

1 CHAIRMAN WALLIS: But it doesn't give you
2 a measure of success. And I think you really need to
3 think more about what is the proper measure of success
4 for a code.

5 MR. BAJOREK: Let me jump ahead for that
6 then.

7 MS. UHLE: Can I answer Professor
8 Schrock's question?

9 MEMBER SCHROCK: I think he said it okay.
10 That really results in more assessment than less. I
11 have a feeling that it is maybe limiting the amount of
12 assessment.

13 MS. UHLE: I think it's just focusing on
14 where we're going to start first and then getting
15 gradually to the lower things.

16 MEMBER SCHROCK: Yes.

17 MR. BAJOREK: Paul, if you pass out that
18 other set --

19 MR. BOEHNERT: This one?

20 MR. BAJOREK: Yes, that one. This is the
21 proposed assessment matrix that will be used following
22 the code consolidated assessment matrix. If it came
23 out well in this, we would continue to do tests
24 looking at tube barometers, types of tests where you
25 know you can do a hand calculation to come up with the

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1 answer that maybe the code has to deal with to perform
2 those tasks before it could go on to the others. This
3 is a way of checking to make sure your latest code
4 change goes through appropriately. But the difference
5 between the consolidated matrix and what we would be
6 doing in what I'm calling this first development
7 assessment matrix, we would greatly expand what we are
8 looking at in the FLECHT SEASET facility so that we
9 could look at how the code performs for a forced
10 reflood, when we change the reflood rate --

11 CHAIRMAN WALLIS: What's your measure of
12 performance? In your two-phase pressure drop here
13 you've got to do some comparisons. How do you know
14 when it's good enough? Maybe a factor of 2 or 10 is
15 good enough two-phase pressure drop. How do you know?

16 MR. BAJOREK: Part of that comes from what
17 we get out of ranging the bias and uncertainties at
18 the light water -- in the light water reactor. So
19 coming up and let me go -- I'll jump to this, and let
20 me show you --

21 CHAIRMAN WALLIS: You really have to do
22 the CSAU thing and look at how does it effect things
23 that matter, like peak clad temperature or something.
24 Then say, have we got a good enough code. Don't you
25 have to go to the things you're trying to predict for

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1 regulatory purposes and the sensitivity of those are
2 the things that you look for.

3 MS. UHLE: That comes out of the fact that
4 these models will probably be ranked --

5 CHAIRMAN WALLIS: But the PIRT doesn't do
6 any of that.

7 MS. UHLE: Well, sure it does. It tells
8 you what experts are thinking of.

9 CHAIRMAN WALLIS: It doesn't tell you
10 what's good enough.

11 MS. UHLE: It does in a sense that --

12 CHAIRMAN WALLIS: What an expert's
13 thinking is really often self-serving. They say I'm
14 an expert on flow regimes so you need to do more work
15 on flow regimes.

16 MS. UHLE: And then in our first
17 experiments we focus on those models that people point
18 out as most important.

19 MR. BAJOREK: We look at the reflood heat
20 transfer to determine how well it behaves, and we have
21 looked at some of the reflood tests and we would see
22 how those uncertainties behave in the full scale.

23 Now, if we continue to see very large
24 uncertainties, that's an indication that we need to go
25 back --

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1 CHAIRMAN WALLIS: If it effects the
2 regulatory decision.

3 MS. UHLE: Right.

4 CHAIRMAN WALLIS: Yes.

5 MR. BAJOREK: So if we range the reflood
6 heat transfer over its broad range of uncertainty
7 based on how we see it in separate effects, but it
8 doesn't make any effect anymore on the peak cladding
9 temperature, that says we should look more at things
10 like bypass or condensation. I don't think we're at
11 the point where we can rule any of those out.

12 MEMBER KRESS: Rather than look for what
13 range it's asking as measured as how good is good
14 enough, I think your aim ought to be being able to
15 capture the uncertainties. And then if you can
16 capture then, you can say how good your prediction is
17 with respect to any of the reactions and then your
18 decision process could factor in those uncertainties
19 on whether or not it's good enough. So again an
20 application --

21 MR. BAJOREK: Once can capture them how
22 well the code's performing based on the separate
23 effects then we can see how it behaves.

24 MEMBER KRESS: So how is the code going to
25 be able to kick out for you the uncertainties.

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1 MR. BAJOREK: If we don't get to that step
2 and we see a large change or no change in the light
3 water reactor, you don't know whether it's because the
4 code is doing input or not or whether it's exhibiting
5 the right sensitivities.

6 MS. UHLE: Another thing, too, focusing on
7 the separate effects test is the fact that if you just
8 focus on the integral effects test you're not sure if
9 the answer isn't changing because of compensating
10 errors. And that's what the separate effects tests
11 really highlights.

12 MR. LAUBEN: No, the point is that there
13 is nothing like the regular development of --

14 CHAIRMAN WALLIS: No, I'm saying that I
15 think the PIRT is based on experts, the wrong experts.

16 MR. LAUBEN: Right.

17 CHAIRMAN WALLIS: They're not your
18 customers. They're just the people who are looking
19 for work. They're the wrong group.

20 MS. UHLE: Any PIRT contributors here?
21 All right. So any PIRT you were involved in we'll
22 throw out.

23 MR. LAUBEN: But if you were to go through
24 the process we talked about today, you'd start out
25 with some kind of PIRT and during the process you'd

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1 focus in on, at the highest level, like you were
2 saying the ability to predict a regulatory effect on
3 the peak cladding temperature, and all of the top
4 level things. The PIRT may change. The PIRT may
5 start out as something, and what is critical changes
6 throughout your whole process.

7 MR. BAJOREK: And it does. I mean, if you
8 look at the PIRTs that are designed for conventional
9 PWR, versus AP600 or AP1000; there are small but
10 perceptible changes in all those, and what's important
11 in one transient versus the next --

12 Our problem is making sure that the code
13 can deal with those things which people have deemed to
14 be very important and then can also deal with those
15 things which are deltas between plants that have been
16 looked at in the past.

17 Now, I think part of the problem in this
18 assessment, I think has just been pointed out, is a
19 lot of folks have focused on solely the peak cladding
20 temperature as being your sole measure of a code
21 performance. And what I did is I grabbed a couple
22 rolls of technical papers and, actually, I took one
23 out of CSAU NUREG for example, how does your code
24 behave. And the common way of doing it is looking at
25 the peak cladding temperature from the scout point.

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1 A plot, if you were, where you predict the PCT as
2 higher than the measured, you deem that it's being
3 conservative and say that your code's conservative
4 forgetting the fact that there may be other things
5 going on in these experiments, CCTF and SCTF in steam
6 binding and the steam generators that may be
7 contributing to the performance of your core heat
8 transfer.

9 Another way would be taking these tests,
10 mix them in with separate effects tests, which is done
11 over on this figure on the left hand side, and use
12 that to get a gauge of your code performance, or in
13 this case as this had been designed to, is well let's
14 just get a delta PCT and you would simply put that on
15 as an adder towards some calculation that you would do
16 for, in this case, the PWR.

17 I think the perception now, and correctly
18 so, is that approach is incorrect because it doesn't
19 deal with compensating errors. It doesn't deal with
20 new ranges and conditions and tells you nothing about
21 whether you're getting things like super heat, drop
22 break-up correct, all of the intricacies of reflood
23 heat transfer that go into calculating that peak
24 cladding temperature.

25 Now, we intend to expand the test matrix

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1 that we're going to for the separate effects tests,
2 but at the same time which when you get away from this
3 type of a measure of the code performance. This is an
4 example of typical practice, and the one I just showed
5 you -- I've got my greater than and equals sign in the
6 wrong direction here. The one where I just pointed
7 out is to take a look at solely the peak cladding
8 temperature, it says your coding is conservative if
9 your predicted is greater than the measured.

10 Now another way, and Joe alluded to it in
11 his presentation, is to look at the one model in
12 reflood that's perceived as having the greatest
13 effect. Okay. This has been done by taking a look at
14 the dispersed flow film boiling heat transfer
15 coefficient; defining a bias and an uncertainty. And
16 in this particular application then the uncertainty in
17 that particular model was used to range at full scale
18 in order to get delta PCTs in the full scale case.
19 PWR in this case.

20 We're going to take advantage of more
21 detailed test data like we're getting out of the rod
22 bundle heat transfer program and information that we
23 can glean from other test programs to increase the
24 total number of peak performance parameters before we
25 can claim success in any one of the models, and I'm

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1 going to reflood as an example.

2 Our approach now is we can use multiple
3 parameters is to try to characterize specific models
4 within the package and the package in total. Okay. We
5 will not rely on simply peak cladding temperature as
6 the sole performance indicator. For reflood heat
7 transfer the type of things that we would get out of
8 the assessment after we have done the simulations and
9 comparison to data, the FLECHT SEASET, that larger
10 number of tests; the FLECHT Skewed, the FLECHT
11 ACHILLES, the other ones that I have listed on there,
12 is to look at break things up into heat transfer
13 regimes. Look at those periods where the test and the
14 code were predicting steam cooling heat transfer, and
15 use this as a performance measure by defining a bias
16 and uncertainty essentially to characterize how well
17 the code is characterizing and calculating in a single
18 phase performance. We would still do the dispersal of
19 film boiler heat transfer coefficient as we've done in
20 the lab, in case you're not aware of.

21 Joe noted that near the quench front,
22 okay, we also have some very important precursory
23 cooling. And we want to know whether the bias and
24 uncertainty in the models that we develop and put into
25 the TRAC-M are reasonable compared to the experimental

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1 data that we get out of the rod bundle and we can also
2 get out of some of the other tests. And this is one
3 case where we might want to jump very quickly to take
4 this biased uncertainty and use those or study those
5 in a light water reactor application and give us an
6 indication should we be looking more closely at
7 inverted annular flow, okay? Or, should we continue
8 to focus on steam cooling dispersed flow film boiling
9 which has been more typical of the past.

10 The answer to that in those simulations
11 would be whether we're seeing very large uncertainties
12 in the light water reactor application, very large
13 delta PCTs. That would be an indication that the bias
14 and uncertainty that you are imposing on the code by
15 a model selection and model development would be
16 unacceptable. It might mean another experimental
17 program or it could at least mean you would have to go
18 back, sharpen our pencils and come up with a better
19 model and do some additional assessment.

20 MEMBER KRESS: Is the plan incorporating
21 these biases of uncertainties into the code itself and
22 combining in some way with the Monte Carlo, for
23 example?

24 MR. BAJOREK: In the long run, yes. Right
25 now we don't have any plans to put in into the input

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1 structure in the TRAC-M the way of incorporating these
2 biases or uncertainties easily.

3 MEMBER KRESS: It seems to me like that
4 should be your eventual goal?

5 MR. BAJOREK: I think if we start to see
6 it -- we did want to have some kind of input or some
7 way within the code structure that we could range
8 these things easily without depending on either the
9 developer or the user to actually go into the code and
10 hard wire the changes, which is the way I've seen this
11 thing done in the past.

12 MS. UHLE: A good thing about the
13 modernization, too is the architecture. The physical
14 models are isolated from any of the -- associated with
15 the alphanumerics. And so the correlation in a
16 specific sub routine is either divided or multiplied
17 by that value, and have that propagate through the
18 answers.

19 MR. BAJOREK: It has also quite helped us
20 to get away from relying on that group of experts that
21 helped develop PIRT. Because once we try to develop
22 a larger range of performance perimeters, and have
23 really to range those in the light water applications,
24 now we can go back and say ah-ha, this should have
25 been on your PIRT and this was missed or hopefully you

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1 guys did a job.

2 MEMBER KRESS: I worry about arranging
3 them individually one at a time. That's why I
4 mentioned in Monte Carlo, you can get away from that.

5 MR. BAJOREK: The way we had done that at
6 Westinghouse was to look at things one at a time and
7 then develop a response service methodology to try to
8 incorporate how combinations of things can change.
9 That also was driven by a couple of different things.

10 One, it was always nice to go to the user
11 and say "This is what you're going to do because this
12 is what was approved," very clear cut.

13 Another approach, and I think that has
14 been used more in Europe and we are going to be
15 looking at that in the long run, is I think is a GRS
16 sampling approach or refer to it as a German sampling
17 approach. I thought that was Oktoberfest.

18 But what this does is it looks at a broad
19 range of uncertainties and simultaneously picks and
20 ranges multiple perimeters, and puts that in your
21 simulation, samples that distribution many times that
22 gives you an uncertainty in your peak cladding
23 temperature, your equivalent clad reaction and also a
24 confidence interval. If you don't like that
25 confidence interval, do it more times.

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1 Now, the nice thing is that it seems as we
2 spend more time in these meetings computers continue
3 to get faster. And what would seem, you know,
4 absolutely insane ten years ago, making a hundred PWR
5 or BWR calculation, is now something that can be done
6 in a reasonable amount of time. So that type of
7 approach now I think is something that can and should
8 be looked at in the long run.

9 But anyway, we're going to break up, for
10 example, reflood into multiple performance perimeters,
11 in some we are going to look at specific model and
12 processes. I wanted to add a couple on here to try to
13 address the hydraulics, although it doesn't
14 individually get at flow regime transition or
15 interfacial drag, but carry over fractions. Rather
16 than just taking a look at mass affluent and what the
17 code is predicting, it applies an uncertainty for as
18 many of these tests that you can so we can determine
19 if the code is doing a good job or not in calculating
20 things like entrainment drop size.

21 Level swell, or another way I would say it
22 interfacial drag below the quench front. And see for
23 a given amount of mass has the quench front propagated
24 too high into the bundle.

25 And in those characterized individual

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1 models or call them packages, we can use things like
2 quench time, clad temp and steam temperatures, these
3 are in the program that was developed at Penn State
4 called ACAP that essentially goes through and takes a
5 look at a predicted trace versus a measured trace and
6 gives you statistics on how well that curve
7 corresponds to one another.

8 I'd like to think it a little bit more as
9 the integral of this curve behaving much like the
10 integral of the other curve. This, again, starts to
11 get closer towards the peak cladding temperatures
12 you're looking at things that's an aggregate, but we
13 think by defining several key performance perimeters
14 and making our holy grail the idea that we're going to
15 get all of these simultaneously in some reasonable
16 bias and uncertainty where reasonable at this point
17 still is yet to be defined, because when we go through
18 the first cuts and range those in PWRs and BWRs,
19 that's going to start to tell us what is reasonable,
20 whether we're looking at hundreds of degree change in
21 clad temperature or a few degrees.

22 Most of this work will not begin until
23 late 2002 with the release of the Rev 0.0 version.
24 2002 is going to be primarily those tests that are
25 being used in the consolidated assessment. What I

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1 wanted to note on here is what we would be doing is
2 expanding the database both in the total number of
3 tests that would be looked at in an individual
4 facility and in the total number of facilities that
5 would be factored into the assessment.

6 Some of these tests will be done in 2002
7 once we get close enough with the Rev 0 version,
8 because one of our first applications is going to be
9 the AP1000 large break LOCA. So we not only have the
10 work at performance for reflood heat transfer, but
11 also things like bypass, we're going to be very
12 interested in the performance of the code for how well
13 it does for direct vessel injection. So we would be
14 look at tests like UPTF 6 and 21 phase D to get the
15 direct vessel injection, and also one of the CCTF
16 tests that also gets --

17 CHAIRMAN WALLIS: All right. Can you
18 finish by 12:30?

19 MR. BAJOREK: Yes.

20 Integral tests also captured in the
21 assessment matrix would expand the number, the total
22 number of facilities. What we would be looking for
23 there is, does the code give us the type of
24 sensitivities that were observed in these various
25 tests. What would we do if we would look at, for

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1 example, SCTF and the difference between flat radial
2 shape and the very peak radial shape, in the sense
3 that we are able to get that same type of a variation
4 in TRAC-M. We wouldn't get that if we just looked at
5 one test.

6 And you can see some of the other
7 sensitivities we would hope to get out of the integral
8 effects tests.

9 The eventual goal then is defining the
10 uncertainty for a large number of models, develop the
11 capability of range and base and assessing their
12 importance in the full scale plants, peak cladding
13 temperature and their effect on normal clad reaction.
14 As we start to see plants being operated, they're now
15 staying at higher temperatures for longer periods of
16 time. Our concern from a risk based regulation is
17 that maybe peak decladding temperatures is what we're
18 going to have to look at in the future, so we're going
19 to have to start looking at clad ductility and clad
20 reaction rate in a lot more detail than it had been in
21 the past.

22 As we mentioned, if we start seeing large
23 uncertainties in the light water reactors, that's an
24 indication that we either have to look at test data
25 closer or we have to go back to develop better models

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1 for the process we're interested in.

2 We see this as being one of our major
3 activities over the next 3, 4 or 5 years.

4 And by way of summary, we're going to
5 expand the consolidated test matrix to look at a
6 larger number of conditions, a larger number of test
7 facilities. We're going to use this quantified code
8 to model accurately and engage what goes on in the
9 other plants.

10 CHAIRMAN WALLIS: You have a lot on your
11 plate.

12 MR. BAJOREK: There's a lot there, yes.

13 One of the things we are going to try to
14 do in 2002 is automate the process. It's a lot of
15 work and there's a lot of comparisons to data. If we
16 do a good job on the first few tests, capturing the
17 scripts to do the comparisons, setting up the methods
18 to run these things in mass and do comparisons to
19 mass, we may save -- we'll definitely save ourselves
20 a lot of grief and agony further downstream.

21 MEMBER FORD: You've got the data
22 scattered around the one to one correlation like that
23 what is your matrix of success?

24 MR. BAJOREK: It's going to be in the
25 several parameters that were defined for reflood

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1 rather than PCT. The matrix would be to have all those
2 at a reasonably small bias and uncertainty. Now,
3 reasonable, I think in the past people have basically
4 looked at 5 or 10 percent in bias and uncertainty on
5 the order of 30 to 50 percent. A lot of that just has
6 to do with the scatter of the experimental data.

7 MEMBER FORD: I was about to say that
8 surely that the scatter is obvious in the experimental
9 data.

10 MR. BAJOREK: Right.

11 MEMBER FORD: But your model should be
12 able to predict that step.

13 MR. BAJOREK: For the different condition,
14 yes.

15 MEMBER FORD: Well, for the -- that
16 scatter is presumably due to uncontrolled experiments,
17 but you can quantify that, the degree of lack of
18 controls. So can you not -- would you not -- your
19 matrix of success be that you can bound your observed
20 scatter? Not only in the experiments, but also in the
21 reactor? I mean that's the uncertainty --

22 MR. BAJOREK: You would hope that if you
23 define, let's say, bias and uncertainty in a model,
24 when you apply that in the separate effects
25 simulation, you also can show that you've bound or you

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1 -- excuse me. You bound it in the separate effects
2 tests and you are confident finding delta C in the
3 whole scheme.

4 MEMBER FORD: The wider reasoning behind
5 my question is that asking for the matrix of success
6 if a licensee comes in with their own code, do you use
7 your code? I mean, I know why you're touting your
8 code, to be an informed reviewer, but at what point do
9 you say this model is no good based on a matrix like
10 that in comparison to the observational query. Does
11 yours do better than he or --

12 MR. BAJOREK: That's what we're hoping.

13 MEMBER FORD: And if that happens, then do
14 you say he can't use his code?

15 MR. BAJOREK: No, because I think what
16 happens is if you do a good job on your code, you
17 should have a relatively small uncertainty when it's
18 propagated. If you did a poor job on the code, that
19 should grow.

20 So, if you come in with a code that does
21 not perform well against separate integral effects
22 tests, the price you pay is a larger uncertainty of
23 the whole scale application. My twist on that is if
24 your code doesn't have the right sensitivity, I guess
25 that's a question we have to look into.

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1 CHAIRMAN WALLIS: Steve, we're going to
2 see you after lunch?

3 MR. BAJOREK: Yes.

4 CHAIRMAN WALLIS: What I propose is that
5 we break for lunch and we get back here by 1:00? Can
6 you do that, have a quick lunch.

7 MR. BAJOREK: How much time do we have
8 after lunch?

9 CHAIRMAN WALLIS: 2:30. We'll be back
10 here at 1:00.

11 (Whereupon, at 12:33 p.m. the meeting was
12 adjourned, to reconvene this afternoon.)

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A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:08 p.m.)

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2
3 MR. BAJOREK: This afternoon what we'd
4 like to start doing then is looking at and reviewing
5 some of the work that has been done over the past year
6 on the experimental programs that we're relying on
7 right now to solve some of the major thermal-hydraulic
8 issues, and also to give us some additional data for
9 the code development.

10 The ones that we're going to talk about,
11 a couple of these we may move quickly because we've
12 talked about these back in July, are:

13 APEX, work that has been going on there to
14 address the pressurized thermal shock; work that has
15 been going on at the PUMA facility, Purdue University.

16 The work that has been going on to take a
17 look at critical flow, and we anticipate using the
18 facility to take a look at the BWR boiling
19 instability, the flow instability.

20 The rod bundle heat transfer program at
21 Penn State.

22 ATLATS or the phase separation work that's
23 being done also at Oregon State University.

24 I'm going to present some work that has
25 been recently given to us by Vijay Dhir at UCLA

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1 looking at subcooled boiling.

2 And finally, we'll wrap up taking a look
3 at the interfacial transport project that's being done
4 at Purdue by Dr. Ishii, also Kajasoy at the University
5 of Wisconsin, Madison.

6 But for the work that's been done in 2001
7 in APEX, APEX in late 2000, maybe a little bit
8 earlier, had been modified to look much like a
9 combustion engineering unit. It took advantage of the
10 fact that the APEX facility in its original format for
11 the AP600 had a 2 x 4 loop, the pumps were replaced.
12 Excuse me. The can pumps were replaced in the APEX
13 facility with loop seals and pumps so that it would
14 look much like Palisades and Calvert Cliffs.

15 Most of the experimental work that has
16 been going on in APEX over 2001 has been designed to
17 take a look at PTS issues.

18 Now, we presented a lot of this
19 information in July of this year when we also got to
20 see a test at APEX. And I've got a couple of
21 overheads to summarize the PTS work.

22 Most of the work that is going to be
23 planned at APEX for 2002 is going to be directed
24 towards the AP1000. Dr. Rais was recipient of a DOE
25 MURE grant earlier this year. This gives him funding

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1 now to modify the APEX facility to replace the heater
2 core, enlarge the pressurizer, change the core makeup
3 tanks, add some additional instrumentation so that it
4 looks much more like the AP1000. And that's the work
5 that will be going on later in 2002.

6 Now the PTS work that was being done at
7 Oregon State was the central part of three overall
8 components to take a look at PTS. OSU, the APEX
9 facilities, was used to develop the experimental
10 database, look at downcomer mixing effects. This was
11 accompanied with RELAP and REMIX calculations to try
12 to gauge how quickly these plumes would dissipate in
13 the downcomer. This was accompanied by a thermal-
14 hydraulic uncertainty evaluation that was done at the
15 University of Maryland.

16 CHAIRMAN WALLIS: Is that still being
17 done?

18 MR. BAJOREK: It's finishing up right now.

19 Following the meeting in July/August time
20 frame, Dave Bissette decided that they needed some
21 additional tests to add to the ones that had been
22 previously done. They started doing those in
23 September/October time frame. As of October they were
24 almost done. I think they still had a couple more to
25 do.

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1 CHAIRMAN WALLIS: Final report is in
2 December?

3 MR. BAJOREK: December. Yes, the end of
4 this year.

5 The work in the facility as it is right
6 now, scaled as I mentioned to the CE plants, the work
7 that had been done --

8 CHAIRMAN WALLIS: The question is whether
9 or not this has been adequate to resolve the PTS --
10 they've done something to my mike? They took it away.
11 Someone took it away. Oh. Yes.

12 MR. BAJOREK: I believe it is. Is Dave
13 Bissette here? I think he's left. But --

14 CHAIRMAN WALLIS: There's a mike here.

15 MR. BOEHNERT: No, it's the table mike.

16 CHAIRMAN WALLIS: There's a mike here. So
17 we're okay?

18 MR. BOEHNERT: Yes.

19 MR. BAJOREK: From my understanding,
20 they're going to be able to wrap up the tests this
21 year, issue the final report and I believe that is
22 going to resolve the PTS issue, which leaves us for
23 upcoming events.

24 The early part of the year will be
25 occupied primarily with finishing the testing, writing

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1 the final report. Excuse me. Not the end of this
2 year, that's going to be due the end of January. But
3 starting the end of this year and into most of 2002
4 leading towards the end of the summer, the facility is
5 going to be modified. The larger-diameter heater rods
6 in the core are going to be replaced with smaller-
7 diameter rods. They're going to put in a new data
8 acquisition system.

