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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

NOVEMBER 28, 2001

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)
THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE

+ + + + +

WEDNESDAY,

NOVEMBER 28, 2001

+ + + + +

ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory
Commission, Two White Flint North, T2B1, 11545
Rockville Pike, at 8:30 a.m., Graham B. Wallis,
Chairman, presiding.

COMMITTEE MEMBERS:

GRAHAM B. WALLIS, Chairman

THOMAS S. KRESS

F. PETER FORD

GRAHAM M. LEITCH

WILLIAM J. SHACK

VIRGIL L. SCHROCK

PAUL A. BOEHNERT, Staff

RICHARD LOBEL, Staff

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1 ALSO PRESENT:
2 STEVE BAJOREK
3 HARV HANNEMAN
4 ROBERT HENRY
5 JOSEPH M. KELLY
6 NORM LAUBEN
7 JOHN MAHAFTY
8 JOE STAUDENMEIER
9 MIKE TESTA
10 JENNIFER L. UHLE
11 TOM ULLSES
12 WEIDONG WANG

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A-G-E-N-D-A

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

(8:32 a.m.)

CHAIRMAN WALLIS: This is a meeting of the ACRS Subcommittee on Thermal-Hydraulic Phenomena. I am Graham Wallis, the Chairman of the Subcommittee.

Other ACRS members in attendance are Peter Ford, Thomas Kress, Graham Leitch and William Shack.

ACRS consultant in attendance is Virgil Schrock.

The purpose of this meeting is for the Subcommittee, firstly, to continue review of the NRC Office of Nuclear Regulatory Research Activities pertaining to thermal-hydraulic phenomena in support of the ACRS annual report for the Commission on the NRC Safety Research Program.

And secondly, discuss a proposal by the licensees of the Point Beach and Beaver Valley plant to perform more realistic analysis of the containment design basis accident EPRI/MAAP code.

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

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

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1 The rules for participation in today's
2 meeting have been announced as part of the notice of
3 this meeting previously published in the *Federal*
4 *Register*, November 15, 2001.

5 Portions of the meeting will be closed to
6 the public as necessary to discuss information
7 considered proprietary to the electric power concerns.
8 A transcript of this meeting will be kept. And the
9 open portions of this transcript will be made
10 available, as stated in the *Federal Register* notice.

11 It is requested that speakers first
12 identify themselves and speak with sufficient clarity
13 and volume so that they can be readily heard.

14 We have received no written comments or
15 requests for time to make oral statements from the
16 public.

17 Now, our hope as a Subcommittee is that
18 today's meeting will be the highlight of the year as
19 we hear about all this great work which is going on.

20 I call upon Jack Rosenthal to get us started.

21 MR. ROSENTHAL: Thank you. I'm Jack
22 Rosenthal. I'm the branch chief of the Safety Margins
23 and Systems Analysis branch in the Office of Research,
24 and I just have some introductory remarks and then, as
25 you can see from your agenda, Jennifer will talk about

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1 applications, Jennifer Uhle. And then Joe Kelly about
2 code consolidation and Steve Bajorek about our
3 experimental program, and I'll get help from much of
4 the other staff.

5 But I wanted to make some introductory
6 remarks in a few areas. The easiest one is that we've
7 accumulated a fair amount of hardware now, and so at
8 least the capability to run the codes. And we're
9 proud of a new PC cluster that we're doing in CFDR.

10 The next thing, more important, and I
11 don't want to embarrass my staff, but we have now in
12 fact I think a world premier staff of people that have
13 come on board, and several recent ones.

14 Joe Kelly was at the NRC and has returned.

15 Steve Bajorek was at Westinghouse in
16 Kansas State and is now with us.

17 Joe Staudenmeier and Tony Ullses were in
18 NRR and have joined us.

19 Chris Murray was at Penn State and has
20 joined us.

21 And so we have a staff that's now capable
22 of analyzing experiments, developing the codes and
23 doing the safety analysis. And we should be proud of
24 the staff.

25 In terms of products, okay, we are using

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1 our codes to make regulatory decisions. We're using
2 MELCOR to come up with a source term for 50.44,
3 combustible gas control.

4 We're using RELAP and TRAC to modify 50.46
5 ECCS.

6 There was another subcommittee out of OSU,
7 and you heard that we're using RELAP and CFD and REMIX
8 to do PTS.

9 We're using RELAP SCDAP to do steam
10 generator high temperature severe accident work, and
11 you had a separate briefing on that.

12 We did some work on combined injected rod
13 LOCA as part of the CRDM issues, and we used RELAP and
14 PARCS and for AP1000 we'll be using RELAP and TRAC.
15 For our work on synergy we're going to be using TRAC
16 and PARCS.

17 So we're actually using these codes to
18 make regulatory decisions, and that's very healthy.
19 And much of that work is being done in-house, and
20 that's very healthy.

21 The last point that I wanted to make is
22 that in prior years it was typical to have a vendor
23 come in with some calculations and what we would cause
24 our contractors to do some calculations to check
25 vendor calculations. But the regulatory decision, to

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1 a great extent, was based on what the vendor came in
2 with. But for changing the rules, we're looking at
3 this synergy issue or the objective art issue. These
4 are safety issues that are before us. And we're using
5 our analysis to make those regulatory decisions. We
6 don't have a vendor to balance this stuff off against,
7 except in the AP1000 case. And that puts a greater
8 burden on us.

9 The entire Office of Research is paying
10 far greater attention to QA than it did in the past,
11 because we're using this for regulatory decisions and
12 we're trying to do the code development and
13 configuration management, etcetera, to modern
14 standards in support of those regulatory decisions.

15 It's the first time that somebody gave me
16 a microphone. I didn't realize I talked softly.

17 With that short introduction, I'd like to
18 turn it over to Jennifer for about an hour -- Jennifer
19 Uhle who is the assistant branch chief now in our
20 branch.

21 MS. UHLE: We're going to do something a
22 little different. Usually we talk about the status of
23 our code development efforts and then talk a little
24 bit about applications. But I think you guys are
25 tired of hearing it in that order, so today I'm going

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1 to start off with what we're currently using our tools
2 for. The question gets asked what do you use the
3 codes for; they're, of course, time-consuming to
4 develop and we have an invested effort in that. And
5 so we're going to be answering this question for you,
6 hopefully.

7 So I'm just going to talk a little bit
8 about the branch mission, the current uses of the
9 codes at NRC. You know, the current applications we
10 have for licensee submittals, generic issues, risk-
11 informing regulation, design certification. And we
12 just draw the conclusion that you'll find on the
13 summary side now, and that is that you do utilize the
14 codes, they are used at NRC for field application.
15 And it is our goal to continue to improve this
16 analytical capability to respond to these emerging
17 issues.

18 We always discuss about the consolidation
19 effort. That effort, of course, sometimes gets in
20 trouble for the fact that we are not making
21 improvements to the physics as quickly as some people
22 may want. And I just want to focus or make the
23 statement that we are consolidating first, we are
24 making improvements as we need to respond to these
25 applications as they arise. But by the end of 2002

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1 we'll be in a prime position to have one code. At
2 that point in time we'll really focus on improving the
3 physical models and as well as the very detailed
4 developmental assessment. And Joe Kelly and Steve
5 Bajorek will be discussing that further.

6 I'm going to skip over this, because I'll
7 do that on the summary side, but Jack Rosenthal had
8 pointed out that we do have five recent hires that
9 have really added to the capability of the branch, and
10 you'll be hearing from them.

11 MEMBER LEITCH: Jennifer, maybe it's
12 obvious, but I'm not sure I understand. What is the
13 advantage of a consolidated code?

14 MS. UHLE: We used to have four thermal-
15 hydraulic codes. And we used RELAP for PWR small
16 break loss of coolant accidents and transients. We
17 used the TRAC-B code for large break loss of coolant
18 accidents for PWRs. We used the TRAC-B code for BWR
19 applications that only required one 1-D kinetics. And
20 then we used the Ramona code for places that required
21 3-D kinetics capabilities. And because of that each
22 of these codes have very similar features. They're
23 not that different, and so we had a lot of maintenance
24 points; that wasn't an efficient way to operate. It
25 was more costly than it needed to be. So when we

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1 needed to make improvements we, in a sense, had to do
2 it four times over. So improvements weren't made as
3 fast.

4 Additionally, the user base was
5 distributed across these four codes. So, again,
6 instead of moving forward we were sort of moving in
7 parallel and not making improvements as fast as we
8 would have liked.

9 Additionally, each of the codes had a
10 different input deck. And so when you're looking at
11 maintaining these large input decks, these very
12 complex models, you would have to do it for two
13 different inputs, because the PWRs would use RELAP and
14 TRAC, the BWRs would use Ramona and TRAC-B. So it
15 just wasn't an efficient way to proceed, especially
16 with the budget reductions and the fact that we wanted
17 to bring the technology in-house and have in-house
18 staff to develop and maintain and use the codes for
19 the regulatory applications.

20 So that was the decision to go with the
21 consolidated code. And what we did is we selected
22 TRAC-B as the base of that consolidation, and we
23 modernized it so it's a new architecture. It's very
24 easy to modify, very easy to extend to other
25 applications and to couple to other tools like a CFD

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1 code. We haven't done that yet, but this is where
2 we're heading.

3 And what we've done is we've just taken
4 the features that were in the different codes, all of
5 the four different codes, and we've only taken the
6 different things that the other codes could do and
7 brought them into TRAC-B. We now call it TRAC-M
8 because it's modernized, and we're trying to find a
9 name for the code. It's a very sore subject.

10 MEMBER LEITCH: And this will be
11 consolidating code that NRC --

12 MS. UHLE: Yes. Yes. It's in-house
13 expertise. We work with contractors. Gil Actess is
14 in the back of the room. He's at ISL, Information
15 System Laboratories. John Mahafy is Penn State
16 University. He was an original developer of TRAC-B at
17 Los Alamos. He's at Penn State now. He is our
18 numerics guru. And Tom Downar at Purdue University is
19 working on -- is more of the original developer of the
20 PARCS code. Now we don't use the code as stand-alone
21 in PARCS; we've coupled just the kinetics routines to
22 TRAC. So it's a modular, so it's the PARCS modular.
23 But, again, we work alongside of the contractors, the
24 staff does, and we've really developed in-house
25 expertise. Tony Ullses is now starting to do PARCS

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1 development so that we can rely more on in-house staff
2 and rely on contractors for specialized skills, so
3 it's not part of the staffing plan to have a full-time
4 employee on one of those particular skills.

5 MEMBER LEITCH: Now, when I think of the
6 consolidated code, I think in terms of simplicity and
7 efficiency. That raises sort of the feeling that
8 maybe there's some compromise of precision for the
9 individual codes, a specific code for Bs and Ps and
10 small break. large break and so forth. Is any of that
11 precision compromised?

12 MS. UHLE: That was a concern. I think
13 Dr. Shack is of that mind. I think that Dr. Zuberg
14 was of that mind as well. And the bottom line is we
15 just couldn't continue to operate that way. We
16 couldn't make any more improvements to the codes
17 because we were spending all of our resources on
18 maintenance. And so as these issues were identified,
19 we just didn't have the staff or the budget to be able
20 to make the changes. So in a perfect world maybe that
21 would be the best way to go, if you had infinite
22 resources and infinite time.

23 So the consolidation plan is that we are
24 forming the consolidation activities. We can read all
25 of the input decks from all the other codes, so we've

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1 recovered the input decks. And at this point or
2 shortly we'll be starting the developmental assessment
3 phase. And for the targeted applications of each of
4 the predecessor codes, we will be comparing the
5 results of the modernized code to the other codes to
6 make sure that we're as good as the other codes for
7 those applications.

8 And the way that the architecture is set
9 up, it's really the physical models; wall drag,
10 interfacial drag, interfacial heat transfer, et
11 cetera. Those are the points that made the codes
12 different. And, for instance, the solution of setting
13 up the numerics, solving the matrix, performing input
14 processing, performing or exporting the answer to a
15 graphical tool; those are all common things. So
16 really the only big differences between the codes is
17 the physical models. The architecture of the
18 modernized code is allowing us to do component-
19 specific physical models.

20 If I'm a pipe, I'm going to use this
21 interfacial drag, this wall drag. If I'm a channel
22 component in a BWR; okay, now I have a rod bundle
23 there, the interfacial drag is going to be different
24 than it would be in a pipe of the same hydraulic
25 diameter. So because of the architecture it's set up

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1 to very easily incorporate component specific physical
2 models which will allow us to be as good, and then
3 eventually better than the old codes. So we're
4 accommodating that concern.

5 We have to prove that to you, but that is
6 our goal.

7 CHAIRMAN WALLIS: Of course, you're also
8 checking that this pipe really is a pipe and isn't a
9 pump because --

10 MS. UHLE: Yes, of course.

11 John wanted to say something. John
12 Mahafty.

13 MR. MAHAFTY: This is John Mahafty.

14 I'd just like to make a comment. I've
15 been kicking around with computers since they took up
16 the whole room and they had the kind of computer power
17 you have in your watch right now, and I understand the
18 concerns about efficiency from that kind of ancient
19 perspective. But the fact is now memory on computers
20 is massive and it's cheap. Disk space on computers is
21 massive and cheap. So that it doesn't matter to me if
22 I've got a large code with a bunch of special
23 subroutines for interfacial guide and BWR and another
24 set for interfacial drag and PWR core; if I'm running
25 BWR, that stuff never gets swapped in where the action

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1 is, which is your real local memory on your chip. It
2 sits out somewhere and gets swapped into virtual
3 memory. It's not impacting you from the standpoint of
4 the efficiency of operation of the code, but it's
5 there when you need it and it's tied together with all
6 these things that everybody needs to make the
7 maintenance and the improvement of the package
8 important. And things don't get overlooked as much.

9 Now I can remember the old days. It used
10 to drive me nuts. We'd find some problem with TRAC-E
11 and we knew that it was an important issue that the
12 people in BWR side, maybe we only had five of them
13 looking at it and communicating that and getting all
14 of this information to run off, it would sometimes
15 take years. But now it's in one place and there are
16 people thinking about it as a whole, so you don't lose
17 improvements that are applicable to everything, and
18 it's a big advantage.

19 MR. ROSENTHAL: Let me do a follow-up
20 then, if I may. And, John, you're absolutely right.
21 Every time we turn around, of course, it's a tenth of
22 what it did before for more horsepower, computer
23 horsepower. But people are expensive, and it takes
24 over a staff-year to create an input deck, one of
25 these really big input decks. And so you really gain

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1 some efficiencies by being able to use decks that were
2 previously created or have common decks for purposes,
3 etc.

4 So I think we're really going to achieve
5 some efficiencies.

6 MS. UHLE: I just want to add to the idea
7 of taking a year to develop a plant deck, and that was
8 again in Jack's old time frame, in the olden times, in
9 the time of the dinosaur. That's how long it used to
10 take.

11 I'll be doing a bit of a presentation on
12 the graphical user interface, which we've also
13 recognized the inefficiency associated with plant
14 modeling and feel we have a program to handle that.
15 We've demonstrated that before to the ACRS, but I'll
16 be touching on some of those points that I think bring
17 that to light, that we have improved the efficiency of
18 the plant modeling.

19 MEMBER SHACK: Just out of curiosity.
20 What language have you settled on? I mean, these were
21 originally --

22 MS. UHLE: Fortran 90.

23 MEMBER SHACK: Fortran 90.

24 CHAIRMAN WALLIS: Well, the plant modeling
25 involves people looking at a lot of drawings and then

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1 turning this into computerese. I would think with a
2 new plant and the plant is already a computer model
3 before it's even being built and you don't have that
4 problem; having to look at drawings and figure out
5 where the pipes go and --

6 MS. UHLE: You're assuming that we
7 communicate to the licensee.

8 CHAIRMAN WALLIS: Well, if that's the
9 problem, you need to fix it.

10 MS. UHLE: At this point that is something
11 that we have thought about, being able to scan in
12 something from the architectural engineers.

13 CHAIRMAN WALLIS: That's the way that
14 industry does it.

15 MS. UHLE: Right. Right. Well, they
16 don't build an input deck by scanning in the graphics
17 --

18 CHAIRMAN WALLIS: But in the automobile
19 industry, if they want to get a piece from a supplier,
20 they just send them a computer model of the stuff that
21 they need to know and they've got it.

22 MS. UHLE: But the computer model's not
23 going to have lost coefficients, reverse and forward
24 lost coefficients. I mean they're going to have
25 geometry, and that's what we can recover.

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1 CHAIRMAN WALLIS: So you have to figure
2 that out.

3 MS. UHLE: But the rest of it is going to
4 still require somebody knowing the code, knowing what
5 each of the input is required.

6 Well, I mean we have talked about that as
7 an ideal way to go, being able to recover any of the
8 geometric information.

9 CHAIRMAN WALLIS: Right.

10 MS. UHLE: We have talked about that.

11 MEMBER SHACK: They probably don't have
12 computerized geometric models in most of these plants.

13 MS. UHLE: They'll have like tech -- what
14 is it called -- CAD drawings. They'll have CAD
15 drawings. And so we've thought about being able to
16 take in the data from the CAD drawings and getting the
17 geometry. And that is somewhere we want to head,
18 we're not there yet. And of course, at NRC we don't
19 have CAD drawings, so it would require interface with
20 the industry.

21 I want to talk to you about the mission of
22 the branch, to give you an idea that this is the
23 Safety Margins and Systems Analysis Branch. So we are
24 tasked with the idea of maintaining these analytical
25 tools. We're also tasked with maintaining the

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1 infrastructure for the understanding of the
2 phenomenology to help out NRR on more complex issues.
3 And this is applied to severe accidents as well as the
4 thermal-hydraulics, and as well as the field behavior.
5 What you're hearing from us today is the thermal-
6 hydraulics, but we are hoping to follow suit in the
7 severe-accident and field-behavior areas so that the
8 team can seamlessly interact throughout the branch;
9 and that includes coupling the computer tools, the
10 field behavior code to the thermal-hydraulics code,
11 the severe accident code to the thermal-hydraulics
12 code, and bringing in-house expertise. And so it's an
13 exciting time in the branch.

14 Hopefully, if all the good things you hear
15 today, you can think that's going to be applying to
16 severe accident. And if it's something you don't
17 like, well then tell us so we don't make the same
18 mistake twice.

19 MEMBER KRESS: When you say criticality
20 safety, what all is wrapped up in that?

21 MS. UHLE: Criticality safety originally--
22 well, for instance in the dry cask PRA they have asked
23 the branch --

24 MEMBER KRESS: Okay. You're not just
25 limiting this to reactors then?

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1 MS. UHLE: No. No. For instance, the
2 most --

3 MR. ROSENTHAL: The burn-up credit comes
4 from in our branch analytically and we provide, as a
5 user need --

6 MEMBER KRESS: I understand what you mean.

7 MS. UHLE: Tony Ullses, in the back of the
8 room, is currently running some calcs with the dry
9 cask PRA to just double check that there's, obviously,
10 very -- I don't know what the word is -- low, low, low
11 probability that anything could happen and cause a
12 criticality accident. And so he's doing that in the
13 branch, because we have the reactor physics tools.
14 We've coupled the reactor with some kinetics tools,
15 but we're getting the reactor physics and with that
16 there is quantum PYLAR codes for criticality.

17 MEMBER FORD: You mentioned safety margins
18 on this slide. Is there any plans in the future to
19 incorporate, for instance, aging phenomena for
20 construction materials?

21 MS. UHLE: We are going to talk -- I will
22 actually talk a little bit about that with respect to
23 the power uprate synergy program that we're undergoing
24 at this point. And Joe Staudenmeir is the lead on
25 that. But, additionally, we do interact with the

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1 engineering division, well for instance, through the
2 pressurized thermal shock rule we are looking at risk
3 informing the PTS rule in the way that we're giving
4 them thermal-hydraulic information and then they're
5 putting it into their FAVA code for the fracture
6 mechanics.

7 So the whole office, really, I think it's
8 a nice tie and we're all starting to interact a bit
9 more. There's a lot of cross-division, cross-branch,
10 as well as in the branch cross-section interaction.

11 MEMBER FORD: Forgive me, because I'm new
12 to this organization. Is this a new mission or has
13 this been a mission you've had for ten years?

14 MS. UHLE: I think this is a mission that
15 we've always had, but I think the way NRC is currently
16 operating we're trying to do it in a more efficient,
17 more --

18 CHAIRMAN WALLIS: Integrated.

19 MS. UHLE: Yes, integrated and more of a
20 outcome-oriented, and all these management buzzwords
21 that make you sick. But, you know, looking at the
22 user offices as our customers, looking at the fact
23 that we're supporting the PRA work as our customers.
24 And because of that, I think this has helped as far as
25 people understanding who is doing what and who to go

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1 to talk instead of not knowing and calling their
2 professor or, you know, and not knowing what NCR is
3 currently doing.

