Official Transcript of Proceedings ACRST-3184

NUCLEAR REGULATORY COMMISSION

ORIGINAL

Title: Advisory Committee on Reactor Safeguards
Thermal-Hydraulic Phenomena Subcommittee
OPEN SESSION

PROCESS USING ADAMS
TEMPLATE: ACRS/ACNW-005

Docket Number: (not applicable)

Location: Rockville, Maryland

Date: Thursday, January 17, 2002

Work Order No.: NRC-177

Pages 194-282

Closed session pp 283-522

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

TR04

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING

+ + + + +

THURSDAY

JANUARY 17, 2002

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The ACRS Thermal Phenomena Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:33 a.m., Dr. Graham Wallis, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

DR. GRAHAM WALLIS, Chairman

DR. THOMAS S. KRESS, Member

DR. VIRGIL SCHROCK, ACRS Consultant

ACRS STAFF PRESENT:

PAUL A. BOEHNERT, ACRS Staff Engineer

STEVE BAJOREK

RALPH CARUSO

HUEIMING CHOW

JERRY HOLM

GENE JENSEN

RALPH LANDRY

BOB MARTIN

BILL NUTT

LARRY O'DELL

I-N-D-E-X

P-R-O-C-E-E-D-I-N-G-S

(8:33 a.m.)

CHAIRMAN WALLIS: The meeting will now come to order. This is the second day of the ACRS Subcommittee meeting on Thermal-Hydraulic Phenomena. I am Graham Wallis, the Chairman of the Subcommittee.

The other ACRS Member in attendance is Dr. Thomas Kress; and the ACRS Consultant in attendance is Professor Virgil Schrock. Today, the subcommittee will begin a review of the Framatome ANP Richland S-RELAP5 Realistic Thermal Hydraulic Code Version, and its application for large break LOCA analyses.

The Subcommittee will gather information and analyze relevant issues and facts, and formulate the proposed positions and actions as appropriate for deliberation by the full-committee.

Mr. Paul Boehnert is the cognizant ACRS staff engineer for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on December 20, 2001.

Portions of the meeting will be closed to the Public, as necessary, to discuss information considered proprietary to Framatome ANP Richland, Incorporated.

A transcript of this meeting is being kept, and the open portions of this transcript will be made available as stated in the Federal Register notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no written comments nor requests for time to make oral statements from members of the public.

Now, we will start this meeting with a short presentation by Ralph Landry from the NRC Staff, who will give us a brief introduction on the status of the review of this code.

MR. LANDRY: Thank you, Dr. Wallis. My name is Ralph Landry, from the NRR staff, and what I would like to do is first go through a little bit of the presentation.

We had planned to update the subcommittee on where we are in the review. I would like to talk a little bit about the review status, and who the review team members are, and the approach that we are taking to this review.

Tomorrow after Framatome has completed their presentations, I would like to address some of the issues that were brought out in the ACRS committee letter on the S-RELAP5 small break LOCA review.

There are a number of points that the Committee made in that letter, and I would like to address where we stand with regard to those points. And then we will have a presentation on the approach that we are taking to the statistical review, and the uncertainty review.

That review is receiving a heavy emphasis in this code review, and then some of our concluding remarks. We received the code and the code documentation in August of 2001, and in October we accepted the code for review.

We determined that there was sufficient material to begin a review. We held a code workshop with Framatome in October of 2001, a full day in which Framatome brought their staff in and led us through the code, and the content of the code, and the uncertainty analysis that was done, and the statistical approach.

It was a very productive workshop in which we became even more familiar with the S-RELAP5 code than we had been from the small break LOCA review.

We are planning to have all the RAIs done in April, early April of 2002. We anticipate all the responses back from Framatome in June. We are aiming for a draft SER by mid-July so that we can have that to the subcommittee and have a subcommittee meeting in August.

Then we would anticipate a full committee meeting at ACRS as per an ACRS letter in September, and the final on the SER by the beginning of Fiscal Year 2003. It is a very aggressive schedule we realize.

CHAIRMAN WALLIS: Now, Ralph, we saw this code previously, and I forget exactly when.

MR. LANDRY: Yes.

CHAIRMAN WALLIS: And we had quite a few comments on the equations and formulations of things at that time. And I would hope that you folks would detect those things that we would detect.

And you would hopefully bring them up in your RAIs so that we don't have to go over that ground at the time when we should be seeing a finished product around August or September.

MR. LANDRY: Yes.

CHAIRMAN WALLIS: And that would be most unfortunate if we ever had to do anything like that.

MR. LANDRY: Well, that leads into a little bit of who is doing the review and how we are approaching the review. Since the code was reviewed for the small break LOCA, which was completed almost a year ago, we have lost two of the key reviewers, and we have gained a couple of people.

So we now have myself doing the review, and Tony Attard, who you are familiar with, focusing heavily in the heat transfer area, and thermal hydraulics.

Sarah Colpo, who has joined us, and who came here, and who had done a lot of experimental work out at Oregon State under Jose Reyes, who is assisting in looking at a great deal of the separate effects assessment and testing that was done, but also is working with the code itself.

Sarah has been looking at the internals of the code, and some of the models, and subroutines within the code, and is planning to continue the work that was discussed on the small break LOCA of varying some of the parameters within the code in determining what is the effect of the --

CHAIRMAN WALLIS: And she is going to run the code?

MR. LANDRY: Yes, she is going to be running the code. In addition, we have Yuri Orechwa, who you met on the TRACG review, and who has done the statistical review on that code, and is doing a statistical review on this one, and he will have a presentation tomorrow morning.

Shih-Liang Wu is assisting us to look at the RODEX model. RODEX has been previously reviewed and approved, but Shih-Liang is assisting us looking at the way that model is being implemented within S-RELAP5 realistic large break LOCA.

And we have hired Len Ward since we lost a couple of key reviewers, and we have hired Len Ward from ISL Laboratories to assist us in thermal hydraulic review. And Len is looking at very heavily the break flow models, and reflood models, and more of the thermal hydraulics area.

Now, you will notice that we have not talked about the review of the kinetics model. The kinetics model is no different than what we saw on the small break LOCA.

So it is a simple point kinetics model, and there is nothing new and nothing different, and so we have determined let's focus our review in some of these other areas.

We don't have the staff available to focus on every single point, and since something here has not changed at all, let's let that go, and look at some of the other areas.

CHAIRMAN WALLIS: But these are all the NRR people, and is RES going to be involved at all in this?

MR. LANDRY: Not at this point.

CHAIRMAN WALLIS: Is there a possibility that if you have specific questions that you might turn to them for assistance for use of their expertise?

MR. LANDRY: There is that possibility. We can talk to Dr. Bajorek, and we can talk to Joe Stoddemeyer, and we can talk to Tony Ulsys. One thing that we would like to talk to, we can't, and that is Joe Kelly, because Joe Kelly was involved in the development of the code when he was working for Siemens, and then Framatome. So unfortunately we cannot talk to him.

MEMBER KRESS:: For how long? Is there a timing on that?

MR. LANDRY: Well, he just came back this fall.

MEMBER KRESS:: I know that, but isn't there usually a year's time in that?

MR. LANDRY: No, I think it is usually two years.

MR. CARUSO: Dr. Kress, the problem is that this is something that he worked on, and that would involve him reviewing his own work.

DR. SCHROCK: You can't review your own work.

CHAIRMAN WALLIS: It would be interesting to see what effects he had.

MR. LANDRY: The way that we are approaching this review, as I tried to allude to, is that we are trying to build on what we did in the S-RELAP5 small break LOCA review.

We are trying to emphasize work that has not been reviewed previously and in particular the statistical analysis, the uncertainty analysis. We are looking very heavily at the experimental base, and one of the things that we are looking at right now is the heat transfer model.

Now, even though according to PIRT heat transfer is not a significant player, we also realize that when you talk about peak cladding temperature in a large break LOCA that things like dispersed fill boiling become very important, even though they don't appear in the PIRT.

We are going to look very heavily at those models. One of the questions that we have already asked, and that Framatome is working very hard on, is that we have asked that they take one of the large breaks, and we will leave it up to them to pick which one they want to look at, and identify the heat transfer correlations that are called into play for the entire term of that transient for each correlation that comes in.

There is at least thee dozen correlations in the code, and so we have said identify the correlations that come into play throughout the transient, and we want to know when they come in, and what are the conditions that exist when that correlation is invoked.

And then what are the ranges of approval of that correlation, or where has that correlation been shown to be valid. So that we can see how do you smooth from correlation to correlation, and what discontinuities exist going from a heat transfer correlation to correlation, and are the correlations all being used in their proper ranges of validity.

And to our knowledge, this has never been done for one of these transients. So this is the area that we are trying to focus on in this review.

We are trying to take the resources that we have available to us, and use those resources in a productive way to look at areas that have not been reviewed heavily, or areas that we feel are very important for a realistic large break LOCA. So we are hard at work on the review right now.

MEMBER KRESS:: Is there a standard sensitivity analysis to find out which of these correlations are most important or most sensitive with respect to get an output?

MR. LANDRY: Some of that comes out in the uncertainty analysis. Some of that comes out in knowing that there are areas where a correlation is very important. As I said, the dispersed room boiling is very important for PCT. The correlations that come into play --

MEMBER KRESS:: How do you know that, Ralph?

