UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Title: BRIEFING ON FINAL RULE ON 10 CFR 50.46, ECCS ACCEPTANCE CRITERIA (APPENDIX K)

Location: ONE WHITE FLINT NORTH, ROCKVILLE, MARYLAND

Date: THURSDAY, JULY 14, 1988

Pages: 1-50

Ann Riley & Associates
Court Reporters
1625 I Street, N.W., Suite 921
Washington, D.C. 20006
(202) 293-3950

DISCLAIMER

This is an unofficial transcript of a meeting of the United States Nuclear Regulatory Commission held on 7-14-88 in the Commission's office at One White Flint North, Rockville, Maryland. The meeting was open to public attendance and observation. This transcript has not been reviewed, corrected or edited, and it may contain inaccuracies.

The transcript is intended solely for general informational purposes. As provided by 10 CFR 9.103, it is not part of the formal or informal record of decision of the matters discussed. Expressions of opinion in this transcript do not necessarily reflect final determination or beliefs. No pleading or other paper may be filed with the Commission in any proceeding as the result of, or addressed to, any statement or argument contained herein, except as the Commission may authorize.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

***

BRIEFING ON FINAL RULE ON 10 CFR 50.46

ECCS ACCEPTANCE CRITERIA (APPENDIX K)

***

PUBLIC MEETING

***

Nuclear Regulatory Commission

One White Flint North

Rockville, Maryland

THURSDAY, JULY 14, 1988

The Commission met in open session, pursuant to notice, at 10:10 a.m., the Honorable LANDO W. ZECH, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

LANDO W. ZECH, Chairman of the Commission

THOMAS M. ROBERTS, Member of the Commission

KENNETH M. CARR, Member of the Commission

KENNETH C. ROGERS, Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

V. Stello	W. Parler
J. Guttman	E. Beckjord
L. Shotkin	B. Sheron
D. Ross	

PROCEEDINGS

[10:10 a.m.]

CHAIRMAN ZECH: Good morning ladies and gentlemen. Today the Commission will be briefed by the NRC's Office of Research on a final rule on 10 CFR Part 50.46, emergency core cooling systems acceptance criteria, Appendix K.

Section 50.46 of 10 CFR Part 50 requires licensees to perform calculations to demonstrate that the emergency core cooling systems will adequately cool a reactor in the event of a loss of coolant accident.

This final rule is a result of over 12 years of research on emergency core cooling systems and thermal hydraulics sponsored by the NRC, DOE, the nuclear industry and various foreign countries.

This research has allowed the staff to develop a more realistic safety assessment of emergency core cooling system performance.

It is my understanding that the proposed final rule will allow the use of best estimate evaluation methods for assessing the performance of an emergency core cooling system. However, current emergency core cooling system methods included in Appendix K will be permitted.

The Commission will be interested in hearing how comments on this proposed rule have been addressed.

Do any of my fellow Commissioners have opening

remarks or comments to make before we begin? Commissioner Rogers?

COMMISSIONER ROGERS: Yes, very briefly, that I noticed in the supporting material that the ACRS has indicated that there are safety advantages to the new rule and that they are substantial and in your presentation, would you somehow try to clearly address what the safety advantages and any safety disadvantages are that may arise from that rule.

CHAIRMAN ZECH: Are there any other comments?

[No response.]

CHAIRMAN ZECH: Mr. Stello, you may proceed.

MR. STELLO: Thank you, Mr. Chairman.

Perhaps it is appropriate to stop for a moment and review briefly the history. There are at least two of us at the table here, Dr. Ross and myself, who are intimately involved in the early years of the ECCS controversy and I guess many have forgotten the intensity of that controversy back in 1970.

There was considerable debate over the relative safety of nuclear plants because of the question surrounding the emergency core cooling systems and a very long complicated hearing process went on that spanned over a two year period, finally coming out with Appendix K in 50.46, which has been the Commission's regulations on emergency core cooling systems that we have used since that time.

In these 18 years since then, the total expenditure of money to bring this to the point of understanding where we can now support the changes we are talking about, in excess of $1 billion, and this very often gets to be a controversy of where does our research money go and what is it used for, that one figure by itself, the amount of money that was spent in dealing with this issue because the Commission at that time indicated that this research had to go on, confirm the conservatisms or identify any further problems.

It has been a very, very long process and a lot of money has been spent. I think we now can say with confidence that the controversy of emergency core cooling systems is now behind us. It was a long process, a complicated one, a lot of hard work has gone into this to bring us to where we are today.

If the Commission finally does go forward with these changes, I think we have brought to rest one of the major controversies that was associated with nuclear power back in the early 1970's and in fact has not been a major controversy of reactor safety in the past several years.

I think that is principally a result of the very hard work and dedicated research that has gone on to resolve these issues.

I think it is a significant occasion that we are at this point in time, at least for me personally and I guess I could speak for those of us who have followed this over these

many years. We are happy to be here with the Commission and I think can speak with confidence, this is no longer a safety issue where we think this agency needs to concern itself and propose to make some significant changes which I think have advantages to them.

With that brief introduction, I think Eric Beckjord has a few introductory comments and then we will get on with the briefing is in two parts, with Brian Sheron doing the first part followed by Lou Shotkin who will get into the substance of that rule.

Eric?

MR. BECKJORD: Thank you, Vic.

Actually, the points I was going to make, several of them have already been covered. I would add that actually there are three of us at the table because I was a member of the AEC Core Cooling Task Force from 1966 to 1968 that anticipated the decisions to increase the capacity of emergency core cooling systems.

The other point I wanted to go over was this proposed revision completes the 1974 mandate from Congress and the Commission to quantify the conservatism and margins in the 1974 rule. At that time, in their assessment of the state-of-the-art, the American Physical Society concluded that the calculational methods were not satisfactory and that experimental verification was needed.

We have now completed this work on the schedule that was anticipated at the time and also the technical basis for this new rule has received peer review.

I think that covers it.

MR. STELLO: Thank you. Brian?

MR. SHERON: Thank you. Could I have the second slide, please.

[Slide.]

MR. SHERON: What I will be talking to you about first is just the purpose of the meeting and then again to give a little more detailed background on the ECCS rule.

[Slide.]

MR. SHERON: The third slide just states our purpose here, to brief you on the final version of the ECCS rule and its technical basis and I guess to ask you to affirm publication of the final rule.

[Slide.]

MR. SHERON: On slide four, the purpose of the rule as you have heard from Vic and Eric is to provide guidance and performance criteria for the design of emergency core cooling systems in light water reactors, both PWRs and the BWRs, in the event of a loss of coolant accident, this is both large break and the small break.

The ECCS rule, just for your information, is broken up into two parts. There is 10 CFR 50.46, which specifies the

criteria, and then there is Appendix K to Part 50 which provides the required and acceptable features of an ECCS evaluation model.

[Slide.]

MR. SHERON: Prior to 1971, the review of ECCS designs from a regulatory standpoint was sort of ad hoc. They were I believe challenged on an individual basis many times in the hearing process. There was no criteria guidance. Also in 1970, testing that was done at Idaho National Engineering lab on a semiscale facility, test number 845, showed indications that when ECCS water was injected into the primary system to make up for coolant loss by a LOCA, that in fact some of that ECCS water might go right around the annulus of the vessel and out the break and not find its way into the core.

[Slide.]

MR. SHERON: You will see as a result of what I just told you, that in 1971, there was a Regulatory Task Force which developed an ECCS design interim acceptance criteria. These criteria were pretty much what the final criteria were except they did allow peak cladding temperature of 2300 degrees rather than the current 2200.

During the period 1972 to 1973, ECCS hearings were conducted. They were very extensive as Vic said, they were very emotional at the time, very intense.

COMMISSIONER ROBERTS: Who were the major

participants?

MR. STELLO: The Union of Concerned Scientists, Dr. Kendall and Dan Ford were the principal intervenor organization in the hearing. There were others that participated but of considerably lesser statute and significance.

CHAIRMAN ZECH: Let's proceed, please.

[Slide.]

MR. SHERON: The current ECCS rule which is embodied in 50.46 and Appendix K was promulgated in December of 1973 and became effective in December of 1974. The Commission issued an opinion with the rule that endorsed the ECCS research program that would confirm the margins that were embodied in the rule.

Since that time, since this research has been ongoing and it has been rather expensive, we have, I would point out, a number of times received congressional concern over the fact that gee, we had done all this research or were conducting all this research and yet why wasn't it being used in any rules.

[Slide.]

One of the things that led to our consideration of when to change the rule was when would a substantial amount of the research be finished. What we didn't want to do was do some research, change the rule and then complete additional research and have to go back and perhaps change it again for a second or third time.

In 1982, General Electric came into the Commission

and requested relief from the LOCA restrictions of the BWRs which they designed. I believe, if memory serves me, they asked if they could have an exception to the decay heat requirement which says use the 1971 ANS standard increased by 20 percent.

That obviously was contrary to the rule and we did not allow it. However, we were I guess sympathetic to the fact that based on the research that we had seen, we did believe there were margins that could be taken advantage of. The staff prepared and sent to the Commission SECY-83-472 which allowed -- said that we were going to propose to allow the industry to use best estimate models for calculating ECCS performance.

In order to comply with the rule that was still on the books however, they would have to do an analysis that used perhaps the best estimate model but it had to use the required features in Appendix K. Acceptable features were not required. They were things that the staff would accept without question or review if they were used, but they were not necessarily required. However, to make sure that we were not giving away too much margin or making plants unsafe, what we also asked for was that in addition to that calculation, the industry should supply us with the best estimate calculation plus an uncertainty assessment.

What we really wanted to know is what the peak clad temperature at the best estimate value plus the 95 percent

uncertainty level. What we wanted to confirm was that the appendix K calculation that they did, namely a best estimate analysis plus the required features resulted in a peak clad temperature that was still in excess of the 95 percent uncertainty level.