4 CHAIRMAN WALLIS: It also helps if your
5 customer is really listening and is in on that
6 decision making.

7 MS. UHLE: Oh, yes, right, and that goes
8 to the user need process.

9 Okay. So we're getting into the activity,
10 because now I'm talking about power uprates synergy.
11 So you read my mind here.

12 This was actually I think at one point
13 discussed by the ACRS, the full committee, looking at
14 the potential for synergy. Synergy coming from the
15 fact that we're operating with higher burnups, higher
16 power and plant aging. And we are currently looking
17 at license amendments for BWRs up to 20 percent power
18 uprate.

19 Also the Office of Research -- I don't
20 want to be giving you a full review of this program
21 because I'm not the lead on this program, but I just
22 want to talk about our branch's use of the codes to
23 support this program.

24 We've got an independent study we'll be
25 doing; the best most rigorous method we could do would

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1 be a level 3 PRA before and after the results, but we
2 don't have the time or the staffing, or the funding to
3 do that. So we're trying to do this in an efficient
4 way, so due to the time and funding limitations we're
5 going to focus on components and the scenarios of high
6 risk significance, and using the knowledge that we
7 have in the field to point to the things that are most
8 sensitive to the changes. We're looking at the
9 results of NUREG-1150 as a guide. And we're going to
10 be looking at generic safety issues and reviewing them
11 to see that if there was something that is affected by
12 any of these changes within the operations.

13 MEMBER KRESS: Now let me see if I
14 understand that. You will do a level 3, but for just
15 selective sequences?

16 MS. UHLE: Yes.

17 MEMBER KRESS: And those sequences will be
18 the ones you feel are more important?

19 MS. UHLE: Yes.

20 MEMBER KRESS: And you'll pick out a
21 number of plants to do this with?

22 MR. ROSENTHAL: The level 3 would include
23 consequence analysis.

24 MS. UHLE: Right.

25 MEMBER KRESS: Yes, you'll forget about

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1 LERF and go to the full consequence.

2 MS. UHLE: Well, we're looking at
3 consequence on the synergy program after listening to
4 the advice from Joe Staudenmeier.

5 CHAIRMAN WALLIS: So you're going to look
6 at casualties in the surrounding countryside and
7 things like that? I mean is that part of your
8 mission?

9 MS. UHLE: Yes, I mean it's going to
10 result in a source term and then --

11 MEMBER KRESS: Well, before we get carried
12 away, I think I'd like to lend the Subcommittee's
13 support to your doing that. Because LERF can only do
14 it when you are talking about power upgrades.

15 MS. UHLE: Well, I mean, the focus is
16 looking at the source term.

17 MEMBER KRESS: Yes, absolutely.

18 MS. UHLE: And we are going out to source
19 term.

20 MEMBER KRESS: And we really ought to do
21 the level 3 in this case rather than stop at LERF.

22 MS. UHLE: And if we have source term
23 going to, you know, the health effects, I mean that's
24 -- I don't see how that's a big step.

25 MEMBER KRESS: Will you use specific sites

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1 for this or some sort of a --

2 MS. UHLE: Joe, do you want to stand up
3 and talk? Joe Staudenmeier is the lead on this. I
4 mean, maybe a lot of it could just be my
5 misunderstanding, but I mean if we're doing source
6 term, I don't see why we wouldn't do the final health
7 effect. I mean, that's just a matter of running the
8 Max code, which takes 5 seconds. But maybe I'm
9 offering work that the office isn't willing to do. I
10 don't know.

11 MEMBER KRESS: Stick by it, I hope you do.
12 Go ahead.

13 MR. STAUDENMEIER: Joe Staudenmeier.
14 Tentatively we had planned to do
15 consequence analysis. We don't really have all the
16 details of this whole study all worked out yet, but
17 tentatively we'll look at the consequence analysis
18 with the PRA people. We're going to provide guidance
19 based on NUREG-1150 study on what sort of sequences we
20 should be looking at and also engineering is providing
21 information on materials and things like that.

22 MEMBER KRESS: Okay.

23 MR. STAUDENMEIER: It's hopefully going
24 to be an integrated study that gives consequence
25 numbers, or at least what we think may be resulting

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1 consequence numbers being more like a prioritization
2 analysis rather than a full level analysis.

3 MEMBER KRESS: Would you use the SPAR
4 models for this or --

5 MR. STAUDENMEIER: I don't know the
6 details of what GRA would be

7 MEMBER KRESS: All right.

8 MEMBER FORD: Could you -- and you ought
9 to be able to put the government timing and funding
10 limitations off. In light of, for instance, synergism
11 between higher power flux and plant aging from a
12 physics point of view, there's a lot of things which
13 are not understood in a quantitative sense. So there
14 is a lot to do beforehand. So far as timing and
15 funding limitations would you have these for is it 3
16 years? --

17 MS. UHLE: I think we have funding out for
18 another 3 years. Is that right, Joe? Three years?

19 MR. STAUDENMEIER: Yes, the program is
20 scheduled to go over three years. The total
21 contracting money for the first two years, I think, is
22 about \$800,000, and from last year about \$1500.

23 CHAIRMAN WALLIS: So probably three years
24 most of these BWRs will already have had power
25 operation approved?

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1 MS. UHLE: That's coming out of NRR. What
2 we're doing is an independent analysis.

3 CHAIRMAN WALLIS: I know, but it's so
4 interesting. So your report will come out after the
5 fact and then --

6 MR. STAUDENMEIER: We are working on a
7 confirmatory report and we are not going to concern
8 ourselves with the licensing process. Unless we do
9 find something. If we do find something it will
10 affect licensing, obviously, we'll provide that
11 information.

12 MEMBER KRESS: Better late than never.

13 MEMBER SCHROCK: So the BWR presentations,
14 these upgrades claimed that the bundle power is not
15 increased, and the flux therefore is not increased.
16 So you have a situation in which the total power in a
17 system is increased by --

18 MS. UHLE: Right.

19 MEMBER SCHROCK: -- working the bundle so
20 they're both hanging over the mark. But it doesn't
21 come through clearly to me how you're dealing with the
22 increased total power, I mean in the context of source
23 term and things of this sort. You don't have a higher
24 local power density, and so the onset of failures is
25 not changed in the sense of local conditions, but the

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1 amount of the core that's involved in the onset of
2 failures is increased.

3 MS. UHLE: Right.

4 MEMBER SCHROCK: How is that --

5 MS. UHLE: Affecting source term?

6 MEMBER SCHROCK: Yes.

7 MS. UHLE: Well, I mean with the higher
8 power the higher fission productivity and then of
9 course if you're getting --

10 MEMBER SCHROCK: Well, of course. But the
11 issue is how much of it gets out.

12 MS. UHLE: Right. Right.

13 MEMBER SCHROCK: And how does the failure
14 propagate?

15 MS. UHLE: Right. But if we're looking at
16 on the very unlikely situation where you'd have a core
17 melt, then you know it's going to be the average of
18 the core that's determining the source term, not just
19 the hot bundle.

20 MEMBER SCHROCK: Yes --

21 MEMBER KRESS: You would get more out
22 sooner.

23 MEMBER SCHROCK: Oh, I'm sure you'd get
24 more out, but my question is how it's being determined
25 in these new evaluations.

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1 MEMBER KRESS: Well, it depends on how
2 they nodalize the core.

3 MEMBER SCHROCK: Because as I read the
4 stuff that we received, I was reading there's an
5 increase in flux, there's an increase in temperature,
6 there's an increase in this and that, which we heard
7 in the arguments in favor of the uprates it didn't
8 exist because we don't have an increase in bundle
9 power, we don't have an increase in center line
10 temperature of the fuel, we don't have this, we don't
11 have that. Whereas, the description that I read
12 sounds to me like it's contrary to the claims that
13 were made in the evidence supporting the approval of
14 these 20 percent uprates.

15 MS. UHLE: I think Joe wants to make a
16 statement here.

17 MEMBER SCHROCK:

18 MS. UHLE: He's behind you.

19 MR. STAUDENMEIER: The source of the core-
20 melt progression in source term release is something
21 we're going to be evaluating under this program. We
22 plan on planning some severe accident calculations.
23 I think we'll probably be talking in more detail about
24 this program, coming up with a presentation sometime,
25 I imagine being the first half of next year coming

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1 down to explain what the parts of our program are and
2 schedule a presentation just describing this in more
3 detail. Right now Jennifer has a long way to go, and
4 this may not be a good time to discuss it any further.

5 CHAIRMAN WALLIS: She has a long way to go
6 in terms of the slides she's going to cover. You're
7 going to cover 19 or 20 or so?

8 MS. UHLE: Well, I don't know. I'm
9 trying.

10 Along those lines, though, I just want to
11 point out that we will be using the codes in the
12 branches, the severe accident analyses with melt core,
13 talking about the melt progression and then the
14 thermal-hydraulic codes. And so we'll be focusing on
15 the risk-significant events and the risk-significant
16 components providing input as success criteria,
17 operator action times, stating the case of ATWS, and
18 also different component failure modes.

19 If it's a DET the division of engineering
20 to look at the effect of additional hydraulic loads on
21 the components, crunch the numbers and come out with
22 a new risk value.

23 So I'll skip the next one there, because
24 I think we've talked about that.

25 One thing I want to talk about, though, is

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1 the fact that we're using this code and how can you be
2 assured that we are getting an okay answer for, say,
3 the BWR cases. The next stage in the consolidation is
4 very consistent with the fact that we need to do a
5 developmental assessment. And so what we're going to
6 do is that we are focusing on the BWR models first.
7 We'll be looking at them in the consolidation matrix,
8 the DA matrix, the BWR models. And that's, of course,
9 good timing with respect to the BWR synergy. So we
10 will be running a developmental assessment for BWRs
11 with the code, and we'll be using the TRAC code for
12 that.

13 We are currently involved in the Peach
14 Bottom Turbine Trap using the TRAC-M code in the PARCS
15 3-D kinetics module. And Tony Ullses -- he's in the
16 back of the room -- he is the lead on that.

17 Based on the results, and I have a few
18 results for you to show you, we found that we know
19 we're going to have to do some BWR specific physical
20 models. And what was put in was an interfacial drag
21 model was changed and -- I think it was the two phase
22 loss multiplier for -- I'm sorry, the two phase
23 multiplier for the wall drag that was important in the
24 BWR sense.

25 Once we replaced those models and reran

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1 the Peach Bottom Turbine Trip for just the CHAN, you
2 know the BWR channel component in the core, we got
3 very good answers. We're still looking at it again to
4 focus on what models we need to change to improve
5 those answers. And I just want to --

6 CHAIRMAN WALLIS: If you take the RELAP
7 models and put them in TRAC, do you predict the same
8 answers as RELAP predicted?

9 MS. UHLE: If we were to do that, it would
10 take time to do it. We haven't done that. But in
11 general -- in general you would say yes.

12 CHAIRMAN WALLIS: You would expect --

13 MS. UHLE: If we run in the semi-implicit
14 numeric scheme.

15 CHAIRMAN WALLIS: It's a test that we
16 probably should run, isn't it, so that there isn't
17 something peculiar about TRAC which gives different
18 answers from RELAP with the same models?

19 MS. UHLE: Well, that's where the
20 developmental assessment work will --

21 CHAIRMAN WALLIS: You haven't done that
22 yet?

23 MS. UHLE: That's what the next stage is.

24 CHAIRMAN WALLIS: I mean, it's related in
25 a way to Graham's question; when you consolidate these

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1 codes, the question will arise probably about whether
2 or not you're recapturing what the codes could do
3 before.

4 MS. UHLE: Right. Right. And so that's
5 why the next phase of consolidation is the most
6 important phase.

7 CHAIRMAN WALLIS: So you won't really find
8 out if there's a hitch to consolidation until you get
9 to that point?

10 MS. UHLE: You have no faith.

11 MEMBER SCHROCK: I've expressed concern
12 for years about using interfacial drag as a tuning
13 device in the codes. And what can you say about what
14 you're doing now that's any different than what's been
15 done before? In terms of the physics, isn't it
16 necessary to have a clearer explanation as to why you
17 needed a different model --

18 MS. UHLE: Yes, we do.

19 MEMBER SCHROCK: -- for one reactor as
20 compared to the other?

21 MS. UHLE: Yes. In particular the CHAN
22 component. The CHAN component is essentially a pipe.
23 And if you put in your hydraulic diameter --

24 MEMBER SCHROCK: That's in the code, but
25 in the reactors they're rod bundles.

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1 MS. UHLE: I know. Right. Exactly. So
2 currently in the code, in the TRAC-M code, if you're
3 going to have a CHAN component, it is a pipe with a
4 different hydraulic diameter. So your interfacial
5 drag is going to be much -- you know, calculated to be
6 very high. Because in reality you have this channel
7 there -- sorry. You have this rod bundle there and
8 you know with the same hydraulic diameter you have a
9 much lower interfacial drag. So in that particular
10 instance we have to put in an interfacial drag model
11 that reflects the fact that there is a rod bundle in
12 this pipe. That's physically based.

13 MEMBER SCHROCK: Well, I didn't, I guess,
14 fully understand the argument.

15 In both reactor systems you have rod
16 bundles. You do have pipes. And so now you're --

17 MS. UHLE: In the PWR we have a 3-D
18 hydraulic model, so it's not a pipe because the
19 hydraulic is three-dimensional -- you can have cross
20 flow, what have you, you don't have the channel boxes.

21 MEMBER SCHROCK: Well, there's a scheme
22 for accounting for cross flow. Calling it three-
23 dimensional is a stretch.

24 MS. UHLE: Not in the TRAC code. It's a
25 three-dimensional model, three-dimensional hydraulic

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1 model.

2 MEMBER KRESS: They don't use these little

3 --

4 MS. UHLE: We don't use the cross flow
5 connections.

6 I think Joe Kelly wants to say a few
7 words, maybe clear it up.

8 MR. KELLY: This is Joe Kelly, from
9 research. And I think I can clear that up, Professor
10 Schrock.

11 In TRAC-P, its mission was for large break
12 LOCA. So consequently, interfacial drag in the core
13 for normal, you know, bubbly flow was never considered
14 a priority. They were always worried about reflux,
15 first of all, from boiling etcetera. So the models
16 that were developed for that actually were fairly
17 crude, based on bubbles and slugs where the slug size
18 is limited by the hydraulic diameter of the channel.
19 But, as you know, in an actual LOCA configuration the
20 vapor structures actually span a number of
21 subchannels, and it can lead to much higher slip than
22 you would get if you only took into account the
23 hydraulic diameter of a rod bundle.

24 So, because the modeling TRAC-P is
25 relatively crude, it was in fact never extensively

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1 accessed against rod bundle void fracture data.
2 There's no expectation that it would do a good job.
3 And what we've found is, yes, indeed it does not do a
4 very good job when you apply it to BWR operating
5 conditions. And so we needed to implement a model,
6 and what we chose was the one from TRAC-B that
7 actually does try to model the interfacial drag in a
8 rod bundle. And that's what was done for Beach Bottom
9 Turbine Trip, and I'll talk a little more about that.

10 MEMBER SCHROCK: Okay.

11 CHAIRMAN WALLIS: When we review other
12 codes, we've been reviewing other codes over the past
13 few years, we get a stack of stuff like this, you
14 know, the documentation. All the equations are
15 spelled out, justified, and the verifications are
16 explained. Are we going to get that for your code?

17 MS. UHLE: Yes.

18 CHAIRMAN WALLIS: When do we get that?

19 MS. UHLE: End of 2002.

20 CHAIRMAN WALLIS: That's a long way.

21 MS. UHLE: Well, we won't know what
22 physical models we're putting in the code until the
23 end of 2002, when we've done the developmental
24 assessment to make sure.

25 CHAIRMAN WALLIS: Well, do you have a

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1 draft --

2 MS. UHLE: We have a theory manual for
3 the--

4 CHAIRMAN WALLIS: If you had a draft
5 version of the theory manual or something, we might
6 give you some useful input before end of 2002. And if
7 we're going to raise any problems --

8 MS. UHLE: Are you offering?

9 CHAIRMAN WALLIS: -- the sooner we do it,
10 the better.

11 MS. UHLE: So you're offering to be a
12 contractor?

13 CHAIRMAN WALLIS: Well, it just turns out
14 that in a peculiar way we should never fault the ACRS.
15 We act as sometimes reviewers of these codes and we
16 find what look like -- not what I should call errors,
17 but --

18 MS. UHLE: Right. We have a theory manual
19 for the base TRAC-P code. We can provide that to you
20 as well as --

21 CHAIRMAN WALLIS: It might be useful if we
22 saw that before you think you've got the final
23 version.

24 MS. UHLE: Right. I'll report that back,
25 although my management is here now.

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1 CHAIRMAN WALLIS: Because that would be
2 really embarrassing if we found an error in some
3 fundamental thing after you think it's final.

4 MEMBER SCHROCK: We used to complain about
5 the lack of recommendation on TRAC. And I remember at
6 a meeting in Saratoga Springs -- from Las Alamos I
7 guess. Said that the latest version was fully
8 documented and I said "Well, I've never seen it." And
9 so there was some correspondence between he and four
10 others.

11 I think that he's under the impression
12 that it's been reviewed by the ACRS. I don't think it
13 ever appeared at the ACRS.

14 MS. UHLE: Okay. Well, I mean that would
15 be very helpful to us if you're willing to do that.

16 CHAIRMAN WALLIS: But you're going to
17 write your own documentation for these facts, right?
18 you're not just going to pick some original TRAC
19 document --

20 MS. UHLE: We're going to redo what needs
21 to be redone, yes.

22 CHAIRMAN WALLIS: Right.

23 MS. UHLE: Sure. As our developmental
24 work has been proceeding, we have quality assurance
25 guidelines and we've generated more documentation than

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1 you can imagine.

2 CHAIRMAN WALLIS: If you go back to the
3 very original TRAC documentation, such as it was, it
4 was extraordinary. It was extraordinary, and it was
5 a maze trying to figure out what was happening.

6 MS. UHLE: I think of "extraordinary" as
7 good.

8 CHAIRMAN WALLIS: Oh, no, no. It was
9 extraordinary. I'll try to choose a word that's
10 neutral.

11 MR. ROSENTHAL: Let me just chime in. I
12 think what's going to happen, the goal and reality
13 would be that by the time we're done, this code will
14 have more review and more scrutiny than anything else
15 out there with a large user community, both
16 domestically and internationally. And we share source
17 code as well as compiled code. And we put it to the
18 user community so that it will be far better reviewed
19 and understood than I think the commercial code.

20 CHAIRMAN WALLIS: I was just trying to --
21 and you might think about how the ACRS could be most
22 helpful to you in that process. We don't have the
23 time to read every line and all that, but as you know
24 we do look at selected parts of this code
25 documentation and assure ourselves that it's credible.

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1 MS. UHLE: And I guess you're interested
2 in the momentum equation?

3 CHAIRMAN WALLIS: We want to be helpful.
4 The last thing we want to do is to shoot you down in
5 some way.

6 MS. UHLE: Yes. I think the --

7 CHAIRMAN WALLIS: And the last time you
8 want to do it is at the end of the process.

9 MS. UHLE: Yes, I mean if you're willing
10 to do that, it would be great. I would think that we
11 would be accepting that.

12 CHAIRMAN WALLIS: Why don't you think
13 about how we might be helpful there.

14 MS. UHLE: I'm not important enough to
15 make that decision. It's these other people.

16 MR. ROSENTHAL: Sure you are. Sure you
17 are.

18 MS. UHLE: You have the results here, I
19 think, in your slides. I'll just skip over them. If
20 you want to pursue them, because I think we're running
21 out of time.

22 MEMBER LEITCH: This Peach Bottom Turbine
23 Trip, is that the generator breaker openings or how is
24 this -- or does that make a difference? In other
25 words, we run them along in the turbine trips, is

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1 that--

2 MS. UHLE: It was a task scheduled at the
3 Peach Bottom facility. Tony Ullses can elaborate on
4 that; he's the lead, as well as Bajorek helped out
5 originally. Go ahead.

6 MR. ULLSES: It was actually a cycled test
7 that they ran at the facility during coasting down
8 gradually from 100 percent power.

9 MEMBER LEITCH: Okay. From a 100 percent
10 power? You say they were coasting down? They
11 weren't--

12 MR. ULLSES: Actually they were at low
13 power and they -- they actually had multiple trips but
14 they were down in the 60 percent power when they
15 started the trip and they actually disabled the
16 initial stops on the valve position --

17 MEMBER LEITCH: Oh, I sure. Okay. So
18 they closed the stop valves at 60 percent power.
19 Okay. Thanks.

20 The other question I had related to that
21 was you mentioned that in the previous LOCA, and I
22 guess you didn't slide 5, but you referred to the
23 Brown's Ferry ATWS. I guess is that a full-blown
24 ATWS, or is that the partial ATWS that occurred at
25 Brown's Ferry in '76 or something?

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1 MS. UHLE: This is just on the matter from
2 the BWR synergy.