MR. LANDRY: The correlations that come into play during reflood are critical, and how the quench flood moves up the fuel, and where you determine Tmin to be, and where you allow quenching to come in.

MEMBER KRESS:: How is it that you know that dispersed room boiling is very important? Is it from this experience?

MR. LANDRY: From the experience and

seeing the results of experiments, the years of experiments, determining that peak clad temperature can vary so much by changing flow rates, so that as you change the heat transfer correlation, or the heat transfer regimes during reflood.

So these are the areas in which we are trying to focus the review. It is a tight schedule, and we realize that this schedule is very aggressive, and that we are trying to do everything we can to meet that.

Now, in the past the subcommittee has made a number of comments on areas that it has felt to be important, and we hope to get some of those areas out of this meeting today, too; and areas where you think we should be looking in particular.

Models in the code such as we discussed with the small break LOCA, where you feel this model is very important, and have you looked at varying parameters within such and such.

Any kind of feedback that we get during this meeting we are going to take into account in the work that we are doing, looking at the independent evaluation of the code itself.

DR. SCHROCK: We have around four models and correlations currently in the material that we are looking at. We previously reviewed MOD-2 and in looking at the new one, it is difficult to identify what the changes are.

But I think it would be helpful if you could ask Framatome to mark the places where the documentation has been changed, just in the interest of saving time in locating it, and seeing what the resources have been.

I see some changes, but at first I thought there were no changes in one chapter at all, and as I studied it further, I see in fact there are some, but they are modest, but that is just a suggestion.

MR. LANDRY: The Framatome people are taking notes.

DR. SCHROCK: Well, I think it is more likely to happen if you ask them.

MR. LANDRY: Well, the documentation that we have received is extensive as you have already encountered. We have three CD-ROMs full of documents.

DR. SCHROCK: Right.

MR. LANDRY: We have the methodology manual, and we have the models and correlations manual, verification and validation manual, users guide, programmers guide, RODEX manual, ICECON manual, and various and sundry other supporting documents.

And looking at it by rough estimate, it was something like 15,000 pages of material here. So that is another factor in our review; that we have to say what are we going to focus on. Let's focus our review on the things that are important.

And let's use our resources productively and as efficiently as we can. So any feedback that we get in the next day-and-a-half will also help us, and if we can get feedback on any of your observations, I think --

DR. SCHROCK: I find it difficult to work from the Cds directly on the screen, especially when figures are rotated by 90 degrees, but quite apart from that, I am not skilled enough at doing that to flip back and forth between text and a figure to sort out ideas that I am looking for.

Well, there is a great deal that we have printed ourselves from the screen, but this is the policy of the agency to encourage electronic submittals.

So we are dealing with it also, and as we get older, some of us have to consider our vision. So those are the remarks that I had planned on making this morning, Mr. Chairman, and I would like to then turn it over to Framatome to make their presentations.

And tomorrow morning when they are complete, then come back and address some of the issues raised in the subcommittee and the committee's letter on the small break LOCA review. And in particular have Yuri Orechwa present his initial thoughts on the statistical review.

CHAIRMAN WALLIS: Before you go, your slide three essentially went through your schedule for things, and I was trying to think about the ACRS parallel schedule. We don't send out RAIs.

MR. LANDRY: Correct.

CHAIRMAN WALLIS: But we have all the information. We have three Cds, and I think we have all looked at them more or less, but we have not looked in detail. Some have looked at more detail in some parts and so on.

But as I said in my introduction, we are starting this process, and it seems quite likely that between now and August, and maybe even next month or so, some of us may dig in pretty deeply in parts of this documentation.

But we have no obligation to send out RAIs or to say anything to anybody. We can wait until all is revealed in August, or we can be part of more directly part of the review process in some way. I am not quite sure how we ought to fit in.

MR. LANDRY: Well, that is also a part, Mr. Chairman, of what I was saying earlier, that we will be taking notes during this meeting, and any feedback that we get, we realize that the subcommittee is not the consultant to the staff.

And we don't want to approach using it as such. But any feedback that we get, we will factor in.

CHAIRMAN WALLIS: I think if there is anything that concerns us as we do our reading, there ought to be a mechanism for it to be sort of injected into the process before September.

MR. LANDRY: Well, any feedback that you provide back to Paul, and Paul can provide to us, we would like to factor into our review. We want to do -- we realize that this is an aggressive schedule, and so we want to do as efficient and complete a review as we can.

MR. BOEHNERT: Yes, I would say a suggestion would be that you compile some notes, or comments, and give them to me, and I can transfer them over to the staff.

MEMBER KRESS:: It seems like it ought to be possibly included in the RAIs.

MR. BOEHNERT: Yes, it should be fairly soon.

MEMBER KRESS:: Yes, that makes it pretty soon.

MR. LANDRY: The procedure that we are using for the RAIs is very much like we have used in previous code reviews. We provide to the applicant our questions in an informal manner as we develop them, and then when we have -- when we determine that we have all the questions together, we prepare the formal questions to send them out so that they can have the questions in advance, and can work on responses to such questions that I just alluded to, such as the heat transfer correlation mapping.

And that is a big problem, and it is not an insignificant effort. So we are trying to provide questions to them in advance so that they can develop answers, and then we give them the formal responses.

And as we did with the Appendix K review for small break LOCA, it was only a few weeks after we gave them the formal questions that we received the formal answers, because we have interacted with the questions and responses throughout the review process.

We found that to be a very productive way in which to transfer information back and forth. So any input that we get from you, and any insights we get from you, we would be very interested in having.

CHAIRMAN WALLIS: We are not consultants to the staff, and neither are we consultants to Framatome.

MR. LANDRY: Right.

CHAIRMAN WALLIS: So it is not our job to fix up something there.

MR. LANDRY: That's correct. But any comments that you --

CHAIRMAN WALLIS: This is assuming that maybe it is a perfect document, but we don't know that yet.

MR. LANDRY: Are there any comments that you care to make to us, we would be happy to look at.

CHAIRMAN WALLIS: Thank you very much.

MR. LANDRY: Thank you.

CHAIRMAN WALLIS: Well, Jerry, welcome back. It has been a while since we saw you here.

MR. HOLM: Yes. Good morning. My name is Jerry Holm, and I am primarily related to S-RELAP5 users manual or programmers manual, a document on RODEX3A, which is the fuel rod code used in the methodology, a document in ICECON, which is the containment calculation, which is actually part of the

S-RELAP5 code these days.

CHAIRMAN WALLIS: These sample columns, are these reactor problems and that the nodalization scheme is all set up for a real reactor system?

MR. HOLM: Yes. They can run the 4-loop sample problem that is in the topical report, and they can go in and vary it to look at other conditions if they want to. But we gave them the base input decks so that they could repeat our sample if they wanted to.

Now, I end up with a schedule, which I am happy to note matches very well with Ralph Landry's schedule. Again, as Ralph said, we submitted a topical report in August of 2001, and made a presentation to the NRC in October.

The presentation that we made to the NRC, this one that you are going to see today, is patterned after that. We went back and based on the reaction to the NRC staff to the presentation, made a few modifications for this meeting.

But in general it is the same structure and same topics. And it says that the first presentation to the subcommittee is today and tomorrow, and I think a really key date in this process is for the NRC to issue the RAIs in April if we are going to respond, get a draft SER, and have another ACRS meeting, and get an SER that is final in September, we really need to hold to that April date.

I would certainly encourage the subcommittee if they have got feedback to provide to the NRC, that they would like the NRC to pursue if you can do it prior to April, and that will facilitate the process quite a bit.

CHAIRMAN WALLIS: This assumes that the Framatome response is acceptable?

MR. HOLM: Yes. It assumes there is not a second amount.

CHAIRMAN WALLIS: You don't need to reiterate on anything?

MR. HOLM: Right. This schedule assumes there is no reiteration.

CHAIRMAN WALLIS: That has always concerned me a bit about these reviews, and it seems to be stuck on a linear track; whereas, some things often require a re-examination.

Just to have one presentation to us now and then the final presentation in August may not be enough. It may work out, and it may be such smooth going that there is nothing to worry about.

MR. HOLM: We hope that we have done a

good enough job on the original documentation that it will be a smooth review process. If there are other meetings requested, we are certainly willing to support those, and we will try to support them in this time frame.

But our goal on these topical reports is that we try to identify in advance what the NRC's interests are, and what their requirements are going to be, and we try to make sure that the topicals have that information. We don't look at this as a process of submitting a topical, and then responding to questions and modifying the methodology.

If I have to modify those topical report, in terms of its functionality, then we have failed at our goal here. We really want to issue this topical as it is basically, with an SER that says that what we submitted was acceptable.

And with that, I will turn it over to Larry O'Dell to start the overview of the methodology.

CHAIRMAN WALLIS: Thank you, Jerry.

MR. HOLM: You are welcome.

MR. O'DELL: Good morning. As Jerry indicated, I am Larry O'Dell, and the project manager for the realistic large break LOCA project, and what I am going to do this morning is provide the overview of the methodology, and what we are calling the methodology road map.

The purpose of this is to provide an upper level overview of the complete methodology, within the intent of providing a perspective in support of the following more detailed presentations which will be following.