This assured us that we still had an acceptably conservative analysis. We did this. General Electric came in with a model. It was reviewed and approved by the staff. It showed that when they did the calculations in this manner, the peak cladding temperature was substantially lowered and therefore there was additional margin which could be used by the industry. Namely, peaking factors could be increased -- so forth.

Westinghouse also decided to use the SECY-83-472 approach on their upper head injection, I'm sorry, the upper plenum injection plants. There are, I believe, six of them. The two-loop plants. That model, I understand, has just been recently approved by the staff and it was the favorable experience that we had received from the industry as well as the staff in applying the SECY-83-472 approach that led us to formulate the proposed rule along the same lines of 83-472.

[Slide.]

On slide 9 you'll see that the criteria of the ECCS rule which are unchanged by the way, specified that the peak cladding temperature calculated using the ECCS models should be

less than 2200 degrees Fahrenheit. The max cladding oxidation that's allowed should be no greater than 17 percent locally. The maximum hydrogen generation should be less than one percent core-wide. That's based on theoretically the amount that could be generated by oxidizing all of it -- cladding.

The coolable geometry should be retained and long-term cooling should be assured.

[Slide.]

On slide ten, just to refresh you, that even though the use of the ECCS rule was designed for coming up with acceptable ECCS system performance and even though we know now for example that the LOCA is a very low probability event compared to other events which could lead to challenges to the systems it did provide several regulatory requirements with regard to establishing the design margins that exist in plants today.

I think the major one is the containment design. The ECCS required -- or I'm sorry -- that the LOCA specified the containment design margins, namely for the large dry containments that they be able to withstand the energy releases from the large break LOCA. This led to design pressures in the large dry containments of around 50 psi and when you looked at the conservative loadings that were required in the structural design of the containment, like for example combining SSE plus LOCA loads, we now have large dry containments which have

ultimate strength perhaps three times greater than the design strength.

For the BWRs it led to the suppression pool systems used to condense the steam. The ECCS also very strongly influenced the core design, the fuel and cladding diameter and the fuel spacing -- the lattice spacing -- the accumulator capacities and set pressures, the high pressure and low pressure systems, and their capacities.

[Slide.]

On slide 11 the other thing that the ECCS rule did and the effect of ECCS on plant operation is that it did put limits on how a plant operated. On some plants, it puts a limit on the total power level that the plant can achieve. I think for most plants this is usually early in cycle when there's very high peaking factors.

It also limits the LOCA power peaking factor in the plant, again because if the LOCA peaking factor would produce several pins that would have very high power levels and therefore their calculation in a LOCA would produce temperatures above 2200. Surveillance requirements were required as a result of the ECCS. Diesel generator start times and loadings were a very important part of ECCS.

In order to meet the 2200 degree limit, diesel generator start times and loading times were typically of the order of ten to twelve seconds. Steam generator tube plugging

-- when plants plugged too many steam generator tubes, it starts to affect the ECCS performance and indeed puts operational restrictions on the plant.

Then component reliability concerns obviously are affected by ECCS. How many systems can be taken out of service or allowed to be out of service. So as you can see, the ECCS, while providing a number of benefits in the area of system design, structural design of the containment, also did put limits on the way plants could operate.

It was the intent when we went forward and changed the rule to make sure that we retained the degree of safety necessary in the ECCS systems to assure that the LOCAs both large and small could be accommodated without any damage to the core and yet did not provide an undue restriction in the operation.

Dr. Shotkin will now tell you about the revised rule.

COMMISSIONER ZECH: Before you go on, let me ask if there are any questions, my fellow commissioners. Mr. Rogers? Mr. Roberts? Commissioner Carr?

MR. STELLO: Let me, if I might, Commissioner Rogers asked us to cite some significant advantages for safety. There's one that I particularly think is very significant and was mentioned and I'd like to emphasize and that's diesel generator start times. These ten to twelve second start times after the rule was issued required cold fast starting of diesel

generators -- very short time periods.

I think they had contributed significantly to the unreliability of the diesel generators. The new start times that would be calculated using this new rule are like on the order of a hundred seconds? And that change in start and loading in the diesels will I think go a long way in making the diesel generators far more reliable because the demand on the diesel generator really comes about from the ECCS calculations.

So if I could cite one that I would use as a very significant safety advantage and there are others -- upper head injection, some of the other things that no longer would be needed in calculations consistent with this rule but the diesel generators I would cite as potentially very very significant advantage.

COMMISSIONER ZECH: Before you go on, could you talk just a little bit more about the -- on your last slide where you talk about the power levels -- what other requirements other than you have in this rule would have to be met for example to approve an upgrade in power levels?

MR. SHERON: Most plants cannot upgrade the power more than about 5 percent and this is because their -- the diesel generator capacity is limiting.

COMMISSIONER ZECH: What would the impact of that kind of --

MR. SHERON: I'm sorry, turbine generator capacity.

COMMISSIONER ZECH: Okay. What would the impact of say a 5 percent or 10 percent increase in power level be on risk?

MR. SHERON: We've looked at that and it's basically negligible. The change in fission product inventory which ultimately is a measure of risk is the release. The fission product inventory change is not as great, okay? It's not a 5 percent increase because of the way the K ratios and so forth. So the fission product inventory really doesn't increase that much and when one looks at the overall uncertainties in our ability to calculate severe accidents right now, a 5 percent change in power is really kind of down in the grass.

COMMISSIONER ZECH: So it would have very little, if any impact on risk, then; is that what you're saying?

MR. SHERON: That's correct.

MR. STELLO: And the new ECCS models would allow because most plants at one time or another are in fact limited because of ECCS calculations. This would allow operating a plant either at higher power level or make the operation of the plant simpler throughout the lifetime because of the problem of peaking at various times in life.

COMMISSIONER ZECH: All right. Thank you very much. Please proceed.

MR. SHOTKIN: Before I start, let me add one aspect to Commission Roger's question because of the ability to use

different peaking of the power in the core we can reduce the vessel fluence in the wall and alleviate the concern of pressurized thermal shock so this is one of the potential advantages of the use of this rule.

[Slide.]

If I go to the second slide, I will be talking about the proposed ECCS rule and the ECCS research that is used for the technical basis for the change. The two are interconnected for two main reasons. First, without the research there'd be no possibility of having the rule revisions. The second is that as has been mentioned, the Congressional intent which has been expressed several times has been to apply the research results -- any research results we have to remove excessive conservatism in our rules and this is one of the rules that is excessively conservative and we are using research to alleviate that and then I'll come with a conclusion.

We go to page three, the key features of the proposed rule require a best estimate calculation plus a measure of the uncertainty and in doing both of these, we have to use the computer codes that have been developed through the research program as well as the data that has been developed. Later on, I'll be talking about the data that we have obtained has been through international as well as domestic cooperative efforts so this has been an international worldwide effort.

The uncertainty that we have in the rule is just

mentioned as to be determined at a high level of probability. The high level is defined in a regulatory guide that does accompany the rule. We propose to grandfather the existing rule so we wouldn't disrupt the regulatory process for those utilities whose plants are not constrained by LOCA and there are most of the B&W and the CE plants are not constrained by LOCA.

It's the Westinghouse and the GE plants that would be -- right now many of them are constrained by LOCA and would benefit from this rule. One of the major things that we are relaxing are the reporting requirements. We're not only relaxing them but we're clarifying them.

In the past utilities have had to report almost any change in their model even if it's up to 20 degrees Fahrenheit. This has put in too much of a burden on their staff and one of the safety benefits of the rule is if we remove the burden of reporting requirements on their staff, they can now concentrate on more important safety issues.

So, we've raised that 20 degrees Fahrenheit to 50 degrees. Most of the public comments have agreed with that. The reporting is now only annually for all error corrections and changes. Now if they exceed the 50 degrees they have to report that in 30 days.

COMMISSIONER CARR: How many different models are there?

MR. SHOTKIN: The evaluation models are one for each major vendor but the individual models within the codes, there are hundreds of them. So any one of them, you could find an error that's either, you put in a two instead of a three, or new research will say that some of it doesn't fit the data too well --

COMMISSIONER CARR: Who ends up making these change reports?

MR. SHOTKIN: The utilities.

COMMISSIONER CARR: Each utility is working this model on his own then?

MR. STELLO: There are six basic, I think, six. Westinghouse, GE, Combustion Engineering, Babcock and Wilcox, Exxon and then we have a set of calculation models -- and Yankee Atomic. And then we have our own models. Those are the basic models that are available to the utilities to use in the calculations.

COMMISSIONER CARR: I guess my problem is why are they changing so much, the models?

MR. SHERON: A lot of times the change is made because they find an error in their model and many times if the error goes in the wrong direction, namely tends to increase the calculated peak clad temperature, what they normally do is go back and look at other models in the code and try and improve on them, I guess sharpen the pencil you might say, in order to

come up with a compensating decrease such that the net resulting peak clad temperature doesn't wind up exceeding 2,200 degrees.

When they make those compensating changes, that's what usually results in their having to come in and report a model change.

They're required by other parts of the regulations to report an error; okay? This is not the error reporting. Error reporting I think is under 50-72 or something like that. But it's when they make compensating changes so that they don't have to suffer the impact of that error that we start seeing these type of submittals.

COMMISSIONER ZECH: All right. Let's proceed.

MR. SHOTKIN: I guess we're using the term model that has two connotations. One the computer code itself. That there are six or seven. And then the individual models within the computer code and those are the ones that will change on the individual models. I'd like to go to the next page. We have had this rule out for public comment. We received 32 of them, most of them from industry. Almost all were favorable.

As you can see, there were 20 utilities, four vendors, two owners' groups. Those were all favorable. The same intervenor sent in two comments and one individual sent in two comments of why we weren't considering multiple steam generator tube ruptures in conjunction with a large break LOCA.