3 MR. ULLSES: That was a partial ATWS.

4 MR. KELLY: Partial ATWS, yes.

5 MEMBER LEITCH: So you're not using a
6 full-blown ATWS for this reference here?

7 MR. KELLY: Well, we're doing the plant
8 calculations on a full-blown ATWS, but we're going to
9 start with -- the deck was developed for the partial
10 ATWS, which is what that was for, and there were some
11 modern calculations on a former ATWS that we were
12 evaluating and we're going to start off by rephrasing
13 those calculations on TRAC-M using that deck as a
14 surrogate high power BWR4 deck as a full ATWS.

15 MEMBER LEITCH: Well, I guess I'm just a
16 little confused as to why you would use the Brown's
17 Ferry rather than a full-blown ATWS.

18 MR. KELLY: Well, we are going to run a
19 full-blown ATWS. What Brown's Ferry had was a
20 development responsible partial ATWS but there's
21 nothing in the input that would keep it running at a
22 full ATWS.

23 MEMBER LEITCH: Okay. Okay. Thank you.

24 MS. UHLE: Okay. I'm going to skip now to
25 the MOX fuel issue. I think we have talked about this

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1 before, but this is the idea of developing our
2 kinetics capabilities to deal with MOX fuel.

3 The PARCS, the Purdue Advanced Reactor
4 Core Simulator, that's the PARCS. What we do is we
5 coupled to just the kinetics features in the code. So
6 we use it as a module. And we are improving the
7 kinetics module to be able to handle MOX fuel. We're
8 adding the ability to do any number of energy groups
9 because of the fact that plutonium has huge capture
10 and fission resonances, and the beta is much lower
11 than in uranium. So you have to be much closer
12 because -- you have to be much more accurate because
13 you can be closer to prompt critical.

14 The way that the MOX core will be run is
15 we will be, we think, be using eight groups for the
16 MOX assemblies and two groups for the uranium
17 assemblies.

18 CHAIRMAN WALLIS: These are delayed
19 neutron group of the N?

20 MS. UHLE: Yes, beta delayed neutron
21 fraction.

22 CHAIRMAN WALLIS: You only need two for U?

23 MS. UHLE: I'm sorry?

24 CHAIRMAN WALLIS: You only need two for U?

25 MS. UHLE: Oh, sorry. The groups. No,

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1 these are two energy groups for --

2 CHAIRMAN WALLIS: These are energy groups?
3 This is something else you're talking about?

4 MS. UHLE: Well, N groups. Additional
5 energy groups. N groups.

6 CHAIRMAN WALLIS: I don't know what an N
7 group is.

8 MS. UHLE: That means N number of groups,
9 how many groups.

10 CHAIRMAN WALLIS: Well, group of what?

11 MS. UHLE: How many bins of energy the
12 neutrons can be in.

13 CHAIRMAN WALLIS: I see. I see. Okay.
14 Okay. Thank you.

15 MS. UHLE: Two fields of neutrons, like
16 the vapor and the liquid.

17 CHAIRMAN WALLIS: You have two groups
18 there and eight groups here.

19 MS. UHLE: Yes. I think Dr. Kress can
20 help you on that.

21 CHAIRMAN WALLIS: Well, it seemed funny,
22 but I mean I guess this is a subgroup -- sub-sub
23 title. This is a sub of the title. The neutron
24 fraction isn't a subtitle of energy groups. Okay.
25 Never mind.

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1 There are new problems with MOX, so we
2 really can't be surprised.

3 MS. UHLE: Yes.

4 CHAIRMAN WALLIS: New neutronic problems.

5 MS. UHLE: I'm glad I got that across.

6 MEMBER SCHROCK: Your bullet on reactivity
7 difference due to mix of plutonium in the range is a
8 little confusing. Error in reactivity can be closer
9 to prompt critical in MOX.

10 MS. UHLE: Yes.

11 CHAIRMAN WALLIS: That's because of the
12 delayed neutron fraction.

13 MEMBER SCHROCK: You need a comma there
14 somewhere? Error in reactivity still can be closer.

15 MS. UHLE: Can be closer to prompt
16 critical.

17 CHAIRMAN WALLIS: Well, you worry about
18 error because you don't have this cushion from the
19 delayed neutron, isn't that the idea?

20 MS. UHLE: Delayed neutrons. So your
21 prompt critical with --

22 MEMBER SCHROCK: Well, I understand the
23 problem, what I'm trying to understand is what message
24 am I to get out of this statement.

25 MS. UHLE: Okay. Take a step back here.

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1 Okay.

2 Additional energy groups, there is a need
3 to have additional energy groups, more than just two,
4 that we currently use for uranium cores. Okay?

5 Why do we need additional energy groups?
6 We need them because of the fact that plutonium has a
7 lot of resonancy, and so around the epithermal range
8 and at the 1 eV range, and around the -- in Pu-241 you
9 get capture and fission resonances at the 1 eV to KeV
10 range.

11 So you have these resonances, whereas in
12 uranium you don't. You pretty much can bend your
13 energy groups of your neutrons into fast neutrons and
14 thermal neutrons because there's none of these big
15 resonances on the way scattering down to the thermal.

16 Additionally, you worry about error in
17 reactivity. We could have used the two energy groups
18 and --

19 CHAIRMAN WALLIS: Would you bend your
20 betas? The beta is an average of a whole lot of
21 different betas, isn't it?

22 MS. UHLE: It's an average of the betas.

23 CHAIRMAN WALLIS: And do you have to worry
24 about individual betas with plutonium?

25 MS. UHLE: Yes. In the 3-D -- yes. In

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1 the code you do. I took off the 235 beta and the --

2 CHAIRMAN WALLIS: Well, that beta's just
3 an average for you, isn't it?

4 MS. UHLE: It's a beta for that isotope.

5 CHAIRMAN WALLIS: There are different
6 groups. Right. So there are different groups in the
7 beta --

8 MS. UHLE: Yes.

9 CHAIRMAN WALLIS: -- itself it subdivides.
10 Okay. You didn't worry about that now, because you've
11 got such a lower beta?

12 MS. UHLE: Well, in the fission event
13 you're -- I guess I don't understand what you're
14 asking. Do you understand what he's asking, Tony?

15 CHAIRMAN WALLIS: There are separate
16 groups. I get confused about the groups.

17 MR. ULLSES: Yes, the code itself, Dr.
18 Wallis, it actually on a node-to-node basis will
19 maintain an individual amount of the actual related
20 neutron.

21 CHAIRMAN WALLIS: But it looks at the
22 simpler fractions of the separate groups?

23 MR. ULLSES: Right.

24 CHAIRMAN WALLIS: Okay.

25 MS. UHLE: Just to give you an idea that

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1 we have to be very accurate, more accurate than we do
2 in uranium cores because of the fact that we are
3 closer to prompt critical because of the --

4 CHAIRMAN WALLIS: So it's not just the
5 average, it's also the group which is slowest -- which
6 is governing in a rapid transit, isn't it? So it's
7 not just the average you worry about?

8 MS. UHLE: Well, it's the most dominant,
9 the most dominant group.

10 CHAIRMAN WALLIS: But, I guess Tony's got
11 it all under control. Tony's got it all under
12 control, certainly.

13 MS. UHLE: I'm sorry?

14 CHAIRMAN WALLIS: I said Tony has it under
15 control; that's all I'd really like to know.

16 MS. UHLE: All right. Great. So does that
17 explain this slide any better?

18 MEMBER SCHROCK: Well, no. The language
19 is what I'm criticizing, as in that statement error in
20 reactivity can be closer to --

21 MS. UHLE: Okay. Okay.

22 MEMBER SCHROCK: There is a reactivity
23 evaluation problem which is rather complex. POR is
24 big, it behaves pretty much like several critical
25 assemblies loosely coupled and each one has different

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1 average values, of the delayed neutron fractions owing
2 to the fact that it has different composition at that
3 point in time, different weighting both the effect of
4 plutonium versus uranium neutronic properties and the
5 neutron fraction specifically. And so you're rolling
6 an awful lot of important information into a
7 simplistic statement here.

8 I've raised questions about this in the
9 context of other codes in the last year and I haven't
10 heard crisp clear answers to those questions. I don't
11 know that you're doing the calculation better than
12 some of the industry codes where they make claims that
13 they're doing it right.

14 Somewhere I'd like to hear a clear
15 explanation of how one keeps track of the local
16 compositions and how that information is then
17 impacting the calculation of such things as the 3D
18 kinetics. I haven't heard any of it yet.

19 CHAIRMAN WALLIS: You need to see the POX
20 -- you need to see the POX documentation.

21 MS. UHLE: We can provide that to you. We
22 have it written up, if you'd like that.

23 MEMBER SCHROCK: I'd like to see it.

24 MR. KELLY: Yes, we can do that. Sure.

25 MS. UHLE: Oh, sure. Or we could have a

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1 separate briefing on the MOX development if that's --

2 MEMBER SCHROCK: You see, in the
3 documentation you're offering here, our code is like
4 the government's code, and therefore it's okay. You
5 guys can't challenge that because you've developed it,
6 it's your documentation and we're doing the same kind
7 of inadequate documentation as you do, but you've
8 judged it's good enough and therefore you've got to
9 accept the fact that we say it's good. What I'm
10 telling you is that it is not good engineering
11 practice. And I'm going to keep asking the question
12 until I hear some better engineering answers.

13 MS. UHLE: With respect to the MOX
14 capabilities?

15 MEMBER SCHROCK: It has to do with the
16 calculation of the reactor kinetics in a 3-D situation
17 in which the composition of the core is nonuniform and
18 evolving, it's different at different points in time--

19 MR. ULLSES: I understand. Right. Okay.
20 I can get back to you on that.

21 MS. UHLE: I mean I have a --

22 MR. ULLSES: I could take a stab at it now
23 or we can do it later.

24 MEMBER SCHROCK: No, I think we need to
25 get back.

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1 MR. ULLSES: Okay. We'll get back to you.

2 MEMBER SCHROCK: Right.

3 MR. ULLSES: I'll bring you the
4 documentation.

5 MS. UHLE: Okay. I can skip over the
6 other slide. I was going to get more into 3-D kinetics
7 methodologies for MOX, but I think we're going to have
8 a more detailed description of that provided to you at
9 a different date, if that's all right.

10 MEMBER SCHROCK: See, the term MOX is
11 generally interpreted as being -- as situations in
12 which the fuel is designed to be mixed oxide.
13 Whereas, what you really have in all reactors is some
14 form of MOX. And my problem with the calculations
15 that I see done is that this level of complication
16 gets getting short-shrift in describing what the codes
17 actually do. With the physics it is relatively
18 straight forward to understand in principle, but
19 complicated to deal with in the calculations.

20 MS. UHLE: Right. And I can tell you that
21 the way we're going to be handling the MOX cores is
22 that the uranium assemblies, the UO₂ assemblies, they
23 will be homogenized so that each -- the node -- the
24 power --

25 MEMBER SCHROCK: Have you asked yourself

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1 the question of why does this issue of error in
2 reactivity arise when you're talking about mixed-oxide
3 fuel and not for reactors that have initial uranium
4 fuel?

5 MS. UHLE: Okay. With the reactor
6 physics, I mean you get three different types of
7 errors -- well, I mean stemming from three different
8 phenomena.

9 One is the number of energy groups that
10 you have because, of course, there are -- you don't
11 want to get into this.

12 CHAIRMAN WALLIS: No, his question is
13 different. I'm sorry. He said why is MOX different
14 from regular reactor because when you've got high --

15 MEMBER SCHROCK: In principle it's all
16 MOX.

17 CHAIRMAN WALLIS: -- burnoff, there's a
18 lot of plutonium there already.

19 MS. UHLE: MOX is because you're going to
20 have uranium dioxide fuel assemblies sitting next to
21 a MOX of plutonium dioxide assembly.

22 CHAIRMAN WALLIS: So there's increased
23 heterogeneity?

24 MS. UHLE: And so -- and you get very
25 different energy spectrums coming out of the plutonium

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1 side because of the different cross sections for the
2 resonances. And so you get this very strong neutron,
3 this gradient in neutron flux between the assemblies.

4 MEMBER SCHROCK: Clearly the more you
5 complicate the spacial variation in fuel composition,
6 the harder the calculation becomes.

7 MS. UHLE: Yes.

8 MEMBER SCHROCK: And in mixed-oxide fuel
9 meaning that you have bundles of different composition
10 loaded into the reactor initially, it's going to be
11 more complex then if you load it uniformly and let it
12 generate its nonuniformity as it burns up. But you
13 get the same phenomena occurring to different degrees.
14 The relative consequences become more important when
15 you're talking about what you're characterizing as
16 mixed-oxide fuel cores.

17 MS. UHLE: The orders of magnitude --

18 MEMBER SCHROCK: But the phenomena are
19 always there.

20 MS. UHLE: Right.

21 MEMBER SCHROCK: And the codes need to
22 deal with the phenomena.

23 MS. UHLE: They deal with the phenomena.

24 MEMBER SCHROCK: Yes. My question is how
25 do they deal with the phenomena.

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1 CHAIRMAN WALLIS: I think that's where you
2 have to look at the documentation.

3 MR. ULLSES: Yes, I understand the
4 question, Dr. Schrock. I mean, I can go through an
5 excruciatingly long discussion right now about
6 hydrogen --

7 CHAIRMAN WALLIS: I don't think we need
8 that. I think --

9 MEMBER SCHROCK: What I'd like is to be
10 given something to read that tells the story in a
11 clean cut fashion.

12 CHAIRMAN WALLIS: So would you agree to
13 give him something to read and then we can move on?

14 MS. UHLE: Yes. That is an action item
15 for us. By Monday we will have a clear --

16 MEMBER SCHROCK: Okay.

17 MS. UHLE: We have it written up. It's
18 upstairs. It's upstairs. We can go get it if you want
19 it.

20 CHAIRMAN WALLIS: Okay. Let's move on.

21 MS. UHLE: We'll give you a brief
22 tomorrow.

23 CHAIRMAN WALLIS: Let's move on.

24 MS. UHLE: Why don't we go get it.

25 MR. ROSENTHAL: Why don't we provide him

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1 with the documentation, okay. And then after he's had
2 an opportunity to look at the documentation, at his
3 discretion we'll schedule a morning session and we'll
4 talk about MOX. When we talk about MOX, we not only
5 talk about the physics, but we'll also talk the
6 neutron physics --

7 MEMBER SCHROCK: See, my emphasis --

8 MR. ROSENTHAL: -- we'll also talk about
9 source term and other related issues.

10 MEMBER SCHROCK: Jack, my emphasis is not
11 on MOX. It's on the fact that I look at old
12 documentation, which continues to be referenced, and
13 what I find is that people say you do these things
14 with delayed neutron yields and there's a table of
15 delayed neutron yields for U-235 presented in the
16 documentation in the early versions of RELAP5, for
17 example. And nothing's said one way or the other
18 about does this deal with the problem that the core
19 contains some other fissile nuclides and what are the
20 delayed neutron fractions from those.

21 It's the latter that I'm concerned with.
22 Why did they get lost in the shuffle?

23 When I raised it in connection with review
24 of another code, I'm told that it's all done
25 correctly, you just don't view it in -- yes, right.

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1 Well, I'll believe it when I see it in a clean cut --

2 CHAIRMAN WALLIS: So you're going to see
3 it, Virgil.

4 MEMBER SCHROCK: Thanks.

5 CHAIRMAN WALLIS: And we're going to move
6 on. You're going to satisfy him with some
7 documentation, otherwise the question will just come
8 up.

9 So, can we move on?

10 MS. UHLE: I think everyone was aware of
11 the control rod drive mechanism issue. The Ocone
12 Unit 3 spring 2001 outage, there were circumferential
13 cracking on the CRDMs. We looked at the idea that
14 there's this potential for a rod ejection because of
15 the circumferential cracking.

16 The question was raised that you could
17 result in, perhaps, an ATLAS because of the fact that
18 you have collateral damage with the CRDM ripping off
19 and taking out a bunch of the other CRDMs in the area.
20 So Research performed a worst case scenario
21 calculations on the off chance that for some very
22 improbable reason there was a full ATLAS. And we did
23 a 3-D kinetic, 3-D hydraulics model using the TRAC
24 code. Jack had said it was a RELAP, but we had used
25 TRAC with this because we, again, want to keep

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1 exercising the TRAC code. And we used the Boron
2 tracking to determine the effect of the RWST injection
3 shutting down the reactor.

4 The results of this actually confirmed NRR
5 from the analysis that NRR had done with RELAP5. And
6 what it showed was that there was no new phenomena
7 identified bounded by the current design basis and no
8 fuel heat up was expected, no core damage was
9 expected.

10 We did this as part of a confirmatory
11 analysis for which that was an activity that we did.

12 One thing to point out was that based on
13 the results of in running these codes is that they,
14 again, there are still bugs in the codes. And one
15 that we found was with respect to the Boron reactivity
16 coefficient.

17 In the PWR people don't picture -- well,
18 typically you're thinking of normal operation, you're
19 not picturing any boiling in the core. And the
20 reactivity coefficient for the boron, assuming no
21 voiding and it was based on parts per million versus
22 parts of boron per parts of liquid. And so it could
23 deal with boiling. And what we have done is, of
24 course, change it to what it should be, which is moles
25 of boron per the volume of the cell that you're

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1 talking about. And this was actually identified also
2 in the TRAC-B code as well for the point kinetics
3 model.

4 So, every time we use these codes it helps
5 us.

6 MEMBER LEITCH: So in your calculations
7 you assumed that there was a partial --

8 MS. UHLE: A full ATWS.

9 MEMBER LEITCH: Oh, a full ATWS?

10 MS. UHLE: Yes. And so you're getting the
11 heat up, you're turning back around and with the
12 depressurization you're injecting the RWST water with
13 the high boron concentration and it's shutting it
14 down.

15 MEMBER LEITCH: Okay. So even with the
16 full ATWS you're still reaching these same
17 conclusions.

18 MS. UHLE: Yes.

19 CHAIRMAN WALLIS: It's a full ATWS and a
20 LOCA at the same time.

21 MS. UHLE: Yes. And Tony also said the
22 network.

23 Steam-generator tube integrity. You've
24 heard that, a briefing on that before. I think I'm
25 going to skip that for reasons of time. You will

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1 please note that we will be using the thermal-
2 hydraulic code in the branch to look at those DPO
3 issues.

4 Let me get into risk-informing activities
5 that we have in the branch and the use of the codes in
6 those areas.

7 Of course, I think that you understand
8 what we mean by risk-informing regulation. The
9 current activities we have with respect to thermal-
10 hydraulics is risk-informing the ECCS rule and the
11 pressurized thermal shock rule. So 50.46 for the ECCS
12 and 50.61 for the PTS.

13 You have seen or the full committee has
14 seen a briefing in our risk-informing of 50.46.

15 I wouldn't say that it's really risk-
16 informing, the activities are more looking at any
17 modifications that can be made to Appendix K based on
18 the industry's desire to reduce regulatory burden.
19 And Ron Lauben and Steve Bajorek are the technical
20 leads on this in the branch.

21 So what has been looked at as an idea to
22 look at the Appendix K evaluation models and note the
23 real conservatisms in the code, and based on better
24 science can we replace the oxidation model for heat
25 generation to Cathcart-Pawel, because Cathcart-Pawel

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1 does a better job as far as the heat generation.

2 We also have better science now with the
3 decay heat curve of 1994 standard versus the '71
4 standard. We were looking at that as an option. We've
5 been running code calculations to get an idea of the
6 change in the PCT based on these changes going to the
7 '94 standard or using Cathcart-Pawel versus Baker-
8 Just.

9 MEMBER SCHROCK: I guess we're going to
10 hear more about that?

11 MS. UHLE: Yes, in detail.

12 MEMBER SCHROCK: In details, but in my
13 mind it's just kind of strange that suddenly there's
14 a large activity going on to revise what has to go
15 through Congress to get approval, I think. Appendix
16 K is in 10 CFR, it's got to be -- it's part of the
17 legislation is involved here.

18 MS. UHLE: Yes.

19 MEMBER SCHROCK: There are lots of
20 complexity, but the background that's covered,
21 evidently, in SECY 01-133 seems to be totally lacking.
22 I don't understand how a decision can be made that we
23 must deal with a modification in Appendix K without
24 the technical evaluation that leads to the decision to
25 do that. Where is it?

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1 MS. UHLE: That's our stance, though, the
2 division position, Research position, and we've had a
3 discussion with NRR in this manner that we're leaning
4 towards the idea of not modifying Appendix K because
5 of the fact that we have found nonconservatisms in
6 Appendix K. And the person who came up with the 71
7 times 1.2 was very good because they accounted for
8 those, in a sense, conservatisms.

9 MEMBER SCHROCK: Well, I read that so I
10 know what it is.

11 MS. UHLE: So you're the one.

12 MEMBER SCHROCK: Well, I'm not "the" one,
13 I was involved.

14 MR. KELLY: One of the ones.

15 MS. UHLE: One of the ones.

16 MEMBER SCHROCK: But what I'm hearing and
17 what I'm reading isn't a very accurate account of
18 that; not that that's a terribly important thing. But
19 what I'm getting at here is why is a lot of activity
20 going on here to revise?

