IN CONJUNCTION WITH TRAC SYSTEM CALC).
TRAC ASSESSMENT AND APPLICATIONS	4,860	7,260	2,400	• INCREASE APPLICATION OF TRAC TO PROBLEMS OF INTEREST TO NRR • CONTINUE DEVELOPMENT OF DATA BANK FOR OPERATING REACTORS.
TOTAL	12,400	15,240	2,840	

278 184

FUEL BEHAVIOR

(THOUSANDS OF DOLLARS)

	FY 1980 (PRES.)	FY 1981 (REQ.)	△	
CLAD AND FUEL	2,080	2,750	670	• EXAMINE SAMPLES OF TMI FUEL
FUEL CODES	1,400	1,490	90	• ESCALATION
IN-PILE TESTING (PBF)	14,260	16,280	2,020	• EXPERIMENTS ON CORES BOILING DOWN (OTHER PBF REQ. DOWN)
IN-PILE TESTING (OTHER)	3,992	4,210	218	• ESSOR
FUEL MELT	1,368	3,970	2,602	• VAPOR EXPLOSIONS, INTEGRATED FISSION-PRODUCT TRANSPORT CODE, TMI F.P. DEPOSITS AND HYDROGEN PROGRAMS
TOTAL	23,100	28,700	5,600	

(61)

278 185

FUEL BEHAVIOR

FY 1981

MINIMUM PROGRAM

$23.3 MILLION

CLAD & FUEL	- MRBT 8 X 8 Bundle examined and analysed. Reports completed on two Additional 4 X 4 bundles
	- Stress/rupture out-of-pile tests complete, start in-pile tests
	- FRAPCON-2 steady state code will be maintained.
FUEL CODES	- FRAP-T-6 transient fuel code will be maintained
	- MATPRO-12 materials property code updated
	- FRAPCON-2 and FRAP-T-6 improvements verified
IN-PILE (OTHER)	- Nuclear tests begin in NRU
	- Halden membership maintained
IN-PILE (U.S.)	- 5 PBF tests in RIA and OPTRAN series
	- PBF Facility engineering and operation continue
FUEL MELT	- Conclude fully instrumented vapor explosion tests
	- Model containment F. P. transport in TRAP
	- F. P. Vapor pressures measured to 1000°C for TRAP model
	- CORCON models for long term core/concrete interaction

FUEL BEHAVIOR

FY 1981

	MIN.	CURRENT	Δ	
CLAD AND FUEL	1,950	1,950	0	----
FUEL CODES	1,486	1,486	0	----
IN-PILE (OTHER)	4,215	[illegible],215	0	----
IN-PILE (U.S.)	14,465	14,465	0	----
FUEL MELT	1,200	1,840	640	- TIME DEPENDENT F. P. RELEASE MODELS - SOURCE TERM CORRELATIONS - SENSITIVITY STUDIES ON INTEG. CODE - CORCON PROGRAMMER - VAPOR EXPLOSION MODEL DEVELOPMENT - LARGE SCALE STEAM EXPLOSION TEST - CORE RETENTION MATERIALS TESTS
	23,316	23,956	640	

278 186

278 187

FUEL BEHAVIOR

FY 81

	CURRENT	REQ.	Δ	
CLAD AND FUEL	1,950	2,750	800	- EXAMINE TMI FUEL
FUEL CODES	1,486	1,490	0	----------------
IN-PILE (OTHER)	4,215	4,210	0	----------------
IN-PILE (U.S.)	14,465	16,280	[illegible]15	- EXPERIMENTS ON CORES BOILING DOWN
FUEL MELT	1,840	3,970	2,130	- TMI FISSION PRODUCT DATA, HYDROGEN PROGRAM, COOLANT CHEMISTRY CONTAINMENT LOAD SOURCES
	23,956	28,700	4,745	

278 188

FUEL BEHAVIOR

	FY 1980 AMEND.	FY 1981 AMEND.	Δ	
CLAD & FUEL	3,080	2,550	-530	- REDUCED BASIC PROGRAM, COMPLETE CREEPDOWN, LOWER COST TMI EFFORT
FUEL CODES	1,400	1,486	+ 86	- ESCALATION
IN-PILE (OTHER)	3,992	4,215	+223	- ESCALATION
IN-PILE (U.S.)	16,260	16.065	-195	- LOWER COST CORE BOILING EFFORT
FUEL MELT	3,968	4,140	+172	- REDUCED BASIC PROGRAM, ADDED SPECIAL ISSUES IN "CURRENT" BUDGET
	28,700	28,456	-244	

171

PRIMARY SYSTEM INTEGRITY
(THOUSANDS OF DOLLARS)

	FY 1980 (PRES.)	FY 1981 (REQ.)	Δ	
FRACTURE MECHANICS	3,250	5,480	2.230	• HYDROGEN EMBRITTLEMENT AND STRUCTURAL RESPONSE TO H_2 EXPLOSIONS • INTERACTIVE PIPE SAFETY ASSESSMENT CODE • PRESSURIZED THERMAL SHOCK
OPERATING EFFECTS	3,350	6,330	2,980	• STRESS CORROSION CRACKING (SCC) IN BWR PIPING • TOUGHNESS LOSS IN CAST STAINLESS STEEL
NON-DESTRUCTIVE EXAMINATION	2.000	2,900	900	• REAL-TIME, IMPROVED FLAW DETECTION
TOTAL	8,600	14,710	6,110	

278 189

112

PRIMARY SYSTEM INTEGRITY

FY 1981

MINIMUM PROGRAM

$6.58 MILLION

FRACTURE MECHANICS

- FABRICATE INTERMEDIATE TEST VESSEL FOR LOW-SHELF MATERIAL.
- VALIDATE TEARING INSTABILITY CONCEPT FOR ELASTIC-PLASTIC ANALYSIS OF VESSELS AND PIPING USING AVAILABLE DATA.
- COMPLETE THERMAL SHOCK TESTING OF UNPRESSURIZED CYLINDERS.
- VALIDATE TWO-PHASE JET AND PIPE WHIP PREDICTIVE CODES - QUICK REFERENCE DATA FOR LICENSING.
- COMPLETE FRACTURE MECHANICS EVALUATION OF MOST LIKELY PIPING BREAKS AND MECHANICAL PROPERTY MEASUREMENTS OF PIPING STEELS.

OPERATING EFFECTS

- COMPLETE DUCTILE SHELF FRACTURE TOUGHNESS CHARACTERIZATION OF LOW-SHELF WELD METALS TO UPDATE THE K_{IR} CURVE AND 10CFR50 RULES.
- PROVIDE DATA FOR CODE AND REG. GUIDE ON REACTOR VESSEL ANNEALING.
- COMPLETE IRRADIATED CRACK GROWTH RATE DATA TO UPDATE ASME CODE.
- MEASURE MECHANICAL PROPERTIES FROM TEST SPECIMENS FROM VESSEL WALL SURVEILLANCE AND DOSIMETRY ASSEMBLY.
- COMPLETE CONSTRUCTION OF TEST BED FOR RETIRED STEAM GENERATOR.
- COMPLETE MODELS TO PREDICT STRESS CORROSION CRACKING IN STEAM GENERATOR TUBING.

PRIMARY SYSTEM INTEGRITY

FY 1981

MINIMUM PROGRAM (CONT.)

$6.58 MILLION

278 191

NON-DESTRUCTIVE EXAMINATION

- CONTINUE CONTINUOUS INTERNAL FRICTION MONITORING OF INTERGRANULAR STRESS CORROSION CRACKING (IGSCC) AND GENERAL CRACKING IN LWR COMPONENTS.
- BEGIN RESEARCH IN ACOUSTIC EMISSION MONITORING OF IGSCC AND GENERAL CRACKING IN LWR COMPONENTS.
- COMPLETE FIELD EVALUATION OF SAFT-UT.
- ESTABLISH PROBABILITY OF ULTRASONIC TESTING FOR FLAW DETECTION IN FERRITIC PIPING AND BI-METALLIC JOINTS.

278 192

PRIMARY SYSTEM INTEGRITY
(THOUSANDS OF DOLLARS)

FY 1981

	MIN.	CURRENT	Δ	
FRACTURE MECHANICS	2,280	3,480	1,200	• TEST AND ANALYZE RESULTS OF ITV FOR LOW-SHELF LIFE MATERIALS. • CARRY OUT SPECIFIC TESTS TO VALIDATE TEARING INSTABILITY. • DEVELOP REALISTIC FLAW DISTRIBUTION IN PIPING AND USE TO IMPROVE PROBABILITY OF PIPE BREAKS UNDER LOCA AND SSE LOADS.
OPERATING EFFECTS	2,700	3,730	1,030	• DEVELOP TEARING INSTABILITY PARAMETERS FOR LICENSING APPLICATION TO PRESSURE VESSELS AND PIPING. • CORRELATION BETWEEN MEASURED AND PREDICTED MECHANICAL PROPERTIES FROM SURVEILLANCE/DOSIMETRY EXPERIMENT. • INSTALL RETIRED STEAM GENERATOR IN TEST BED, BEGIN RESEARCH.

278 193

PRIMARY SYSTEM INTEGRITY
(THOUSANDS OF DOLLARS)

FY 1981 (CONT.)

	MIN.	CURRENT	Δ	
OPERATING EFFECTS (CONT.)				• VALIDATE PREDICTIVE MODELS FOR STRESS CORROSION CRACKING OF INCONEL STEAM GENERATOR TUBING.
NON-DESTRUCTIVE	1,600	2,700	1,100	• START DEVELOPMENT OF REAL-TIME, AUTOMATED FLAW DETECTION. • PROVIDE BASIS FOR CODE CASE FOR EDDY CURRENT STEAM GENERATOR INSPECTION. • EVALUATE NEW NON-CODE NDE TECHNIQUES.
TOTAL	6,580	9,910	3,330	

PRIMARY SYSTEM INTEGRITY
(THOUSANDS OF DOLLARS)

FY 1981

	CURRENT	REQ.	Δ	
FRACTURE MECHANICS	3,480	5,480	2,000	• HYDROGEN EMBRITTLEMENT AND STRUCTURAL RESPONSE TO H_2 EXPLOSION. • INTERACTIVE PIPE SAFETY ASSESSMENT CODE. • PRESSURIZED THERMAL SHOCK.
OPERATING EFFECTS	3,730	6,330	2,600	• STRESS CORROSION CRACKING IN BWR PIPING AND CARBON STEEL. • TOUGHNESS LOSS IN CAST STAINLESS STEEL COMPONENTS DUE TO THERMAL SHOCKING.
NON-DESTRUCTIVE	2,700	2,900	200	• REAL-TIME, IMPROVED FLAW DETECTION, ELIMINATION OR REDUCTION OF OPERATOR ERROR.
TOTAL	9,910	14,710	4,800	

278 194

PRIMARY SYSTEM INTEGRITY
(THOUSANDS OF DOLLARS)

	FY 1980 AMEND	FY 1981 AMEND	Δ	
FRACTURE MECHANICS	4,250	5,880	1,630	• CONTINUE HYDROGEN EMBRITTLEMENT AND STRUCTURAL RESPONSE TO H_2 EXPLOSIONS. • CONTINUE DEVELOPMENT OF INTERACTIVE PIPE SAFETY ASSESSMENT CODE. • CONTINUE PRESSURIZED THERMAL SHOCK TEST.
OPERATING EFFECTS	3,350	6,330	2,980	• CONTINUE STRESS CORROSION CRACKING (SCC) STUDY FOR BWR PIPING AND FERRITIC COMPONENTS. • CONTINUE TOUGHNESS LOSS STUDY FOR CAST STAINLESS STEEL DUE TO THERMAL SHOCKING.
NON-DESTRUCTIVE EXAMINATION	2,000	2,900	900	• CONTINUE REAL-TIME, IMPROVED FLAW DETECTION, ELIMINATION OR REDUCTION OF OPERATOR ERROR.
TOTAL	9,600	15,110	5,510	

278 196

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY
($ MILLIONS)

	PRES. FY 80	REQ. FY 81	△	
STRUCT. ENGR.	$2.28	$5.70	$3.42	• EXPERIMENTAL VERIFICATION OF STRUCTURAL FAILURE MODES AND SAFETY MARGINS • VERIFICATION OF COMPUTER CODES • INITIATE PHASE II OF SEISMIC SAFETY MARGINS RESEARCH PROGRAM (SSMRP) RELATED TO STRUCTURAL AREAS • CONTAINMENT BUCKLING • DAMAGE ASSESSMENT OF PLANT STRUCTURES.
MECH. ENGR.	$2.64	$5.80	$3.16	• INITIATE PHASE II OF SSMRP RELATED TO MECHANICAL AREAS • EXTEND LOAD COMBINATIONS BEYOND LOCA PLUS EARTHQUAKE • START EXPERIMENTAL PHASE OF PUMP, VALVE AND SNUBBER PROGRAM • CONTINUE PROGRAM TO VALIDATE MECHANICAL COMPUTER PROGRAMS • INITIATE ASSESSMENT OF ASME CODE REQUIREMENTS.
SITE SAFETY	$5.08	$6.50	$1.42	• MAKEUP AND INFLATION FROM PREVIOUS YEAR (FY 1979) • THROUGH-PUT INCREASES IN REGIONAL SEISMOLOGY OF NORTHWEST U.S., CHARLESTON, AND NEW MADRID AND IN EARTH STRESS MEASUREMENTS AND METEOROLOGICAL DISPERSION FIELD PROGRAMS.
EQUIPMENT	$0.2	$0.6	$0.4	• INSTRUMENT AND RECORDING EQUIPMENT FOR EXPERIMENTAL PROGRAMS.

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY
FY 1981
BASE PROGRAM - MINIMUM LEVEL
$12.6 MILLION

278 197

- ASSESS FACTORS CONTRIBUTING TO SEISMIC RISK
- DEVFLOP FAILURE PROBABILITIES OF THE REFERENCE PLANT FOR INCREASING EARTHQUAKE SIZES
- ASSESS CURRENT METHODS TO DEFINE EQUIVALENT SEISMIC INPUT
- PERFORM PROBABILISTIC ANALYSIS OF CURRENTLY PRESCRIBED LOAD COMBINATIONS
- PLANS FOR EXPERIMENTAL VERIFICATION OF FAILURE MODES AND SAFETY MARGINS
- DEVELOP LIMITED QUALITATIVE INSIGHTS INTO: SEISMIC BEHAVIOR OF COMPONENTS; RELIABILITY OF PUMPS, VALVES AND SNUBBERS; DAMAGE EVALUATION TECHNIQUES TO REQUALIFY DAMAGED PLANTS
- PROVIDE GUIDANCE ON LOAD COMBINATIONS AND VALIDATION OF COMPUTER CODES
- COMPLETE 5 YEAR INCREMENT OF SEISMOTECTONIC STUDIES IN NORTHEAST, CHARLESTON, NEW MADRID AND NEMAHA REGIONS
- COMPLETE SOIL FOUNDATION PROPERTIES AND EARTHQUAKE RESPONSE STUDIES, AND EARTHQUAKE SOURCE MODELING STUDIES
- COMPLETE TORNADO HAZARD REGIONALIZATION AND LAB MODEL LOADING STUDIES
- CONDUCT FULL-SCALE FIELD EXPERIMENTS ON ATMOSPHERIC DISPERSION AT COASTAL AND RIVER VALLEY SITES.

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY
FY 1981
($ MILLIONS)

	MINIMUM	CURRENT	△	
STRUCT. ENGR.	$3.20	$3.90	$0.70	• ACCELERATE DEVELOPMENT OF REALISTIC SEISMIC MODELS • STAFF POSITIONS FOR WATER HAMMER EFFECT AND SHORT-TERM SEISMIC DESIGN CRITERIA • FRAGILITY CURVES FOR SSMRP
MECH. ENGR	$3.20	$3.80	$0.60	• EXTEND ASSESSMENT OF LOAD COMBINATIONS • CONDUCT EXPERIMENTS TO DETERMINE PUMP, VALVE AND SNUBBER RELIABILITY • AVOID DELAYS IN SSMRP • DAMAGE ASSESSMENT TECHNIQUES EXTENDED TO LOW LEVEL DAMAGE
SITE SAFETY	$6.20	$6.20	$0.0	• CURRENT ACTIVITY SAME AS MINIMUM

278 199

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY
FY 1981
($ MILLIONS)

	CURRENT	REQUESTED	Δ	
STRUCT. ENGR.	$3.90	$5.70	$1.80	• VERIFICATION OF COMPUTER CODES • EVALUATION OF NEW CONCEPTS • DAMAGE ASSESSMENT OF PLANT STRUCTURES • ENHANCEMENT OF SSMRP
MECH. ENGR.	$3.80	$5.80	$2.00	• MORE ACCURATE ASSESSMENT OF SEISMIC METHODOLOGY UNCERTAINTIES • DEVELOP FRAGILITY CURVES • IDENTIFY ADDITIONAL LOAD COMBINATIONS • DEVELOP SEISMIC RESTRAINT DEVICES • ASSESS ASME CODE LIMITS • ADDRESS SHORT-TERM USER REQUESTS
SITE SAFETY	$6.20	$6.50	$0.30	• STUDIES OF GEOLOGIC STABILITY OF WASTE DISPOSAL SITES • ADDITIONAL GEOPHYSICAL PROFILING IN EARTHQUAKE ZONES • MORE COMPREHENSIVE ATMOSPHERIC DISPERSION TESTS • MINIMUM METEOROLOGICAL MONITORING REQUIREMENTS

SEISMIC, STRUCTURAL, MECHANICAL AND SITE SAFETY
($ MILLIONS)

	FY 80 AMEND	FY 81 AMEND	Δ	
STRUCT. ENGR.	\$3.00	\$6.00	\$3.00	• EXPERIMENTAL VERIFICATION OF STRUCTURAL FAILURE MODES • ACCELERATE PROGRAM ON CONTAINMENT SAFETY MARGIN AND EFFECTS OF HYDROGEN EXPLOSION • VERIFICATION OF COMPUTER CODES • INITIATE PHASE II OF SEISMIC SAFETY MARGINS RESEARCH PROGRAM (SSMRP) RELATED TO STRUCTURAL AREAS • CONTAINMENT BUCKLING • DAMAGE ASSESSMENT OF PLANT STRUCTURES.
MECH. ENGR.	\$3.92	\$7.40	\$3.48	• ACCELERATE ANALYSIS AND EXPERIMENTS ON PUMP AND VALVE OPERABILITY • ACCELERATE PROGRAM ON DAMAGE ASSESSMENT TECHNIQUES FOR MECHANICAL COMPONENTS • INITIATE EXPERIMENTAL VERIFICATION OF MECHANICAL COMPUTER CODES • INITIATE PHASE II OF SSMRP RELATED TO MECHANICAL AREAS • EXTEND LOAD COMBINATIONS BEYOND LOCA PLUS EARTHQUAKE • INITIATE ASSESSMENT OF ASME CODE REQUIREMENTS
SITE SAFETY	\$5.08	\$6.50	\$1.42	• MAKEUP AND INFLATION FROM PREVIOUS YEAR (FY 1979) • THROUGH-PUT INCREASES IN REGIONAL SEISMOLOGY OF NORTHWEST U.S., CHARLESTON, AND NEW MADRID AND IN EARTH STRESS MEASUREMENTS AND METEOROLOGICAL DISPERSION FIELD PROGRAMS.

278 200

183

278 201

LMFBR PROGRAM

(IN MILLIONS)

ACTIVITY	FY 80	FY 81	△	COMMENT
ANALYSIS	5.4	7.8	2.4	• COMPLETE & RELEASE ACCIDENT CODES
SAFETY TEST FACILITY STUDIES	0	0.7	0.7	• REACTIVATE ARSR PROGRAM
MATERIALS INTERACTION	2.8	4.6	1.8	• DESIGN/FABRICATE ACRR SODIUM LOOP
AEROSOL RELEASE & TRANSPORT	2.2	3.0	0.8	• CORE MELT AEROSOL SOURCE AND TRANSPORT
SYSTEM INTEGRITY	3.3	6.0	2.7	• CONTAIN QUALIFICATION • LARGE CORE MELT RETENTION TESTS
TOTAL	13.7	22.1	8.4	

184

FY 81 LMFBR PROGRAM

ANALYSIS $ 7.8 M

278 202

- ISSUE CONTAIN-II, BIFLO AND SSC-S CODES
- COMPLETE 2-PHASE COMMIX-2 AND BODYFIT CODES
- COMPLETE PHASE-2 OF ACCIDENT DELINEATION STUDY
- CONTINUE CODE QUALIFICATION PROGRAMS

SAFETY TEST FACILITY STUDIES $ 0.7 M

- REACTIVATE NRC PROGRAM

278 203

FY 81 LMFBR PROGRAM

MATERIALS INTERACTION $ 4.6 M

- ACRR LOOP DESIGN / FABRICATION
- ACRR 7-PIN ACCIDENT ENERGETICS CAPSULE TESTS
- ACRR FUEL DISPERSAL TESTS -- IRRADIATED FUEL
- ACRR TRANSITION PHASE TESTS

186

278 204

FY 81 LMFBR PROGRAM

AEROSOL RELEASE & TRANSPORT

- CORE MELT AEROSOL SOURCE TERM
- NSPP CORE MELT AEROSOL TRANSPORT
- FAST NA TESTS -- HCDA SOURCE
- HAARM-3 EXTENSION TO CORE MELT

187

278 205

FY 81 LMFBR PROGRAM

SYSTEM INTEGRITY $ 6.0 M

- CONTAIN QUALIFICATION
- LARGE CORE MELT RETENTION TESTS
- ACRR CORE DEBRIS COOLABILITY TESTS
- TESTS ON CELL LINER RESPONSE TO ACCIDENT LOADS

278 206

ADVANCED CONVERTERS

ACTIVITY	FY 80 (PRES.)	FY 81 (REQ.)	COMMENT
GCR	0*	3.9	CONTINUE MIN. MAINTENANCE PROGRAM

*EXPECT $3.7M TO BE MANDATED BY CONGRESS

FY 81 ADVANCED CONVERTERS PROGRAM

278 207

<u>GCR</u> $3.9 M

- COMPLETE CORE SUPPORT BLOCK (PGX) TESTS
- QUALIFY FSV TRANSIENT ANALYSIS CODES
- COMPLETE FSV CONVECTIVE PLUME HEAT TRANSFER TESTS

170

FY 80 SUPPLEMENT FOR SAFETY RESEARCH

BUDGET SUMMARY

Category	($ Million)
Better Understanding of Transient and Small LOCA Accidents	$ 13.4
Enhanced Operator Capability	3.8
Plant Response Under Accident Conditions	5.1
Post Mortem Examination and Plant Recovery	2.7
Improved Risk Assessment	3.1
Improved Reactor Safety	1.7
	$ 29.8

278 208

139

278 209

Better Understanding of Transient and Small LOCA Accidents	($Million)
Modifications and Checking of Existing Codes to Improve their Capability to Handle Transient, Natural Circulation and Small LOCA Accidents in PWRs and BWRs	$ 3.1
Upgrade Semiscale to Study PWR Transients	3.0
Upgrade TLTA to Study BWR Transients and Small LOCA	2.2
Modify LOFT to Accelerate Small LOCA Tests	1.0
Separate Effects and Thermal-Hydraulic Tests	1.3
Coolability of Severly Damaged Cores; Release and Transport of Fission Products	2.4
Establish Data Bank for Each Operating Reactor for NRC Calculations	0.4
	$13.4

278 210

Enhanced Operator Capability	($Million)
Develop Improved Control Room Display and Diagnostic Systems and Improved Requirements for Operator Training Simulators	$ 1.8
Develop Instrumentation Needs and Improved Status Monitoring of ESF's	1.0
Define Data Transmission Requirements and Review Accident Response Procedures	1.0
	$ 3.8

141

278 211

Plant Response Under Accident Conditions	($Million)
Improved Understanding of Coolant Chemistry after Fuel Failure; Better Sampling Methods	$ 0.5
Hydrogen Behavior in Coolant and Containment; Effect of Hydrogen Explosions	1.2
Response of Plant Equipment and Structures to Accident Conditions	2.1
Potential Design Improvements for Maintaining Containment Integrity under Fuel Melt Conditions	0.5
Benchmark Testing of Structural and Piping System Analysis Codes	0.8
	$ 5.1

14-

278 212

Post Mortem Examination and Plant Recovery	($Million)
Examine Samples of TMI Damaged Fuel	$ 1.0
Measure Fission Product Chemistry and Plateout Data	0.6
Post Mortem of TMI Safety Related Equipment and Establish Requalification Criteria	1.1
	$ 2.7

143

Improved Risk Assessment	($Million)
Develop Event Trees of Accidents Leading to Severe Core Damage and Assess Site Specific Accident Consequences	$ 1.4
Analysis of Human Error Rates and Impacts of Human Errors on Risk	1.2
Operational Failure Data Analysis	0.5
	$ 3.1

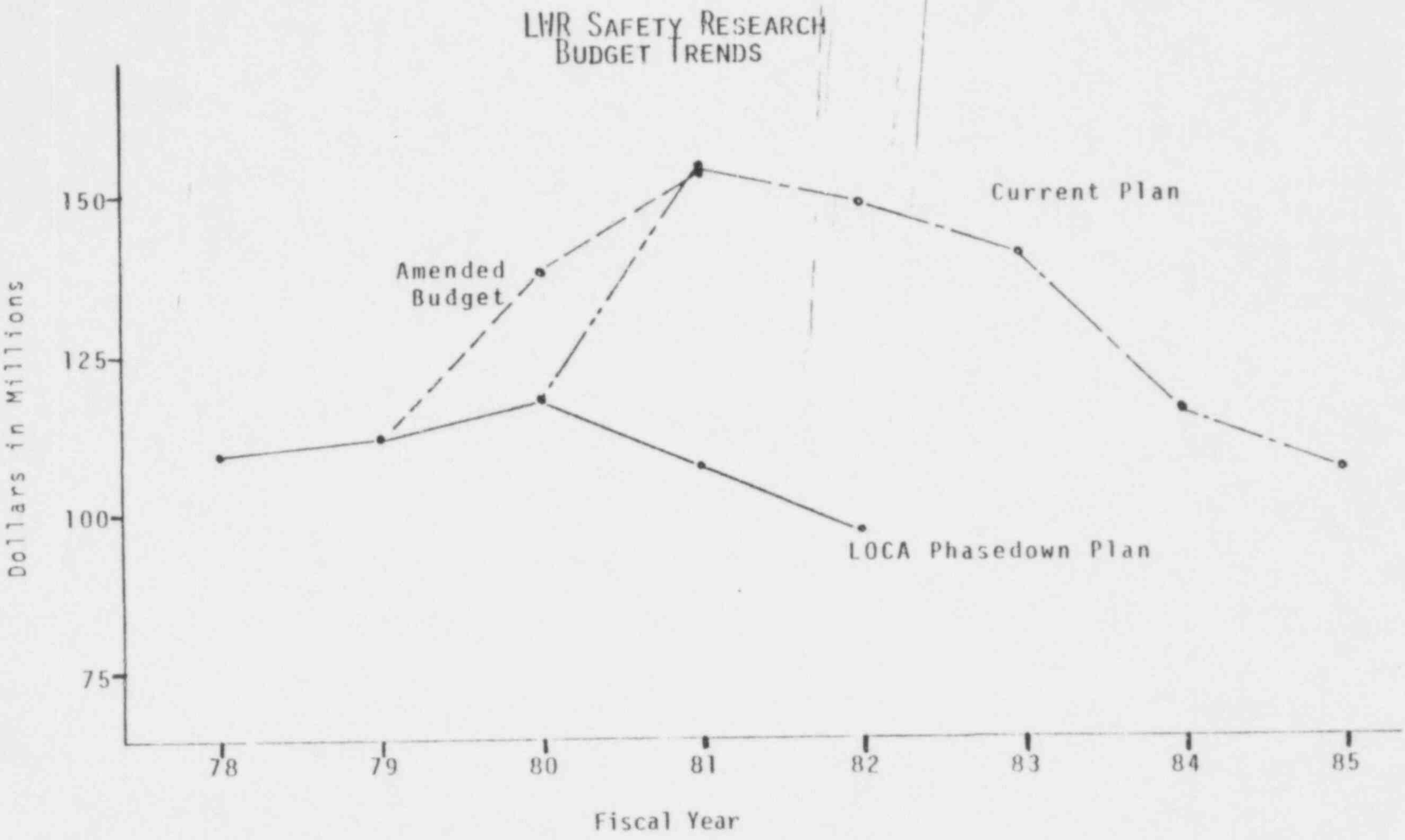
278 214

Improved Reactor Safety	($Million)
Improved Containment Concepts	$ 0.5
Improved Safety Systems for Coping with Accidents	1.0
Improved Value/Impact Methodology	0.2
	$ 1.7