9 The pressurizer in the AP1000 is
10 substantially larger than it is in the AP600. That's
11 being replaced. Likewise, the CMTs. CMTs are larger
12 in the AP1000, they also have a different type of
13 orifice to reduce the form loss from the CMT into the
14 DVI line.

15 CHAIRMAN WALLIS: Do you know what the
16 licensing schedule is likely to be for 1000?

17 MR. BAJOREK: Right now we're scheduled to
18 issue an SER early next year. I'm not sure exactly --

19 CHAIRMAN WALLIS: So these tests will come
20 after the SER has been issued?

21 MR. BAJOREK: I'm sorry. SER for phase 2
22 of the review. Phase 2 of the review is taking a look
23 at the codes, for their adequacy, taking a look at the
24 test and the analysis program. And we're going to be
25 issuing our opinion on those, probably March or so of

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1 2002.

2 Phase 3, Westinghouse decides to go ahead,
3 they would be issuing their analysis, the finalized
4 design and then going through the rest of the review.
5 I think the SER for that would have to be sometime
6 late in 2003/2004.

7 CHAIRMAN WALLIS: So your results will be
8 timely enough input?

9 MR. BAJOREK: Yes. Yes. It seems very
10 aggressive and ambitious, but they're hoping to do all
11 of this modification to the facility and be able to
12 begin hot down testing the end of next August. If that
13 were the case, testing would begin later in 2002 and
14 probably continue well on into 2003.

15 CHAIRMAN WALLIS: Now is the government
16 doing some analytical work to figure out what key
17 tests need to be run?

18 MR. BAJOREK: DOE asked us several months
19 ago to comment on the text matrix. They made it clear
20 it is their test. We gave them some recommendations
21 based on previous tests that have been run in the
22 AP600. The ones there that had been the most
23 interesting from a licensing standpoint were the DVI
24 line breaks, cold leg breaks, okay, where you had
25 multiple failures and failures of the ADS-4 system.

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1 Those are the ones that gave the minimum inventory in
2 those tests. And we would presume that those tests
3 would also generate the minimum inventory in the
4 AP1000.

5 At the top of the list is the DVI line
6 break. That one, by far and away, seemed to be
7 generate the minimum inventory.

8 One of the things that I've been involved
9 with over the summer and the last couple of months has
10 been in a scaling analysis for the AP1000 in the test
11 program. Part of our concerns stemmed with what will
12 go on in the facility -- or more, the full scale plant
13 during this ADS-4 period.

14 The DVI line break is clearly going to
15 make entrainment in the upper plenum pool, entrainment
16 in the hot leg, into the branch line much more severe
17 than it was in the AP600. Going from AP600 to AP1000,
18 that's a 73 percent increase in the core thermal
19 power.

20 The vessel is the same diameter. The hot
21 leg is the same diameter. So having this additional
22 core power is going to greatly increase the
23 superficial velocities during the ADS-4 period and
24 also during the long-term cooling period. So we're
25 looking at that.

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1 We did make a recommendation that they add
2 instrumentation to try to get the branch line quality-
3 -

4 CHAIRMAN WALLIS: That's the sort of thing
5 I had in mind. If you'd thought about what are going
6 to be the big differences that we need to worry about,
7 therefore design the experiment so they focus on the
8 right thing?

9 MR. BAJOREK: Yes. But those tests will
10 start later in the year and I look forward to seeing
11 some of those results.

12 PUMA is the integral test facility that
13 represents the SBWR. It's located at Purdue
14 University. It's an integral test facility that has a
15 reactor pressure vessel, internal components to
16 represent the core, downcomer, chimney and separator.

17 Most of what has been done over 2001 has
18 been used using the the facility as a separate effects
19 test. Now, this also stems from work that was noted
20 in AP600, again during this ADS-4 blowdown period.
21 Rather than critical flow at higher pressures being
22 the most important break flow phenomena or range of
23 conditions, during the ADS-4 we have critical flow at
24 a relatively low pressure.

25 During the AP600 analysis using RELAP it

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1 was noted that one of the deficiencies in the code was
2 the performance of its critical flow model during this
3 lower pressure period. They've been gaining some
4 additional information in the facility corresponding
5 to these lower pressures, making use of some advanced
6 instrumentation.

7 The long range intended use in 2002 is to
8 start to look at the BWR flow instability problem.

9 CHAIRMAN WALLIS: You're saying that PUMA
10 is going to be used to look at critical flow at low
11 pressures?

12 MR. BAJOREK: It has been. It has been.

13 CHAIRMAN WALLIS: It has been?

14 MR. BAJOREK: And what I'd like to do now
15 is Weidong Wang has a few overheads to describe that
16 work.

17 MR. BOEHNERT: What's the issue with flow
18 instability? Has it been looked at or -- are you
19 going to talk about that?

20 MR. WANG: Yes.

21 CHAIRMAN WALLIS: I suppose that these
22 valves are going to be tested anyway for ADS-4?

23 MR. BAJOREK: Not the ADS-4. They've
24 tested the ADS 1 through 3.

25 CHAIRMAN WALLIS: Oh, it's too big to

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1 test?

2 MR. BAJOREK: Right.

3 CHAIRMAN WALLIS: Blowdown from a valve
4 isn't something you predicted, right?

5 MR. BAJOREK: Yes. The AP1000 you get a
6 preset line size --

7 CHAIRMAN WALLIS: And it's like a straight
8 pipe?

9 MR. BAJOREK: Yes.

10 MR. WANG: My name is Weidong Wong. I'd
11 just like to give you a little overview about PUMA
12 project.

13 I will basically deliver an overview of a
14 PUMA project and also talk about critical flow and why
15 we do that, and also inflow instability and the status
16 for the plant for the coming year.

17 This PUMA facility is the only operational
18 facility for the next generation SBWR in the United
19 States. And the facility is a scientifically scaled
20 from SBWR and it has extensive instrumentations, over
21 500, for flow void fraction. And Steve just went over
22 all this. And I just give you a few pictures,
23 cartoons that let you have a better idea about what it
24 looks like.

25 This is a schematic of what this PUMA

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1 facility. And they have a reactor vessel just very
2 tall like a pen here, a pen. And this is containment,
3 and it's a compression pool, basically it's a separate
4 component and connected by pipes.

5 Just give you a few pictures so that you
6 know what we are talking about.

7 And this is the size of the dry well
8 containment. You do not have these pictures because
9 I have difficulties because it's white -- black and
10 white. And it's not real clear. And here inside is
11 the vessel and the people are working here.

12 So you will see it's a pretty large
13 facility.

14 And this is a control room, and there are
15 people working there. And they have extensive
16 instrumentations and they're all monitored by these
17 computers or televisions, because we can see the
18 bundle and the boiler fraction goes through core
19 vessel or in the compression pool.

20 And Y which is for the critical flow, as
21 Steve just mentioned about, actually we know critical
22 flow from the light water reactor is important under
23 low pressure, because either that they are all AP600,
24 they have automatic deprivation systems.

25 And at a low pressure, basically

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1 mechanical non-equilibrium for the liquid phase and
2 the vapor phase, so the last thing is that can be
3 large due to density ratio. And also thermal non-
4 equilibrium can be large.

5 And for our code TRAC-M and RELAP5 we note
6 basically it's assessed for the pressure above 500
7 psi.

8 And the shortcomings for the previous
9 tests, first of all, we know it's not -- they do not
10 have a detailed in-line measurement for the critical
11 flow and also no systematic experiment to address the
12 mechanical non-equilibrium and thermal non-equilibrium
13 and the pressure effects.

14 And I tried to quickly go over some
15 examples results and then give you the conclusion,
16 because of time.

17 This is one of the example results.
18 Pressure effect for the slip ratio. You will see from
19 here the quality -- okay, this here different
20 pressures. With the low pressure like for 30 psi with
21 the experiment we have to go either from 30 psi to 150
22 psi. And you'll see this slip ratio can be very
23 significant here.

24 CHAIRMAN WALLIS: This is for what? Flow
25 through a nozzle or something?

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1 MR. WANG: I have two plugs, actually. We
2 plug both for nozzle and for the orifice. For this
3 particular one, it is for the nozzle. And basically
4 for the nozzle and for the orifice we saw the same
5 trend.

6 And this can tell us, you know, for the
7 the AP600 application -- first, we had difficulties
8 with original critical flow model. Then later we
9 developed some temporary or interim critical flow
10 model. Use Henry Fausky, which is a homogenous type
11 of flow model. And then here you will see, at a very
12 low pressure, the slip ratio can be high.

13 MEMBER SCHROCK: Of course, your earlier
14 experiment wouldn't be very good for flashing critical
15 flow, would it?

16 MR. WANG: We have went through --
17 basically we tried to study this mechanical non-
18 equilibrium, thermal non-equilibrium, and for chemical
19 non-equilibrium we used air and water. And for the
20 thermal non-equilibrium we used super-cooled water and
21 the flow between we basically used saturated water and
22 steam to make this experiment.

23 MEMBER SCHROCK: You misunderstand the
24 intent of my question. As liquid is vaporizing it's
25 adding more momentum mass to the vapor phase. That

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1 phenomenon doesn't occur to your water experiments.
2 So the question, is the adequacy of information from
3 air-water experiments in flashing steam flow
4 experiments.

5 MR. WANG: Well, certainly, I'm not sure
6 for the answer, but I think that we have a
7 parametrical study basically for this -- our objective
8 to get mechanical non-equilibrium and here, if we have
9 a pressure, it's high enough.

10 CHAIRMAN WALLIS: Well, this slip ratio is
11 very dependent on the flow regime. If you have
12 flashing mixture which is breaking up into droplets
13 because of flashing, it's very different from
14 something like an annular. So you have to be pretty
15 careful about duplication.

16 MR. WANG: This slip ratio actually is
17 measured above the break point. It's not really at
18 the choking plane And basically we've --

19 MEMBER SCHROCK: Measured where?

20 MR. WANG: Above the break point. This
21 measured in -- we measured the void fraction and then
22 we measured the quality. And these void fraction, we
23 measured it by impedance meter, and this quality is
24 computed by the inlet of this critical flow. And from
25 this correlation we calculate -- from this equation we

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1 calculated the separation and tried to see under this
2 low pressure condition this slip ratio of water
3 relation or with slip ratio with this -- with
4 pressure. And certainly this one can not really
5 represented as the choking plane but it can tell you
6 something about the slip ratio. It's important at
7 this choking plane.

8 I'll give you another example for the test
9 results. Subcooled water. And from here I have
10 showed 150 psi for the orifice and a nozzle. And
11 therefore we focus on one of this same pressure and we
12 noticed that for the nozzle have a higher critical
13 flow mass rate. And for the orifice -- for the
14 orifice it is smaller.

15 CHAIRMAN WALLIS: What area is this based
16 on? This is based on the total area of the orifice
17 hole?

18 MR. WANG: Yes.

19 CHAIRMAN WALLIS: No vena contracta or
20 something?

21 MR. WANG: Right, for the orifice, right.

22 CHAIRMAN WALLIS: You expect something
23 like this from the contraction.

24 MR. WANG: Right. And here, we tried to -
25 - basically tried to see what is important factors for

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1 this thermal or mechanical non-equilibrium and we
2 concluded basically -- I say we, this project is done
3 at Purdue University -- and we have concluded because
4 say if you only have this orifice and the orifice,
5 since it's short, and it doesn't have much time for
6 the liquid to evaporate. And we expect some kind of
7 higher critical mass flow rate, but we see here it's
8 smaller. And we conclude that basically it's a
9 mechanical non-equilibrium is more important than
10 thermal non-equilibrium. This is all that we wanted
11 to say here.

12 CHAIRMAN WALLIS: When you compare a
13 nozzle with an orifice, how do you decide what's the
14 effective flow area for the --

15 MR. WANG: We use the same flow area.

16 CHAIRMAN WALLIS: You don't have a
17 contraction coefficient?

18 MR. WANG: Yes, we do not. We'll use
19 that, but we expect, of course, for this orifice you
20 have a higher loss, but here we focused on the
21 orifice, first for the geometry basically for the --
22 for the nozzle, the lighter liquid -- lighter vapor
23 have a high acceleration. This is also is not a
24 explanation. But we really try to here to see what
25 the effect of the thermal or mechanical non-

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1 equilibrium

2 MEMBER SCHROCK: I don't think you've got
3 it right. Critical flow rate is going to depend so
4 strongly on where the flashing begins. The orifice is
5 not going to behave like a nozzle. I think you're
6 seeking an answer to a question which is -- may be a
7 reasonable question, but I don't think your approach
8 is going to get you there.

9 MR. WANG: Okay. We'll feed it back this
10 to Professor Ishii and we'll have more discussion and
11 try to get back to you.

12 And these tests show you the examples
13 related to this, because the code cannot really
14 predict the data well. This is the RELAP5 prediction
15 for this critical flood, 30 psi for the orifice case.
16 And also we should check on here there's some bigger
17 problems.

18 Just gave a summary of this program.

19 And for the critical flow we have
20 basically 15 to 25 percent higher flow rate for the
21 nozzle than orifice. And we notice a larger slip
22 ratio with the lower upper-stream pressures.

23 MEMBER SCHROCK: In the Purdue work is
24 their critical flow measurement using water?

25 MR. WANG: Basically we have -- the upper

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1 stream is controlled and we use a steady state.

2 MEMBER SCHROCK: Well, you've shown us
3 data for air water systems. And I would argue, just
4 in general, one should not expect to get critical flow
5 phenomena where splashing water is based on air/water
6 measurement. They're quite different systems.

7 CHAIRMAN WALLIS: Well, I think that the
8 subcooled water test must be for water alone.

9 MR. WANG: Subcooled water, yes it's for
10 water alone.

11 MEMBER SCHROCK: Water alone?

12 CHAIRMAN WALLIS: So what you're telling
13 us is that the code's probably not going to give a
14 good prediction for this ADS-4?

15 MR. WANG: Right. And we tried to get
16 some data and see, in the future model development, we
17 use this data to develop some better model or at least
18 we have some data here and maybe for the critical flow
19 models there's some adjustment we can use to improve
20 the prediction.

21 CHAIRMAN WALLIS: Presumably, AP600 was
22 licensed on the basis that the critical flow
23 predictions were okay.

24 MR. WANG: We do have done some work to
25 predict this -- improve the AP600 and --

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1 CHAIRMAN WALLIS: After they built it,
2 then they have to open ADS-4 on a running reactor?

3 MR. STAUDENMEIER: Yes.

4 CHAIRMAN WALLIS: I thought they were
5 going to be full scale tests.

6 MR. STAUDENMEIER: For the valve

7 CHAIRMAN WALLIS: That's going to be the
8 proof of the pudding.

9 MR. WANG: Thank you, Joe. And also
10 actually, maybe the flow regime use is --

11 CHAIRMAN WALLIS: I'm suggesting that
12 since this is critical flow, maybe Professor Schrock
13 should see whatever reports are coming out of Purdue.
14 Can you do that?

15 MR. WANG: Sure. Right now I have a draft
16 report, so I will try to -- but right now we only have
17 a draft report, so it's not --

18 CHAIRMAN WALLIS: So it's a useful time to
19 review it.

20 MR. WANG: Right. Actually, I try to get
21 it to you as soon as possible.

22 MS. UHLE: We'll give that to you.

23 MR. WANG: And the flow instability, it's
24 planned for this year and next year. Why we do that
25 is because we saw some flow instabilities for the

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1 operating PWRs and also for the AP600. Small break
2 LOCA we noticed there's a lot of flow instability.
3 And we would like to get some data to assess TRAC-M.

4 For advanced BWR based on natural
5 circulation, for example, like SBWR. And this --
6 based on natural circulation pressure is more prone to
7 instability, especially during start up because
8 there's no forced flow which you have a -- if you have
9 forced flow, you reduce a chance to have instability.
10 And flow is determined by natural circulation and void
11 fraction. And the power affected also by the
12 fraction, as I've said, some feedback and there's some
13 strong covering.

14 And for the largest scale experiment which
15 takes data from simulated material is not available
16 and the effect of void fraction, feedback and also
17 time lag for this -- convection time lag is not
18 studied -- that is our objective to try to --

19 CHAIRMAN WALLIS: PUMA isn't a nuclear
20 facility, is it?

21 MR. WANG: It is not, but we try --

22 CHAIRMAN WALLIS: How do you do void
23 reactivity power --

24 MR. WANG: We try to use some parametrical
25 studies. For example, we can measure inside the core,

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1 we can measure the void fraction and from the void
2 fraction, we can use our kinetics code to get some --
3 the power feedback on the zed power.

4 CHAIRMAN WALLIS: Can you program the
5 power to reflect the void?

6 MR. WANG: Yes. And for time lag also we
7 do similar trick. Say, for this use electrical rod.
8 It's not nuclear power and the time lag, they will be
9 different, but we will try to find out from the
10 nuclear fuel and for the time lag how much, then we
11 will try to control the electrical power to delay the
12 --

13 CHAIRMAN WALLIS: So electrical power was
14 a shorter time response --

15 MR. WANG: Right, it's much shorter.

16 CHAIRMAN WALLIS: -- so you could program
17 in?

18 MR. WANG: Try to delay some certain
19 amount so that it could match the feedback.

20 And this is basically our objective to try
21 to obtain some instability data from this larger
22 facility at the low pressure and also obtains
23 experiment data for BWR and low point when reactivity
24 you have a feedback. And evaluate TRAC-M for the
25 ability to predict three different types of

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1 instabilities like density wave, flow excursion and
2 the flashing-induced instabilities.

3 And also try to see the accuracy of
4 prediction based on stability boundary and amplitude
5 and frequency. And the ability to model effects of
6 neutronics and thermal conduction time lag on
7 instability.

8 And where we thought -- just a summary.

9 MEMBER LEITCH: How do you get low
10 instability with power feedback. I thought it was the
11 power feedback that basically led the PWR into an
12 unstable situation?

13 MR. WANG: Basically in say we cover
14 constant power. And if it's a perfect steady state
15 it's fine. But if you have some perturbation for the
16 inlet velocity, then instability can occur with
17 certain geometries. For example, like density wave,
18 if you have some inlet velocity perturbation, then the
19 boiling lengths will be changed. If the boiling
20 lengths has changed, then there's a pressure drop
21 across the channel because a two-phase flow in a
22 single phase pressure drop it's kind of automated and
23 it contains. And that effect can propagate into the
24 system if system just have like out of phase and you
25 have density wave --

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1 CHAIRMAN WALLIS: I think if you change
2 the words a bit, if you said data on BWR transient
3 flow response, but you could sort of vary something
4 and then look at the transient response. It doesn't
5 have to be unstable just strictly to produce a
6 transient response which could then lead to
7 instability when coupled. It doesn't have to be
8 unstable for you to measure these kind of times in
9 response.

10 MR. WANG: And basically I just revealed--
11 actually I have a summary --

12 CHAIRMAN WALLIS: Does this feed into a
13 summary of regulatory response to say BWR, how it
14 operates?

15 MS. UHLE: Yes.

16 MR. BAJOREK: It's part of the synergy
17 program.

18 CHAIRMAN WALLIS: Part of the synergy
19 program. We'll find out two years later whether or
20 not we made the right decision on it.

21 MR. BAJOREK: According to General
22 Electric they stay away from those regimes where they
23 would get these instabilities.

24 CHAIRMAN WALLIS: According to General
25 Electric there's no problem at all.

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1 MR. WANG: Well, in summary, for the
2 inflow instability -- actually we only can say the
3 status -- right now we have done some analytical study
4 and basically found out we have to reduce some
5 payloads in the inlet in order to have some
6 instability. And that is where we are, and we will
7 start to do our experiment very soon.

8 CHAIRMAN WALLIS: Thank you. Stole your
9 mic? I guess you'll have to speed up again.

10 MR. BAJOREK: Okay. The way I think I'm
11 going to do that is by not spending a whole lot time
12 on the rod bundle heat transfer project.

13 Joe talked this morning about the type of
14 data that we hope to get out of the facility. Just by
15 way of background, the facility itself is full height,
16 very well instrumented, essentially a 7 x 7 bundle
17 with the corner rods knocked out for a total of 45
18 rods.

19 The rods are prototypical, not only in
20 length but also in diameter.

21 An interesting feature about the rods.
22 I'm sorry.

23 CHAIRMAN WALLIS: Well, I guess we've seen
24 a lot about this before. The question's always been
25 when we going to get some results?

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1 MR. BAJOREK: The results we hope are
2 going to be coming in later in spring, early summer
3 this year.

4 As I mentioned, most of the work that had
5 been done at Penn State this year has basically been
6 in bundle construction, shaking down the facility,
7 putting in supply tanks, putting in the DC power
8 supplies. Their schedule right now is to begin
9 testing in, I believe, April of this year. They're
10 going to start with a battery of about 15 tests.
11 Those will be reflood tests and then continue further
12 on in the year looking at steam cooling tests and then
13 tests where there would be steam and droplets injected
14 at the bottom of the bundle.

15 CHAIRMAN WALLIS: My concern has been this
16 is an expensive long term program that someone's going
17 to cut the budget before it gives you any data at all.

18 MS. UHLE: We will be finishing our
19 reflood data, the first phase at any rate, by the end
20 of this calendar year.

21 MR. BAJOREK: It should be January.

22 MS. UHLE: Right.

23 CHAIRMAN WALLIS: It would be good,
24 though, to start showing some results as soon as you
25 can so that you can show that the program --

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1 MR. BAJOREK: That's why I guess the
2 reflood tests are going to be up there first. Try to
3 get the most important information and then build
4 things later on.

5 MS. UHLE: We're also in the discussion
6 with Korea to extend the program with some of their
7 grid spacer designs in a collaborative effort to
8 extend the program to get even more data.

9 MEMBER SCHROCK: So does this imply that
10 pressurization problems will have been resolved?

11 MS. UHLE: Yes.

12 MEMBER SCHROCK: Yes.

13 MR. BAJOREK: Okay. The next facility
14 that I want to talk about is the ATLATS for the phase
15 separation. But kind of as a lead-in to that and the
16 problems that we're observing in the ATLATS, I want to
17 put that in light with what we're seeing from the
18 AP1000.

19 As I mentioned earlier, one of the big
20 differences in the AP1000 compared to the AP600 is the
21 very large increase in the total core power. We're
22 going to see much large superficial velocities at
23 anytime during the transients that we observe in the
24 AP1000.

25 They've changed the resistance of the ADS-

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1 4 line, greatly reducing the resistance. They've also
2 reduced the resistance of the CMT. They made some
3 other changes to the PRHR. But primarily with respect
4 to entrainment processes, it's been the increase in
5 core power that's really going to drive things.

6 As I mentioned, we have been doing some
7 scaling evaluation from a top-down scaling
8 perspective. Westinghouse doesn't have too bad of a
9 story. Actually what they've done in the AP1000 by
10 increasing the ADS-4 valve, they've made it look
11 actually a little bit more like the SPES facility. So
12 when you look at the scaling parameters early on, it's
13 even better agreement with SPES, which they have used
14 for code validation, than the AP600.

15 Later on it still looks very much like
16 APEX in the OSU tests, not too far off. Critical
17 period where we're having some heartburn showing from
18 a top-down scaling perspective whether OSU is okay is
19 during this ADS-4 period. Part of the question comes
20 into what is the critical flow, as the pressure
21 decreases, what's the quality that leaves the ADS-4
22 line?

23 One of the issues that is definitely going
24 to be -- have to be taken up in the phase 3, however,
25 are items that come from a bottom-up scaling. Well a

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1 bottom-up scaling looking at more localized processes
2 in the core, steam generator, where else in the
3 facility.

4 Where we see problems right now from the
5 scaling leads us again to look at phase separation at
6 the hot leg leading to the branch line.

7 These figures don't show up very well, but
8 the situation we feel that is going to become even
9 more important in the AP1000 than it was in the AP600
10 is this condition where we have a froth going up into
11 the hot leg and we're entraining some fraction of that
12 into the branch line and out. Now, this factors back
13 to the safety of the system and in the analysis,
14 because if we start to entrain large amounts of fluid,
15 you get a larger two phase pressure drop and that
16 delays the time at which you transition over -- excuse
17 me, drop to a low enough pressure that your IRWST can
18 begin to inject into the system. The question mark if
19 that period probe is too prolonged and you have too
20 high an entrainment, too high a boil off, you lead to
21 some part of core uncover.

22 The second question that is arising from
23 our bottom-up scaling is what goes on in this type of
24 a scenario where it might be a DVI line break? You
25 don't necessarily have a level pushed up into the hot

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1 leg, but now we have a high-quality froth above the
2 core. The question is how much of that becomes
3 entrained in the gas flow, eventually up and out the
4 branch line.