21 MS. UHLE: What is the initiative?

22 MEMBER SCHROCK: What is the impetus to
23 revise Appendix K?

24 MS. UHLE: Appendix K --

25 MEMBER SCHROCK: What is the technical

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1 basis for it?

2 MS. UHLE: Well, why this started was a
3 petition submitted by NEI looking at replacing the
4 '71 standard with the '94 standard. And so the idea
5 of reducing unnecessary regulatory burden or --

6 MEMBER SCHROCK: They're totally different
7 things. You're comparing apples and oranges.

8 MS. UHLE: I think -- can I finish what I
9 was saying?

10 MEMBER SCHROCK: Yes.

11 MS. UHLE: I think it'll -- okay.

12 That's why this, we started looking at
13 this one here with this idea to a risk-informed Part
14 50 is where a lot of -- we were looking at changing
15 Part 50, changing the regulations under this risk
16 initiative, this risk-informing initiative. And this
17 work here was put in with that based on the petition.

18 MR. BAJOREK: Jennifer, can I jump in?

19 MS. UHLE: Yes, sure, Steve.

20 MR. BAJOREK: This is Steve Bajorek.

21 One of the things that we're trying to
22 deal with is accuracy in the various models; the decay
23 heat or Cathcart model versus Baker-Just versus the
24 expectation that those can be changed in an evaluation
25 model.

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1 I think there's been a recognition in the
2 SECY paper that the '79 or the '94 standard is
3 technically better than the '71 decay heat standard,
4 more accurate with regards to more recent data. And
5 likewise, with the Cathcart-Pawel versus Baker-Just.

6 The expectation that seems to have been
7 raised in the SECY paper is that we can just simply
8 replace those in Appendix K. The work that we have
9 been doing in our branch has been twofold: (1) To take
10 a look at what do you need to go from this decay heat
11 standard to the '94, and there's more complications
12 involved in dealing with the uncertainties. Norm
13 Lauben has been looking at that. But the other issue
14 is to what extent do the present day Appendix K
15 evaluation models depend upon the conservatism that
16 was inherent in the '71 plus 20 percent to cover other
17 issues.

18 Now, when we start to delve into this what
19 we have been finding are things like downcomer boiling
20 and fuel relocation would result in increases in the
21 peak cladding temperature that would almost offset any
22 kind of benefit that would be gained with the 1971
23 model.

24 MEMBER SCHROCK: Well, do you really
25 believe that the people that drafted 10CFR back in the

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1 early '70s brought the uncertainty in decay power as
2 taking care of unrelated uncertainties?

3 MR. BAJOREK: No.

4 MEMBER SCHROCK: No. Okay. So why is
5 that brought up as an issue here?

6 MR. LAUBEN: Norm Lauben.

7 There was an evolution and it didn't start
8 out that nobody thought the decay heat multiplier, as
9 you say, we dropped another degree but as time went on
10 different things were discovered that was discovered
11 that there was a larger conservatism in the '71 than
12 was originally thought, but at the same time there
13 were -- how do I want to say this -- there was
14 creeping reduction in conservatism in Appendix K
15 evaluation models that ate away at some of the
16 increased margin that was perceived as time went by.

17 So, people then began to think, "Ah, well
18 there is extra conservatism in the decay heat model."
19 But it truth at the beginning we did not believe that.

20 MEMBER SCHROCK: Well, yes, I think that's
21 a historical fact that people have thought that way
22 that expressed their view, etcetera.

23 MR. LAUBEN: Yes, right.

24 MEMBER SCHROCK: But it's not something
25 that's documented as a basis for licensing evaluation.

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1 MR. LAUBEN: And in fact --

2 MEMBER SCHROCK: So it's not something
3 that has anything to do with issues of whether you're
4 going to change it or not.

5 Those rules were created when there was a
6 lot of information that was still, basically, unknown.

7 MR. LAUBEN: Right. Right.

8 MEMBER SCHROCK: And did a remarkably good
9 job under the circumstances.

10 MR. LAUBEN: And may be lucky, too.

11 MEMBER SCHROCK: I think it was --

12 CHAIRMAN WALLIS: Well, I guess, one of
13 the things said here is that it could change the
14 regulations and became more realistic about decay
15 heat; it would look good and industry would think they
16 had gained something. It turns out you've got to be
17 realistic about some other things, which take away the
18 gains from the decay heat.

19 MEMBER SCHROCK: Yes.

20 CHAIRMAN WALLIS: And so that it's not
21 clear that there's a gain to anybody by changing the
22 regulations, except the new regulations would be more
23 based on more realistic physics, and that's probably
24 a good thing.

25 MEMBER SCHROCK: Well, I've probably

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1 gotten into this at the wrong time in our discussions.
2 I know you have a presentation coming up on it. But
3 it does seem to me the starting point is thrown at
4 this committee in a very strange way. This SECY paper
5 has not been reviewed yet by this group. Okay. I don't
6 know what in the world it says or why they think
7 there's a sound basis. All I hear is rumors to the
8 effect that it is something that was initiated by NEI.

9 MR. LAUBEN: Is that true with the
10 activities with the --

11 MEMBER KRESS: Yes, we have. Not this
12 subcommittee.

13 MR. BOEHNERT: Yes, not this Subcommittee.
14 The full committee of ACRS I think, because it's
15 handled under subcommittee.

16 MR. LAUBEN: Have you reviewed all the
17 other copies of this?

18 MEMBER KRESS: Yes.

19 MR. BOEHNERT: It was handled by another
20 subcommittee, that's my --

21 MEMBER SCHROCK: Well, what I'm
22 challenging here is why does the Research branch of
23 NRR get deeply engrossed in a lot of considerations,
24 it's obviously an expensive thing to do, to address a
25 problem which somebody has told them is a change that

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1 has to be made? On what basis can a decision such as
2 that be made without the technical work preceding the
3 decision?

4 MR. LAUBEN: Of course the technical work
5 has to be done.

6 MEMBER SCHROCK: Yes.

7 MR. LAUBEN: And I think 01-133 says the
8 technical work must be done. And if the decision
9 comes that we shouldn't change it, then we won't
10 change it.

11 MEMBER SCHROCK: My concern was, pure and
12 simple, that this is something that's going to get
13 railroaded through despite everything. And you're
14 saying that it isn't true. All right.

15 MR. AYER: Well, let me jump in. This is
16 Charles Ayer from Research. Let me just to correct the
17 record a little bit.

18 The SECY paper we're not risk-informing
19 50.46.

20 MEMBER SCHROCK: Yes.

21 MR. AYER: It was looking at several
22 issues, part of which was the Appendix K model for
23 decay heat. The petition to change the decay heat
24 came along later, and that was just something that's
25 come in very recently, but that was not the driving

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1 force --

2 MEMBER SCHROCK: Okay.

3 MR. AYER: -- the NEI submitted a petition
4 and the agency jumped up and ran off to limit it to
5 50.46. It came in subsequent wanted a simple change
6 on 50.46. This other effort to risk-inform, which is
7 also looking at the large break LOCA and loss of
8 power. But that effort had been going on and is going
9 on. At the onset we're looking at the technical basis
10 for the smaller needs that Jack's branch is working on
11 to see if you can incorporate '94 decay heat, to see
12 what other things would have to be incorporated and
13 perhaps be more realistic in the other areas.

14 But I just wanted to make it clear this
15 wasn't initiated because of a petition from NEI.

16 MR. LAUBEN: As a matter of fact, Paul,
17 you were at several workshops last year in which this
18 group was starting to deal with it, so you know, so
19 you knew this was augmented to the initiative.

20 MR. BOEHNERT: Yes, that's correct.

21 CHAIRMAN WALLIS: Well, I think the
22 message for us is I think we would have said that you
23 could sort of change this decay heat code independent
24 of all the other considerations. And let's do it,
25 it's an obvious thing to do under the ACRS initiative.

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1 We ought to follow that line. And what we are being
2 warned about here is if you do that, you're giving up
3 some conservatism which you really need to cover some
4 of these other things, and therefore you should be
5 more careful about saying, viewing the decay heat code
6 as something completely independent that you can fix
7 and then you can deal the other part separately.

8 MEMBER SCHROCK: Well, another way of
9 looking at it is that there is a very simplistic
10 rather conservative scheme for licensing put in place
11 in the early '70s that's antiquated, it was
12 grandfathered when the new rule was passed in '88.
13 And now the issue is, does it make sense to reduce
14 conservatism in an antiquated method. That's an
15 overall issue, it seems to me, and it needs to be
16 addressed, and it ought to be addressed by this
17 Committee, too.

18 To me it makes no sense whatsoever to say
19 we are going to go back and take all the conservatisms
20 out of an antiquated scheme and expect that it's going
21 to be technically sound in the end.

22 MR. ROSENTHAL: We briefed about two weeks
23 ago.

24 MR. KELLY: Two weeks ago, yes.

25 MR. ROSENTHAL: We briefed the PRAs and

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1 members of the subcommittee --

2 MR. LAUBEN: And this subcommittee, too.

3 MR. ROSENTHAL: And this subcommittee.

4 MR. LAUBEN: We briefed three
5 subcommittees.

6 MR. ROSENTHAL: And now we have some more
7 technical work to do, and we would more than welcome
8 an opportunity bringing the technical work before this
9 Subcommittee. I think it would be very appropriate.

10 MEMBER KRESS: But I think from the point
11 I've heard in these other reviews that we're basically
12 on the same page you are with respect to that issue.
13 They're not going to just go in and blindly change
14 that Appendix K. They're going to look at what the
15 implication are.

16 And so I think we're closer to your side
17 of the table than you might think of.

18 CHAIRMAN WALLIS: We probably have to move
19 on.

20 MEMBER KRESS: Yes.

21 CHAIRMAN WALLIS: And we're going to have
22 a whole meeting on 50.46 some day.

23 MEMBER KRESS: Right.

24 CHAIRMAN WALLIS: And we can't dig into
25 that in depth today.

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1 MEMBER KRESS: Yes. Okay.

2 CHAIRMAN WALLIS: But we've been warned,
3 I think, that we've got to worry about some of these
4 things, which has been very useful.

5 MS. UHLE: The point of slide too is to
6 point out that with respect to your concern about
7 doing the technical work to make sure that this is a
8 viable technical approach is that we will be running
9 and analyzing a great deal of cases with respect to
10 any of these activities. And it was with support that
11 we have given to NRR concerning the effect of the
12 downcomer boiling, especially as being a primary
13 concern that is shaping the technical position that is
14 leading in a direction that I think is very consistent
15 with yours. So we are using these tools for their
16 purposes.

17 Again, in the future we would also be
18 using them in the SECY paper to look at certainly the
19 effect of redefining large break LOCA size, looking at
20 success criteria evaluation for the PRA runs and the
21 effect of the different restrictions concerning delay
22 diesel generator start time, loss of offsite power and
23 signal failure. But, again, we will -- all of these
24 activities 54 -- or the risk-informing Part 50 are
25 going to be made, you know, using the available tools

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1 and, as well as the knowledge and the analyses of the
2 staff.

3 MEMBER KRESS: My next door neighbor in
4 Oak Ridge has asked me to be sure you pronounce his
5 name correctly. It's Pawel, Dr. Pawel; just as if it
6 were P-A-U-L.

7 MS. UHLE: Pawel.

8 MEMBER KRESS: Yes. Not P-A-W-E. It is
9 spelled correctly, but it's not pronounced Powell,
10 it's Pawel.

11 MS. UHLE: I know how he feels, because
12 nobody pronounces my last name right either.

13 MEMBER KRESS: I know this is trivial, but
14 it upsets him.

15 CHAIRMAN WALLIS: Jennifer, are you going
16 to take a long time now?

17 MS. UHLE: No. I can skip over 61. We're
18 doing the same thing with 50.61. We're running the
19 tools; you had a briefing on that. We've made sure
20 that the calculations are consistent with data that
21 was taken at OSU. So we're looking at the idea of
22 when we use these potent codes how can we prove that -
23 - or at least appease the masses that the answers that
24 we are generating are acceptable. We're not believing
25 everything that comes out of the code, that we're

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1 skeptical about it.

2 With respect to AP1000 design
3 certification, we had an NRR user need request
4 concerning looking at the Westinghouse assertion
5 concerning the scaling of AP1000 is consistent with
6 the AP600 work, and that they're claiming no
7 additional testing is required and minimal code
8 modifications would be required. That's the
9 Westinghouse position.

10 So NRR requested technical assistance from
11 Research to review these assertions, identify what
12 code versions should be used if phase 3 were to take
13 place.

14 And we for the small break loss of coolant
15 accident, I know a lot of you are involved in the
16 adequacy assessment of RELAP5 over that 5 to 6 year
17 period. TRAC had not been -- we didn't have a program
18 to do adequacy assessment for small break LOCA on the
19 TRAC code, so the RELAP code will be used for the
20 AP1000 phase 3 for small break. And in phase 3 if it
21 were to come in, the TRAC code would be used for the
22 large break LOCA application.

23 Now, one thing of note is, and an activity
24 that has stemmed from this initiative is that the
25 AP600 had a lower power density. So PCT values

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1 predicted by TRAC were below the limits, the 2200.

2 AP1000 has an increased power density. We
3 realized that there won't be as much margin there and
4 we're based on calculation run with the reflood
5 models in TRAC. We're expecting that it would be over
6 the limit, not because of the actual physical
7 processes but because we have a lot of conservatism in
8 the TRAC large break model.

9 To remove some of this conservatism, will
10 we do a preliminary or an interim model development on
11 the reflood model. Bajorek is working on that
12 currently with Weidong Wang of the staff. And it is
13 hoped that or it is the goal to have that in by, say,
14 the spring or the summer and start doing some
15 developmental assessment work on that version for the
16 consolidated code. So by the time the consolidated
17 code is finished we will have, you know, this interim
18 reflood model developmentally assessed and use that
19 for the AP1000 submittal. Because RELAP large break
20 model tends to be nonconservative and TRAC is too
21 conservative.

22 Now, I don't want to confuse you with the
23 fact that the RBH, the rod bundle heat transfer
24 program. That's focused on developing a mechanistic
25 model for reflood. And we're thinking 2004, 2005 time

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1 frame for it to be the model in the code.

2 What we're doing for the AP1000 work is
3 more of a -- we're simplifying what's currently in the
4 code with something that's more of a -- Joe, do you
5 want to say what you're doing?

6 I don't want to say it's simple, but it's
7 not the mechanistic model with a droplet diameter and
8 the interfacial area tracking, and what have you.
9 It's going to be easier to follow than what's
10 currently in the code. It will get rid of the
11 conservatisms that are coming from too much
12 entrainment at the punch front. And we're hoping to
13 have that done by the spring/summer time frame.

14 Do you want to --

15 MR. KELLY: I'll have several slides in my
16 presentation, so I'll wait for that.

17 MS. UHLE: Okay. I didn't mean to say
18 what you're doing is simple.

19 Again, we know that the phase separation
20 model in the RELAP5 code was determined to be
21 inadequate for the phenomena. It turned out that the
22 AP600 had so much water reserve that it didn't make a
23 difference in assessing collapsed liquid level, so the
24 code was determined to be adequate for the AP600
25 calculations with the fact that they have a higher

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1 power density and the inventory to power ratio of the
2 AP1000 is reduced. We realize that the phase
3 separation model for the stratified conditions during
4 ADS 4 time frame is going to be of higher priority, so
5 we're looking at that.

6 Steve Bajorek will talk about that in more
7 detail.

8 We have there, too, for the PBMR design
9 certification that we're expecting to come in. I
10 think you know the background on that with the idea
11 that it is now a helium cooled/graphite moderated
12 reactor. It's a little bit different than the light
13 water designs that we currently deal with. It's a
14 pebble bed rather than the force flow parallel to the
15 bundle situation that we currently deal with.

16 We've drawn the conclusion that we would
17 be upgrading -- or not upgrading, but extending the
18 TRAC code and the MELCOR code to be used in real
19 certification if it were to come in. And we have
20 identified what needs to be changed in the code, and
21 you have a list of them on your slides. I don't need
22 to go into them. I don't think --

23 CHAIRMAN WALLIS: You're worried about
24 water ingress?

25 MS. UHLE: Yes, water ingress because of

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1 the reaction with the graphite. Because you have the
2 second -- well, you have the cooling on the -- you
3 have the bring cycle but you've got the compressor in
4 the intercooler.

5 CHAIRMAN WALLIS: The intercooler is a
6 water cooler?

7 MS. UHLE: Yes, so you can get water
8 ingress. We can do water ingress and air ingress at
9 the same time and we have it working for the helium.
10 So we'll be able to run the whole gambit of the
11 accident scenarios with respect to the pebble bed.

12 Now, we do have some code development to
13 do as well as benchmarking, and we'll be doing that
14 in-house as well at Las Alamos National Laboratory.

15 CHAIRMAN WALLIS: Hydrogen and CO --

16 MS. UHLE: Yes.

17 CHAIRMAN WALLIS: -- process, or whatever.

18 MS. UHLE: Yes. Modifications also had to
19 be made to MELCOR and we've identified those, and
20 those will be done at CNL and National Laboratory with
21 staff involvement.

22 So that's where we're heading. We're
23 going to not get away from this. It was thought that
24 maybe we would use a special code for the pebble bed.
25 Again, we're focused on this idea of having modules

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1 that only need to be exercised if they need to be
2 exercised to get this approach with the consolidated
3 code having one code.

4 MEMBER KRESS: Well, what's the purpose of
5 looking at the water ingress for example. There are
6 no graphite structural ingress in there, are there?

7 MS. UHLE: There are no what?

8 MEMBER KRESS: Structural ingress in the
9 graphite? There's only the spheres of graphite isn't
10 there, they're not structural. So that's the --

11 MS. UHLE: It's a fuel damage issue.

12 MEMBER KRESS: We're looking to see
13 whether in the break the spheres --

14 MS. UHLE: Yes, that would be in the
15 severe accident situation.

16 MEMBER KRESS: -- break or something of
17 that kind?

18 MS. UHLE: Or would oxidize, getting
19 brittle, break and then get the fission products out
20 because the pebbles are the --

21 MEMBER KRESS: But you have no data on
22 sphere strength. I don't understand what you will do
23 --

24 MS. UHLE: That's the last bullet. Data
25 for benchmarking.

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1 Originally in the budget this year there
2 was going to be some money for fuels testing.

3 MEMBER KRESS: I don't understand --

4 MS. UHLE: As the submittal comes in, that
5 will be ramped up to meet the data needs. We're not
6 going to use the code unless it's assessed.

7 MEMBER KRESS: You're going to degrade
8 these spheres, make them go through the separating
9 devise and see if the break --

10 MR. ROSENTHAL: All right. I'll be fast.
11 Presentations of the pebble bed say it's a very benign
12 system.

13 MEMBER KRESS: Yes. Absolutely. Okay.

14 MR. ROSENTHAL: And so we started asking
15 ourselves, okay, what about the accident provisions.
16 And bare in mind that design bases accident goes
17 beyond design base, or even that language is not yet
18 defined for this system.

19 MEMBER KRESS: Yes.

20 MR. ROSENTHAL: And we may be talking
21 about a spectrum of accidents, one accident, whatever.
22 Okay. And so we started saying, okay, what kind of
23 issues might we face, and we recognized that we needed
24 to start thinking about well what happens if we put
25 air in there, or water in there instead of helium, and

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1 what kind of chemical reactions would take place, or
2 whatever. And because of the time it takes to develop
3 a code, we needed to get a jump start on these issues.
4 And that's really where we are now, you know, we
5 haven't thought it through. We're still defining the
6 research plan for it.

7 MEMBER KRESS: My question is --

8 MR. ROSENTHAL: But the concern is --

9 MEMBER KRESS: Yes. My question is are you
10 concerned about degradation of strength of these
11 spheres or are you worried about the effects on
12 fission products, or both?

13 MS. UHLE: Both. I mean, you get the
14 oxidation action causing fuel heat up and then you're
15 also getting fuel damage and how that's going to --
16 essentially if there's no containment, how the fission
17 products would be escaping because of that. So with
18 respect to the why in the TH code are we worrying
19 about that? Well, we're going to tell you how much
20 water comes in and what state it's in. Is it steam,
21 what temperature, what have you and get the oxidation
22 reaction and then, of course, going into the
23 theorizing for the core degradation.

24 CHAIRMAN WALLIS: So you're identifying
25 all the things that you're TRAC-M modification have to

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1 be able to handle, that's really the message you're
2 giving us?

3 MS. UHLE: Yes.

4 MEMBER SCHROCK: What doesn't come through
5 clearly to me is why one would choose TRAC-M as a code
6 to analyze this new system.