What I intend to do as indicated in Jerry's presentation was go through the various steps that we followed in compliance with the CSAU methodology, going through the requirements and capabilities of the CSAU-1, steps 1 through 6, and the assessment ranging of parameters, CSAU Element-2, Step 7 through 10.

And the sensitivity uncertainty analysis, CSAU Element-3, Steps 11 through 14. Moving into the first element, Element 1, CSAU
Step-1, follows the selection of the transient. Here we have selected the large break LOCA scenario for analysis.

We selected the plant types and the selection of the plant types influences the dominant phenomena, and their interactions. Here we have selected the Westinghouse 3 and 4-loop plants, and the CE plants.

All three plant types have inverted U-tube steam generators, a pressurizer connected to a hot lay, an ECCS injection into the cold legs, and our experience with the Appendix K large break LOCA analyses indicate that the three plants, plant types, behave similarly in the blowdown, refill, and reflood phases of a LOCA.

DR. SCHROCK: Excuse me, but doesn't step-one require specification of a frozen code to be used?

MR. O'DELL: I think that is one of the following steps which I will get to.

DR. SCHROCK: But it is not in Step-1?

MR. O'DELL: No. Step-1 is picking the scenario that is going to be analyzed, and I don't remember which one of the steps it is, but we will hit that one.

MEMBER KRESS:: Is that one scenario, or is it perhaps a series of break sizes?

MR. O'DELL: As we get through it, we do a full break spectrum on the guillotines and splits.

MEMBER KRESS:: For a large break spectrum?

MR. O'DELL: Right. And in fact we phalange up with our small break LOCA methodology. We go down to a break size consistent with the upper bound on our small break LOCA methodology.

MR. BOEHNERT: Do you have any plants to do large break LOCA for BWRs?

MR. O'DELL: For BWRs?

MR. BOEHNERT: Yes.

MR. O'DELL: That as not necessarily been decided at this point in time, and we have a follow on project that has initiated this year, and in which we are looking at using S-RELAP5 for BWRs.

However, we will start with the non-LOCA transients. Okay. CSAU Step-3 has to do with the development of the PIRT, and we developed the identification in a ranking table, and this is performed by experts who are knowledgeable of the specific large break LOCA scenario.

The PIRT identifies and ranks the important phenomena for the specified scenario and plant types, and the important phases of the large break LOCA are defined, and the important plant components are identified, and the important phenomena in each component during each phase are identified.

And the relative importance of each phenomena during each large break LOCA phase is identified.

CHAIRMAN WALLIS: Now, this isn't really

the process, because you don't really know much about the last part until you have run the code, and looking at sensitivities and so on?

MR. O'DELL: Exactly. As I will discuss, what we did here is -- well, in fact, it leads in fairly well --

CHAIRMAN WALLIS: You have to come back to the PIRT again and again.

MR. O'DELL: Yes.

CHAIRMAN WALLIS: And look around and say did we make the right decision.

MR. O'DELL: Right. Now, what we -- the process that we followed was basically to develop what we call the final PIRT, and at that point in time the PIRT was set.

Now, we did sensitivity studies, and as a result of those sensitivity studies we did determined which ones are the phenomena that we were going to actually treat statistically without going back and changing the PIRT.

So the final PIRT you see from this in the documentation is the one that we actually developed going through the process.

DR. SCHROCK: Are you going to identify PIRT team?

MR. O'DELL: I can identify the PIRT team. It was basically our internal Framatome people, and we brought in -- well, Joe Kelly was one of the ones that came in part-way through the process, and reviewed the PIRT.

Dr. Hochreiter participated in the review of the PIRT, and we also had him come out and participate in the peer review, and we used Marv Thurgood as another outside source to participate in the review of our PIRT, and in also the peer reviews.

DR. SCHROCK: I think the credibility of the PIRT depends in part on insuring that you have recognized people doing it, and I think also my experience in PIRT has been that the degree of adherence to the principles of the PIRT process has varied widely in previous PIRTs.

So I think that they should document in some way how they have been managed, and what the process really is, and has it been done in accordance with the defined process for PIRTs.

MR. O'DELL: Well, I think I have the one after this slide that will go into sort of the details of what we did there. The PIRT provides the basis for determining the code applicability, and does the code model the important phenomena in plant components.

It establishes the assessment and helps provide the information for establishing the assessment matrix. That is, identifying the test data that contain the appropriate phenomena during each accident phase.

And finally identifying the important phenomena to be quantified and ranged for evaluating uncertainties. The process we followed I think -- and going with Dr. Shrock's comments -- was we first started with an initial PIRT, which was developed from a number from both the expert, the original expert evaluation, and the analytical hierarchy process.

And what we did is we averaged them where there was no number for the experts provided for there, and we went with the analytical hierarchy process. We then had this initial PIRT reviewed by three independent experts, and

CHAIRMAN WALLIS: What is the analytical hierarchy process?

MR. O'DELL: Okay. The analytical hierarchy process involves going through identifying the various plant components, and the phenomena that occur within those components, and then on a component basis, ranking -- going through and ranking the phenomena within the component, and then the --

CHAIRMAN WALLIS: And that is based on judgment, or is it based on something analytical? It says analytical and something.

MR. O'DELL: Well, it is only analytical from the standpoint that you first rank the phenomena within the component, and you rank the components --

CHAIRMAN WALLIS: The ranking is done in a subjective way?

MR. O'DELL: Exactly.

CHAIRMAN WALLIS: I guess, or I think, or I estimate, or whatever.

MR. O'DELL: Right. It is trying to come through and rank it, and then based on the ranking of the importance of the components, combining those rankings, you end up with a final overall ranking.

And then as I indicated, the PIRT was reviewed by three independent experts, and they suggested additional phenomena and ranking changes, and we have outlined what the final set of changes were within the documentation.

The final PIRT was then generated through a peer review, and as I indicated, there were Framatome key personnel participating in that, which at that time included Joe Kelly.

And there was external experts, such as

Dr. Hochreiter, and Marv Thurgood, and as part of this peer review, we started off by first developing consistent definitions for everyone to use for the large break phases and phenomena.

DR. SCHROCK: And the purpose of my question was really to see is this documented someplace as to who the people are, the three independent experts, for example. Is there some place in the documentation where those people are identified?

MR. O'DELL: It isn't. We didn't address people's names and stuff in the documentation. One of the things that we could have done, I guess, is put in the acknowledgements, but we didn't do that I don't believe in the document as I recall.

DR. SCHROCK: I think it should be, but evidently not. It may be just my own opinion.

MR. O'DELL: I think it would have been appropriate to put them in the acknowledgement sections for certain, and in the attempts to get some of these things out, not all of the niceties always get addressed unfortunately.

And the large break LOCA phases that we considered, is somewhat different, particularly for the blow down phrase and the follow on refill phase from what you normally see in Appendix K.

In the blowdown, we defined this as the time period from the initiation of the break until flow from the accumulators or safety injection tanks begin. And based on the members that participated in the peer review of the PIRT, they felt that there was a significant change in the actual phenomena that was occurring at this time, and that was a better break point in a LOCA than what is normally in Appendix K.

And also by having it occur somewhat earlier, you don't have the -- it should be acceptable from the standpoint that you don't have an Appendix K requirement of throwing away the water at the end of the blowdown.

And then the refill and reflood definitions pretty much fall in line with what we had in Appendix K. The final PIRT, as I indicated, there were numerous minor changes to the phenomena rankings, and those are laid out and described in the documentation, EMF-2103.

And just some of the major ones that I listed here was the single phrase natural convection was deleted from the PIRT because the experts believed that this was covered in the post-CHF heat transfer model.

The 3-D flow, void distribution, and generation were combined into a single phenomena. Again, the flow and void distribution were directly related, and it was felt that they were really not separable.

Accumulator discharge was added to the PIRT, and the discharge rate was felt to be a significant primer in determining the refill and reflood rates.

And a upper head component was added because the initial upper head temperature was expected to impact the blow down phase.

CHAIRMAN WALLIS: I have a question for you while I have been looking through your slides here. You have not really told us what S-RELAP5 is. You are jumping into the process here, but I take it that S-RELAP5 is something that is just something that exists somewhere and then you go through this process with it?

MR. O'DELL: Well, we viewed this meeting as more of a building process on our previous meetings with the ACRS. I mean, we went through this with the S-RELAP5 code is something that has sort of evolved through time and from wherever the previous S-RELAPs were and all that.

It is a long history, of 40 years of evolution, and that it is a realistic code, and it didn't start out being all that realistic, but there is some kind of a belief that it is now realistic?

MR. O'DELL: Well, as I indicated, we were viewing this meeting as more of a follow-on to the previous presentations on S-RELAP5.

CHAIRMAN WALLIS: But we had a lot of questions about it.

MR. O'DELL: And we tried to respond to those questions.

CHAIRMAN WALLIS: And I think somewhere it is up to you to say what this thing is that you are taking for granted in a way.

MR. O'DELL: Okay. I guess I am not exactly following the question. Above and beyond --

CHAIRMAN WALLIS: Well, you have made this basic assumption, I think, that S-RELAP5 is a mature code, and you don't have to question anything about it, and we will just go ahead and go through the CSAU process using it.

And it may be there that as it has evolved there are some kind of bad genes that have never mutated to anything better. I don't know. I am just saying that you are accepting that it is now mature enough to be accepted without question.