5 Now, I think everybody remembers seeing
6 some of the test results in the ATLATS facility back
7 in July. And by way of background, the basic reason
8 for having the ATLATS arose from some of the AP600
9 beyond design basis tests that had been run which
10 showed that there was some core dryout when they
11 started with a lower inventory in the vessel. The
12 RELAP couldn't predict that.

13 We have a situation where we're showing
14 hints of core uncover, the codes aren't predicting it
15 and we know it was due, primarily, to not being able
16 to predict entrainment in RELAP.

17 Now, we saw the facility, saw some of the
18 some film clips and also saw how the facility behaved
19 in July. And the meeting, unfortunately or
20 fortunately, noted that, hey, there's some significant
21 problems with the facility.

22 First and foremost, they're system-
23 dependent oscillations. It seemed to make a very
24 large difference depending on whether they have
25 blocked off at the steam generator, have a line open

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1 from the steam generator back to the top of the upper
2 plenum. Other comments that we have received at the
3 meeting is that there was an inappropriate use of the
4 previous data and existing correlations in their most
5 recent model development.

6 The model that they were developing seemed
7 to assume some type of an annular ring around the
8 bottom of the branch line. This was the physical
9 picture that was being used to develop a newer model
10 for onset branch line quality.

11 And, Dr. Schrock, you have made a number
12 of comments on the references that they were
13 incorrect. Previous comments have not been
14 incorporated. And that their use of this person's
15 data and this person's correlation was at least very
16 confusing, misleading and probably wrong.

17 CHAIRMAN WALLIS: This just doesn't just
18 affect the entrainment, it affects behavior of ADS-4.
19 In ADS-4, the choke flow, you sometimes see steam,
20 sometimes you see it very wet or even a slug of liquid
21 coming along, that changes the flow rate out of ADS-4
22 to the entrainment, and you can set up conciliatory
23 behavior. You may need to be able to model
24 conciliatory behavior, not just some average. I'm not
25 sure they're doing that.

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1 MR. BAJOREK: No. What I want to go over
2 are the types of things that we've started to do since
3 that meeting. I'm sorry.

4 MEMBER SCHROCK: No, finish what you were
5 saying. I'm ready to comment further on the summary
6 of what we learned from that meeting in July.

7 MR. BAJOREK: Okay.

8 MEMBER SCHROCK: Are you done?

9 MR. BAJOREK: Well, I was going to go into
10 the things that we're going to be doing with the
11 facility and the things that we're going to try to do
12 --

13 MEMBER SCHROCK: In terms of the answering
14 Dr. Wallis.

15 MR. BAJOREK: I'm sorry, I'm not sure what
16 you're asking right now.

17 MEMBER SCHROCK: Well, what I'm trying to
18 make a comment on is this summary of the things that
19 you found to be significant problems in the old
20 facility as a result of the meeting in July. There
21 are, in my mind, important aspects of that that are
22 not reflected in this statement. One of them is the
23 fact that the code attempts to solve the problem by
24 saying it knows what the flow regime is. When the
25 flow regime is satisfied there's a potential for

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1 entrainment of liquid in the branch line. For that to
2 be a reasonable proposition, you have to see that in
3 the experiment, in fact, you get stratified flow. In
4 that experiment you did not get stratified flow. You
5 had a sloshing back and forth.

6 MR. BAJOREK: That's certainly correct.

7 MEMBER SCHROCK: No stratified flow
8 evident, and therefore that's the number one question
9 I think to be addressed, is your problem in running
10 RELAP, TRAC -- whatever code it may be that you're
11 trying to do the calculation with it -- is the
12 difficulty that you have the flow regime wrong or is
13 the difficulty something about the model that you use
14 if the flow regime is right?

15 MS. UHLE: Can I answer it?

16 MEMBER SCHROCK: So that you haven't
17 addressed that issue, and I think that's step number
18 one in coming to grips with how you're going to get
19 something out of the OSU facility that will solve your
20 problem.

21 MS. UHLE: Can I answer at this point, at
22 least, do you mind?

23 MR. BAJOREK: Go ahead. Go ahead.

24 MS. UHLE: Okay. I think what was shown
25 to you at the OSU facility was the goals of the

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1 facility was to look at essentially each flow regime,
2 first starting with the horizontally stratified and
3 going into the intermittent regimes as well. And what
4 the movie that was shown to you was looking more at
5 the intermittent. And we have data from --

6 MEMBER SCHROCK: Well, we weren't looking
7 at a movie, we were watching what was happening in the
8 facility.

9 MS. UHLE: Well, okay. I wasn't there. So
10 you saw not a movie, but the real facility.

11 That was for an intermittent regime. We
12 do run in horizontally stratified mode. And there was
13 data taken for the horizontally stratified. I don't
14 think that was communicated to you because it was
15 Research's goal to develop phase separation models
16 spanning all flow regime and horizontal pipes.

17 And the reason why we looked at -- or the
18 first attempt was to see if we could, regardless of
19 flow regime, come up with a correlation that just
20 looked at, say, average level and superficial
21 velocities was because of exactly what you're saying.
22 That the code, if you took this model and you applied
23 it across all different flow regimes, the answer you
24 would get would be dependent on what code you're using
25 and its prediction of flow regime. And so they tried

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1 to come up with factors such as average level
2 superficial velocities regardless of flow regime to
3 come up with your entrainment rate. And that didn't
4 pan out.

5 So what will happen now is we will,
6 unfortunately, have to rely on the fact that you know
7 your flow regime and take the data and make sure that
8 we are consistently determining the flow regime for
9 the horizontally stratified case as well as the
10 intermittent, the wavy.

11 MEMBER SCHROCK: The flow regime that we
12 saw was -- the flow condition which is not described
13 by the flow regime maps.

14 MR. BAJOREK: I think your basic question
15 is okay, you have this condition in the facility. The
16 flow regime maps and the code right now, and for at
17 least the next several years, are static. They cannot
18 track waves or track the development and change of one
19 flow regime down a pipe. In the long run, we would
20 hope we would hope that we would get that type of
21 thing out of the Purdue or, actually more appropriate,
22 the interfacial area transport being done out of
23 University of Wisconsin.

24 For right now we're kind of stuck with
25 regimes we have.

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1 MS. UHLE: And they are looking at the
2 fact that they were getting reflection from the steam
3 generator side and getting rid of that to run the
4 intermittent tests, you know, getting a flow regime
5 that is not --

6 CHAIRMAN WALLIS: It maybe required that
7 you ask them to develop a general correlation
8 entrainment out of the branch but using a geometry
9 that looks like AP1000. Because if you had a long
10 pipe instead of just try to find a flow in the other
11 branch, you might get something completely different
12 at what you see. Maybe you ought to be focusing more
13 on what actually happens in something which simulates
14 AP1000, therefore results might be at least useful for
15 analyzing AP1000. Don't claim this is some sort of
16 scientific study of a branch pipe under other
17 conditions.

18 MS. UHLE: But it's not just prototypically
19 AP1000. I mean, in some ways PWR or hot leg
20 pressurizer. I mean, there are a few LODs down from
21 the --

22 CHAIRMAN WALLIS: How many LODs do you
23 actually get? Maybe you could analyze that, what will
24 actually really happen, get a good correlation in
25 terms of models of what really happened and not try to

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1 mix in almost for something else, with 1000 --

2 MS. UHLE: But in a reactor, I mean you're
3 typically more fully developed. So the point of having
4 a really long, horizontally stratified regime, there's
5 no place in the reactor that you ever would be fully
6 developed.

7 CHAIRMAN WALLIS: Right.

8 MS. UHLE: Right. So we're trying to
9 identify the horizontally stratified in a sense that
10 as horizontally stratified as you can get in a
11 prototypic reactor geometry. You know, that's the hard
12 part.

13 MEMBER SCHROCK: Well, what we saw in
14 Oregon was explained to us as the experiment that was
15 used to produce conclusions about the containment
16 problem and in fact the level shown as a level which
17 is determined by reducing the flow rate until it
18 ceased to have liquid entrainment.

19 MS. UHLE: And then they came back up in
20 the other direction and it mismatched.

21 MEMBER SCHROCK: I didn't see any coming
22 back up in the other direction. I asked about it and
23 there was no answer at that time. Maybe those came
24 after that question was asked; I'm not sure. But I
25 think -- what I'm reading here doesn't convince me

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1 that you have a clear picture yet of sorting out what
2 you're going to have to do to get useful information
3 out of the OSU experiment.

4 CHAIRMAN WALLIS: I think that will
5 probably be in the conclusion. Sometime we're going
6 to summarize.

7 MR. BAJOREK: Well, let me go through and
8 summarize the actions as we see them right now.

9 CHAIRMAN WALLIS: The pictures you're
10 showing here of these double bumps -- that's not what
11 happened?

12 MR. BAJOREK: No. No. No, that's --

13 CHAIRMAN WALLIS: That's a fantasy?

14 MR. BAJOREK: No. And I mean it certainly
15 wasn't what we saw in the facility. But we think that
16 the goal one on this --

17 CHAIRMAN WALLIS: It's an analyzable
18 situation, but not relevant.

19 MR. BAJOREK: -- We think the first thing
20 is the basic, we're going to try to better understand
21 the system oscillations. The question is these
22 oscillations as we see in ATLATS facility, do they
23 also occur in the APEX facility, and how transferrable
24 is the information that we're getting from ATLATS to
25 the full-scale AP1000? The scaling that was done for

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1 ATLATS, as well as for the OSU hot leg and branch
2 line, were based upon having the right void fraction
3 in the upper plenum, the right L over D between the
4 upper plenum and the branch line, and the correct
5 capital D to small d ratio between the branch line.
6 It really did not look at anything on the length
7 between the branch line and the steam generator, size
8 and heights of the waves that might form in a pipe of
9 diameter D.

10 What we would like to do is to try to
11 understand that better to realize whether the waves as
12 we see them at ATLATS are also going to occur in the
13 larger scale facility. That would be a review of the
14 scaling criteria.

15 Now, we did take Dr. Wallis' suggestion
16 and asked them to run a series of tests in which they
17 injected into the top and this figure shows what had
18 been intended to be porous injectors to go into the
19 core -- it doesn't show up very well at all. But it
20 does have an auxiliary air port by which we can do
21 injection into the top of the facility.

22 They ran those tests, they sent those to
23 us earlier in the month. We haven't had a chance to
24 go through those in great amount of detail, however my
25 observation in taking a look and plotting the liquid

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1 levels, there still are a very high amount of
2 oscillations. It does not appear as to whether that
3 smoothed things out.

4 We've since gone back to them and asked us
5 based on those oscillations what are some of your
6 averaging procedures? Because we see a lumping of
7 much of this data, some of which Jennifer noted was
8 horizontal stratified. If we had those movies, I
9 think we'd be able to see that. A lot of it was
10 intermittent.

11 We think at this point we need to start
12 segregating that data into information which was truly
13 horizontal stratified and something that it is
14 intermittent, wavy, what other type of flow regime
15 that was apparent.

16 In future work we're going to request that
17 they supply a CCD or some other recording of what that
18 flow pattern was. Our expectation and understanding
19 going into the meeting is that we were going to see a
20 lot of horizontal stratified flow. We'd like to try to
21 get that recorded in addition to the comments that
22 they do have in the test reports. You have to dig to
23 find them, but there is a visual observation on what
24 that is. We'd like to start with that and segregate
25 out the points and get them into their appropriate

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1 regimes right now.

2 CHAIRMAN WALLIS: Just want to make a
3 point that joining of the hot leg and the vessel is
4 accomplished by intersecting two cylinders leaving you
5 with a sort of strange, sharp edge around that
6 opening. That doesn't exist in the plant. It could
7 be of some significance in the hydrodynamics that
8 you're looking at here.

9 MR. BAJOREK: Okay. With respect to the
10 references and their use of the data, we've also asked
11 them to supply all copies of the references that
12 they've been using in assimilating their report and
13 plan to ask them to rewrite that section where they
14 talked about their literature search.

15 Based on the information we got, we agree
16 with you that it's confusing and misleading the way
17 things have been lumped together. Some of the reports
18 are difficult to get. We've asked that they supply
19 them to us. We're going to do our own review.

20 We feel that the model development needs
21 to be revised to be more regime-dependent. If we can
22 some day lump everything together, that would be the
23 simplest thing for the code application. But based on
24 what we've seen, we should use the horizontal
25 stratified data, keep that with models which are

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1 appropriate for horizontal stratified flow regimes.

2 This in your ring picture that seems to
3 have been used in their development certainly didn't
4 show up in the experiments. And what we would prefer
5 is, rather than this figure over on the right which
6 they assumed, go to a picture which a similar model
7 had been devised by, I think it was Yanamoto, where
8 the picture, physical picture of the fluid beneath the
9 branch line is something that is forming more a
10 conical or a pyramid shape. At least that physical
11 picture looks -- corresponds much closer to what we --

12 CHAIRMAN WALLIS: But if you have a photo
13 that looks like a sketch?

14 MR. BAJOREK: There is one in the report.

15 CHAIRMAN WALLIS: We found a situation
16 where at least at the moment it looked like that
17 picture.

18 MR. BAJOREK: In fact, it was interesting
19 how they did it. They must have had a boroscope
20 inside the pipe looking axially. And you can see
21 almost a formation of a water spout.

22 CHAIRMAN WALLIS: Well, maybe it does for
23 some regimes, but what we remember very much was
24 large-scale oscillation of the whole pipe.

25 MR. BAJOREK: Yes. Yes. In fact, the

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1 oscillation was between the branch line and the steam
2 generator.

3 CHAIRMAN WALLIS: Okay. We have to move
4 on to the next one.

5 MR. BAJOREK: Okay.

6 CHAIRMAN WALLIS: And then you can 15
7 minutes of summing up or so.

8 MR. BAJOREK: Okay. Subcooled boiling is
9 work that is going on at UCLA. We had Professor Dhir
10 come and present his results to us about 3 or 4 weeks
11 ago.

12 Now, the work that's being done at UCLA is
13 also in response to AP600 and AP1000, where there's a
14 realization that most of the decay heat removal is now
15 going to be done at lower pressure. We feel that the
16 models for subcooled boiling would not be as good at
17 the lower pressures as they were at higher pressures,
18 typically where you would need them for small break
19 LOCA.

20 The other question that's going to be
21 answered by the UCLA work is the idea of heat flux
22 splitting. How much of the energy and subcooled
23 boiling goes into void generation versus sensible
24 heating of the liquid? Right now whether it be in
25 TRAC or RELAP, the models are largely ad hoc. Based

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1 on some limited test data to come up with the models,
2 but nothing very mechanistic in the way its treatment
3 of this heat flux split. So the objective of the UCLA
4 work, very much like the Penn State for dispersal of
5 film boiling, used advanced instrumentation and
6 detailed facilities to get high-quality information by
7 which we can develop these mechanistic models.

8 MEMBER SCHROCK: I don't know if you read
9 the comments that I made in a recent report, but my
10 recollection was in reviewing the -- TRAC's
11 documentation back in 1987 was that they had heat
12 transfer directly from the wall to the vapor, and
13 cases where the wall was -- the flow regime map let
14 it. So the transfer is nonphysical. It has to be to
15 the liquid and then to the vapor.

16 So I think it would be useful if this
17 could get sorted out in the way this was being
18 described and state more clearly what this heat flux
19 splitting is all about, and the way it's used in the
20 code. It originated the subcooled boiling models and
21 that got massaged and massaged and massaged and came
22 out as a GE thing under Leahy's name. But I think
23 that a lot of people have had confusion about what
24 this heat flux splitting means. And I think most of
25 those people have been people who work with codes, not

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1 the people with experience. It needs to be dealt
2 with.

3 MR. BAJOREK: Well, I think there's the
4 physical models, and I think what you're pointing to
5 there's -- a lot of times the code -- you look at the
6 hydrodynamics and you pick your flow regime on one set
7 of conditions and then you take the wall temperatures
8 and maybe some gross estimate of a void and say this
9 is what's going on near the wall. But those physical
10 pictures may not necessary correspond. You may
11 predict a bubbly flow, who knows whether the bubbles
12 are concentrated out in the fluid or close to the
13 wall. Those selections have to be consistent --

14 MEMBER SCHROCK: For heat to be
15 transferred from the wall to the vapor, you have to
16 have a dry wall.

17 MS. UHLE: Right. But see, we have this
18 problem --

19 MEMBER SCHROCK: In the physical work.

20 MS. UHLE: But in the problem of numerics
21 if we're taking one second time steps, you can't do
22 that because you would get way too much super heating
23 of the liquid. And you can't get around that. So
24 that's where some measure of realizing that you're in
25 a numerical system in some way differs from reality,

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1 and that's why you have to rely on assessment.

2 MR. KELLY: May I make interjection? This
3 is Joe Kelly from Research.

4 What Professor Schrock is alluding to goes
5 way back, in forced convection flow they did things
6 like void fraction volume --

7 MS. UHLE: Not necessarily. That's what
8 I'm trying to say is the fact that if you're taking
9 over a period of a time step of a second, you can't
10 put all of the liquid, all of the heat flux into the
11 liquid. And you know currently in our numeric systems
12 or numeric schemes and we would have too much super
13 heat the liquid and then the next time step you would
14 get the interfacial heat transfer to the vapor. I
15 mean, that's all I'm trying to say is that whether--
16 how we solve this problem we can talk about later, but
17 why it was done in the past, it may sound weird to you
18 but a lot of it is simply because we had to work in
19 the numerics of the time. Now when we make the code
20 more implicit, then we can get rid of those things.
21 But the computer limitations in the past prevented
22 that because we just didn't have enough memory or
23 speed of the computers were too slow.

24 CHAIRMAN WALLIS: I think that again we're
25 getting into too much detail. If we're going to

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1 review Professor Dhir's work, we're going to have to
2 spend a whole afternoon.

3 MR. BAJOREK: Well, it would take quite a
4 bit of time.

5 CHAIRMAN WALLIS: There's no way that we
6 can get an overview of these programs beginning at
7 that level. What I get from this is that there is a
8 problem with predicting the amount of voids you get
9 and the heat flux in subcooled boiling --

10 MR. BAJOREK: Yes.

11 CHAIRMAN WALLIS: And that probably
12 sometime during the year we may need to look at this
13 in more detail.

14 MR. BAJOREK: Yes. I think sometime in
15 probably the spring would be the right time.

16 CHAIRMAN WALLIS: I don't recall actually
17 having a presentation.

18 MS. UHLE: It came to the staff.

19 CHAIRMAN WALLIS: Well, maybe that's where
20 we could contribute.

21 MR. BAJOREK: To summarize what he is
22 working on. Breaking up the wall into several
23 components using high speed visualizations. Two
24 different test sections, one a rod bundle another a
25 flat plate test section. Flat plate in order to give

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1 him things like nucleation site densities, motion of
2 the bubbles, collapse rate of the bubbles as they
3 leave the wall and then getting additional information
4 from the rod bundle to augment that.

5 I've left in the package the types of
6 measurements that are being obtained in the facility.

7 I'm going to jump to more conclusion,
8 closer to the conclusions.

9 He's been successful at developing a model
10 to predict the delta T at the onset of nucleate
11 boiling in a subcooled flow, that seems to do a pretty
12 decent job at predicting not only his own data, but a
13 fairly substantial set of data that he also obtained
14 in a literature search.

15 CHAIRMAN WALLIS: Your measure of success,
16 this sort of a picture?

17 MR. BAJOREK: Well, this would be one of
18 them. I mean, because he's trying to get the onset
19 correct. He's also trying to get the right heat flux
20 at the onset correct, simultaneously. Get the single
21 phase heat transfer coefficients and also be able to
22 get models for the bubble size and the rate of
23 collapse of those bubbles. It basically gives you the
24 condensation component of that split.

25 This shows the heat flux based on his

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1 model to try to predict the heat flux, which is a
2 contribution of a partial subset of those terms, and
3 by in large it seems to do a successful job not only
4 of his data but also on other sets of data.

5 CHAIRMAN WALLIS: Could you give us time
6 to see what the state of the art was before he came
7 along, and if he drew a picture like this based on
8 whatever you were using before, is this an
9 improvement?

10 MR. BAJOREK: Yes, it would. I mean, he's
11 also done the comparisons to some previous models and
12 you can see where the scatter is significantly larger.

13 MS. UHLE: Joe Kelly has a good paper on
14 the subcooled boiling model if you'd like to see the
15 current state of the art.

16 MR. BAJOREK: Okay. Now where he's going
17 with this work now, he's gotten enough data on the
18 flat plate test section. Most of the work that's
19 going to be done in 2002 is to try to come up with a
20 better term for this flux split, to get the additional
21 terms in this heat flux contribution to the total heat
22 flux during subcooled boiling, expand the data base,
23 getting additional information for the rod bundle,
24 increase the range of subcooling and look at some
25 higher pressures. Right now everything is fairly

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1 close to atmospheric.

2 I think he can take the facility up to
3 close to 3 or 5 bars. And he thinks that most of that
4 work can be completed in 2002, which is why in the
5 overall schedule we're looking at trying to implement
6 those models later in 2002, but probably not in time
7 to get into the Rev 0.1 release.

8 Okay. The last topic that we're going to
9 have is looking at the interfacial transport, which
10 has been done primarily at Purdue and University of
11 Wisconsin. Jennifer's going to talk about that.

12 MR. BOEHNERT: Do we have these slides,
13 Jennifer?

14 MS. UHLE: No, I'll get them. Because I
15 thought that Steve had them, he thought I had them.

16 I've talked about this before at the ACRS
17 meeting, so the objective of the interfacial area work
18 is to get away from the static flow regime use in the
19 code, the reason being is that for one thing, we need
20 to use interfacial area in the code. It's a value that
21 we have to have a closure relation for. It determines
22 the interfacial heat transfer as well as the
23 interfacial drag.

24 We currently model it using static flow
25 regimes. I think everyone's aware of the fact that the

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1 flow regimes were developed in steady state
2 situations, lots of air/water. At any rate, the
3 transition criteria and the use of the static flow
4 regime, it doesn't represent the actual physical
5 processes of creation and the destruction of the
6 interfacial area, so there's no time and length scale.
7 And so if you change your flow rate; in some sense if
8 you have an oscillation you instantaneously change
9 your flow regime. That doesn't sound that bad, but if
10 you consider the situation of annular flow and you
11 increase your vapor flow rate so that it's beyond the
12 point where you're entraining liquid drops, you can
13 increase by several orders of magnitude the drag in
14 the interfacial area of interfacial heat transfer so
15 that it causes this oscillation and it can also cause
16 some inaccurate answers.

17 So we're trying to develop a first order
18 equation for the transport of the interfacial area;
19 that is the objective. We realize --

20 MEMBER KRESS: If you have that, you no
21 longer need flow regimes at all?

22 MS. UHLE: That is the goal, but before we
23 can take out the flow regimes we have to have the data
24 in the model covering all flow regimes in geometries
25 prototypical of nuclear power plants. And that is the

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1 big effort. That's why we're trying to collaborate
2 with France and Japan, and open this up for
3 international collaboration, so it's a big scope. We
4 are making progress ourselves but we realize that we
5 had originally thought that Japan and France were
6 going to provide the steam water. We're still working
7 on that.

8 MEMBER KRESS: What is the position now?

9 MS. UHLE: I can go through where we currently are.
10 I just want to point out, though, if we don't to the
11 point where we actually do use this interfacial area
12 transport equation for the flow regimes, this project
13 is not useless by any stretch of the imagination
14 because of the fact that we do use values for
15 interfacial area.

16 We will be able to take these measured
17 quantities of interfacial area and then compare them
18 to the correlations that we use in the code currently
19 to make sure that we are at least getting a prototypic
20 value of interfacial area for the flow regime of
21 interest.

22 So, again, if the modeling doesn't work
23 out in the long run, the data is still useful.

24 CHAIRMAN WALLIS: This principle has a
25 separate conservation equation --

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1 MS. UHLE: Yes.

2 CHAIRMAN WALLIS: It's something you can
3 could put into your TRAC now --

4 MS. UHLE: Yes, I did that. Yes, I did
5 that. If you remember a couple of years ago where I
6 put in the first or I put in the -- one group
7 interfacial area equation. In other words, it was for
8 bubbly flow. So by one group I mean that the vapor
9 phase was all spherical, and therefore the drag
10 coefficients were, again, first spherical
11 configuration. And in --

12 CHAIRMAN WALLIS: So how long did it take
13 you to do -- a long time?

14 MS. UHLE: Yes, it took me a week. It
15 took me a week, and that includes modeling and
16 comparing to the data, although I did call our
17 numerics guru for a few challenges along the way.

18 CHAIRMAN WALLIS: You called this TRAC-M
19 development.

20 MS. UHLE: Yes.

21 CHAIRMAN WALLIS: And the thing is if
22 these guys are successful --

23 MS. UHLE: It'll go in easily.

24 CHAIRMAN WALLIS: -- in 2004 or something,
25 put into TRAC as an implement?

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1 MS. UHLE: Yes.