7 MS. UHLE: It's probably at this point in
8 time --

9 MEMBER SCHROCK: I mean almost none of the
10 --

11 CHAIRMAN WALLIS: It's the only one they
12 have.

13 MEMBER SCHROCK: Well --

14 MS. UHLE: No, that's not right.

15 CHAIRMAN WALLIS: It's the only one they
16 will have.

17 MS. UHLE: No, that's not the answer.
18 I'll give you the answer.

19 MEMBER SCHROCK: But they're so different
20 from one another and --

21 MS. UHLE: Well --

22 MEMBER SCHROCK: -- all these gory details
23 of what goes on in water reactors has no impact.

24 MS. UHLE: Again, it's going to be
25 physical models that are going to be different. You

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1 have -- I mean, if you look at the code as far as how
2 many hundreds of thousands of lines it may be, the
3 physical model package, I mean it's dinky. It's maybe
4 where the correlations are, maybe 400 lines or more,
5 or less. I mean, it's not -- putting in a different
6 wall drag or a different -- you know, effective
7 conductivity for the fuel. I mean, that's small.
8 What's in the code is the setting up of the matrix, it
9 is the communication of the data between the cells if
10 you have -- like in a 3-D. We have a 3-D vessel here
11 of porous media. The hydraulic model in TRAC is
12 essentially a porous media 3 dimensional model with
13 wall drag, that is assuming the flow is parallel.
14 Well, now the flow is going to be over spheres so we
15 have to replace that wall drag term with something
16 that represents the fact that you're flowing over a
17 pebble bed.

18 So, looking at all the codes that are out
19 there, TRAC was the one that had the less amount of
20 work done. We already have helium as a working fluid
21 in the code. Again, we have the porous media hydraulic
22 model.

23 We can do -- on the intercooler side, the
24 secondary -- if you want to call it the secondary
25 side, you know, we have the water loops for the heat

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1 transfer. We have a turbine model that we have to
2 modify so that it's a two-phased turbine. But, you
3 know, we have the equation set up and already
4 dispartized; it's a matter of putting in different
5 physical models. But that's the, in some sense, the
6 easy part.

7 MEMBER KRESS: But you could have a break
8 in the intercooler, and the water is a lot lower
9 pressure than the helium. How do you deal with that
10 in terms of ingress to the water, or you haven't
11 gotten that far yet?

12 MS. UHLE: Well, I mean we are modeling
13 the -- you mean, the intercooler breaking and not
14 flowing into the helium, because there are two
15 different sections. And so if we had an intercooler
16 break, it'll just be like faster flow out and cooling
17 down; it'll be like a main steam line break in some
18 sense.

19 MEMBER KRESS: Yes, but I presume if
20 you're given a small leak, you know, have a crack in
21 it.

22 MS. UHLE: Yes.

23 MEMBER KRESS: And it gets some water
24 ingress.

25 MS. UHLE: Into the helium? Sorry?

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1 MEMBER KRESS: How do you get water into
2 the helium is my point?

3 MS. UHLE: Oh, how do you get the water?
4 Well, for instance, if a steam generator were to
5 rupture, the same kind of situation where it's passing
6 over, if you get the water in -- oh, you're saying the
7 helium's higher pressure. Oh, I see.

8 MR. ROSENTHAL: Let's not get too far
9 ahead.

10 MEMBER KRESS: It's a technical issue.

11 MR. ROSENTHAL: At one time a few weeks
12 ago I asked at this plant if it had MSIVs, and I was
13 told, well MSIVs is the wrong term. There would be an
14 MHIVs. And so I said okay, is this plant going to
15 have MHIV? And I was told we don't know yet.

16 So let's not get too far out ahead of the
17 planning cycle. What we know is we started. We
18 really need tools to do analyses.

19 MEMBER KRESS: And that's the main thing.

20 MS. UHLE: But in the sense that you can
21 have a lower pressure or you can have a break in your
22 helium side, you get loss of forced circulation and
23 you still have hot graphite, you're at a low pressure,
24 water can get in. Because -- okay.

25 MEMBER KRESS: I'm sure there's some areas

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1 that we can -- again --

2 CHAIRMAN WALLIS: We can't spend an hour
3 on the pebble bed reactor. We have to move on. Yes,
4 they're just giving us an overview, I think.

5 MS. UHLE: Yes. We will be using the code
6 and, again, the changes in the physical models are --

7 CHAIRMAN WALLIS: And you're thinking of
8 all the things you need to put in that code, you need
9 to build a model.

10 MS. UHLE: Yes, and we have done that or
11 in the process of doing that.

12 CHAIRMAN WALLIS: And when are going to be
13 ready to run?

14 MS. UHLE: Well, the work scope for next
15 year is putting in the physical models for next year
16 and finding data for benchmarking and doing modeling.
17 So by next time we meet in front of you, we should
18 have a pebble bed.

19 CHAIRMAN WALLIS: I just hope that you've
20 got models up and running before someone's already
21 made a decision for license on what the design bases
22 accidents are and all those sorts of things.

23 Do you actually have put in inputs to give
24 so quality decisions are made?

25 MEMBER KRESS: Well, is one of the models

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1 going to be the fusion of water vapor in the graphite
2 spheres and what is the chemical reaction?

3 MS. UHLE: That would be the MELCOR side.

4 MR. ROSENTHAL: We may do that in MELCOR
5 fusion and hydrogen. We've got two major efforts.
6 One is TRAC and the other is MELCOR.

7 At one time we thought that -- just
8 conceptually that many of the pebble bed issues really
9 would be more chemical type issues and that the MELCOR
10 frame would be the place to focus. Then at the
11 experts meeting -- but we still had money in for TRAC.
12 Actually, it was Andy Kadak that kept bringing up
13 issues of reactivity events that might occur with
14 restacking or you lose the pressure, the walls move,
15 or stuff like that. Well, again, we had PARCS again
16 with TRAC. And so PARCS TRAC becomes the natural
17 place for us to want to explore that. But we really
18 are at the level of building the MELCOR models,
19 building the TRAC as tools for what we don't know yet.

20 MS. UHLE: I just want to point out with
21 looking at the kinetics, since that's been brought up,
22 we're really benefitting from the MOX program. I
23 can't believe I'm bringing that one back up. But the
24 things that are immediate is the soon to be needed for
25 the pebble bed work is similar to what has already

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1 been for MOX. And so what has to be done for MOX is
2 a cylindrical co-ordinate system, but that's pretty
3 simple to do. And the fact that the control rods are
4 in the peripheries, we would need a transport in that
5 area, but we have that for MOX already, and that's
6 currently being tested.

7 So, we're using what we already have.

8 All right. So I'm going to summarize. I
9 think this was the slide that Professor Wallis has
10 been looking for.

11 CHAIRMAN WALLIS: So we can get close to
12 the end?

13 MS. UHLE: Yes. I don't know if it's the
14 end of my life or my career, or at least my
15 presentation.

16 The branch provides technical support to
17 the offices as needed, and we use the analytical tools
18 and, of course, the analyses capabilities of the
19 branch to meet those needs.

20 We're currently looking, the applications
21 we're looking at are associated with licensee
22 submittals, such as the power upgrades and the MOX
23 fuel. Generic issues such as the CRDMs, steam
24 generator tube integrity. Risk-informing activities,
25 50.46 and 50.61. And design certification, AP1000 and

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1 pebble bed.

2 We realize that we will have to make to
3 improvements to these codes as emerging issues arise
4 and, again, we're focusing on doing that more in an
5 in-house fashion looking at perhaps coupling to other
6 codes as needed rather than using separate codes with
7 the same functionality. We're going to get away from
8 that. We're only going to use -- or only use what we
9 need to versus having ten codes in our code suite for
10 just TH.

11 And, of course, we're doing internal model
12 improvements such as for the AP1000 case.

13 Jack had talked about this, and I
14 mentioned it in the introduction, is that we have
15 hired -- we are in process of hiring entry level
16 employees as well to round out the technical
17 capabilities of the branch. Because we are actually
18 busier now than we have been in a while.

19 It's not just going to be for thermal-
20 hydraulics. It's also computation of fluid dynamics
21 as we start to use CFD more as a tool, especially with
22 the pebble bed work CFD will be used in the single
23 phased situations.

24 The severe accident in the fuel behavior,
25 we'll be ramping up the program and making a strong

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1 connection in the branch so that we can work
2 seamlessly across the sections.

3 MEMBER FORD: Could I just ask a question?
4 Why entry level?

5 MS. UHLE: Because there's a lot of -- if
6 you look at the Office of Research, there's a lot of
7 experience in the Office of Research. And so with
8 staffing issues, we're not allowed to be top heavy and
9 all 15-10s there's some --

10 MEMBER FORD: Six to 1 ratio or something?

11 MS. UHLE: Yes. There's some, you know,
12 there has to be some ratio. And this idea of
13 everyone's going to start to retire, we need to bring
14 in entry level and mentor and, you know, have a more
15 gradual --

16 MEMBER FORD: I wasn't thinking of the 60
17 year olds, I was thinking of the experienced 40 year
18 old.

19 MS. UHLE: Experienced 40 year olds.

20 MEMBER FORD: Given the fact that you've
21 got a lot of workable --

22 MS. UHLE: We found some positions for 15s
23 in the branch that we are hiring in the severe
24 accident as well as the fuel behavior. In thermal
25 hydraulics, if you look at who has been hired, they've

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1 been at the higher grade levels. So it's not all
2 entry levels.

3 I say entry levels, that's in some sense
4 we are more active in the entry level hiring because
5 there's more positions available. But the office is
6 looking at, you know, the higher grades as well.

7 MEMBER KRESS: Are any of those new hires
8 here?

9 MS. UHLE: Yes, they're all here. You
10 guys want to stand up.

11 MEMBER KRESS: They're all here.

12 MS. UHLE: Steve Bajorek. Da, da, da.
13 He's our SL, senior level scientist. He's our
14 experienced -- you're at least a 40 year old. Okay.

15 Joe Kelly, you know Joe Kelly. He is --
16 yes he's another -- he's another 29 year old.

17 MR. BOEHNERT: I think, Jennifer, you're
18 going to have to give your age now.

19 MS. UHLE: 32 November 23rd. I just turned
20 32.

21 MEMBER KRESS: You're not counted in the
22 new hires, are you?

23 MS. UHLE: What?

24 MEMBER KRESS: Are you one of the new
25 hires?

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1 MS. UHLE: No. I've been demoted to
2 assistant branch chief. They won't let me touch the
3 code anymore.

4 CHAIRMAN WALLIS: Jennifer, we're way
5 behind in time. How long are you going to go on with
6 this?

7 MS. UHLE: Chris Murray. For
8 introductions, it's quick.

9 Chris Murray's from Penn State University.
10 Tony Ullses from NRR. He's been sparing with
11 Professor Schrock there for quite a bit.

12 And Joe Staudenmeier from NRR.

13 Chester Gingrich has been in severe
14 accidents. He was doing some thermal hydraulics work,
15 now he's going to go back to severe accidents.

16 And then, of course, there's Weidong Wang
17 in the back. Shanlai Lu and Jim Han is doing analysis
18 for us in the back. And Dave Bissette lead on the PTS
19 work.

20 CHAIRMAN WALLIS: We're severely behind in
21 time. Of course, you have given us more detail in
22 some of these things, since you were going to
23 summarize. Does that mean that we can move faster with
24 some of the later.

25 MS. UHLE: I think the question is how

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1 many questions get asked.

2 CHAIRMAN WALLIS: Well, you had a
3 tremendous amount of stuff.

4 MS. UHLE: Well, when I went over it in my
5 head, it went very fast.

6 CHAIRMAN WALLIS: We need to be finished--
7 or you need to be finished by 1:30 because we have
8 another group, a very different group coming in and we
9 can't short change them. So we're going to take a
10 break now and then maybe you can work with your
11 colleagues to get us through on time. You work with
12 your colleagues to get us through on time.

13 And I'm a little nervous about Joe Kelly,
14 he always runs over. Maybe we could find a way to
15 prevent that happening.

16 So we'll take a break. Thank you very
17 much. And we'll start again at 20 to 11:00.

18 (Whereupon, at 10:25 a.m. off the record
19 until 10:40 a.m.)

20 MR. KELLY: My name is Joe Kelly, and I'll
21 be talking about the TRAC-M code consolidation and
22 development.

23 Now, the last time I was in front of this
24 Subcommittee I was up here for 6½ hours. And since
25 we're already an hour behind schedule, Professor

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1 Wallis is concern is well taken.

2 So this presentation really is three
3 presentations in one. I was going to talk about the
4 code consolidation status followed by Jennifer Uhle
5 talking about the SNAP development that's the
6 graphical user interface. Then I was going to talk
7 more about our long term development plans and a
8 movement about how we're going to integrate some of
9 our stand alone programs into the code development.

10 So what I'm going to do is condense the
11 code consolidation status, you've heard a lot of this,
12 in half, and Jennifer is going to skip this
13 presentation, because you've heard about SNAP before,
14 and then I'll try to give most of what I had planned
15 to give.

16 When we first started this program back
17 almost 5 years ago, we laid out five areas that we
18 wanted to make improvements in. Modernize the
19 architecture, accomplish the code consolidation to
20 conserve resources, improve the ease of use, accuracy
21 and numerics. And I was going to say something in
22 each of those areas, but I'm going to shorten it
23 because first I what wanted to do is give you an idea
24 of where we are today. And that should somehow avoid
25 --

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1 Take my word for it. The colors on the
2 view graph are much prettier than the colors here.
3 That's really horrendous.

4 But anyway, this is where we are today.
5 We have accomplished the modernization and the
6 functionality. We have parts and functionality of
7 TRAC-B and RELAP5. We do not have physical models of
8 those codes, nor do we intend to implement all of the
9 physical models of those codes.

10 What we're working on at the moment is
11 called the component mapping, and that's the way that
12 you take your RELAP5 component through the SNAP
13 graphical interface and translate it to a TRAC-M
14 component. And that's what's going to enable us to
15 take the RELAP5 input deck, read it in and run it with
16 the TRAC-M code. This work is almost complete. This
17 line is supposed to show about where we are. It will
18 be complete shortly after the beginning of the year,
19 at which point we'll start a development assessment.

20 Now, originally the idea was to start the
21 assessment and let the model deficiencies from TRAC-M
22 show up as a result of the assessment. Then when you
23 identify a deficiency, go look at them. First, go
24 look at the models in the other code and try and make
25 a judgment that, say, interfacial drag in TRAC-B is

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1 better than TRAC-P, etcetera, and then bring that
2 model in. And that would then be a cyclical process.

3 Now, we're still going to do that to some
4 extent, however there are two deficiencies that
5 immediately showed up. The first is rod bundle
6 interfacial drag, and that's what we've alluded to in
7 the Peach Bottom Turbine Trip when Jennifer was
8 talking about that. We simply couldn't predict the
9 action in a void track and operate the BWR accurately
10 enough. So what we're going to do is implement,
11 again, basically the interfacial drag and interfacial
12 heat transfer routines from the TRAC-B code to be used
13 only for BWR channels and probably also the BWR core,
14 but not globally.

15 Likewise, this is a deficiency that has
16 been identified in the reflood model. I'll talk a
17 little bit more about that. That's what I'm working
18 on.

19 These will feed in as soon as they're
20 finished through developmental assessment, and we'll
21 have roughly about a six month period where all the
22 models of the code will be frozen and go through the
23 entire assessment matrix and then that leads to
24 releasing the consolidated code at the end of calendar
25 '02.

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1 CHAIRMAN WALLIS: So maybe by the middle
2 of next year or something you can show us some of your
3 development assessment work?

4 MR. KELLY: Yes.

5 These are the type of slides I'm not going
6 to belabor. The only thing I want to point out on
7 this one is that we have something called an exterior
8 communication interface, and that was built in to
9 allow us to very easily couple the other codes or
10 special modules into the codes for capabilities that
11 we don't either have in TRAC-M or don't want to build
12 in. It's already been done in an explicit with the
13 REMIX code, the PPS calculations, and also we've done
14 a preliminary coupling with the CONTAIN code.

15 We're skipping the SNAP presentation, and
16 I'm going to not belabor this also, but we've put a
17 lot of work in the draft communication interface
18 making it easier to use. So if you ask our new group
19 what is their highest priority item, this is it.

20 Most of what we need is going to be done
21 in early 2002, but the playback capability will be
22 mid-2002 and interactive display with user feedback,
23 that is where you can run it like a simulator mode, is
24 sometime in the future.

25 Documentation was mentioned earlier.

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1 Documentation is a very important step and it has to
2 be a continuing effort over the life of this project.

3 CHAIRMAN WALLIS: Is it true that the code
4 has not yet run?

5 MR. KELLY: Excuse me?

6 CHAIRMAN WALLIS: The question I get is
7 that it hasn't yet run, because it hasn't yet done
8 these PWR transients or PWR LOCA or anything?

9 MR. KELLY: No, we did those. No. The
10 code runs and it has been all throughout the process.
11 We did the development that way. And there are
12 several hundred test problems designed with each
13 developmental version.

14 I shouldn't have skipped probably over
15 this. It's seeing results of TRAC-M coupled to PARCS
16 for the Beach Bottom Turbine Trip as well as a main
17 steam line threat. So that is TRAC-M doing those
18 calculations.

19 We can do BWR to our transients now, the
20 reason I say early 2002 here is so that we can read in
21 a TRAC-B input deck, and existing one, and run it in
22 TRAC-M. All that capability is there. But the reason
23 it has this date on it is for the upgrade to the
24 interfacial drag package. Which Tony Ullses is trying
25 to quickly put that in to see if it would work and

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1 make the improvements that he needed for Peach Bottom,
2 but we want to put it in a more correct way according
3 to what we call a low level modularity. And so that's
4 when this work will be finished.

5 For the SBLOCA, I don't know that we've
6 actually run any of those. The completion date here,
7 though, is for the component mapping, you know, when
8 that development work will be finished. And that's
9 when the assessment for SBLOCA applications will
10 start.

11 For large break LOCA, we could do a large
12 break LOCA now but from my standpoint the reflood
13 model was flawed so that this is the date by which
14 we'll have an interim reflood model and we'll start
15 doing the reflood part of the assessment matrix.

16 MS. UHLE: Joe, can I just clarify one
17 thing on that. I'll only be a second.

18 This is the last --

19 MR. KELLY: Just don't get my slides out
20 of order.

21 MS. UHLE: I know. I am just going to --
22 this was going to be my presentation on the buoy.
23 Again, here, with respect to RELAP release, we have a
24 RELAP5 version completely finished for the post
25 processing and the model editor where you're dragging

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1 and dropping models. We can interact with that
2 display. You want it in a simulator mode already with
3 RELAP and TRAC. The date here being future is that
4 with the idea of having -- we have a three dimensional
5 model and right now when you look at the playback,
6 you're seeing it in 2-D. We want, for the ease of use
7 for the user, extend that so that you can represent
8 the three dimensionality in a more easier way. So
9 that's why under this there's a future, although we do
10 have the ability. We showed you that last year,
11 running of TRAC in an interactive mode while we opened
12 valve and saw it blow down. So that's been in for two
13 years -- I mean, for a year.

14 And in early 2002 being able to run,
15 taking a RELAP5 input deck and converting it to TRAC
16 and doing the drag and drop through the TRAC model,
17 that's the last bit that we're doing right now. And
18 also the plotting here with the mid-2002 date. Again,
19 that's associated with three dimensionality. We can
20 2-D plot now already. We want to be able to 3-D plots
21 very easily to get the surface plot of the core boil
22 fraction and the 3-D kinetics.

23 MR. KELLY: Good. Thank you, Jennifer.

24 CHAIRMAN WALLIS: I notice the
25 documentation is a continuing effort.

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1 MR. KELLY: Yes.

2 CHAIRMAN WALLIS: Doesn't the
3 documentation come first or do you write the code and
4 then figure out what you did and write up the
5 documentation?

6 MR. KELLY: As Jennifer said earlier, we
7 have conformed with a fairly rigid SQA, certainly
8 compared to anything that's ever been done with NRC
9 code.

10 CHAIRMAN WALLIS: Then this documentation
11 should be in good shape.

12 MR. KELLY: Yes, but each piece, each new
13 piece has to be folded in in the overall
14 documentation. And, for example, it was mentioned
15 earlier that the TRAC manuals were extraordinary and
16 it's hard to find your way around in some of them.
17 Rewriting all of that from scratch is a major task.
18 And what we're doing at the moment is basically
19 putting in the pieces that we're changing. We do need
20 to go and make all the whole restructure done but
21 that's a huge effort and we've connected randomly to
22 make it work at the moment, but we are going to --
23 that's why somebody has to start and keep working at
24 it.

25 CHAIRMAN WALLIS: But it's important. The

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1 way you present the documentation is important; that's
2 what's out there, people look at it.

3 MR. KELLY: Yes.

4 CHAIRMAN WALLIS: It's got to be credible
5 and not have typos and all the usual stuff.

6 MR. KELLY: Right.

7 MR. BOEHNERT: Historically what's
8 happened is the documentation was always put off the
9 end and then somehow it never got done.

10 MR. KELLY: Right. What we're trying to
11 do is have the people as they develop a model or
12 implement a component do the documentation for that as
13 part of the SQA. But it's still does need to get
14 folded in better to a master document. We're not
15 there on that yet.