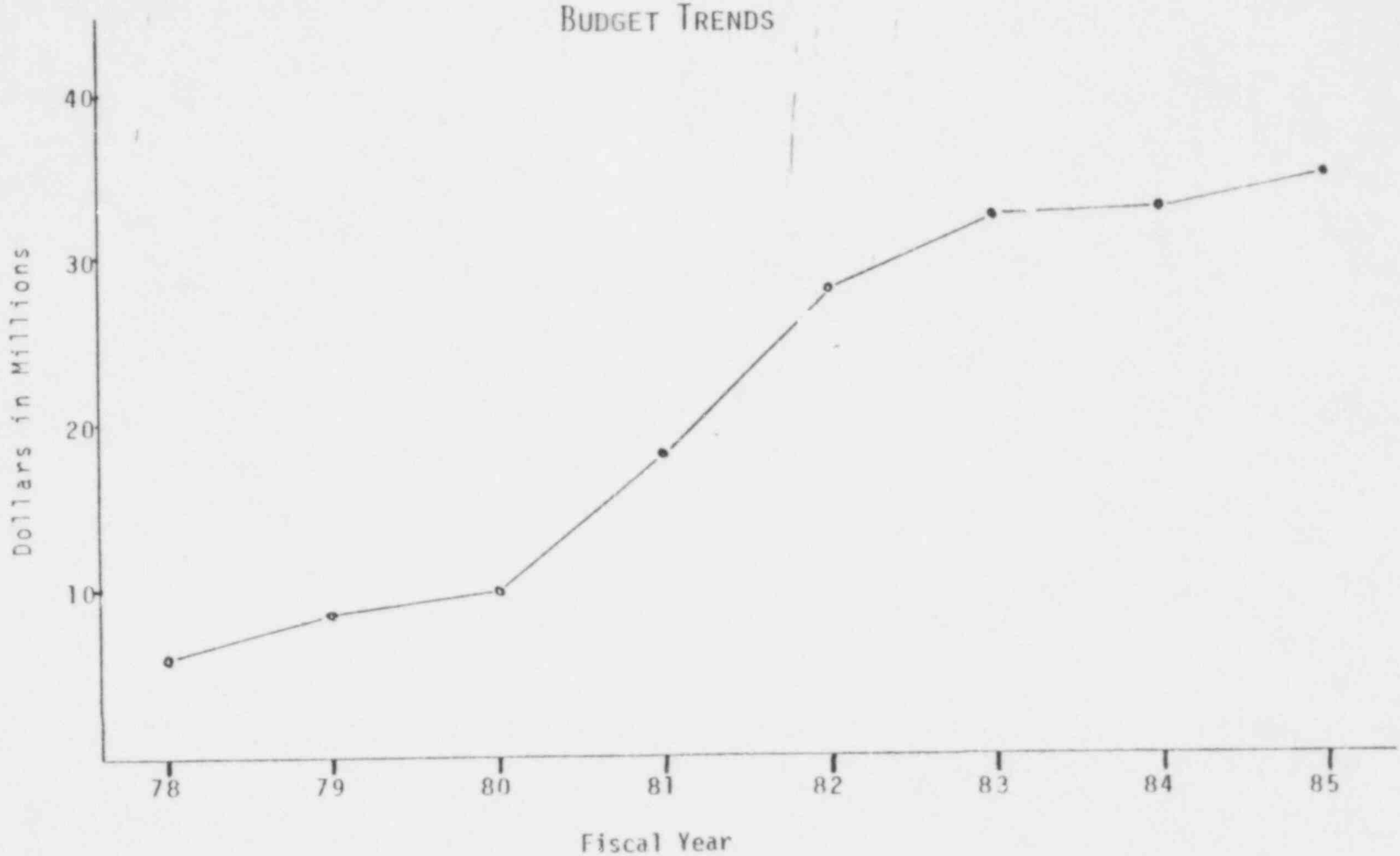
6-19-79

136

278 215

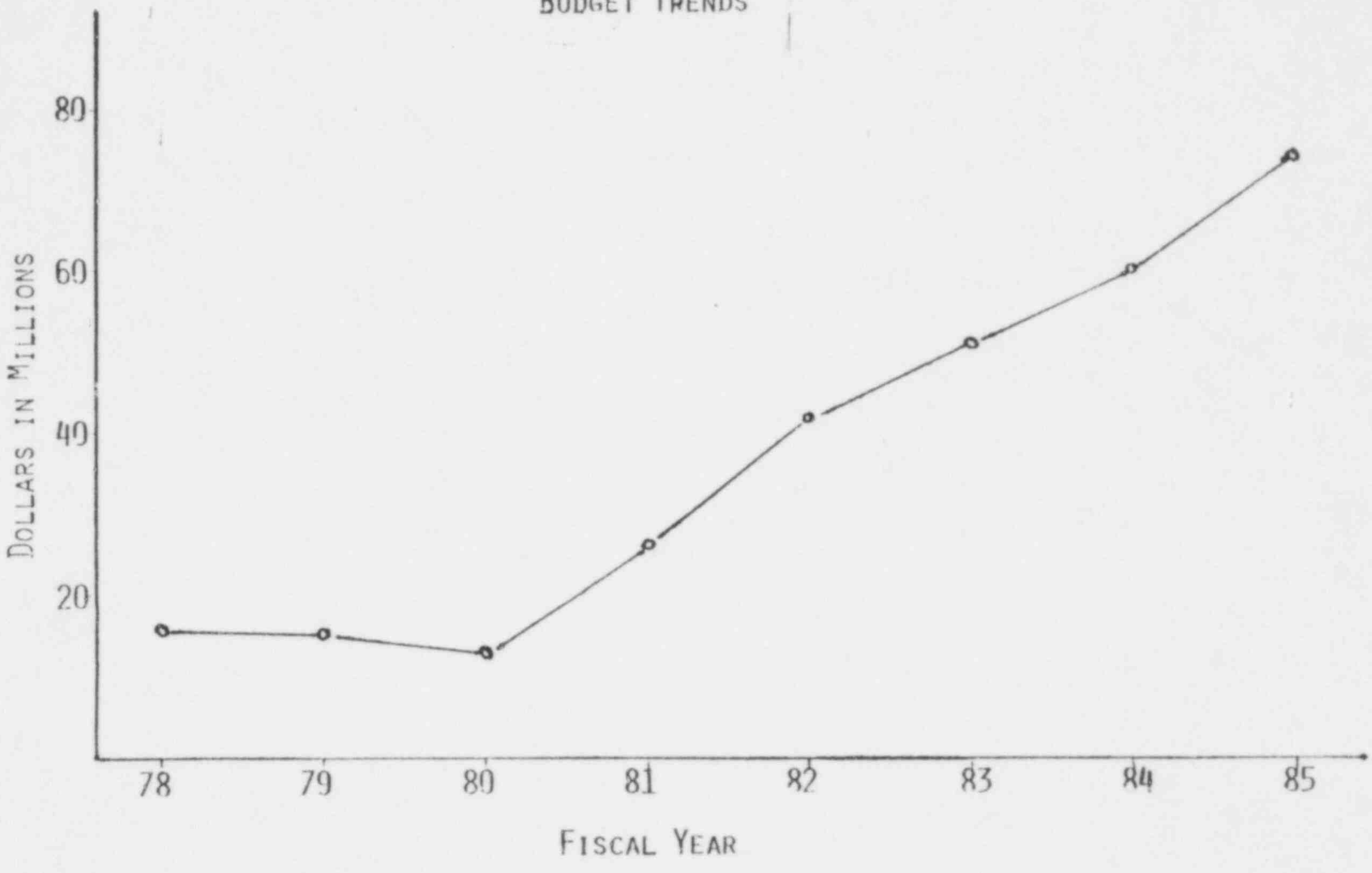


Seismic, Engineering, and Site Safety Budget Trends



278 216

ADVANCED REACTOR SAFETY RESEARCH
BUDGET TRENDS



278 217

RESEARCH PROGRAMS' REVIEW

FOR THE

ACRS SUBCOMMITTEE ON ECCS

SEPARATE EFFECTS RESEARCH BRANCH

JUNE 20, 1979

A. W. SERKIZ
ACTING BRANCH CHIEF

97

278 219

SERB RESEARCH PROGRAMS

. SEMISCALE

. BLOWDOWN AND REFLOOD HEAT TRANSFER

. . PWR BDHT AT ORNL

. . BWR BD/ECC AT GE (SAN JOSE)

. . BWR CCFL AT GE (LYNN)

. . FLECHT SEASET AT WESTINGHOUSE (PITTSBURGH)

. MODEL DEVELOPMENT

. TECHNICAL SUPPORT

278 220

"SYSTEMS ENGINEERING" DECISION UNIT

. SEMISCALE

. BLOWDOWN AND REFLOOD HEAT TRANSFER

. 2D/3D

. MODEL DEVELOPMENT

  . . SERB

  . . ADB

. OPERATIONAL SAFETY (RSB)

. TECHNICAL SUPPORT

  . . SERB

  . . RSB

. GENERAL SUPPORT

SEPARATE EFFECTS RESEARCH BRANCH

	FY 1979
. SEMISCALE	$ 6.2M
. BD AND RF HEAT TRANSFER	7.0M
. ECC BYPASS (SMALL SCALE)	1.7M
. MODEL DEVELOPMENT	1.5M
. TECHNICAL SUPPORT	1.2M
SERB TOTAL	$17.6M

SYSTEMS ENGINEERING DECISION UNIT = $33.7M

278 221

CURRENT ACTIVITIES

- PROGRAMS UNDER REVIEW TO ADDRESS TMI-2 LESSONS LEARNED
- DE-EMPHASIZE LARGE LOCA RESEARCH
- CONCLUDE PROGRAMS UNDERWAY
- ADDRESS NEW RESEARCH REQUIREMENTS
- RETHINK FY 1980 EFFORT AND REDIRECT
- REQUEST SELECTIVE FY 1980 AND FY 1981 BUDGET SUPPLEMENTS

SEPARATE EFFECTS RESEARCH BRANCH

BUDGET OVERVIEW

	FY 1979	FY 1980		FY 1981 (REQ)	
		(PRES. BUDGET)	(TMI_{Δ})	(REQ'D)	(W/Δ_{80})
. SEMISCALE	$ 6.2M	6.7M	$3.5M	$10.2M	$ 8.1M
. BD AND RF H.T.	7.0M	6.2M	3.0M	9.4M	8.4M
. ECC BYPASS	1.7M	0.9M	-	0.5M	0.5M
. MODEL DEVEL.	1.5M	1.9M	-	0.5M	0.5M
. TECH. SUPPORT	1.2M	1.0M	-	1.1M	1.1M
	$17.6M	$16.7M	$6.5M	$22.7M	$19.6M

NOTES:

1. FY 1981 ESTIMATES ARE PRELIMINARY AND UNDER REVIEW

2. FY 1980 ESTIMATES ARE PRE-TMI DISTRIBUTIONS PER THE PRESIDENTS BUDGET

SEMISCALE OVERVIEW

. FY 1979, CONDUCT UHI EXPERIMENTS

. DOWNCOMER VOIDING AND OSCILLATORY BEHAVIOR (REF. S-06-7 EXPERIMENT)

. MASS DEPLETION STUDIED, ADDITIONAL TESTS RUN

.. EXCESSIVE HEAT FROM DOWNCOMER WALLS
.. CORE BACKFLOW AND HIGH CORE STEAMING RATES

. TMI SUPPORT EXPERIMENTS

.. GAS BUBBLE VENTING

.. TMI TRANSIENT SIMULATION

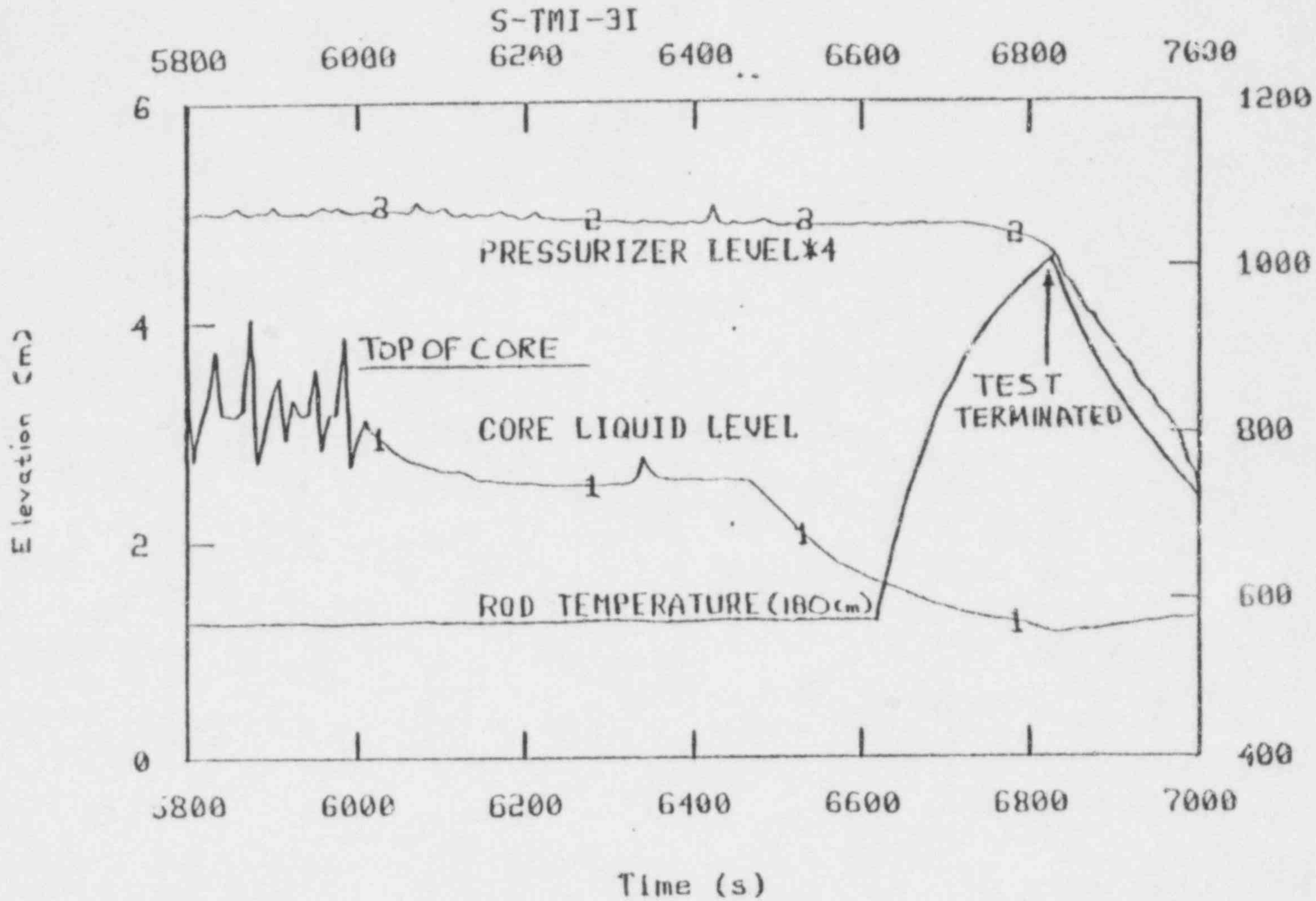
. PROGRAM REDIRECTION RECOMMENDED

.. MOVE SMALL BREAK TEST UP (JULY - SEPTEMBER 1979)

.. SYSTEM UPGRADE EFFORTS (OTSG, ADDITIONAL PRIM. PUMP ADD SECONDARY LOOPS)

278 224

COMPARISON OF CORE AND PRESSURIZER LEVEL WITH ROD CLAD TEMPERATURES - TEST TMI-3I



278 225

278 226

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SEMISCALE PROGRAM SCOPE

PRE-TMI (FY 79-81)

FOCUS:	LOSS-OF-COOLANT ACCIDENT (WESTINGHOUSE UHI DESIGN)
TEST PROGRAMS:	MOD-3 BASELINE TESTS
	SMALL BREAK LICENSING EVALUATION
	SMALL BREAK TESTING
	MOD-3 INTERIM EVALUATION TESTS
	UHI ECC TESTS
	TWO-PIPE DOWNCOMER SEPARATE EFFECTS
	TWO-PIPE DOWNCOMER INTEGRAL TESTS
SYSTEM MODIFICATIONS:	INTERNAL WALL INSULATION
	TWO-PIPE DOWNCOMER
	MOD-2 CONFIGURATION

278 227

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PRELIMINARY SEMISCALE PROGRAM SCOPE

POST - TMI (FY 79 - 81)

FOCUS:	OPERATIONAL TRANSIENTS / SMALL BREAK (WESTINGHOUSE, B & W DESIGNS)
TEST PROGRAMS:	MOD-3 BASELINE TESTS SMALL BREAK LICENSING EVALUATION SMALL BREAK TESTING LOSS-OF-FEEDWATER TRANSIENTS UHI ECC TESTS CLOSED LOOP VERIFICATION TESTS (WESTINGHOUSE CONFIGURATION) NATURAL CIRCULATION TESTS (SINGLE-PHASE, REFLUX) B & W CONFIGURATION BASELINE TESTS
SYSTEM MODIFICATIONS:	INTERNAL WALL INSULATION MOD-2 CONFIGURATION CLOSED LOOP SECONDARY B & W CONFIGURATION

PRELIMINARY SEMISCALE BUDGET ESTIMATES

FY-1979 - FY-1980

ACTIVITY	PRE-TMI 1979	PRE-TMI 1980	PRE-TMI 1981	POST-TMI 1979	POST-TMI 1980	POST-TMI 1981	DIFFERENTIAL
LEVEL OF EFFORT, OPERATIONS & SUPPORT	5170	4940	5225	5170	5290	5505	+630
TESTING	345	855	775	398	452	624	-501
CONVERSIONS							
TWO-PIPE CONVERSION	620	240	30	620	135	-0-	-135
MOD-2 CONVERSION	70	415	470	70	435	340	-110
CLOSED LOOP SECONDARY	-0-	-0-	-0-	100	1541	-0-	+1641
B&W CONFIGURATION	-0-	-0-	-0-	100	2035	1565	+3700
CE CONFIGURATION	-0-	-0-	-0-	-0-	100	600	+700
TOTALS	6205	6450	6500	6458	9988	8634	5925
DIFFERENTIAL BY YEAR				+253	+3538	+2134	

278 228

106

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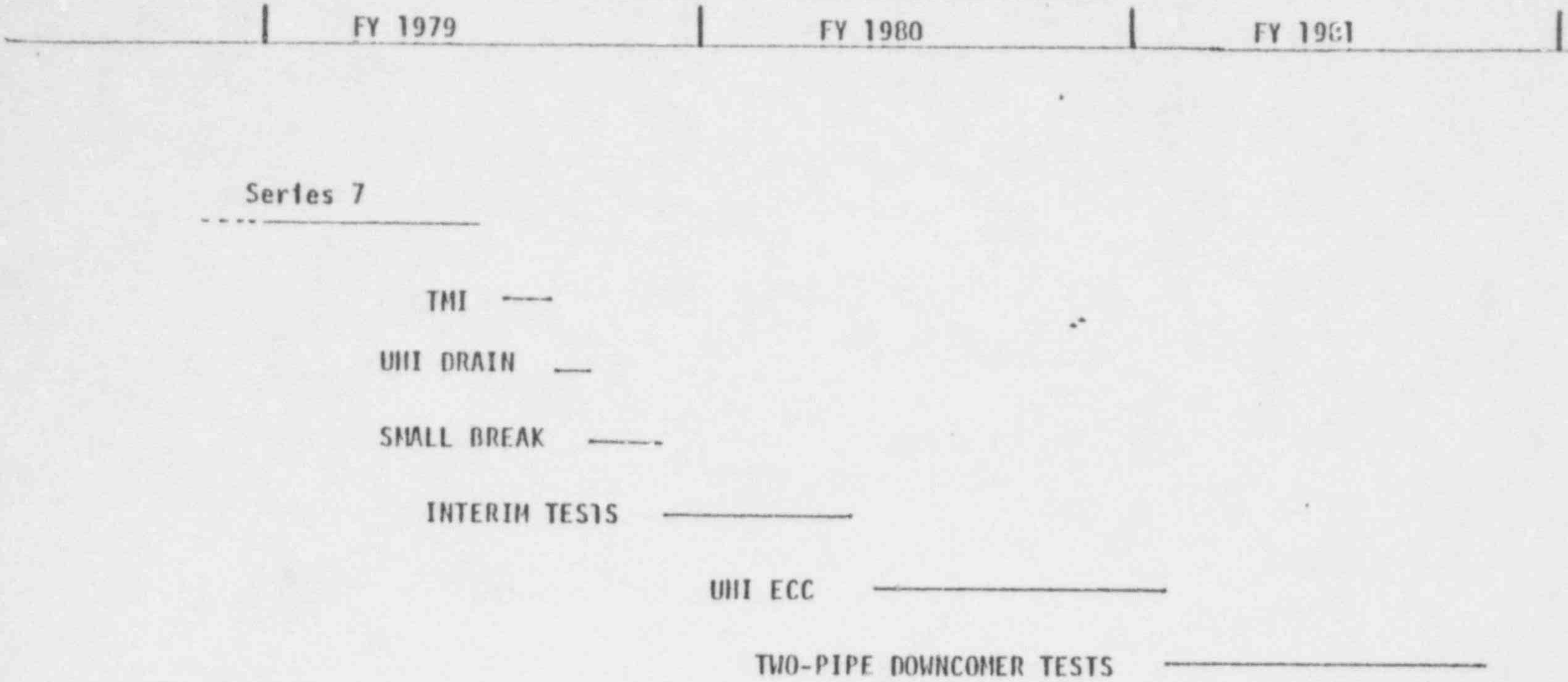
SEMISCALE PROGRAM EXISTING SCHEDULE



278 229

103

PROPOSED SEMISCALE PROGRAM SCHEDULE

| FY-1979 | FY-1980 | FY-1981 |

Series 7

TMI ——

UHI Drain —

Small Break ————

Test S-07-6 Repeat △

Loss-of-Feedwater Tests ————————

Closed Loop Sec Install ↓

UHI ECC ————

Closed Loop Sec Verif —

W Op Tran Tests —?— Facility Down

B&W Config Install ↓

NOTE: IN PRELIMINARY PLANNING STAGE

278 230

BLOWDOWN AND REFLOOD HEAT TRANSFER

- PWR BDHT (B0125)
- BWR BD/ECC (B3014)
- BWR CCFL (B5877)
- FLECHT SEASET (B6204)
- TECHNICAL SURVEILLANCE AT INEL (A6039)

278 231

PROJECTED COSTS SUMMARY

BLOWDOWN AND REFLOOD HEAT TRANSFER PROGRAMS

	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983
PWR BDHT	$ 4.3M	$ 4.1M	$ 2.9M	$ 1.9M	$ 0M
BWR BD/ECC	0.3M	-	<2.0M>	1.0M	1.2M
BWR CCFL	0.7M	1.4M	1.9M	1.0M	0.6M
FLECHT SEASET	1.4M	0.4M	1.5M	1.2M	0.9M
TECH. SURVEL.	0.3M	0.3M	0.3M	0.3M+	0.5M
	$ 7.0M	$ 6.2M	$ 6.8M	$ 5.6M	$ 3.2M

NOTES:

1. FY'S 1982 AND 1983 ESTIMATES INCLUDE EXTENDED TESTING

2. ESTIMATES STILL UNDER REVIEW, THESE ESTIMATES FOR ROUGH PLANNING PURPOSES

278 232

<u>PWR BDHT AT ORNL</u>

. TRANSIENT HEAT TRANSFER DATA FOR:--

.. TRANSITION BOILING

.. FILM BOILING

.. TRANSIENT CHF DATA

.. POST CHF BUNDLE DATA

. BUNDLE NO. 1 - COMPLETED TESTING

.. TIME TO CHF

.. GROSS BUNDLE DATA

.. SLOW DEPRESSURIZATION TESTS FOR NRR

.. BUNDLE BOILOFF INFORMATION (REF. TMI)

. BUNDLE NO. 3

.. HIGHLY INSTRUMENTED

.. TARGET FOR INSTALLATION = JULY 1, 1979

278 233

BUNDLE NO. 3 TESTS

. ISOTHERMAL AND REACTOR BLOWDOWN SIMULATION	3 EA
. FILM BOILING IN UPFLOW	4 EA
. FILM BOILING IN DOWNFLOW	3 EA
. TRANSITION BOILING	2 EA

- PLUS -

. QUASI-STEADY STATE EXPERIMENTS

278 234

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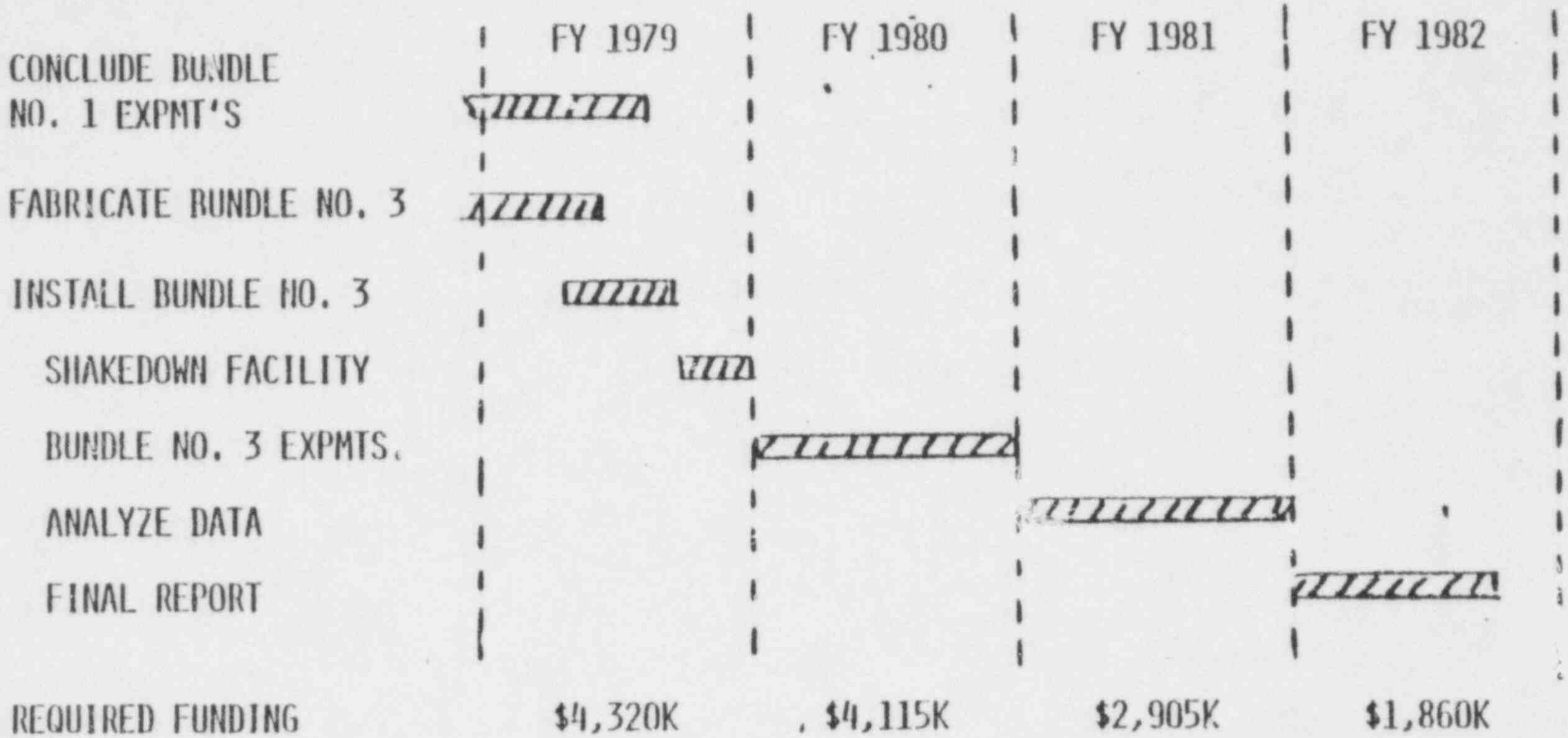
ORNL PWR BDHT PROGRAM OVERVIEW



278 235

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BWR RESEARCH

. BWR BLOWDOWN (TLTA)

. . CURRENTLY BD + REFILL

. . UPGRADE PROPOSED

. BWR CCFL (LYNN, MASSACHUSETTS)

. . UPPER PLENUM PHENOMENA (SPRAYS)

. . FLOODING AT UPPER CORE TIE PLATE

278 236

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278 237

TLTA UPGRADE FOR LOCA TESTING

- LOCA TESTING OF BLOWDOWN + REFLOOD
- THREE FULL LENGTH 8 X 8 BUNDLES
- UPGRADE INTERNALS
  - FULL HEIGHT JET PUMPS
  - SCALED PROTOTYPIC STEAM SEPARATOR
- IMPROVED BYPASS AND VOLUME (L.P.) SCALING
- SMALL BREAK TEST CAPABILITY

116

BWR TRANSIENTS UNDER CONSIDERATION

FOR TLTA EXTENSION

- FEEDWATER TRANSIENTS
- PRESSURIZING EVENT
- RELIEF VALVE CYCLING
- RECIRCULATION FLOW CHANGE
- ADS, LOW FLOW, MID-PRESSURE
- RCIC SPRAY INJECTION
- FLOW BLOCKAGE

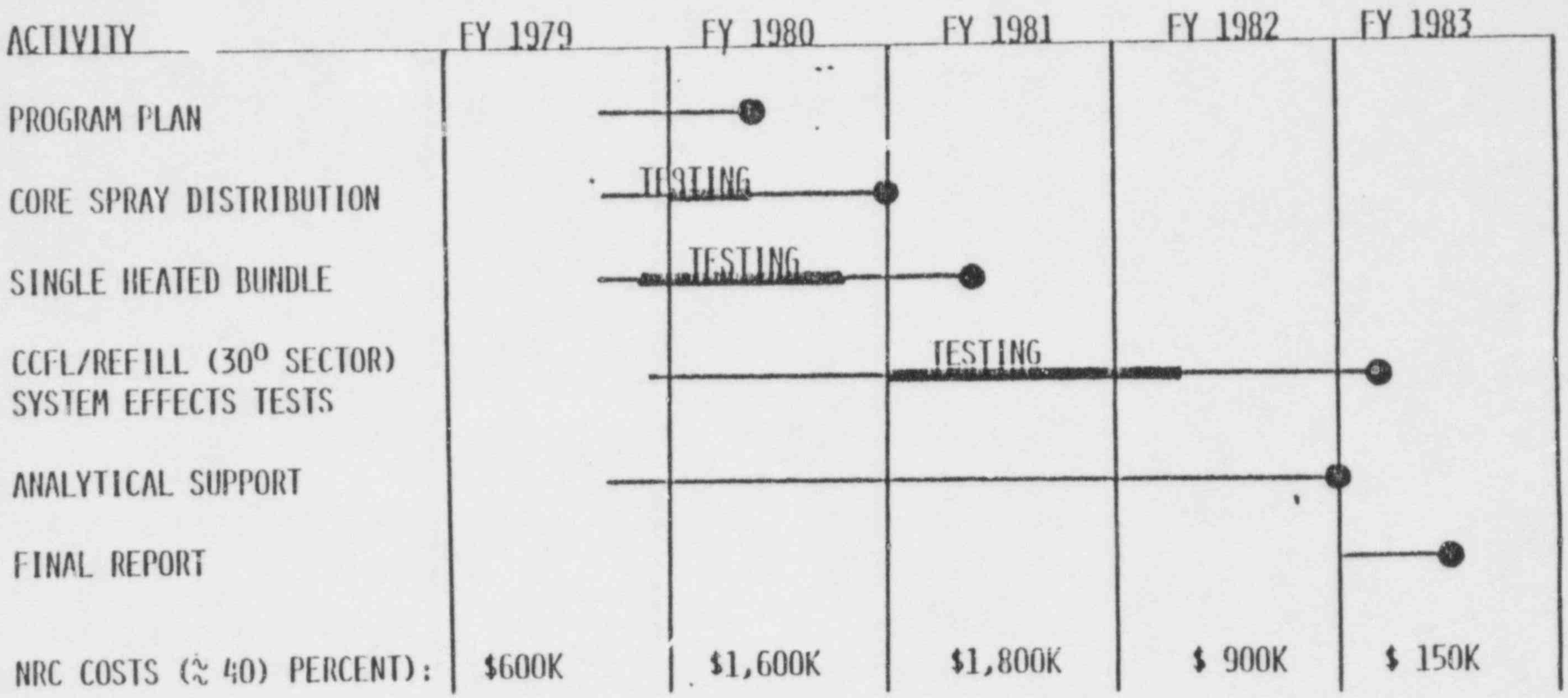
- PLUS -

- NATURAL CIRCULATION
- SINGLE LOOP OPERATION
- STABILITY TESTS

278 238

278 239

BWR REFILL - REFLOOD MAJOR TASKS



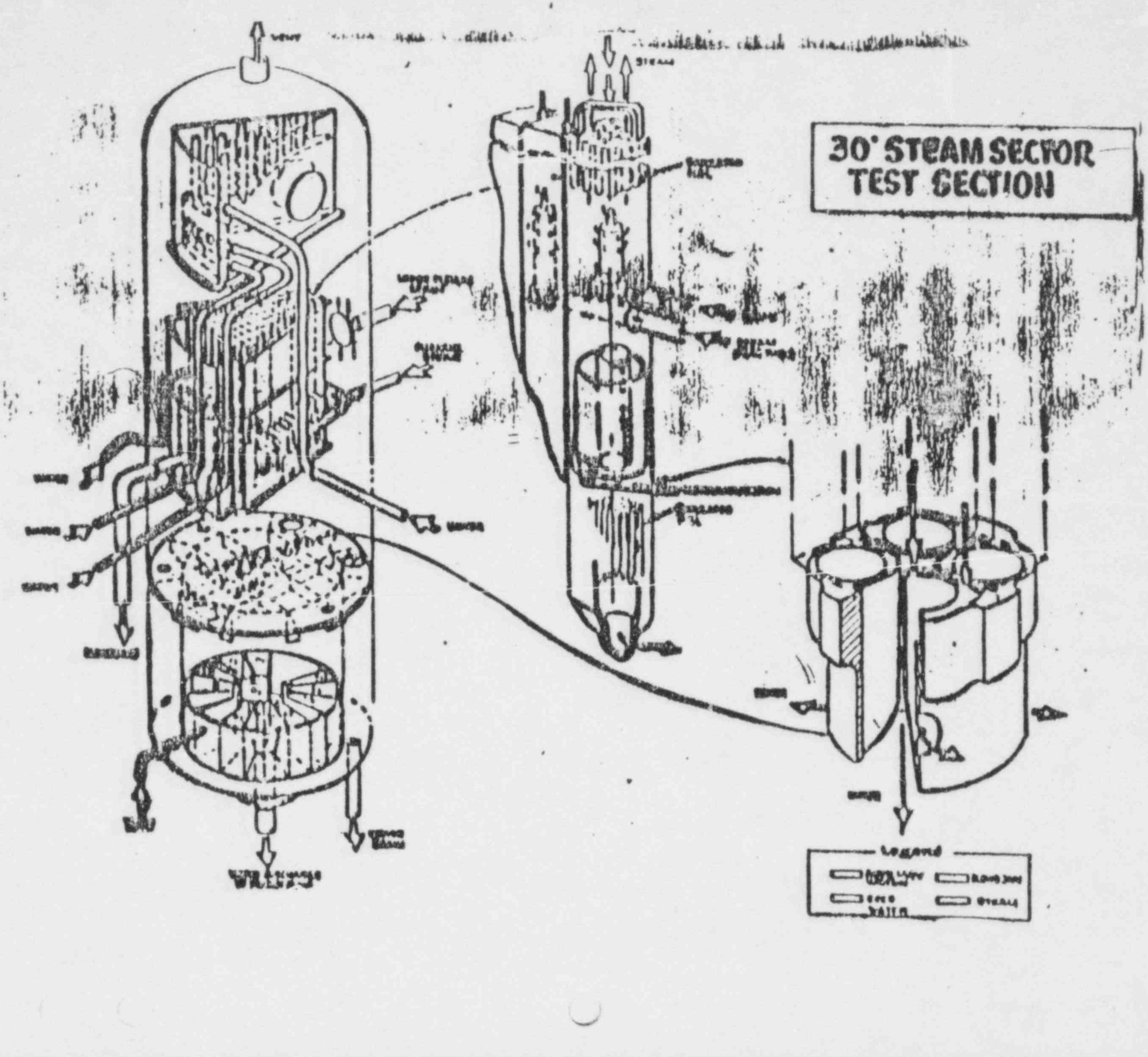
BWR CCFL/REFILL - REFLOOD PROGRAM

TESTING:

- CORE SPRAY DISTRIBUTION (30° SECTOR, BWR-4 AND BWR-6)
- SINGLE HEATED BUNDLE TESTS
- CCFL/REFILL SYSTEM EFFECTS TESTS (30° SECTOR)
- 360° UPPER PLENUM TESTS

ANALYSIS:

- DEVELOPE TRAC BWR MODELS
- COMPARE CODES AND EXPERIMENTS



278 241

FLECHT SEASET

- BUNDLE SEPARATE EFFECTS TESTS
  - 161 ROD 12 FOOT BUNDLE
  - PARAMETRIC REFLOOD STUDIES WITH AND WITHOUT BLOCKAGES
- STEAM GENERATOR SEPARATE EFFECTS TESTS
  - FULL HEIGHT U-TUBE DESIGN
  - PARAMETRIC STUDIES OF HEAT TRANSFER
- UPPER PLENUM SEPARATE EFFECTS TESTS
  - FULL HEIGHT WITH SIMULATED INTERNALS
  - PARAMETRIC STUDIES OF LIQUID/VAPOR SEPARATION
- SYSTEM EFFECTS TESTS
  - SCALED TWO LOOP PWR UTILIZING COMPONENTS STUDIED IN SEPARATE EFFECTS TESTS
  - PARAMETRIC STUDIES OF SYSTEM BEHAVIOR WITH ALTERNATE INJECTION LOCATIONS

278 242

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278 243

SMALL SCALE ECC BYPASS PROGRAMS

*BATTELLE COLUMBUS LABORITORIES - 1/15 AND 2/15 SCALE TESTS

*CREARE, INC. - 1/30 AND 1/15 SCALE TESTS

* DARTMOUTH COLLEGE - AIR/WATER FLOODING IN TUBES (2"-10")
AND ANNULI (1/7 AND 1/10 SCALE)

*COORDINATION WITH ADVANCED CODE DEVELOPMENT

122

SMALL SCALE ECC BYPASS PROGRAMS

- PROGRAMS NEARING COMPLETION
  - MAJOR REDUCTION IN EFFORT IN FY 1980
  - MINIMAL SUPPORT EFFORT BEYOND FY 1980
- RESEARCH INFORMATION LETTER SUMMARIZING SMALL SCALE ECC BYPASS RESULTS
  - DRAFT ISSUED FOR COMMENT APRIL 1979
  - TARGET DATE FOR FORMAL RELEASE JULY 1979

278 244

<u>PRELIMINARY HIGHLIGHTS ECC BYPASS RIL</u>

*PRESSURE EFFECT - ACCOUNTED FOR THROUGH STEAM PROPERTIES

EVIDENCE THAT J MAY BE BREAKING DOWN AT 2/15 SCALE

*EVIDENCE THAT CONDENSATION MAY BE INCREASING IN IMPORTANCE WITH INCREASING SCALE SIZE

*MOST UNCERTAINIES IN TRANSIENT HOT WALL MODEL CAN BE BOUNDED AND STILL PRODUCE RESULTS CONSERVATIVE WITH RESPECT TO CURRENT LICENSING CALCULATIONS

*DEFINITIVE RESULTS MUST AWAIT LARGE SCALE TESTING IN UPTF

278 245

/23

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278 246

FUTURE SMALL SCALE WORK

BATTELLE COLUMBUS LABORATORIES

* FLOW TOPOLOGY INSTRUMENTATION IN 2/15 VESSEL - COMPLETE, MAY 1979
* BREAK LEG SPOOL PIECE IN 2/15 VESSEL - JULY 1979
* TEST TO CONFIRM MAJOR RIL ITEMS - THROUGH 3RD QUARTER FY 1979
  MAY EXTEND THROUGH 4TH QUARTER
* TEST WITH EXPANDED 2/15 INSTRUMENTATION - LATE FY 1979 AND EARY FY 1980

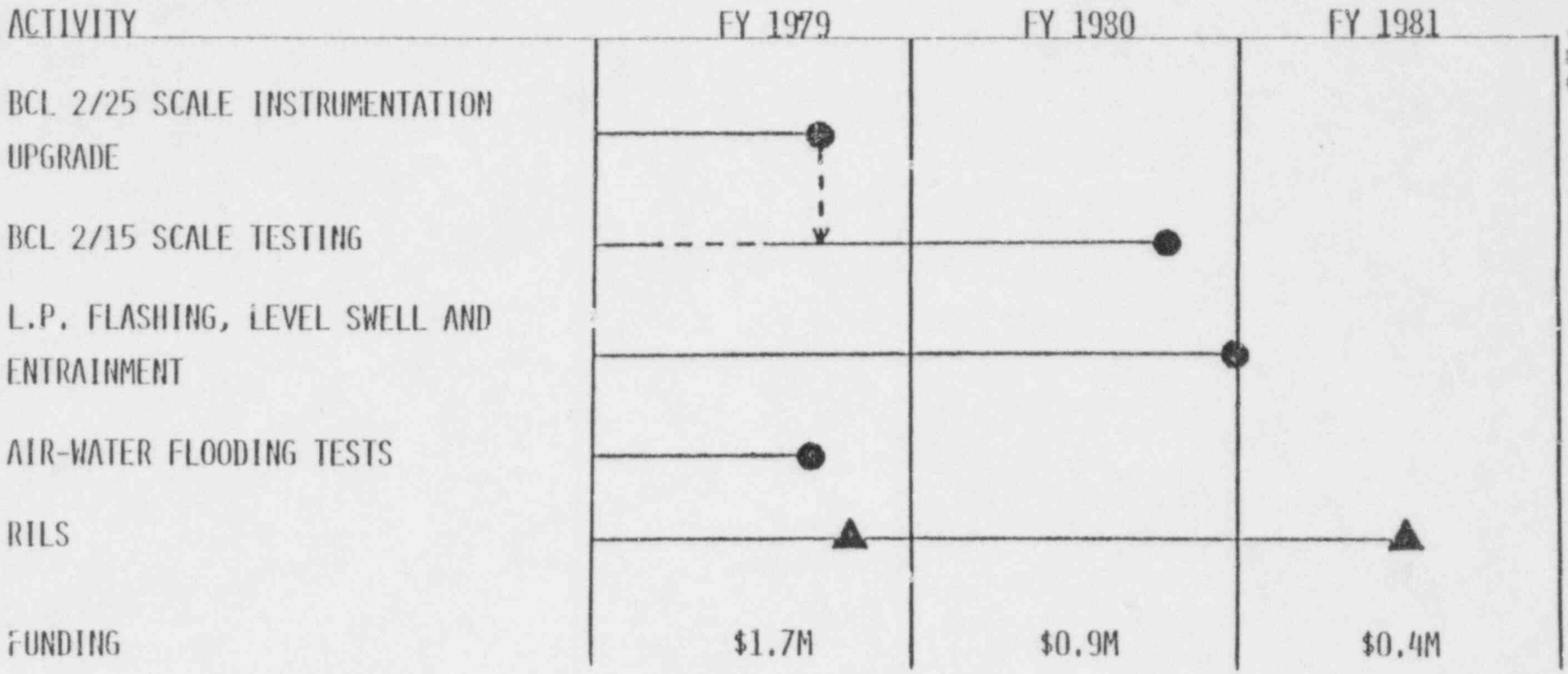
CREARE, INC.

* LOWER PLENUM VOIDING AND LEVEL SWELL TEST AND ANALYSIS
* COMBINED ECC PENETRATION/REFILL MODEL - TARGET END OF FY 1980

/25

SMALL SCALE ECC BYPASS PROGRAMS

MAJOR ACTIVITIES



278 247

MODEL DEVELOPMENT:

- ADDRESSES BASIC PHENOMENA
- CORRELATIONS AND MODELS DERIVED
- UNIVERSITIES AND NATIONAL LABS

278 248

126

127

SERB MODEL DEVELOPMENT

	FY 1979
ANL, TRANSIENT HEAT TRANSFER MODELING	$ 180K
BNL, NON-EQUIL. PHASE CHANGE STUDIES	330K
INEL, HEAT TRANSFER CORRELATIONS AND VERIFICATION	250K
LEHIGH, NON-EQUIL. HEAT TRANSFER	96K
MIT, REFLOOD THERMAL HYDRAULICS	75K
N-WEST, CONDENSATION RATES	50K
RPI, LWR SAFETY RESEARCH	228K
SUNY, DROPLET ENTRAINMENT	150K
U-WASH, TWO PHASE FLOW REGIMES	100K
	$1,459

278 249

SERB MODEL DEVELOPMENT

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THERMAL HYDRAULIC MODELING

. MODES OF NATURAL CIRCULATION DURING REFLOOD

. . 2 X 6 ROD TEST SECTION (HOT VERSUS COLD REGIONS)

. . LIQUID FLOW STUDIED

. STEAM GENERATOR MODELING DURING REFLOOD

. . 4 U-TUBE STEAM GENERATOR

. . FLOW REGIMES STUDIED AS FUNCTION OF AIR AND LIQUID VELOCITIES

. GRAVITY FEED REFLOOD OSCILLATIONS

. . MODEL BEING DEVELOPED

. . COMPARISONS WITH SEMISCALE UNDERWAY

SERB MODEL DEVELOPMENT

RENSSELAER POLYTECHNIC INSTITUTE

TWO PHASE FLOW PHENOMENA IN NUCLEAR REACTOR TECHNOLOGY

. TWO PHASE FLOW INSTRUMENTATION

. . DEVELOPED INSTRUMENTS FOR GLOBAL VOID FRACTION - - RADIO FREQUENCY PROBE, OPTICAL DIGITAL INTERFEROMETER

. . DEVELOPED INSTRUMENTS FOR LOCAL VOID FRACTION - - SIDE SCATTER GAMMA RAY SYSTEM, OPTICAL PROBE

. PHASE SEPARATION AND DISTRIBUTION

. . PHASE DISTRIBUTION IN SEVERAL GEOMETRIES INCLUDING 4 ROD BUNDLE; MEASUREMENT OF LOCAL AND VOID FRACTION

. . PHASE SEPARATION OF Y'S AND T'S COMPLETED

. PARALLEL CHANNEL EFFECTS

. . LOOP COMPLETED AND TESTING UNDERWAY TO EXAMINE BWR "STEAM BINDING" POTENTIAL

. . PARAMETRIC TEST SERIES PLANNED

SERB MODEL DEVELOPMENT

- **LEHIGH UNIVERSITY: NON-EQUILIBRIUM HEAT TRANSFER AND TWO PHASE INSTRUMENTATION**
  - . . DIRECT MEASUREMENT OF NON-EQUILIBRIUM QUALITY IN TWO PHASE FLOW UNDER CONTROLLED CONDITION
  - . . IMPROVED CORRELATION FOR POST-CHF HEAT TRANSFER
  - . . DEVELOPMENT OF FILM PROBES FOR THE MEASUREMENT OF LIQUID FILM THICKNESS AND VELOCITY

- **SUNY: DROPLET ENTRAINMENT**
  - . . STUDY OF DROPLET FLOW WITH 2D/3D TIE PLATE GEOMETRY
  - . . EFFECT OF GRID SPACERS ON FLOW
  - . . EFFECT OF BLOCKAGES ON ENTRAINED DROP DISTRIBUTION

/3/

278 253

SERB MODEL DEVELOPMENT

. ANL, PHENOMENOLOGICAL MODELING

. . BEST ESTIMATE MODEL FOR TRANSIENT CHF, FINAL REPORT FY 1979

. . SUBCHANNEL ANALYSIS FOR A TWO FLUID MODEL OF TRANSIENT TWO PHASE FLOW

. NWU, CONDENSATION RATES IN STEAM WATER FLOWS

. . PARAMETRIC STUDY OF CONDENSATION IN HORIZONTAL AND VERTICAL STEAM/WATER FLOW

. . UPPER PLENUM POOL HOLD-UP EXPERIMENT

. . SIMULATED UPPER TIE PLATE

. . STUDY OF STEAM FLOW RATES REQUIRED TO SUPPORT WATER POOL

. . HOLOGRAPHY OF TWO PHASE FLOWS: FEASIBILITY STUDY UNDERWAY

TECHNICAL SUPPORT

- PROVIDE TECHNICAL SUPPORT FOR OTHER PROGRAMS
- ADVANCED INSTRUMENTATION
- ASSIST MODEL DEVELOPMENT

278 254

132

TECHNICAL SUPPORT

	FY 1979
ANL, HEAT TRANSFER STUDIES AND COORD.	$ 200K
INEL, DATA BANK	400K
ORNL, MEASURED DATA REPOSITORY	80K
ORNL, ADVANCE TWO PHASE INSTRUMENT	150K
SANDIA, PULSED NEUTRON GENERATOR	250K
ANL, TWO PHASE FLOW TRACERS	100K
	$1,180K

278 255

133

SERB TECHNICAL SUPPORT

- ORNL, ADVANCED TWO PHASE INSTRUMENTATION
  - CURRENT
    - IMPROVED SPOOL PIECES
    - TESTING IN AIR/WATER LOOP
  - PLANNED (FY 1980)
    - LIQUID LEVEL DETECTOR FOR REACTORS
    - TESTING IN STEAM/WATER LOOP

- ANL (TWO PHASE FLOW TRACERS) AND SANDIA (NEUTRON GENERATORS)
  - DEVELOPMENT OF TECHNIQUE BY ANL
    - MEASUREMENT OF ECC BYPASS AT LOFT
    - CALIBRATION OF INSTRUMENTS
  - DEVELOPMENT OF PULSED NEUTRON GENERATORS AT SANDIA
    - HIGH OUTPUT (10^{10} N/PULSE) AND RAPID RECOVERY (5 SEC) - MAY 1979
    - DELIVERY OF PNG'S BY JUNE 1980

SERB MODEL DEVELOPMENT AND TECHNICAL SUPPORT

- ANL, HEAT TRANSFER STUDIES
  - CURRENT
    - TRANSITION AND FILM BOILING STUDIES
    - EFFECTS OF OSCILLATIONS ON REFLOOD
  - PLANNED (FY-79/80)
    - SURVEY OF DATA BASE FOR NATURAL CONVECTION TO STEAM
    - SURVEY OF DATA BASE FOR NATURAL CIRCULATION HEAT TRANSFER
- BNL, NON-EQUILIBRIUM PHASE CHANGE STUDIES
  - CURRENT
    - PARAMETRIC STUDY OF FLASHING VAPOR GENERATION RATES
    - IMPROVEMENT OF MODELS
  - PLANNED (FY 1980)
    - DISCHARGE AND SOLUBILITY OF NON-CONDENSABLES
    - DELETION OF OPTICAL PROBE DEVELOPMENT

278 257

135

2D/3D REFILL AND REFLOOD

EXPERIMENTAL AND ANALYTICAL RESEARCH PROGRAM

PRESENTATION TO

ACRS SUBCOMMITTEE ON ECCS

JUNE 20, 1979

GARY L. BENNETT, CHIEF
RESEARCH SUPPORT BRANCH

SCOPE OF 3-D	FRG-BMFT	JAPAN-JAERI	USNRC
INTEGRAL TESTS . LARGE BREAK . SMALL BREAK . NATURAL CIRCULATION AND CORE UNCOVERY	PKL-CORE II 340-ROD, (FULL-HEIGHT CORE, 3-LOOP)	CCFT CORE II (2000-ROD, FULL-HEIGHT CORE, 4-LOOP)	ADVANCED INSTRUMENTATION TRAC ANALYSIS
SEPARATE EFFECT TESTS (SCALING) . ECC PENETRATION . STEAM BINDING COUPLING . FLOW BLOCKAGE	UPTF (FULL SCALE VESSEL, UNHEATED CORE)	SCTF (2000-ROD, FULL-HEIGHT, 6 FT WIDE SLAB)	ADVANCED INSTRUMENTATION, TRAC ANALYSIS

NOTE: PKL - PRIMARKREISLAUF
CCTF - CYLINDRICAL CORE TEST FACILITY
SCTF - SLAB CORE TEST FACILITY
UPTF - UPPER PLENUM TEST FACILITY

1. ALL FACILITIES INCLUDE TESTS WITH COLD-LEG ONLY INJECTION (USA AND JAPAN) AS WELL AS TESTS WITH COMBINED COLD-LEG AND HOT-LEG INJECTION (FRG).

2. ALL FACILITIES ARE LARGE SIZE, WELL INSTRUMENTED, BUT LOW PRESSURE. THE SIZE EFFECT (3D) AND PRESSURE EFFECT ARE STUDIED IN CONJUNCTION WITH OTHER TEST FACILITIES.

278 260

THE OBJECTIVES OF THE COORDINATED 3-D PROGRAM ARE:

1. TO STUDY THE STEAM BINDING EFFECT DURING REFLOOD FOR A MEDIUM AND LARGE-BREAK LOCA USING VARIOUS ECCS (COLD LEG INJECTION, HOT LEG INJECTION, LOWER PLENUM INJECTION AND VENT VALVE) BY MEASURING:

   - THE PRESSURE DIFFERENCE BETWEEN THE UPPER PLENUM AND THE TOP OF DOWNCOMER IN AN INTEGRAL SYSTEM TEST (PKL, CCTF)
   - THE PRESSURE DROP ACROSS STEAM GENERATORS (PKL, CCTF)
   - THE LIQUID CARRYOVER AND FALLBACK AT UPPER CORE SUPPORT PLATE (CCTF, SCTF, UPTF)
   - THE DE-ENTRAINMENT OF LIQUID IN UPPER PLENUM (CCTF, SCTF, UPTF)

278 261

2. TO STUDY THE FLOW DISTRIBUTION IN A HEATED CORE:

   A. DURING REFLOOD FOR A LARGE-BREAK (CHIMNEY EFFECT)

   B. DURING A SMALL-BREAK (CORE UNCOVERY)

   C. UNDER CONDITIONS OF NATURAL CIRCULATION (CORE FLOW BLOCKAGE)

   BY MEASURING:

   . DENSITY DISTRIBUTION IN THE CORE (CCTF, SCTF)

   . VELOCITY DISTRIBUTION IN THE CORE (CCTF, SCTF)

   . LOCATION AND CLAD TEMPERATURES AT HOT SPOTS (CCTF, SCTF, PKL)

3. TO STUDY THE FLOW HYDRODYNAMICS IN THE CORE, DOWNCOMER AND UPPER PLENUM DUR. G REFILL AND REFLOOD FOR A LARGE-BREAK LOCA BY MEASURING:

- ECC PENETRATION AND LOWER PLENUM FILLING DURING REFILL (CCTF, SCTF, UPTF)
- DOWNCOMER FLOW TRANSIENT INDUCED BY THE CONDENSATION OF STEAM BY ECC WATER DURING REFILL (CCTF, SCTF, UPTF)
- U-TUBE FLOW OSCILLATION DURING REFILL (CCTF, SCTF, PKL)
- LIQUID HEIGHT AND TEMPERATURE OF WATER ACCUMULATED IN UPPER PLENUM DURING COMBINED INJECTION (UPTF, SCTF)

278 262

278 263

4. TO STUDY THE EVENTS LEADING TO CORE UNCOVERY DURING THE END OF SMALL-BREAK AND THE CONDITIONS FOR NATURAL CIRCULATION (REFLUX BOILER) IN FACILITIES WITH UNIQUE FEATURES THAT

   . MINIMIZE THE HOT-WALL EFFECT

   . ALLOW MEASUREMENT OF CORE-WIDE INTERNAL NATURAL CIRCULATION DUE TO POWER DISTRIBUTION

   BY MEASURING:

   . LOCAL LIQUID-LEVEL AND TEMPERATURES IN THE CORE, UPPER PLENUM, DOWNCOMER AND LOWER PLENUM (PKL, CCTF, SCTF)

   . NET FLOW RATE OUT OF THE VESSEL (PKL, CCTF, SCTF)

   . TEMPERATURE DISTRIBUTION IN STEAM GENERATORS (PKL, CCTF)

   . PHASE SEPARATION IN THE UPPER PLENUM UNDER NATURAL CIRCULATION (REFLUX BOILER) CONDITIONS (UPTF, CCTF, SCTF)

278 264

SIGNIFICANT ACHIEVEMENTS IN FY 1979

1. COMPLETED CONSTRUCTION OF CCTF, 2/79
2. COMPLETED PRELIMINARY DESIGN OF SCTF, 4/79
3. COMPLETED FOUR SHAKEDOWN TESTS OF CCTF, 5/79
4. COMPLETED AIR/WATER LOOP TESTS FOR INSTRUMENTS, 11/78
5. COMPLETED INSTALLATION OF SELECTED INSTRUMENTS IN CCTF AND PKL, 4/79
6. COMPLETED TRAC CALCULATIONS FOR PWR AND TEST FACILITY DESIGN, 5/79

EFFECT OF 3D PROGRAM ON LICENSING

278 265

1. STEAM BINDING EFFECT ON PEAK CLAD TEMPERATURE FOR MARGIN OF SAFETY PER APPENDIX K ASSUMPTIONS WITH VARIOUS BREAK SIZES OF LOCA
2. DOWNCOMER BEHAVIOR AND EFFECTIVENESS OF VARIOUS ECC INJECTION MODES:
   - COLD LEG
   - HOT LEG
   - COLD AND HOT LEGS COMBINED
   - LOWER PLENUM
   - UPPER PLENUM
   - DOWNCOMER
3. STUDY OF SMALL BREAK AND NATURAL CIRCULATIONS
4. CODE CHECKOUT AND EXTRAPOLATION TO FULL SCALE REACTOR
   - A. INTEGRAL EFFECT
     - FULL HEIGHT AND COMPLETE SYSTEM SIMULATION IN CCTF AND PKL
   - B. SEPARATE EFFECT
     - FULL SIZE UP AND DC IN [illegible]
     - FULL HEIGHT AND RADIUS IN SCTF

3D ASSISTANCE ON TMI

PKL FACILITY

1. SMALL BREAK TESTS

CCTF FACILITY

1. NATURAL CIRCULATION SYSTEM COOLING TESTS
2. CORE COOLING TESTS FOR SMALL BREAK

SCTF FACILITY

1. BLOCKED BUNDLE COOLING TESTS FOR SMALL BREAK

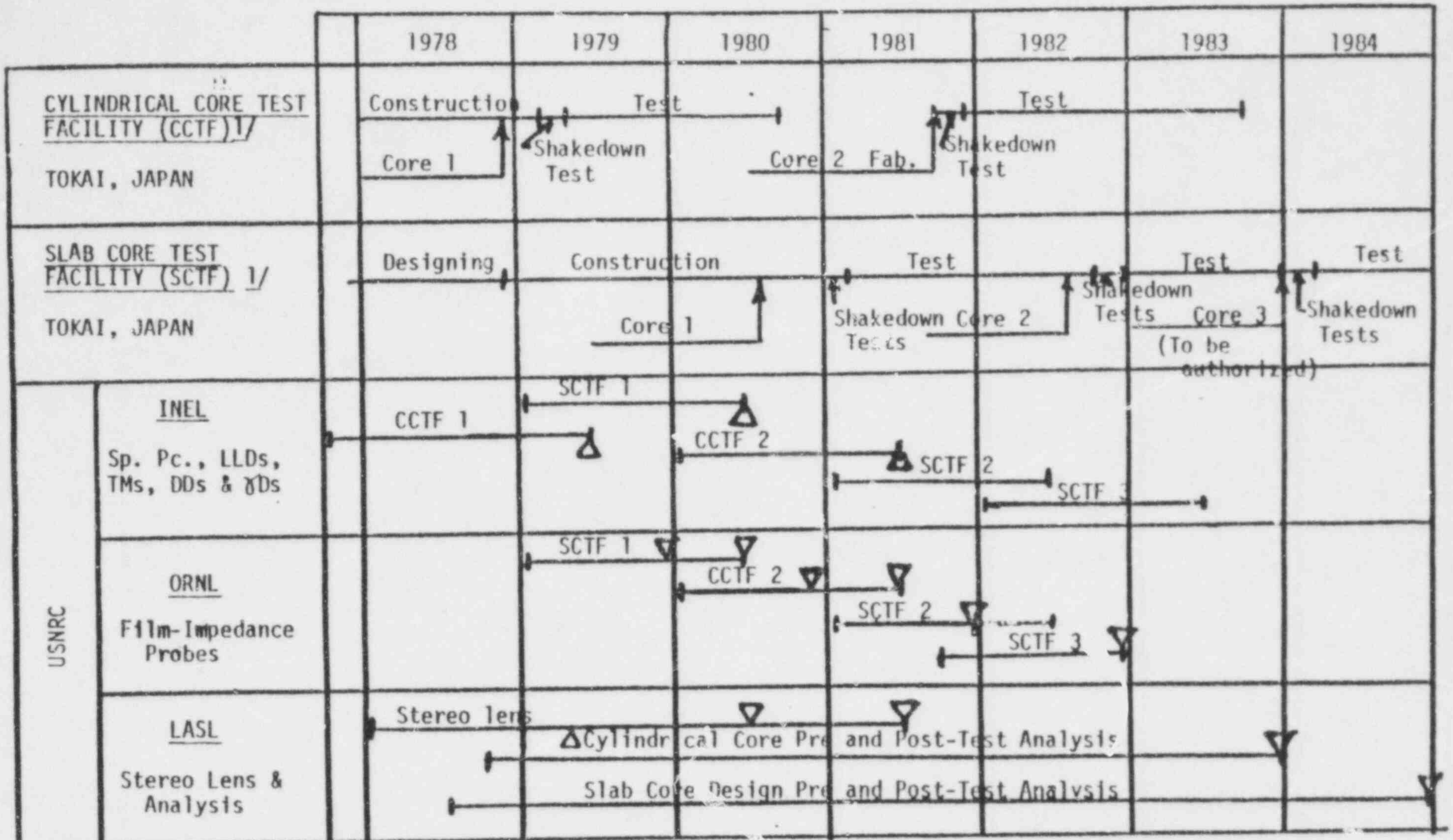
278 266

87

2D/3D RESEARCH PROGRAM SCHEDULE

JAERI REFILL-REFLOOD FACILITIES

CALENDAR YEAR

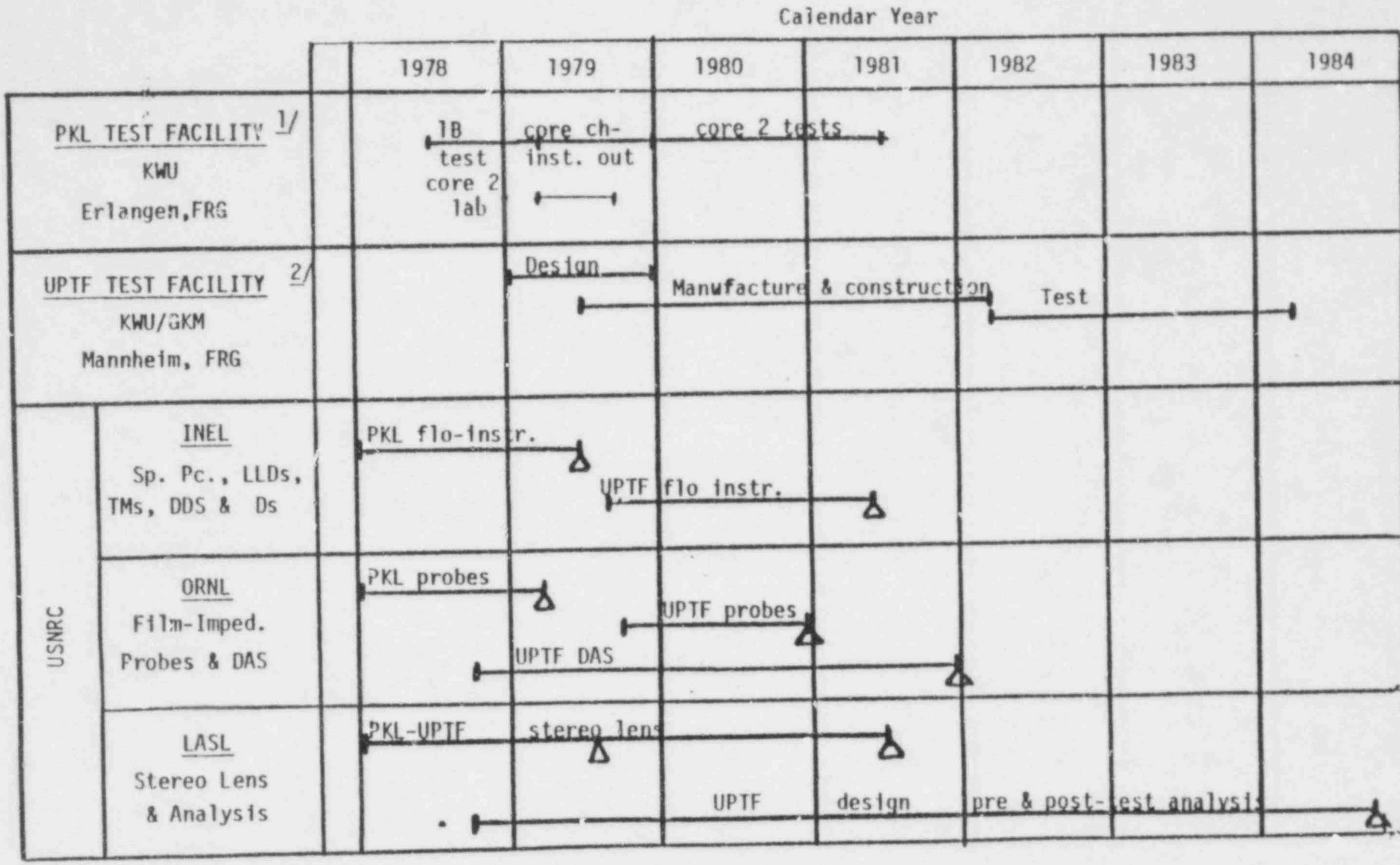


278 267

93

2D/3D RESEARCH PROGRAM SCHEDULE

FRG Refill-Reflood Facilities



278 268

2D/3D USNRC PROGRAM COST ESTIMATE

(NO CONTINGENCY FUNDING INCLUDED)