2 CHAIRMAN WALLIS: With an option or
3 something.

4 MS. UHLE: Right. Now with the two group,
5 it's going to take me more than a week. I was going
6 to do it this year, but then I said I was demoted to
7 assistant branch chief and they don't let me touch the
8 code anymore. But I was planning on doing that to put
9 in the two group equation. And there's a little bit
10 more complexity with the two group equation, because
11 you do have to solve a matrix.

12 CHAIRMAN WALLIS: All you have to do is
13 delegate somebody younger and quicker.

14 MS. UHLE: I thought it was older and
15 wiser.

16 PARTICIPANT: That's his answer why we
17 hire lower grades --

18 CHAIRMAN WALLIS: I'm not sure we need to
19 spend on this. It's going on it's processing --

20 MS. UHLE: It's going on. We're covering
21 flow regimes. With respect to Professor Schrock's
22 questions, we've covered bubbly flow -- sorry. For
23 the co-current upflow we've covered all flow regimes
24 up to annular. We're doing counter current flow.
25 We've completed bubbly flow. Started to do co-current

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1 down flow for bubbly flow. Horizontal, we've covered
2 all co-current regimes and we're starting to extend to
3 other geometries, so we do have this database and
4 comparing.

5 There are two group models that they've
6 come up with, although it's not put in the code, they
7 do compare to the data as they develop it.

8 In the future, we need to go to steam
9 water for the source and sink term of the phase
10 change. And, again, extending to just other flow
11 regimes and geometries.

12 We're hoping to have the final model, you
13 know, our ideal would be to have it in 2005 in the
14 code and replace the static flow regime. It depends
15 a lot on --

16 CHAIRMAN WALLIS: I hope that they are
17 publishing results --

18 MS. UHLE: Yes. Yes. You haven't been
19 reading *International Journal of Heat and Loss*
20 *Transfer* then because, yes, we just published
21 something.

22 CHAIRMAN WALLIS: You're jumping ahead
23 with that accusation. You don't know what I've been
24 reading.

25 MS. UHLE: Yes, we've been publishing.

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1 Are we done except for the summary?

2 CHAIRMAN WALLIS: Well, I was hoping that
3 we could talk about the papers

4 MS. UHLE: I can give you the papers, if
5 you'd like.

6 MR. BOEHNERT: Yes, we'd like the papers.

7 CHAIRMAN WALLIS: I was trying to jot down
8 as where we could interact with you in the future that
9 would be profitable. My colleagues should come in on
10 this. But I feel with the development of this
11 consolidated code that what we should do is encourage
12 you to keep up your enthusiasm for the activity but I
13 think where we might contribute is in the
14 documentation. Do you have draft documentation that
15 we can look at and give you some input and avoid
16 giving you surprises when we see it later on? Maybe
17 we'll make the documentation better? I think in the
18 other areas of Joe Kelly and company, doing work with
19 their former knowledge of what they're doing than we
20 are, I think that they go for it and we'd like to see
21 the result. But then I think we should discuss what
22 we need to do about each of the review of some of
23 these other programs, USU, Penn State. But can we
24 first look at other comments on the TRAC

25 MEMBER LEITCH: My question, I guess, or

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1 comment is that I'm a little confused about what
2 release means. Does that mean that it can only be
3 used in certain circumstances? And if so what
4 purposes? In other words, are there other grounds or
5 to what extent -- seeing that we've talked about
6 perhaps 8 or 10 applications and I guess what I think
7 should be the outcome of the status of this by the end
8 of next year. It would be useful to address these
9 other applications. What will the status be? In
10 other words, I guess we've seen a program that ends
11 sometime at least in the next 13 months, but obviously
12 the research effort is geared towards the targeted
13 applications. But I'm just a little confused as to
14 what will be value of using the TRAC code and the
15 RELAP5 in these applications. I guess that's a
16 reasonable question.

17 MS. UHLE: No, no. That's a very
18 reasonable question, and it's a quick answer here. Is
19 that by the end of 2002 we will be as good as the old
20 codes for the targeted applications, so we can from
21 then on rely on the TRAC code.

22 Now, the fact that RELAP5 is now the
23 workhorse code mostly for the international community
24 as well as for NRR, we foresee bringing that in-house
25 and maintaining and it using it as a benchmarking tool

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1 as we continue the effort. So it's not like we'll be
2 dumping RELAP5. But at that point we'll be able to
3 use either code for, say, the PWR applications. We
4 will, of course, think that TRAC will be better for
5 the large break LOCA for the PWR.

6 We will be as good as TRAC-B used to be
7 for the BWR applications. And we can do stability and
8 3-D kinetics for the BWR to replace RAMONA.

9 So, again, we'll be starting to focus and
10 start this transition into relying on TRAC-M.

11 MEMBER LEITCH: The synergistic effects?

12 MS. UHLE: That will be done with TRAC-M.

13 MEMBER LEITCH: And the PBMR?

14 MS. UHLE: TRAC-M. Right. But we will by
15 the next time we -- we say the next fall meeting, we
16 will have the physical models in to do the PBMR.
17 Hopefully, have identified data sources and at least
18 have a few plots to show with respect to system
19 behavior.

20 MEMBER LEITCH: I guess just to
21 paraphrase, I think what I heard you saying is by the
22 end of next year this is when it comes out, TRAC-M
23 will be equal to or better than?

24 MS. UHLE: Yes.

25 MEMBER LEITCH: So you will make another

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1 presentation to the committee?

2 MS. UHLE: Yes. That is the goal, yes.

3 CHAIRMAN WALLIS: So you will come to us
4 towards the end of next year with a consolidation of
5 the codes?

6 MS. UHLE: Yes.

7 CHAIRMAN WALLIS: You will then have
8 consolidated the codes?

9 MS. UHLE: Yes.

10 CHAIRMAN WALLIS: Right so you won't have
11 improved them much.

12 MS. UHLE: In some cases, for example, the
13 level tracking we've improved. The large break
14 calculations with Joe Kelly and Weidong Wang's reflood
15 work, we would have improved. Hopefully we will have
16 the phase separation stratified flow model in for use
17 with the AP1000, we would have improved that.

18 The other improvements have been more user
19 convenience , speed, robustness rather than physical
20 models. And then at that point in time as we then go
21 into more of a PIRT base developmental assessment
22 effort and continue working more closely with the test
23 programs, we would then focus on improving the
24 physics. But the original charter of the
25 consolidation and what the Commission had signed off

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1 on was to recover capabilities by the end of this
2 period, and we feel will achieve that.

3 MEMBER SCHROCK: Do you have any
4 indication that industry wants to start using it?

5 MS. UHLE: Not so much industry.
6 Industry's interested in the graphical user interface
7 because it works with RELAP5. And, of course, there's
8 the strong use of RELAP5 in industry.

9 Shanlai Lu on the staff has for NRR's use
10 has taken the TRAC-G and developed a pearl strip that
11 allows us to take a TRAC-G input deck and convert it
12 into what TRAC-M can run. So NRR would be using that
13 and is a comparison for the future application of the
14 TRAC-G submittal for the large break case.

15 The Naval Reactors is very interested in
16 using the consolidated code because Betest and Capital
17 are looking at, and in fact consolidating their
18 analytical work as well.

19 And then, of course, the international
20 user group is holding off, you know, waiting to see
21 how it works. Most people are interested in the
22 ability to recover RELAP5 functionality, and that is
23 what we need to -- we will proving this in a month or
24 so.

25 MEMBER FORD: I've got three comments.

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1 Not being a fellow hydraulic person and not specific
2 to the physics.

3 First is, you weren't clear about the
4 qualification of the code especially when you're
5 qualifying it against scattered databases. Presumably
6 the code should be able to predict the uncertainty
7 that you have.

8 The second question, and actually more a
9 comment. The second question is what will the
10 hierarchy be for the various codes when this TRAC-M
11 code versus the licensee's code, what determines
12 whether one is better than the other? Really a
13 professional comment.

14 The third one is really also a comment. In
15 the beginning that mission statement said safety
16 margins and therefore presumably the next stage after
17 TRAC-M is to incorporate it into materials
18 degradation, and I'd be interested to hear about that.
19 Is that your ultimate goal?

20 MS. UHLE: I'm Sorry.

21 MEMBER FORD: Well, aging phenomena of the
22 materials.

23 MS. UHLE: I mean, our work with the
24 materials interaction really is coming from providing
25 thermal-hydraulic conditions to the division of

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1 engineering, and as well as working with the PRA
2 branches where we provide, you know, based on the
3 material degradation at these new thermal-hydraulic
4 conditions, or maybe because of flow induced or flow
5 accelerate corrosion you're going to have a higher
6 failure -- or sorry. A higher break frequency, you
7 know, that would go into the PRA. You know, that's
8 more of our interaction.

9 MEMBER FORD: Well, there's a lot of
10 material degradation issues when you have a synergy.
11 Presumably that's all been passed along --

12 MS. UHLE: Typically the level of detail
13 you need to couple thermal-hydraulics to something
14 like flow accelerated corrosion is not going to come
15 out of a system code, because our nodes are like this
16 big. And you're looking at the boundary layer to look
17 at, you know, the physical processes going on to do
18 the flow accelerated corrosion. And more --

19 MEMBER FORD: I see.

20 MS. UHLE: That would be more a
21 computational fluid dynamics linkage.

22 MEMBER FORD: Perhaps this phenomena is
23 related to the core shroud.

24 MS. UHLE: Again, the idea of the thermal
25 fatigue cycling, that again is looking more at large

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1 eddy simulation to get the frequency of the water
2 coming up at a different temperature, going back down.
3 That is not something a system code is ideally suited
4 for. That would be more of a computation fluid
5 dynamics application.

6 And we do have CFD technology in-house,
7 and we are, again, hiring to increase that and that is
8 something that we can think of as far as interacting
9 with the division of engineering as these applications
10 come up.

11 CHAIRMAN WALLIS: What I had in mind in
12 this summary was we give you some input, and we speak
13 again about more activities, say, in six months, and
14 how we can interact in the next six months.

15 Tom, did you have -- I think we're talking
16 about the TRAC-M --

17 MEMBER KRESS: Yes. TRAC-M. I did have
18 a couple comments, but I'm not sure my comments are on
19 how best to interact. My comments are more with
20 respect to what Ms. Uhle was saying. I think you
21 ought to view integral experiments as rough. I don't
22 think you're going to predict experimental error.
23 We're talking about two different things. Go look and
24 see if your predictions fall within the boundaries of
25 the experimental error. So my comment there is use

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1 separate effects testing to determine the
2 uncertainties in your specific model. Think very hard
3 about how to incorporate them in the code in a way
4 that you get an uncertainty distribution in your final
5 product. When you get to that point, you really have
6 a code that is very useful.

7 My other comment I had is that I certainly
8 like what I see and I encourage you to continue with
9 this. If you are very successful it would solve a
10 whole lot of these problems with flow regimes, how you
11 transition from one to the other and how you deal with
12 them on the code. I'd certainly like to hear more
13 about that later.

14 CHAIRMAN WALLIS: Can we move on then to
15 the separate programs?

16 The OSU program, I'm not sure -- any hope
17 of bringing them around to our viewpoints? Why don't
18 we try to figure out if there is some way in which we
19 can interact. I don't want to be with you or them at
20 the end of the program and have exactly the same
21 comments we had when we visited.

22 MS. UHLE: As part of my action items that
23 I have written down, it is to schedule some sort of
24 test program review if I can interact with Paul to do
25 that. Because, obviously, with your expertise it's of

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1 good value to us to learn.

2 CHAIRMAN WALLIS: Right.

3 MS. UHLE: And I mean I think our goals
4 our consistent really, although sometimes it can be a
5 combative interaction. You know, we want an accurate
6 code, we want to be able to extend the code to other
7 applications easily, we want to be able to understand
8 uncertainty and calculate it so that this tool can be
9 of use. You're looking at a whole lot of people that
10 have put a lot of time in this program, and the idea
11 of it not being useful, you know, we wouldn't get out
12 of bed in the morning.

13 So I do think that our goals are
14 consistent, and so I think further interaction with
15 you on a more frequent basis can only benefit us.

16 CHAIRMAN WALLIS: Maybe there is a way in
17 which OSU can come before this Committee before the
18 report to the full assembly. There's no way.

19 MS. UHLE: That's --

20 MR. BAJOREK: No, that was for the ETS.

21 CHAIRMAN WALLIS: ETS. The other work is
22 still going on?

23 MR. BAJOREK: The work is --

24 MS. UHLE: Oh, yes, we're getting a
25 preliminary model for the --

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1 CHAIRMAN WALLIS: Work on a useful
2 interaction with OSU that we could have.

3 MS. UHLE: Yes. Okay.

4 CHAIRMAN WALLIS: Penn State, it seems
5 they're still building the apparatus, they haven't
6 gotten their results. I'm not sure we have anything we
7 can --

8 MS. UHLE: I mean, they're doing shakedown
9 testing now and characterizing like volumes and lost
10 coefficients and things of that nature.

11 CHAIRMAN WALLIS: And PUMA oscillations,
12 I don't think we have anything to get until they start
13 doing something? We might, I think, contribute to the
14 critical flow models.

15 MS. UHLE: Right. I have down to give you
16 that critical flow report for Professor Schrock.

17 CHAIRMAN WALLIS: And maybe you can evolve
18 at some time an actual presentation by them?

19 MS. UHLE: Yes.

20 CHAIRMAN WALLIS: And then on DEER, I
21 think we really are due a presentation. It's been
22 going on for some time, we have not had the detailed
23 interaction, the kind of questions we'd love to ask
24 and don't have time for today, so maybe we should
25 schedule something for later. After the start of the

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1 year maybe.

2 MR. BOEHNERT: That'll be fine.

3 CHAIRMAN WALLIS: All right. Anything
4 else on -- I didn't have anything immediate

5 MR. ROSENTHAL: You expressed an interest
6 in some of the MOX work.

7 MS. UHLE: MOX work.

8 CHAIRMAN WALLIS: There is a fuel
9 subcommittee of the ACRS.

10 MR. ROSENTHAL: Yes, I think that will be
11 a better place for that and we could advise it --

12 CHAIRMAN WALLIS: It's all from a drop,
13 it's neutronics.

14 MR. ROSENTHAL: We would do the neutronics
15 and other MOX related issues about how you load the
16 power and then the source.

17 CHAIRMAN WALLIS: But we'll do that with
18 kind of a separate subcommittee on MOX. Maybe that's
19 where it actually --

20 MS. UHLE: Okay. Yes, I have that down.
21 Although we will give you some written information to
22 respond to Professor Schrock's questions. Although it
23 may not be answering all the questions that you've
24 asked, that can be at a future time.

25 CHAIRMAN WALLIS: I think that the purpose

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1 of this meeting is for us to give some input for the
2 main committee and the writing of the research --

3 MR. BOEHNERT: That's correct.

4 CHAIRMAN WALLIS: This does not require
5 some letter or anything?

6 MR. BOEHNERT: No, it does not require a
7 letter. It's fed into the work on the research --

8 MS. UHLE: I mean, one thing I do want to
9 point out, because based on the feedback you give us
10 annually is that we understand we need to tie in our
11 test programs closer. It's not news to us to hear
12 that.

13 In the past it's simply been how much time
14 we have and the staff we had available. Now that
15 we've been in this hiring mode and we've been bringing
16 more expertise in-house, we're going to try to start
17 to do that. It's a big focus for us.

18 CHAIRMAN WALLIS: I just want to be
19 encouraging.

20 MS. UHLE: We realize that, it's not -- in
21 fact, you know, Steve being the senior level scientist
22 here is the perfect person to really lead that
23 initiative, and he's been doing a great job in trying
24 to tie in the model development work, the test
25 programs more closer to the code development work that

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1 Joe Kelly will be overseeing.

2 CHAIRMAN WALLIS: I hate to go back to the
3 TRAC thing, but you know you have done a good job of
4 consolidating these codes and at the end of this next
5 year you're going to show that they'll at least do all
6 the things the previous codes did, which is a bit like
7 saying Amtraks going to run at least as fast as the
8 steam trains used to run in the '30s. And what we're
9 really looking forward to is that there's a high speed
10 train or something that's really that much better.
11 That's what we'd love to see.

12 MS. UHLE: Right.

13 CHAIRMAN WALLIS: The sooner that can get
14 on the track, the better.

15 MS. UHLE: Yes, right. Again, we agree
16 with that. Now, we've been doing what management has
17 assigned us to do as far as the Commission policy
18 being to do the consolidation first before we start
19 the improvements. We also want to make improvements,
20 probably faster than you do, because we're the ones
21 doing the work and it frustrates us more than it
22 probably frustrates you. So that is going to be our
23 focus.

24 But we were tasked with this consolidation
25 effort first, and that was the high priority.

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1 CHAIRMAN WALLIS: Even if you have to
2 smuggle the improvements along.

3 MS. UHLE: We've done that.

4 MR. ROSENTHAL: No, no. But we work in
5 accordance with the operating plan, of course. But,
6 no, in conjunction with the synergy work we have
7 planned ATWS calculation and we can now do couples,
8 3-D, space time kinetics, really better ATWS
9 calculations than we were able to do. And that'll be
10 a shorter term product. But we do some benchmark.

11 So we're going to start seeing the
12 benefits now.

13 MS. UHLE: Ready for your next victim? I
14 think they're behind you.

15 CHAIRMAN WALLIS: I'm very glad that you
16 have all these people now to work on these problems.
17 It's good to see Joe Kelly back here. Go away with a
18 good feeling.

19 MS. UHLE: I also went away with the
20 concept that any PIRT that you are involved in we're
21 supposed to ignore, because you are unduly prejudice,
22 that's the number one lesson we learned today.

23 CHAIRMAN WALLIS: I think I'm utterly
24 clean. I don't think I've ever been involved in a
25 PIRT. Now nor have I ever been.

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1 Do you have a few final remarks? Then we
2 will close this part of the meeting.

3 I would like to take a break. I notice
4 there are all the people waiting. We have caught up
5 some time, so we'll try to keep on time, at least get
6 out of here before 6:00.

7 We'll take a break.

8 (Whereupon, at 2:43 off the record until
9 2:02 p.m.)

10 CHAIRMAN WALLIS: No introduction, Mr.
11 Henry, please begin.

12 MR. HENRY: Thank you, Mr. Chairman.

13 We're happy to be here today just to have
14 the opportunity to present to you this new activity of
15 using the MAAP5 containment code to replace the models
16 for containment integrity at both Beaver Valley and
17 Point Beach.

18 Before I get into talking about it, I
19 thought perhaps you would like to hear from the two
20 different sites of their motivation for going to a
21 different code for containment integrity, that it has
22 some differences which are site specific. So, maybe
23 just a couple of minutes with each site.

24 I'd like to introduce Mike Testa from the
25 Beaver Valley site and then he'll be followed by Harv

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1 Hanneman from Point Beach.

2 MR. TESTA: My name is Mike Testa. I'm
3 with First Energy, and we operate the Beaver Valley
4 Power Plants, that's Beaver Valley 1 and 2. And I'm
5 Project Manager for the Power Upgrade that's being
6 undertaken there. The power upgrade that we're looking
7 at for the Beaver Valley plants to increase the power
8 in total by about 9.4 percent.

9 The MAAP code and the use of the MAAP code
10 is an integral part of that, and I just want to give
11 you, as Bob said, a minute or two perspective on the
12 use of MAAP at Beaver Valley.

13 The Beaver Valley plants are three loop
14 Westinghouse PWRs. The architect engineer was Stone
15 and Webster. The containments were designed
16 subatmospheric, that's the way they're currently
17 operated. And we want to use the MAAP5 computer code,
18 basically, to replace the existing design basis
19 computer code LOCPIIC. And using the MAAP5 code we
20 want to, again, reanalyze the containment and move to
21 an atmospheric containment.

22 Benefits for going to an atmospheric
23 containment are that right now for personal access to
24 the containment, it's in an oxygen deficient
25 environment and the people that access the containment

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1 are required to wear supplemental breathing apparatus.
2 And this will eliminate the need for that. That goes
3 towards enhancing personnel safety on access to the
4 containment.

5 The other thing this does for us is that
6 with a move to atmospheric containment where we change
7 the initial condition for the containment operating
8 pressure, we're incorporating that into our best
9 estimate LOCA analysis. And this will allow us to gain
10 margin on peak clad temperature, so we'll be gaining
11 a benefit in that respect also.

12 And, as I mentioned, this supports our
13 power uprate initiative in that the power uprate is
14 going to be based on the containment analyses that's
15 done with MAAP5.

16 CHAIRMAN WALLIS: If you do not use MAAP5,
17 are you not able to get this 9.4 percent power uprate?
18 Is it critical?

19 MR. TESTA: Yes, it's critical in that,
20 yes, we've done some studies with the existing code
21 and with then we looked at MAAP5 and it affords us
22 additional benefit in that we can increase the initial
23 containment pressure and basically review or rerun the
24 design basis spectrum of accidents and stay within our
25 containment design pressure.

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1 MR. BOEHNERT: You said you're going to a
2 best estimate LOCA code.

3 MR. TESTA: We're going to use that, yes.
4 Westinghouse best estimate LOCA.

5 MR. BOEHNERT: Westinghouse?

6 MR. TESTA: Yes.

7 MR. BOEHNERT: Have you checked with them?

8 MR. TESTA: Yes. Again, our plans for
9 MAAP5 is that we're going to utilize it for the
10 containment integrity evaluation. Again, we want to
11 replace the LOCPIC code. And in doing this we're going
12 to perform the analysis using MAAP5 code consistent
13 with the current design basis requirements, and that
14 we're going to analyze for LOCA, steam line break,
15 different spectrum of breaks and look at the
16 corresponding results, the response of the containment
17 given pressure temperature and so forth.

18 And the last thing is that, again, the
19 MAAP5 takes advantage of the latest experimental
20 information. And what we want to do with MAAP5 is
21 move or take the computer code in-house so that we can
22 put our engineers in a position to be able to utilize
23 the computer code and to make operating assessments.
24 We've been working up to this point with Dr. Henry to
25 develop the inputs and the parameter files, which is

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1 a benefit to our developing our in-house expertise.

2 MEMBER KRESS: What was your last code
3 that you used before?

4 MR. TESTA: LOCPIC.

5 MEMBER KRESS: L-O-C?

6 MR. TESTA: Yes, L-0-C-P-I-C.

7 MR. BOEHNERT: When are you making these
8 submittals?

9 MR. TESTA: We talked about that yesterday
10 a little bit. There's going to be a topical submitted
11 in January time frame for the MAAP5 code and we're
12 looking at May for the Beaver Valley plant specific
13 submittal. And in there will be the MAAP5 code, the
14 analysis that was conducted, the results and also the
15 supporting information on allowing us to move to an
16 atmospheric containment.

17 MR. BOEHNERT: What about the LOCA code,
18 when are you going to make these submittals?

19 MR. TESTA: Well, the LOCA code, that will
20 follow. That will be later on in around September time
21 frame. And we're basically putting in the building
22 blocks for a power uprate submittal.

23 MEMBER KRESS: When you use MAAP5, and I
24 don't know if this is for you or somebody else, do you
25 use it differently? Do you use other sources also?

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1 What do you use as the input?

2 MR. TESTA: The input of MAAP5 is going to
3 be the Westinghouse mass and energy input.

4 MEMBER KRESS: Okay. So you use the mass
5 and energy input?

6 MR. TESTA: Yes. Yes. Correct.

7 MEMBER KRESS: You'll only use the
8 containment part in MAAP5?

9 MR. TESTA: Right.

10 MEMBER KRESS: Then the NRC would use this
11 and they'd never have to check the containment?

12 MR. TESTA: Correct

13 MEMBER LEITCH: Does MAAP5 have the option
14 of one region, or five regions?

15 MR. TESTA: Do you mean as far as
16 analyzing or --

17 MEMBER LEITCH: Yes.

18 MR. TESTA: Yes. Right now the developed
19 model for Beaver Valley is 17 nodes for both Beaver
20 Valley 1 and 2. Basically the same model is broken
21 down into 17 nodes and review that for large breaks,
22 you know, which nodes or compartments they occur in
23 and then we're evaluating the corresponding response
24 within the given of the multi-node response capability
25 of the code.

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1 CHAIRMAN WALLIS: So how many nodes are in
2 this MAAp5 code?

3 MR. TESTA: Seventeen.

4 CHAIRMAN WALLIS: How many in your present
5 code?

6 MR. TESTA: One.

7 CHAIRMAN WALLIS: One?

8 MR. TESTA: Yes.

9 MEMBER LEITCH: So to get the results
10 where the containment pressure is acceptable you not
11 only are changing the code but you're increasing the
12 number of regions analyzed.