16 CHAIRMAN WALLIS: As I said earlier, we
17 can help in the early reviews of this documentation.

18 MR. KELLY: That would be very good.

19 CHAIRMAN WALLIS: We'd like to do so.

20 MR. KELLY: We also need to, as you know,
21 improve the code accuracy. And really what I wanted
22 to say here is we're beginning now to put the models
23 in the code. And that's a huge effort, but what we
24 focused on for the last few years is putting in
25 capabilities of the functionality consolidating. But

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1 we've got a lot to do here and this is just starting.
2 But that's not part of the code consolidation, that's
3 part of us evolving to this actual state-of-the-art
4 thermal hydraulic code.

5 CHAIRMAN WALLIS: Beginning isn't a good
6 word, though.

7 MEMBER SCHROCK: One of the problems has
8 been that the codes run part of the way through a
9 problem and then crash, and then people fix it up and
10 run the rest of it. In my mind that leaves a lower
11 level of reliability when that kind of thing happens.

12 Do you have an objective for this code
13 that that is not going to be allowed or is this going
14 to be a continuing problem?

15 MR. KELLY: What we have the objective of
16 is to improve the robustness of the code and that is
17 just what you are talking about. It is making the
18 code be able to run to completion and not only run to
19 completion, but run without these periods where it
20 just grinds to near like halt and you go to, you know,
21 10^{-6} time steps.

22 So what we're going to do is starting in
23 the assessment when we start running in to those
24 problem, the code either fails or it has significant
25 swim outs, we're going to, in effect, ship that

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1 problem off to our numerics guru, otherwise known as
2 Professor John Mahafy, who is going to help us track
3 down the root cause of it.

4 Sometimes it'll be the numerics. You
5 know, some like the way the water tracking interacts
6 with level tracking of whatever. Sometimes they will
7 just have to be an old condition numerical, an old
8 condition physical model, the physical model that
9 causes, you know, oscillations or causes you to
10 accelerate your condensation as you go to saturation,
11 which makes it hard to put numerics to solve. In
12 which case if it's a physical model, John will kick it
13 back to me and we'll work together to try to make it
14 more robust. But, again, that's going to be a
15 process. It's going to be a process over a lifetime
16 of the code. But it is something we're committed to
17 provide. John?

18 MR. MAHAFTY: Yes, this is John Mahafy
19 from Penn State.

20 If I could make one comment on that. You
21 know, I've given guidelines to people at NRC and other
22 places that if the time step gives 10^{-5} , there's
23 something wrong with the code, and I should see it.
24 If it runs for any significant period of time below
25 10^{-4} there's something wrong with the code and I

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1 should see it. So, you know, we're not taking the
2 kinds of shortcuts -- that's a good term -- that were
3 done in the past. And I've seen problems where people
4 have run RELAP5 and it grinds down and runs at 10^{-6}
5 seconds for long periods of time and finally it
6 recovers and goes on. That's not acceptable for us,
7 because it tells you there's something wrong with the
8 code, some kind of numerical problem is potentially
9 masking what physically should be done and audited.
10 It needs to be looked at and it needs to be fixed.

11 MR. KELLY: And I agree completely.

12 The numerics can also effect accuracy, and
13 there are a few things here. In the future we'll be
14 looking at higher order differencing in order to
15 resolve things like thermal fronts. As most of you
16 know, the difference in the code at the moment is
17 first order accurate upland differencing so it tends
18 to smear out sharp interfaces. Thank will be future
19 activity. One that we have gotten created is level
20 tracking. And level tracking doesn't just mean, you
21 know, we are a 2 face interface hits and where is this
22 continuity of void fractions. What it means is you
23 find where that is and you go in and modify as part of
24 the time step your mass energy and momentum
25 conservation equations to take account of where that

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1 interface is on your computational grid. And I'm
2 going to show you an example in an oscillating
3 manometer problem of why that's important.

4 In this last, we reimplemented semi-
5 implicit scheming code which turned out to be very
6 revealing in order for that we could do our stability
7 calculations so that you don't get the damping that
8 can develop in implicit scheming.

9 This is an oscillating manometer test
10 problem. Very simple. Two vertical pipes, they're
11 each 10 nodes one meter long. And this is collapsed
12 liquid level versus time. The two pipes are joined at
13 the bottom, they're open to the atmosphere at the top
14 so it's an air-water simulation. They were
15 initialized half full at the 5 meter level with a
16 velocity such that this should oscillate with an
17 amplitude of 3 meters.

18 CHAIRMAN WALLIS: No friction?

19 MS. UHLE: No friction.

20 MR. KELLY: No friction. Water pressure
21 is turned off. Thank you.

22 Hence, we can tolerate it, but the orange
23 curve is an analytical solution, and when this was cut
24 and pasted from the frame maker document into
25 PowerPoint the curves got kind of shaky. But this is

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1 an analytical solution showing no dissipation.

2 The black curve was the TRAC-M calculation
3 with a standard curve. And after about two cycles it's
4 totally damped out. And the reason for that has to do
5 with the discretization of the momentum-flux terms
6 across that sharp interface.

7 CHAIRMAN WALLIS: It's a numerical
8 diffusion, in a way.

9 MR. KELLY: Yes. It's an artificial --

10 CHAIRMAN WALLIS: Artificial --

11 MR. KELLY: -- viscosity that wasn't
12 intended, but because of the way the two phase
13 momentum-flux changes. When you correct that, and
14 this was work done by Birol Aktas of ISL, this is what
15 you get.

16 Now, the test problem was changed slightly
17 --

18 CHAIRMAN WALLIS: Are all those points on
19 the curve, those are predictions?

20 MR. KELLY: Yes.

21 CHAIRMAN WALLIS: That there on a big Sine
22 wave which is in length about ten times the --

23 MR. KELLY: Okay. The legend is missing
24 here. The upside down triangle is simply an
25 identifier for the curve. It's not a point.

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1 CHAIRMAN WALLIS: Oh.

2 MR. KELLY: And likewise, so what you're
3 seeing are two curves sitting right on top of each
4 other. And they're virtually indistinguishable, which
5 is very nice that we can actually reproduce the
6 innerlocal solution. But not only that, we make the
7 test problem a little bit more difficult. It still is
8 two pipes, but it's actually now six individual pipe
9 components so that we could make sure that the level
10 traction in steam could cross boundaries between pipes
11 smoothly without putting any dissipation between that.

12 So, as far as the level tracking concern,
13 there's no difference now between a no boundary in a
14 pipe and a boundary between pipes. And it's just part
15 of the QA process to make sure the model works.

16 There have been a number of improvements
17 to the --

18 CHAIRMAN WALLIS: It seems to me there's
19 a whole slew of these QA models you need to check, not
20 just this one.

21 MR. KELLY: Right. And the more of that
22 we can do the better.

23 CHAIRMAN WALLIS: And I think it's been
24 one of the concerns with all these codes that they're
25 okay for nuclear safety, but they can't predict some

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1 of these very simple lab experiments.

2 MR. KELLY: Yes. I don't hold to that
3 theory. I think you have to predict the phenomena
4 that are actually there.

5 CHAIRMAN WALLIS: I think you should,
6 right. It's got to be honest.

7 MR. KELLY: And that's going to be a
8 process, and one of the most important parts of this
9 program is going to be the assessment. And that's got
10 to be a continuing activity at a fairly high level for
11 years, and just continue.

12 CHAIRMAN WALLIS: I hope you keep doing it
13 already. Have been doing it.

14 MR. KELLY: I'm not going to really talk
15 about the improvements to the kinetic module. That
16 was pretty much gone over in Jennifer's presentation.
17 I simply don't have the moxy to do it.

18 MEMBER SCHROCK: What did you do to the
19 numerics again to change the picture so drastically?

20 MR. KELLY: Okay. If you get me off into
21 details, I may have to go to Birol, but I think I can
22 give you the idea.

23 MS. UHLE: Birol left. John Mahafy is
24 his thesis advisor, he can answer the question.

25 MR. KELLY: If you have an -- in the

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1 momentum-flux term there's an alpha row of DVDX. How
2 do you discretize that term across an interface is the
3 problem. And if you look at the way it's typically
4 done in RELAP or TRAC normally, it's really built into
5 the two fluid model an assumption that you have these
6 continuous evolution of weight fraction across the
7 computational mesh. And when you do that, that term
8 is suitably accurate. But if instead you actually
9 have a sharp interface, so let's say you're on
10 convection vapor out as this interface goes, but
11 you're averaging between these cells to get these
12 alpha rows and DVDXz then you introduce a dissipation
13 term.

14 And I've actually even seen in some codes
15 when it said dissipation, in fact situation will reduce
16 oscillation. But normally it's dissipating.

17 So what we've done is say we have this
18 tracking scheme that tells where this level is. Now
19 in our, you know -- we basically pull our back of the
20 envelop and write down what the momentum equation
21 should be if you've got the single phase vapor going
22 across this with this level approaching it. And then
23 put in, adjust the terms in the momentum equation and
24 make them what they really should be.

25 MEMBER SCHROCK: But I thought there was

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1 already a level tracking in the original track.

2 MR. KELLY: There was one in TRAC-B.

3 MEMBER SCHROCK: Yes.

4 MR. KELLY: And there was -- it works more
5 as an interface sharpener. So what it would do is try
6 to track where the level is and adjust interfacial
7 drag in an interfacial heat transfer model. Level
8 tracking has to, if it's going to work right, has to
9 do a lot of things. And so it basically it turns
10 interfacial drag down. It says, okay, there should be
11 a level here. Let's lessen interfacial drag so we
12 don't pull this liquid up when we shouldn't be.
13 Likewise, it says okay the interfacial area is a pipe
14 instead of treating the vapor as bolts.

15 But that's just really -- that's the easy
16 part. The tough part, which really gets this to work,
17 is going in and actually fixing the conservation
18 equation for a different physical situation.

19 CHAIRMAN WALLIS: So this goes back to
20 what I said this morning. Jennifer was talking about
21 a pipe. You can recommend an equation for a pipe, and
22 in fact they were this way, so that it behaves like a
23 pump.

24 MR. KELLY: True.

25 CHAIRMAN WALLIS: Under some circumstances

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1 because of the way you're averaging the stuff.

2 MR. KELLY: You have to be very, very
3 careful. And this is something that Birol under
4 John's guidance did a very good job on.

5 The last stage of the consolidation
6 program is developmental assessment. And what I've
7 done is put together an assessment matrix that we're
8 going to start to do during calendar year 2002. I'm
9 going to give you an example of how that was put
10 together.

11 I also have a handout, I'll give you what
12 I've proposed test matrix says. I've got that written
13 in, I'll get it to you.

14 Now, the test matrix is quite extensive,
15 but it is far, far from comprehensive. I mean, there
16 are whole areas that are left out. And those areas
17 are going to have to be plugged by the assessment we
18 do in the future. And that's why Steve Bajorek is
19 going to talk after me.

20 We're going to a per face developmental
21 assessment for each of the applications that the code
22 is going to be used for.

23 So what I'm doing here is, remember our
24 success criteria for the consolidation. For the TRAC-
25 M code we will be able to run it against each of the

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1 predecessor codes; TRAC-B, TRAC-P and the RELAP5 for
2 the application of interest for each of those codes,
3 and TRAC-M would do at least as well. That's our
4 success criteria.

5 CHAIRMAN WALLIS: Do you have a matrix
6 like this for simple experiments, like the manometer
7 as well as these --

8 MR. KELLY: Yes.

9 CHAIRMAN WALLIS: -- messy experiments
10 where everything's going on and you get AB
11 compensating errors and so on?

12 MR. KELLY: There's about half of those in
13 the works. And that's something that could be
14 expanded.

15 This one is for separate tech specs
16 reflood heat transfer. And what I'm going to do is
17 just give you an example of how this got made up.

18 The first thing I did was for the three
19 predecessor codes; this was TRAC-M the F77 version,
20 which is basically just TRAC-P. There are no models
21 in this version at all. An assessment of that was
22 done relatively recently, and that's the document
23 NUREG/CR-6730, and that was published, I think, about
24 a year ago.

25 For TRAC-B the last NUREG-B developmental

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1 assessment code was, i believe, the 3663, and after
2 that there were two other NUREGs by other contractors
3 that did further assessment of the TRAC-B code. And
4 I also had input from INEL and Penn State.

5 For RELAP5 this was the last published
6 development assessment of the code, because there was
7 also an assessment of it in this NUREG as well as the
8 assessment we did for as part of the AP600.

9 So I looked at all of the tests that were
10 done for these, and for this phenomena listed each of
11 the ones according to the code it was used for. And
12 we then in the TRAC-M column, I basically summed them.

13 Now, if we simulated with one of the other
14 codes, I brought it over and stuck it in here. And so
15 these are the ones we're going to do unless there was
16 some reason not to do so, and that logic is what I'm
17 going to show you now.

18 All of the codes the flux is at 31504;
19 that's a one inch per second 40 psi base case force
20 reflood test. So, obviously, we're going to do that.

21 31701 is 6 inches a second, so that's at
22 the other end of the spectrum, so that was done in
23 RELAP5 and we will include that here.

24 Now, this test 33436 is a gravity reflood
25 test done in FLECHT SEASET, and because of the way the

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1 downcomer is and the way the exit coming up the front
2 is there are a lot of uncertainties in the downward
3 positions. So there's no good reason to do a gravity
4 reflood simulation for that facility when we have
5 facilities like CCTF and SCTF. So I'm going to
6 eliminate this test.

7 Now, when I looked at -- I just mentioned
8 CCTF. As part of the TRAC-B assessment measure there
9 was a CCTF basis run in 14. But what they did is
10 actually a gravity test, but they ran it as a forced
11 reflood test. What that means is they stripped off
12 the downcomer, stripped off the wall clamp and imposed
13 a flooding rate at the bottom of the core. That's
14 artificial. No one knows what that flooding rate is.
15 They inferred it, it was inferred from the
16 experimental data based upon what came out the top of
17 the bundle and the build up of inventory in the
18 bundle.

19 So running this as a forced test -- I mean
20 if you're not even monitoring what you're putting into
21 the bundle right, how can you do an assessment of it.
22 So I think this is of limited value and as part of the
23 integral effects testing we will be doing a couple of
24 CCTF cases. That's something in the future we'll have
25 to expand. I saw no point in doing this, so I took it

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1 out.

2 FLECHT SEASET there was one test run for
3 TRAC-B, and obviously we're going to keep this. This
4 is a large scale reflood gravity. It's 8 bundles,
5 2,000 meter rods lined up in a slab, so it models at
6 full scale the distance between the reactor core
7 center line and the core barrel. Very important
8 contributing effects. The Lehigh Rod Bundle, this was
9 done with TRAC. It's a nine live bundle, so it's 3 by
10 3, which means it's about this big, and there's a
11 heated shroud there's a lot of questions in its regard
12 to things like heat losses, its quality fully
13 instrumented and plus as you know, if you try to do a
14 two phase, and this is also in one atmosphere, test
15 in something this big, any vapor structure is going to
16 span it and it's going to act not like a broad bundle
17 at all, but more like a tube. So it's not productive,
18 its of limited usefulness, let's not waste our time on
19 it.

20 FLECHT test 9077 which was done on TRAC-B, is
21 from the original FLECHT series and it's 6 inch per
22 second new core rate capacity. Now that facility does
23 not have delta P cells, and likewise did not measure
24 specifically the steam temperatures. There is a lot
25 in that less experimental information than there is

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1 with the more modern codes like FLECHT SEASET. So I'm
2 going to get rid of this test and replace it with
3 31701.

4 The GOTA, and I know I don't pronounce
5 that right, but this reflood test is combined top
6 spray cooling and bottom reflooding. Well if we're
7 going to discuss the BWRs you need to have assessment
8 cases for that, so we've got to keep this.

9 The NEPTUN facility which was done in
10 Switzerland is 33 rods of half height. Now, again, 33
11 rods as counted as 6 by 6 with the corners taken off,
12 is relatively small.

13 The two tests that were done, one was at
14 one 1½ centimeters and one was at 15 centimeters a
15 second. So what I've done is instead of doing these
16 two tests, I'm going to substitute the FLECHT SEASET
17 test run. This one is 6 inches a second. I added
18 this test, which is 34006, which is 0.6 inches a
19 second to compensate for the NEPTUN test that I'm
20 going to drop out. So what I'm trying to do is to
21 come up with a test basis that makes sense and covers
22 the range of conditions that we have been testing
23 before.

24 CHAIRMAN WALLIS: Of course, the advantage
25 of something like NEPTUN in is that it's not -- your

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1 conclusions are not test dependent so much on FLECHT.
2 You can say you've got something independent, you're
3 able to predict. And if there's something wrong with
4 the modeling because of the geometry of NEPTUN, maybe
5 that means that something should be in the code
6 anyway. So you might see if you can get a more
7 diversity, perhaps, in the sources of the experiments.

8 MR. KELLY: What we will be doing --
9 remember, these are -- we will be doing in the future,
10 okay. We're going to expand the matrix both in the
11 CCTF and SCTF, and this is something that Steve is
12 going to talk about. There are actually forced
13 reflood tests in SCTF, which are of great value
14 because then you know actually what you're showing in.
15 You don't have the complications of, you know,
16 potential oscillation and some down time.

17 CHAIRMAN WALLIS: You've got to prepare
18 NEPTUN. When you sort of release the code somebody
19 else may, and you might want to do it ahead of time.

20 MR. KELLY: The problem is there's a lot
21 of data out there and we have to just do the best we
22 can.

23 MS. UHLE: Our international partners
24 have, especially Switzerland with respect to NEPTUN,
25 are interested in doing assessment for us. And that's

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1 what helps us get, you know, broadening our assessment
2 range. And so I think that first to meet the 2002
3 deadline, we are trying to make one that, you know,
4 take some consideration with the good data that's out
5 there and then in the future, with the fact that we
6 have the PM program, that really broadens out our
7 assessment on this.

8 MR. BAJOREK: We would welcome other
9 groups coming in, any additional tests that would have
10 matrix. One of our problems has been resources and
11 trying to pick the test step that will give us the
12 most information without letting the matrix get to out
13 of hand.

14 MR. KELLY: And I'll give you a copy of
15 the proposed matrix as soon as I get off the stage
16 here.

17 That ended the part the presentation on
18 the status of the code consolidation. And we're going
19 to skip over the presentation on the SNAP, and what
20 I'm going to jump into now is instead the code
21 development effort for the future.

22 Again, when we first started this project
23 we went out and queried our users, both internal and
24 that would have been NRR and was then a ADOD, as well
25 as PT and RAS. And our external users liked, you

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1 know, he said, if we're going to have a state of the
2 art thermal-hydraulics code, what should it have in
3 it? And this is the laundry list they came up with.

4 In items number 1 was an improved user
5 interface. And that part of the reason why we're
6 putting in the effort on this now, to make the code
7 easier to use.

8 I'm not going to go through all of these,
9 but I'm going to do instead --

10 CHAIRMAN WALLIS: Well, where there's a
11 gap, does that mean you're not doing it at all?

12 MR. KELLY: No. It means that that it
13 hasn't started.

14 And what I'm going to show you now --

15 CHAIRMAN WALLIS: You're not using modern
16 numerical method?

17 MR. KELLY: Well, that means that
18 developmental efforts incorporate, for example, either
19 higher order differencing or a more fully implicit
20 scheme has not started. And for what I'm going to
21 show you, again the colors are abominable on the
22 viewgraph. I don't know what it worked out that way,
23 but --

24 MS. UHLE: They're extraordinary.

25 MR. KELLY: To say the least. This is our

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1 plan for what we're going to do next year and the in
2 the future.

3 So, up to here is the conclusion of our
4 current five year plan. From this line on is the
5 future.

6 Now, I've broken this down into these
7 categories: Consolidation and assessment; physical
8 models; numerics improvements; modeling capabilities;
9 and, then along the bottom I've shown code release
10 dates. And this Rev zero will be the first release of
11 the consolidated code, and that is at the end of 2002.
12 And what we're planning is annually at the end of each
13 calendar year to release another revision to the code.

14 And now let me explain this a little. If
15 you could see the colors, there's a color code here.
16 This is supposed to be a light blue. You notice these
17 boxes go with this code release. So these activities
18 will be finished and go into this code release.

19 Likewise, the green boxes feed into this
20 one.

21 CHAIRMAN WALLIS: You must have had a
22 color consultant or something.

23 MR. KELLY: Well, apparently I didn't have
24 a very good one. A budget decrease.

25 And so forth. And then actually this is

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1 revisions 3 through 5. I didn't -- once we get out
2 this far in the future I don't know exactly what we're
3 going to be doing when.