MR. O'DELL: Well, I don't think we would take the position that the -- with the without question part, I guess. If you feel there are questions from our previous discussions on S-RELAP5 that have not been resolved in some fashion, I think it would be very appropriate that those be passed --

CHAIRMAN WALLIS: That is what I am kind of asking. Now what I would really like to see if a really authoritative document that people can look at and say, yeah, they have really made the case for S-RELAP5.

And in that case, seeing that, you really have to say something about what it is, and some kind of overview of what it is based on, and what it can do, and what its weaknesses and strengths are, or something.

I have not looked at that in the documentation and I don't know where we can find it.

MR. O'DELL: I guess in part with the CSAI process, I would say that actually comes in the assessments of the experiments and development of the uncertainties, and --

CHAIRMAN WALLIS: You can keep using it and say, well, it is justified by what it can do?

That seems to be the argument.

MR. O'DELL: Well, I think it is a multiple phase process, all right? I mean, you go through and you develop the code, and you document it in the code documentation, which I believe we have attempted to do, and then you assess the code against experimental data to in fact demonstrate that the models and correlations used in the code are in fact giving you reasonable type results.

And that's where I am trying to say we are trying to build on our previous or felt that we were building on our previous presentations, where we went through and presented the code, and we went through and tried to respond to your questions at that point in time, and when Joe Kelly went through the equations and tried to lay the basis for the development of those equations.

And so basically what you are seeing in the presentations that we have laid out here are sort of -- well, you have seen the code, and this is the way the code is being applied, and these are the results that we get from that application.

CHAIRMAN WALLIS: So it is not something like the old caloric theory of thermal dynamics, which could do a lot of things, and then got fixed up, and got fixed up, and got fixed up until eventually a sort of change occurred, where people's views of thermal dynamics became different, and then you had to add something else to the basic theory in order to do a better job.

So you went back and redid thermal. I just wonder if some of that isn't in some of these codes, where there is some old assumptions made because we had to do something 40 years ago and no one has really had the courage to say we really ought to do something different. I just don't know if --

MR. O'DELL: Well, I think that at least as we view codes, is that they are a continually evolving system, okay? And we are going through and we believe the code based on the assessments that we have done, and the sensitivity studies that we have done, that he code is in a condition where we can demonstrate it is applicable for PWR realistic large break LOCA.

Now, when I say it is going to evolve, the version that we are running here and that we were presenting the results of here, is the version that we intend to use in the performance of analysis.

But we are starting the BWR development process now, and we are going to start assessing the code on the BWR sets of conditions and stuff. If there is something that comes out of that that says we have got to go in and modify the code, we will go in and try to improve the models and stuff in the code, such that it can predict BWR phenomena.

And that is what I mean by it is going to evolve, and we will have the versions that we are going to have for the PWRs, but it will continue to evolve and move forward from there.

CHAIRMAN WALLIS: Well, I am just trying to formulate a feeling here that in the presented code there has to be some kind of a description of what it is and why it is good for this purpose.

Maybe it is somewhere in the documentation, and maybe we should move on with your presentation, but it is interesting to me that you don't find it necessary to say anything about that.

MR. O'DELL: Well, our incoming position was that we presented the code, and you had an opportunity to look at it and comment on the code, and we are going to be dealing primarily with that code's application.

DR. SCHROCK: I had difficulty understanding your bullet, 3D flow void distribution and generation combined into a single phenomena. What does that mean? What is happening here?

MR. O'DELL: Well, I think if you go and look at the PIRT and the compendium, it had two components, or two phenomena listed. One was the 3D flow, and one was a void distribution. And we felt that given the power distribution that the calculation of the 3-D flow and the void distribution were a combined effect.

DR. SCHROCK: Well, you don't calculate 3-D flow in it. The effects are not really combineable into a single phenomenon. I don't understand what the argument is here. I mean, the void will depend upon the total enthalpy of the mixture, as well as flow conditions.

MR. O'DELL: Right.

DR. SCHROCK: You can't relate void to flow alone

MR. O'DELL: Yes, and that is not the --

DR. SCHROCK: That's not what the bullet means?

MR. O'DELL: That's right.

DR. SCHROCK: So what I am asking is what does it mean?

MR. O'DELL: Well, what it means is that the calculation of the 3-D flow and the mixing within the various radio assemblies within the core sets that enthalpy, which then in-turn sets the calculated void distribution given the powers and calculated flow.

CHAIRMAN WALLIS: And so for the purposes of the PIRT, you have sort of put these things in the same basket. It does not mean that they are thermologically related. Isn't that what you are just saying for the convenience of the product?

MR. O'DELL: Right.

CHAIRMAN WALLIS: That you have got some extra phenomena and you put them in this same sentence, the same slot.

MR. O'DELL: Right. As far as being able to rank them.

CHAIRMAN WALLIS: But if one of them turned out to be very important on its own, you would have to break it out and put it in as a separate item it seems to me.

MR. O'DELL: Well, let's say, for example, that I -- well, I think what we are trying to say here is that if we said, okay, the void distribution is extremely important, that that void distribution is fed by the calculated flows to some extent, and by the mixing that it calculates in there to get the enthalpies for calculating that void distribution.

So as I understand that if you looked at one node, and you had the heat coming into that node, and the enthalpy of the liquid in that node, you would calculate the void distribution.

And what I am saying is that the enthalpy coming in, the conditions of the fluid coming in to that specific node is determined to some extent by the calculated 3D flow distributions.

DR. SCHROCK: I am having trouble understanding how you are viewing the relationship of the PIRT to the code calculation. The PIRT is trying to identify important phenomenological behavior of this complex system, and to psyche out which things are of greatest importance to the evolution of a major transient, the one identified specifically.

And then to examine in a later stage how well the code is able to do what you imagine from the PIRT has to be done in order to get a reasonable result. If you begin with an argument that 3D effects and void distribution, and void generation are representable by some single figure of merit, I am not sure that you would be able to ask the right questions about the code.

So what would your image be of what that bullet leads you to from the PIRT to ask about what the code is doing.

MR. O'DELL: Well, I think if you look at the assessments, we have done a series of calculations where the flow and the void distribution have been looked at.

We used the FRIGG0-2 test to look at void distributions, and we used the -- I think it was the GE level swell test, and THTF level swell test, all looking at void distributions.

And we have used some multi-dimensional tests, and I think they were performed by Westinghouse, where they had two 15-by-15 assemblies together, and where we tried to look at the effect of the 3D flow.

And I think again to the extent that one can separate out the effects of the two in those tests, we presented comparisons to the test data.

DR. SCHROCK: Okay. I don't think I should pursue it further. Thank you.

MR. O'DELL: And here is the CSAU Step-4, which involves a selection of the frozen code versions, and in these frozen code versions the requirements are that you have consistency throughout the process.

We selected frozen versions of the

RODEX3A and S-RELAP5 code, and that is --

CHAIRMAN WALLIS: Who decided to freeze the code? What is the process that decides that the code is freezable and appropriate to freeze it at this time, and not to change anything anymore?

MR. O'DELL: Well, it was integrative process obviously. I mean, we picked a subset of the assessments, including the interval and some of the separate effect tests, and we ran those sets of assessments.

And we also developed a model for the plant, and we ran sensitivity studies based on that plant model, and ran the assessments. And what we did is we determined that the code was providing reasonable results for those.

Now, as we went through the process and added more assessments, we also incorporated the results from those assessments and went back into the code.

And then once we came to the conclusion that the code was giving us acceptable results, from the standpoint of being able to quantify uncertainties, et cetera, for the code, then we froze that code version, and made a final pass through all of the assessments.

So this was definitely an interactive process getting to this condition for S-RELAP5. RODEX3A, we had already gone through that process and that code had been reviewed and approved, and we have an SER on that.

CHAIRMAN WALLIS: So the code is sort of adaptable until it fits most of the data, and then you freeze it, and then you assess something else that is independent of what you used before you froze it?

MR. O'DELL: Yes, and in fact, the whole process involved exactly that kind of an approach, and you will see as you look at the assessments that the SETF, you would have to say that was jus a blind assessment.

It took us so long to get the data that we didn't get to use that assessment for as much as we originally wanted to use it for.

And all we ended up using the SETF for was a nodalization, because that was all that we had time left for once we got the SETF data. But we did run the set of assessments that we had planned to run all along.

DR. SCHROCK: It seems as though the identification of a frozen version is a bit vague, and maybe impossible at this stage, if the code is still under review by NRR. And you may have to do things to it in order to make it acceptable to NRR. But you have already marched ahead with the process of implementing CSAU, with a presumption that a frozen version exists. How do you identify it?

MR. O'DELL: Within our own --

DR. SCHROCK: It just seems vague to me, and that is my comment.

MR. O'DELL: Well, within our own --

DR. SCHROCK: The process seems out of step and the identification seems imprecise.

MR. O'DELL: Well, I don't think the identification -- well, I would disagree that the definition is imprecise, at least within our own code development hierarchy. When we come through --

DR. SCHROCK: I mean by that that in your description of it to us, it seems imprecise. There needs to be some way in which the existence of a frozen code is describable and what does it mean.

MR. O'DELL: Well, what it means from my definition --

DR. SCHROCK: A certain MOD version of the code, with a --

MR. O'DELL: It is a use version, and we quantify them with a use version. It is saved in our

CSAU, our code control system, and that version basically can't be changed, okay?