We assigned this a generic issue, GI-141 and that has been prioritized and we're recommending it as a drop primarily because the large break LOCA itself is such a small probability and small contributor to risk.

So based on the public comments, we proceeded -- we are proceeding with the rule. The rule is unchanged. We did change the regulatory guide to make some of the things more clear as a result of many of the comments. The regulatory guide defines the high level of probability as 95 percent and again, most of the public comments supported this as good engineering practice.

The regulatory guide also details general features of what the best estimate calculation should be and ends with putting in many acceptable models and data that come from the last 12 years of research that our staff has agreed that if anyone uses these, we won't challenge them.

The research that we have done on page six is detailed in a compendium of ECCS research. It's 1,200 pages. I brought a copy just to show you that it does exist and it's big. It's primarily a road map for use of the industry and others to help them find where the research is available. The research as Vic mentioned, the NRC part was about $700 million and took about 12 years to accomplish.

If you include DOE, industry and foreigners, it's about double that. On the next page, some of the benefits of

the new rule and some of these are safety benefits and some of these are not directly related safety benefits. First, I think the most intangible or tangible -- however you want to call it -- is a more accurate understanding of ECCS behavior.

If we calculate what's going to happen with best estimate codes we feel that the staff and the utilities and the operating crew will have a much better understanding of what's actually happening in their plant rather than using very overconservative models.

Vic mentioned the longer diesel generator start times and I've mentioned this reduced neutron fluids at the vessel wall which reduces the PTS risk. The main thing to keep in mind is that this design basis loss of coolant accident -- this stylized scenario that we're dealing with is a very small contributor to risk.

That's primarily because the ECCS system works. Let me mention here that EPRI has recognized the benefits of this new rule and they are sponsoring a conference in Boston -- Cambridge, Massachusetts, August 11 and 12 and it's called "Appendix K Relief Using Best Estimate Methods -- The Revised LOCA ECCS Rule."

This conference is being sponsored by EPRI and two utilities, Northeast Utilities and Yankee Atomic Electric Company and they go and discuss the benefits -- pretty much the same benefits that I'm showing you.

[Slide.]

If we go to the next slide, eight, other benefits of this new rule will provide for less stringent power peaking limitations and this will allow more operating flexibility. The utilities can more their fuel around more so it will lead to more efficient fuel utilization. There'll be reduced monitoring of the flux shape and again, one of these intangible benefits, it will allow industry to more intelligently optimize the ECCS design.

One specific example of this has been the upper head injection where the research has shown that the benefits of UHI are not that great and I believe the utilities are proposing to remove that from their plants.

The next page, I'd like to cover some of the spinoffs from the ECCS research program. We're talking today of the ECCS rule revision which of course is the major benefit. But there have been other spinoffs that are related to the computer codes that have been developed under this program.

These computer codes have been applied to many other regulatory issues. A partial list would be the pressurized thermal shock issue, anticipated transient without scram, steam generated tube rupture, decay heat removal using feed and bleed. Recently the B&W safety reassessment -- we did some calculations far NRR using these codes.

When there is a transient in a plant like at Davis-

Besse or the recent stability concern of LaSalle we take these codes and use them to analyze what happened in these plants and do "what if" studies. In addition, and that's NRC use -- in addition these codes that I'll describe later are also being used by other agencies.

For example, DOE at Savannah River is using these computer codes, TRAC and RELAP in particular, to analyze the safety of their production reactors. Finally, Knolls Atomic Power Laboratory is using TRAC to analyze the safety of their naval reactors and they've been doing this over the last seven or eight years.

In addition, these codes and the research itself will be used to look at severe accident analysis and uncertainty. In the past they have been used to calculate the front end of severe accidents and now we are using them to go into the new field of accident management.

[Slide.]

MR. SHOTKIN: On page 10 we reviewed the mandate for the ECCS research program and I think we can go back to primarily three different sources. First in 1973 both the Commission and Congress mandated the AEC at the time to start an Office of Research which would quantify the margin of safety and conservatism in the ECCS rule which was just being published at that time.

In 1974 the American Physical Society appointed a

peer review committee which published their report in 1975, a very detailed report. It's an excellent report. It provides to us a measure of the accomplishment we've achieved over the last dozen years.

In fact, that report predicted over a decade of research would be needed to quantify this conservatism in the rule and that's about what it took. And finally, in 1976 the NRR gave a user need that was developed best estimate computer codes, developed the data, assessed the codes against the data so that we can quantify this margin of conservatism.

[Slide.]

At the end I'll tell you that we feel we have answered this mandate. On page 11 I will just give you a little overview of some of the test facilities and later, some of the computer codes that we've used to develop the data. I think there's two points to be made from this slide.

First that the facilities that we've used -- the principal LOCA test facilities have not been only in the U.S. There have been several -- Loft, semiscale, FIST, SSTF -- but also in Japan and Germany and in fact, Japan and Germany have been under this 2D/3D program. The 2D stands for the two-dimensional facilities that are in Japan and the 3D refers to the 3D full-scale facility in Germany and I'll describe these in a little more detail later.

The point is that in all of the facilities in the

U.S. have closed now. We've finished the work. If you can see the dates there, they show when we finished the work. LOFT in 1986, SSTF which was the multidimensional BWR facility and the counterpart of UPTF finished as early as 1983.

The Japanese facilities have finished testing this year and the Upper Plenum test facility in Germany is going to finish next year. Now not only did we have to build these facilities almost from scratch to get the data, we also had to develop our own instruments. I think one of the major results of this program -- one of the major spinoffs -- is the instruments that were developed that will be I think used in the future for measurements in two-phase facilities and in other industries, not just ours.

We have, if you can see in the screen, we've provided some of these -- examples of these instruments -- on a table in the back that you can look at if you have time later. Some of these are video probes where we can look inside the facility and see what's going on. We have optical probes that can detect the difference between water and steam. There are drag transducers that as the momentum of the water hits them they can tell what the deflection is, what's the momentum of the water. These have provided the main data that has come out of mainly the 2D/3D facilities.

[Slide.]

On page 12 the principal products of our program

besides the instruments have been the computer codes. As I mentioned before, we've used them to resolve several other regulatory issues. The point here is just to give you the names of them. TRAK/PWR, TRAC/BWR, RELAP 5 and COBRA. They've been developed at places like Los Alamos, Idaho National Engineering Lab and Battelle Northwest.

We're finished with that work just about. We're -- 1987 was COBRA. We finished TRAK/BWR this year and through an international consortium, primarily with the Federal Republic of Germany, with Japan and with the U.K., we're going to finish TRAK/PWR and RELAP 5 next year. This is primarily using funding and resources that our international partners are providing.

Now I'd like to just show you some pictures to give you an idea of what some of these facilities look like and if we can go to 13, one of the major concerns that we've had is that we can't afford to build a full-scale facility or until we built the UPTF in Germany we couldn't afford to build a full-scale facility. We've had to use small-scale facilities and semi-scale is shown here and LOFT, loss of fluid test, compared to a full-scale reactor.

What we've had to do is take the data on these small-scale facilities and then use our computer codes to extrapolate the results to the full-scale reactor. Now on page 13, I show the relative scale of the PWR test facilities and on page 14, I

show the relative scale of some of the BWR facilities to let you know that we've done not only the research for the pressurized water reactors but also for the boiling water reactors and on this page, in the middle, you see a full-scale boiling water reactor.

On the right, you see the older TLTA or two loop test apparatus and on the left, the new full-height interval system test, the FIST facility. One parenthetical remark is that GE is now developing a 600 megawatt advanced boiling water reactor. They have taken the FIST facility and modified it. They now call it the JIST facility and they are running test on their new advanced BWR.

On page 15, I just want to show you the kind of detail that we had as far as modeling the geometry. This is the Japanese cylindrical core test facility which provided most of the integral data that resolved the issues that were in existence in 1975 on steam binding, on the ability of the water to cool the core in a fast enough way so that the temperature wouldn't rise.

As you can see, this looks pretty much like a full-scale reactor. It's full height. It has the four loops. It has two steam generators. It has pump simulators and a containment. On the next viewgraph I'll show the grand daddy of them all.

[Slide.]

This is the Upper Plenum test facility in Germany. This viewgraph shows you a little bit of the size of the facility. It also shows you some of the interesting problems we have. As you can see this is in a populated area of Germany. In the background you see the city of Mannheim. Just to the right of the facility there's a flat building which is a public swimming pool that had nothing to do with the facility.

Much of the equipment that was installed was to reduce the noise of this facility when it was in operation. The facility is right next to the Rhine. Just to the left is the huge gross craftwork Mannheim power generating facility which is a coal-fired plant.

Because of the turbine generator motion in this GKM facility and the traffic on the Rhine River, many of our instruments were subject to high cycle fatigue and on one of outage we had a couple of years ago, we had to replace about half of our instruments because of a very small weld that had broken in many of them because of this high cycle fatigue.

[Slide.]

On the next page, I show an interior of the Upper Plenum test facility after it was built. In the middle, you see the top of the vessel simulator and the four other devices there are the steam generator facilities. This building is about seven stories high and it contains about 50 to 100 of each of the instruments that you see on the table in the back.

Finally, I'd like to get to the uncertainty methodology. As you can remember, this rule provides for a best estimate analysis plus an uncertainty methodology where the sum of the best estimate plus uncertainty has to be less than 2,200 degrees Fahrenheit.

The question was, is it possible to do a meaningful cost effective uncertainty analysis with the codes and with the data that we have. We felt -- we at NRC felt -- that we ought to demonstrate this before we put it out for industry and we feel that we have demonstrated it. So the purpose of this CSAU which stands for Cold Scalability, Aptability and Uncertainty was to demonstrate the viability and practicality of the concept in the proposed rule.