13 MR. TESTA: Yes, that's part of what Dr.
14 Henry's discussion will be is on the benefits or the
15 need to incorporate multi-node model.

16 CHAIRMAN WALLIS: Thank you very much.

17 MR. TESTA: Thanks.

18 MR. HANNEMAN: Good afternoon. I'm Harv
19 Hanneman. I work for Nuclear Management Company and
20 the Power Uprate Project Manager for Point Beach
21 Nuclear Plant.

22 A little background, Point Beach is a two
23 unit site with two LOOP Westinghouse reactors, roughly
24 1500 megawatts thermal each. We have large dry
25 atmospheric containments for both units. And our

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1 initial motivation for using the new MAAP5 methodology
2 is to support containment integrity analysis for
3 possible future power uprate of about 10 percent in
4 reactor power. And we're in the planning phases of
5 that project right now, and we saw the need to get
6 additional margin for our peak pressure and also
7 temperature in containment because of the 10 percent
8 higher reactor power.

9 However, other benefits that we expect to
10 achieve by the use of MAAP include the accommodating
11 a pre-accident containment pressure of 3 psig. So
12 that would be in our technical specifications in the
13 range of pressures that would be allowed in
14 containment initially.

15 Provides margin for some of the issues on
16 containment fan cooler service water boiling, which
17 came out of Generic Letter 96-06.

18 And also provides a plant specific main
19 steam line break containment analysis for Point Beach.

20 Currently our licensing basis is an
21 evaluation of a generic two LOOP Westinghouse analysis
22 for containment, so going to the uprate, we thought we
23 needed a plant specific analysis and we believe MAAP
24 will give us the margin that we need.

25 CHAIRMAN WALLIS: Does MAAP give you a

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1 margin for this service water boiling issue? Does it
2 predict containment or something?

3 MR. HANNEMAN: We expect it to predict
4 slightly lower peak temperatures early in the
5 accident, and that's when boiling is an issue.

6 CHAIRMAN WALLIS: Coolant containment?

7 MR. HANNEMAN: Right. Right.

8 CHAIRMAN WALLIS: I understand now.

9 MR. HANNEMAN: So our application of MAAP
10 would be to use MAAP5 for the containment integrity
11 analysis for the plant. We would continue to use the
12 Westinghouse methodology for calculating the mass and
13 energy releases as an input for both LOCA and steam
14 line break accidents. We currently use the
15 Westinghouse COCO methodology for containment
16 integrity, and we would replace that with the MAAP5.

17 This would allow us to take advantage of
18 some of the latest experimental information that Bob
19 Henry will be discussing here in a few moments. And
20 it also provides us an opportunity to bring the
21 containment integrity analysis in-house so our own
22 engineering staff will be performing the plant
23 specific calculations; that'll give us greater
24 knowledge of that analysis in-house and also allow us
25 to perform more timely responses to any operational

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1 emergent issues that come up with regard to
2 containment response.

3 MEMBER LEITCH: Harv, do you, like Beaver
4 Valley, also need to use MAAP5?

5 MR. HANNEMAN: We've done some initial
6 analysis using the COCO methodology for both LOCA and
7 steam line break. The LOCA peak pressure was slightly
8 under our containment design pressure of 60 pounds,
9 but the steam line break the pressure exceeded it at
10 the uprated condition. So, that's why we feel we need
11 this methodology to give us a little bit more margin.

12 MEMBER LEITCH: How many nodes are using?

13 MR. HANNEMAN: I'd have to defer to 10 --
14 9.

15 MEMBER LEITCH: Nine.

16 MR. HANNEMAN: Nine volumetric nodes. And
17 currently we have one also with the COCO.

18 MEMBER LEITCH: Just a quick aside to
19 Mike, the people at Point Beach are talking about an
20 initial pressure in pounds, do you have a similar
21 number for Beaver Valley?

22 MR. TESTA: Yes, and for the move to
23 atmospheric containment we're looking at developing an
24 operating band of 12 to 16 pounds. One atmosphere for
25 us is 14.3

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1 MEMBER LEITCH: Thanks.

2 MR. HENRY: What I want to present for you
3 today is really a work in progress, and we
4 particularly wanted to get your feedback on the
5 approach. As you can see, there's a couple of sites,
6 that we really want to know how you feel about this
7 and what has to be done in the future. And has been
8 said by both of them, there will be a submittal to the
9 staff sometime planned early next year and it'll be
10 led by a submittal of the methodology itself for the
11 staff to begin to review.

12 But in addition to your feedback on the
13 methodology, as we go through this you'll see that
14 there's a lot of experiments here and the experiments
15 represent a level of understanding and the
16 capabilities of the calculational tool. If there's
17 some experiments that we haven't managed to cover here
18 that you think would be very helpful in understanding
19 the capabilities of the model, we also want to get
20 that particular feedback and get it early on so that
21 we can take advantage of the expertise on this
22 committee.

23 Obviously, I don't have to tell you. Feel
24 free to ask me any questions as we go through this.
25 But let me also say early on that there's obviously a

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1 lot more material than we can cover in the time that's
2 allotted. I apologize for that. We'll go as slow as
3 you want to go, but we did want to bring to you the
4 fact that we've worked very hard at trying to make
5 sure that the model is comprehensive of these
6 experiments and in a very simple manner.

7 So, the things that I'd like to cover for
8 you today are the issues that are related to:
9 nodalization; representation of the atmospheric
10 motion, which is circulation within the atmosphere has
11 a major influence on the rate of energy transfer from
12 the containment atmosphere on a nodal basis to the
13 wall.

14 Let me also say just up front the
15 nodalization scheme and map is generalized. You can
16 have as many as you want to define. Right now the
17 code will allow you up into the range, of what, I
18 think 26 or so. But usually it's a very highly
19 compartmentalized containment that would need 26
20 nodes, but that's why there's different nodalization
21 schemes for the different plants. As an example, two
22 LOOP versus three LOOP gives us different
23 compartments. Different geometry gives represented
24 differently. But we'll talk about that as we go
25 through this.

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1 CHAIRMAN WALLIS: Circulation is going on
2 within the nodes?

3 MR. HENRY: Within each individual node is
4 where it's evaluated, yes.

5 CHAIRMAN WALLIS: Now, I don't quite
6 understand that. So you have some sort of a model and
7 it interconnects the hose between the nodes, but it
8 also super imposes some kind of a circulation within
9 each node?

10 MR. HENRY: We will get to that. And the
11 place that's important, Graham, is that's what
12 dictates what the local boundary layer is and
13 therefore, the rate at which energy can be transferred
14 to the wall.

15 In addition to this, this blow down and
16 give you forced circulation flows, but then you also,
17 obviously, have to comprehend natural circulation
18 flows because there can be compartments that are
19 isolated or there's later in time when the flows die
20 down. Natural circulation dominates. That has to be
21 a key part of it.

22 Another very essential part, which is
23 nothing new to MAAP5, that's already in MAAP4, is the
24 ability to have countercurrent natural circulation if
25 you have heavy over light at an opening between the

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1 two so that they can exchange mass and energy, and
2 that natural convection type phenomena.

3 Condensing heat transfer, of course, we
4 look at the condensing on cold heat sinks. We looked
5 very hard at the separate effects test, and that's
6 where our understanding comes from. And we try to
7 make that step to the containment analysis in a very
8 structured logical manner without any kind of games.
9 So our whole understanding comes from the separate
10 effects tests.

11 And then lastly, the influence of water
12 entrainment, and that's another place where the local
13 circulation velocity is important because we can have
14 water films on the walls, we could have water
15 accumulate on the floor. If you have velocity which
16 exceed the entrainment rate, then that material could
17 be picked up and put into the atmosphere.

18 So from our perspective, as has already
19 been discussed, we want to move to something from a
20 design basis approach to something which is more
21 realistic, and we hope to be very realistic of the
22 containment response.

23 And the issues that we see that are
24 involved in this are:

25 Certainly nodalization, because we want to

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1 represent the containment geometry;

2 The need to represent the displacement of
3 noncondensable gases, and that's a major reason why
4 multi-node differs from single node because you can
5 displace air out of the region and, of course,
6 displace noncondensable gas means that for certain
7 conditions at short time frames the energy that's
8 transferred to the wall can be much greater. If you
9 have strictly a single node, then the partial pressure
10 of the air is always the same;

11 We need to represent the potential for
12 induced circulation, which means we solve the momentum
13 equation in the gaseous atmosphere as this blowdown
14 occurs;

15 And we want to represent the potential for
16 stratification, so we look at these nodalization
17 schemes. There's always a potential above the
18 operating deck of having more than one more node. So
19 if you have light gases, there is a potential that it
20 can accumulate in the top of the dome.

21 MEMBER KRESS: In read in the material we
22 received that there is no momentum equation in that.
23 Did I get that wrong?

24 MR. HENRY: I think so. But like I say,
25 there's a lot of momentum equations.

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1 CHAIRMAN WALLIS: But they're not
2 transient momentum, they're in a pseudo-steady state.

3 MR. HENRY: Correct. Transient in the
4 sense that you give me the current conditions and
5 I'll--

6 CHAIRMAN WALLIS: It really should be
7 momentum DT in there.

8 MR. HENRY: Yes. Well, for a given cell
9 the momentum in a cell -- in a node changes given the
10 blowdown time. Circulation velocity is a function of
11 time. You can ask me the question when we get to it.
12 Maybe I'm misrepresenting or misconstruing what you're
13 saying.

14 CHAIRMAN WALLIS: Well, I think your
15 momentum equation does have a D by DT determinate. It
16 just balances.

17 MR. HENRY: Okay. Well, we'll get to it.
18 For the kind of nodalization schemes that we
19 recommend, certainly it's to move away from the single
20 node for reasons noted here, but you don't have to
21 have tremendous number of nodes. You just have to
22 represent the fact that the air can be moved to
23 different locations, that you can have stratification,
24 etcetera.

25 From our perspective, what it means to

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1 have a realistic model, and I'm just going to discuss
2 both of these points together in time, to save us some
3 time.

4 We want to make sure that we represent all
5 the systems and all the phenomenaology, that have a
6 first order effect. And that's very straight forward.
7 And we want to also represent those which clearly have
8 a second order effect, which means that they impact
9 things in the order of 10 percent.

10 MEMBER KRESS: When you say systems, you
11 mean things like fan coolers and sprays?

12 MR. HENRY: Sprays, right. And, of
13 course, the M&E coming out of the break and any
14 special things. If we're looking at another plant,
15 like Cook, the dynamics of the ice condenser and its
16 melt and drainage, and etcetera.

17 And the things that relate to 10 percent
18 that could be issues. Things like water entrainment
19 may either influence things by order of a 100 percent
20 or the order of 10 percent. As we'll see later on,
21 both nodalization of water entrainment have a
22 significant influence on this.

23 That's our real focus, to make sure that
24 we cover all these phenomena, and when you get down
25 things which relate to one percent, it's kind of hard

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1 to deduce what kind of influence they really have and
2 then take the jump to full scale containment
3 experiments and try to look for that particular
4 effect.

5 CHAIRMAN WALLIS: The first order is 100
6 percent, and you can't have very many of those, can
7 you?

8 MR. HENRY: Correct. Don't have too many.
9 That's where order of magnitude comes in.

10 CHAIRMAN WALLIS: You said first order was
11 30 percent or something, then you could have three of
12 them.

13 MR. HENRY: That looks like an argument I
14 need to delegate to somebody who is younger and
15 quicker, Graham.

16 Okay. First off, but what's the influence
17 of nodalization? Because that's one of the aspects
18 that you just heard that's important to these two
19 sites. They currently are licensed with single node
20 models and it gives them some difficulties when they
21 take the current design basis in the M&Es and apply it
22 to the model. So is it the limitation of the model or
23 is it a limitation of the design? Well, the only way
24 you can figure that out is to do something which has
25 more than one node and look at the influence of it.

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1 So what we did to just determine the
2 influence of moving to a multi-node containment was
3 take MAAP and let MAAP produce the M&E. And so this
4 is not coming from a design basis M&E, but it's not
5 meant to say this the plant response. All we want to
6 look at here is what's the influence of single node
7 verses multi-node for a large break LOCA response and
8 for main steam line break response.

9 What we have then --

10 CHAIRMAN WALLIS: What you want to do with
11 CFD is you keep applying the nodes until it makes no
12 difference. Here you're showing there is a
13 difference, but you don't show -- you keep on going to
14 a 100 or 200 or 300 node --

15 MEMBER KRESS: I think there's a
16 difference of what we're calling nodes. These nodes
17 have specific boundaries --

18 CHAIRMAN WALLIS: A physical basis.

19 MEMBER KRESS: Yes, physical basis. Those
20 ones you're talking about are kind of different.
21 There's a difference, I think.

22 MR. HENRY: And you're also taking away
23 any information I could use if you guys say come talk
24 to us again. I mean, that was one of the things I
25 want to do next time was show you how we progressed.

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1 In any way case, we're going to get to
2 that in a little bit. And unfortunately I didn't have
3 it put in here, but try to look at the differences in
4 example CVTR going from one to 4 nodes and then 6
5 nodes. Six nodes which are this way and 6 nodes which
6 -- might be 2 this way and 4 this way and etcetera.
7 What you really find is you're not very sensitive to
8 that. What you're sensitive to is getting past one
9 node so you can have air move throughout the
10 containment.

11 If you have various rooms, then it's
12 certainly to your benefit to make those nodes, because
13 things could potentially be more concentrated in that
14 room if there's not sufficient natural circulation.

15 CHAIRMAN WALLIS: You might say it's
16 rather ridiculous if you take several rooms and mix up
17 all the atmospheres and then saying that that's
18 typical of everything that's going on. That's s very
19 crude and probably inappropriate way to look at what's
20 happening.

21 MEMBER KRESS: So it would depend on where
22 your break -- which room your break occurs in?

23 MR. HENRY: Slightly. And as Tom said --
24 Mike said, excuse me. Your Tom, right?

25 CHAIRMAN WALLIS: But the room where the

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1 break is very different from the rest of the
2 containment?

3 MR. HENRY: I think Tom's point is we look
4 at a break in each of the three different compartments
5 for Beaver Valley, as an example. And that's part of
6 the analysis. But it's not greatly different between
7 them, but it is tenths of psi difference because you
8 don't necessarily get the same condensing profile
9 throughout the containment depending upon where the
10 break is. Because even though the compartments you
11 might think are equivalent, but they don't necessarily
12 have the same entry area and existing area, etcetera.

13 Anyway, to the point of nodalization, this
14 is a demonstrative calculation. This happens to be a
15 Westinghouse two LOOP plant, and we divided this up
16 into 5 nodes and also ran it with 1 node. So one of
17 the nodes is, of course, the reactor cavity. The
18 second node is the loop compartment which houses the
19 two loops. The third node is the annular region which
20 is outside the loop compartment. And then the
21 operating deck, which is here, we put two nodes in.
22 one above the operating deck, one here and one in the
23 region above the spring line.

24 CHAIRMAN WALLIS: I have to ask why would
25 you ever mix 1 and 5 in any kind of node?

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1 MR. HENRY: I think the answer to that is
2 originally when people did design basis calculations
3 that was judged to be conservative, give you a higher
4 peak pressure. And from a practical point of view it
5 certainly makes sense that you would always have the
6 same air pressure, pressure everywhere, so it limits
7 the condensation rates.

8 CHAIRMAN WALLIS: So the big action role
9 of this is the condensation on structures and that
10 sort of thing?

11 MR. HENRY: Yes, the big actor is
12 condensation on heat sinks. That's what really drives
13 the bus on whether or not you live within your current
14 design basis pressure differential. And some of that
15 is shown in this slide. What we have here is really
16 single node and multi-node, which is shown here when
17 it says 5 node and 1 node.

18 So if I take these two, which says 5 node
19 and 1 node, which is this solid line and this large
20 dashed line here. This is MAAP4, and I apologize I
21 didn't get that written on there, but that does not
22 have things related to atmospheric circulation to
23 water entraining. And as we walk through this you'll
24 see some of those influences. Whereas there here are
25 MAAP5, which is the design basis code that we're

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1 looking for for these two sites. And you'll notice
2 that you can identify, this induced flow is equal to
3 1 means the induced flow from the break was included
4 here.

5 But as you look at this for 5 node with
6 MAAP4, this solid line, and 5 node with MAAP5 you see
7 no difference. And it's true. Because the only real
8 thing that made a difference here was going from 1
9 node to 5 node reduced the peak pressure
10 substantially, roughly in atmosphere. And the whole
11 reason is that in the local near the break you pushed
12 air away and you got enhanced condensation during this
13 short time frame of about 10 seconds. And that makes
14 a difference.

15 And all we're doing here, it's the same
16 code, it's the same physics. Obviously, we're just
17 changing the number of nodes. So you can see even by
18 including all these new models we're going to talk
19 about from MAAP5 that didn't make any difference and
20 it's strictly the single node going from 1 node to
21 multi-node that made the difference.

22 CHAIRMAN WALLIS: This is pressure
23 absolute?

24 MR. HENRY: Correct. This is pressure
25 absolute here.

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1 CHAIRMAN WALLIS: But it says G on the
2 other side, right?

3 MR. HENRY: And here, as you can see, this
4 is one atmosphere there. This is .5 and 1.5 times 10
5 to the fifth. This is absolute and SI units and we've
6 put it in gauge over here.

7 For this particular plant, the design
8 basis pressure is 60. But, again, that's for --

9 CHAIRMAN WALLIS: 60 psig?

10 MR. HENRY: 60 psig. And that's for
11 design basis mass and energy increases, which are not
12 in this calculation. That was not the intent here.
13 The only intent was to illustrate the difference of
14 going to multi-node.

15 And, as you might expect, for a large
16 break LOCA this is just the temperatures in
17 containment, again, in terms of Kelvin and Fahrenheit.
18 There's really not much difference between the two
19 codes.

20 CHAIRMAN WALLIS: Of which node?

21 MR. HENRY: Excuse me, Graham.

22 CHAIRMAN WALLIS: Which node? Temperature
23 in the containment is different in different nodes.

24 MR. HENRY: Well, of course, this only has
25 one node. This is the lower compartment, so this

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1 would be node number--

2 CHAIRMAN WALLIS: It's different nodes.

3 Okay.

4 MR. HENRY: Right. This is 2. I think
5 that's 4 and 3.

6 But in essence it says that there's not a
7 big difference between them, and that's not surprising
8 for a large break LOCA, because the blowdown itself
9 puts so much moisture into the atmosphere.

10 So then we take the same analysis, again,
11 just from a demonstrative point of view what does it
12 mean for main steam line breaks, and that's a little
13 different story then. But here we have these two are
14 MAAP4, that have nothing after them. And these that
15 say induced flow=1, this is MAAP5, which again is the
16 code that we're talking about here.

17 CHAIRMAN WALLIS: I only see 3 curves.

18 MR. HENRY: You always take my punchline,
19 Graham. This 1 node curve and this 1 node curve are
20 on top of each other. It doesn't make any difference
21 from a practical standpoint. And the reason this is
22 different here is now, as we'll get to later on,
23 what's influential in MAAP5 is induced circulation
24 because a main steam line break goes on for a lot
25 longer time. But if you say there's only 1 node

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1 available, then as a result of that you're doing this
2 momentum equation into one huge node of the
3 containment, and really it's a huge mass and it hardly
4 stirs it all all and issues related to enhancing any
5 local velocities or entrainment really go away. So
6 that part really disappears in one node and they
7 become the same calculation.

8 But when you go to 5 nodes now, of course,
9 the blowdown is coming into one of those nodes, which
10 is a much smaller region and also you, obviously, have
11 higher heat transfer in that local. Because it is 5
12 nodes you're displacing air away from it and you have
13 the potential for also reentraining moisture in the
14 containment because a local velocity in that node can
15 be above an entrainment criteria.

16 MEMBER KRESS: Does that act like a water
17 spray?

18 MR. HENRY: Exactly.

19 MEMBER KRESS: Does the code then account
20 for revaporization of the droplets?

21 MR. HENRY: They can allow the droplets to
22 revaporization. But principally when you entrain
23 something, you're entraining the film off the wall, so
24 you entrain at the average temperature, which is T
25 side on the outside and T wall. So you actually get

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1 some subcooling.

2 MEMBER KRESS: So you get some subcooling.

3 MR. HENRY: Which really is the major
4 thing to do. But yes, Tom, it can revaporize. In
5 fact, that's part of what you see with multi-node
6 because it can get down to something in the bottom of
7 the containment for local partial pressure is not so
8 high and the droplet might be warmer and it can
9 vaporize down there as it falls through that node.

10 MEMBER KRESS: Do you have a model for the
11 rate of entrainment when the droplet --

12 MR. HENRY: At the rate of entrainment and
13 we put that into -- it goes directly into the aerosol
14 model where the deposition rate is depending upon the
15 airborne density. So the airborne density --

16 MEMBER KRESS: So you exercise -- is this
17 still the aerosol model that was built by --

18 MR. HENRY: Mike Epstein. Yes. So it
19 becomes -- water is just part of the aerosol --

20 MEMBER KRESS: Part of the aerosol?

21 MR. HENRY: Right. But the only reason I
22 wanted to make a point, is the aerosol can come from
23 either entrainment or from cooling of steam, both of
24 them get put into the aerosol mix.

25 And this, Graham, to go back again, we

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1 have 4. The piece in the legend, the two curves are
2 simultaneous on top of each other because here again,
3 the circulation has no influence. It's so slow. And
4 what we get out of that since it's also not
5 entraining, you get temperatures which are typical of
6 what you see in some of the main steam line breaks.

7 CHAIRMAN WALLIS: I don't know how we
8 would apply it, the circulation model to those five
9 different rooms and there's not going to be one big
10 circulation pattern to these five rooms. It just does
11 not plot.

12 MR. HENRY: I agree with that. Just from
13 the concept if I assume that it applies, it says it's
14 not going to make any difference anyway because I'm
15 too big, you can't make me circulate fast enough. But
16 if it does and it entrains, you can see what's gained
17 on the peak temperature, so it's again substantial. So
18 not only is the pressure lower than the 1 node system,
19 the temperature is also lower.

20 CHAIRMAN WALLIS: These are all, of
21 course, predictions?

22 MR. HENRY: These are calculations, right.
23 We're going to get to comparing this with experiments.

24 I just hesitate saying predictions because
25 it's really for a generitized system. It's a two LOOP

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1 plant, but it's different from Point Beach's
2 containment model in terms of nodes and level of
3 qualification.

4 And also then we just look at for main
5 steam line break between MAAP4 for a 5 node model and
6 MAAP5 for 5 node model. And this all becomes because
7 MAAP4 knows nothing about atmospheric circulation,
8 knows nothing about entrainment model. And all we're
9 comparing here is the influence temperature of those
10 particular models which is what we'll talk about
11 today. And this has the multi-node in it, but it
12 still isn't enough to really -- I'll get to CVTR. If
13 I take this approach from MAAP5, which we thought was
14 a quite good code when we started that comparison, it
15 overstates the pressure in CVTR by something in the
16 range of 10 psi and it overstates the temperature by--
17 I forget the actual number. Like 50/60 degrees
18 Fahrenheit. This is the physics that we believe is
19 controlling that.

20 So I mentioned MAAP is not a 1 mode model,
21 so this isn't meant to -- this just shows you the
22 various pieces of physics that are in the model, and
23 some of these are severe accident related which Tom
24 correctly asked us earlier what's being reviewed. And
25 what's being reviewed is that the containment model as

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1 it applies to design basis accidents.

2 Now, the key actors in that for these two
3 different plants, we obviously focused on the heat
4 transfer to heat sinks, which is shown here. Tom, the
5 aerosol model we just talked about, which is part of
6 this.

7 The heat transfer to equipment, which is
8 just all the steel and everything inside, whether it's
9 handrails or ducting or whatever it may be.

10 Condensation on all the walls and on all
11 the heat sinks. The metal, concrete, steel lined
12 concrete, stainless steel line for fueling pools.

13 Fan coolers for Point Beach. And, of
14 course, the sprays for both Beaver Valley and Point
15 Beach.

16 And lastly, the flow from the primary
17 system. This is not coming from MAAP now when we talk
18 about design basis things. This is coming from
19 Westinghouse design basis mass and energy release
20 calculation for both large break LOCA and the main
21 steam line break.

22 MEMBER KRESS: This allows the use of
23 sprays and fan coolers. Is there a single criteria in
24 the DBA that says you can't use the full capacity on
25 those?

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1 MR. HENRY: Correct.