278 269

COST ESTIMATE BY FISCAL YEAR (ESCALATED)
($1000x)

PROGRAM	CONTRACTOR	78	79	80	81
3D TECH SUPP. & INSTR.	EG&G	3340	3921	5898	4814
ADV. INSTR.	ORNL	2303	4775	6299	2175
TRAC APPL. & INSTR.	LASL	1150	1584	1850	2124
DESIGN SUPPORT AND MISC.	MPR/OTHERS	855	535	1753	2887
OPERATING EXPENSES		7648	10815	15800	12,000
STEREO LENS (CAP EQ.)	LASL	50	70	70	
ADV. INSTR. (CAP EQ.)	ORNL	537	315	546	272
TOTAL CAPITAL EQUIP EXP.		587	385	616	272
TOTAL PROJECTED 3D EXP.		8235	11200	16416	12,272

gb

2D/3D RESEARCH PROGRAM

FY 1980 PROGRAM PLAN

278 270

RESEARCH ORGANIZATION: IDAHO NATIONAL ENGINEERING LABORATORY

FY 1980 FUNDING: $5898K (OPERATING)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, INEL WILL

- FABRICATE AND CHECK OUT TURBO PROBES - PKL II
- FABRICATE, DELIVER AND CHECK OUT INSTRUMENTS FOR SCTF CORE I
- INITIATE DESIGN AND PROCUREMENT OF UPTF INSTRUMENTATION
- INITIATE DESIGN AND PROCUREMENT OF CCTF CORE II INSTRUMENTATION
- COMPLETE FABRICATION OF FLOW DISTRIBUTION GRIDS FOR SCTF CORE I
- PROVIDE TECHNICAL AND FIELD SUPPORT, INCLUDING RELATED SOFTWARE APPLICATIONS

2D/3D RESEARCH PROGRAM

FY 1981 PROGRAM PLAN

RESEARCH ORGANIZATION: IDAHO NATIONAL ENGINEERING LABORATORY

FY 1981 FUNDING: $4814K (OPERATING)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, INEL WILL

- FABRICATE, DELIVER AND CHECK OUT INSTRUMENTS FOR THE UPPER PLENUM TEST FACILITY
- REFURBISH INSTRUMENTS FROM CCTF CORE I AND PROVIDE NEW INSTRUMENTS FOR CCTF CORE II
- PROVIDE TECHNICAL AND FIELD SUPPORT

2D/3D RESEARCH PROGRAM

FY 1980 PROGRAM PLAN

278 272

RESEARCH ORGANIZATION: OAK RIDGE NATIONAL LABORATORY

FY 1980 FUNDING: $6299K (OPERATING)
$ 546K (EQUIPMENT)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, ORNL WILL

. DELIVER, INSTALL AND TEST PROBES FOR SCTF CORE I

. DESIGN AND INITIATE FABRICATION OF PROBES FOR UPTF AND CCTF CORE II

. COMPLETE CALIBRATION TESTS IN STEAM/WATER LOOP

. DEVELOP MODELING EQUATIONS

. DEVELOP IMPROVED AND/OR ALTERNATE INSTRUMENTATION SCHEMES, IF NEEDED

. PROVIDE TECHNICAL AND FIELD SUPPORT

. DEVELOP ALGORITHMS FOR THE INSTRUMENTS DELIVERED

2D/3D RESEARCH PROGRAM

FY 1981 PROGRAM PLAN

8108270273

RESEARCH ORGANIZATION: OAK RIDGE NATIONAL LABORATORY

FY 1981 FUNDING: $2175K (OPERATING)

$ 272K (EQUIPMENT)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, ORNL WILL

. DELIVER, INSTALL AND TEST PROBES FOR CCTF CORE II

. INITIATE DESIGN AND FABRICATION OF PROBES FOR SCTF CORE II

. PERFORM TESTS AS NEEDED IN INSTRUMENT DEVELOPMENT LOOP

. FABRICATE, DELIVER AND CHECK OUT INSTRUMENTS FOR UPTF

. PROVIDE TECHNICAL AND FIELD SUPPORT

. DEVELOP ALGORITHMS FOR THE INSTRUMENTS DELIVERED

2D/3D RESEARCH PROGRAM

FY 1980 PROGRAM PLAN

278 274

RESEARCH ORGANIZATION: LOS ALAMOS SCIENTIFIC LABORATORY

FY 1980 FUNDING: $1850K (OPERATING)

$ 70K (EQUIPMENT)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, LASL WILL

. PERFORM FULL-SCALE PWR SYSTEM CALCULATIONS

. PERFORM UPTF CALCULATIONS

. CONTINUE CALCULATIONS FOR ALL CCTF TESTS AND SOME SCTF DESIGN STUDIES

. SUPPLY LENS SYSTEMS

90

278 275

2D/3D RESEARCH PROGRAM

FY 1981 PROGRAM PLAN

RESEARCH ORGANIZATION: LOS ALAMOS SCIENTIFIC LABORATORY

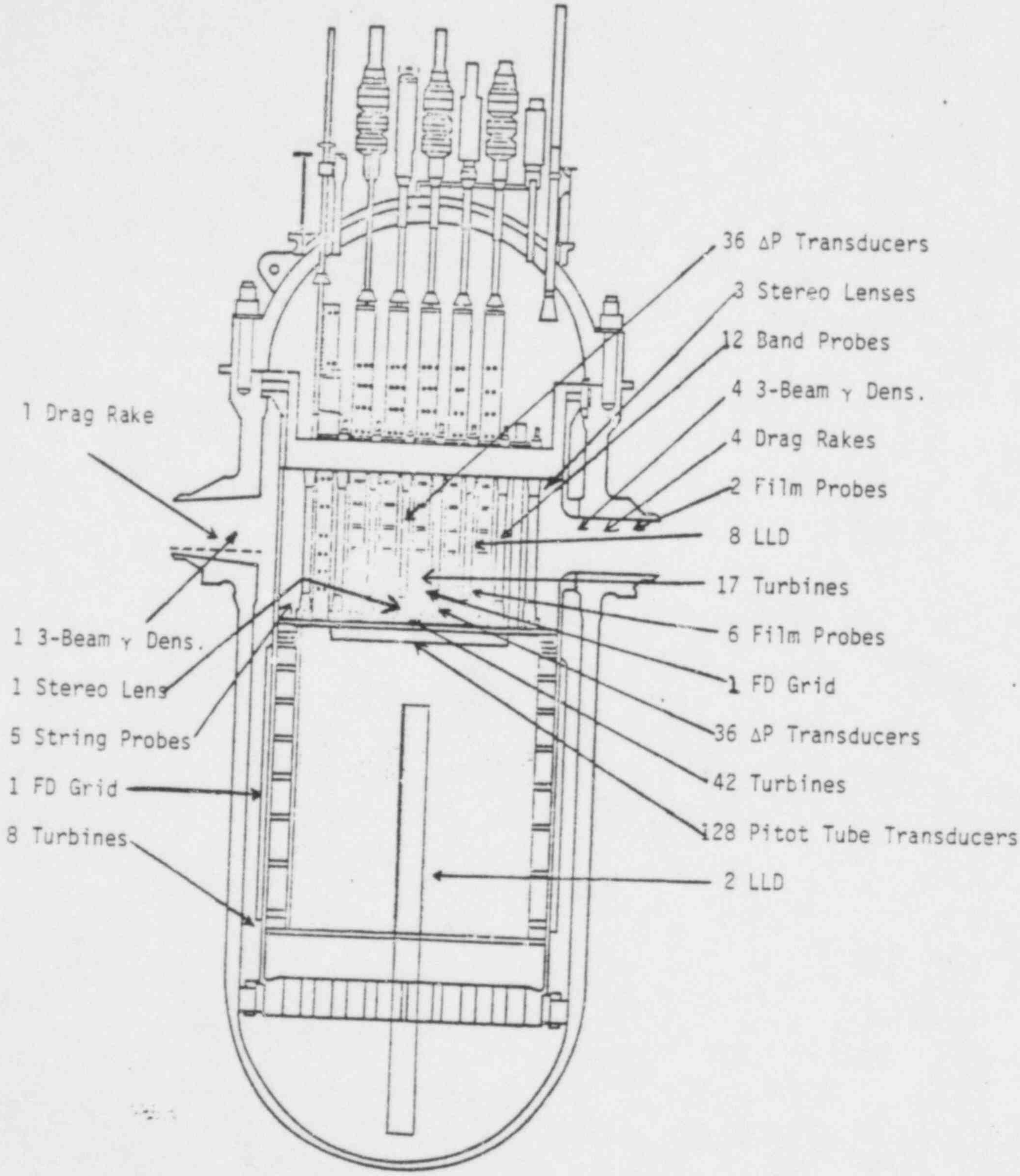
FY 1981 FUNDING: $2124K (OPERATING)

WORKSCOPE:

IN SUPPORT OF THE 2D/3D PROGRAM, LASL WILL

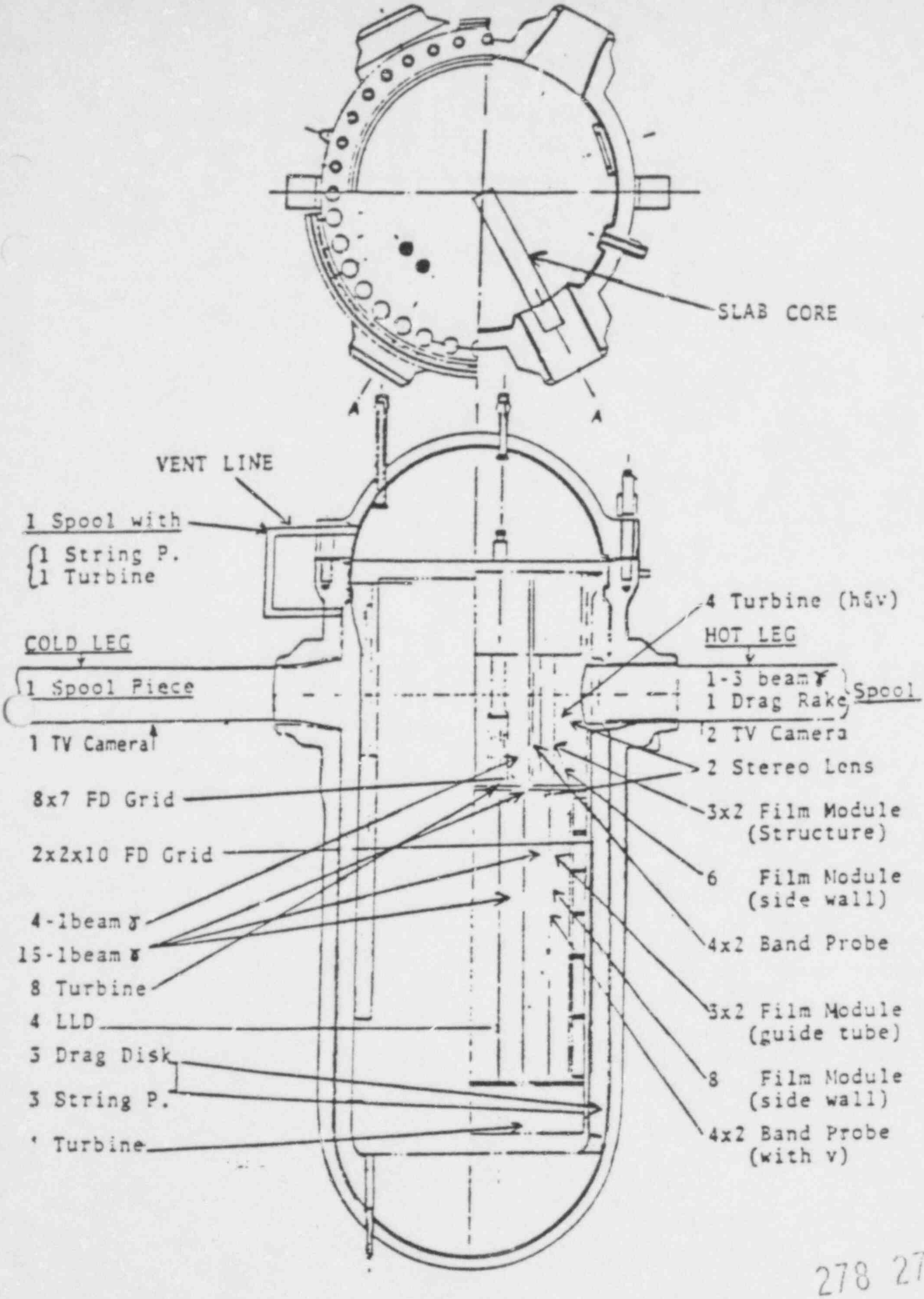
- PERFORM DESIGN AND EXPERIMENTAL CALCULATIONS FOR CCTF CORE II
- PERFORM EXPERIMENTAL CALCULATIONS FOR SCTF
- PERFORM DESIGN CALCULATIONS FOR UPTF
- SUPPLY LENS SYSTEM

5/9/79



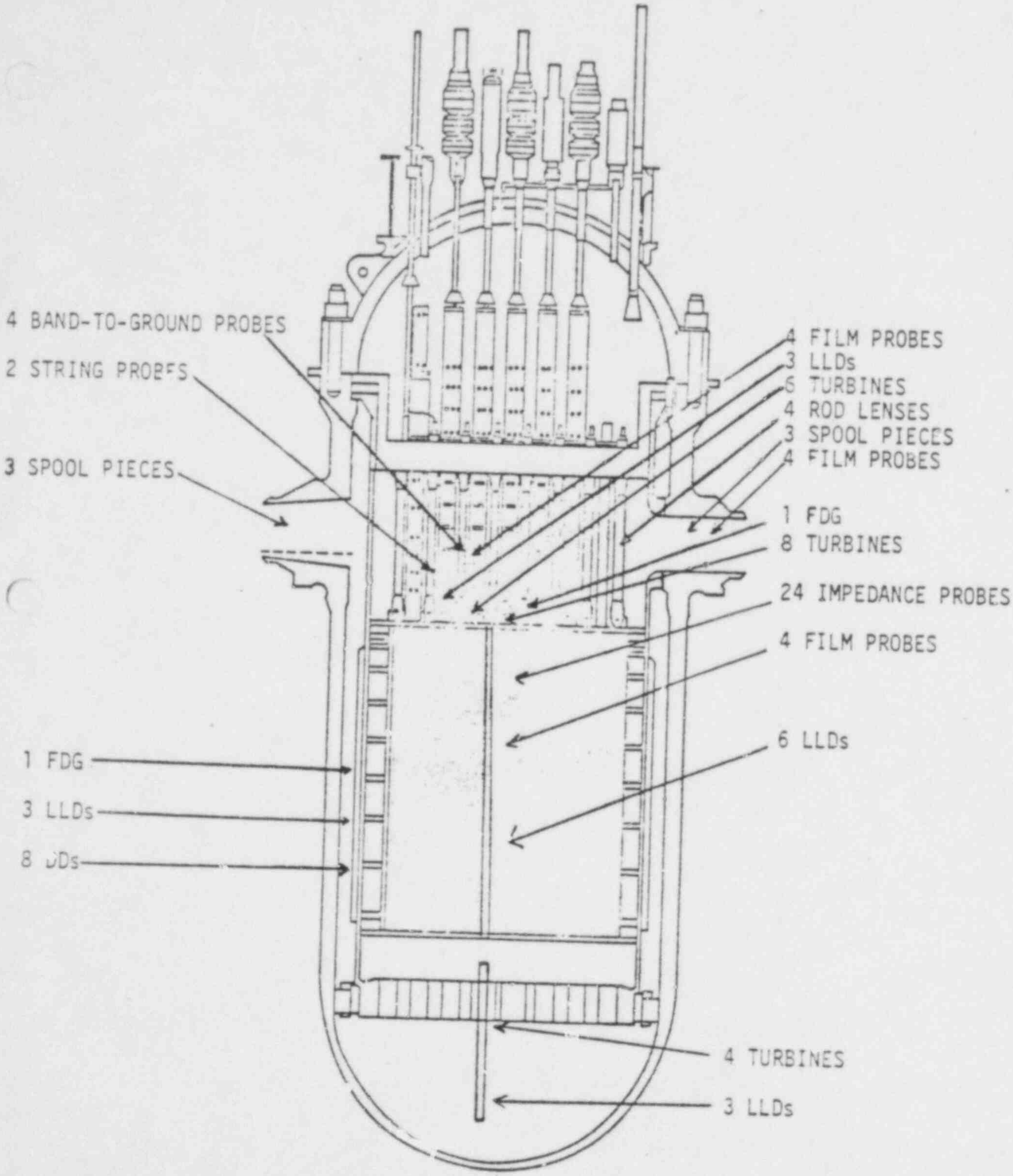
USNRC INSTRUMENTATION FOR UPTF

278 276



278 277

USNRC INSTRUMENTATION FOR SCTF



USNRC INSTRUMENTATION FOR CCTF I & II

278 278

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OTHER TRANSIENT TESTS IN 2D/3D

CONDUCTING OTHER TRANSIENT TESTS IN THE 2D/3D PROGRAM WILL PROVIDE INFORMATION CONCERNING

- INTERNAL CORE FLOW DISTRIBUTION AND BEHAVIOR ("3-D EFFECTS"), INCLUDING CORE UNCOVERY IN SMALL BREAKS
- MORE REALISTIC SURFACE/VOLUME RATIO ("STORED HEAT EFFECT")
- MORE REALISTIC TIME SCALES
- GEOMETRIC EFFECTS (SIZE, HEIGHT)
- PARAMETRIC EFFECTS (E.G., PRESSURE)
- TWO-PHASE NATURAL CIRCULATION
- FLOW BLOCKAGE IN DAMAGED CORE

WHICH WILL HELP IN THE DEVELOPMENT AND ASSESSMENT OF SAFETY ANALYSIS COMPUTER CODES.

RESEARCH SUPPORT BRANCH
TECHNICAL SUPPORT

- NUCLEAR SAFETY INFORMATION CENTER
- NATIONAL ENERGY SOFTWARE CENTER
- FACULTY INSTITUTE
- CRITICAL REVIEWS
- CONSULTANTS/SUPPORT SERVICES

278 280

NUCLEAR SAFETY INFORMATION CENTER
OAK RIDGE NATIONAL LABORATORY

- COLLECT, EVALUATE, DISSEMINATE RELEVANT SAFETY INFORMATION
- COLLECT, MANAGE, ASSESS FOREIGN SAFETY DOCUMENTS
- PREPARE BIBLIOGRAPHIC INDEX LISTINGS
- MANAGE U.S./FOREIGN REPORT EXCHANGE
- PUBLISH NUCLEAR SAFETY JOURNAL

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NATIONAL ENERGY SOFTWARE CENTER

ARGONNE NATIONAL LABORATORY

- COLLECT, PACKAGE, MAINTAIN AND DISTRIBUTE NRC CONTRACTOR-DEVELOPED PROGRAMS AND DATA
- CHECK LIBRARY SOFTWARE FOR COMPLETENESS
- EXECUTE TEST PROBLEMS
- PREPARE AND EDIT ABSTRACTS
- DISTRIBUTE NOTES ON CHANGES
- ASSIST USERS
- DEVELOP STANDARDS AND PROCEDURES

ACHIEVEMENTS TO DATE

- Completed Power Range Testing
- Issued RIL on Non-Nuclear Test Series
- Performed First Two Nuclear LOCE's
- Performed Isothermal Small Break LOCE
- Replaced Central Fuel Assembly

278 283

55

278 284

New Focus

System Response to
- Off-Normal Conditions
- Natural Perturbations
- Operator Intervention

Assessment of small-break and transient codes in specific areas

Study means of recovery from uncontrolled situations

By-Product Role

Assessment of conventional process instrumentation

Provide data for code assessment through Standard Problem Program

Assurance and understanding to
- Regulatory staff
- Technical community
- Media and public

LOFT NUCLEAR PROGRAM

CURRENT

- LARGE BREAK 8 KW/FT — L2-2
- LARGE BREAK * — L2-3
- — FY 79/80 —
- LARGE BREAK LOSS-OFFSITE — L2-5
- LARGE BREAK 16 KW/FT — L2-4
- — FY 80/81 —
- LARGE BREAK (PRESSURIZED FUEL) — L2-6
- SMALL BREAK — L3-1
- — FY 81/82 —
- ALTERNATE ECCS (LOWER PLENUM) — L4-1
- LG. HOT LEG BREAK — L5-1
- — FY 82/83 —
- LG. BREAK + S.G. TUBE RUPTURE — L7-1
- SMALL BREAK — L3-2
- ALTERNATE ECCS (B & W VENT VALVE) — L4-5
- — FY 83/84 —
- ALTERNATE ECCS (HOT AND COLD LEG) — L4-3
- ALTERNATE ECCS (HOT LEG) — L4-2
- — FY 84/85 —
- LG. BREAK + S.G. TUBE RUPTURE — L7-2
- ALTERNATE ECCS (DOWNCOMER) — L4-4
- SMALL BREAK — L3-3
- — FY 85/86 —
- LG. HOT LEG BREAK — L5-2
- — FY 86 —

CONSIDERING

- L2-2 LARGE BREAK 8 KW/FT
- L2-3 LARGE BREAK *
- +L3-0 SMALL BREAK 0 KW/FT
- — FY 79/80 —
- L3-1 SMALL BREAK HPIS<BREAK FLOW
- L3-2 SMALL BREAK HPIS>BREAK FLOW
- L3-3 SMALL BREAK HPIS=BREAK FLOW
- L6-1● NAT. CIRC. FOLLOWING L3-3
- L2-5 LARGE BREAK LOSS-OFFSITE
- — FY 80/81 —
- L6-2● NAT. CIRC. *
- L2-4 LARGE BREAK 16 KW/FT
- L2-6 LARGE BREAK PRES. FUEL
- L6-3● OFF-NORMAL TRANSIENT
- — FY 81/82 —
- L6-4● "
- +L3-4 SMALL BREAK
- +L3-5 "
- L4-1 ALTERNATE ECCS
- — FY 82/83 —
- L6-5● NAT. CIRC.
- L5-1 LARGE HOT LEG BREAK
- L6-6● OFF-NORMAL TRANSIENT
- +L3-6 SMALL BREAK
- — FY 83/84 —
- L7-1 LG BREAK + S.G. TUBE RUPTURE
- L7-[illegible] "
- L7-[illegible] "
- — FY 84/85 —
- L4-[illegible] ALTERNATE ECCS
- L4-[illegible] "
- L5-2 LG. HOT LEG BREAK
- L5-3 "
- — FY 85/86 —
- — FY 86 —

* ALL TESTS INITIATED AT 12 KW/FT UNLESS OTHERWISE NOTED.

● OFF-NORMAL TRANSIENTS, SERIES L6, WAS PLANNED FOR INSERTION INTO CURRENT PROGRAM.

\+ ADDED SMALL BREAK TESTS.

EXPECTED ACHIEVEMENTS FY 1980

- PERFORM THREE SMALL BREAK LOCE'S
- PERFORM LARGE BREAK LOCE
- BEGIN NATURAL CIRCULATION TESTING
- ISSUE RIL'S ON L2-2, L2-3, AND SMALL BREAKS

278 286

EXPECTED ACHIEVEMENTS FY 1981

- Complete Power Ascension Series of LOCE's
- Continue Natural Circulation Testing
- Begin Off-Normal Transient Testing
- sue RIL's on Large Break LOCE's

LOFT BUDGET SUMMARY

	FY-80	FY-81
EXPERIMENTAL PROGRAM	3.930	4,030
FUEL	6,120	6,280
EXPERIMENTAL INSTRUMENTATION	7.720	7,900
PLANT SUPPORT	7,860	8,070
CORE & SAFETY SUPPORT	3,720	3,810
COMMON SUPPORT	5,850	6,010
FACILITY OPERATIONS	7,700	7,900
TOTAL	42,900	44,000

	FY-80	FY-81
EXPERIMENTAL PROGRAM	3930	4030

- EXPERIMENT PREDICTION AND ANALYSIS
- ISSUE TOPICALS, ANALYSIS, DRAFT RIL'S
- LARGE PWR EVALUATIONS BASED ON LOFT RESULTS
- SEMISCALE - LOFT - COMMERCIAL PWR SCALING EVALUATION
- SUPPLY LOCE TEST DATA TO REQUESTORS
- ELECTRICAL/NUCLEAR HEATER ROD COMPARISON

278 239

	FY-80	FY-81
FUEL	6120	6280

- FUEL MATERIALS PERFORMANCE EVALUATION
- FUEL POST - TEST ANALYSIS
- RELOAD CORE II AND FABRICATION
- CONTRACT FOR RELOAD CORE III
- DOWNCOMER INSTRUMENT FABRICATION

278 290

19

	FY-80	FY-81
EXPERIMENTAL INSTRUMENTATION	7720	7900

- DEVELOPMENT AND PROCUREMENT OF ALL LOFT INSTRUMENTATION, INCLUDING:
    - HARDENED AND SOFT GAMMA DENSITOMETERS
    - ULTRASONIC DENSITY DETECTORS
    - MOMENTUM - AND VELOCITY METERS
    - OPTICAL, TRACERS, NEUTRON ACTIVATION METHODS/INSTRUMENTS
- TESTING AT THE TWO-PHASE FLOW STEADY STATE LOOP
- EFFECTS OF SURFACE MOUNTED THERMOCOUPLES

278 291

	FY-80	FY-81
PLANT SUPPORT	7860	8070

- PROVIDE SUPPORT FOR MAINTENANCE, UPGRADE, AND MODIFICATION OF FACILITY

- PROVIDE PERSONNEL AND EQUIPMENT FOR FUEL CHANGE OUT

- PLANT REQUALIFICATION FOLLOWING EXPERIMENTS

278 292

	FY-80	FY-81
CORE & SAFETY SUPPORT	3720	3810

- CORE PHYSICS CALCULATIONS FOR CORE CHANGE OUT
- ANALYTICAL PHYSICS TRACKING OF OPERATING PLANT HISTORY
- STATISTICAL THERMAL-HYDRAULIC SAFETY ANALYSIS
- ZERO POWER AND POWER RANGE TESTING FOLLOWING CORE CHANGE OUT
- PERFORM SAFETY ANALYSIS FOR EXPERIMENTS

	FY-80	FY-81
COMMON SUPPORT	5850	6010
- PREPARE COSTS AND SCHEDULES		
- QA, ENGINEERING, INSPECTION AND TESTING		
- INDUSTRIAL HYGIENE & SAFETY		
- DOCUMENTATION CONTROL		
- SPECIAL PROCESS SPARES		

278 294

	FY-80	FY-81
FACILITY OPERATIONS	7700	7900

- PLANT OPERATION IN SUPPORT OF LOCE TESTING
- RADIOLOGICAL AND INDUSTRIAL SAFETY
- REQUALIFY PLANT FOLLOWING EACH LOCE
- MAINTAIN AND MODIFY PLANT AS NECESSARY TO CARRYOUT TESTS
- SUPPORT DECONTAMINATION FACILITIES ASSOCIATED WITH SYSTEM CLEANUP

278 295

	FY 80	FY 81
ADVANCED FUEL INSTRUMENTATION	300	300

278 296

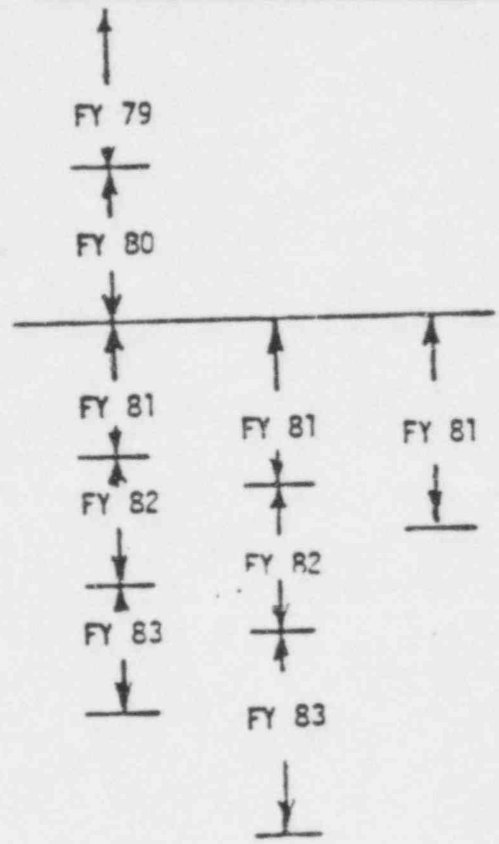
ANNUAL LOFT OPERATING BUDGET (DOE & NRC), $\$10^6$

FY	PRESIDENT'S	NEW RESPONSIBILITIES		RELATIVE BUDGET
1978	40.0			40.0
1979	39.1	PURCHASE DOE'S SPECIAL SPARES INVENTORY	1.9	37.2
1980 WITHOUT SUPPLEMENTAL	42.9	PURCHASE DOE'S SPECIAL SPARES INVENTORY	1.8	
		INCREASE SPECIAL SPARES INVENTORY TO FULL REQUIREMENTS	2.0	
		INITIATE CHANGEOVER TO BUDGET AUTHORITY ACCOUNTING SYSTEM	2.0	
		TOTAL	5.8	37.1
1980 WITH SUPPLEMENTAL	44.9	HARDWARE CHANGES TO ACCELERATE SMALL-BREAK AND TRANSIENT TESTS	1.0	
		INSTRUMENT APPLICATION TO COMMERCIAL PLANTS	1.0	
		TOTAL	2.0	39.1

TABLE OF ACCOMPLISHMENTS PLANNED FOR EACH BUDGET LEVEL

FY 1981 Budget Level

	$44.3M	$48.3M	$49.3M
Planned Accomplishments	Min & Cur	Req.	Suppl.



L2-2 large break 8 Kw/ft
L2-3 Large break*
L3-0 small break 0 Kw/ft
L3-1 small break
L3-2 small break
L3-3 small break with recovery
L6-1 natural circ following L3-3
L2-5 large break
L6-2 off-normal transient
L2-4 large break 16 Kw/ft
L2-6 large break w/pressurized fuel
L6-3 off normal transient
L6-4 off normal transient
L3-4 small break
L3-5 small break
L4-1 alternate ECCS
L6-5 natural circulation
L5-1 large hot leg break
L6-6 off normal transient
L3-6 small break
L7-1 large break & steam generator tube rupture
L7-2 large break & steam generator tube rupture
L7-3 large break & steam generator tube rupture
L4-2 alternate ECCS
L4-3 alternate ECCS
L5-2 large hot leg break
L5-3 large hot leg break

End of Complete Program.