Now we didn't want to tie up the rule waiting until we had finished it but fortunately we did finish it in time. The methodology is first to determine the key variables. After 12 years, we can get together a group of experts and they can agree on what the key variables are for a loss of coolant accident. We have enough data, we have enough predictions that we can then compare the predictions versus the data. We can then determine the uncertainty and the probability of that uncertainty and in many cases, we have to add a bias.

I'll give you one example of the bias. ECCS bypass was a main issue as a result of the semi-scale test 845 in 1970 that Brian mentioned. The question was in a full-scale

reactor, can the ECC water penetrate down the downcomer or how much will be bypassed out the break.

We ran several small-scale facilities over the years and because of the small gap of the downcomer which was, say, half an inch, one inch, up to two inches, a lot of the water did bypass. We developed our computer codes with models based on that small-scale data. Very recently we have obtained the full-scale data for the Upper Plenum test facility that shows most of the water penetrates the facility and we've had to take that as a bias because that shows that our models always underpredict -- always overpredict the bypass.

Finally, we have had a peer review of this rule and the uncertainty methodology. It's been done by the ACRS, the full committee and the subcommittee on thermal hydraulics plus we've had an expert panel that was chaired by Neil Todreas of MIT and they have reviewed the uncertainty methodology.

The result is shown on the next page, page 19, and this is the only technical graph that I have.

[Slide.]

What this shows is that we can do it. This shows the probability density function for a large break LOCA using one code in one plant developed at the 95 percent probability level for the three peaks that occur -- the blow-down peak and the two reflood peaks and you can see that the mean temperature is about 1,000 degrees. If we add the 95 percent probability, the

maximum turns out during blow-down about 1,400 degrees Fahrenheit and both of these are well below the 2,200 degrees Fahrenheit that's in the rule.

So we believe -- and this was done with I think a very ingenious way with only about 10 or 15 computer calculations we feel this will be accessible to the industry and they will be able to get benefit from this rule and we have demonstrated it.

[Slide.]

MR. SHOTKIN: The final slide our conclusion is that we feel that have fulfilled the original mandate in 1973 of both Commission and Congress which was to confirm the safety of the ECCS design. In order to do this we've had to develop a large research program. We've completed that research program and it's led to this proposed revision of this major regulation.

The rule itself is performance based so that is the utilities that do better, they'll get more advantage. The smarter their staffs are and the better their tools are the more advantage they'll be able to get and I think that will improve regulation and safety.

So it provides an incentive for industry to develop accurate, best estimate analysis models. That's all I have.

MR. STELLO: That concludes our briefing, Mr. Chairman.

COMMISSIONER ZECH: All right. Thank you very much.

MR. STELLO: We're ready for any questions.

COMMISSIONER ZECH: Questions from my fellow Commissioners? Commissioner Roberts?

COMMISSIONER ROBERTS: I have no questions. This is certainly a massive effort.

MR. STELLO: Expensive too.

COMMISSIONER ROBERTS: Yes.

COMMISSIONER ZECH: Commissioner Carr?

COMMISSIONER CARR: I think I must have lost the picture by not following this all 12 years. It looks to me like the original mandate was to confirm that you had adequate safety in your design. That was the question, was there enough conservatism, I assume. Is that right? From the Congress and from us?

MR. STELLO: I believe the original opinion from the Commission and I'll have to check. I think that the words indicated that we would do additional research to determine the conservatism. "Quantify the margins" were I think the words.

COMMISSIONER CARR: I guess -- but normally you'd only worry about quantifying the margins if you were worried that there weren't enough. Wouldn't you?

MR. STELLO: No, I think what we did back then and I'll need others to help me but my recollection is that we intentionally put in very large conservatisms because we simply

didn't know how to do much less. The idea was to quantify those conservatisms. To a degree, confirm, too, by definition. Since your judgment may be wrong.

COMMISSIONER CARR: It seems unusual to me that the Congress would worry about us being overly conservative.

MR. PARLER: Mr. Chairman?

COMMISSIONER ZECH: Yes.

MR. PARLER: I'm the fourth member at the table that in another capacity was around at the time that this was going on. I was a counsel to a Congressional committee that was interested in this and strange as it may seem now, the concern was with overconservatism that took to pursue that aspect of it.

MR. STELLO: I might add one more dimension clearly has been a concern at least as I perceive it by Congress of having now spent all of that money, a sense of impatience about not using the benefit of that research by modifying our regulations to take into account --

COMMISSIONER CARR: That followed on after we had to do the research.

MR. STELLO: Yes.

COMMISSIONER CARR: If we were supposed to quantify the margin, as a matter of fact, what was it?

MR. SHOTKIN: As I pointed out, the margin and best estimate is for PWR is about 800 degrees Fahrenheit. It's a

considerable margin.

COMMISSIONER CARR: That's what was in our 1973 rule. What was it today?

MR. SHOTKIN: That was the margin that is independent of time. That's the margin that is in the rule.

COMMISSIONER CARR: If you calculate it by the current rule. What was the margin in the 1973 rule?

MR. SHOTKIN: It was not quantified. That was the charge.

COMMISSIONER CARR: But now that we've looked at it we ought to be able to figure out what it was.

MR. SHOTKIN: Yes. It's 800 degrees.

COMMISSIONER CARR: So we haven't made any progress.

MR. SHOTKIN: Well, the 2,200 degrees Fahrenheit was listed as the temperature beyond which you couldn't go. You're evaluation models couldn't go beyond that. The question was, if you went to a best estimate, what is the real temperature that a real reactor would see if they had this kind of an accident and that wasn't known at the time.

What we've now shown is that to 95 percent probability in a PWR that temperature is around 1,400 degrees Fahrenheit. So the difference between 1,400 that we can calculate today to a 95 percent probability and the 2,200 Fahrenheit that is in the rule is about 800 degrees Fahrenheit.

MR. STELLO: Let me help, I think. When you did the

calculations before, they were basically limited using those conservative models and if you want to look at temperature, to 2,200 degrees. So if you do the calculations --

COMMISSIONER CARR: But 2,200 degrees because we thought that gave us a sufficient margin.

MR. STELLO: For different reasons.

COMMISSIONER CARR: That meant we really thought there was 3,000 degrees or something.

MR. STELLO: Oh, no, no, no, no. Once you get above -- the reason -- the 2,200 was picked on the basis of the behavior of the cladding. You get autocatalytic once you get much beyond 2,200.

COMMISSIONER CARR: That was the best guess absolute top.

MR. STELLO: Uh.

MR. SHOTKIN: It was based on data. There was data at that time.

MR. STELLO: Well, I was trying to answer your question.

COMMISSIONER CARR: But we haven't changed that number.

MR. SHOTKIN: That's right.

COMMISSIONER CARR: So now what are we doing?

MR. STELLO: Let me try to help answer the question. The calculations before -- a utility would do them and they

could go to 2,200 degrees. Today, using these models he can go to 2,200 degrees. These calculations that you're shown on this viewgraph says there's about an 800 degree margin. So he can revise his diesel start times and do the other things and allow that temperature to go up to 2,000 degrees and get some safety benefit.

He can reduce his operating problems by allowing more margin and peaking in the core and go up to 2,000 degrees.

COMMISSIONER CARR: But he could do that before.

MR. STELLO: No. That was the problem. He was basically --

COMMISSIONER CARR: I thought he just couldn't figure out how close to 2,200 he was getting.

MR. STELLO: No. He was at 2,200 using the prescribed models. Using the prescribed models is how he got to 10, 12 second start times. That's how he got to the control and the limits on bubble power and peaking factors in the core. He had to in fact reduce power level in some cases because he would calculate a temperature of 2,200 degrees at a power level less than 100 percent. So he had to derate.

COMMISSIONER CARR: You've permitted him to sharpen his pencil.

MR. STELLO: This now, based on that research, allows you to take the benefit of that research, do a new calculation and then you can take the benefit of what that excess

conservatism that was in there was all about.

COMMISSIONER CARR: Okay. Now what do we expect him to do with it?

MR. STELLO: Well, what based on what Lou has indicated --

COMMISSIONER CARR: Are they going to provide less core cooling because they got more margin, or they got increased power. Are they going to do all of the above? What do you expect them to really do with this?

MR. STELLO: I think some of the things that were on the slide that we can go back to. The benefits -- here, the diesel generator start time. You can do a calculation and change it. If you reduce the neutron fluids at the vessel wall.

COMMISSIONER CARR: How will they do that?

MR. STELLO: By getting the peaking more in the middle of the core so you don't have as much of the fluids in the wall.

COMMISSIONER CARR: Fuel arrangements?

MR. STELLO: Fuel arrangements.

COMMISSIONER CARR: How they load the cores?

MR. STELLO: Right. Less stringent power peaking. That will allow them a lot more flexibility in how they operate the machine. Shift fuel around --

COMMISSIONER ROBERTS: Shouldn't that be quite

helpful for the pressurized thermal shock issue?

MR. STELLO: Oh the fluence will be yes. Quite a bit.

COMMISSIONER ROBERTS: I mean I would think a significant factor.

MR. SHOTKIN: That's correct.

MR. STELLO: That's correct. Those are the kinds of things if they do these calculations will have benefit.

COMMISSIONER CARR: I'm trying to figure out what they're really going to do with it though.

MR. STELLO: That's the meeting they're having in August.

COMMISSIONER CARR: They're going to do all of the above?

MR. STELLO: I suspect that some utilities will do all of the above. Some utilities will do some of the above and of course, we'll have some that will do probably none of the above. It's not mandatory. They are not required to do this. It's elective.

COMMISSIONER CARR: If they're not limited by the LOCA they probably won't do anything.

MR. STELLO: Those -- right. It's going to cost money for them to do calculations and there will be some that clearly will elect not to do anything.