If we make changes to that code version, then this designation has to be updated to whatever version that code is. If we go through this review process, and it turns out that we have to go back to the code and make significant changes, then obviously we are going to have to go back and rerun the assessments, and we are going to have to rerun the sample problems.

But again from the perspective of the CSAU approach, we have to pick essentially what we would call a frozen code version within our system in order to be compliant with CSAU.

CHAIRMAN WALLIS: But this is why it is important to make sure that your formulations are correct, because there is an equation in your documentation which has a D-by-DX, and where I think it should be a D-squared-by DX-squared.

Now, that is in the equation. I don't know what is in the code, but maybe in the code there is a D-by-DX instead of a D-squared-by-DX- squared, in case there is a fundamental error in the code.

And I don't know what the consequences ares. They may be absolutely minor. But it means that there is something which is fundamentally wrong about a formulation which might conceivably be in this frozen code, and what do you do then? Do you go back and -- do you have to change it, or do you say, well, it doesn't matter, or what?

MR. O'DELL: Well, if we were to find -- and again we have gone through the verification process. Just based on the comments that we received on the documentation last time, we went back and took the documentation, and broke it up into sections, and assigned an independent engineer to go through each of the sections of the documentation to try to catch all of these issues with the equations.

Once we got it all put together, we hired an outside technical editor to go through the report, from front to back, and basically try to catch all of the English problems, okay? Now, I am not all that sure what else I can do with that.

CHAIRMAN WALLIS: Well, it's not just that. It's what do to do when you find an error, and how does this affect what you may call a frozen code and its assessment?

MR. O'DELL: Well, we have gone through a --

CHAIRMAN WALLIS: It is an embarrassing

position to be in, but I don't know what you do. I mean, you get yourself a bit like Arthur Anderson and ENRIN.

MR. O'DELL: Well, we have gone through a verification process on these codes, where we have had a number of people go through the codes, and we sectioned the codes up by model type areas and stuff, and had individuals go through the code.

CHAIRMAN WALLIS: We know that you have done all the good things, but what do you do when an error is discovered?

MR. O'DELL: Well, if you point out that there is an error in the documentation, we would go look at that documentation, and we would go and then confirm that in fact that is not in the code.

If it is in the code, we would then go run calculations and stuff to find out what the effect of that is, and quantify the effect, and then presumably we would fix the code.

CHAIRMAN WALLIS: Well, I have often wondered though, it seems to me that English is a pretty good language, and the equations we are very familiar with. But it would seem easier to check the written language in the equations than to check all those details of this arcane code.

So if there are errors in the equations, then one might suspect that the errors in the code would be greater.

MR. O'DELL: Well, I guess I have to somewhat disagree from that because we are using Word, okay? And Word knows more than the person telling it what to do.

CHAIRMAN WALLIS: So is it equation equivalent to what corrects the momentum if it doesn't like it?

MR. O'DELL: Well, it comes in and does things to you, and you print it out, okay? And I think we went through the process, and you are going to see some of it on some of these slides, and you will probably see a few things, and I think Bob's slides actually have some higher graphics in the proprietary statement than --

CHAIRMAN WALLIS: Well, let me ask the staff then, and the staff must face the same thing. If you find an equation that has an error in some term, the real question would seem to be is this a typo, or is it fundamental.

And if it is fundamental, then is it in the code. Do you actually look at the source code and check that the source code matches what the equation should be?

MR. LANDRY: Ralph Landry from the staff. The requirements for approved codes have been established since 1974, when 5046 and Appendix K were set out.

Whenever an error is found in a code, whether it is found by the staff or by a licensee, or by a vendor, the effect of that error must be assessed by the owner of the code. It must be documented, and fixes must be made.

Just because a code is frozen doesn't mean that it is frozen into perpetuity. If an error is found, it is fixed, and that is reported to the staff, and that code version then becomes the frozen version of the code.

There has always been a process in place for discovery, correction, and documentation, and approval of fixes to errors and codes, and that is independent of whoever finds the errors.

CHAIRMAN WALLIS: Well, I guess I want to be reassured that in the review process that somebody is checking that the code reflects the right formulations.

This is even more important than the fact that there might be typos in the equations, let's say, and even if the equations are perfect, they might be programmed in a way that doesn't reflect what is really there.

Someone -- I just hope that you guys do look at source codes, and check out suspicious or anything that you have reason to want to check out actually at the source code level, and see if this corresponds to what should be there.

MR. LANDRY: Part of what we are doing within this independent evaluation that I talked about a little earlier is looking at some variations within models, and in that process, if we identify something that is not clear to us, or that is suspect, we would bring it up with Framatome.

We are not going through the code itself, the source code itself, and looking line by line to evaluate it.

CHAIRMAN WALLIS: You don't have to look at every line, but I think you ought to do some -- there are some equations which have a lot of leverage in the answer, and someone ought to be checking to see if the code doesn't have a two instead of a three or something; something squared instead of something cubed, and it is very easy for that to be there.

MR. LANDRY: Well, yes, that is a part of what we are doing with this independent assessment, or this independent evaluation. Excuse me.

If in looking at these models we determine that a particular model is one that we would like to examine in detail, and would like to see the effect of this model, of course to examine it, we are going to have to go into the source code and make some changes to evaluate its importance.

And in that process, looking at what we determine to be interesting or important, we find that we don't understand, we will talk to Framatome and make sure that what we don't understand is because we don't understand, or because it is wrong, and proceed from that point. Does that answer your question, Dr. Wallis?

CHAIRMAN WALLIS: Well, I don't know, because I have yet to see an example of someone having discovered an error in the code, although I have seen oodles of examples of people discovering errors in written equations.

The implication would seem to -- well, there is no reason why the code should be purer, and less prone to error, than the equation.

MR. LANDRY: Well, we don't think it is. But there has been this process in place for years that if an error is found, it is corrected.

CHAIRMAN WALLIS: I know, but the process of going after the errors is really what I am after. I know that if you find an error that you have to do something, but you can carefully avoid finding errors by just not even looking carefully for them, and not find them, or whatever.

MR. LANDRY: It is not a matter that we are not looking carefully at what has been done. We are trying to focus our resources --

CHAIRMAN WALLIS: Someone is looking at the source code? You have to look line by line, and you have to figure it out, and you have to say how do they formulate, say, this energy conservation equation in a way which does not have errors.

I just want to be very sure that someone at some stage does that.

MR. LANDRY: But generally with these reviews, we don't take a code and start going line by line. We simply don't have the staff to do that.

CHAIRMAN WALLIS: Well, no, you can't look at all the lines, but there ought to be a random or some kind of a -- well, especially if there is -- well, everything depends upon the proper formulation, let's say, of conservation of mass energy momentum, and that is the basis of everything.

So there is a real reason to get that right, because if you get it wrong, and it is found out 10 years later, then it is very embarrassing and difficult.

MR. LANDRY: Yes, it is.

CHAIRMAN WALLIS: So if there is a real justification, and motivation to get it right, then I just wonder what steps are taken to make sure that there isn't some error at some fundamental level.

MR. LANDRY: We will be looking as I said at this independent evaluation at some models, and then we will be trying to look at some of the more important models, especially those --

CHAIRMAN WALLIS: So you haven't found or identified anybody who is going to audit the code?

MR. LANDRY: -- identified within the PIRT as important models, and going line by line.

CHAIRMAN WALLIS: Yes, going line by line, okay. Someone will audit line by line, at least occasionally, and with tenacity, and thoroughness?

MR. LANDRY: Right. And that's one of the things that Sarah will be doing for us.

CHAIRMAN WALLIS: Okay.

MR. LANDRY: Of course, we can't through

the entire code, but we will have -- it is just spot checking.

CHAIRMAN WALLIS: Would it be possible for the ACRS to get a look at some of these line-by-line things, or is that something which is not allowed?

MR. LANDRY: If what we find will be shared?

CHAIRMAN WALLIS: I mean, can we look at it? I mean, we look at the equations --

MR. LANDRY: Well, would you like to look at the source code itself?

CHAIRMAN WALLIS: I would hate to look, but I may feel obligation.

MR. LANDRY: I guess the question is are you asking to look at the code itself, or are you asking to look at the staff while it looks at the code?

CHAIRMAN WALLIS: No, I think the code comes as a whole lot of statements in some language.

MR. LANDRY: FORTRAN.

CHAIRMAN WALLIS: FORTRAN. So it might be possible for one of us to figure out what is going on, and there must be some pages of code which are not very long which describe, let us say, a momentum equation in FORTRAN.

MR. LANDRY: If you would wish to look at the individual source code --

CHAIRMAN WALLIS: Yes, it might be interesting to look at that.

MR. LANDRY: It would be possible for us to make that available.

CHAIRMAN WALLIS: Okay. So we may ask for it.

MR. LANDRY: I think it is possible.

CHAIRMAN WALLIS: And if we ask for it, it will happen?

MR. LANDRY: It's possible.

CHAIRMAN WALLIS: Okay. Thank you very much.

MR. HOLM: Dr. Wallis, if I could just say one thing. This is Jerry Holm. You are asking about what we do to devise a frozen code if it has to be changed.

I think if you let Mr. O'Dell go through the slides, he actually has an example of it, because we are going to acknowledge that we actually use two separate versions of the code in S-RELAP5.