* All tests initiated at 12 Kw/ft unless otherwise noted.

278 298

170

278 299

FY 1981 LOFT OPERATING BUDGET, \$$10^6$

MINIMUM AND CURRENT	NEW RESPONSIBILITIES		RELATIVE BUDGET
44.3	COMPLETE CHANGEOVER TO BUDGET AUTHORITY ACCOUNTING	3.0	
	NEW FACILITY OPERATIONS HOT SHOP & HOT CELLS 2-PHASE CALIBRATION	2.3	
	TOTAL	5.3	39.0
REQUESTED (COMPARED WITH CURRENT LEVEL)			
48.3	INCREASE EXPERIMENT TURNAROUND TIME BY 25%	2.0	
	INITIATE INSTRUMENT APPLICATION TO COMMERCIAL PLANTS	1.0	
	INITIATE OPERATIONAL FAULT DIAGNOSTICS	1.0	
	TOTAL	4.0	39.0
SUPPLEMENTAL (COMPARED WITH CURRENT LEVEL)			
49.3	ADD 2 TMI-2 RELATED EXPERIMENTS	3.0	
	CONTINUE INSTRUMENT APPLICATION TO COMMERCIAL PLANTS AND OPERATIONAL FAULT DIAGNOSTICS BEGUN WITH FY 80 SUPPLEMENTAL	2.0	
	TOTAL	5.0	39.0

TMI-RELATED TESTS IN FLECHT SEASET

278 300

- FORCED AND NATURAL CONVECTION TO STEAM

- FORCED CONVECTION TESTS WERE PERFORMED IN MAY, 1979 IN 161-ROD BUNDLE
  - RE = 2,100 TO 18,000
  - PRELIMINARY ANALYSIS SHOWS BETTER COOLING THAN PREDICTED
  - HIGH TEMPERATURE CAPABILITY IMPORTANT: STEAM FLOW CHANGES FROM TURBULENT TO LAMINAR DUE TO AXIAL TEMPERATURE INCREASE

- TESTS ARE PLANNED IN 21-ROD BUNDLE TO STUDY BLOCKAGE EFFECTS

TECHNICAL SUPPORT

RESEARCH SUPPORT BRANCH

PROGRAM	FUNDING ($000) FY 79 (ACTUAL)	FY 80 (PRES.)	FY 81 (REQ.)
NUCLEAR SAFETY INFORMATION CENTER	625	500	1272
NATIONAL ENERGY SOFTWARE CENTER	75	75	180
FACULTY INSTITUTE	0	0	53
CRITICAL REVIEWS	0 (FUNDED EARLIER)	0	42
CONSULTANTS/SUPPORT SERVICES	0 (FUNDED EARLIER)	0	43
TOTAL (OPERATING)	700	575	1590

ANALYSIS DEVELOPMENT RES/RSR

BRIEFING AGENDA

1. SYSTEMS CODES & COMPONENT CODES
   - COMPLETED
   - UNDER DEVELOPMENT
   - RILS
   - CODE AVAILABILITY PER GENERIC ISSUES

2. CODE APPLICATIONS

3. CODE ASSESSMENT

4. STATISTICAL STUDIES

5. BUDGETS

278 302

15

NRC CODE DEVELOPMENT
- PERSPECTIVE -

1972 RELAP-4 "COMPLETED"
DEVEL. OF ADVANCED CODE (SLOOP) INITIATED AT IDAHO

1974 AMERICAN PHYSICAL SOCIETY STUDY
RECOMMENDS MORE PHYSICALLY BASED CODES

1974 RES PLANS FOR CODE DEVELOPMENT

- FIX-UP RELAP-4 (BAND-AIDS)
- DEVELOP ADVANCED CODES
  - DETAILED: TRAC
  - FAST RUNNING: THOR (RELAP-5)

1978 FAST RUNNING CODE SELECTION (FROM AMONG THOR, RELAP-5, AND TRAC)

12/78 NRC MANAGEMENT DECISION
DEVELOP FAST RUNNING TRAC AT LASL
INEL TO TAKE CARE OF TRAC-BWR

3/79 FIRST DETAILED TRAC, PWR VERSION (TRAC-P1A) RELEASED TO PUBLIC

3/79 TMI-2 ACCIDENT
CONSEQUENCE: ACCELERATE DEV. OF FAST RUNNING TRAC

12/79 EXPECTED COMPLETION OF FIRST VERSION OF FAST RUNNING TRAC, FOR PWR APPLICATION 16

278 303

PERCEIVED UNHAPPINES, FROM VARIOUS SOURCES, WITH "NUMBER CRUNCHERS"

COMPLEX CODES UNWIELDY FOR EXTENSIVE MAPPING OF GREAT VARIETY OF POSTULATED ACCIDENTS
EQUIPMENT MALFUNCTIONS
OPERATOR ACTIONS

SUGGESTED COURSE OF ACTION
(IN ADDITION TO CURRENT PLANS)

HYBRID-BASED ANALYTICAL TOOL

* GOOD PHYSICS (1-D, THERM. NON-EQUILIB., PLUS NON-CONDENSIBLE GAS, PLUS 1-D NEUTRON KINETICS)
* COMPUTATION SPEED FASTER THAN ACCIDENT (REAL) TIME
* INSTANT INTERACTION BETWEEN USER AND "MACHINE"

NEED TO DEVELOP DEDICATED HARDWARE
~ 4 YEARS

DEV. OF VERY FAST DIGITAL ROUTINES, WITH INTELLIGENT SHORT-CUTS.

POSSIBLY DEVELOPED IN-HOUSE.

EXAMPLE: IN-HOUSE COMPLETED CODE FOR NATURAL CIRCULATION IN B&W PLANT WITH CORE DAMAGE.

278 304

SYSTEMS CODES – COMPLETED

CODE	COMPLETED	RELEASED TO PUBLIC	DATE OF RIL
RELAP-4/MOD5	6/76	7/76	—
RELAP-4/MOD 6	9/77	1/78	11/78
RELAP-5/MOD 0	3/79	5/79	—
TRAC-P1		12/77	—
TRAC-P1A		3/79	9/79
BEACON/MOD 1	12/76	—	—
BEACON/MOD 2	10/77	12/77	6/78
BEACON/MOD 2A	12/78	3/79	—

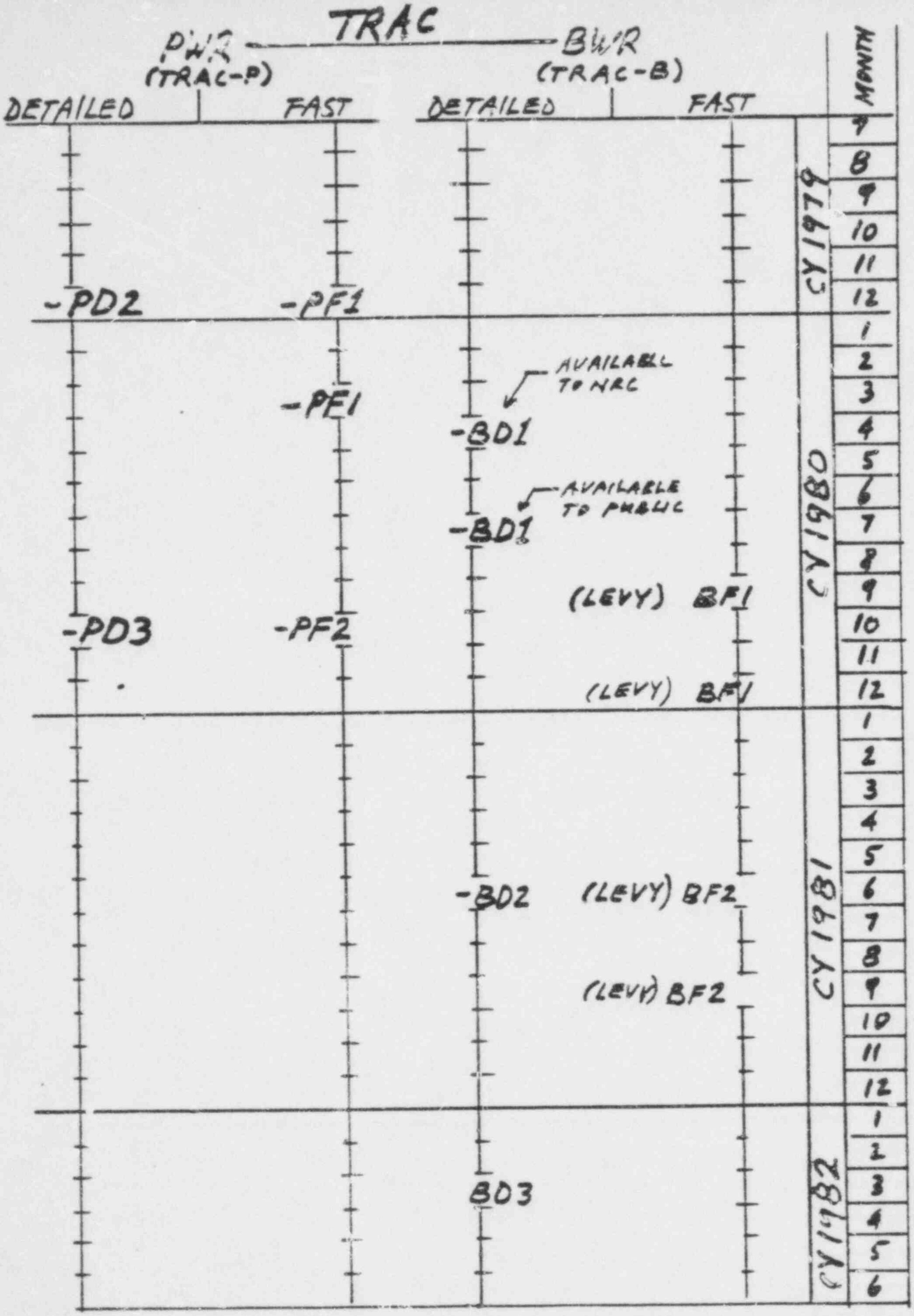
COMPONENT CODES - COMPLETED

CODE	COMPLETED	RELEASED TO PUBLIC	DATE OF RIL
K-FIX (Vers. 1)		4/77	9/79
K-TIF (Vers. 1)		5/78	11/79
SOLA-DF		1/79	—
SOLA-LOOP		1/79	12/79
COBRA-IV-I		7/76	
COBRA-TF-a	12/78		12/79

CURRENTLY AVAILABLE SYSTEMS CODES
ALSO, AVAILABLE BY END OF CY. 1979

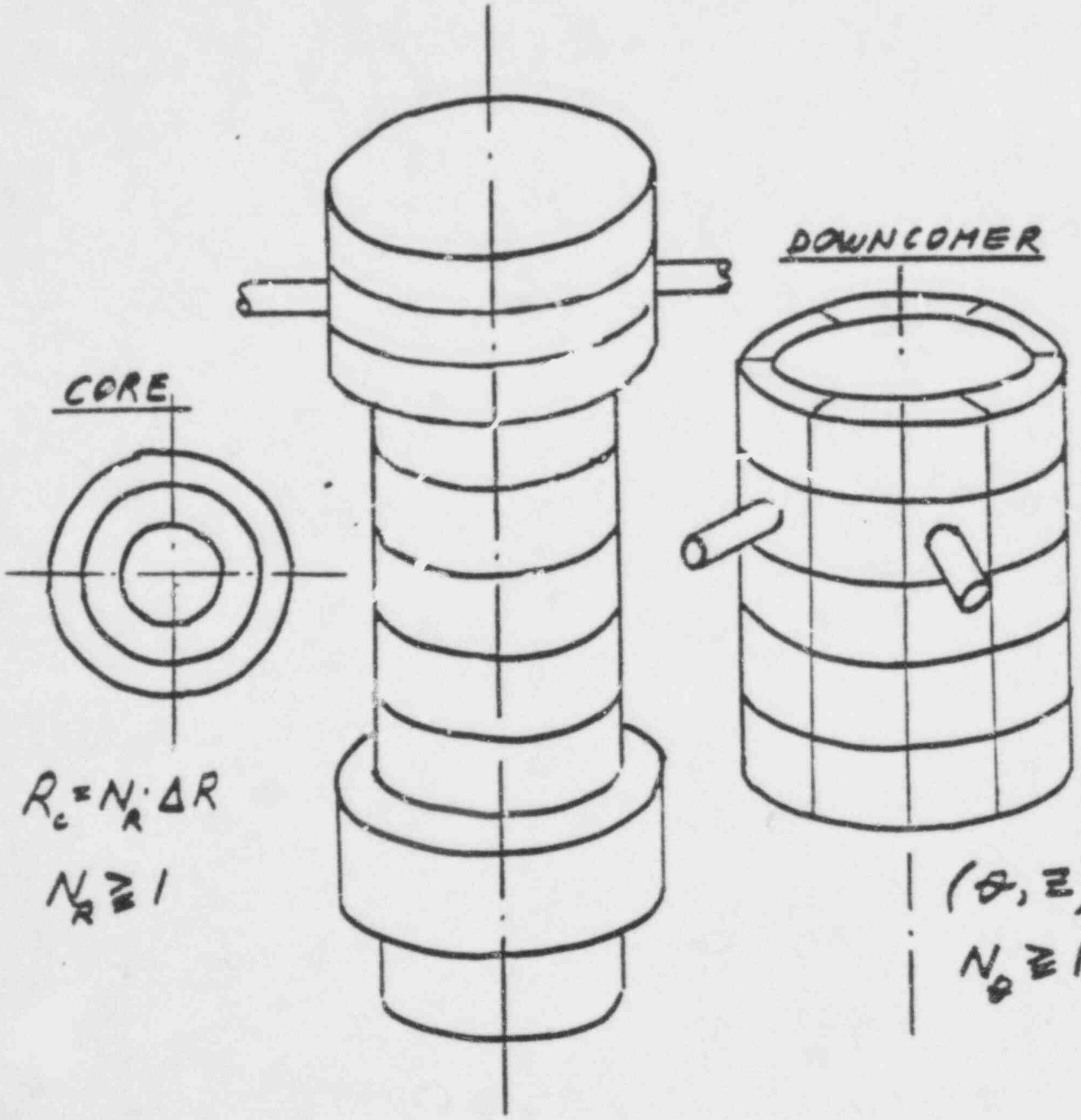
	LARGE & INTERM BREAK LOCA		SMALL BREAK LOCA		STEAM LINE BREAK	ATWS		OTHER TRANSIENTS	
	PWR	BWR	PWR	BWR	PWR	PWR	BWR	PWR	BWR
EM	WRAP/PWR	WRAP/BWR	WRAP/PWR ?	WRAP/BWR ?	IRT	RELAP-3B		IRT	
"BE"	RELAP4 MOD6 RELAP-4 MOD7	RELAP-4 MOD7	RELAP-4 MOD7		IRT, RELAP4 MOD6	RETRAN		RETRAN	
BE (ADV.)	TRAC-P1A TRAC-PF1		TRAC-P1A TRAC-PF1	RAMONA-III ?	TRAC-P1A TRAC-PF1		RAMONA-III	TRAC-P1A ? TRAC-PF1	RAMONA-III

278 307


TRAC
PWR (TRAC-P)
BWR (TRAC-B)
DETAILED
FAST
DETAILED
FAST
MONTH
CY 1979
CY 1980
CY 1981
CY 1982
-PD2
-PF1
-PE1
-BD1
AVAILABLE TO NRC
AVAILABLE TO PUBLIC
-BD1
(LEVY) BF1
-PD3
-PF2
(LEVY) BF1
-BD2
(LEVY) BF2
(LEVY) BF2
BD3

278 308

PWR VESSEL NODALIZATION FOR FAST RUNNING TRAC



ALL PLENA 1-D (z)

SYSTEMS CODES UNDER DEVELOPMENT

CODE	COMPLETION	PUBL. RELEASE	RIL
RELAP-4/MOD 7	12/79	3/80	6/80
WRAP/BWR (EM)		10/79	1/80
WRAP/PWR (EM)		12/79	3/80
TRAC-PD2	12/79	3/80	6/80
TRAC-PD3		10/80	2/81
TRAC-PF1	12/79	3/80	6/80
TRAC-PF2		10/80	1/81
TRAC-BD1	4/80	7/80	10/80
TRAC-BD2		6/81	9/81
TRAC-BD3		3/82	6/82
TRAC-BF1	9/80	12/80	3/81
TRAC-BF2	6/81	9/81	12/81
BEACON/MOD3	12/79	3/80	9/80
COBRA/TRAC	7/79	9/80	12/80
RAMONA-III	12/79	12/80	3/81

278 310

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COMPONENT CODES - UNDER DEVELOPMENT

CODE	COMPLETION	PUBL. RELEASE	RIL
SOLA-FLX		6/79	5/80
K-FIX-FLX (3D)		6/79	5/80
COBRA-MF (HOT BUNDLE)		12/80	9/81
PELE-IC		12,'79	6/80
K-FIX (Vers. 2)	12/79	3/80	9/80

FINAL SYSTEMS CODES
(BY END OF FY 82)

	LARGE & INTER. BREAK LOCA		SMALL BRK LOCA		STEAM LINE BRK	ATWS & RIA		OTHER TRANSIENTS	
	PWR	BWR	PWR	BWR	PWR	PWR	BWR	PWR	BWR
EM	TRAC-PD2 TRAC-PF2	TRAC-BD2 TRAC-BF2	TRAC-PF2	TRAC-BF2	TRAC-PD3 TRAC-PF2				
BE (DETAIL)	TRAC-PD2,3	TRAC-BD2,3	TRAC-PF2	TRAC-BF2	TRAC-PD3	TRAC-PD3	TRAC-BD3	TRAC-PD2,3	TRAC-BD2,3
BE (FAST)	TRAC-PF2	TRAC-BF2	TRAC-PF2 HYBRID	TRAC-BF2 HYBRID	TRAC-PF2 HYBRID	TRAC-PF2 HYBRID	TRAC-BF2 HYBRID	TRAC-PF2 HYBRID	TRAC-BF2 HYBRID

NEUTRON KINETICS:
- 0-D TRAC-PD2, BD2
- 0-D, 1-D TRAC-PF2, BF2
- 0-D, 1-D, 3-D TRAC-PD3, BD3

278 312

CODE APPLICATIONS

I. TMI-2 ANALYSES

A. AT INEL, USING RELAP-4

* HPI EFFECT ON NATURAL CIRCULATION ---- (12 RUNS)
* STEADY, FORCED FLOW (WITH RCS PUMPS RUNNING), W/ VARIATIONS IN CORE RESISTANCE, S.G. LEVEL, AND B-LOOP STATUS. --- (~30 RUNS)
* CHANGE-OVER TO NATURAL CIRCULATION ---- (12 RUNS).
* LETDOWN FROM 1000 PSI, VARIOUS RCS PUMP TRIP TIMES ---- (6 RUNS)
* H_2 EFFECT IN RCS
* TMI SCENARIO, FIRST 20 MINS
* TMI SCENARIO, 20 MINS ≤ t ≤ 2½ HRS
* OCONEE SMALL BREAK --- (3 RUNS)
* W SMALL BREAK ... (3 RUNS)
* C.E. SMALL BREAK ... (3 RUNS)

278 313

B. AT LASL, USING TRAC-P1A

* TMI-2 SCENARIO
* 3 BENCHMARK CALCS FOR SMALL BREAKS, USING ZION DECK (3 DIFFERENT BREAK SIZES, ...)
* GENERIC STUDY OF PRESSURIZER TRANSIENTS
* GENERIC STUDY OF S.G. TRANSIENTS

C. AT PNL, USING COBRA-IV

* TRY TO REPRODUCE HOT SPOT FLUID TEMPER., TO ASSESS CORE DAMAGE

D. IN-HOUSE

* FAST RUNNING CODE FOR SCOPING STUDIES OF NATURAL CIRCULATION IN B&W PLANTS, WITH OR WITHOUT DAMAGED CORE.

II ANALYTICAL SUPPORT TO NRC/FRG/JAPAN 2D/3D RESEARCH

ALL AT LASL, USING TRAC CODE

* US PWR LOCA W/EFFECTS OF NODING
* GERMAN (KWU) PWR LOCA
* CCTF PREDICTION
* PKL PREDICTION
* SCTF DESIGN CALCS
* UPTF DESIGN CALCS

III. ANALYT. SUPPORT TO NRC/EPRI/GE BWR REFLOOD EXPERIMENTS TO BE RENDERED BY INEL, USING TRAC-B CODE.

IV. FORSEE FUTURE REQUESTS FOR ANALYTICAL SUPPORT, AT LASL, USING TRAC-P CODES, ON

* OPERATING REACTORS ISSUES
* RESPONSE TO RES REQUESTS

INDEPENDENT ASSESSMENT OF SYSTEMS CODES

1. RELAP-4/MOD 6

* MAIN EFFORT COMPLETED AND REPORTED IN 1978
* LOW LEVEL EFFORT CONTINUING, INVOLVING

  LOFT, MARVIKEN-III, LOBI, SEMISCALE/MOD 3 (SMALL BREAK)

SUMMARY OF ASSESSMENT RESULTS

* CODE RESULTS COMPARED WITH TEST DATA OBTAINED IN:

  SEMISCALE/MOD 1, SEMISCALE/MOD 3, THTF, LOFT, PKL, FLECHT, FLECHT SET, MARVIKEN, AND PBF TEST FACILITIES.

* FULL VERIFICATION WAS NOT POSSIBLE DUE TO VERY LIMITED TEST DATA UNCERTAINTY INFORMATION

FINDINGS

A. GOOD AGREEMENTS FOR PRESSURE-TIME HISTORY PRIOR TO ECC ACCUMULATOR INJECTION

B. BLOWDOWN CLAD TEMPERATURE GENERALLY ADEQUATE EXCEPT WHEN DELAYED CHF WAS ENCOUNTERED.

C. SYSTEM BLOWDOWN HYDRAULICS GENERALLY GOOD. HOWEVER CORE FLOW DETAILS (E.G. CORE INLET FLOW) POOR IN SOME CASES.

D. FULL LENGTH REFLOOD HYDRAULICS:

BETTER FOR FULL LENGTH CORES THAN FOR SHORT CORES, PRIMARILY BECAUSE MODEL COEFFICIENTS WERE NORMALIZED ON THE BASIS OF FLECHT DATA. GOOD AGREEMENT ON QUENCH PROPAGATION ALONG THE <u>WHOLE</u> CORE LENGTH USUALLY NOT OBTAINED.

E. CODE WEAKNESSES WERE FOUND IN THE FOLLOWING AREAS:

1. ENTRAINMENT AND PHASE SEPARATION
2. DE-ENTRAINMENT AND FALL BACK
3. VERTICAL SLIP EQUILIBRIUM ASSUMPTIONS
4. TRANSITION AND DISPERSED FLOW HEAT TRANSFER
5. CHF
6. STEAM GENERATOR NODING SENSITIVITY
7. CRITICAL FLOW
8. TURNAROUND AND QUENCH TIME SOMETIMES POOR
9. USER GUIDELINES NOT GENERAL

   BETTER USER GUIDELINES WERE DEVELOPED AS PART OF INDEPENDENT ASSESSMENT

2. TRAC

* ASSESSMENT MATRIX COMPLETED IN-HOUSE FOR ALL PWR TRAC VERSIONS.

* FORMAT FOR TRAC ASSESSMENT RESULTS PREPARED (IN-HOUSE)

* WORK ASSIGNMENT PLAN DEVELOPED FOR BY 79 AND FY 80, FOR LASL, INEL, AND BNL (BEFORE TMI-2 INCIDENT)

* IF FY 80 BUDGET SUPPLEMENT NOT AVAILABLE SCHEDULED TASKS WILL NOT BE ACCOMPLISHED DUE TO RE-ALIGNMENT OF FUNDING (ASSESSMENT $ → CODE DEVELOPMENT $, TO ACCELERATE DEVELOPMENT OF FAST RUNNING CODES)

NEXT STEPS

* ASSESSMENT PLAN FOR TRAC-BWR

* CODE ACCEPTANCE CRITERIA

PRIMARY MEANS OF CODE ASSESSMENT:

COMPARISONS OF CODE RESULTS WITH TEST DATA, TAKEN IN

(a) Integral test facilities

(b) Separate Effects tests

(c) Basic Tests

all at different scales and test conditions.

In test types (a) thru (c) looking at different aspects of the code:

(a) Integral tests comparisons will show ability of the code to dynamically couple various system components and account for interactions and propagation of kinematic waves, as such affect the flow and void distribution within the reactor core.

(b) Separate Effects tests comparisons will show the code ability to correctly simulate actual flow and heat transfer phenomena, in selected, individual system components, to account for variations is geometry and size, during different stages of transients. Examples: Steam generator, PWR downcomer, LWR upper plenum BWR jet pump, LWR core, etc.

(c) Basic Experiments yield data for evaluating thermo-hydraulic models for local phenomena, and for evaluating the code's numerics.

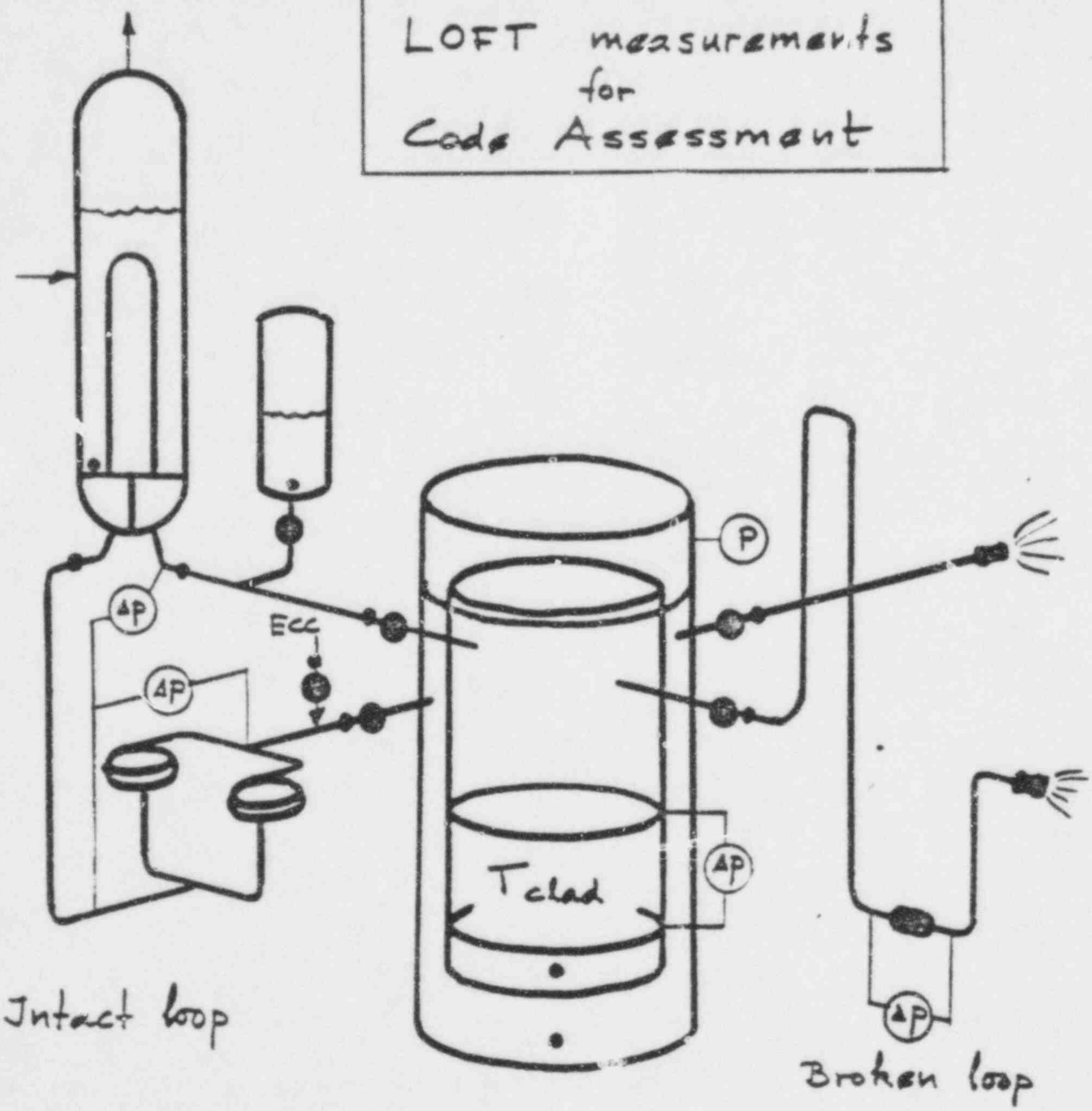
QUALITATIVE (subjective) ASSESSMENT

Based on observation of specified code results in time and space domains, to ascertain whether such results are physically reasonable. Test data are also cross plotted, wherever available. This will be the predominant mode of code assessment for the basic experiments and for the separate effects tests. In the case of integral tests, the qualitative assessment will be supplemented by the quantative assessment described below.

278 319

The following viewgraphs illustrate selection of code results to be plotted for qualitative assessment pertaining to integral tests (LOFT is shown as an example), to separate effects test (Steam generator test in FLECHT-SEASET, as example), and to basic tests (MARVIKEN-III Critical Flow test, as example).