2 MEMBER KRESS: That's probably --

3 MR. HENRY: There's a whole run matrix
4 that's used by both of the sites depending on what
5 their specific conditions are. They look at all the
6 different kinds of single failures and look for the
7 worst one in both sets of conditions.

8 And then also, some temperature is part of
9 that, so that has another set of M&Es or way that you
10 treat the previous M&Es, to mix or not mix them coming
11 out of here.

12 And, again, we talked about uncertainties
13 in the models, but there's also variations in the
14 operating perimeters that have to be part of that DBA
15 calculation. You have to look for the most limiting
16 case of operating conditions.

17 MEMBER KRESS: I guess I would look for a
18 net positive suction head located in those
19 compartments that could prove affected.

20 MR. HENRY: Well, the analyses that you
21 look for is the net positive suction head when you go
22 into recirc there for sure, yes.

23 MEMBER KRESS: But you look at that?

24 MR. HENRY: Yes, that's part of the --

25 MEMBER KRESS: You don't --

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1 MR. HENRY: Yes. And you look at it on a
2 plant specific basis. Because even when you have two
3 units at the same site, they don't necessarily have
4 the same systems.

5 Okay. So this is the conceptual part then
6 of the circulation, which is one of the key things
7 that we think is missing in MAAP4 and it wouldn't buy
8 you anything if you just looked at a one node anyway.
9 But the concept that it has is that a blowdown into
10 this gaseous region adds momentum to the atmosphere.
11 Obviously, if we just had one node and we have
12 momentum going in, where did it go?

13 CHAIRMAN WALLIS: These are different
14 nodes in the sense that there's previous nodes or are
15 these different nodes within a given compartment?

16 MR. HENRY: These are nodes in the same
17 sense as the previous nodes.

18 CHAIRMAN WALLIS: So there are rooms?
19 These are four different rooms?

20 MR. HENRY: They may be rooms or they may
21 -- this node boundary may be drawn in the atmosphere,
22 as an example.

23 CHAIRMAN WALLIS: I find this an
24 extraordinary diagram. I mean, the idea that there
25 are rotating cylinders in each one of these rooms.

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1 Fantastic. And the idea that the incoming flow coming
2 up like that rotates the cylinder on top of it is also
3 fantastic. And the idea that nothing happens between
4 them except interfacial shear is also fantastic.

5 I couldn't understand what you could
6 possibly be showing. This is sort of a study of what
7 it sees in liquid helium or something.

8 MEMBER KRESS: You just conserve momentum.

9 CHAIRMAN WALLIS: No, there's no momentum.
10 It's on the angular momentum.

11 MEMBER KRESS: You've got momentum coming
12 in to flow and you're going to put that all in the
13 atmosphere until it circulates.

14 CHAIRMAN WALLIS: It doesn't happen that
15 way, it's all angular.

16 MR. HENRY: Well the angular momentum is
17 still momentum. Graham, this is merely now to
18 describe the concept. Because the concept is it will
19 -- let's first just think of a single node here as an
20 example.

21 CHAIRMAN WALLIS: But that's not the way
22 it works.

23 MR. HENRY: I know it isn't. I know it
24 isn't. But from a single node point of view, it's
25 easier to see what happened to the momentum that came

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1 in here. Where did it all go? Because in a single
2 node you now have inflow, where did all that momentum
3 go? We can have conservation mass and conservation of
4 energy, where did the momentum go? It has to go in
5 terms of somehow this fluid is circulating.

6 CHAIRMAN WALLIS: I thought you were going
7 to say, the incoming flow in region 2 there actually
8 set up some sort of a circulation around the jet which
9 helped the heat transfer to the wall?

10 MR. HENRY: It certainly does that. This
11 doesn't mean that this sits here and spins with either
12 a sphere or cylinder, whichever you choose on that
13 one. It only means -- it only gets down to this
14 fundamental thing right here. Schematically what the
15 code thinks of is I've got some velocity in this node
16 which is different from the through flow velocity. I
17 have circulation. And this is merely a way of
18 representing that, but that momentum that gets added
19 to that node says the only way I can satisfy my
20 momentum balance is I've got to circulate faster.

21 CHAIRMAN WALLIS: I don't understand that.

22 MEMBER KRESS: Well, it bothered me when
23 you said that those nodes could be virtual nodes in
24 the middle of the air and still do that. Those are
25 not really boundaries of rooms?

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1 MR. HENRY: Certainly whenever it is a
2 boundary of a room, you use the boundary of the room.
3 But sooner or later you'll have to draw if you want to
4 be able to investigate whether or not things can be
5 stratified.

6 MEMBER KRESS: I see.

7 MR. HENRY: You have to eventually draw
8 something up here, which is air. Otherwise you're
9 always just going to have rooms and this will always
10 be one node and you won't have any stratification
11 potentially.

12 MEMBER KRESS: But you can't treat that in
13 terms of momentum the same way --

14 MR. HENRY: Let's talk about it.

15 CHAIRMAN WALLIS: Let's go back to this
16 other picture that you showed us. I don't understand
17 it. You've got nodes and you've got flow between
18 nodes, which is the usual thing.

19 MR. HENRY: And that's part of the
20 calculation.

21 CHAIRMAN WALLIS: And within each node you
22 have some sort of circulation as well? Is that the
23 idea?

24 MR. HENRY: Yes. Because if you have flow
25 coming in and you conserve mass and energy, so what

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1 you have going out of here is merely the through flow,
2 then you won't be conserving momentum.

3 CHAIRMAN WALLIS: Well, that's because it
4 forces on the wall.

5 MR. HENRY: No, even without that. You're
6 just going to defuse or any momentum goes away. You
7 don't satisfy it by the through flow alone.

8 CHAIRMAN WALLIS: You're really confusing
9 me altogether.

10 MR. HENRY: Okay. That's tough to do.
11 You're a hard guy to confuse.

12 CHAIRMAN WALLIS: No. I mean the momentum
13 balance works out always. If you don't have -- if the
14 momentum balance doesn't work out you've got forces of
15 some sort. The idea that the linear momentum is
16 balanced by angular momentum is a very strange
17 concept. So something else is going on.

18 I think what you're saying is that the
19 incoming flow in to that chamber stirs things up so
20 the fact that this sort of -- some average velocity,
21 which is low, is not characteristic of the real
22 velocity seen by the wall. Isn't that what you're
23 saying?

24 MR. HENRY: Well, in a sense yes. That's
25 why I wanted to go back to just from a simple concept

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1 look at a single node. If I did an experiment with a
2 single node. And I blew down into that. What would
3 be the governing velocity of the through flow that
4 comes out, if I make it one dimensional. Of course
5 not.

6 MEMBER SCHROCK: The way you've run it, it
7 doesn't look like there should be any shear between
8 nodes in that picture.

9 MR. HENRY: Well, we're going to get to
10 that.

11 MEMBER SCHROCK: You're both going in the
12 same direction.

13 MR. HENRY: Right. Yes, they're going in
14 the same direction, but they don't necessarily have to
15 be going at the velocity.

16 Suppose I put a bunch of structure up in
17 this node, as an example, Virgil. So this may be
18 going at a much higher velocity than this. I still
19 have to represent the fact that there could be
20 momentum transfer across this arbitrary boundary that
21 the nodalization has created. That's all it really
22 means.

23 MEMBER SCHROCK: How you come by those
24 velocities, you're going to show us.

25 MR. HENRY: Sure. I knew you'd guys would

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1 have tons of questions on this, and that's why we're
2 here.

3 CHAIRMAN WALLIS: Well, I just understood,
4 let's go to the next equation.

5 MR. HENRY: Okay. I would just say,
6 before we leave this, Graham, you said it very well.
7 All this is meant to merely say -- all this says is
8 that a node has a property that we looked at as
9 circulation. And that's merely the way of making sure
10 that we do conserve momentum throughout these various
11 nodes.

12 CHAIRMAN WALLIS: Circulation cannot
13 conserve momentum.

14 MR. HENRY: Okay.

15 CHAIRMAN WALLIS: Circulation cannot
16 conserve linear momentum.

17 MR. HENRY: Yes, you're right. It does
18 not conserve linear momentum, but --

19 CHAIRMAN WALLIS: Spin those things up to
20 the speed of light, and it won't conserve --

21 MR. HENRY: That's why I wanted to make
22 sure we talked about the single node. Within a single
23 node is an example there can't be any linear momentum.
24 There's no out flow. The only thing you could have is
25 something that goes back to that's going to spin it

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1 somehow or other. But you know from those kinds of
2 experiments that you have a lot higher energy transfer
3 at the wall, and that you get by the through flow
4 velocity or the pressurization velocity.

5 CHAIRMAN WALLIS: What is this -- can we
6 go to the first line here?

7 MR. HENRY: Sure.

8 CHAIRMAN WALLIS: What's going on here?

9 MR. HENRY: All this does is say that the
10 way we look at this is the equation -- equating the
11 impulse and the rate of change in that specific node.
12 What's it's mass and what it's velocity.

13 CHAIRMAN WALLIS: "U" is a circulation
14 velocity?

15 MR. HENRY: Yes.

16 CHAIRMAN WALLIS: So this is spinning?

17 MR. HENRY: It's a concept of there's
18 something going on and whether it's one thing or
19 spinning this way or whatever, it's not a through flow
20 velocity.

21 MEMBER KRESS: It's not spinning. It's
22 just falling circle. That's different than spinning.

23 MR. HENRY: Okay.

24 MEMBER KRESS: It's not angular momentum -

25 -

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1 CHAIRMAN WALLIS: If you give something an
2 impulse, it moves linearly, it doesn't --

3 MR. HENRY: Yes, it does.

4 MEMBER KRESS: Well, this is a linear
5 motion. But I don't know what "F" is yet, that's
6 what's bothering me.

7 MR. HENRY: We have three different forces
8 that we look at, which is the force on the wall here,
9 on the shear force on the adjacent node, which Virgil
10 was asking about. So if you have a difference in the
11 rate at which you have the circulation velocity and
12 nodes, then that has its own influence. And then if
13 you could have any kind of embedded structures that
14 slow things down, they also have to be --

15 CHAIRMAN WALLIS: What is U_c in your
16 figure?

17 MR. HENRY: U_c is the property in the node
18 which is --

19 MEMBER KRESS: That's the result you're
20 trying to calculate, right?

21 CHAIRMAN WALLIS: What is U_c in this
22 figure?

23 MR. HENRY: U_c in the concept of the model
24 is that in addition to through flow that this is also
25 has --

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1 CHAIRMAN WALLIS: Where is the U_c ? I mean
2 is it an average of some sort or is it on the wall, or
3 in the middle. Where is U_c ? I don't understand.

4 MR. HENRY: Okay. U_c when we look at the
5 energy transfer to this wall right here, U_c is the
6 velocity that's dictating what the boundary line --

7 CHAIRMAN WALLIS: U_c is the velocity along
8 the wall?

9 MR. HENRY: U_c is the free stream velocity
10 next to the wall.

11 MEMBER KRESS: It has to be some integral
12 of the velocity in the whole mass --

13 MR. HENRY: It is, yes, right, Tom. And
14 that's because it's coming from a momentum balance on
15 each node.

16 When you have a through flow velocity and
17 in each node you have a property called circulation.
18 And whatever that velocity is, that's what determines
19 the free stream velocity next to the wall, it also
20 determines the velocity that could entrain anything
21 that's collected in that node. Reentrain water, which
22 is what --

23 CHAIRMAN WALLIS: What you would call a
24 turbulence velocity or be about the same thing?

25 MR. HENRY: Yes.

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1 CHAIRMAN WALLIS: It would be about the
2 same thing?

3 MR. HENRY: Exactly the same thing.

4 CHAIRMAN WALLIS: It is the amount of
5 stirring up of the nodes, a measure of the stirring up
6 of the fluid in the node by incoming flow?

7 MR. HENRY: Exactly. Exactly. The only
8 reason I pictured it this way is to try to break it
9 down to the most simple thing. The code thinks I have
10 a velocity here and so where does that go. Well, it's
11 evaluating as if it is stirring or a turbulence
12 velocity. It's not the through flow velocity to the
13 next node.

14 CHAIRMAN WALLIS: Well, I think you're
15 going to have to look at the details of this somehow,
16 because, you know -- it may be a brilliant idea, but
17 I'm having trouble understanding it especially treated
18 like this. There's no way that incoming flow going
19 straight up there is going to stop, swirling things
20 around in the way you've drawn that.

21 If you had said there was a level of
22 turbulence, a mixing or something, I think I might
23 come closer to understanding what you mean.

24 MR. HENRY: But that's exactly what it is.
25 But the code has to have some concept that you're

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1 loyal to and how it incorporates this information into
2 -- the information flow of what you're actually
3 calculating.

4 MEMBER KRESS: Did you mean for your Ms in
5 that first equation -- second equation to be under the
6 parentheses?

7 MR. HENRY: This is what the M is, this
8 has the same units of force. This is kilograms per
9 second and --

10 CHAIRMAN WALLIS: There's no way that in
11 the way you've described U_c that that first equation
12 you've got comes from a control volume analysis. It
13 comes from some kind of a word picture of some kind.
14 There's no way you can draw those Fs on a box and show
15 me how the linear force produces angular momentum.

16 MR. HENRY: Graham, I completely agree
17 with that. You won't be able to take this into
18 something and say, gee look that's now angular
19 momentum. But by the same token, when it -- when you
20 hit all these structures, and I'm just trying to
21 follow through what you've done, is you've created
22 turbulence. So some way this thing has a velocity
23 that's different than the through flow velocity.

24 CHAIRMAN WALLIS: I think that this is
25 important and you're going to have to establish there

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1 some sort of a believable, mechanical basis for these
2 U_s in terms of physical phenomena.

3 MR. HENRY: Absolutely.

4 CHAIRMAN WALLIS: Because I'm not looking
5 for something that's academic and terribly fancy --

6 MR. HENRY: I know.

7 CHAIRMAN WALLIS: But this seems to be
8 fanciful.

9 MR. HENRY: We'll take that as an action
10 item. When you see us the next time we'll go through
11 how we get to that.

12 CHAIRMAN WALLIS: We have to sort of buy
13 off on this. It may turn out to be a brilliant move
14 in terms of a way out of the box, so you're going to
15 have to represent something which is important
16 physically.

17 MR. HENRY: That's a very good way of
18 putting it. You have to find something that's
19 consistent with this big thing that represents 17
20 nodes. What's going on. Right. What's going on.

21 MEMBER KRESS: And I think this is a
22 reasonable concept if you have real boundaries. But
23 I'm not sure when you stick these virtual boundaries
24 in --

25 MEMBER SCHROCK: Yes, I'm having the same

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1 problem.

2 MEMBER KRESS: That's why I think I need
3 to see this, the validation.

4 CHAIRMAN WALLIS: I'd like to see it also
5 --

6 MEMBER KRESS: I think it can be done,
7 really.

8 MR. HENRY: Well, we have some experiments
9 here that focus on just that thing.

10 CHAIRMAN WALLIS: I think what you're
11 saying is if you open this door and you open that door
12 and there's a draft going through here, it stirs up
13 the fluid in the corners as well. Is that the sort of
14 thing you're saying?

15 MR. HENRY: Yes. And the rate at which it
16 stirs it up is dependent upon the -- you can't get it
17 from mass balance.

18 MEMBER SHACK: But you're saying that the
19 stirring is related to the momentum? You don't get
20 the stirring without some momentum.

21 MEMBER KRESS: He actually has another
22 equation that calculates this momentum going out.
23 He's got momentum coming in and going out. It's the
24 difference between those that goes into the stirring
25 up. It is sort of an integral -- it's an integral

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1 amount. It has to go somewhere.

2 CHAIRMAN WALLIS: Because you always get
3 the forces on the wall.

4 MEMBER KRESS: I'm ignoring those.

5 CHAIRMAN WALLIS: You ought to give him a
6 D for that.

7 MR. HENRY: I knew we were going to have
8 a lot of questions on this. You guys are true to
9 form. You're still younger and quicker than I am.

10 Graham, what actually happens here if I
11 take all of this out of here, is I would expect this
12 to be a jet which begins to entrain as it goes up
13 through here. It entrains on the way up and it hits
14 up here, and it spreads and it comes down. But all
15 that ends up being, stirring of this atmosphere, and
16 stirring eventually -- well, basically it hits this
17 wall and you take momentum out of it and you start
18 turning it angular momentum now.

19 The way the code has a concept of that,
20 because you can't -- it's very difficult to put all
21 this kind of structural detail in --

22 CHAIRMAN WALLIS: The code doesn't have
23 any concept. You write the concepts.

24 MR. HENRY: Okay. You're right. The way
25 my code has a concept --

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1 CHAIRMAN WALLIS: No. The way you imagine
2 it does. Let's get it clear: This is some kind of a
3 Henry fantasy.

4 MR. HENRY: This goes way back. We've had
5 a lot of fun with this over the years. So it's always
6 been his fun, though.

7 Anyway, what is imagined for this then and
8 the way it gets incorporated into the code is instead
9 of trying to represent all this through detail, as an
10 example, for jet flow etcetera, is to put this in
11 something that says okay let's do the momentum balance
12 on this and it will be interpreted as a velocity,
13 which is turbulence, circulation and that velocity,
14 that influence is what's used to determine the shear
15 on the wall, the energy transfer to the wall and also
16 it's ability to entrain.

17 So, that's why I put this up as a concept
18 trying to put this into a large code that you could
19 easily track through what it is or what its influence
20 is and what are all the things related to slowing it
21 down, whether the influence is out of entrained
22 structures. But you eventually have to get to drawing
23 boundaries in the air someplace or you won't have
24 stratification.

25 CHAIRMAN WALLIS: It would be easier for

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1 me if instead of calling it circulation you said
2 there's a schematic of -- there's a mixing, mixing
3 velocities which are produced by the flows or
4 something like that. The idea of the circulation with
5 these big cylinders rotating is something that I have
6 trouble with. But if you said -- same as you got flow
7 in a pipe where the transfer to the wall it's governed
8 by the turbulence which it's sort of set up by the
9 main flow and you just don't say it's a linear flow
10 because then you wouldn't have transfer to the wall at
11 all. Let us somehow model the turbulence. I think
12 that's what you're trying to do.

13 MR. HENRY: That is what we're trying to
14 do.

15 MEMBER KRESS: But tell me, how do you get
16 the momentum out?

17 MR. HENRY: Well, see, I've got to get
18 even with him next time. We have a slide that's
19 nothing but words and he's going to say can't you draw
20 me a simple picture of this.

21 Okay, Tom.

22 MEMBER KRESS: How do you get the momentum
23 out there with a pressure difference in an area, a
24 lost coefficient bobbing between the node?

25 MR. HENRY: Yes.

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1 MEMBER KRESS: So really --

2 MR. HENRY: Since it is a pressure
3 different --

4 MEMBER KRESS: You don't have any screening
5 in the momentum code.

6 MR. HENRY: We have the pressure
7 difference that says what is the flow rate that's
8 leaving the node.

9 MEMBER KRESS: Okay.

10 MR. HENRY: And that's evaluated. And
11 what it carries with it is whatever that turbulence
12 velocity is.

13 MEMBER KRESS: It carries its node
14 velocity with it?

15 MR. HENRY: Yes.

16 MEMBER KRESS: Computing the pressure
17 difference?

18 MR. HENRY: The pressure difference --

19 MEMBER KRESS: Is this that lost
20 coefficient?

21 MR. HENRY: Yes. Yes, there's a lost
22 coefficient if it's just wide open, then there's
23 basically no lost coefficient. But, you know, the
24 real fundamental thing at least we've discovered here,
25 and that's what I want to also verify to myself as we

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1 work through this is what was the insight here was if
2 you didn't this, then you never got the right answer.
3 If you did have it, it didn't make much difference how
4 much detail you went to as long as you said someplace
5 that momentum got observed and therefore we had
6 turbulence velocity which was higher than just the
7 through flow velocity.

8 MEMBER LEITCH: You've talked about this
9 containment of pressure and temperature in macroscopic
10 sense but then do you calculate pressure and
11 temperature in each one of these virtual nodes, or
12 which one --

13 MR. HENRY: Each node has its own
14 pressure.

15 MEMBER LEITCH: And I guess my question
16 then is that it seems to me to say in the LOCA, that's
17 where the LOCA occurs, you would have a higher
18 pressure and temperature.

19 MR. HENRY: It does.

20 MEMBER LEITCH: Does that become limiting?

21 MR. HENRY: Generally not because it's
22 usually the saturation temperature corresponding to
23 the pressure in the room, and that's what we figure
24 with most plant's design basis already is. But
25 certainly the pressure and the temperature in the

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1 break room are highest. We'll get to a little bit of
2 that later on.

3 MEMBER LEITCH: Higher than the previous
4 methodology that are indicated?

5 MR. HENRY: Lower. Lower pressure and
6 some are lower temperature than previous
7 methodologies. Because you get more condensation by
8 displacing the air. Temperature is also mitigated
9 because of all the moisture that gets entrained back
10 into the atmosphere. So it's hard to ever have super
11 heat, which is again what the experiments seek.

12 MEMBER KRESS: When you say dry runs is
13 submerged pressure, what does this submerged mean
14 here?

15 MR. HENRY: It could be things like
16 grading, I-beams.

17 MEMBER KRESS: Submerged means it's just
18 in there --

19 MR. HENRY: This is submerged in the air
20 right here, as an example.

21 MEMBER KRESS: Okay. It didn't mean it
22 was under liquid?

23 MR. HENRY: No. No, it's just submerged
24 in whatever the local fluid is.

25 MEMBER KRESS: Submerged surfaces normally

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1 is a function of exposed surface area.

2 MR. HENRY: Right.

3 MEMBER KRESS: It depends on which
4 direction the flow is going. Does the code recognize
5 flow direction somehow and --

6 MR. HENRY: No. No, it just thinks it's--

7 MEMBER KRESS: It takes the polarity of
8 whatever the structure is --

9 MR. HENRY: If you have a pipe that runs
10 through the room, you know, it doesn't care whether
11 it's horizontal or vertical it has this turbulence
12 velocity that's used. We value how fast the it can
13 slow itself down.

14 CHAIRMAN WALLIS: How do you get drag on
15 submerged structures? It's the circulation velocity
16 that's dragging on this structure or --

17 MR. HENRY: Yes.

18 MEMBER KRESS: Do you use some sort of
19 friction lost coefficient or --

20 MR. HENRY: Just drag coefficient.

21 MEMBER KRESS: Do you have form losses in
22 it?

23 MR. HENRY: Well, it take it -- basically,
24 again, it comes down to if you put it in the code,
25 once you have it in it doesn't matter a whole lot on

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1 details. But what we really use are just drag
2 coefficients associated whether we think it's a
3 cylinder or a square, or -- it's usually a pipe or
4 some kind of I-beam or grading --

5 MEMBER KRESS: So there is some sort of
6 consideration of flow direction versus the orientation

7 MR. HENRY: Yes. Again, yes. I did not
8 answer your first question right. We're always
9 assuming it's going across it, it's not going with.
10 You asked me a question, I responded incorrectly.

11 CHAIRMAN WALLIS: I think you have
12 something like a K epsilon here. You're saying that
13 the turbulence level in these nodes is a source of
14 energy to be fed in to increase the turbulence which
15 is the flows and then there's various frictions and so
16 on are dissipating turbulence. So you get some
17 measure then of atypical mixing velocity within the
18 node. I think that's the kind thing you're doing
19 here?

20 MR. HENRY: Yes. As opposed to saying
21 it's only the through flow velocity, which I'll come
22 back to in a second.

23 One other aspect is the condensation
24 occurs under natural convection conditions. In MAAP
25 we use the analogy for between heat to mass transfer.

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1 So the thermal boundary layer is the same as what we
2 have for the natural circulation flow. Of course,
3 under laminar conditions, the Nussel number for all
4 gaseous flow -- excuse me, for single phase flow is
5 proportion to one-fourth power and then turbulent flow
6 we have the lower Reliegh numbers, the one-third power
7 at the higher Reliegh number, about .4 power which
8 comes out of standard textbooks.

9 And what we use for that, there's the
10 maximum of all these, depending upon what your
11 specific conditions are. The Reliegh number --

12 CHAIRMAN WALLIS: Your whole idea of
13 having circulation velocity is that the stirring
14 enhances the forced convection and produces the
15 transfer to the wall.

16 MR. HENRY: Right.

17 CHAIRMAN WALLIS: Now you're bringing in
18 pre-convection --

19 MR. HENRY: There are times where stirring
20 velocity is so slow it has no real relevance. It
21 eventually dies away, in other words. But there are
22 times when this is the governing process of energy
23 transfer to the wall.

24 CHAIRMAN WALLIS: So you have mixed
25 natural convection and stirring convection --

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1 velocity?