4 CHAIRMAN WALLIS: Why didn't you use the
5 primary colors?

6 MEMBER SCHROCK: If you put actual dates
7 in there, whatever they're going to be, 0.0 is
8 October 1, 2002.

9 MR. KELLY: No, these are the calendar
10 year.

11 MEMBER SCHROCK: Calendar year.

12 MR. KELLY: Yes.

13 MEMBER SCHROCK: So that means January 1,
14 2002?

15 MR. KELLY: Exactly. That'll be the first
16 release of the consolidated code.

17 MEMBER SCHROCK: So that's 13 months away
18 and you don't have a document that describes the code
19 in any complete way today. You intend to have one
20 prior to that and have some feedback as to how good it
21 is?

22 MS. UHLE: You want me to answer?

23 MR. KELLY: Please.

24 MS. UHLE: We have -- I mean, because we
25 started from a TRAC-P code, we have the base TRAC-P

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1 theory manual. And in-house we're going through that,
2 Frank Odar, Jim Han and they're pointing out where
3 things are confusing. With the developmental work
4 that has been going on we follow S2A procedures. And
5 when it involves physical modeling, of course, there
6 are sections written by the developers documenting
7 what was done so that those sections will be put into
8 the theory manual. So we have the documentation. It
9 has to be merged and it has to, again, get another
10 read through to make sure that there are --

11 MEMBER SCHROCK: I guess what I'm asking
12 is are you going to release this whether the
13 documentation has been reviewed or not?

14 MS. UHLE: No, no, no. We will have the
15 documentation released with in-house review and if
16 you're offering review from the ACRS if that's what
17 you're offering. But, yes, I mean we realize that
18 it's fast approaching. But I don't want you to think
19 that there is no documentation.

20 If you go up to the consolidation room,
21 there's documentation like up to here. It's a matter
22 of going through, organizing it and putting it into
23 the master document. Now everything is written in the
24 same way, word processor format, so that's going to
25 facilitate things. And then we're starting to begin

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1 the merging.

2 The user manual is up to date. We have to
3 put in modeling approaches on how to model the BWR,
4 but we're going to take out of the TRAC-B and, again,
5 go through read through and add to it as necessary.
6 But the user guide is the one that's in the best
7 shape, and the theory manual is our one that --
8 especially during the developmental assessment and we
9 start to replace physical models, we'll be adding to
10 that.

11 The programmer's guide talking about the
12 architecture of the code, we have made revisions to
13 that with the modernization, but that one is the one
14 that's lagging the most, although because we're
15 focusing on making this code more maintainable that is
16 something that we will have to do.

17 MR. BOEHNERT: Does the master document
18 include those three things you just mentioned?

19 MS. UHLE: No. There's a theory manual,
20 that is a master document. There's a user guide, that
21 is a master document.

22 MR. BOEHNERT: So each one -- okay.

23 MS. UHLE: But, again, if you're
24 interested in looking at what we've generated so far
25 and reviewing it, then we would be, I would think,

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1 more than willing. Although I don't know, I'm not the
2 office director.

3 MR. KELLY: Thank you, Jennifer.

4 CHAIRMAN WALLIS: Is this thing suitable
5 for any two phase flow problem? I mean, it doesn't
6 have to be nuclear reactors, does it?

7 MR. KELLY: Well, you can keep the
8 components of a couple of different pieces.

9 CHAIRMAN WALLIS: I think it would add a
10 tremendous amount of credibility if it was something
11 like the commercial code which is out there and has
12 been proved to work for oil and gas, and chemical
13 plants and all kinds of things. If it works for all
14 these other areas as well, then it must be really
15 good. When it's only been shown for a couple of
16 nuclear applications, then it looks real suspicious.

17 MS. UHLE: We are getting requests for the
18 code for the oil industry. And also heat exchanger.

19 CHAIRMAN WALLIS: It would be very nice if
20 you could in some of these presentations, particularly
21 the public presentations show that it's not just been
22 tuned to some nuclear applications. Okay.

23 MR. KELLY: For the consolidated code,
24 what is going to show up is what we've talked about
25 before, finishing the way to translate RELAP through

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1 SNAP to be able to run it in TRAC-M, the developmental
2 assessment and then there's the two model changes, the
3 bundle interfacial drag, which is an implementation of
4 the TRAC-B and the interim reflood model, which I'm
5 working on. And then we are going to do some work in
6 the beginning of the year on robustness.

7 And one of the things I tried when I set
8 this up was have development activities in
9 approximately in mid-year so that we would have a
10 frozen type version for, hopefully, as much as six
11 months to go through the testing before you get to the
12 release date. So that on December 31st we're not
13 changing the code model of a code that we're going to
14 release January 1.

15 Probably one of the most important
16 activities here is the PIRT based assessment which I
17 show across the top. And that's what Steve is going
18 to talk about. And it can be this assessment where
19 you look at the important phenomena and see how well
20 the code does against them that then will drive what
21 we do here.

22 The only other thing I want to talk about
23 is some of the model development from our experimental
24 programs. The green box here is supposedly subcool
25 boiling, and that refers to the UCLA program on

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1 subcool boiling and low pressure. We're going to
2 receive a model approximately mid-year and we'll be
3 implementing it during the end of 2002. But because
4 it's going to come in at the end of year, I don't want
5 it in the release code version because we want in for
6 suitable testing. So it will be part of the Rev 1.0
7 release.

8 This box is phase separation and this is
9 to build on the experimental work at OSU. So when
10 we're able to get a model from them that we have
11 confidence in we'll be putting in the code, hopefully,
12 in early to mid-2003 to show up in the Rev 1.0 code.

13 The other one is -- it really should be
14 more mechanistic but obviously we're not thinking we
15 put first principles, but more mechanistic than
16 certainly what we have today. And that's going to
17 build on the external information from rod bundle heat
18 transfer facility at Penn State. And I have several
19 slides on that later.

20 These tests are not yet defined, but I
21 have an idea of what's going to go in them. And those
22 actually take the next few slides. I'm not going to go
23 over those in detail, but this is what we anticipate
24 as of today that we're going to have change in the
25 code to make it really do a good job on more and more

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1 reactors. Core spray model, boiling transition. For
2 example, the model incurred is normally the OXY
3 correlation, which is basically the annular pore
4 regime in tubes. Obviously that does not give a very
5 good representation of dry auditing of water reacting
6 models, but also putting the place in the code that
7 supports, if you will, where a user in NRR or actually
8 at the request of NLR can incorporate on a temporary
9 basis a proprietary model in order to help them
10 facilitate their review. You have to adjust modern
11 fuel designs and fuel designs. And obviously, as I'll
12 show you, the reflood model needs a lot of work. That
13 applies to more and more reactors as well as to
14 pressurized water reactors. And also we'll have to
15 look a little more at top-down rewet both on the
16 channel box and the fuel lines.

17 MEMBER SCHROCK: This item on the BWRs
18 incorporated the proprietary model, you have in mind
19 something like what GE says they have for their rod
20 bundle on the first principle.

21 MR. KELLY: I assume what you mean is
22 where they have a drop of pH and look at the stripping
23 of the drops and the deposition of the drops
24 downstream of the grid. That's not what I meant.
25 What I meant here was the better correlation. Like,

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1 for example, I'm looking at pressurized water
2 reactors. Each vendor of each fuel design goes
3 through a testing program and develops and in effect
4 licenses the correlation for that particular type of
5 fuel. And then if you go and do some kind of
6 operational transient where your success criteria is
7 DMBR margin, well if you forget to write thermal-
8 hydraulic conditions versus time, but you want to
9 check the margin, you need to have an actual
10 correlation for the BMBR that suits that fuel
11 geometry. And it even depends upon all the little
12 tabs on the rib spacer, and it's somewhat analogous
13 for boiling-water reactors.

14 MEMBER SCHROCK: Well, here's you're
15 talking about boiling-water reactors.

16 MR. KELLY: Right, that's true.

17 MS. UHLE: Can you do a Drexal
18 correlation?

19 MR. KELLY: Well, what I'm talking about
20 is more like that.

21 MEMBER SCHROCK: That's what I'm talking
22 about.

23 MR. KELLY: Not going to actually trying
24 to predict it by stripping the film off the rods and
25 then depositing the drops downstream; that would be a

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1 research project.

2 CHAIRMAN WALLIS: Joe, you are half way
3 through your slides and taken about the time that was
4 promised.

5 MR. KELLY: Really? I thought this was
6 going pretty fast. Okay.

7 MEMBER SCHROCK: One last simple question.
8 Do you envision this option to incorporate the
9 proprietary model as something to be used by industry
10 in their use of the code or something you would do
11 with your code?

12 MR. KELLY: I envision it as something
13 that we would do in order to facilitate doing our in-
14 house calculations. But it would be something that
15 other people could use to more easily implement.

16 MEMBER SCHROCK: Yes.

17 MR. KELLY: And this is, you know, just
18 what we would like to do.

19 MR. BOEHNERT: Well, I don't know how you
20 get around, though, the thing that these codes are
21 supposed to be publicly available. I mean, that's --

22 MR. KELLY: That's why we're not going to
23 build it into the code.

24 MR. BOEHNERT: Yes, I understand.

25 MR. KELLY: Just a box, you code it

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1 yourself.

2 MR. BOEHNERT: Yes, a black box you put it
3 in. Yes. Okay.

4 MR. KELLY: Similarly, I've looked at, you
5 know, based on what we've done in the past, we looked
6 at small break LOCA, what were the problem areas. And
7 we made up a laundry list of where I think once we
8 really start doing the PIRT based PA we're going to
9 have problems. And this is the list, and in the
10 essence of time, I won't go through the list.

11 I have a similar one for large break LOCA.
12 And that takes me to what we're doing now, which is
13 the current model development activities. And there
14 are two, as I've mentioned. The first is not model
15 development so much as it model implementation, so
16 it's a rod bundle on interfacial drag, boundaries
17 necessary for the Peach Bottom Turbine Trip benchmark.
18 What we're going to do is implement the TRAC-B
19 interfacial drag and interfacial heat transfer models
20 all in route for the CHAN which is a BWR fuel
21 assembly. And we're going to look at applying it to
22 the core region of the 3-D vessel. Because,
23 obviously, the interfacial drag per bundle is better
24 than the correlations we have at the moment, which
25 were mainly focused for 2-D. And it'll just be

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1 implementing them at what I call low-level
2 modularization. This is an in-house effort by Joe
3 Staudenmeier and Tony Ullses.

4 The development activity is to come up
5 with an interim reflood model, and it's necessary for
6 doing realistic auditing calculations for the AP1000.
7 The reason it's necessary is the current model has
8 unacceptably large oscillations and at least for
9 separate FLECHT tests it's highly conservative. I'll
10 briefly show you the results of one of those.

11 We have to look at two things; the
12 physical models and also the fine-mesh numerical
13 scheme, and also is an in-house effort with Weidong
14 Wang and myself.

15 I'm going to skip the fine-mesh rezoning
16 scheme, just in the interest of time, unless there are
17 questions about it.

18 So I'm going to skip over the next two
19 slides.

20 MEMBER SCHROCK: You never question the
21 adequacy of flow regime maps in the code.

22 MR. KELLY: Well, I do. Do you mean the
23 idea of using flow regimes in general or the ones in
24 the code in particular?

25 MEMBER SCHROCK: Well, I mean the ones in

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1 the code in particular.

2 MR. KELLY: Yes. I mean, certainly
3 something that's based on a one inch diameter air-
4 water atmospheric pressure is not anything close to
5 what, you know, we should be having in reality. And
6 that's something we have to look at. There's lots of
7 areas of physical models --

8 MEMBER SCHROCK: But it isn't going to be
9 a part of the TRAC-M development?

10 MR. KELLY: Not part of the development to
11 be released at the end of December 2002. In my
12 master--

13 MEMBER SCHROCK: So you think it will be
14 eventually?

15 MR. KELLY: Yes.

16 MEMBER SCHROCK: Okay.

17 MR. KELLY: I'm pretty sure. There was an
18 item on here for low pressure interfacial drag that I
19 didn't talk about, and we're pretty sure that once we
20 start doing things like AP1000 and low pressure EKD
21 models that we're going to over predict interfacial
22 drag. And that's a point where we revisit the bundle
23 interfacial drag model and try to establish a database
24 and maybe come up with a new model if we can't find or
25 develop one that is accurate enough.

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1 The whole idea of replacing flow regimes
2 is out here much later in time, and that's the
3 interfacial area transport work.

4 But speaking of flow regimes, there are a
5 number of idealized points in reflood. And what I'm
6 showing here is clad temperature versus time of 1 inch
7 porous reflood case, and this is the heat transfer
8 coefficient versus time. And so at any one point you
9 do through a progressional regime starting with steam
10 cooling. The steam cooling actually probably stopped
11 here, and this is when the dispersed flow film boiling
12 started. The dispersed flow film boiling started as
13 the most important regime simply because that's the
14 point in which the turnaround in the clad temperature
15 established a peak value. So you always think you
16 need to model this very well. However, there's
17 another regime just a little up stream of it which
18 I've labeled the froth region here. And in the future
19 you'll hear me talk about invert slug, invert annular,
20 those types of things.

21 This region could be anything from a few
22 inches to a couple of feet, depending on the flooding
23 rate and liquid subcooling. It's very important from
24 the standpoint that with this cooling that brings the
25 clad temperature down to your quench, the temperature

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1 at which the rods get wet. So not only does it
2 control the propagation of the quench time, but it's
3 again that the vapor generation in this area and at
4 the quench time provide the source term for vapor flow
5 and entrainment that you have in the dispersement
6 area.

7 Currently in TRAC-P -- this is from the
8 manual, this is the reflood heat transfer coefficient
9 module. And I don't expect you to be able to read
10 that from this, but it's okay.

11 This is an imagine the idealized flow
12 regimes when we go from transition boiling, smooth
13 inverted annular, rough wavy, agitated inverted
14 annular, dispersed flow, highly dispersed. In all
15 these different regimes, you go through the code and
16 you use a weighted sum of contribution to each regime.
17 So what you have is one model turning on, ramping off
18 and another model turning on and ramping off and so
19 on, and you add all these pieces together. Well, it's
20 highly confusing, it's also very complicated.

21 CHAIRMAN WALLIS: That is the problem in
22 using a high pressure syllabus. I couldn't read it, so
23 I thought the flow was coming from the right.

24 MR. KELLY: That's hysterical --

25 CHAIRMAN WALLIS: You're going through

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1 bubbly and slug and annular.

2 MR. KELLY: But worse, you know it's bad
3 that it's so highly complicated. But what's worse is
4 that it's poorly suited for inclusion in the
5 computational model. I'll briefly tell you what I
6 mean. Each of these regimes is characterized by a
7 link and that link is a function of capillary number.
8 So this is based upon the type of break-up you get if
9 you take your garden hose out and turn it upside down
10 and have a jet coming down, when that jet breaks up.
11 So each of these links is a function of the liquid
12 velocity, at the quench front. And any of you that
13 have ever worked at code calculations you know how
14 noisy that is.

15 So what that says is the length of each of
16 these regimes that's been used oscillates with the
17 liquid with velocity. So, in effect, this type of
18 scheme amplifies any numerical noise whatsoever. And
19 in practice, for a forced reflooding case it leads to
20 very large oscillation that throws most of the liquid
21 out of the bottle.

22 MEMBER SCHROCK: I mean this view of
23 physics ignores the fact that when you look at such
24 experiments you actually see some large masses of
25 liquid that get thrown up and then they fall back. So

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1 at any given instant what's happening at some point
2 above quench front is some liquid going down, some
3 going up and some hitting each other, of course some
4 not and net flows. There are aspects of the physics
5 that are not recognized in this view point.

6 MR. KELLY: And there are aspects that we
7 will never capture, even if we implemented second
8 liquid fuels so you can have some going up and some
9 down. Because we'll always end up having to treat it
10 in a time average sense. You know, averaging over some
11 suitable period which may be on the order of seconds.
12 But that's --

13 MEMBER SCHROCK: Well, this is a very
14 fundamental issue with regard to these equations
15 altogether. You have variables which are presumably
16 space and time averaged. No attention given to what
17 that really has to mean in terms of specific parts of
18 the two phased domain, where in fact the time scaled
19 at which you have to be doing the averaging is pretty
20 long. It's a little bit of a stretch to imagine that
21 you really have meaningful time smooth variables that
22 you can work with the same sense that you do, for
23 example, in single turbine and single phased flow.

24 MR. KELLY: That's a limitation that, you
25 know --

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1 CHAIRMAN WALLIS: This is the present
2 state of the arch you put up there and they're going
3 to improve it.

4 MR. KELLY: Well, the first thing I want
5 to simplify it and come up with the energy and
6 hopefully, the plan then is to use the theta from the
7 RBHT facility to come up with a more mechanistic
8 model. But to go to the one more detail that
9 Professor Schrock is, that's really out there,
10 especially in a computational framework where you're
11 talking of modeling the power output.

12 And as a result, this shows an example.
13 This is FLECHT-SEASET 31504 which is the rate
14 excessive force flooding case. Clad temperature
15 versus time, this is just above the core mid-plane.
16 This is the data from three different thermal couples,
17 and this is the current TRAC calculation. And you
18 notice this is more than 300 degrees K, and this would
19 be completely --

20 MEMBER SCHROCK: Well, it's conservative.

21 MR. KELLY: It's highly conservative.

22 MS. UHLE: Extraordinarily.

23 MR. KELLY: At least for a forced flooding
24 case and that's because there are in effect these
25 vapor explosions, if you will, which throw most of the

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1 liquid from the bundle out the top and FLECHT-SEASET,
2 you know, can point to that as a phase separator so
3 the water can't come back down. So a one inch per
4 second case ends up being like a one-tenth of a second
5 case which with that flow rate we have a very hard
6 time turning the temperature around.

7 CHAIRMAN WALLIS: It's pretty good to be
8 up at 1400 degrees Fahrenheit.

9 MR. KELLY: So, obviously, we have some
10 work. This is why we're doing the work, while we try
11 to apply this to AP1000. And so, obviously,
12 improvements need to be, we have to reduce the
13 oscillatory behavior and improve the accuracy of the
14 prediction. And I'm going to try to do that with
15 using a simple modeling first, and wherever I can use
16 bundle data, sometimes tube data to come up with a
17 simple way of doing this and one that is less
18 suspectable to oscillation.

19 I'm now on the last page of my talk and,
20 hopefully, this is practically finished.

21 CHAIRMAN WALLIS: Well, you've had your
22 hour.

23 MR. KELLY: Yes, I'm afraid so.

24 And I'm going to talk about incorporation
25 of experimental results, and hopefully very briefly.

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1 And I've got a little note here, the ACRS
2 role is I think that would be very good. As we do
3 these experimental programs and these are our
4 contractors who are asked to develop models from them,
5 it would definitely help us to come in front of you,
6 present those models and get your opinion. And in
7 effect, for us to have a peer review via you of how
8 good those models are before they get, you know,
9 encapsulated in concrete. So this is certainly an
10 area where I think you could help us. You know, as
11 kind of as unpaid consultants.

12 We currently have four experimental
13 programs. Low pressure, subcooled boiling at UCLA,
14 phase separation at OSU, which you already know about
15 since it's been out there, the rod bundle heat
16 transfer programs at Penn State, and the interfacial
17 area transport at Purdue and the University of
18 Wisconsin.

19 This general program will be finishing in
20 the middle of the year. The model will be delivered
21 and they will be implementing the code late 2002.

22 Phase separation, hopefully that in 2003.

23 The rod bundle heat transfer, this is one
24 I want to talk a little bit more about. It's designed
25 to provide detailed measurements for model

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1 development. It's not simply let's get some more
2 reflood data, because there's a lot of reflood tests
3 out here. But there was a lot of thought in how to
4 try to instrument the bundle and what development
5 information we need. And that's the example that I'm
6 going to use on the incorporation of experimental
7 results.

8 The reflood tests will be conducted in
9 mid-2002. There will be 15 of them, roughly 12 or 13
10 will be for model development. There will be no
11 constant flooding rate for test cases to look at one
12 particular regime.

13 There will also be 2 or 3 variable
14 flooding rate cases which we'll use for code
15 validation.

16 But we're also going to use steam cooling
17 and drop injection tests, and I'll talk about those in
18 a little bit. And those will be in late 2002. Then
19 the data analysis and model development will be in
20 2003/2004. And at that point we'll have low
21 mechanistic reflood model in the code to do that.

22 The interfacial area transport, this
23 should be viewed as a long term exploratory research
24 program and the idea is to try to move the level of
25 the physical models one step closer to something

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1 mechanistic where you're now looking at pebble
2 coalescence and breakup instead of the static flow
3 regime model. And so we're due to implement this
4 model in 2005, however the data is being generated now
5 we'll be able to use as part of PIRT assessment
6 program.

7 And the key thing on this slide is as
8 these programs end, we hope to start other
9 experimental programs to take their place so we keep
10 the level of thermal-hydraulic experiments that we're
11 funding more or less constant in time instead of
12 on/off. But replacements to these experiment programs
13 will come about from code assessment results. We
14 identify a deficiency in the code in an important
15 element, can't find the data in the extent database
16 and get a targeted date, then we'll identify an
17 experimental program and try to get one started.