COMMISSIONER CARR: And after they do a calculation,

how long is it going to take us to review one?

MR. SHERON: Typical models -- from the time they submit a model to the time we issue a safety evaluation report approving use of that model, it's typically one calendar year. Staff time actually reviewing it is around four to six months. A lot of it depends on how fast the utility or the vendor can respond to any questions the staff might have.

Two of the vendors already have models approved. Westinghouse has one and GE has their models approved already. Like we said, we've seen no indication from B&W or CE that they wish to avail themselves of this. I don't know. Does CE have someone -- or not? I'm sorry, CE is coming in but that's for the Westinghouse two loops plants that they're doing reloads for.

COMMISSIONER CARR: Now are they -- they'll use this in reloads for current reactors and I assume they'll start using it for new designs in their future reactors.

MR. STELLO: Yes. Commissioner Carr, you might be interested -- in answer to your question, Mr. Shotkin just handed me --

COMMISSIONER CARR: Attend the meeting, huh?

[Laughter.]

MR. STELLO: No, that's what the industry has put out as a pamphlet for the meeting and it does identify what they believe are some of the benefits that can be derived from it.

COMMISSIONER CARR: Okay.

COMMISSIONER ZECH: Commissioner Rogers?

COMMISSIONER ROGERS: Yes, a couple of comments. On this, it's a very general comment on this question of conservatism, so-called conservatism, in calculations of this type and their consequences. We may feel comfortable with the word conservatism in this context but let's remember, it's an error. It just means we're in error by a large amount that we've automatically introduced into the system.

This kind of a approach reduces that error and creates a better understood system that gives us much more confidence in it than a jury-rigged system with a whole bunch of fudge factors ground into it that leads us really, to a never-never land.

I think we're seeing some of the benefits that can emerge here from a better understanding of quantification of these uncertainties and when we simply introduce arbitrarily large errors, yes, in one direction, biased in one direction, and we think that we feel very comfortable about that, we in fact are creating from an engineering point of view, a nightmare.

I think that this is a point that I'd really like to be understood much better in this context because the word conservatism when it's applied really to just an erroneous, overestimation of a number of some sort or a parameter, leads

to a system in which you don't have an awful lot of confidence.

It isn't a well engineered and well-designed system. Therefore, anything you do has some question about it. I think what I was asking about, what some of the benefits are and I'm glad you cited the diesel generator one. Because there's an example it seems to me, maybe a relatively small one but an important one, that says by not understanding the engineering features of the system adequately, by doing this kind of hard work to reduce uncertainties and to create a better understood overall system, we build in certain requirements that in fact, are counterproductive.

I think all of us have been worried about what really seems to be an absurd way in which we handle the restart of diesel generators. We wear them out before they ever get a chance to be used. So I think that that's one example. I suspect that there might be some others that can emerge from this and I would really suggest that some real thought be given to clarifying what really has happened here because it's easy to say that we're less conservative because we've reduced some of the so-called conservatisms in the earlier approach.

I submit that those were not conservatisms, they were simply errors all biased in one particular direction and led us to a lack of understanding of the system as completely as we understand them today.

Now, that doesn't mean we know everything about them

however. So having said that and asking you to stress that in your thinking and presentations on exactly what we have done here with 18 years and $1 billion of research and I suspect that it makes a lot of sense in answering Commissioner Carr's question and why as Mr. Parler pointed out that Congress -- maybe there were some people at that time who were concerned about creating a system that really wasn't understood that well by just building in very large biased uncertainties in it.

So therefore I think that I'd like to revisit the use of that word conservatism in this context because to me it happens to be all in one direction but it creates a less well understood engineering system by taking that approach.

I think what we have done is clarified that matter to a large degree through this work and there probably is more work to be done in this way in various aspects of understanding the system but I think that this is an important point to be kept in mind.

MR. STELLO: I would like to suggest that what we did back then may be a little bit different than you are describing. Let me give you an example. We did not have a lot of data so we had to use judgment. Very often what we had to do was look at -- we had data spread when we couldn't find out where we were, if we to, if you will, put a bounding curve on, knowing you could feel comfortable that with that spread, if we took a bounding or a conservative representation of the data,

because of the lack of data. We had to do a lot of things that were in fact bounding by nature that led to these large conservatisms, and indeed, there are errors. They are basically telling you that you didn't really have enough data to pick the true --

COMMISSIONER ROGERS: I wouldn't argue with you on that at all. When you don't know, that's the way you have to go. My point is that I think we have to recognize really what we were doing and in a sense what we were doing was we were trading an error always in one direction to be on the safe side. Now we know that we don't have to do that. We know how we can understand the system better.

All I am saying is I think it is time to now begin to put that in a little broader and better understood context.

MR. STELLO: It is important. Let me help you make the argument. We were very, very concerned for many of the reasons you gave, we had examples where to do these calculations, they were so artificial because of the conservatisms, we would literally have to go in and tell the utility, take some water out of the accumulator and remove it, just to satisfy the calculation.

The water that you need to cool the core, in order to do this calculation this way, you would have to do those things. A lot of artificiality and a lot of things that I think in fact were counter to producing the kind of safety we

could have produced if we had that information but we just lacked it.

COMMISSIONER ROGERS: I'm not being critical of what was done either at that time or the final result. I'm simply saying I think this is the time now to review what we really meant by conservatism. At that time we had to call it that. I think today we can put a new label on it because we know more.

The other point is with respect to the benefits of the new rule, I would suggest that we go very, very carefully on implementing some of these things and that each one of them be looked at very carefully. For example, the reduced flux shape monitoring is something I would be a bit concerned about backing off on at this time. It may be other situations that have nothing to do with this particular understanding that we need to know more about, in particular I am thinking about the LaSalle situation. I would say I would hope that none of these things would be allowed without individually being looked at carefully, every single one of them in the particular context of the individual plant reactor design and so on.

MR. STELLO: We certainly would do that.

COMMISSIONER ROGERS: It seems to me that some of them may be benign and others may open the door for less of an understanding of actually what is happening. I don't know what you mean by reduced flux shape monitoring, but if it means turning off diagnosis equipment, I would be a little concerned

about that.

MR. STELLO: Yes.

COMMISSIONER CARR: On your last chart here that shows peak temperatures and the benefits of the utility, it says 100 degree F. reduction in peak cladding temperature can allow a 5 percent power increase. The way I read that, some guy could go to 130 percent of what he is currently operating. It shows that much on the chart.

MR. STELLO: If that was all you were limited by, the answer would be yes. He would be limited by other pieces of equipment and other considerations. With respect to ECCS --

COMMISSIONER CARR: If somebody had oversized steam generators, he might be able to make it?

MR. STELLO: You have a turbine generator there and typically the nameplate ratings won't let you get anywhere near that. You have all the other impositions on the plant, the transient analysis, all the other accident analyses.

COMMISSIONER CARR: How much would you predict they could raise the power from the current levels?

MR. STELLO: Five to some of them maybe even getting as high as ten, depending on the nameplate rating on the machine.

MR. ROSS: We had a letter from Westinghouse a couple of years ago to this effect. They had done a survey and five or ten percent was about what they said, it was the maximum

they could get. It would take some substantial modifications in the feed and steam system.

COMMISSIONER CARR: All right.

CHAIRMAN ZECH: Did I understand you to say regarding ACRS that ACRS agrees with what you have done and the approach you have taken? It seems to me there was some recent communication from them that indicated they thought there were substantial safety advantages and there might have been some disconnect there between the staff and ACRS.

Do you agree with ACRS in that regard?

MR. SHOTKIN: The question that the ACRS raised was on the grandfathering of the present rule. Their argument was if this new rule has such a great safety benefit, why don't we force everyone to go with the new rule and give up the old rule. We feel that the old rule is conservative enough that it does serve safety. The new rule can improve safety but since the loss of coolant accident is such a small contributor to risk, for any given plant, it is going to be touch and go. It is going to have to be plant specific, whether use of the new rule will improve risk or decrease risk, and in fact we did a generic study that says it is going to be awfully hard to quantify that.

CHAIRMAN ZECH: Do you feel that you are in agreement with ACRS in that view or do you have a problem with that?

MR. STELLO: I remember the letter as saying

basically that we ought to consider making the rule mandatory, everyone has to do the calculation and use this rule. We don't feel the need to cause it, based on our judgment, as a required way for everyone to do it. We feel comfortable with allowing the either/or.

Those who wish to go through the cost and effort and energy of doing it because they see the advantage and want to do it, we want to let that be an option to them to do it, but we are still satisfied we get adequate protection of public health and safety using the old models.

CHAIRMAN ZECH: Thank you. In talking about the advantages that perhaps could accrue from this study and this review process, is there any impact on plant life extension of this rule?

MR. SHERON: Yes.

CHAIRMAN ZECH: Could you discuss that briefly?

MR. SHERON: Primarily in the area of the vessel fluency. Plants that want to extend their life will obviously have to justify to the staff why the vessels will last for the extension period they request and we hope that they will not allow their plants to hit the PTS screening criteria, for example. Plants that want to do that, this should be a great benefit because they can start the flux reduction program now and extend the life of their vessel, even if it is maybe not for a full 20 years. They will be able to get substantially

more life out of it with the flux reduction.

COMMISSIONER CARR: Let me make sure I understand that. You mean they are going to shift the flux towards the center of the core, have a higher peak in the core?

MR. SHERON: I can remove for example the outer fuel and put on a reflector and by increased peaking, still maintain the power level.

COMMISSIONER CARR: Permitting them to go to a higher level in the center?

MR. SHERON: Yes.

MR. STELLO: They actually put a ring of dummy elements down which reduces the fluency and increases the power in the inside elements to make up for it.

CHAIRMAN ZECH: Thank you very much. Are there any other questions?

[No response.]