And so I think it gives you an example that we went through a verification process, and we found something that needed to be changed, and we decided which part s of the assessment had to be redone.

So I think if you let Larry go through the slide in more detail, he will give you an example of what you are asking about.

MR. O'DELL: And I would also interject in this process, that as we went through the verification of the code, we documented that in what we call our internal calculation notebook process, and those are available obviously for the staff to audit at any time.

CHAIRMAN WALLIS: I know all the things that you have done and that you are going to talk about today, and it may well be quite possible for all of this to be done, and there is still to be a two instead of a one at some line, and which is not important.

MR. CARUSO: Dr. Wallis, I guess I can give you one example from -- well, I think about a year ago, where the staff did a review, and I think it was of TRACG, and we had some questions about neutronic method.

And one of the reviewers, Dr. Tony Ulsys, actually went into TRACG and looked at the details of the actual coding to try to understand why it was doing something, and he did not understand.

And I believe he actually modified it to see if he could make it do what he thought it should do. In the end, he understood why it was working the way that it was. So the staff does do this.

CHAIRMAN WALLIS: That's very good. That is reassuring.

MR. CARUSO: And I believe he made a presentation on that subject. The staff always has the ability to do that, and whether we do it depends on our -- what peaks our curiosity as I believe you would say.

And in this case we have someone, Sarah Colpo, who is going to do that. And I would offer that this way of doing things is something that we only started about 3 or 4 years ago when we started the RETRAN review.

And we intend to continue with it, but as Ralph Landry said, we don't intend to review every line of the code, and we don't intend to verify that every equation in the documentation has been accurately transcribed into the code.

We just don't have the resources for that, but we have curious people, and when they see something, it is their job, and I hold them to it, to figure out why things aren't the way that they think they should be. And I encourage them to ask probing questions.

CHAIRMAN WALLIS: Thank you. Sorry to hold you up.

MR. O'DELL: That's fine. With respect to the RODEX3A code version that we use, the UJUN00 in all fuel rod analysis, we did end up using as Jerry Holm indicated two versions of S-RELAP5 in the report of analysis, UJUN00, and UMAR01.

The UMAR01 included the additional of the final set of multiplication factors for the uncertainty analysis, and some corrections to the RODEX3A implementation in S-RELAP5. The RODEX --

DR. SCHROCK: Are those the only differences going from one version to the other, or are there other things that are modified as well?

MR. O'DELL: No, these are the things that were modified in going to this version of the code.

DR. SCHROCK: The only things?

MR. O'DELL: Yes.

DR. SCHROCK: I don't understand the meaning of this statement, the final set of multiplication factors for uncertainty analysis. What multiplication factors are there?

MR. O'DELL: Well, to apply the biases and the range of uncertainty on the parameters, you have to go into the code, and implement that. That is not already in the code.

So we had to go into the code and make changes to the code that allowed us to actually perform the statistical analysis.

MEMBER KRESS:: You put a coefficient on these, on some of the things --

MR. O'DELL: Right.

MEMBER KRESS:: -- that you can range.

MR. O'DELL: Exactly.

MEMBER KRESS:: What does the U stand for in there?

MR. O'DELL: I stands for what we call a use version, which is in effect a frozen version of the code that has gone through our software development process, and is now available once it is approved, available for people to use in the performance of licensing analysis.

DR. SCHROCK: But it seems inconsistent that you have RODEX version UJUN used for all fuel rod analyses, but then in the next bullet you have these other versions used for electric rods in some cases, and all nuclear rods in the other case.

So you really have three versions involved here.

MR. O'DELL: No, there is only one RODEX3A version. That is UJUN00. These are versions of S-RELAP5; UJUL00 and UMAR01, okay? They are two separate codes. You run the RODEX3A code, and it generates a file that then feeds into S-RELAP5, an electronic file.

And it provides the initial study state conditions for the fuel to start the S-RELAP5 calculations.

And we have implemented the models out of -- the necessary models out of RODEX3A into S-RELAP5, and it was when we went through the verification of that implementation that we found some difficulties with that implementation.

We then went in and corrected those, and then in the software development record for UMAR01, we ran a number, a fairly large number, of the electrical heater rod cases which should not have been impacted to prove in fact that they weren't impacted.

And we got the same results on the electrical heater rod cases between UMAR01 and UJUL00, and that is all documented in the software development record for UMAR01.

DR. SCHROCK: I see. Thank you.

MR. O'DELL: CSAU Step-9. I'm sorry, Step-5, involves providing complete documentation supporting the codes which must be -- and this documentation must be consistent with the frozen code versions.

We develop models of correlations documents, programmers guides, and user manuals for the frozen code versions, which I believe as Jerry indicated have been supplied.

We performed code verification to ensure consistency between the codes and the associated documentation, and this verification was performed with a combination of Framatome ANP and external personnel.

CHAIRMAN WALLIS: Does that seem to mean that there was an error in the documentation? It is also in the code.

MR. O'DELL: I again would say that that is not the case, okay?

CHAIRMAN WALLIS: Well, you don't really know. It is being performed by all these experts, and there is consistency between codes and documentation.

MR. O'DELL: Well, the task given to the people performing the verification was that they were to look at the equations, and the references that were given to those equations, and look at the implementation within the code.

Now, the fact that you end up with some of these errors in the documentation, as I indicated, every time you run the bloody things out again, I get a different result out of Word.

CHAIRMAN WALLIS: It never happens to codes. It happens with typing, but it doesn't happen with codes.

MR. O'DELL: Well, the word processor is what is giving us most of the grief in the documentation, okay?

DR. SCHROCK: I think IEEE has established standards for this verification process; isn't that true?

MR. O'DELL: That's true.

DR. SCHROCK: And do you use those?

MR. O'DELL: We used -- well, actually, there were several standards that we looked at. I think there is an ANS standard and there is an IEEE standard that we looked at. And we tried to conform to those standards.

DR. SCHROCK: Okay.

MR. O'DELL: One of the difficulties that you always have is that a lot of those standards are put together for use as you are developing the code. And since you are not developing the code from scratch, you sort of try to mash the two of them together.

CHAIRMAN WALLIS: The code has three different sets of units; and old English units, and SI units, and some other kinds of units all mixed up?

MR. O'DELL: Dr. Chow, I don't believe that is the case.

CHAIRMAN WALLIS: I think in the heat transfer correlations -- I am trying to think back because it has been a year or so ago, but some of them are formulated in SI units, and some of them are formulated in BTUs, and some have some kind of mixed thing. Is that right? Is that still the case?

MR. CHOW: This is Hueiming Chow. I think that we always use British units, and so anything that verifies a British unit, and most of the cases is that in the reader files SI unit.

But there are some provisions that there is only in the English unit, and we sometimes just didn't convert it. But still we use the original British unit, but in the course convert into the SI unit.

MR. O'DELL: Okay. And the verification consistent with going through the coding to ensure that the models in the documentation were actually coded, or were actually in the code, and were coded correctly.

This was performed on the RODEX3A code, and the S-RELAP5 code, including the ICECON models for the containment analysis. CSAU Step-6 is to determine the code applicability, and here you can form the presence of the code model for the important PIRT phenomena.

And verification to perform an S-RELAP5 and confirm the presence of documented models, and the presence of PIRT required conservation and closure equations were confirmed in S-RELAP5.

The code numerics were demonstrated through the code sensitivity studies, and the assessments and the sample problem analysis, and code ability to model selected NPP components were confirmed by comparison of the required NPP components and the code component modeling capabilities.

And in all cases the S-RELAP5 was demonstrated to meet the requirements, and this is documented in --

CHAIRMAN WALLIS: What were the

requirements?

MR. O'DELL: With respect to what, MPP components?

CHAIRMAN WALLIS: Well, it says demonstrate to meet requirements. Is it numerical to --

MR. O'DELL: NO, it is demonstrated to meet the requirements that in fact it has the appropriate --

CHAIRMAN WALLIS: About all of the things above?

MR. O'DELL: Yes.

CHAIRMAN WALLIS: By the requirements you mean to confirm the presence of; is that what you mean by meeting requirements?

MR. O'DELL: Yes. Basically what I mean is that it has conservation and closery equations, and it is able to stable the code from the numeric standpoint.

CHAIRMAN WALLIS: Okay. Thank you.

DR. SCHROCK: The application of the code allows a fairly wide range of user options. How is that controlled in the use of the code in this application?

MR. O'DELL: Okay. Well, the way that we

control it within our system is that we put together a series of guidelines that say how you will model the plant, and what the options and stuff are that you are going to turn on in the code, and how the code is to be applied.

We provided, I believe, a guideline in the documentation that you have for both the development of the input deck, and for the execution of the analysis.

DR. SCHROCK: There are such things even as multiple correlations for the same phenomena, and they select different ones.

MR. O'DELL: And I believe --

DR. SCHROCK: And there are such things as critical flow models, and Appendix K application, and other things for realistic applications. The things are in the code, but how do you assure making the code as exercised for this purpose as regulated to use the right selection?

MR. O'DELL: Well, for example, in the critical flow, we use the HEM model, and it is stated in the guideline that they use the HEM model for the analysis.

And the way that we go through the process is one engineer will run the sets of calculations following the guideline, and a second engineer will come through and do a quality assurance QA review.