LOFT measurements for Code Assessment

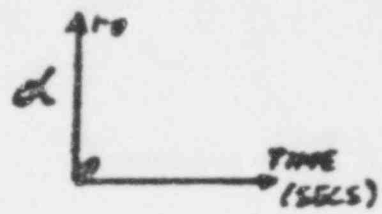


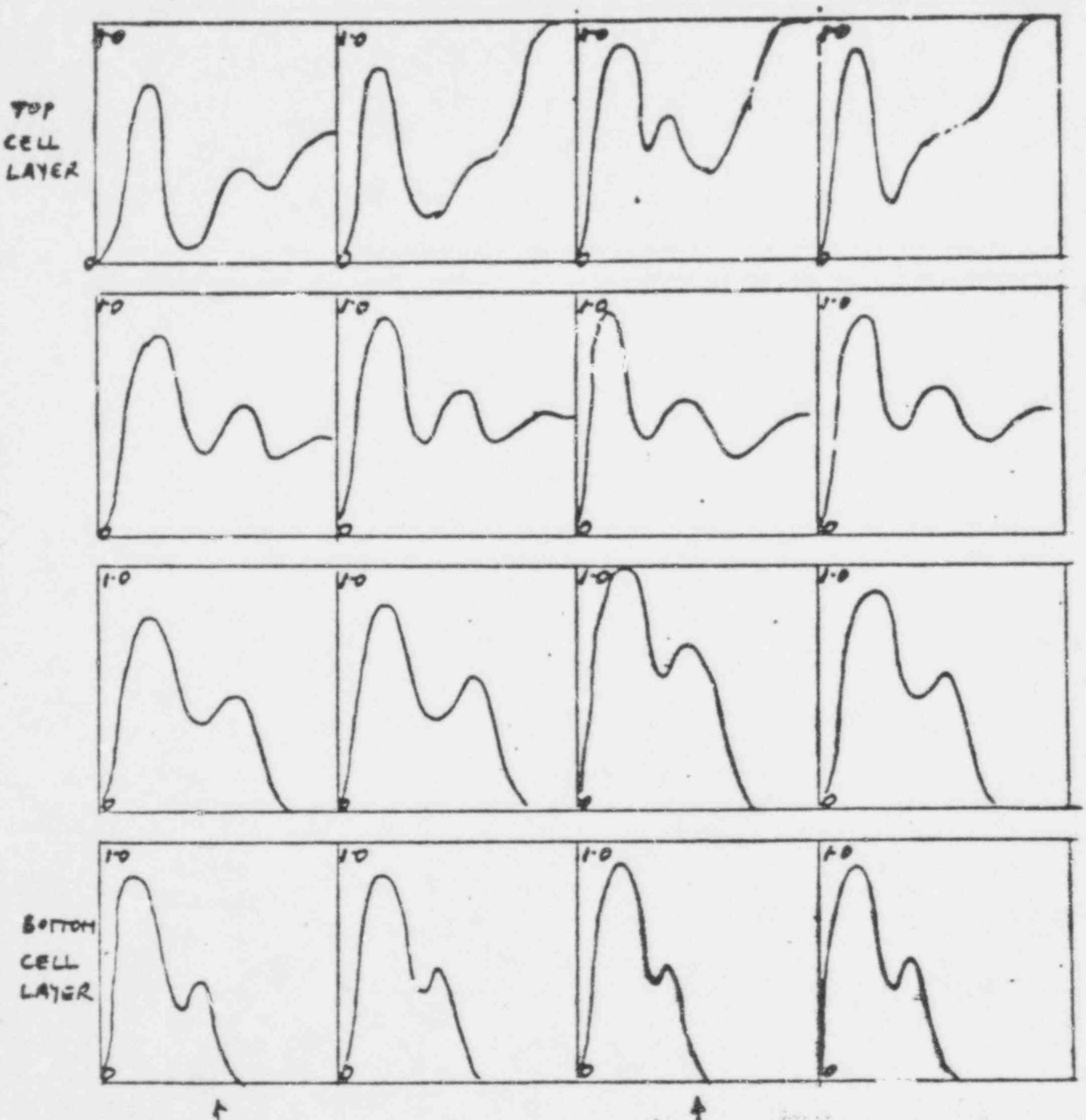
• Fluid Temperature
● Flow rate and density

278 321

VOID FRACTION IN CELLS OF UNWRAPPED DOWNCOMER

FOR QUALITATIVE ASSESSMENT



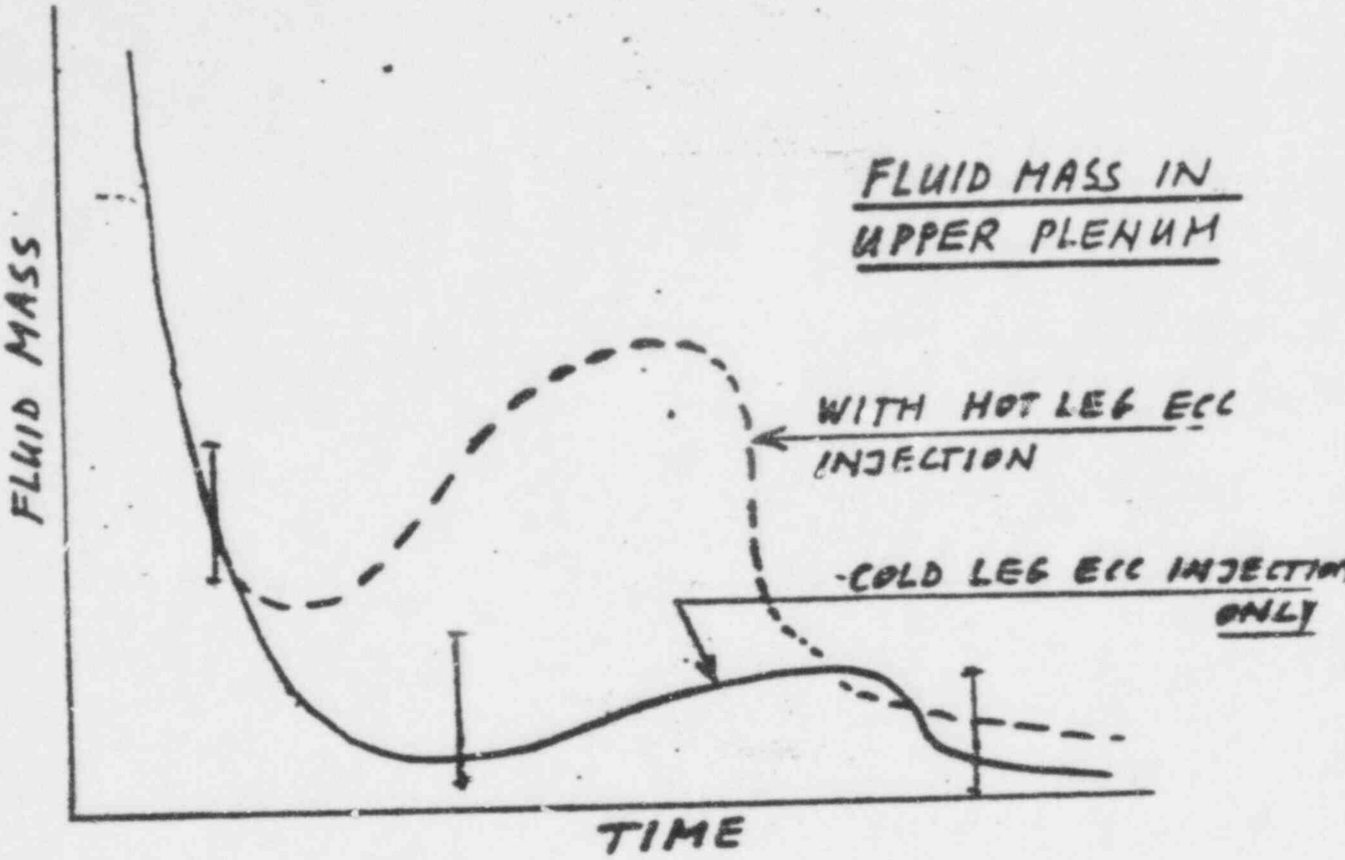


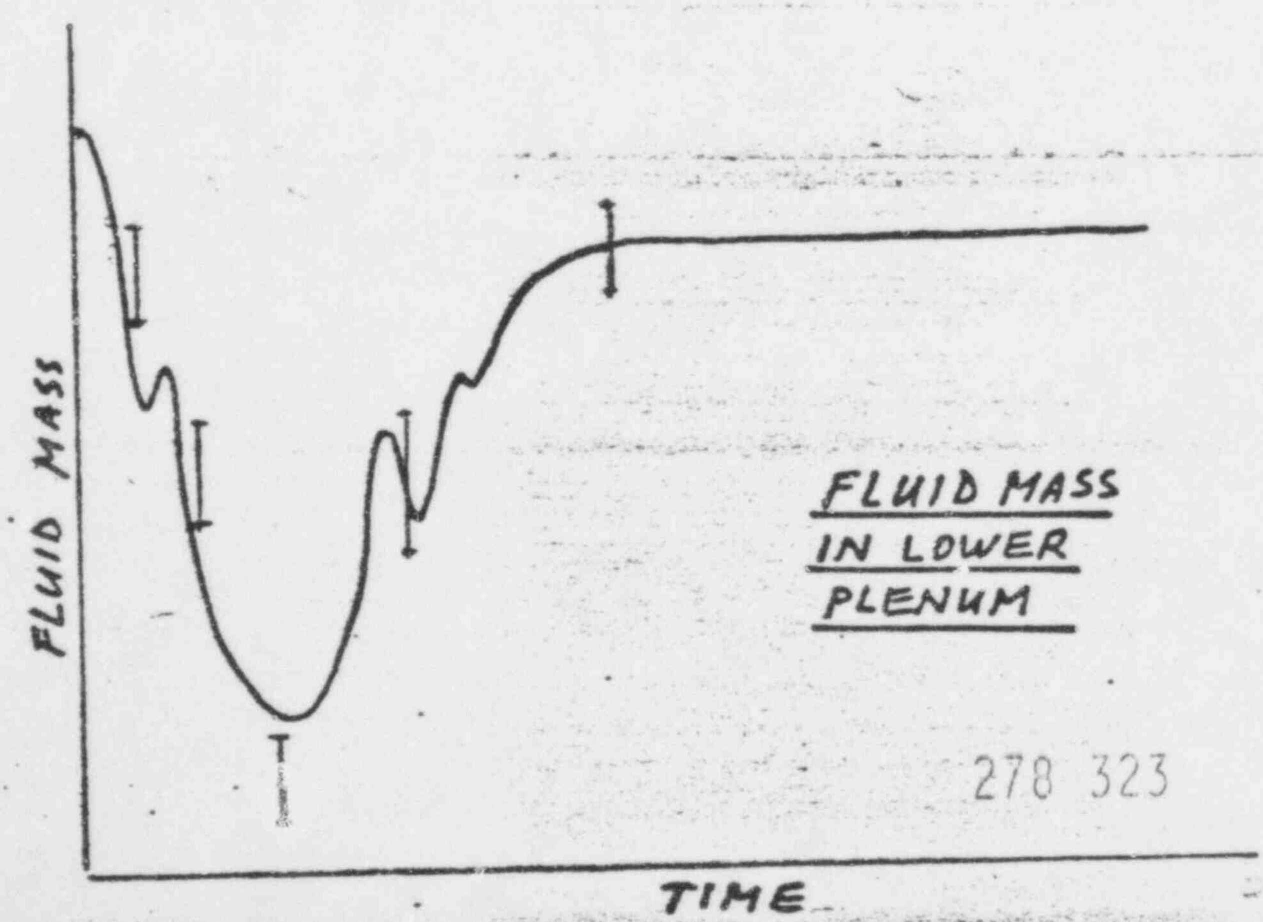
RC[illegible]ONTAINING
INTACT LOOP
INLET NOZZLE

ROW CONTAINING
BROKEN LOOP
INLET NOZZLE

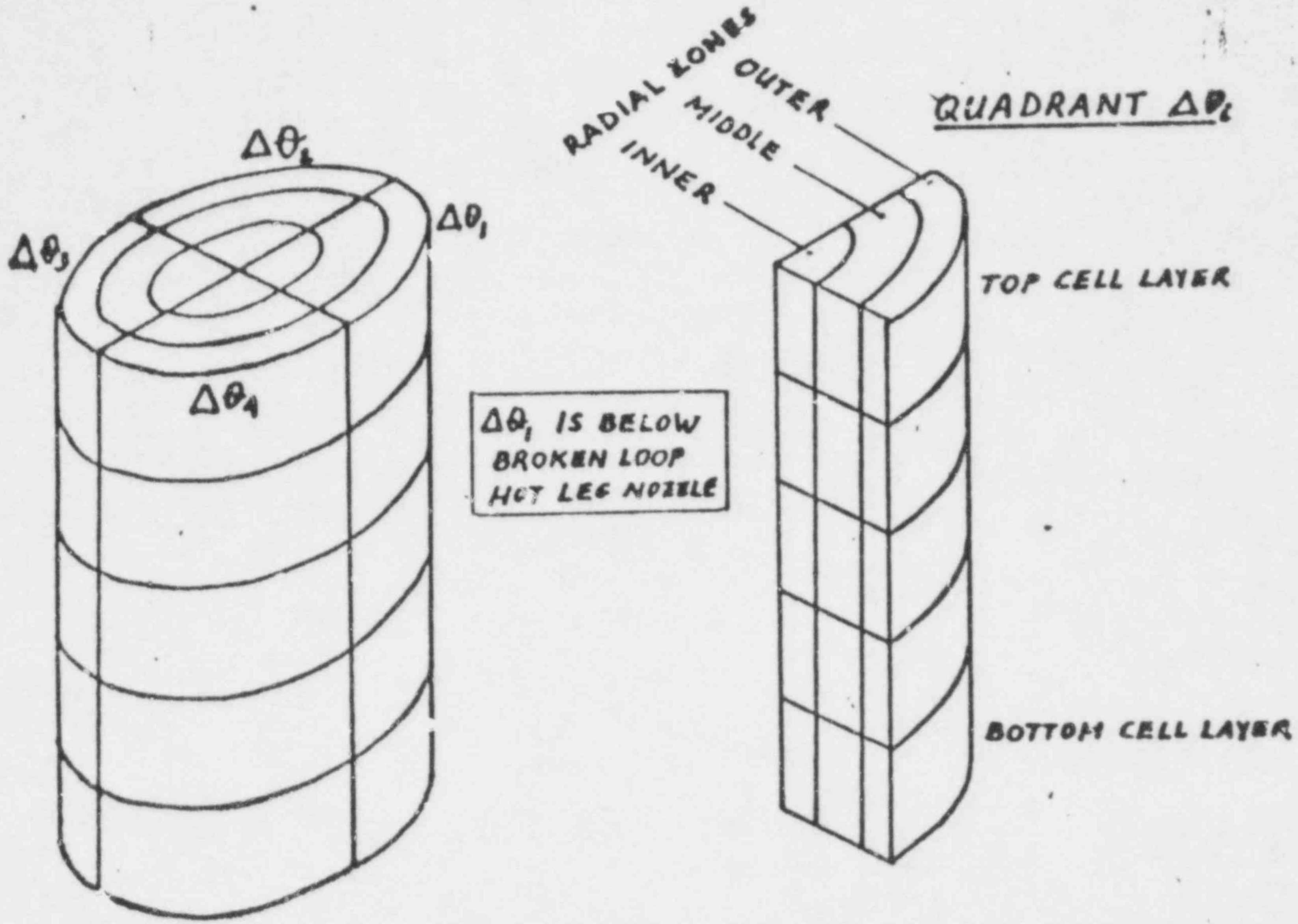
278 322

FOR QUALITATIVE ASSESSMENT





278 323

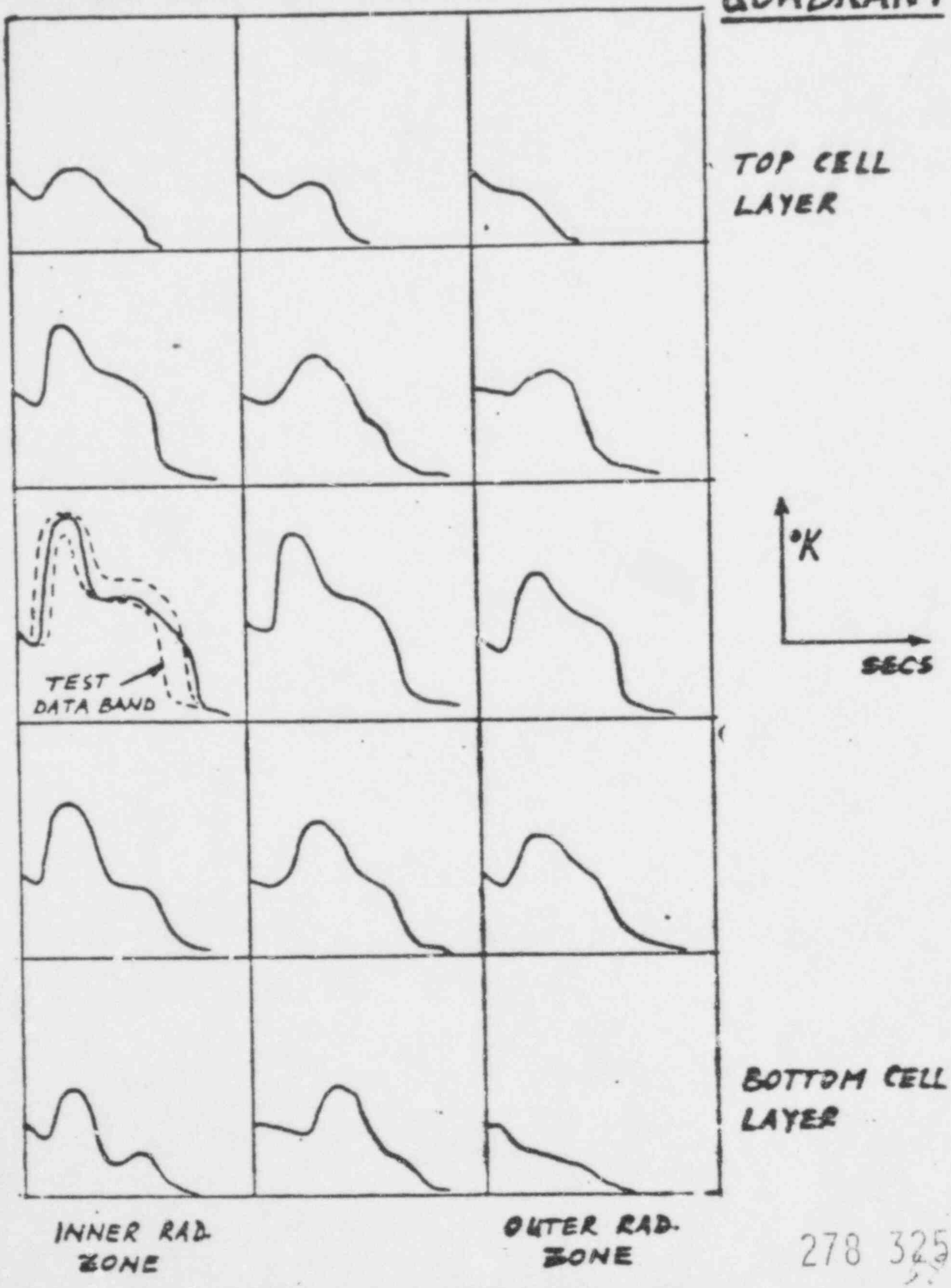


LOFT CORE NODALIZATION

278 324

CLAD TEMPERATURES IN Δθ QUADRANT

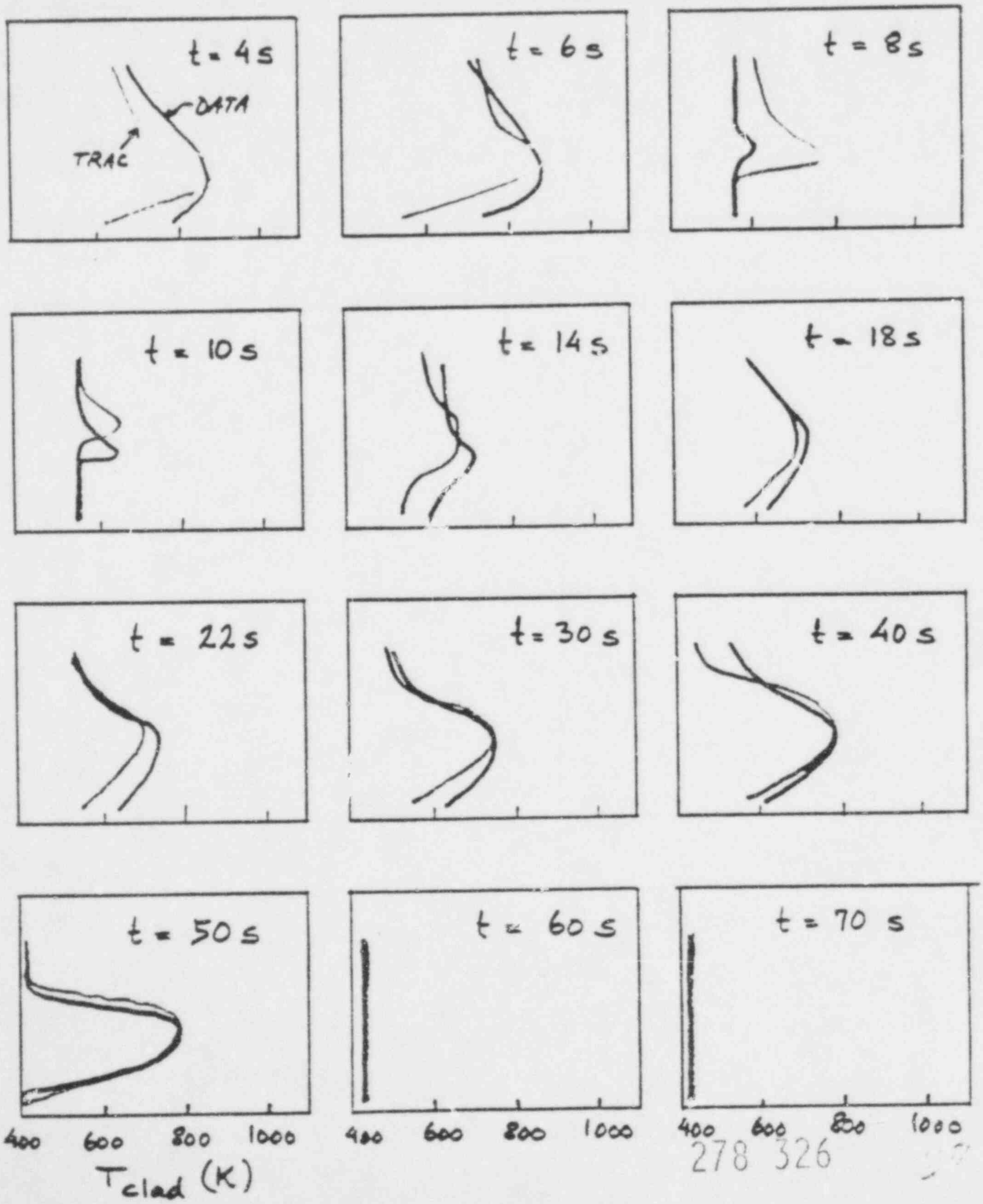
FOR QUALITATIVE ASSESSMENT



278 325

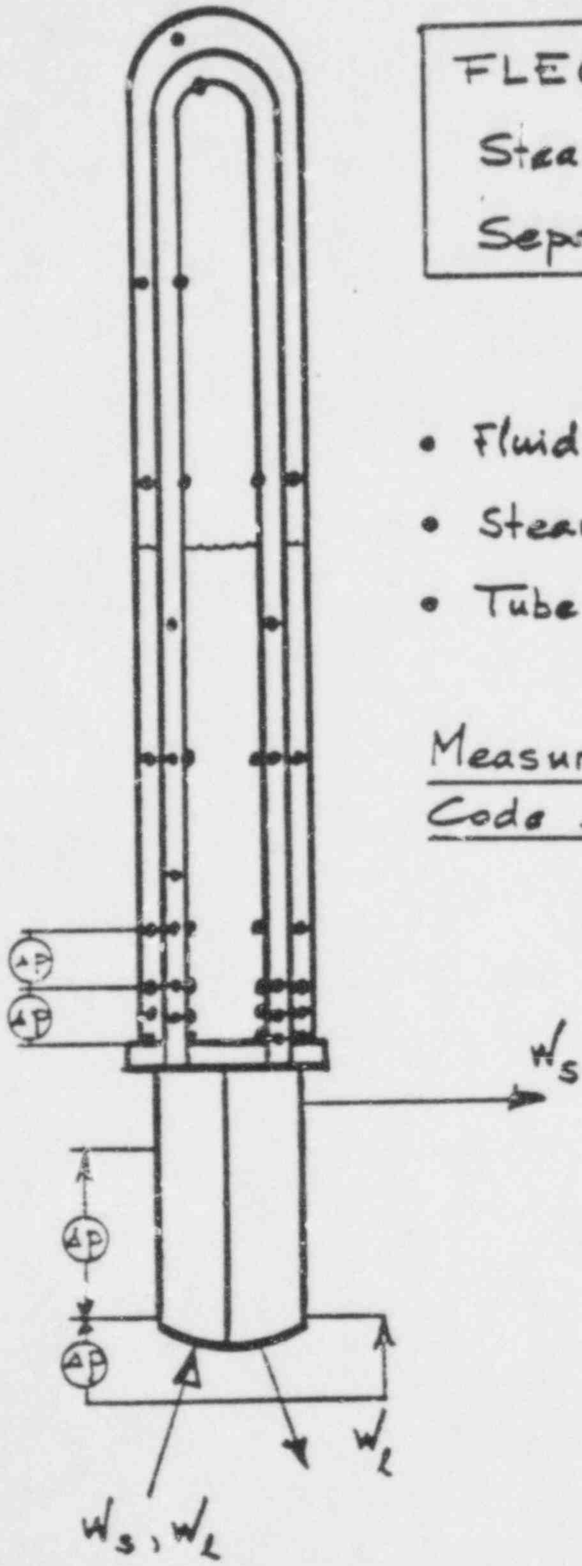
HOT ROD AXIAL TEMPERATURE DISTRIBUTION

— LOFT TEST L2-3
— TRAC PIA (ILOEJE)



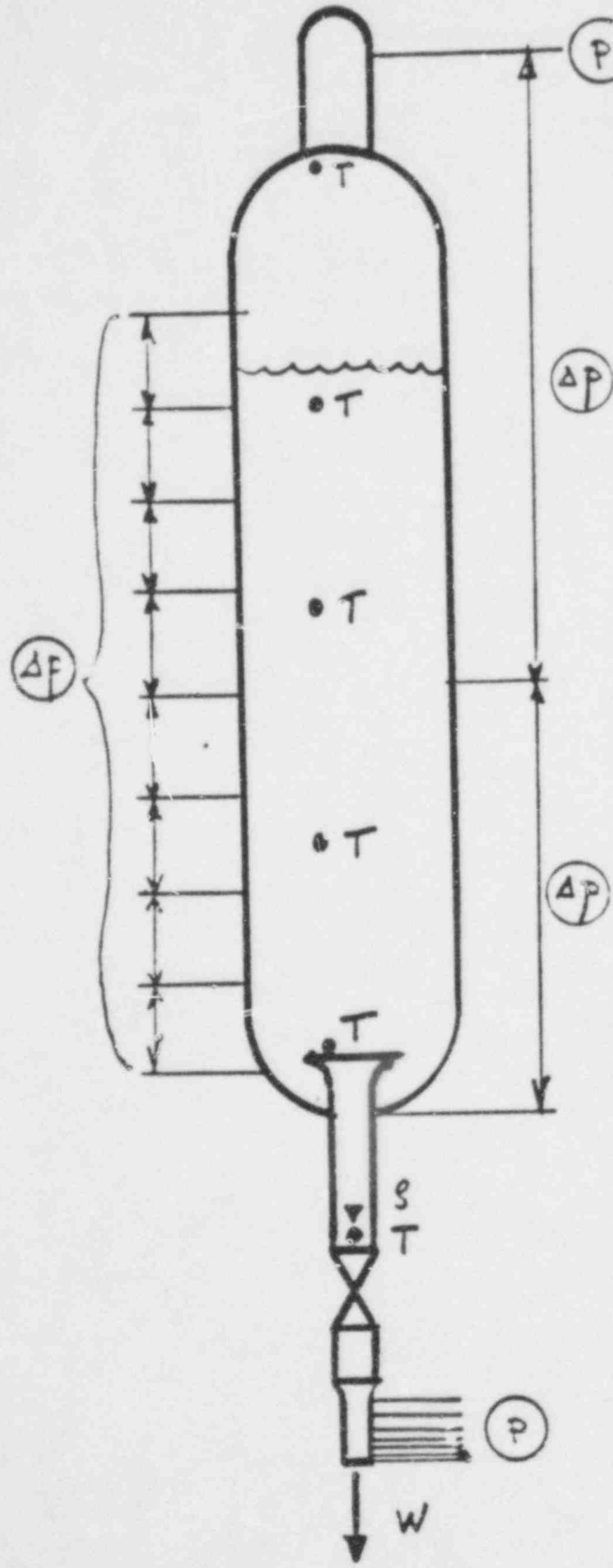
278 326

FLECHT SEASET
Steam Generator
Separate Effects Test



- Fluid Temperature (Secondary)
- Steam Temperature (Primary)
- Tube wall Temperature

<u>Measurements for Code Assessment</u>



MARVIKEN
CRITICAL FLOW
TESTS

MEASUREMENTS
FOR
CODE ASSESSMENT

278 328

QUANTITATIVE ASSESSMENT

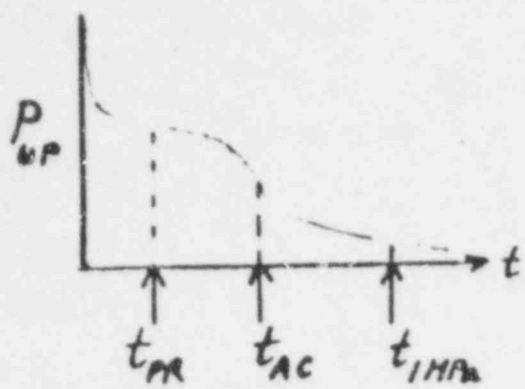
Based on obtaining "scatter plots" of certain key "indicators". Such scatter plots (of calculated vs. measured) give information that reflects the code's ability to describe a single parameter in a normalized manner thereby accounting for differences in test geometry scale, break size, etc. It is possible to extract, from that information, and extrapolate to full scale, the "code error".

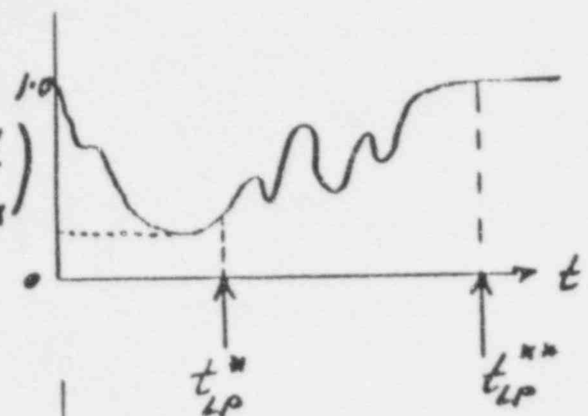
The latter goes beyond the uncertainties in coefficients and other code inputs.

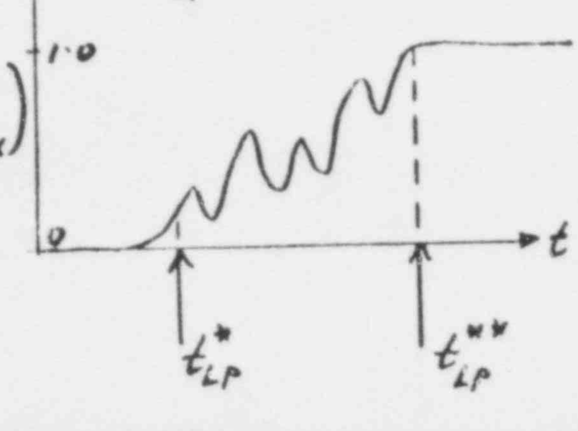
Examples of key indicators pertaining to integral LOCA tests are shown in the next viewgraph.

Indicators for very small break LOCA tests, natural circulation, non-LOCA transients, and for BWR LOCA, have not yet been worked out.