CHAIRMAN ZECH: Let me thank the staff for a very important contribution. I think the staff has done an outstanding job in this endeavor. It has been a long task as you have pointed out earlier. Perhaps 20 years with 12 years of research and over $1 billion, a significant effort. I think it has been a milestone, as I understand it, in the regulatory actions. I think it is a cooperative venture with our own industry as well as international partners and certainly something that should be recognized.

Again, I do think what you have done is a very professional contribution to improved understanding and improved regulatory decision making.

It truly is a significant accomplishment in my judgment. I commend the staff and the industry, our international partners and all those who have played a role in what I consider at least a significant milestone and regulatory action.

I would ask my fellow Commissioners to review what we have heard here today and I believe you have this rule before us to take action on and that we do so when we are satisfied and attempt to move forward with this significant regulatory action.

Thank you very much. We stand adjourned.

[Whereupon, at 11:30 a.m., the briefing was concluded.]

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON FINAL RULE ON 10 CFR 50.46, ECCS ACCEPTANCE CRITERIA (APPENDIX K)

PLACE OF MEETING: Washington, D.C.

DATE OF MEETING: THURSDAY, JULY 14, 1988

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Marilynn Nations

Ann Riley & Associates, Ltd.

ECCS RULE (10 CFR 50.46 AND APPENDIX K): BACKGROUND

BRIAN W. SHERON, RES/DRPS

COMMISSION BRIEFING
JULY 14, 1988

OUTLINE

- PURPOSE OF MEETING
- ECCS RULE: BACKGROUND

PURPOSE OF MEETING

- o BRIEF COMMISSION ON FINAL VERSION OF ECCS RULE AND ITS TECHNICAL BASIS
- o ASK COMMISSION TO AFFIRM PUBLICATION OF FINAL RULE

PURPOSE OF ECCS RULE

PROVIDE GUIDANCE AND PERFORMANCE CRITERIA FOR DESIGNS OF EMERGENCY CORE COOLING SYSTEMS IN LIGHT WATER REACTORS (BOTH BWR'S AND PWR'S) IN THE UNLIKELY EVENT OF A LOSS OF COOLANT ACCIDENT (LOCA).

EARLY ECCS REGULATORY HISTORY

PRE-1971: AD HOC DESIGN REVIEW
NO CRITERIA OR GUIDANCE

1970 - SEMISCALE TEST 845

1971: REGULATORY TASK FORCE: ECCS DESIGN INTERIM ACCEPTANCE CRITERIA

1972-1973: ECCS HEARING

- CURRENT ECCS RULE (50.46 AND APPENDIX K) PROMULGATED ON DECEMBER 1973 TO BECOME EFFECTIVE IN DECEMBER 1974.

- COMMISSION OPINION ENDORSED ECCS RESEARCH PROGRAM TO CONFIRM MARGIN EMBODIED IN RULE.

- CONGRESSIONAL CONCERN EXPRESSED ON NUMEROUS OCCASIONS OVER LACK OF USE ECCS RESEARCH RESULTS

SECY-83-472

- GE REQUEST FOR RELIEF FROM LOCA RESTRICTIONS ON BWR's (1982).
- STAFF RESPONSE (SECY-83-472)
- ALLOWED ECCS ANALYSIS WITH ALL BUT REQUIRED FEATURES PERMITTED TO BE AT BEST ESTIMATE VALUES.
- CONFIRM APPROPRIATE CONSERVATISM WITH BEST ESTIMATE PLUS UNCERTAINTY.
- FAVORABLE EXPERIENCE LED TO PROPOSED RULE REVISION.

CRITERIA OF ECCS RULE (UNCHANGED)

1. PEAK CLADDING TEMPERATURE (2200°F)
2. MAXIMUM CLADDING OXIDATION (17% LOCAL)
3. MAXIMUM HYDROGEN GENERATION (1% CORE WIDE)
4. COOLABLE GEOMETRY
5. LONG-TERM COOLING

USE OF ECCS RULE: EVEN THOUGH DESIGN BASIS LOCA IS A LOW PROBABILITY EVENT, IT IS USED TO SPECIFY SEVERAL REGULATORY REQUIREMENTS:

REACTOR DESIGN (DESIGN BASIS ACCIDENT) CONTAINMENT PRESSURE AND TEMPERATURE LOADS

FUEL AND CLADDING DIAMETER AND SPACING ACCUMULATOR, HPI, LPI: FLOW AND CAPACITY

REACTOR OPERATION

- LIMIT ON TOTAL POWER LEVEL
- LIMIT ON LOCAL POWER PEAKING FACTOR
- SURVEILLANCE REQUIREMENTS
- DIESEL GENERATOR START TIME AND LOADING
- STEAM GENERATOR TUBE PLUGGING
- COMPONENT RELIABILITY

ECCS RULE (10 CFR 50.46 AND APPENDIX K): REVISION AND RESEARCH

LOUIS M. SHOTKIN, RES/DRPS/RPSB

COMMISSION BRIEFING
JULY 14, 1988

OUTLINE

- o PROPOSED ECCS RULE
- o ECCS RESEARCH
- o CONCLUSION
- o COMMISSION ACTION REQUESTED

KEY FEATURES OF PROPOSED RULE

- o BEST ESTIMATE CALCULATION + UNCERTAINTY LESS THAN 2200°F
- o UNCERTAINTY TO BE DETERMINED TO HIGH LEVEL OF PROBABILITY
- o GRANDFATHER EXISTING RULE
- o REPORTING REQUIREMENTS RELAXED AND CLARIFIED:
  - 50°F RATHER THAN 20°F FOR MODEL CHANGES
  - ANNUAL REPORTING

SUMMARY OF PUBLIC COMMENTS

- 32 RECEIVED
  - 20 UTILITIES
  - 4 VENDORS
  - 2 OWNERS GROUPS
  - 2 SAME INTERVENOR
  - 2 SAME INDIVIDUAL
  - 1 INDIVIDUAL
  - 1 ANONYMOUS
  - 32 (total)
- ALMOST ALL WERE FAVORABLE
- SUPPORT APPROACH

REGULATORY GUIDE

- HIGH LEVEL OF PROBABILITY IS 95%
- GENERAL FEATURES OF BEST ESTIMATE CALCULATION
- SOME ACCEPTABLE MODELS AND DATA

COMPENDIUM OF ECCS RESEARCH

- 1200 PAGE SUMMARY AND BIBLIOGRAPHY OF ECCS RESEARCH
- $700 MILLION AND 12 YEARS
- PROVIDES "ROAD MAP" FOR APPLICANTS AND LICENSEES

BENEFITS OF NEW RULE

- MORE ACCURATE UNDERSTANDING OF ECCS BEHAVIOR.
- LONGER DIESEL GENERATOR START TIMES.
- REDUCED NEUTRON FLUENCE AT THE VESSEL WALL REDUCES PRESSURIZED THERMAL SHOCK RISK.

BENEFITS OF NEW RULE
(CONTINUED)

o LESS STRINGENT POWER PEAKING LIMITATIONS WILL ALLOW

- MORE OPERATING FLEXIBILITY
- MORE EFFICIENT FUEL UTILIZATION
- REDUCED FLUX SHAPE MONITORING
- ALLOW INDUSTRY TO MORE INTELLIGENTLY OPTIMIZE ECCS DESIGN (UHI)

SPIN-OFFS FROM ECCS RESEARCH PROGRAM

- ECCS RULE REVISION
- COMPUTER CODES APPLIED TO OTHER REGULATORY ISSUES
- SEVERE ACCIDENT ANALYSIS AND UNCERTAINTY
- ACCIDENT MANAGEMENT