18 So this is the example of how to
19 incorporate the experimental results. At least the
20 beginning of that. What I'm going to talk about is
21 the dispersed flow film boiling agent, which is the
22 one that we think of as the most important in terms of
23 the large break LOCA because that's where you turn
24 around the clad temperature.

25 In this regime the most important heat

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1 transfer mechanism is forced convection from the rods
2 into the vapor. To the superheated vapor. But there
3 are two major unknowns. One is the drop diameter,
4 which is a rather fundamental quantity and the other
5 is two-phase convective enhancement.

6 The drop diameter is primarily important
7 because of its effect on the vapor superheat. I mean,
8 after all, that's your sink temperature. You're
9 transferring heat via conduction through the steam to
10 a highly superheated steam. So what that temperature
11 is is very important.

12 However, it also effects drop breakup on
13 the grids, the two-phase convective enhancement, as
14 well as the wall-drop radiation heat transfer.

15 In reflood the drop formation mechanism is
16 not known, and every paper you read says something
17 different. Is it aerodynamic breakup of liquid slugs,
18 or a breakup of an actual inverted annular column.
19 Sometimes it may be one, sometimes another.

20 There could also be wave entrainment
21 either from waves on an inverted annular core or if
22 you're in a low flooding rate case where you actually
23 have annular core below the quench front it can be
24 waves on that film.

25 You can also have wall to drop

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1 interactions. A drop can collide with the wall and
2 bounce off and shatter, or it can collide with the
3 wall and in effect be blown off by rapid boil, and
4 that can shatter the drop.

5 Which of these mechanisms or how these
6 mechanisms interact to control an average effective
7 drop size is really unknown.

8 CHAIRMAN WALLIS: These are all
9 speculations or fantasy, you mean?

10 MR. KELLY: Yes.

11 CHAIRMAN WALLIS: They're not based on
12 observation?

13 MR. KELLY: Well, some of them are.

14 CHAIRMAN WALLIS: They are?

15 MR. KELLY: Yes. Depending upon which
16 paper you read, various people say different things.

17 CHAIRMAN WALLIS: Is that because they've
18 actually seen it or they've speculated it?

19 MR. KELLY: Well, some of it is seen. For
20 example, the annular film and waves on the annular
21 film comes from a British paper reflood in, I believe
22 it was a quartz tube.

23 The breakup of liquid slugs, I don't
24 really remember.

25 But, you know, I've been through a lot of

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1 references and you see a lot of different things.

2 Two-phase convective enhancement, what
3 this is, you know, we know that the core's conduction
4 is steam. But if you have a dispersed phase, whether
5 it happened to be solid particles or drops, that will
6 effect the heat transfer rate. And now especially in
7 the case of drops, the act is heat sink, so vapor
8 sources -- preliminary estimates of data say that this
9 should enhance your flows convection heat transfer by
10 20 to 100 percent. But, again, the controlling
11 phenomena is not known. Is it via turbulent
12 enhancement?

13 We know from like, you know, grasped
14 particles in air if the particles are very small, in
15 the order of 30 microns or so, they do tend to excite
16 the turbulence and increase the heat transfer. If
17 those particles go up to about 100 microns, they damp
18 the turbulence and decrease the heat transfer.

19 Our drops tend to be more like 1,000
20 microns. So how do they interact with the turbulence?
21 But, of course, there's not one drop size anyway.
22 There's a spectrum of drop sizes. Some might enhance
23 the turbulence, some might dampen it. But once you
24 get up to a millimeter and larger drops, now you've
25 got drops with significant weight regions which could

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1 generate more turbulence because of that.

2 Likewise, if you have all these drops
3 distributed in this hot steam, you change the
4 temperature profile of the steam.

5 CHAIRMAN WALLIS: It's dispersed flow
6 boiling, it's not film boiling. There is no film.
7 It's dispersed flow boiling.

8 MR. KELLY: That's true. That's, you
9 know, just the way it's been. And what we're trying
10 to say is that the surface is dry.

11 CHAIRMAN WALLIS: Yes, but what I think
12 what they mean is the surface is dry.

13 MR. KELLY: Right. That's what the film
14 in that context means. If you will, a vapor film.

15 So those are two of the most important
16 things or us to look at. And how are we going to do
17 that with the rod bundle heat transfer facility.
18 Let's talk about drop diameter first.

19 And what I've done is basically put up all
20 of the drop diameter data that I could find in the
21 open literature, and this drop diameter data from a
22 reflood test. And, as you know, there's tons of data
23 for primarily air, water and tube annular mist flow,
24 but even if you go from one of those papers to the
25 other, what the correlations for drop diameter are are

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1 different; there are dependencies on physical
2 properties or even the vapor momentum flux are
3 different.

4 So what I've applied are sauter mean
5 diameter versus pressure reported in a test. ACHILLES
6 and FLECHT-SEASET are actually bundle reflood tests.
7 This is the FLECHT-SEASET data all run at about 40
8 psi. I spread it out in pressure just so you could
9 see the points, but they're actually all at the same
10 pressure or almost the same pressure.

11 These are from a -- high speed group from
12 several -- about half a dozen different reflood
13 tests, different flooding rates and so on. It's
14 actually pretty amazing that the sauter mean diameter
15 is as constant as it is, just a little above one
16 millimeter.

17 CHAIRMAN WALLIS: Six millimeter is a
18 humongous drop.

19 MR. KELLY: Yes, that's a problem, too.
20 And what you have then is water plugging the tube, and
21 that's why the drop can be carried up. It's the
22 container wall effect otherwise for those cases the
23 vapor velocity would be low enough you couldn't carry
24 the drop up.

25 CHAIRMAN WALLIS: Even one millimeter

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1 seems pretty big.

2 MR. KELLY: I agree, especially if you
3 look at a rod bundle with the grid space, and you go
4 how can a poor little drop get through.

5 The ACHILLES tests, those were actually
6 from two different reflood tests, but the distribution
7 isn't --

8 CHAIRMAN WALLIS: So mean diameter, that's
9 a mean diameter of 6 millimeter. It must mean some of
10 them are two centimeters. That's crazy.

11 MR. KELLY: Well, it can't be bigger than
12 the tube. I agree, those are huge.

13 These tests, these are rod bundles, these
14 are tubes. This Hall & Ardron, this was done at CEGB
15 I think in the early '80s, I don't remember. This was
16 done at University of California Berkeley by Seban et
17 al.

18 This is reflooding --

19 CHAIRMAN WALLIS: Before they married to
20 one another.

21 MR. KELLY: It's hard to know which of
22 these to believe. But it would appear --

23 MEMBER SCHROCK: This kind of statement
24 bothers me, it's hard to know which of these to
25 believe. These experimentalists are presenting data

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1 from different kinds of experiments and why do you
2 think that as a code developer you're going to
3 evaluate which among these that had maybe different
4 objectives even, is right or wrong? I wouldn't begin
5 by assuming some are right and some are wrong. I'd
6 begin by trying to understand why is there this kind
7 of apparent discrepancy that arises out of these
8 different kinds of experiments and how does it relate
9 to the simple or the actual system that I'm trying to
10 model with this code.

11 MR. KELLY: No. That's a very good point.
12 Both of these were tube tests, but one was a quartz
13 tube, one was a, I don't know if you know the CRE
14 valve. They were both basically the same kind of
15 traditions opposed to directed methods of tube
16 resonance.

17 MEMBER SCHROCK: If you get into details
18 of the paper, you'll see that the credibility of the
19 meaning of a sauter mean diameter for some experiments
20 may be better than, you know, some other experiments.

21 MR. KELLY: Depending on the sample size,
22 that's exactly correct. And what I probably
23 misstated, misspoke a little -- what I should say is
24 this isn't solely a function of pressure. And what
25 you may very well be seeing here, rather than one

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1 being right and one being wrong, there may be at
2 different values of the vapor momentum flux, and that
3 may explain the large discrepancy. But from
4 everything I've seen so far, is the vapor momentum
5 flux goes up, the drop diameter goes down.

6 CHAIRMAN WALLIS: I guess the message I
7 get is that you're looking at all these things, you're
8 trying to figure out the reasons for discrepancies and
9 do better at it.

10 MR. KELLY: Right.

11 CHAIRMAN WALLIS: At the level we're at
12 today, we can't get into the details.

13 MR. KELLY: Right. Most of the current
14 models that people tend to use in codes are simple
15 functions of the LaFosse number. So it's a function
16 of pressure only.

17 CHAIRMAN WALLIS: LaFosse with gravity in
18 it?

19 MR. KELLY: Σ over $G \Delta \rho$
20 squared.

21 CHAIRMAN WALLIS: Does gravity have
22 anything to do with the phenomena that's happening
23 here?

24 MR. KELLY: Well, what they're saying is
25 that you can only -- if you're given vapor flow, you

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1 can only get up to a certain size drop, and less, then
2 use a critical web number of criteria for what that
3 size will be equated to and you come out with that.
4 And that's roughly how you come up with that. And
5 that will give you the maximum size drop, then you
6 have to make some assumption to get from that to a
7 sauter mean, typically a factor of 3 or so, but you
8 know what exactly it is is hard to define. But it
9 looks like there's a pressure relation here, but that
10 could be some other reason.

11 CHAIRMAN WALLIS: If you did the
12 experiment in a space shuttle, the drops would have
13 zero diameter is that what you mean?

14 MR. KELLY: No, because then you would
15 have to have different non-emotional groups because
16 you have a different control element.

17 CHAIRMAN WALLIS: Okay. I understand.

18 MR. KELLY: And as I recall, you'd tend to
19 get really large drops.

20 So anyway, that's the data that's there,
21 but that is certainly not sufficient to develop to a
22 correlation level. And the real reason it isn't is
23 because the data base lacks the information on the
24 flow conditions and we don't know what the vapor
25 velocity is. We don't know the vapor density. So we

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1 can't come up --

2 CHAIRMAN WALLIS: So that's right, this is
3 an example of why you need your RBHT?

4 MR. KELLY: Exactly.

5 CHAIRMAN WALLIS: So can we skip to the
6 conclusion, do you think?

7 MR. KELLY: Sure. And I'll just go ahead
8 and skip the convective enhancement.

9 CHAIRMAN WALLIS: And the rest, we can
10 read the summary page.

11 MR. KELLY: Yes. The real point here is
12 with RBHT we've tried to design the instrumentation to
13 give us the information, and Professor Schrock earlier
14 talked about the mechanisms. One of the things to
15 look at will be high speed video, and I'm looking
16 forward to seeing and looking at high speed video over
17 and over again to try to get a better idea of
18 physically what's happening.

19 For the convective enhancement by the
20 drops, I mentioned earlier there'll be two types of
21 tests run. The steam cooling test, with steady state
22 heat transfer forced convection to steam.

23 CHAIRMAN WALLIS: And you haven't been
24 skipping. I was asking you to go to the end.

25 MR. KELLY: Okay. But this is something

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1 unique about the facility.

2 CHAIRMAN WALLIS: We can't spend a lot of
3 time on all these different items.

4 MR. KELLY: Right. And there's the
5 summary.

6 CHAIRMAN WALLIS: We'd probably need two
7 days.

8 MR. KELLY: Okay. So the code development
9 associated with the consolidation effort will be
10 completed in the year 2002, probably by the end of
11 January.

12 The developmental assessment will be
13 conducted throughout calendar year 2002.

14 We're going to update the interfacial drag
15 and the reflood models; those will appear in the
16 consolidated code. The consolidated code will
17 probably be released at the end of 2002.

18 And then long term code development and
19 experimental programs will be driven either by code
20 deficiencies that arise from the assessment program or
21 by user needs for new capabilities.

22 CHAIRMAN WALLIS: So you're counting on a
23 lot of input from this work -- your subcontract? Do
24 we need to have presentations from these people during
25 the year so we can see how they're doing?

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1 MR. KELLY: I think that would be a good
2 idea.

3 CHAIRMAN WALLIS: Should we probably do
4 something like that at sometime in the middle of the
5 year.

6 MR. BOEHNERT: Sure.

7 MR. KELLY: I would prefer coming --

8 CHAIRMAN WALLIS: Again, you don't want to
9 us shoot down, let's say, phase separation models just
10 before you're putting them in the code?

11 MR. KELLY: Right. And Steve -- Steve's
12 talks is on the status of these program, but I think
13 that's a good idea.

14 CHAIRMAN WALLIS: There's nothing like
15 speaking to the people who are actually doing the
16 work.

17 MR. KELLY: Right. Well, hopefully, we're
18 going to be --

19 CHAIRMAN WALLIS: Maybe at the end of the
20 day, but I don't that we'll have any time. We need to
21 think about how the ACRS can be more central to you
22 folks.

23 Although I think when I look at a schedule
24 here, I wondered if it wouldn't be better off to --
25 well, I guess, Steve, you have two presentations.

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1 MR. BAJOREK: I've got to two of them.
2 The first one --

3 CHAIRMAN WALLIS: Maybe you should make
4 the first one, and then we can have lunch and come
5 back for a second one.

6 MR. BAJOREK: I think that will do well.
7 Well, if you pass out the one handout, what I am going
8 to do is I'll just bring out a couple of overheads?

9 MR. BOEHNERT: This one first, Steve?

10 MR. BAJOREK: That one first, please.

11 MR. BOEHNERT: Yes.

12 CHAIRMAN WALLIS: You're in the last lap
13 here, and you've got to make up -- you've got to run
14 at double speed.

15 MR. BAJOREK: I'm ready to go now.

16 But in the earlier presentations, one of
17 the things you may have noticed that Jack noted that,
18 in the long run, we're going to be counting on the
19 code and more to make regulatory decisions. The
20 accuracy will be much more important to us now than
21 they had been in the past, because we're going to be
22 relying on TRAC-M, the developers of TRAC-M to come up
23 with these decisions as opposed to information that we
24 had previously been asking from the vendors.

25 Joel also in his presentation pointed out

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1 in the developmental assessment that's going to be
2 done over 2002, most of that is being directed at
3 completing the consolidation showing that TRAC-M can
4 meet the functional requirements of RELAP, TRAC-B and
5 TRAC-P. The matrix that Joe put up using primarily
6 the tests that had been used in the past to try to
7 develop the code and assess its performance. It's not
8 necessarily the best set of experiments to use to try
9 to determine whether we're doing a good job or what
10 we're weak in, or to really characterize the accuracy.

11 So what I'm going to talk about now is
12 assessment and quantification of the performance of
13 TRAC-M. But in many ways what this really represents
14 in the elements, I think, another five year plan. The
15 consolidation effort is going to go on through most of
16 2002. Through that effort we're not going to be able
17 to do the total amount of assessment that we would
18 like to have. So we're looking at work further
19 downstream, 2003 and beyond. What I'd like to try to
20 do is layout a better picture of where we think we're
21 going to be able to go with TRAC-M, apart from the
22 development of the potential model development that
23 Joe just talked about.

24 We see three major elements. One, a
25 continuing model improvement to get information from

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1 these test programs, having we things out, they are
2 success oriented. We are assuming that the data that
3 we're going to get from the rod bundle heat transfer
4 programs are high quality, and likewise for the phase
5 separation.

6 We're talking about those programs that
7 are all the things that we're going to be doing to try
8 to ensure that we are going to get the right
9 information to develop those models.

10 But I think one of the more important
11 aspects that we're going to have to address in the
12 next one or two years is how do we assess the code
13 accuracy?

14 We've seen models of the code right now
15 that clearly don't perform as we'd like them to. We
16 see TRAC as being "conservative," and RELAP being
17 nonconservative in the reflood heat transfer.

18 CHAIRMAN WALLIS: Do you really mean
19 uncertainty? Is that the same thing as accuracy in
20 your mind?

21 MR. BAJOREK: Pretty close, yes.

22 CHAIRMAN WALLIS: So for the user, the
23 user needs to come to us to identify some
24 uncertainties in the use of the code, and accuracy may
25 be a part of that.

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1 MR. BAJOREK: The way I would break it
2 down is we're going to be looking at various processes
3 in the code. We're going to have to assess how
4 accurate the code --

5 CHAIRMAN WALLIS: Well, all codes are
6 probably perfect for one point, if you're on the right
7 point.

8 MR. BAJOREK: When we get everything in
9 there, the issue, of course, is that errors arise.
10 And one of the things I'm going to point out in one of
11 the next coming overheads is how we are going to try
12 to overcome that.

13 CHAIRMAN WALLIS: So I say, the second
14 bullet is related to the first. The user uses the
15 code and there's some uncertainties associated with
16 that. And that leads to margins and all kinds of
17 stuff. If the uncertainties are reduced, that could
18 be model improvement. For certain applications you
19 don't need any model improvement. But for other
20 applications you made a lot of model improvement.
21 It's got to be somehow related to the uncertainties
22 which are needed for the purpose of regulation.

23 MR. BAJOREK: That's why as we go through
24 our model development we'll be relying on separate
25 effects testing to get this biased uncertainty from

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1 models. But an element that we will build in early on
2 is how to do those uncertainties propagate a behavior
3 when you apply them to a PWR or a BWR.

4 CHAIRMAN WALLIS: So you're going to have
5 some sort of mathematic or analytical framework for
6 this? If you know the uncertainties in this current
7 correlation of the model from separate effects tests,
8 and then you can predict the uncertainties in the
9 integral effects tests and so on?

10 MR. BAJOREK: Yes.

11 CHAIRMAN WALLIS: And then you can predict
12 the uncertainties associated with some licensing
13 calculations.

14 MR. BAJOREK: Yes. Many times I've seen
15 in the past we've spent an awful lot of time
16 developing a model for one process or phenomena only
17 to find out that when you arranged it in a PWR
18 calculation, it was only effecting your answer by a
19 few degrees. I mean, that kind of tells you that your
20 model development effort is being misdirected, where
21 as other models --

22 CHAIRMAN WALLIS: This is risk-informed
23 code development.

24 MR. BAJOREK: Risk-informed without
25 development. But that final piece, seeing how the

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1 uncertainty needed in the light water reactor
2 application is very valuable, because that allows us
3 to redirect our model development. It also allows us
4 to refine or define new experiments that we need to
5 do. And that's why what we'd like to try and do with
6 the assessment element of this is to start looking at
7 light water reactor applications early on, assess the
8 uncertainties so that we can account for and correct
9 those in the model development efforts.

10 MEMBER SCHROCK: I don't quite grasp the
11 significance of the separate PIRT-based assessment.

12 MR. BAJOREK: The difference between what
13 we are calling a PIRT-based assessment matrix and the
14 code consolidation matrix is in the overall scope and
15 how the simulations that were performed in the PIRT-
16 based give a broader coverage of those processes that
17 have been highly ranked in the PIRT.

18 The code consolidation matrix is largely
19 historical. It picks certain FLECHT tests, some which
20 are antiquated data, they didn't have the best test
21 instrumentation in there by way you could assess some
22 of the code models and correlations. What we would
23 like to do is to get away from some of these tests
24 that had been used on more of a historical basis,
25 broaden that to make use of a broad range of FLECHT

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1 SEASET, but not rely just on FLECHT SEASET, look at
2 the Skewed test, some of the Cosine tests, the
3 ACHILLES test and other reflood tests to avoid coming
4 up with a code where it may work good for FLECHT
5 SEASET, but not do well for other types of experiments

6 MEMBER SCHROCK: Well, it sounds kind of
7 like you have to limit the amount of assessment you
8 can do, and so here is a way of choosing more
9 important things to perform the assessment on. But
10 that increases the likelihood that there maybe
11 something and it's never been understood these things,
12 it isn't going to be properly addressed in this new
13 code version, and it never will be.

14 MR. BAJOREK: We'd like to try to expand
15 the matrix so it exercises the code over a much
16 broader range. In some ways there's also some economy
17 in doing that.

18 A lot of the work in developing these
19 input decks for a certain test facility, in some cases
20 it takes as much work as it does to set up a PWR or
21 BWR deck. But when you're only going to be running
22 one test out of the higher series of tests that can
23 run in that matrix, you're losing a lot of information
24 that you may gain by increasing the number of tests
25 that you look at in that facility. CCTF or SCTF are

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1 an example. The consolidated matrix only looked at,
2 I think, one or two tests. What we're proposing is to
3 expand that to look at on the order of 10 or 12 tests
4 so you examine how well the code can perform as you
5 change things like your boundary conditions, your
6 break size, your power distributions both axially and
7 laterally within the core. See how the code uses --
8 the sensitivities you can get through the code rather
9 than just looking at one point.

10 CHAIRMAN WALLIS: I would like you to move
11 in the direction of risk based assessment. PIRT is
12 just some expert sitting down and saying "Gee, you've
13 got to do a better with more than condensation." I
14 mean, there's no measure of better job until you come
15 up with things that you're going to use it for. Use
16 it for making regulatory decisions.

17 So PIRT I never felt was a really good
18 measure of goodness of a code, even if it were used
19 for that purpose.

20 MR. BAJOREK: Well, the PIRT's kind of
21 done beforehand, and it really only gives you some
22 guidance on what --

23 CHAIRMAN WALLIS: PIRT is a starting
24 point.

25 MR. BAJOREK: Right.

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