And part of that process is to look at the guideline and make sure that the analysis engineer in fact used the requirements and met the requirements of the guideline.

So that is the way that the process is controlled at Framatome.

DR. SCHROCK: That is a fairly important aspect of the application, and I would think it would be natural to describe it in some detail in the documentation.

MR. O'DELL: Right. And like I said, I believe, too, that we provided two guideline; one for the development of the input model, and the other for running the analysis.

DR. SCHROCK: Okay.

MR. O'DELL: Okay. Now we are moving into CSAU Element 2, which is the assessment ranging of parameters. CSAU Step-7 deals with the selection of the assessment matrix, which consists of a series of separate and integral effect tests.

These tests much support the code evolution of the important PIRT phenomena, and defined as those phenomena ranked five or higher in the PIRT.

Must provide validation of the selected NPP nodalization, and must support the demonstration of the code's scalability from experimental facilities to the NPP; and must support demonstration that even if compensation errors exist in the code, the code is capable of reliably predicting the selected scenario.

For all PIRT phenomena ranked five or higher, a series of --

MR. BOEHNERT: Are you going to discuss how you deal with compensating errors?

MR. O'DELL: Only from the standpoint that if you look at the various assessments, and the range that was done on the assessments and stuff, that if there are compensating errors in it, it is shown to exist across the range, and that we get reasonable results.

We have tried to rely heavily on the larger assessments, both separate effects in particular, and we have used the UPTF for essentially everything but the core, because it has full size vessel for the downcomer lower plenum and upper plenum type arrangements.

We have relied heavily on using FLECHT-SEASET, CCTF, and as I mentioned earlier, to a lesser degree, SCTF, and THTF for the core type regions.

So we have tried to ensure that we had full height in the core, and we have looked at various different sizes radially, including the slab that runs all the way out through the slab cut core, and slab core test resulting.

So we tried to do that primarily though the choice of the assessments that we have run. And in the sensitivity analysis, we ran over 250 analyses performed using the 3 and 4 loop NPP models.

We classified the results of these sensitivities as basically high, medium, and low. And based on the results of the sensitivity studies, we determined -- we picked experimental facilities, and specific tests to cover those phenomena.

And we also sent some of the phenomena or what is listed in the PIRT as phenomena as actually determined by the plant. We identified the required plant data to support those parameters.

DR. SCHROCK: So you do this for more than one plant type?

MR. O'DELL: Yes, we ran the sensitivity studies on both the four loop and three loop problems, and we ran them at different powers to drive the PCT up closer to the limit of twenty-two hundred.

We ran a set of cases up there for both

the 3 and 4 loop, and then we ran them at the more nominal conditions. The thinking process there was that if you -- you know, you may see somewhat different sensitivities if you are running it like 1,800 degrees than you would see if you were running the model at more like 2,000 to 2,1000 degrees.

DR. SCHROCK: Don't you dilute the purpose of the thing by trying to cover more than one plant? I thought the idea was to select a particular plant, and a particular code, and then go to work on applying that calculation?

MR. O'DELL: And what we did in relationship to that is we basically built one for the four loop set of important phenomena ranked by importance.

That is, magnitude of the sensitivity; and for the four loop plant, and for the three loop plant, and then we basically said, okay, if it is important to any of these plants, we are including it, okay?

And so that is the way that we handled the differences in the plant types. You do see somewhat different sensitivities between the plant types, and we have gone in and directly made sure that we have covered them.

Okay. Having looked first at the

assessment matrix at the important PIRT phenomena, the second thing we looked at was the nodalization, and based on the assessment matrix generated from the PIRT, the only added thing was the SCTF, which gives us the slab running out regularly through the core.

And we picked assessments there with a radio power distribution that would allow us to confirm that the code is able to handle that. With respect to scaling considerations, the assessment matrix generated for the PIRT covered a scaling range from 1 to 1500. and 1 to 1.

We did go in and try to pick a counterpart LOFT and semiscale interval effect test to specifically support the scaling analysis, and it was 023 in the LOFT, and S06-3 in the semiscale test.

With respect to compensating errors, these occur if an when an error in one code model is compensated for by an error in an other code model. This may result in the code being able to predict some assessments, but not others that produce different results in the assessments in the NPP calculations.

This was addressed by including integral effect and large scale separate effects tests as I indicated in a previous statement, where we looked at the FLECHT and FLECHT-SEASET, and SCTF, and CCTF, and

THTF for the core phenomena.

And we used the UPTF for most of the other MPP components, which is a one to one test. And then we used LOFT and semiscale for the interval large break LOCA scenario evaluation.

CHAIRMAN WALLIS: Why does that resolve the compensating error question?

MR. O'DELL: Well, as we are going through developing the uncertainties and stuff, and we are using those assessments which are basically full scale in an axial direction for the core, and full scale components here for the development of the UPTF component variations, it sort of gets around the issue of does it scale from the bottom up.

And it also by looking at the LOFT and semiscale, you have got the two integral tests at the smaller scales. So by including a wide range and by concentrating our efforts up here, we have tried to reduce the potential impact of the compensating errors if they exist.

The final assessment matrix included the THTF facility, where we had 35 heat transfer tests that we looked at, and three level swell test for the void distributions.

I think we looked at the G-level swell in the FRIGG-2 test as I previously mentioned, again to look at void distribution predictions. We looked at the Bennett tube, and the heat transfer and spacer effects, and FLECHT-SEASET, where we looked at heat transfer, and did some nodalization studies.

And axial power distribution scalability, and upper plenum and hot leg entrainment. We used some of our own tests in the PDTF/SMART facility, where we looked at the impact of different types of spacers, looking at our HTP specific design and mixing vain spacers.

We used the Marviken test, 9 test, to examine the break performance of the code for break flow.

DR. SCHROCK: There were no separate effects tests involved in this kid of thing really, huh?

MR. O'DELL: We would define all of those just mentioned as separate effects tests.

DR. SCHROCK: Well, I wouldn't. For example, Marviken is a blow down experiment, and the credibility of the critical flow calculation depends on the code's ability to calculate what is happening in the vessel.

There are many, many controlled laboratory experiments, separate effects, that can be used as well. But it has not been the practice in this industry to do that. There are selected few tests which are conventionally chosen, and the arguments are that these are sufficient.

Nine tests to cover the full range of critical flow phenomena is very sparse. Marviken had more than nine tests.

MR. O'DELL: Again--

DR. SCHROCK: And that, together with the other point that I made, that there is a wealth of controlled laboratory separate effects experiments on critical mass flow over a wide range of upstream conditions, and conditions which exist throughout parts of the transient in these reactors.

So what you have for assessment is extremely sparse, and that is just one example.

MR. O'DELL: Well, I am not going to argue that point.

DR. SCHROCK: Well, CSAU is not the place where all these additional things need to be done, but they have not been done at any level.

MR. O'DELL: Well, it has been the biggest problem that we have had in this whole process, was actually getting data, okay? Our original plan was to use a significantly larger number of the Marviken tests.

We were able to get data for nine, okay? It has been -- and as I indicated --

DR. SCHROCK: I know. It is a real world problem. I understand that.

MR. O'DELL: Yes. Just trying to get this information has impacted us from the very beginning of this project, and all the way through, and has basically delayed the project by significant amounts of time, just because we didn't have enough data to in fact feel like we could comfortably generate uncertainties and things.

So I realize that there is a lot more data out there, but it is a matter of getting the data, and accumulating it, and we have started. We have got our libraries built up in our own control system, data management system that we have there at Framatome.

And as we get this data, we are continually trying to get more of it, and we are trying continually to enter it into our database and build up a database so that future work will have the data available when we start.

Right now, we are working at trying to get some of the BWR data that is available out there to support our BWR project that is initiating this year. And I have said that it is not an excuse. We are just trying to get the data, and we use what we are able to get our hands on.

CHAIRMAN WALLIS: Now, somebody later is going to go through the results of this assessment process?

MR. O'DELL: There will be some limited comparisons in the assessments, and Gene Jensen will present the integral effects test. And as I will mention later, we use those integral effects tests to first run them, and we then calculated biases from all the other tests.

We reran the integral effects tests, and the CCTF test, applying those biases to demonstrate that those biases in fact moved the model as expected.

CHAIRMAN WALLIS: So someone is going to explain this process of assessment later on today?

MR. O'DELL: Yes.

CHAIRMAN WALLIS: When I looked at the 200 plus figures in Section 4, and I don't quite know what to conclude. And sometimes the comparisons are good, and sometimes there are questions that one might have.

And I didn't quite know what to conclude in general, and you are going to guide us, or someone is going to guide us through that?

MR. O'DELL: I don't think we are going to go through every one of them in a high level of detail.

CHAIRMAN WALLIS: Well, tell us how you did this in the comparisons and assessments.

MR. O'DELL: Right.

CHAIRMAN WALLIS: And what criteria you used and so on.

MR. O'DELL: Okay. Continuing on with the assessment matrix, we used the Westinghouse EPRI one-third scale nine test, and we looked at cold leg condensation and interfacial heat transfer.

Again, we performed some of the CCFL tests in our own mini-loop there at Framatome, where we looked at the upper tie plate designs, and our own specific upper tie plate designs for the different types of plants that we were supporting.