MANDATE FOR ECCS RESEARCH PROGRAM

- 1973 COMMISSION AND CONGRESS
- 1975 AMERICAN PHYSICAL SOCIETY PEER REVIEW
- 1976 NRR USER NEED REQUEST

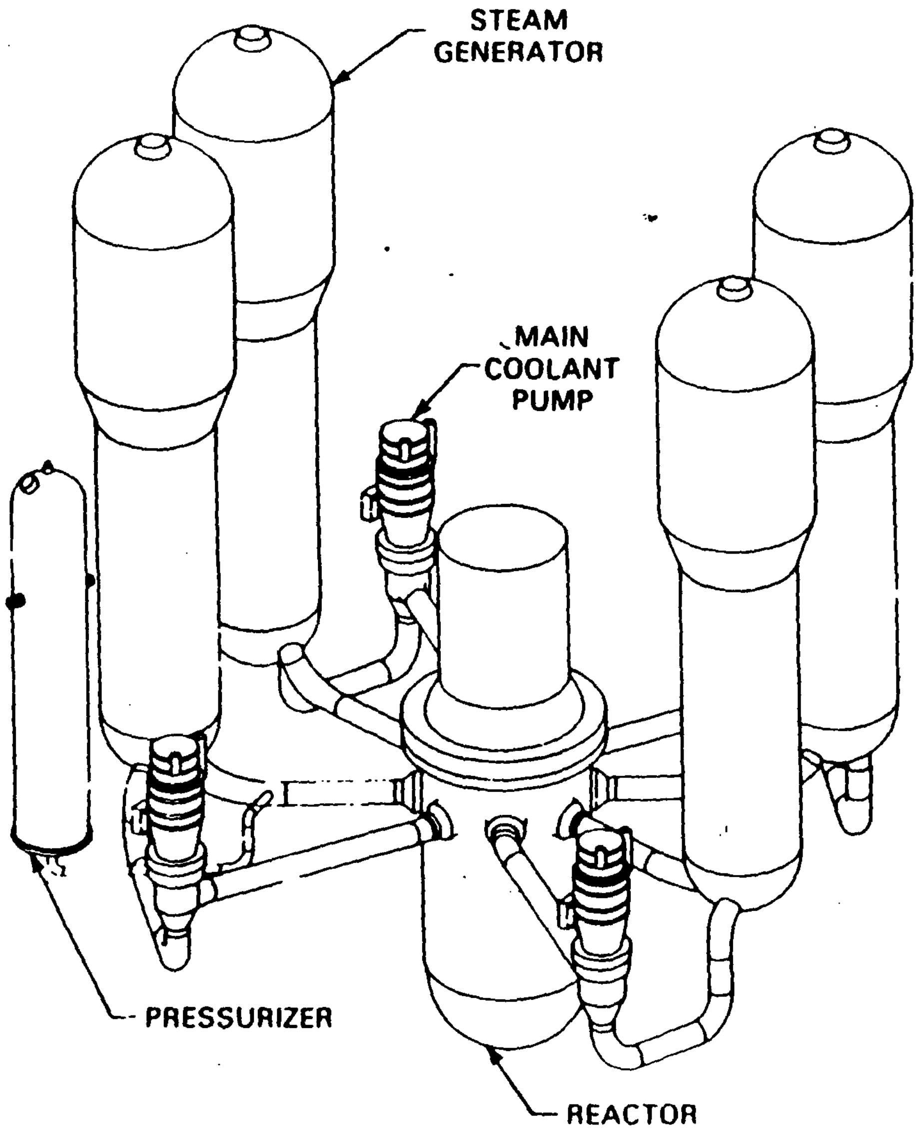
PRINCIPAL LOCA TEST FACILITIES

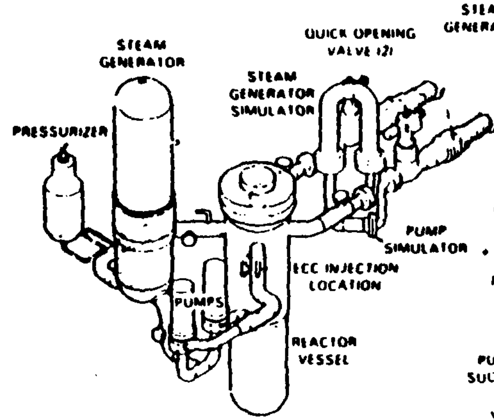
USA:	LOFT	INEL	1986
	SEMISCALE	INEL	1986
	FLECHT-SEASET	W	1984
	FIST/TLTA	GE	1985
	SSTF	GE	1983
JAPAN:	CCTF	2D/3D	1988
	SCTF	2D/3D	1988
GERMANY:	UPTF	2D/3D	1989

PRINCIPAL LOCA COMPUTER CODES

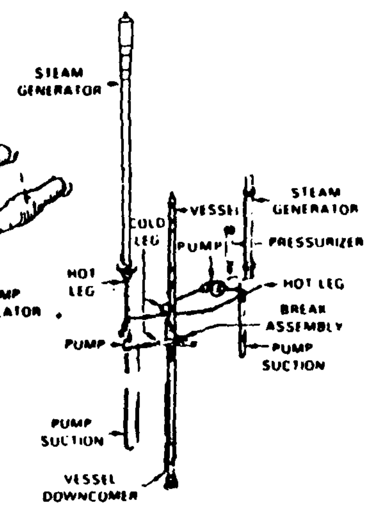
TRAC-PWR	LANL	1989
TRAC-BWR	INEL	1988
RELAP5	INEL	1989
COBRA	PNL	1987

USNRC Reactor Safety Research Test Facilities Compared to Westinghouse PWR

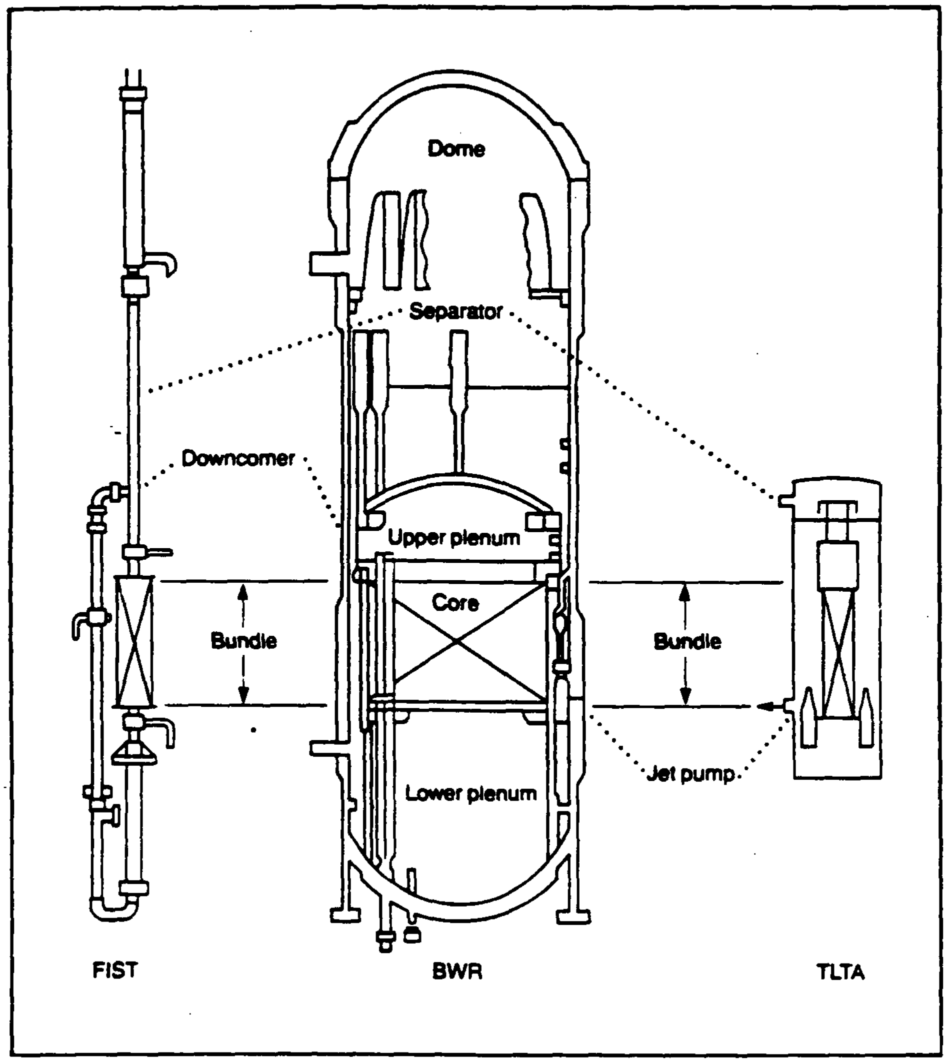




Loss-of-Fluid Test



Semiscale


Dome
Separator
Downcomer
Upper plenum
Core
Bundle
Bundle
Jet pump
Lower plenum
FIST
BWR
TLTA