KEY INDICATORS FOR QUANTITATIVE ASSESSMENT







278 330

A. TO CHARACTERIZE UPPER PLENUM PRESSURE-TIME HISTORY

t_{PR} = TIME TO EMPTY PRESSURIZER (OF LIQUID)

t_{AC} = TIME OF START OF ACCUMULATOR DISCHARGE

t_{1MPa} = TIME WHEN U.P. PRESSURE EQUALS 1 MPa

B. TO CHARACTERIZE LOWER PLENUM MASS INVENTORY AND BEGINNING OF SUSTAINED CORE REFLOOD

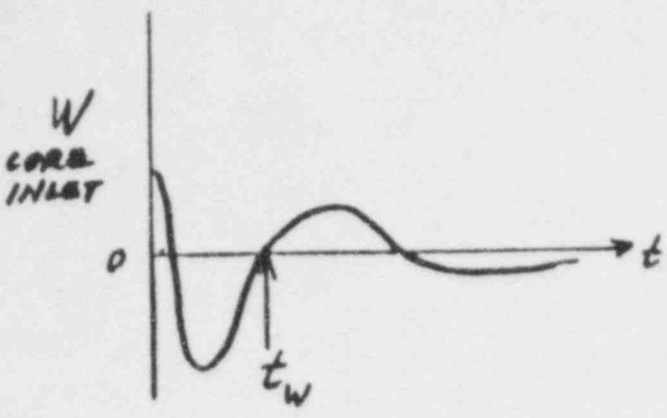
t^*_{LP} = TIME WHEN MASS IN LOWER PLENUM, M_{LP}, FIRST EQUALS $1.1 \times M^{MIN}_{LP}$, AFTER OCCURRENCE OF FIRST MINIMUM

OR IF $M^{MIN}_{LP} = 0$ (AS IN SOME INTEGRAL REFLOOD TESTS)

t^*_{LP} = TIME WHEN M_{LP} FIRST EXCEEDS $0.1 \times M^{MX}_{LP}$ (I.E. 10% OF FINAL MASS)

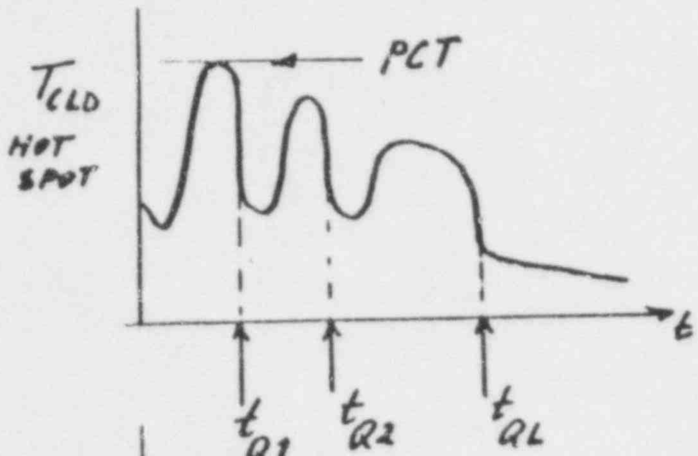
t^{**}_{LP} = TIME WHEN SUSTAINED CORE INLET REFLOOD BEGINS (NO FURTHER VOIDING AT CORE INLET)

KEY INDICATORS – CONTINUED



C. TO CHARACTERIZE CORE INLET FLOW (AS MEASURED AT OR NEAR CORE AXIS)

t_W = TIME WHEN CORE INLET FLOW EQUALS ZERO, AFTER EXPERIENCING FIRST NEGATIVE FLOW CYCLE



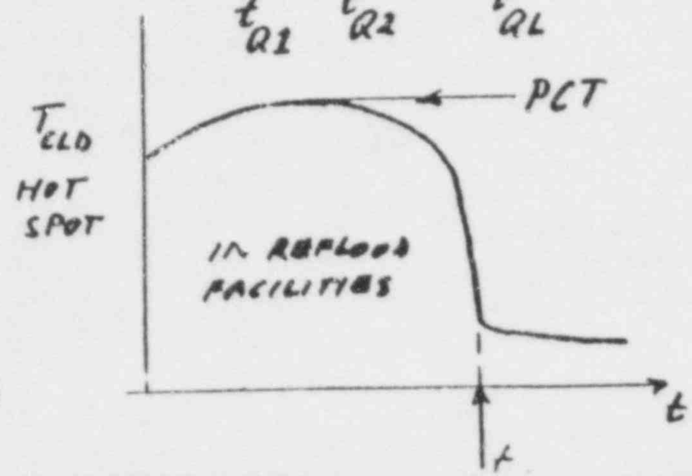
D. TO CHARACTERIZE FLOW NEAR CORE HOT SPOT, PEAK CLAD TEMPERATURE (PCT), AND QUENCHING OF HOT SPOT

t_{Q1} = TIME OF FIRST QUENCH OF HOT SPOT

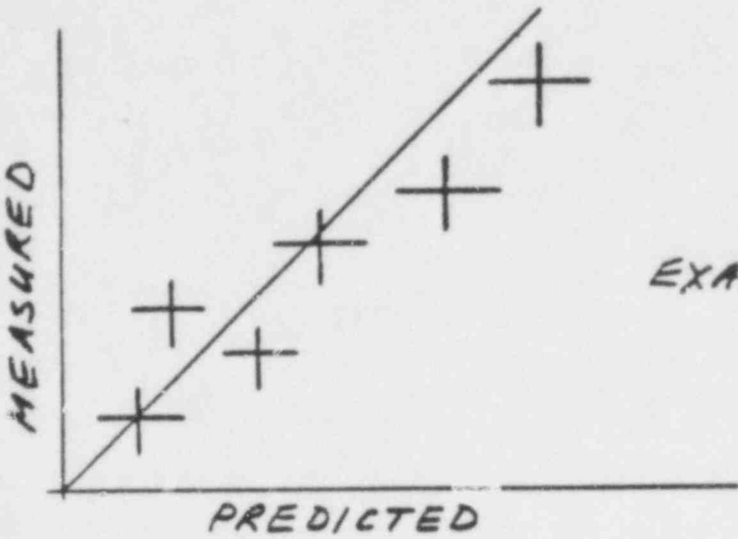
t_{Q2} = TIME OF SECOND QUENCH OF HOT SPOT (WHERE APPLICABLE)

t_{QL} = TIME OF FINAL QUENCH OF HOT SPOT

PCT = MAGNITUDE OF PEAK CLAD TEMPERATURE



PRESENTATION OF KEY INDICATORS



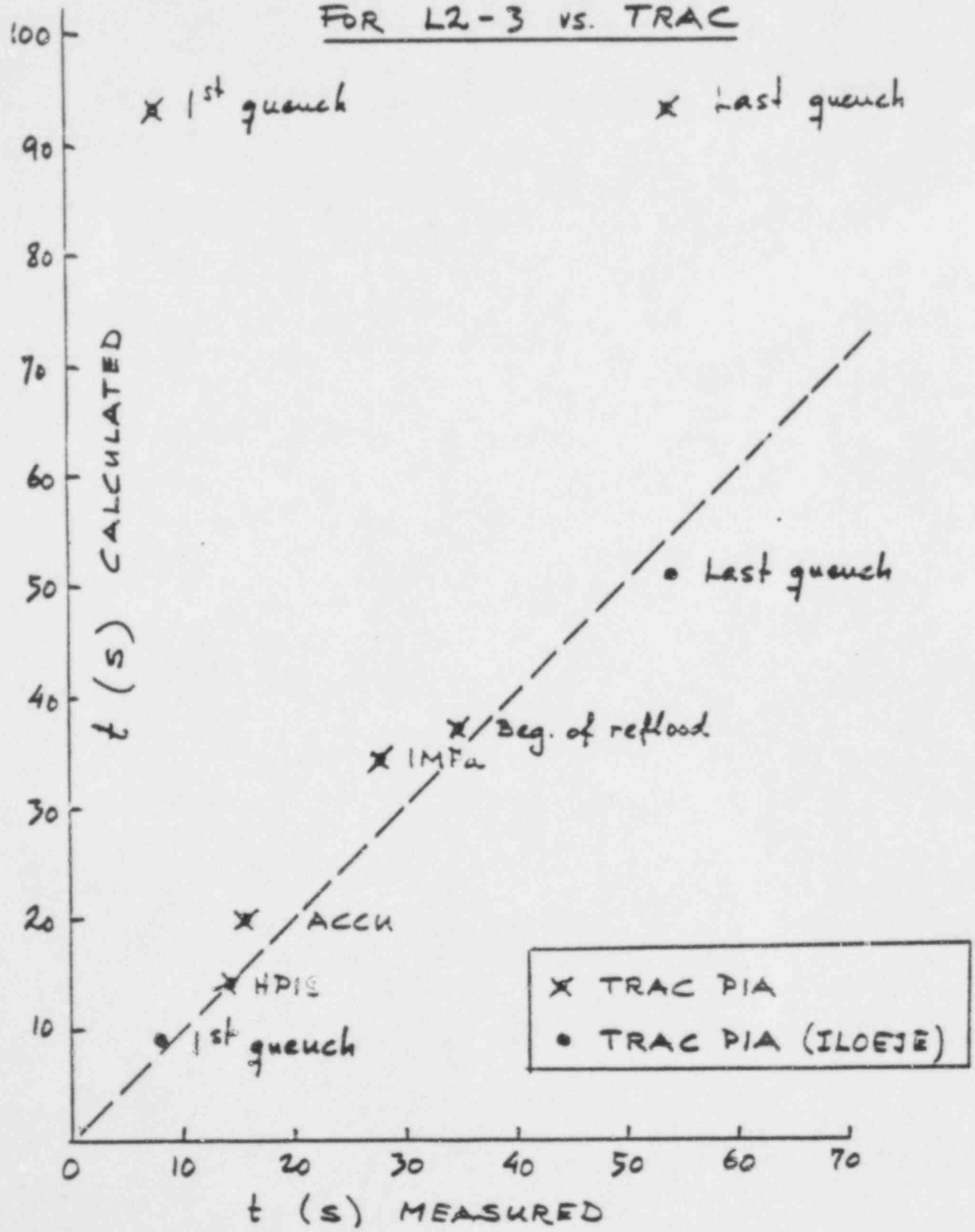
EXAMPLE FOR INDICATOR x

1. EACH ENTRY IN THE GRAPH INDICATES THE MEASUREMENT AND, ALSO, CALCULATION UNCERTAINTY. THE LATTER DUE TO UNCERTAINTY IN VARIOUS INPUT COEFFICIENTS AND MODEL "CONSTANTS."

2. CODE ERROR INFORMATION COMES FROM CONDITIONS IN WHICH THE 45° LINE DOES NOT INTERSECT WITH DOMAINS OF INFLUENCE DEFINED BY INDIVIDUAL CROSSES.

3. SINCE INDIVIDUAL ENTRIES MAY REPRESENT DIFFERENT SIZE TEST FACILITIES IT COULD BE POSSIBLE TO EXTRAPOLATE CODE ERROR TO FULL SCALE PLANTS.

PLOT OF ALL (TIME) KEY INDICATORS FOR L2-3 vs. TRAC



TRAC - P1A ASSESSMENT

	TOTAL DESIRED IN FY 79 & 80	FY 79 LASL DONE	FY 79 LASL NEW	FY 79 BNL	FY 79 INEL	FY 80 LASL	FY 80 BNL	FY 80 INEL	FY 80 SANDIA
A. INTEGRAL TESTS									
SS MOD-1	27	5				10		12	
SS MOD-3	11	1	2			5		1	3 UNIT
LOFT L1	2	2						2	
LOFT L2, ETC	5	1	2			2			
LOBI	6		1			5			
PKL	6		1			3		2	
FLECHT-SET	2		0					2	
FLECHT-SEASET (SYST)	?		0			?		0	
CCTF	8		3			5		0	

POOR ORIGINAL

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TRAC - P1A ASSESSMENT

	TOTAL DESIRED IN FY 79 & 80	FY 79 LASL DONE	FY 79 LASL NEW	FY 79 BNL	FY 79 INEL	FY 80 LASL	FY 80 BNL	FY 80 INEL	FY 80 SANDIA
B. SEPARATE EFFECTS									
FLECHT	5		0					5	
FLECHT-SEASET	4		1			3			
PDF	5		0			3		2	
KWU FORC. RFLD	2		0			2			
FLECHT-SEASET-S.G.	5		1			4			
CREARE 1/15	3x3 SS, 4 RAMP	2 (RAMP)				11			
BCL 1/15	2x3 SS		0			6			
BCL 2/15	3x3 SS, 6 RAMP		0			15			
NRU	1		0			1			

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TRAC - P1A ASSESSMENT

	TOTAL DESIRED IN FY 79 & 80	FY 79				FY 80			
		LASL		RNL	INEL	LASL	RNL	INEL	SANDIA
		DONE	NEW						
C. <u>BASIC TESTS</u>									
FRIGG	5		0	3			2		
RPI/2D (3x5)	2		0	2			0		
RPI/2D (3x3)	4		0	0			4		
IRB	9		1(R)	3		2 (R)	6		
CANON	4		0	4			0		
SUPER CANON	4		0	0			4		
MOBY DICK (AIR/W)	6		0	2		1 (R)	4		
MOBY DICK (S/W)	6		0	2		1 (R)	4		
SUPER MOBY DICK	6		0	2		1 (R)	4		
MARVIKEN-III	17		3			4	6	4	
U. HOUSTON	8		0	2		1 (R)	6		
BATTELLE-FRANK	2		1	0		1 (R)	1		

POOR ORIGINAL

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CODE UNCERTAINTY/SENSITIVITY STUDY

1. AT SANDIA LAB.

* COMPLETED UNCERTAINTY STUDY FOR BLOWDOWN REGIME OF LOCA, USING RELAP-4/MOD 6

* DRAFT REPORT ISSUED.
FINDINGS: OF 21 PARAMETERS THAT WERE VARIED, 7 DOMINATED THE PEAK CLAD TEMPER.

  GAP WIDTH
  TOTAL PEAKING FACTOR
  UO_2 CONDUCTIVITY
  FILM-BOILING HTC
  2-φ FRICTION MULTIPLIER
  SLIP (VAPOR/LIQUID REL. VEL.)
  POWER LEVEL

* NEXT PHASE: REPEAT ABOVE WITH TRAC-P1A AND CONTINUE THRU END OF LOCA.

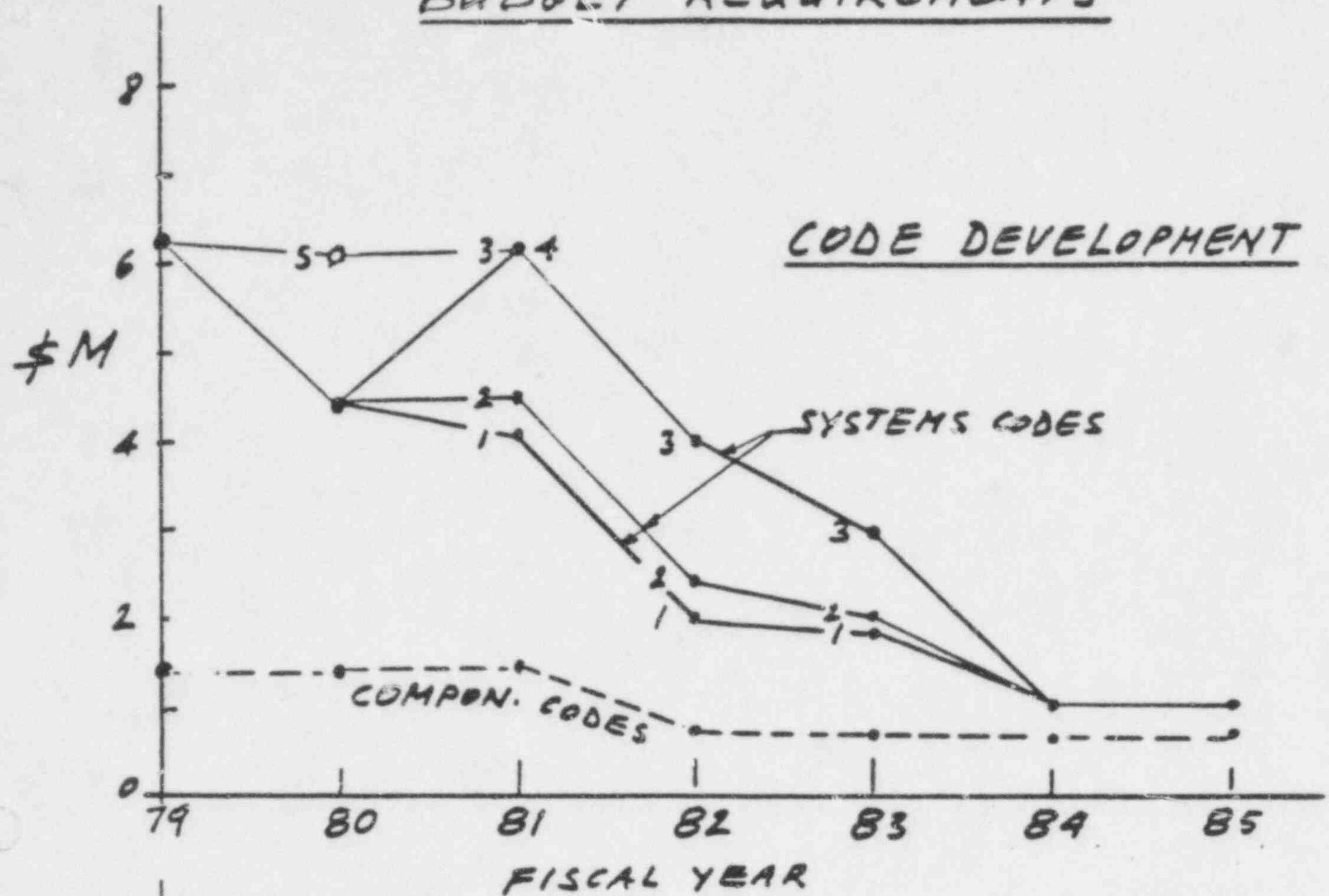
2. AT LASL

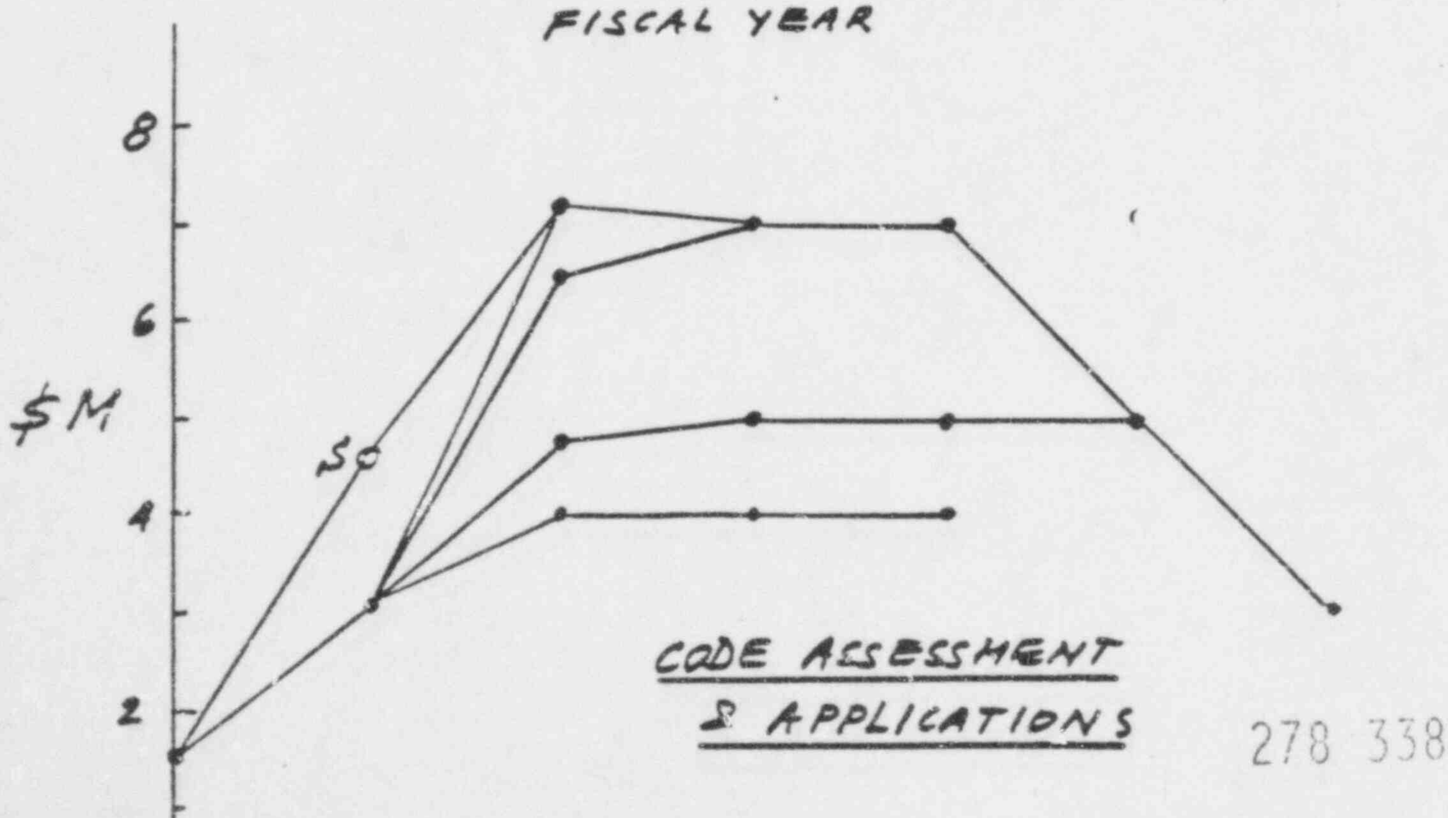
* CONDUCTING MODELING SENSITIVITY STUDY TO DETERMINE WHICH ARE THE MOST IMPORTANT 2-φ FLOW MODELING PARAMETERS, IN TRAC CODE, THAT NEED TO BE INCLUDED IN SANDIA'S STUDY.

* CONDUCTING NODING SENSITIVITY STUDY

278 337

BUDGET REQUIREMENTS





278 338

NRC SPONSORED CALCULATIONS

OF TMI-2 ACCIDENT SCENARIO

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TABLE I

SUMMARY OF NATURAL CIRCULATION RUNS

---

1. A & B steaming - 90% operating level in secondary

2. A & B isolated

3. A steaming, B isolated

   a. 90% operating level in secondary
   b. 10% operating level in secondary
   c. 90% operating level - 3 MW
   d. 90% operating level with vent valves operational
      p = 0.0 to open
   e. 90% operating level - vent valve stuck open
   f. 90% operating level - factor of 35 increase in core resistance
   g. 40% operating level in secondary
   h. 90% operating level, p = 500 psia, circulation established, 8.3 MW, B loop valved off, transient initiated from zero initial flow
   i. 90% operating level, 95% area blockage
   j. 90% operating level, 99% area blockage

4. A solid, B isolated - 6 volume S.G., counterflow on Secondary side

   a. 20 gpm secondary flow
   b. 5000 gpm secondary flow
   c. 40% core area blockage, 5000 gpm secondary flow
   d. parallel flow, 5000 gpm secondary flow
   e. 5000 gpm secondary flow, 98% blockage
   f. 5000 gpm secondary flow, 92% blockage

5. A solid, B isolated - 17 volume ...

   a. no core area blockage, 5000 gpm secondary flow
   b. no core area blockage, 500 gpm secondary flow

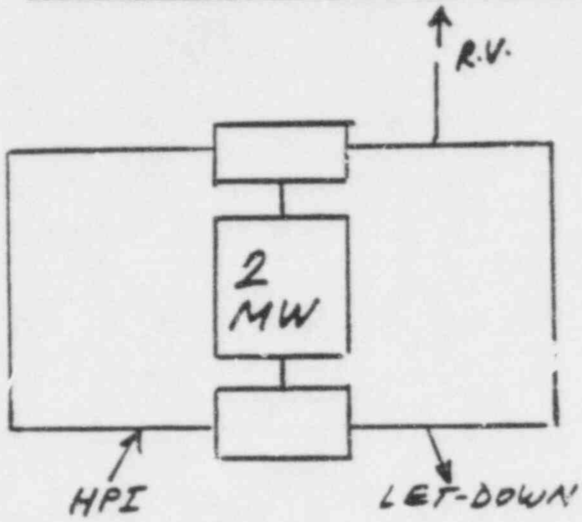
6. A & B solid - counterflow

   a. 40% core area blockage, 5000 gpm secondary flow
   b. no area reduction

---

22 calcs.

II RELAP-4 STUDIES: COULD PLANT BE COOLED BY HPI PLUS LETDOWN PLUS RELIEF VALVE FLOWS, WITHOUT ACTIVE STEAM GENERATORS NOR PUMPS



ASSUMPTIONS

P = 1000 psia

T = 2000 °F

98% CORE BLOCK.

BOTH ST. GEN. INACTIVE

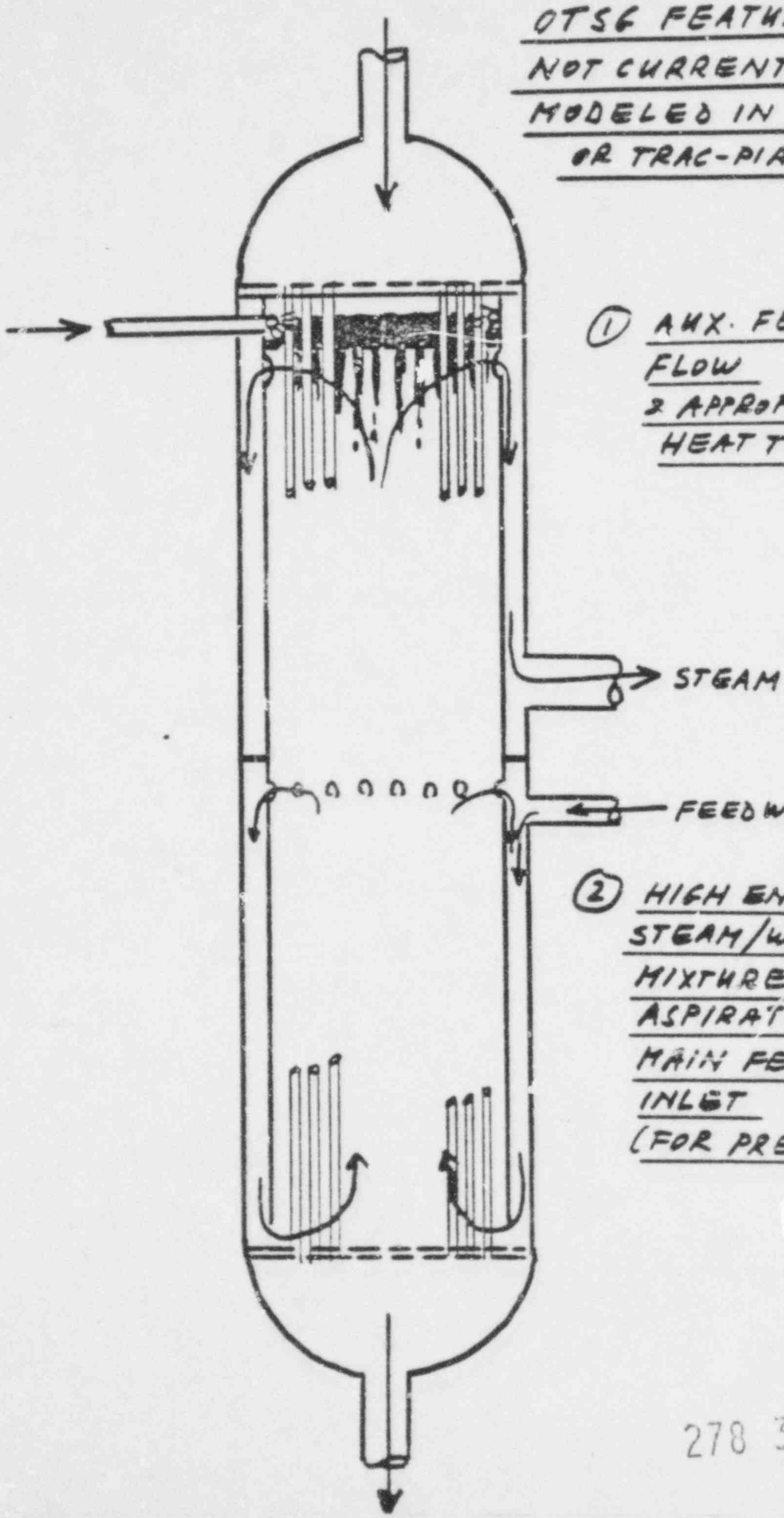
CASE	HPI (GPM)	LETDOWN (GPM)	HOT LEGS BLOCKED?	STEADY STATE REACHED?	COOLANT TEMPER.
1	500	0	NO	YES	↘
2	175	100	NO	YES	↘
3	0	0	NO	YES	↗
4	175	0	YES	YES	↘
5	175	0	NO	NO	↘
6	100	0	NO	NO	↗
7	100	100	NO	NO	↗

CONCLUSION: NAT. CIRC. NOT AFFECTED BY HPI & LETDOWN ACTIVITIES

TMI-2 ACCIDENT SIMULATION DIFFICULTIES DUE TO UNCERTAINTIES IN FOLLOWING BOUNDARY CONDITIONS:

1. SECONDARY SIDE OF STEAM GENERATORS
   * MANUAL INTERVENTION OF FEEDWATER FLOW CONTROL
   * TURBINE BYPASS FLOW
   * LIQUID LEVEL IN S.G.
2. PRESSURIZER RELIEF VALVE
   * WAS THE VALVE STUCK OPEN ONLY PARTIALLY ?
   * WAS THE FLOW AREA CHANGING WITH TIME ?
3. HPIS AND LETDOWN FLOWS
   * WHEN ON AND WHEN OFF ?
   * HOW MANY PUMPS ON ?
   * WHAT FLOW RATES ?