2 MR. HENRY: You could also put here --

3 CHAIRMAN WALLIS: Is this why you put the
4 max in here, is that --

5 MR. HENRY: Yes. Because as the velocity
6 dies away, then this natural convection will take
7 over. So you have to have a consistent way of
8 addressing that as well.

9 CHAIRMAN WALLIS: There could be a
10 condition where the circulation would actually act in
11 the opposite direction of the natural convection and--

12 MR. HENRY: Right.

13 CHAIRMAN WALLIS: -- the net result would
14 be to reduce the heat transfer.

15 MR. HENRY: Right. That's one of these
16 pieces right here. When we use this, as I'll show you
17 in a second, which is just a straightforward saying
18 this looks nothing more -- it doesn't know that
19 there's a film on the wall, you just have natural
20 convection driven by the temperature difference and,
21 therefore, what's the hydrodynamic boundary layer,
22 what's the mass transfer boundary layer. We find that
23 we under predict the condensation rate when we go to
24 specific experiments, separate effects experiments.

25 MEMBER KRESS: What do you use for L?

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1 MR. HENRY: This is the height of the
2 wall.

3 MEMBER KRESS: The height of the node if
4 it's the virtual node.

5 MR. HENRY: Yes. It almost cancels itself
6 out, as you know.

7 So what we have -- we'll get to, is it's
8 strictly correlating factor that says okay what are
9 our differences. And when we look at the data, the
10 higher the mole fraction of steam, the worse we do in
11 this straightforward representation of going from
12 single phase -- the heat transfer analogy, applying
13 this single phase gaseous representation to the
14 condensing potential.

15 MEMBER SCHROCK: What do you do for
16 condensation on your horizontal surfaces?

17 MR. HENRY: The condensation on horizontal
18 surfaces, it's usually dictated by the conduction on
19 the surface. That's water, it's very low, of course.
20 And if it's vertically -- if we're on a ceiling which
21 is facing downward, then we end up using this same
22 thing for experiments that I'll get to later.
23 Because, obviously, we have ceilings to the
24 containment and --

25 MEMBER SCHROCK: These natural convection

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1 for mass transfer formulations are not appropriate
2 then?

3 MR. HENRY: That's right. And that's why
4 we go to the experiments. When we get to these
5 ceiling, which are facing downward, that is the
6 representation that they see in those particular
7 experiments.

8 CHAIRMAN WALLIS: I guess your document
9 explains this F_m so I can understand it?

10 MR. HENRY: This F_m is right here. This
11 is the correlating parameter, this is merely a
12 viscosity radiogram that says --

13 CHAIRMAN WALLIS: Oh, that's viscosity?

14 MR. HENRY: This is a viscosity ration,
15 this is to say this N_u of the gas over N_u of the
16 fluid. It merely gives us -- this is the most -- as
17 we'll see in a second, this is the most effected
18 parameter here that says the more steam you have, the
19 worse this representation does.

20 CHAIRMAN WALLIS: What is N ?

21 MR. HENRY: That is the mole fraction of
22 steam.

23 CHAIRMAN WALLIS: So there's something in
24 your documentation that justifies this equation
25 somewhere?

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1 MR. HENRY: This is strictly --

2 CHAIRMAN WALLIS: So it explains where it
3 came from in your documentation? If we've got the
4 code documentation, could we understand where that
5 came from?

6 MR. HENRY: I hope so. This is really
7 just a correlation for -- this is dimensionless
8 obviously, and these which we -- the viscosity ratio
9 because we have to cover all pressure levels here, the
10 reason this is to the .8 is viscosity squared to the
11 .4 power. And this is linear because all this is is
12 the fact that if you have low density gases that are
13 being condensed, they can collect in the boundary
14 layer and they can impose the natural convection which
15 is going on. And there's a ton of papers in
16 literature that say this virtually cancels itself out,
17 and it does.

18 MEMBER KRESS: What happens to things that
19 condense on the ceiling and other horizontal surfaces?

20 MR. HENRY: Let me come back to that when
21 we get to the experiments in a second, if you would.
22 Because we're going to certainly come back to that.

23 I just wanted you to understand when we
24 get to natural convection, there is an enhancement to
25 the condensation rate to the natural convection side

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1 that, again, comes from separate effects.

2 In the interest of time, I won't spend a
3 lot of time on this because we already talked about
4 it. The mass energy releases comes from design basis
5 calculations as they are applied to the containment
6 models for both sites.

7 And I'm not going to spend a lot of time
8 on this one either, because it really says much the
9 same thing. We look at all these types of accidents
10 and as a result we'd like to find all the experiments
11 that we could find that are applicable to these kind
12 to test the total capabilities of the containment
13 model.

14 The fact that the design bases mass energy
15 releases come from separate models and they get their
16 input to the containment model. So in essence what
17 MAAP is calculating for the core in the RCS is just
18 thrown away. It's ignored.

19 There's a mass energy release time
20 dependent mass energy that's coming into the
21 containment. That's exactly what we do to benchmark
22 the calculation against these major experiments of
23 CVTR and HDR. We have the mass energy releases which
24 are specified by the experimenters.

25 So I think I came to you guys once before

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1 and said would it be worthwhile to try to make sure
2 that we preserve some of this very key data and put it
3 in the codes and that's really what we're trying to do
4 here as well. So it's preservation activity as well
5 as a convenient way to benchmark the code on a
6 continual basis.

7 Experiments that we currently have pulled
8 together, and this again, as I said, this is one of
9 the key places that we want to have your feedback, is
10 separate effects.

11 We've used the Dehbi condensation
12 experiments at MIT, the Anderson condensation
13 experiments at Wisconsin, the Hitachi condensation
14 experiments which related to a containment test but it
15 gave us another separate set of tests that we could
16 compare the condensation model against under natural
17 convection. Uchida condensation experiments, Tagami.
18 When we get to the spray experiments they just lightly
19 touch on the nice thesis that was done in Canada by
20 Kulic for both single droplet as well as spray header
21 behavior. And for countercurrent natural circulation
22 we used the salt water, the brine water tests done by
23 Epstein and Kenton for countercurrent natural
24 circulation where you have both heavy over light as
25 well as heavy over light with a through flow induced

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1 as well to assess that set of conditions that could
2 flood the natural circulation flow too.

3 So these are the separate effects tests
4 that we've built up to date.

5 The large scale integral tests include
6 small break, large break and main steam line like
7 conditions for HDR. CVTR tests -- I should say the
8 HDR tests are all international standard problems
9 also. CVTR tests are steam into a containment. Steam
10 came from an adjacent power plant.

11 And the containment standard problem tests
12 were done at the Battelle Frankfurt facility. There
13 are two different types of hooking up of that
14 particular set of containment compartments.

15 By doing these, of course, we're also
16 demonstrating the use of external M&Es, because that's
17 what these are.

18 MEMBER KRESS: Have you checked into the
19 Marveicken --

20 MR. HENRY: We have, and they're so
21 dominated by the suppression pool.

22 MEMBER KRESS: They are, yes.

23 MR. HENRY: But, indeed, those are ones
24 that we like to add to this whole thing but not so
25 much for these guys.

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1 That's a good point, Tom, because I wanted
2 to -- there are a couple of other experiments here.
3 One in particular is a CSDF test at Hanford. While
4 it's ice condenser related, it certainly enables you
5 to see what's this code going to do for the natural
6 circulation flows that they put into those
7 compartments. So that's also part of it, but not
8 listed here.

9 And the separate effects, one is the
10 experiments that we used heavily were the experiments
11 performed by Dehbi at MIT. And this was interesting
12 to us because you had a very long condensing length,
13 even though this is maybe something like an inch to an
14 inch and a half or so, but it had 3.5 meter condensing
15 length that gave nice natural convection conditions to
16 benchmark the model against. And they also,
17 obviously, had air as the noncondensable gas and they
18 put in light gas to see what the influence was with
19 helium also.

20 MEMBER KRESS: The vials for the outer
21 chamber heated or insulated --

22 MR. HENRY: Yes. These were insulated
23 here so that the steam came from boiling water and the
24 cold water was flowing through this copper condensing
25 cylinder that they have here.

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1 CHAIRMAN WALLIS: And you put in a certain
2 amount of air so you have some noncondensibles?

3 MR. HENRY: Right. And in some case they
4 have a set of experiments where they bled steam
5 through the boiling water as well.

6 CHAIRMAN WALLIS: Now your code with nodes
7 in it, now it really doesn't address the question of
8 how do you predict the heat transfer coefficient in a
9 geometry like this, does it?

10 MR. HENRY: Well, natural convection heat
11 transfer coefficient that I just showed you, you could
12 either benchmark it based upon the condensing
13 coefficient on the wall just due to the natural
14 circulation condition --

15 CHAIRMAN WALLIS: Are there correlations
16 for a cylinder inside a cylinder or this kind of
17 natural convection?

18 MR. HENRY: Well, I can show you exactly
19 what --

20 CHAIRMAN WALLIS: You borrowed them from
21 some other context, or something?

22 MR. HENRY: The size of the cylinder means
23 that this almost looks like a flat plate in terms of
24 what the -- vertical flat plate in terms of what the
25 natural convection is on the outside.

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1 CHAIRMAN WALLIS: But it's long, so you
2 have flow --

3 MR. HENRY: You do the hand calculation,
4 this steaming rate is nowhere near what it takes to
5 flood the film. This steaming rate is very slow.

6 MEMBER SCHROCK: Does it count as
7 turbulent film?

8 MR. HENRY: The following film?

9 MEMBER SCHROCK: Yes.

10 MR. HENRY: Yes. The turbulent film gets
11 fit for the turbulence.

12 CHAIRMAN WALLIS: I didn't mean it that
13 way in terms of that sort of flooding. I mean you're
14 going to use some sort of Nussel numbers or something
15 or obtained from a correlation like the ones you've
16 showed us?

17 MR. HENRY: Yes. It comes directly from
18 those correlations.

19 CHAIRMAN WALLIS: Assuming that this is
20 the same as flat plate in an infinite environment?

21 MR. HENRY: Yes. That's the assumption.

22 And this is the data. I apologize, these
23 are pretty small figures, but this is at a pressure
24 4.5 atmospheres. In essence, one atmosphere of air.

25 This is at a pressure of 3 atmospheres and

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1 1.5 atmospheres. For a variety of air mass fractions
2 this is the way the data was reported by the
3 experimenter.

4 And then this plus the two on the next
5 page have helium fractions, this being 1.7 and the
6 others the 4 something and 8 something percent helium.

7 Now, this solid line right here is MAAP4,
8 which is just those mass and energy, the analogy of
9 heat to mass transfer applied to this set of steam
10 conditions.

11 CHAIRMAN WALLIS: So what you're testing
12 is is this F_m ?

13 MR. HENRY: In essence F_m comes from
14 these, Graham. That's the correlation that comes from
15 the separate effects tests. What's the reason that
16 this-- why don't these equations work, as an example.
17 Well, you can see, certainly, as we have more and more
18 steam in here, the difference between those equation
19 by themselves and the data increases.

20 CHAIRMAN WALLIS: When you say comparison
21 of MAAP with Dehbi's, the only thing that MAAP did was
22 introduce this F_m .

23 MR. HENRY: Right, and that's a
24 correlation that comes from this information.

25 CHAIRMAN WALLIS: The information itself

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1 came from these data.

2 MR. HENRY: Right.

3 CHAIRMAN WALLIS: It ought to fit them, it
4 was itself derived from the data.

5 MR. HENRY: My only point here is to show
6 you this is all fit --

7 CHAIRMAN WALLIS: How well it does?

8 MR. HENRY: Yes, how well it does and the
9 fact that you've known correlations from day one,
10 right?

11 CHAIRMAN WALLIS: Yes.

12 MR. HENRY: This is a value of that F_m of
13 1. I'd like to get that as close to 1 as --

14 CHAIRMAN WALLIS: And what this does is it
15 justifies that F_m is a reasonable way of modeling
16 condensation.

17 MR. HENRY: Exactly. Exactly. It's
18 nothing to say this is how well this does. But then
19 I'm going to take this same thing to all the other
20 experiments before I ever apply it --

21 CHAIRMAN WALLIS: Okay, so now I begin to
22 understand. Because, you know, you send us our slides
23 ahead of time, which was a very good idea.

24 MR. HENRY: Obviously. Well, it's always
25 a good idea.

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1 CHAIRMAN WALLIS: Well, I'll look at this
2 and I say what has this got to do with containment.
3 It's really a separate effects to get the condensation
4 coefficient.

5 MR. HENRY: Yes. And I should if I look
6 at this test, I should be able to go to other tests
7 and do just as well. If I don't do as well, I'd
8 better broaden these uncertainties --

9 CHAIRMAN WALLIS: So you're not modeling
10 any of the circulations or --

11 MR. HENRY: No, no, no. In fact, this is
12 really set up to be just natural convection is the
13 dominant thing.

14 This is a value of 1. This is a value of
15 that F_m of .5 and 1.5.

16 Well, certainly from the standpoint of
17 moving through various pressures, it does a reasonable
18 job of bounding the data so we can find out the role
19 of uncertainties or this uncertainty, where this
20 particular thing applies in a containment analysis.
21 But before we do that, we obviously want to go to a
22 bunch of other separate effects tests and see just how
23 well does it do with those as well, different
24 geometries.

25 This is the same calculation and the only

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1 difference here is that little term I say we put in,
2 here's the influence of light gas accumulated in the
3 boundary layer. And the only difference between here
4 and here is that term, and this a hydrogen -- or
5 excuse me, a helium accumulation of 1.7 percent.

6 CHAIRMAN WALLIS: This is the average heat
7 transfer coefficient?

8 MR. HENRY: Yes, it is. That's all they
9 measured in that test.

10 Now I should -- I mean, to give the author
11 credit, he developed his own correlation for what that
12 was. This effective -- of course, this really should
13 just be heat transfer coefficient here. That's my
14 fault. But in essence, he had his own correlation.
15 Again, following in the structure of the code he
16 wanted to put something and clearly understand how the
17 code's using it. That's why we put in our own
18 correlation for it here, because we know exactly how
19 the information is getting transferred from node to
20 node to node.

21 But here you can see the obvious
22 influence. If you have a one node model, so we're
23 always sitting at some kind of mass fraction down here
24 someplace -- let's see, I should be more like in here.
25 Here. As opposed to pushing air out so some nodes may

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1 be condensing here, but the break node is much more
2 down here. That has a tremendous influence on the
3 peak pressure that you would calculate.

4 CHAIRMAN WALLIS: So this noncondensable
5 mass fraction appears as N in this F_m ?

6 MR. HENRY: NFST, that's all one thing.

7 CHAIRMAN WALLIS: Your also influence as
8 FST?

9 MR. HENRY: Well, NFST is the mole
10 fraction of steam. NF is mole fraction and ST is
11 steam.

12 CHAIRMAN WALLIS: So this is saying that
13 F is one plus something that's proportional to mole
14 fraction?

15 MR. HENRY: Yes.

16 CHAIRMAN WALLIS: And the Nussel number
17 goes up when N goes up or does it go down?

18 MR. HENRY: The Nussel number goes up with
19 increasing steam mole fraction. The more steam we
20 have in there, the more -- the measured -- yes, this
21 is N for mole fraction and F and ST is steam.

22 CHAIRMAN WALLIS: We're looking here at
23 noncondensable mass fraction.

24 MR. HENRY: Right. Since it's only air
25 and steam you could --

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1 CHAIRMAN WALLIS: Use it the other way
2 around?

3 MR. HENRY: Right. But this is of steam
4 here. I could turn it around, but that's the way the
5 experimenter reported his data and I always try to be
6 faithful to what he represented as information.

7 MEMBER KRESS: Well, how did he
8 extrapolate against the cube of MC delta P of the
9 water, probably, you've got the area.

10 MR. HENRY: Measured wall temperature --

11 MEMBER KRESS: Measured wall temperature?

12 MR. HENRY: And the environment
13 temperature.

14 I just want to make sure, this was no
15 indictment of his correlation, but we put it in in our
16 own way and we know how the code's going to use the
17 information.

18 CHAIRMAN WALLIS: Well, this looks a
19 little strange, but I guess we've got to go on.

20 Usually when you put in a little bit of
21 air it has a big effect, and this looks as if it
22 doesn't. As a matter of fact, it's rather a gentle
23 effect of putting in air. You have to put in a lot of
24 mass fraction.

25 MR. HENRY: Well, we're going to get to

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1 that, Graham.

2 CHAIRMAN WALLIS: Because there's a zero,
3 and you may never get to zero.

4 MR. HENRY: Right, never get to zero
5 there. Right.

6 CHAIRMAN WALLIS: Because zero is way off.

7 MR. HENRY: Right. We're going to get to
8 that.

9 MEMBER KRESS: I think that's the reason
10 we didn't get it the first time.

11 CHAIRMAN WALLIS: That's why I didn't
12 understand it because F_m seems to be linear and steam
13 fraction they always kind of leap up when you get very
14 close to 1.

15 MR. HENRY: Here's a couple -- Virgil
16 asked me a question before about what happens with
17 vertical -- with the flat systems, and in particular
18 the ones that are important to us are the downward
19 facing systems, which are the containment doom as well
20 as all the floors of the compartments. And that's why
21 we focus on Anderson's experiments because he had,
22 indeed, measured things, which I'll show you.

23 Let's go to his configuration, which were
24 interesting to us so that we could relate what he
25 measured in downward facing systems.

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1 So he ha something that looked like the
2 top of the containment all the way down to the side.
3 So this was heat flux zone 1 up through 14. That goes
4 from vertically downward all the way up to -- excuse
5 me. Horizontal facing downward to vertical. And it
6 was a slice of the containment-like geometry.

7 MEMBER SCHROCK: Is the water running down
8 or is it dripping off?

9 MR. HENRY: Both.

10 MEMBER SCHROCK: Both.

11 MR. HENRY: Both. And the net result of
12 what he saw as we go from 1 to 14 as shown here for a
13 particular test, so this is horizontal facing downward.
14 This is cooling plate number one. But here's number
15 14, so this is the one that's vertical.

16 And what he saw from the practical point
17 of view is that there's no difference in the energy
18 transfer rate to the wall. And he had two different
19 ways of doing it with a heat flux measurement and a
20 containment energy balance here. And I need to get
21 back into his thesis to make sure I understand what
22 these -- the relative uncertainties of these are, but
23 that will come.

24 And what we gleaned from this is for
25 downward facing systems there's virtually no

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1 influence. And, as you know, of course, when you go to
2 those natural convection kind of relationships, the
3 length essentially cancels out of it anyway.

4 So, this is just a preview of how we're
5 going to look at it, but at least this gave us -- and
6 this is things that Anderson reported -- of various
7 hot flow of temperatures and wall temperatures, this
8 is what Anderson measured as the heat transfer
9 coefficient. And this is what Dehbi's correlation,
10 which I mentioned here the author had formulated
11 himself, shows.

12 As the temperatures increase, which means
13 the pressure has to increase. These are reasonably
14 close. If anything, Anderson's tend to be higher than
15 Dehbi's or even more energy -- higher heat flux,
16 higher heat transfer coefficient than what we're
17 doing, except at this very low one. So this will also
18 dictate when we finally get to doing this detailed
19 comparison what the uncertainty boundaries are that we
20 think have to come from separate effects tests.

21 MEMBER SCHROCK: So do we know where these
22 experiments, where the relationship between the
23 resistance in the diffusion layer is compared to the
24 conduction resistance in the film?

25 MR. HENRY: For most of these that relate

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1 to design basis type of energy transfer rates, there's
2 hardly any resistance in the film. Resistance is on
3 the gas side and/or on the concrete wall, and the film
4 is a very small amount of the resistance. We
5 struggled with that for a long time, Virgil, ourselves
6 and we went to the trouble of making sure that we had
7 this Laminar to turbulent film transition. We saw no
8 influence of it, but I'm not surprising you with it
9 I'm sure, you've seen it many times.

10 MEMBER SCHROCK: This funny shift from a
11 lower value in Anderson to a higher value in Anderson
12 as you go across these conditions which correspond to
13 higher temperatures in the steam environment.

14 MR. HENRY: Let me tell you where this
15 comes from. This comes out of Anderson's paper that
16 he put into literature. This table was in there --

17 MEMBER SCHROCK: I haven't seen it. Where
18 was that published?

19 MR. HENRY: I can get that to you. I'm
20 trying to think. I think it was in *Nuclear*
21 *Engineering and Design*. But I will get it for you.

22 MEMBER SCHROCK: And this thing you showed
23 us --

24 MR. HENRY: I've got to get his thesis so
25 I could understand where these numbers actually come

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1 from, because he's obviously averaged over some of
2 these plates.

3 I'm sorry?

4 CHAIRMAN WALLIS: On the previous
5 transparency something went by me. You've got plates
6 at different orientations, is it related somehow to
7 the picture in slide 24. What were the various plates
8 here?

9 MR. HENRY: This is looking at a frontal
10 view of his experiment. This is the side view. So
11 these plates are individual plates that have their own
12 cooling core so they can --

13 CHAIRMAN WALLIS: This is like a sort of
14 two dimensional containment?

15 MR. HENRY: Yes. Steam comes in here and
16 they measure condensation rates in each one of these
17 plates under average conditions that are in that
18 table.

19 CHAIRMAN WALLIS: And the orientation
20 makes no difference?

21 MR. HENRY: The orientation makes very
22 little difference.

23 CHAIRMAN WALLIS: This might indicate that
24 it's some sort of a circulation locally that's been
25 happening rather than --

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1 MR. HENRY: It is spinning.

2 CHAIRMAN WALLIS: Yes. Is that what's
3 happening or is it --

4 MR. HENRY: I really think that -- and,
5 again, I want to get his thesis so I understand more
6 than what's in that particular paper. But there's a
7 couple of things that have been going on here.

8 Obviously, you have heavy over light. But
9 if you collect enough water in this region, which is
10 just horizontal facing downward, that by itself is
11 going to fall away --

12 CHAIRMAN WALLIS: And it drips off the
13 top.

14 MR. HENRY: Drips off and that certainly
15 tears up any stable boundary layer. And what you
16 eventually get to over here, which is vertical, this
17 is also in excellent agreement with Dehbi's vertical
18 experiments.

19 CHAIRMAN WALLIS: This is with a lot of
20 noncondensibles.

21 MR. HENRY: Right, this is.

22 CHAIRMAN WALLIS: So it's nothing to do
23 with Nussel's film, and the limiting thing is in the
24 air spout.

25 MR. HENRY: Right. Right. And to that

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1 effect, I should also mention they went to great
2 trouble to make sure the condensing plates weren't
3 limiting, for obvious reasons.

4 But I found this to be very helpful in
5 going to these containment conditions.

6 CHAIRMAN WALLIS: When this happens,
7 there's some global replacement variable, which is the
8 same for horizontal and vertical it's dominating
9 everything. Gravity doesn't really matter in that in
10 that global picture.

11 MR. HENRY: That's right. It's probably
12 a mixture of setting itself up this way as well as
13 stuff coming down this way, and so gravity doesn't
14 matter much.

15 But this also gives you the kind of
16 information you need to say, the containment side,
17 they're pretty complex geometry, how do I treat this
18 thing. And fundamentally what we say and our logic is
19 the length already canceled out anyway, so from a
20 practical point of view, systems which are facing
21 downward we treat with the same kind of heat transfer
22 coefficient, effective heat transfer coefficient,
23 because that's what these are all put in. HTC is heat
24 transfer coefficient.

25 There are a couple of things we should get

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1 to, so I'm going to -- I do need to leave here not too
2 long after 5:00, Mr. Chairman, if that's okay.

3 For the Hitachi experiments and for the
4 Uchidas, I put -- this came, again, from the Hitachi
5 paper that shows their measurement. And they had a
6 geometry that was related strictly to suppression
7 pool. But again they were measuring the effective
8 heat transfer coefficient. Graham, the only reason I
9 put this up here is, here's your steepness that you
10 were looking for. So that's all there.

11 And this is not my line, this is
12 Hitachi's. However, the way in which MAAP looks at
13 Uchida, which is shown on that Hitachi slide is shown
14 here. So, that representation I showed you with F_m
15 etcetera as a function, and now this is the ratio of
16 noncondensable gas to steam. Here's the steepness and
17 this is the way that correlation looks. And this
18 needs to eventually have those same uncertainty
19 boundaries put on it, but this was all we could do is
20 digitize the information that came out in the original
21 Geneva paper, which was a real tiny figure.

22 I'm going to skip the next ones because I
23 want to get to some of the integral tests, because our
24 whole process is to try to build the understanding
25 from separate effects tests and then test their

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1 capabilities when we get to integral experiments. So,
2 if it's okay with you, I'm going to jump to the CVTR
3 experiments.