We then looked at the multi-dimensional flow, and these as I mentioned were Westinghouse tests. We looked at three of these, and where we looked at the performance of the code for predicting the core flow distributions.

We looked at 14 tests in UPTF, and we looked at ECCS bypass, and steam binding, and CCFL, and scalability, and nodalization. With CCTF, we looked at those --

CHAIRMAN WALLIS: Four CCTFs, and UPTF, I noticed the data was sort of on one line, and your equation is on another, and it is not clear that the comparison is very good, to make one statement about it.

MR. O'DELL: And in fact they were fully intended to be -- the selected parameters were fully intended to be conservative from a CCFL perspective. And the reason that we did that, and I will mention that on one of the slides, is that we didn't have sufficient information to determine what the actual CCFL was on all of the different assessments.

So what we did is that we went and picked a series of conservative ones, and then we ran these tests, the CCFL tests, to demonstrate that they were conservative for our fuel designs and we used that consistently through that.

CHAIRMAN WALLIS: It is supposed to be a realistic code, and not a conservative assessment isn't it?

MR. O'DELL: I understand that, and I would say that in some of the instances -- I mean, I used the same sets of CCFL coefficients in all the assessments to generate my uncertainties and stuff, all right?

And if I would have been able to generate CCFL parameters, or add information for CCFL parameters for all of the assessments, then I could have used real information in all of the assessments, and developed uncertainties.

But given that I couldn't do that, I felt that the only approach that was actually defendable was to choose conservative ones, and then demonstrate that they were conservative, and use those throughout the CSAU assessment.

CHAIRMAN WALLIS: That means that for a bias in here that your values are always less than or greater than the real one, instead of trying to model the real one.

This has to be somehow reflected in your statistical treatment of uncertainties later on then. There is a bias in your CCFL for being somewhat on the conservative side.

MR. O'DELL: They will be somewhat on the conservative side. Now, we have not tried to try to quantify that, or take any kind of credit for it, for reducing PCTs. We just accepted that conservatism.

And I think when we get to Gene's

presentation, you will see that the biases and stuff that we did develop moved and improved the assessment results as one would expect, but in general we can still be somewhat to the high side.

MR. HOLM: Dr. Wallis, this is Jerry Holm. I think this is an important point, because I think as we mentioned in one of our previous meetings, we chose the word realistic, trying to differentiate ourselves from a true best estimate code.

We found that there are a number of phenomena datasets that there just is not enough information to develop models, and so for those we tried to choose conservative models, and in the presentation today, we will list where we had made these decisions to not best estimate models like Larry will state in his presentation later.

And to try and identify so that it is clear where we are not best estimates. We need to acknowledge that in our areas where there are not best estimates.

MR. O'DELL: Okay. We ran four CCTF tests, and steam binding, and again nodalization, and scalability. With SCTF, we ran six tests, but we actually only used the ones that confirmed our nodalization.

Again, that was primarily getting the data late. We ran one ACHILLES test, and that is the international standard problem number 25, where we looked at the accumulator nitrogen discharge effects.

DR. SCHROCK: Do you have any separate effects testing of the models in the code for this two component case?

MR. O'DELL: Well, the two component case was used, or the two component model was used throughout the modeling on the UPTF. It was used to model the UPTF downcomer, and upper plenum. So we have used that model throughout these.

DR. SCHROCK: To react to this accumulator discharge --

MR. O'DELL: There is no 2D model, and we don't use a 2D model on the accumulator discharge.

DR. SCHROCK: And that is simply the accumulator discharge into the primary system and not its interaction within the primary system?

MR. O'DELL: Beyond the entrance point?

DR. SCHROCK: I just don't remember what ACHILLES really involves. It is just simply the blowdown of the accumulator?

MR. O'DELL: Right. It is simply a blowdown of the accumulator, where they measure the effect of the nitrogen coming in, and what happens in the core with respect to the temperatures and predictions in the core.

DR. SCHROCK: It doesn't deal with the role of the nitrogen in the primary system, and its influence in the subsequent part of the transient when the discharged containment involves two components, and that is not modeled in that test?

MR. O'DELL: Well, it is modeled from the standpoint that you have got the accumulator water blowing down, and you blow down the nitrogen, right.

I mean, the ACHILLES test actually has the nitrogen blowing down into the system, okay, blowing down into the ACHILLES system. And we modeled that to demonstrate the code's performance with respect to the treatment of the nitrogen.

And as I previously indicated, we ran integral effect tests for LOFT and semiscale. There were four tests run, where we looked at overall code performance, and nodalization, scalability, and compensating errors.

Again, semi-scale, we ran two tests, and one for the blow-down heat transfer, and the other one for nodalization scalability and compensating errors.

Overall, we looked at like 15 separate

effect facilities, and 130 tests; and two integral effect facilities, and two IET facilities, and 6 tests evaluated.

CHAIRMAN WALLIS: Well, I think you can look at the first three of those -- the scalability, nodalization, and overall code performance; but I don't know quite how you would assess compensation errors.

You can say that we didn't find anything that was a clue that indicated that there might be.

MR. O'DELL: Right.

CHAIRMAN WALLIS: It didn't see this sort of strange performance where it did a good job here, and not a good job there, and we couldn't explain why or something. But it is difficult to really pin down whether or not you have compensating error.

MR. O'DELL: No, and that's exactly right, and I don't think that any of us here is going to take the position that there are no compensating errors in the code.

CHAIRMAN WALLIS: You have sort of an awareness that you are looking for the signs that there might be something.

MR. O'DELL: Exactly. Moving now to CSAU Step 8. This deals with the nodalization, and we selected a common nodalization for use in the SET effects and IET effects, and plant analysis.

The nodalization has to be selected to preserve the dominant phenomena, and minimize the code uncertainty, support the NPP design characteristics, but at the same point in time it has to remain economical.

You have to be able to run a significant number of calculations with that code in a reasonable period of time. If you can't do that, then you can't respond to plant questions, et cetera, and in order to support a plant, you have to be able to run it in a reasonable period of time.

CHAIRMAN WALLIS: Well, to minimize code uncertainty is -- well, how do you show that you have done that?

MR. O'DELL: Well, what I really mean there when I say minimize code uncertainty is to minimize the code numerical uncertainty. As you will see when you look at the thing, we did a series of -- if you look at the submittals, we did a series of time studies with the code, where we actually went in and varied the time steps, and ran a series of cases, and looked at how the range varied in the results.

And what I am saying is what we are trying to minimize here is that numerical uncertainty by choosing the nodalization approach that in fact does minimize that.

CHAIRMAN WALLIS: So there is a way to minimize that? If you have, say, one unfamiliar of an uncertainty, and a zillion node elements adding up to some optimum number of nodes that minimizes the uncertainty.

MR. O'DELL: Well, I am not going to say there is a optimum number of nodes, okay? One of the things that we found, and as you look through it, you will see in UPTF that we did a nodalization study on the lower plenum, okay?

And what we found is that if we used a 2-D component down there, we improved our results compared to the assessment, but what we did is that we hurt the prediction of the code uncertainty in this time step study, all right?

So what that told us is that by going to that level, and to an increasing level of complication in the lower plenum, it actually didn't help us in regard to this particular piece of it.

I mean, it is a balancing act, and that's why I think Dr. Schrock's comments on these guidelines are very important, because we have to state how we are going to apply the code.

And if we don't state that, then we don't minimize things like the code to uncertainty. We don't control those. The process we followed was to start off I think, and previously referred to as tribal knowledge, but we developed our initial nodalization on previous industry and Framatome-ANP experience.

We then ran a series of sensitivity studies using the plant models, where we revised this initial nodalization. We then held a peer review again, including Framatome and outside consultants, and where we looked at the nodalization and developed again some revisions to that nodalization.

And the final nodalization that we came up with was validated and refined based on the performance of the actual SET and IET assessments, with heavy emphasis on UPTF, and SETF, and CCTF, and FLECHT-SEASET, LOFT, and semiscale.

The key features of this nodalization and where it was primarily different than what we have done in the past involved the use of the two dimensional component, and the downcomer core and upper plenum regions.

CHAIRMAN WALLIS: Are you going to become proprietary at this point?

MR. HOLM: Yes, I was just going to mention that. This is the last of the nonproprietary information.

CHAIRMAN WALLIS: Would this be a good time to take a break?

MR. HOLM: Yes.

MR. O'DELL: Well, it definitely works for me.

CHAIRMAN WALLIS: I am very impressed with your resilience and ability to keep going in spite of all of our interruptions.

MR. O'DELL: Thank you.

CHAIRMAN WALLIS: Just to check, are we running behind here? I don't see a schedule of timing, but is this supposed to be for most of the morning?

MR. HOLM: This is Jerry Holm. I think we are in reasonable shape. I would like Larry to finish number 11, I think.

CHAIRMAN WALLIS: So we have another speaker before lunch?

MR. HOLM: Yes.

CHAIRMAN WALLIS: And so let's take a break, and I think it would be good if we came back here at 20 minutes before 11:00. Is that adequate for everybody? So we will take a break until then.

(Whereupon, the open hearing was recessed at 10:30 a.m.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: ACRS Thermal Hydraulic Phenomena Subcommittee

Docket Number: (Not Applicable)

Location: Rockville, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Pippa Antonio

Pippa Antonio
Official Reporter
Neal R. Gross & Co., Inc.