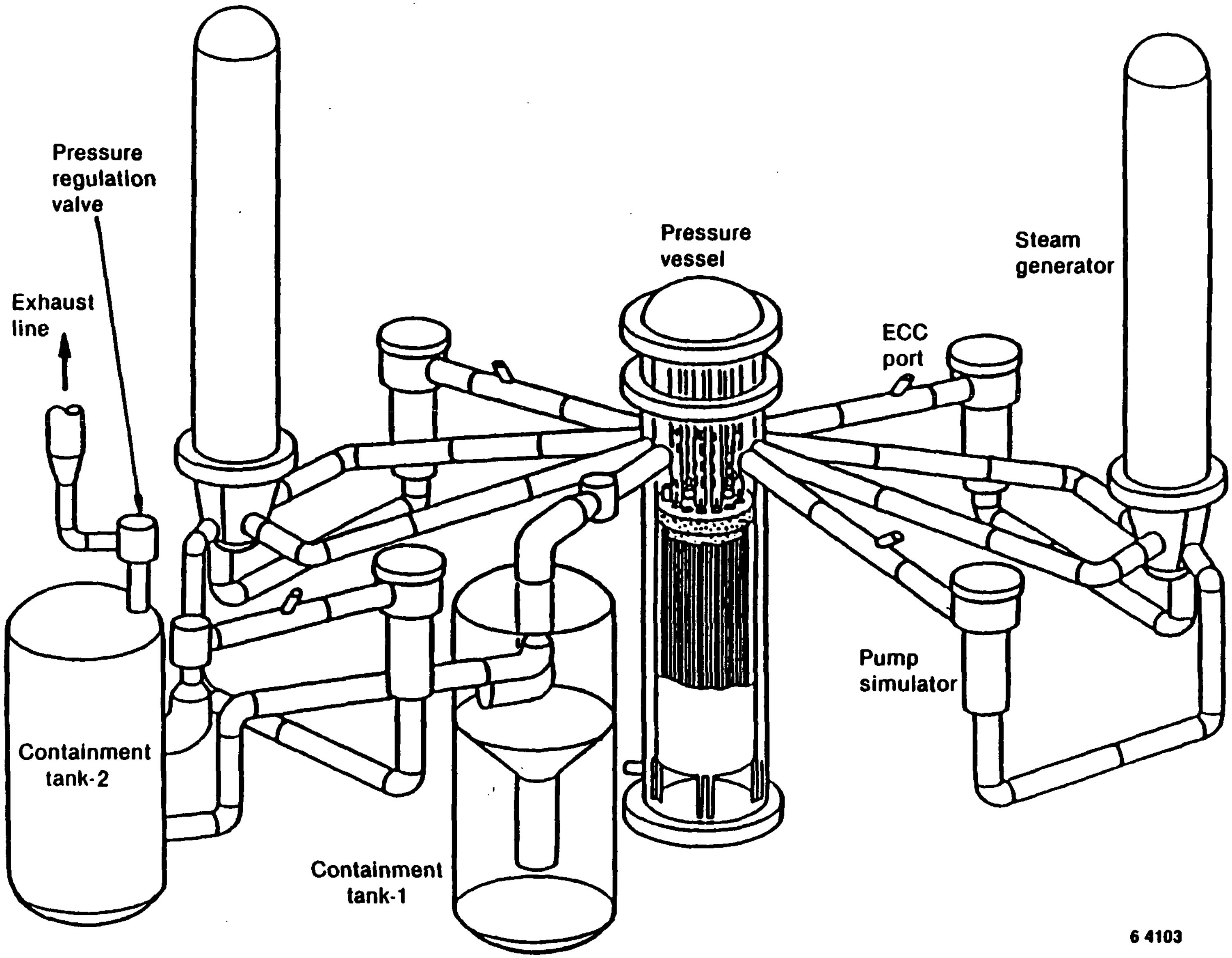
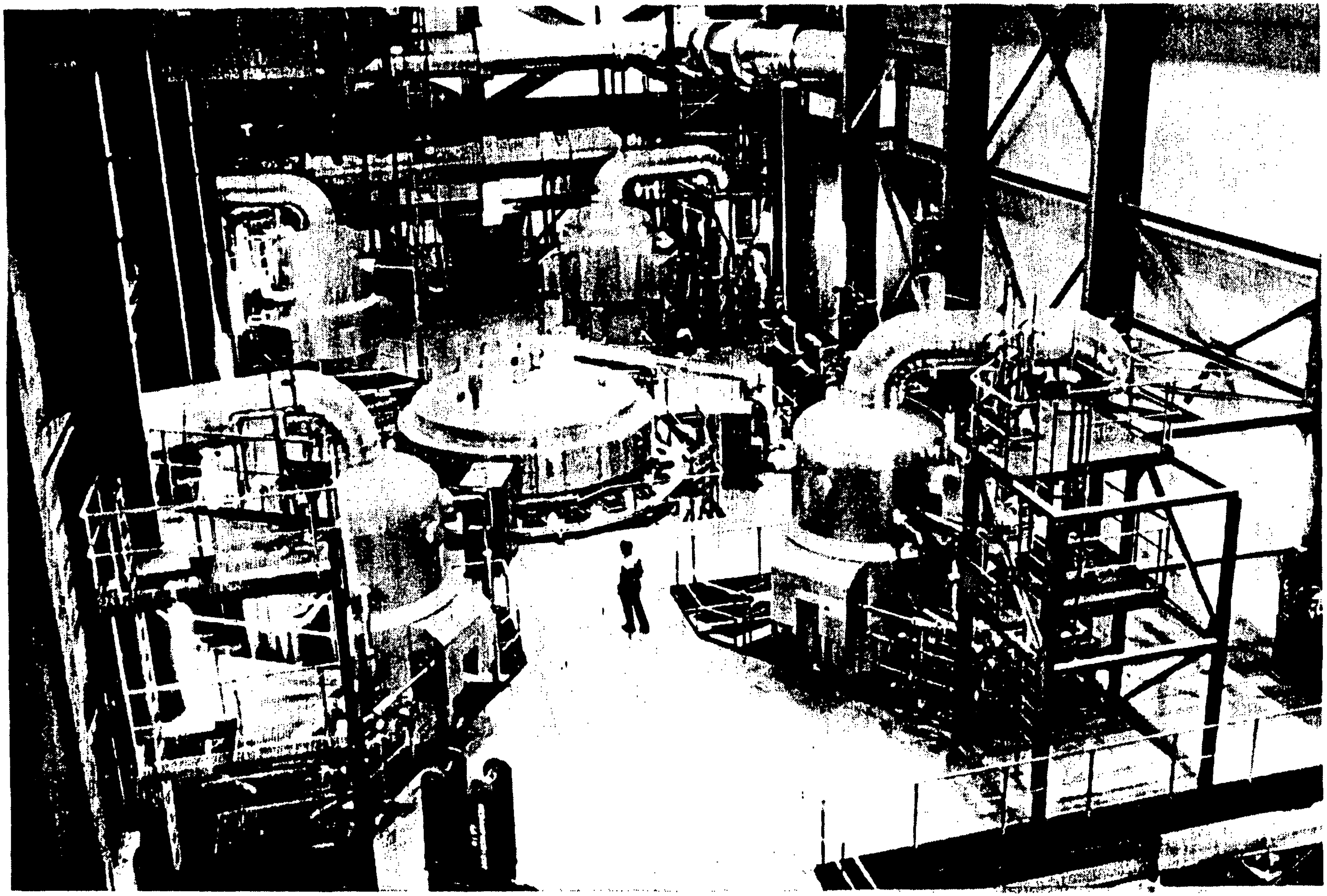


Figure A.5-1 Cylindrical Core Test Facility (CCTF)



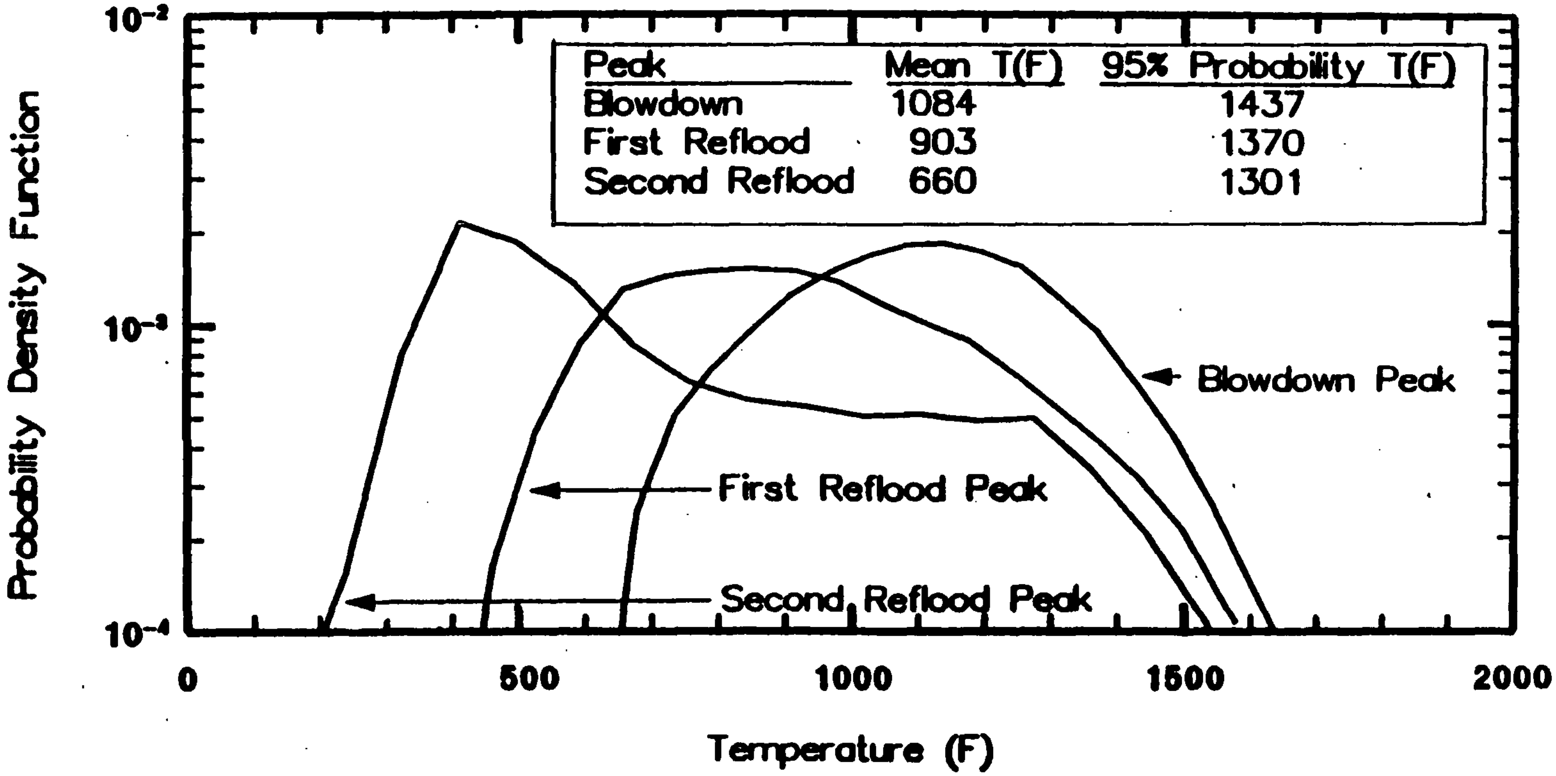
Interior of UPTF Facility

UNCERTAINTY METHODOLOGY (CSAU)

PURPOSE: DEMONSTRATE VIABILITY AND PRACTICALITY OF CONCEPT IN PROPOSED RULE.

METHOD: DETERMINE KEY VARIABLES
PREDICTIONS VS. DATA
PROBABILITY AND BIAS

PEER REVIEW: ACRS
EXPERT PANEL (TODREAS)


Peak
Mean T(F)
95% Probability T(F)
Blowdown 1084 1437
First Reflood 903 1370
Second Reflood 660 1301
Blowdown Peak
First Reflood Peak
Second Reflood Peak
Probability Density Function
10^{-2}
10^{-3}
10^{-4}
0
500
1000
1500
2000
Temperature (F)

NSL00964

CONCLUSION

- o FULFILLED ORIGINAL MANDATE OF COMMISSION AND CONGRESS TO CONFIRM THE SAFETY OF ECCS DESIGN

- o COMPLETED LARGE RESEACH PROGRAM LEADING TO REVISION OF MAJOR REGULATION

- o RULE IS PERFORMANCE-BASED AND PROVIDES INCENTIVE FOR INDUSTRY TO DEVELOP ACCURATE BEST ESTIMATE ANALYSIS MODELS.