OTSG FEATURES
NOT CURRENTLY
MODELED IN RELAP-4
OR TRAC-P1A



① AUX. FEEDWATER
FLOW
& APPROPRIATE
HEAT TRANSFER

② HIGH ENTHALPY
STEAM/WATER
MIXTURE
ASPIRATION AT
MAIN FEEDWATER
INLET
(FOR PRE-HEATING)

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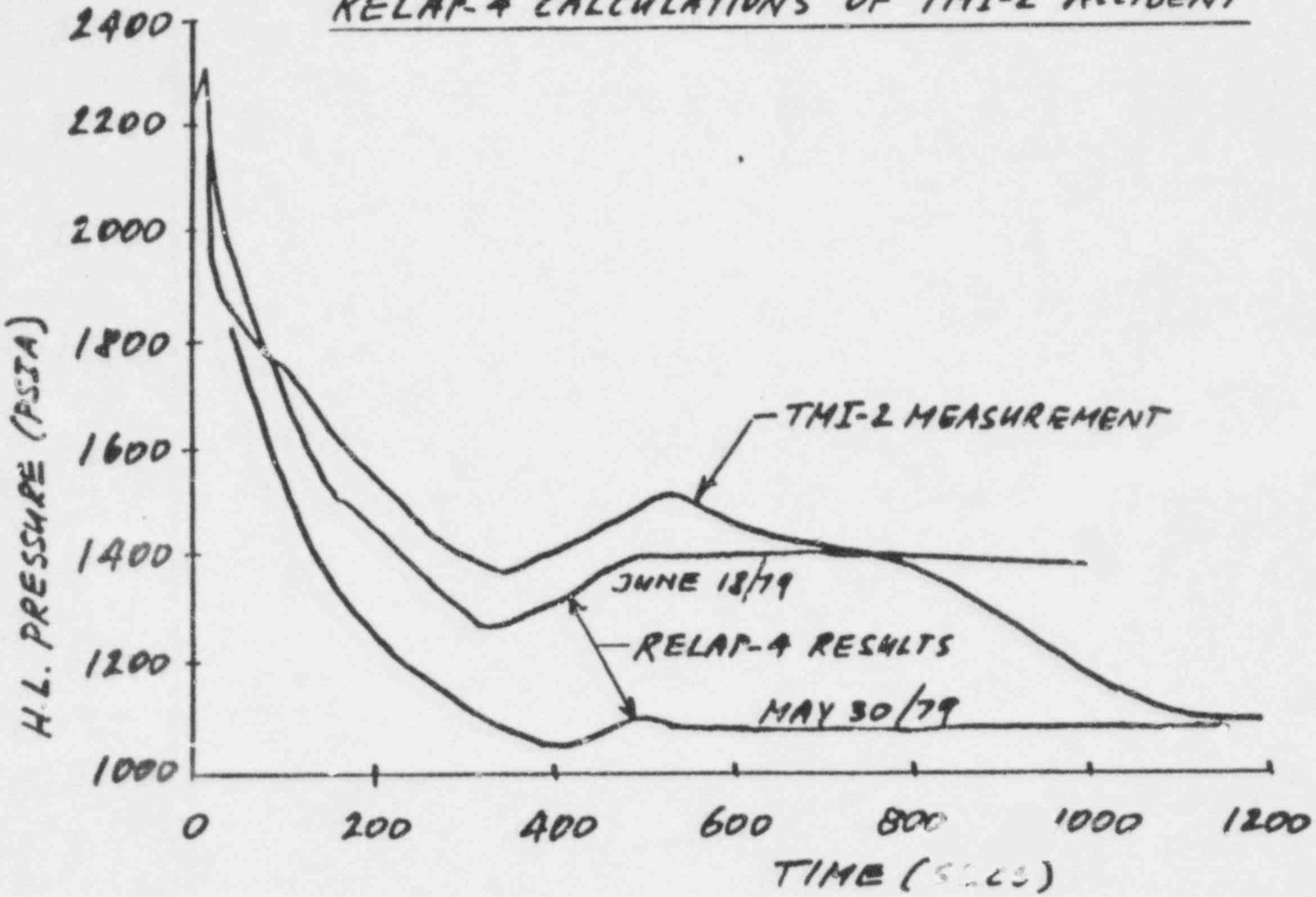
5

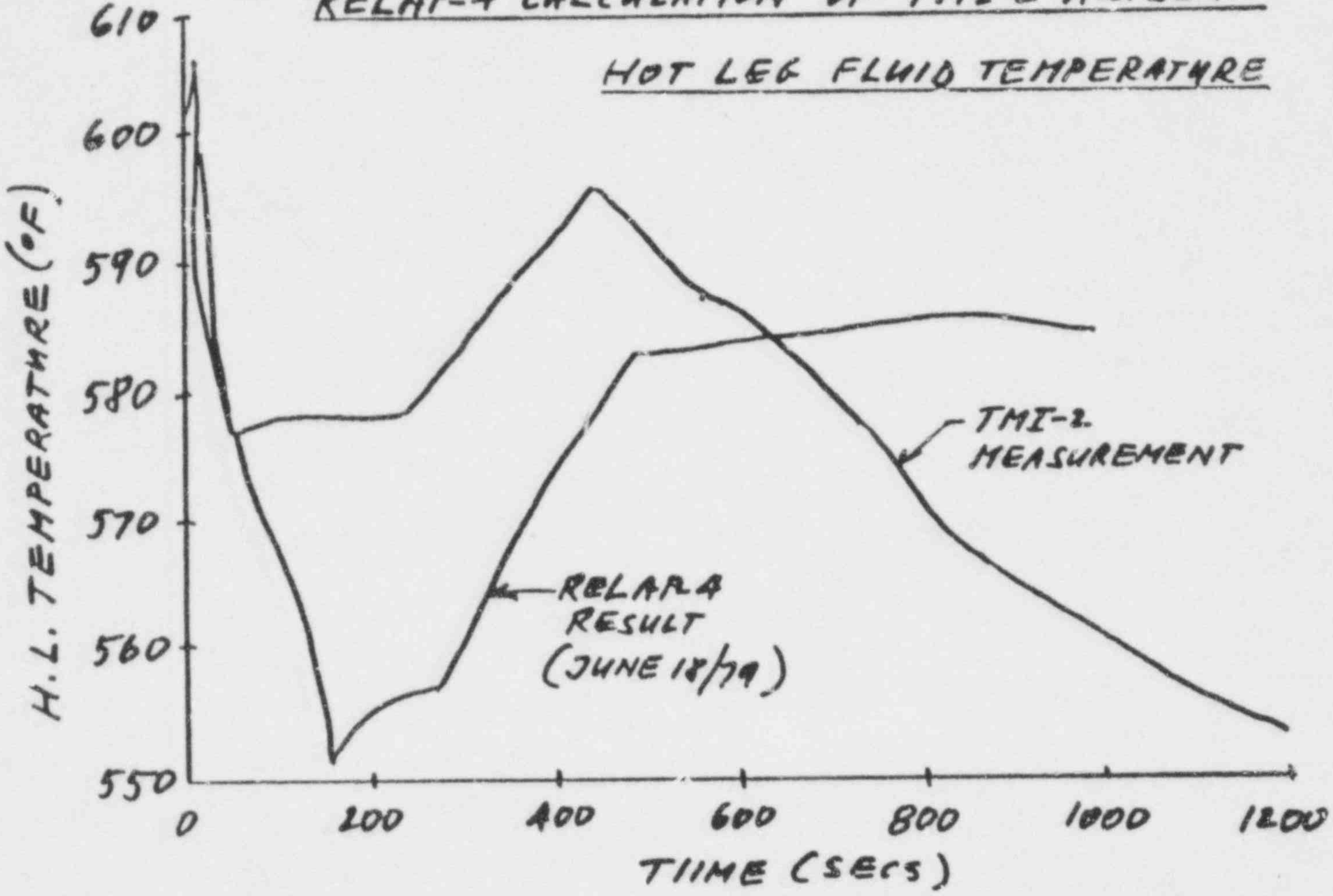
RELAP-4 CALCULATIONS OF TMI-2 ACCIDENT



278 344

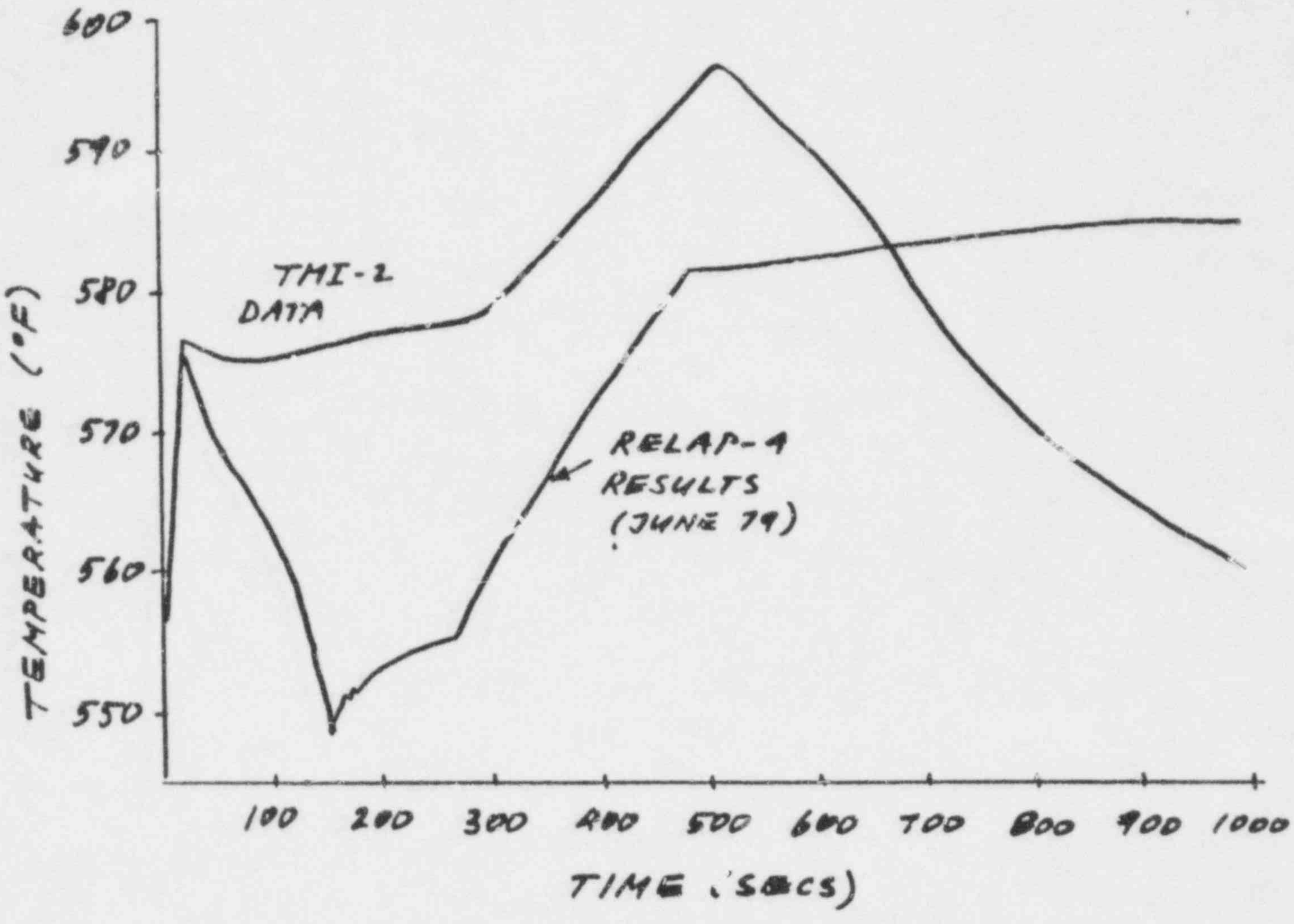
RELAP-4 CALCULATION OF TMI-2 ACCIDENT

HOT LEG FLUID TEMPERATURE



278 345

RELAP-4 CALCULATION OF COLD LEG FLUID TEMPERATURE, DURING TMI-2 ACCIDENT



278 346

5

RELAP-4 CALCULATIONS OF THI-2 ACCIDENT SCENARIO
FOR PERIOD $t > 20$ MINS (MAY 1979)

RUN #	CONDITIONS USED	RESULTS
1	* STEAM GEN. SECONDARY HOMOGENEOUS, QUALITY VARIED * HPI ON (500 GPM) * ACCUMULATOR OPERATIONAL	SYSTEM PRESSURE DECAYS TO 200 PSIA. ACCUMULATOR EMPTIES. NO CORE UNCOVERY.
2	* ST. GENER. SECONDARY LEVELS 1.0 FT AND 1.0 FT * HPI ON	SYSTEM PRESSURE STEADILY INCREASES ABOVE 2000 PSI. CALC. TERMINATED
3	* ST. GEN. SECONDARY LEVELS 1.0 FT AND 1.0 FT * HPI OFF	SYSTEM PRESSURE ABOUT 100 PSI HIGHER THAN IN RUN # 2. CALCULATION STOPPED.
4	* ST. GEN. SECONDARY LEVELS 3.0 FT AND 7.5 FT * HPI ON (200 GPM) * ACCUMUL. OPERATIONAL	SYSTEM PRESSURE DECAYS TO 200 PSIA, ACCUMUL. EMPTIED, NO CORE UNCOVERY
5	* ST. GEN. SECONDARY LEVELS 3.0 FT AND 7.5 FT * HPI ON (200 GPM) * NO ACCUMULATOR	SYSTEM PRESSURE DECAYS TO 200 PSIA. NO CORE UNCOVERY

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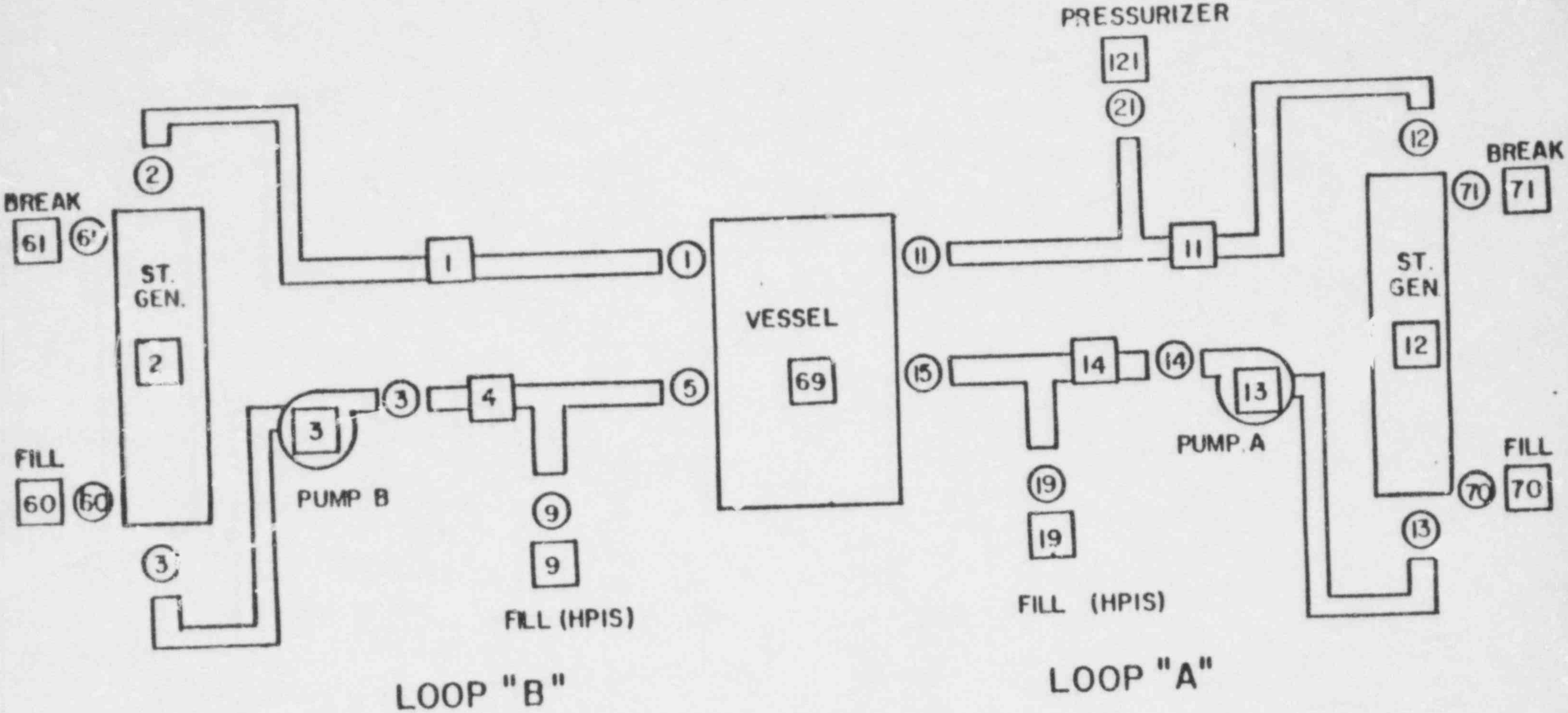
THREE MILE ISLAND (UNIT 2) - TRAC SCHEMATIC



□ COMPONENT NO.

○ JUNCTION NO.

16 COMPONENTS

17 JUNCTIONS

24 VESSEL CELLS
37 I-D CELLS
61 TOTAL CELLS

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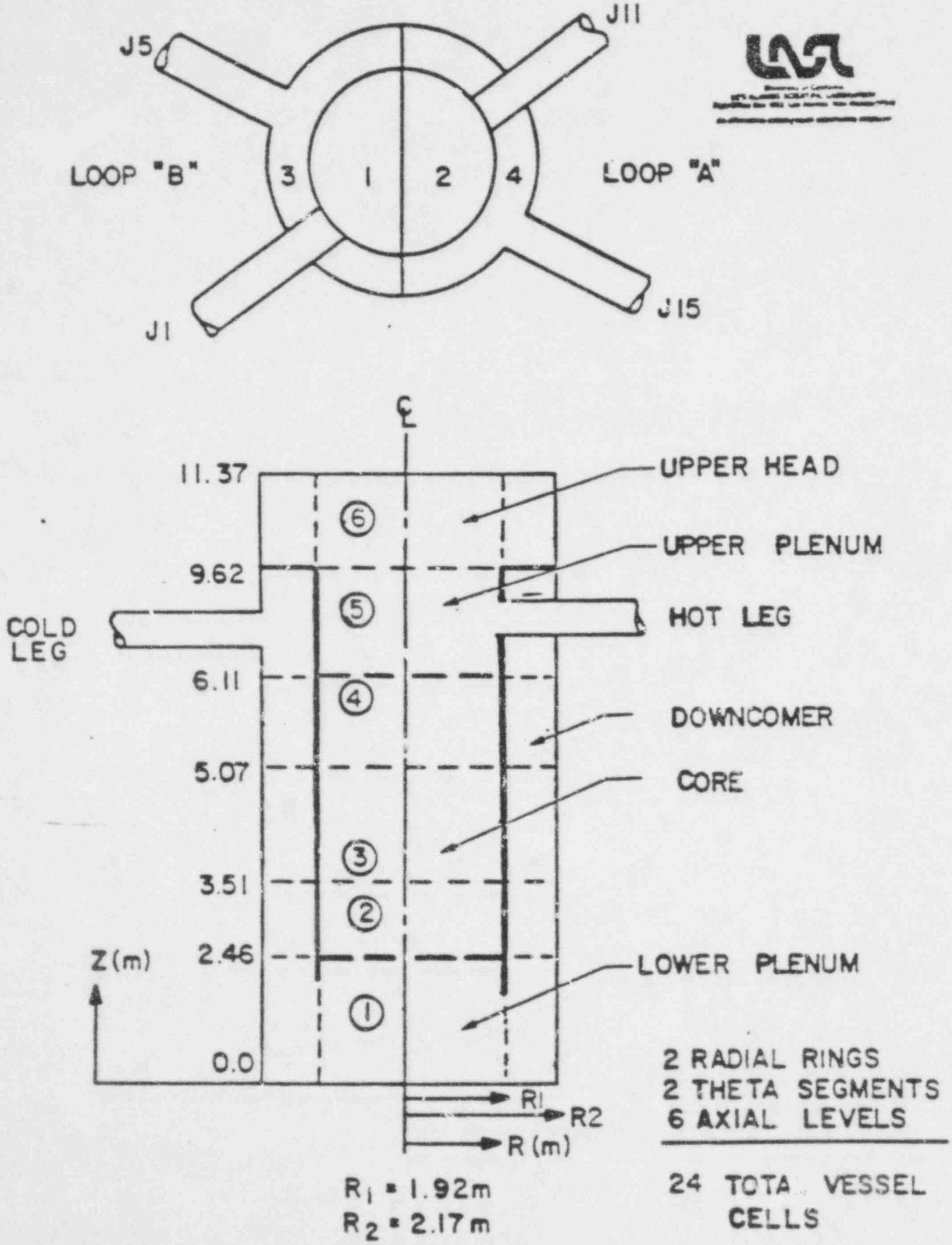
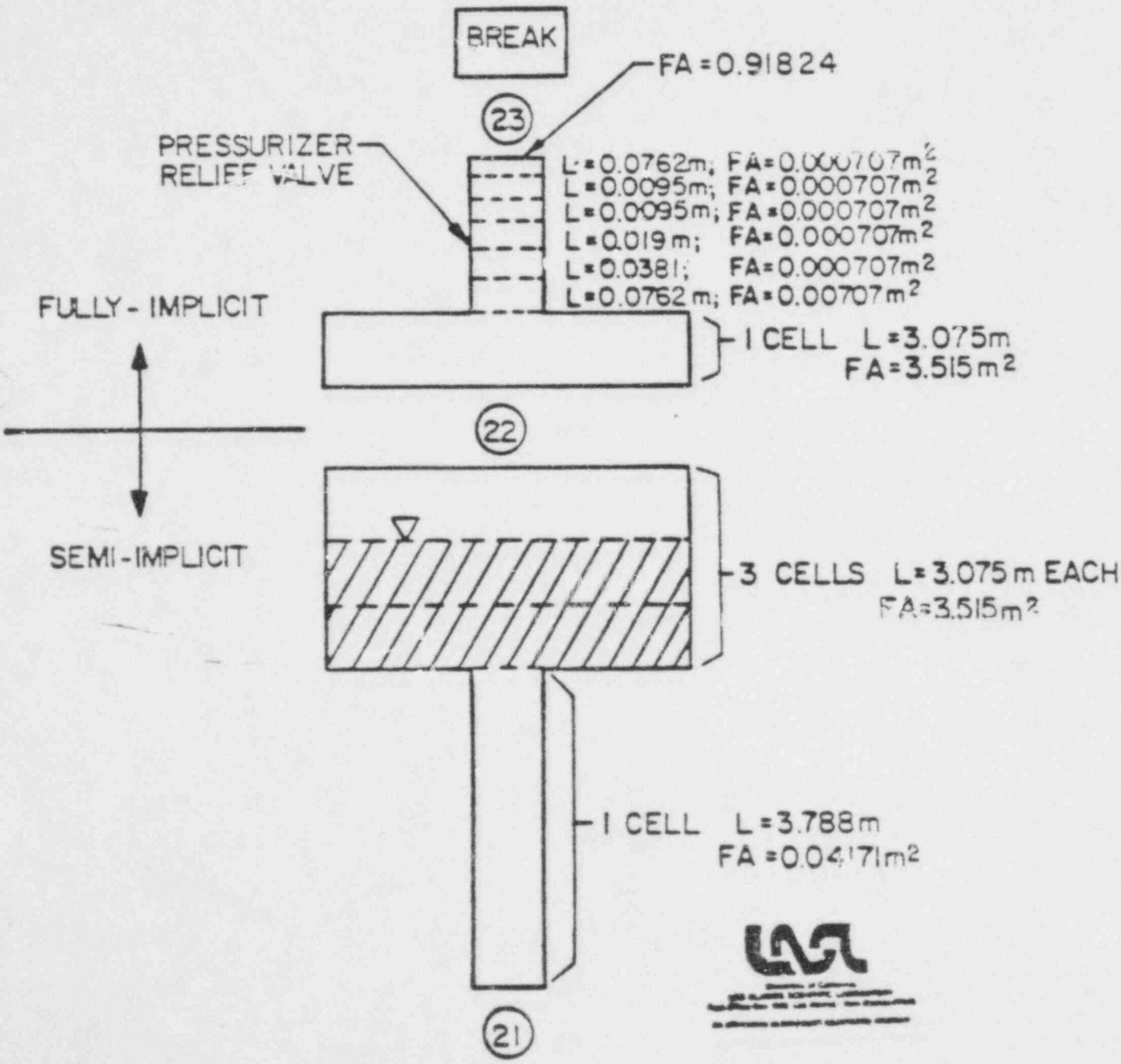
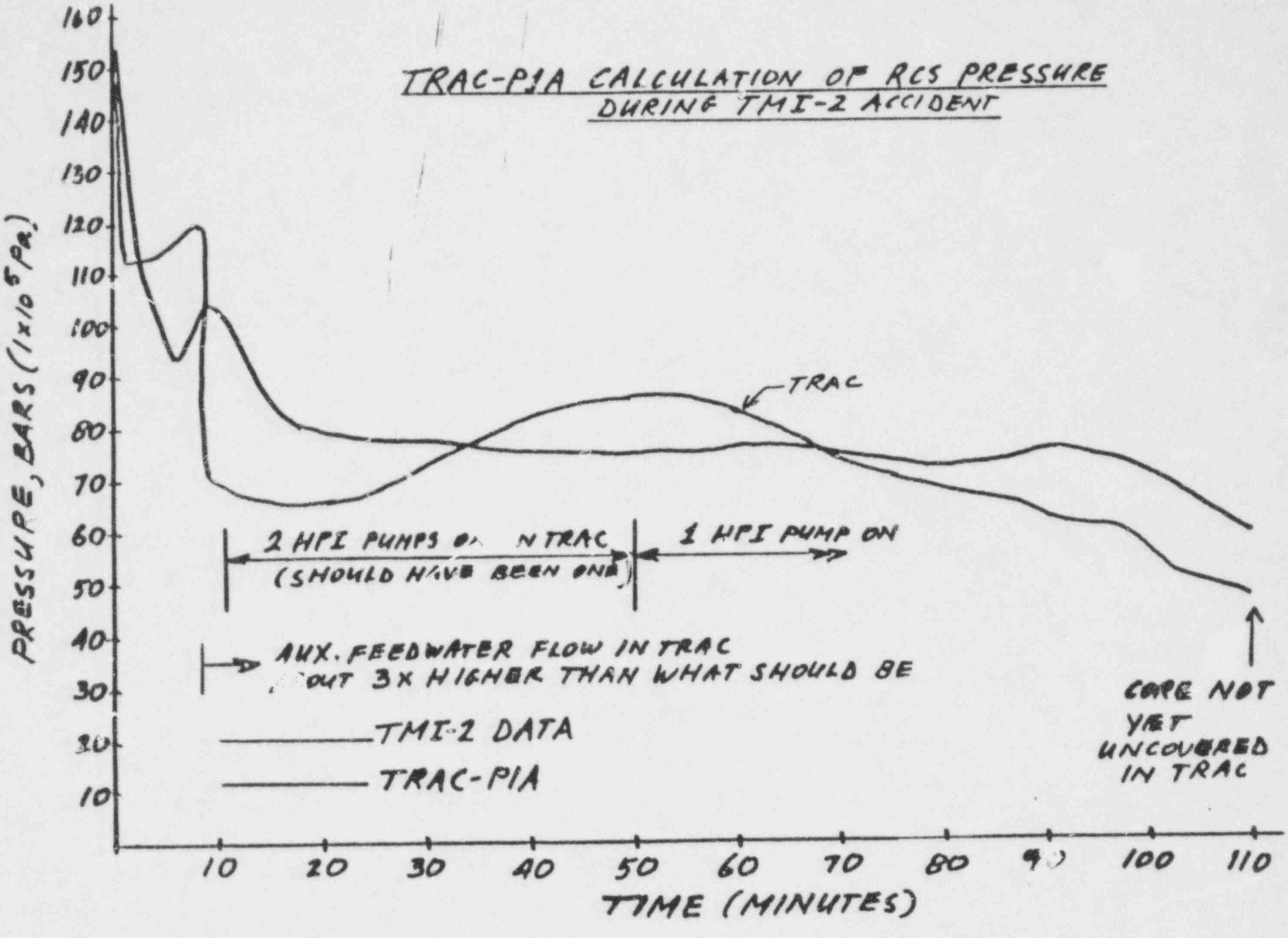
THREE MILE ISLAND (UNIT 2) - VESSEL DETAILS



278 349

THREE MILE ISLAND – UNIT 2
PRESSURIZER MODEL




TRAC-P1A CALCULATION OF RCS PRESSURE
DURING TMI-2 ACCIDENT
PRESSURE, BARS (1x10^5 Pa)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
TRAC
2 HPI PUMPS O N TRAC
(SHOULD HAVE BEEN ONE)
1 HPI PUMP ON
AUX. FEEDWATER FLOW IN TRAC
OUT 3X HIGHER THAN WHAT SHOULD BE
TMI-2 DATA
TRAC-P1A
CORE NOT
YET
UNCOVERED
IN TRAC
10
20
30
40
50
60
70
80
100
110
TIME (MINUTES)

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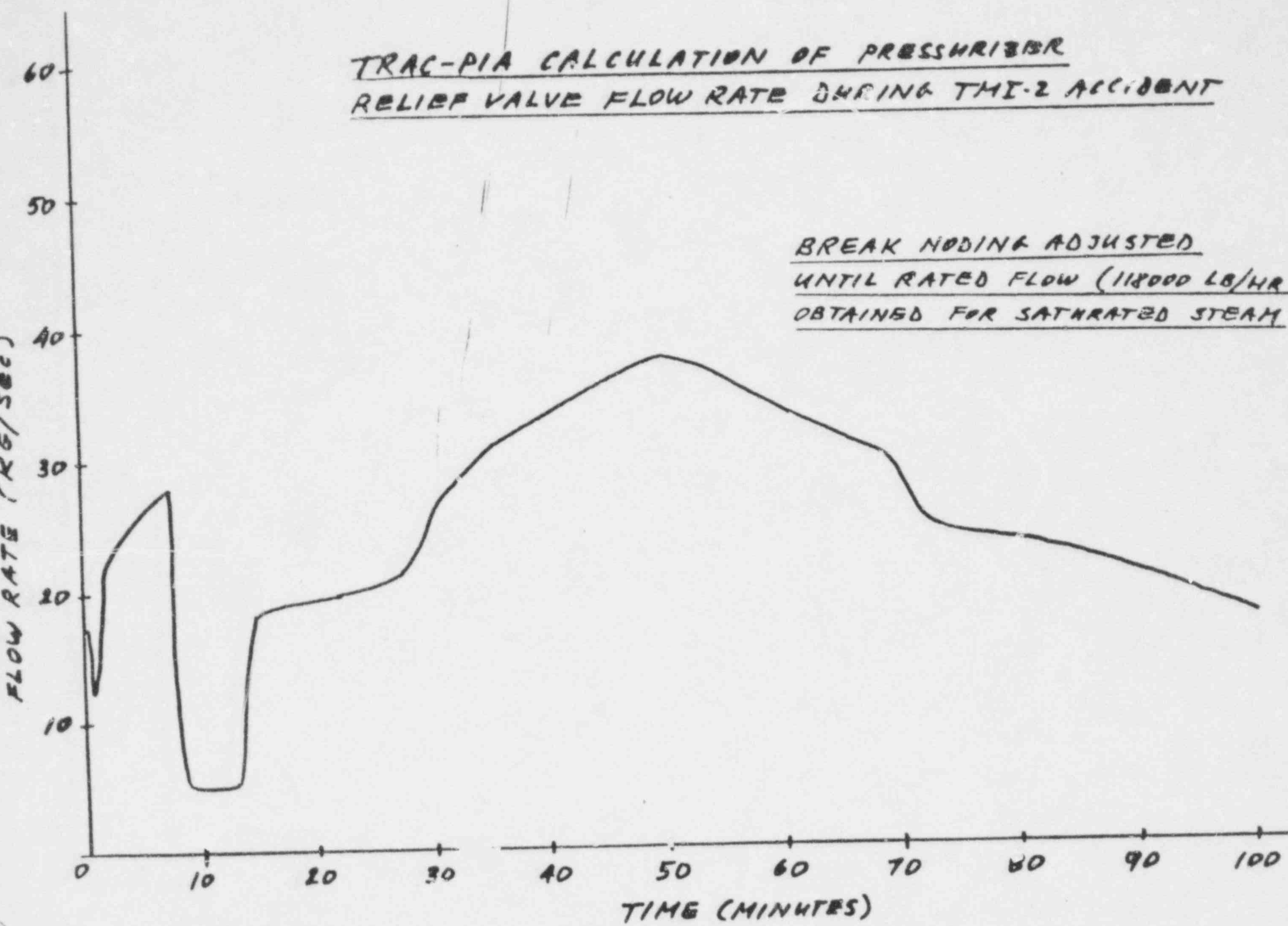

TRAC-PIA CALCULATION OF PRESSURIZER
RELIEF VALVE FLOW RATE DURING TMI-2 ACCIDENT
BREAK NODING ADJUSTED
UNTIL RATED FLOW (118000 LB/HR)
OBTAINED FOR SATURATED STEAM
FLOW RATE (KG/SEC)
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
TIME (MINUTES)

278 352