4 So, this is CVTR, which is a
5 decommissioned containment now. I'll wait until
6 everybody gets this. And they had a line from an
7 adjacent power plant that came into here and it
8 discharged into this node.

9 Now, a couple of things here. This is a
10 12 node model and as we talked before, this is a
11 generalized containment scheme, so historically these
12 nodes got added later down here. That's why 11 and 12
13 are down in here. And 9 and 10 are embedded nodes that
14 are inside of the -- that we represent the refueling
15 cavity and I forget what else inside. It just doesn't
16 show up on this figure.

17 CHAIRMAN WALLIS: There are structures and
18 things in there that you don't show?

19 MR. HENRY: Right. And that's part of the
20 problem is, it's hard to find a description of all
21 those structures. But there is in the experimental
22 report, there is a specification of what the heat
23 sinks are and the uncertainties that they subscribe to
24 their estimation of heat sinks. So we use that. And
25 to some extent we have to do a little bit of guessing

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1 of where they are, but there's only a couple above the
2 operating floor. This particular thing had a steam
3 generator on it. There's a fair size structure up
4 here.

5 MEMBER SCHROCK: When these guys do it for
6 the plant specific, they have to make these choices?

7 MR. HENRY: Right. They have to go look at
8 where they have rooms.

9 MEMBER SCHROCK: Yes.

10 MR. HENRY: And they certainly have to
11 have something which says I want to make sure that I
12 can see stratification if it would ever occur.

13 MEMBER SCHROCK: But you make a comment
14 that it's hard to come by that information.

15 MR. HENRY: For CVTRs it's hard to come by
16 that information, because it's a decommissioned
17 containment.

18 MEMBER SCHROCK: Okay.

19 MR. HENRY: In fact, it's being torn down
20 now.

21 The reason I wanted to make this point
22 here, there is a generalized nodalization scheme. You
23 could hook nodes together anyway you want, so node 4
24 can talk to node 11, there's no sequential problem
25 associated with it.

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1 The other thing I wanted to show you was
2 the thermal couples that we will talk about here in
3 comparison, there's a thermal couple 28 that sits out
4 in this location, I think it's at elevation 370.
5 Thermal couple 11 is right below the operating deck,
6 so it's in this region between these two nodes.
7 Thermal couple 7 is sitting at, and I think it's
8 something like 297 or so, it's right here. And
9 thermal couple 5 is here. And just so you know where
10 they are inside the nodalization scheme.

11 And one of the things I need to show the
12 staff and of course this committee in the future is
13 suppose we started with one node, what would we get?
14 If we had two nodes, what would do we get? If we have
15 four, what do we get?

16 And also, I can tell you ahead of time,
17 basically if I would have made this one node, two
18 nodes, three nodes, four nodes, I'd get something very
19 close to what you see now. But don't take my word for
20 it. I owe that to you in the future.

21 We used these 12 nodes because we wanted
22 to see what are all the axial temperatures and the
23 influences on containment pressurization. So, we'll
24 keep coming back and forth to this, I'm sure.

25 There were three tests; test number 3,

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1 number 4, number 5. The only difference is test 3 had
2 no sprays at all in it, so steam went into containment
3 and then it just cooled down over a number of hours.

4 In test number 4 they turned the sprays on
5 at about 210 seconds at half the capacity that the
6 containment had.

7 And test number 5, exactly the same except
8 full capacity of the sprays.

9 So this is the pressure that's measured
10 for all these different gauges throughout the volume.
11 And, of course, they're in very close agreement, which
12 is expected. And this is only the first 400 seconds,
13 this is the same set of measurements over the first
14 hour.

15 Remember that thermal couple 28 that's up
16 somewhere around 370 or so, that's this thermal couple
17 TC28 and showing here both the temperatures in node 1
18 and node 2, and this is that measurement for zero to
19 400 seconds and zero to 4000 seconds.

20 The sprays come on just about right here.
21 You see a little kink right there, and that's when it
22 comes on. And so all this that you see here is all
23 being driven by the spray cooling.

24 MEMBER KRESS: The break is when the steam
25 quit going in?

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1 MR. HENRY: Yes, that's exactly right,
2 Tom, the steam -- the mass energy stopped right here.

3 Now, why we do this to begin with. We
4 thought MAAP4 was a pretty good code, as it
5 generalized nodalization and it had the kind of energy
6 with the natural convection thing I showed you that
7 didn't have F_m in it, and it allowed air to be pushed
8 around containment. And we did the best job we could
9 with MAAP4 and this CVTR test, we had a pressure that
10 was up here. It over-predicted the pressure by about
11 7 psi, as I recall.

12 The best nodalization we could think of,
13 all the heat sinks, everything else, the best thing
14 that we could put in there. So that's what really got
15 our attention. What are we missing? And the thing
16 that we're missing is when we do mass and energy
17 balances, as an example, we don't end up having any
18 idea of what that turbulence, whatever that
19 circulation is because we never were solving for it.
20 That momentum just disappeared. So everything that
21 was driving through the containment was all just due
22 to through flow and what it had to have to pressurize
23 the various other nodes to the same pressures. And it
24 would push air either way. But no way could we get it
25 down from up here to there. So that's where the whole

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1 concept got started: What does this mean? What are
2 we missing in these nodes?

3 The other aspect is the temperature. We
4 over-predicted this temperature by something like 50
5 or 60 degree Fahrenheit. So we obviously had some
6 things that were really missing in both. What governs
7 the peak pressure, what determines the temperature in
8 these nodes.

9 And we also looked at the rest of the
10 temperatures as we worked down into the containment.
11 So this one is TC11 you see here, which is right below
12 the operating deck by 4 or 5 feet. TC7, which is
13 further down. And you can see with this one having a
14 peak of something in the range of 230, it's not too
15 much different than right above the operating deck.

16 When you get further down, this is hardly
17 increasing at all. And that's still a challenge to us
18 because this particular rise that you see right here
19 is only because the system's pressurizing because the
20 pressure is going up.

21 So what we do in order so that we have
22 some kind of perspective of what's going on, these
23 three lines right here are a heat sink that's a
24 quarter inch -- assumed to be quarter inch thermal
25 couple, which is a big thermal couple, just sitting in

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1 that node. So how much would we slow down this
2 measurement if we had this generic thermal couple
3 sitting in there, because we don't know what that
4 thermal couple or RTD looks like, that wasn't in the
5 report.

6 Now you can see, that slows it down a
7 little bit, but still not as much as -- there's
8 something else even going on that makes that lower
9 region even cooler. But if we didn't have this
10 turbulence circulation velocity, we would really
11 overstate this temperature again, and this would also
12 be overstated because the pressure's higher. This
13 whole thing is coming about because the pressure is
14 going up and it's just eV to the gamma as a constant.

15 You can see certainly after the sprays
16 come on, we get quite bit agreement down low in the
17 containment as well.

18 And then we go to the very bottom of the
19 containment.

20 This is TC5 for the first 400 seconds, the
21 first 4000 seconds. And now we get much better, at
22 least understanding that this could be because of some
23 thermal response to the thermal couple and maybe it's
24 seeing some water dripping down from the wall.

25 This is again the average temperature up

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1 in node 2, but the key thing I wanted to mention to
2 you the CVTR provides is it has detailed
3 representations of the liner temperature in the break
4 region.

5 So this is the side of the liner that
6 faces the gas space. This is the side of the liner
7 that faces the concrete. And in CVTR the liner does
8 not contact the concrete, at least not at the
9 beginning of the test. It's separated by 3/8th of an
10 inch. It doesn't mean that it couldn't be pushed out
11 during the test.

12 But this is our evaluation of the liner
13 temperature that's facing the steam. And the reason
14 this data that's shown here and the data shown here is
15 exactly the same, and the whole reason is that we
16 don't know where that measure was taken. We just know
17 where its elevation is. We don't know azimuthally
18 where it was in the test report. This is that
19 particular heat sink, which is our break node, which
20 was node number 2. And this is the node right beside
21 it at the same elevation. So we show a little bit
22 higher temperature, of course, in that node than we do
23 here, but at least we can see it's certainly following
24 the liner temperature quite well, which is one of the
25 evaluations that these guys have to do. They have to

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1 evaluate the liner temperature during these design
2 basis calculation.

3 So that's why this was particularly
4 important to us. And this one I'm going to put in
5 better context for you in the future, but this is,
6 again, the liner temperature. We have nodes in the
7 concrete, which can be fairly thick. This is our
8 node, and this is what their temperature is, imbedded
9 in the concrete. And, again, these two are exactly
10 the same thing. It's just that they're two different
11 nodes at the same elevation.

12 I will put this in a heat flux context for
13 you, so you can really see this in terms of how much
14 energy, what's the transient deposition of energy into
15 the concrete, because that's really matters.

16 CHAIRMAN WALLIS: I don't quite understand
17 the lines here. The data are the results.

18 MR. HENRY: Right.

19 CHAIRMAN WALLIS: And there's something
20 called MAAP calculations -- which line is that? There
21 are two solid lines --

22 MR. HENRY: This is best estimate or what
23 I should be calling realistic just to get --

24 CHAIRMAN WALLIS: Realistic and
25 pessimistic.

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1 MR. HENRY: Okay.

2 CHAIRMAN WALLIS: And then the data is way
3 down below there.

4 MR. HENRY: Right. This calculation right
5 here is basically the same as what's up here, because
6 this is the inside liner temperature. There's the
7 liner, then there's a gap and there's the concrete.

8 CHAIRMAN WALLIS: And your thermal couple
9 reading is way down there?

10 MR. HENRY: No, this thermal couple is
11 sitting in the concrete.

12 CHAIRMAN WALLIS: And what's the other --

13 MR. HENRY: This is our first concrete
14 node. The node can be -- so that's why I say in the
15 future I'll put this into the heat flux rate.

16 CHAIRMAN WALLIS: Somewhere in between.

17 MR. HENRY: Right. I'll characterize the
18 transient heat flux, which is more meaningful for you.
19 I apologize for that.

20 But this, of course, is easier to
21 represent. Okay. They have temperatures in the
22 concrete, how well you're doing there.

23 So these CVTR tests are very important to
24 us because that was the first clue we had there's
25 something that's really missing in this process and

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1 what is it. Unfortunately right after that are the
2 spinning cylinders.

3 There's a couple more here that I'll go
4 through very quickly, again, Graham, with your
5 permission, just because this is a particular
6 containment configuration that gets put together two
7 different ways for these two CASP experiments.

8 CHAIRMAN WALLIS: It's very easy. We do
9 this for homework. I mean, you could just take one of
10 the rooms with flow in one and up the other side and
11 do some of that room calculation, you would show that
12 these flows in and out set up separation cells in the
13 room; they wouldn't be quite like your cell, but they
14 would be straight up.

15 MR. HENRY: That's right.

16 CHAIRMAN WALLIS: And you could actually
17 predict from some of CFD calculation what the role of
18 heat transfer should be. That would be not too
19 difficult a thing to do.

20 MR. HENRY: You got my attention. I'm
21 sure we'll come see you again.

22 CHAIRMAN WALLIS: Students do this for
23 homework.

24 MR. HENRY: I guess we'll have to find
25 someone who's younger and quicker.

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1 CHAIRMAN WALLIS: Well, the frequency here
2 has CFD capability. It could do the same thing.

3 MR. HENRY: Sure.

4 CHAIRMAN WALLIS: That might be the more
5 realistic thing you should put in the cylinder.

6 MEMBER KRESS: Well, the building in some
7 ways you have to validate the concept he is trying to
8 put across.

9 MR. HENRY: And we'll go look for some
10 things.

11 I also apologize, I skipped over the first
12 HDR experiment very quickly, which is a large break
13 LOCA to get to CVTR, which is more meaningful. The
14 reason I skipped over HDR, not that it doesn't mean a
15 lot, it does. But as I showed you earlier on with 1
16 and 5 nodes, there was no benefit to looking at
17 circulation or turbulence or anything else. MAAP4 did
18 a good job with HDR. But the CVTR it stunk, so we
19 wanted to get right to the heart of the issue. And
20 the reason was we believe we were not correctly
21 representing the potential for energy transfer of the
22 break nodes.

23 I should also mention the way we do this
24 calculation of turbulence, etcetera, we get about the
25 right kind of circulation velocity that was observed

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1 in CVTR, which is a very difficult thing to measure.
2 They did have some -- I think they had turbine driven,
3 turbine flow meters sitting in the annulus. You get
4 down to the bottom of the containment, their velocity
5 is almost none existent. So it's only a couple of
6 nodes that see this enhanced energy transfer rate.

7 Okay. The reason I want to touch briefly
8 on these, D15 with CFP1 with this schematic -- which
9 was again, now, Graham, this is their schematic, not
10 mine.

11 CHAIRMAN WALLIS: I realize that. The
12 actual thing looks quite different.

13 MR. HENRY: Right. This looks like it's
14 a straight through thing, which is what its intent
15 was, but when you get to the real thing -- I guess we
16 already went past it.

17 CHAIRMAN WALLIS: Did they clear the
18 special building for this test?

19 MR. HENRY: Well, this is a whole series
20 of tests. This went on for a number of years.

21 CHAIRMAN WALLIS: -- a series of
22 compartments.

23 MR. HENRY: So this says, for those of you
24 that may not have seen this before, it's breaking your
25 node out of room 6, and then it goes through room 4 to

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1 room 8, then up to room 7 and into and out of 4.
2 These two roles are in line, and then into room 5 and
3 into room 9. So it looks all straightforward there.
4 But just so you appreciate the complexity of it, when
5 you look at the configuration, room 9 which is shown
6 here, includes all this annular region here, which is
7 there also, as well as this big hole in the middle
8 right here, which is this hole right there.

9 So here's room 6 and this is the break
10 pipe coming into it. And room 6 then flows through
11 room 4 here, the level of path, and this is room 4,
12 that little tiny thing, but it is the full height.
13 And goes into room 8. At room 8 goes up into room 7,
14 which is right above it. And room 7 over to room 5.
15 Here's 8 to 7. And back through 4 into room 5 and
16 then up to 9.

17 So it's a very complicated structure, but
18 it at least gives you an idea -- gives you a test of
19 how well you're doing representing the pressure
20 distribution in this particular test.

21 I also wanted to mention to you that there
22 are the two experiments; the test configuration of
23 course comes from the test report. The mass energy
24 releases and their uncertainties are characterized in
25 the individual test reports. So we used this.

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1 The additional information is, and this
2 got us in touch with Teja Kantzleiter who was the key
3 experimenter on this a long time ago. He was kind
4 enough to send an email that defined the inner
5 surfaces of the outer concrete walls, the thing that
6 defined room 9, to have a 1 millimeter surface
7 coating, that the inner walls had half a millimeter
8 surface coating on both sides. So all those floors
9 and ceilings, and that had a thermal conductivity of
10 about .3 watts per meter degree K. And that the
11 concrete itself, of course, is density to specific
12 heat, and thermal conductivity to the best they could
13 figure out was about 2 watts per meter degree Kelvin.

14 So the information that you have in front
15 of you -- and again to try and get the most
16 information to you, these are fairly small figures --
17 but this represents the transient pressurization for
18 the most realistic behavior in containment. And where
19 this says optimistic and pessimistic, the pessimistic
20 also has in it their maximum mass and energy release.
21 The maximum you can get from that uncertain analysis.
22 And the optimistic has the minimum here, whereas this
23 which is realistic is using what they thought was
24 their best estimate of how fast this came in the
25 containment. And, of course, these are measured with -

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1 - it's a two-phase flow and they're estimating it from
2 a momentum measured on the drag disk.

3 So this is the pressure in containment.
4 Temperatures for the three different things, again, in
5 these rooms close to the break. And this one is the
6 break room.

7 And this looks like a real mess here, like
8 a bunch of spaghetti, but what's shown, again, is this
9 generic thermal couple. So if we look at the solid
10 line, which is right here, as an example, that's the
11 most realistic representation, and this is that
12 generic thermal couple that we respond, and then right
13 above it here.

14 So, again, I don't know what their thermal
15 couples look like. I don't know if they're close to
16 any structure, etcetera, but at least we can see that
17 something is -- it's roughly a quarter of an inch
18 piece of structure holding the thermal couple in place
19 -- is one of the reasons these things could lag and
20 then the temperature could stay up. Because out in
21 here there is basically no motion going on. It's just
22 radiation, the environment, and natural circulation.
23 The blowdown's all over with back in here. Obviously
24 the blowdown is over with right there.

25 And this because we had -- we had talked

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1 before about measuring the pressure differences
2 throughout the containment, these are now compartment-
3 to-compartment pressure differences. So now from room
4 4 to room 7 this is the measured pressure difference.
5 Again, this is in terms of Pascals, of course, but
6 it's negative because of just the direction of the
7 flow. But this is from room 7 to room 8.

8 CHAIRMAN WALLIS: Well, the Pascal is
9 pretty small.

10 MR. HENRY: Right, these are fairly small
11 pressure differences.

12 This is 10 to the 4th here that we're
13 looking at --

14 CHAIRMAN WALLIS: Oh, there is a 10 to the
15 4th.

16 MR. HENRY: Right. That's still not a big
17 pressure difference.

18 And the other point I wanted to make to
19 you, this one that was measured to be zero because
20 there are things we still want to make sure that the
21 code comprehends but does not comprehend -- as I said
22 it's a work in progress -- this is room 4 to room 5.
23 And that's that small little room where the holes are
24 in line. So in essence we get streaming flow directly
25 from 5 through 4 into 7.

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1 CHAIRMAN WALLIS: And you don't deal with
2 streaming flow very well?

3 MR. HENRY: Right now the way the code
4 thinks of it, it goes from room 4 to 5 -- whichever
5 way this is -- and mixes and then it goes out. So it
6 needs a delta P to get out, that's why this is here.
7 But in essence it says there's no reason for me to
8 stop here.

9 MEMBER SCHROCK: Momentum never began and
10 got quieted down.

11 MR. HENRY: Right, and that is linear
12 momentum.

13 The only reason I wanted to show you that,
14 is there's another test, again, schematically now,
15 it's the same set of rooms but they're hooked together
16 differently. So now the break is into that little
17 room 4. Then it goes up and goes out those two holes,
18 which in 4 it was streaming through this way. Now it
19 goes out both ways into room 7, then into 8, into 5,
20 up into 9 and eventually comes around into room 6.

21 So this shows you, it's the same set of
22 figures now, but it's going into this little room here
23 4, so here's the pipe that's going into it, right
24 there. So it's this little square, but it is the full
25 height and this is a hatch on top which after the

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1 experiment was over we detected there was a leak path
2 here from this break room into 9. So, again, we
3 include that in the representation. But as it goes
4 into that room, then it goes out sideways right here
5 into room 7 and 5, whichever way it was. One of them
6 went down into, I think, 8. Yes. And 5 went upwards
7 into 9 here and eventually came around and filled 6
8 from down below.

9 CHAIRMAN WALLIS: So if you have one of
10 these horseshoe shaped rooms, or whatever, I don't
11 know how you describe it.

12 MR. HENRY: Yes. Half a ring.

13 CHAIRMAN WALLIS: Half a ring around it,
14 you have the same circulation velocity in all parts of
15 it in your model?

16 MR. HENRY: Yes, there's the same
17 turbulence velocity in each node.

18 CHAIRMAN WALLIS: It's a first
19 approximation, right?

20 MR. HENRY: Right. And the key thing here
21 is --

22 CHAIRMAN WALLIS: I think a realistic
23 model would actually say we'll model the annular ring
24 as one thing and the cap as another. Two nodes
25 instead of one. Even though it's one room, but it's

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1 so different.

2 MR. HENRY: Yes.

3 CHAIRMAN WALLIS: You're not going to do
4 that?

5 MR. HENRY: Yes, I can. I can.

6 And since you've made that point, I should
7 also tell you that clearly it represents this part of
8 this room 9, there's 2 nodes out here, 2 more nodes up
9 here --

10 CHAIRMAN WALLIS: There's all various
11 nodes that --

12 MR. HENRY: In the calculation, yes. But
13 I thought your point was in these also, because these
14 -- here's where the half thing is. You could
15 certainly do that.

16 One reason I thought this was also helpful
17 is the first was the linear progression through the
18 nodes. This is more like parallel flow paths.

19 And this is, again, the best estimate and
20 most realistic for pressurization in the break room 4,
21 and this is over the first 50 seconds, this is over
22 the first 1000 seconds. It didn't come through very
23 well, but that's 10 to the third here.

24 And then this is pressure difference from
25 room 4 to room 9 and the first 2.5 seconds. And the

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1 pressure history of room 9 over the first 50 seconds,
2 which is one of the nodes in the outside region.

3 This is -- 7 to 8 there's an example,
4 which is break room into the next largest room out.
5 Excuse me. 7 is the next largest room out and then 8
6 is the room it goes down into.

7 CHAIRMAN WALLIS: When you've got this
8 concrete -- this insulating concrete wall -- doesn't
9 the thermal resistance of the insulation actually end
10 up dominating rather than the condensation side?

11 MR. HENRY: The only thing it's insulating
12 is the paint. The paint matters --

13 CHAIRMAN WALLIS: I thought they said they
14 had some coating on this.

15 MR. HENRY: Well, that's the coating, so
16 it's like an epoxy coating. And that epoxy coating is
17 only on the walls which are going outside, and it's
18 there to be a sealant.

19 CHAIRMAN WALLIS: But it is a significant
20 heat transfer, isn't it?

21 MR. HENRY: Yes, it is. And it is prior
22 to calculation.

23 We don't have to go through this detail to
24 compare. We just want to make that you can see that
25 it's doing a reasonable job on compartment-to-

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1 compartment pressure history, transient pressurization
2 as well.

3 When we look at all these things, whatever
4 those various things that are happening in a point of
5 time, whether it's natural convection, forced
6 convection, etcetera, the uncertainty boundaries you
7 have for each of those models that came from separate
8 effects tests were the same in all cases. So you're
9 not tooting one of those parameters for a specific
10 test, and different tests.

11 The part which gets into uncertainties
12 gets to a short set of propriety slides, so I don't
13 know if we need to -- we can be out of here probably
14 about 15 minutes.

15 CHAIRMAN WALLIS: Well, you said this was
16 work in progress, so we're not -- you don't have to
17 give an evaluation of the MAAP in its final form.

18 MR. HENRY: No.

19 CHAIRMAN WALLIS: This is just to let us
20 know that you're doing it and get the feedback.

21 MR. HENRY: Get the feedback; I certainly
22 got plenty of that, and I appreciate it. And if
23 there's any experiments that you think that we should
24 have in this mix that we have overlooked --

25 CHAIRMAN WALLIS: When will this come up

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1 in its final form?

2 MR. HENRY: We have a deadline to submit
3 to the staff in January, which is next year.

4 CHAIRMAN WALLIS: Fairly soon?

5 MR. HENRY: Fairly soon, yes. And then
6 the staff has heard from us twice on this; once in
7 June and yesterday to keep them updated on our
8 approach by the experiments. We want to make sure
9 that when it comes to the technical basis that we're
10 looking at things that you guys think, that they're
11 the driving force -- here's how I understand it -- it
12 must be doing, what the containment must be doing.

13 CHAIRMAN WALLIS: So you expect to come to
14 us again fairly soon with a finished product?

15 MEMBER KRESS: The staff review.

16 CHAIRMAN WALLIS: Or the staff has to
17 decide you want to do that.

18 MR. HENRY: Right.

19 CHAIRMAN WALLIS: They may not want you to
20 see us at all.

21 MR. HENRY: That's between you guys and
22 the staff. Certainly if you want us to come talk
23 about it, we're at your disposal to talk about it.

24 CHAIRMAN WALLIS: Well, it looks like a
25 considerable step forward in the modeling of

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1 containment. Up there on the right-hand page
2 dovetails with industry.

3 MR. HENRY: Appreciate that.

4 MEMBER KRESS: Of course, the staff, they
5 plan, I guess, I don't know, access, too.

6 CHAIRMAN WALLIS: And I think also, since
7 this seems to be key for you, maybe that can be used
8 for these outbreaks.

9 MR. HENRY: Yes, we're particularly keen
10 on making sure that once we have a model that goes
11 with the experiments, that all that knowledge that's
12 associated with the experiments gets transferred into
13 their --

14 CHAIRMAN WALLIS: I think the outbreaks
15 are going to come to ACRS anyway.

16 MR. HENRY: Right.

17 MEMBER KRESS: Do you view this as saying
18 that in old code and this is a way to utilize that
19 margin by getting rid of some of those conservatisms?

20 MR. HENRY: That's exactly right, Tom.
21 But one of the ways that we would say that is that the
22 top suppliers do the right things for the right
23 reasons.

24 CHAIRMAN WALLIS: This margin isn't the
25 real margin, it's a margin of something in theoretical

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1 equations, because you didn't know what was going on,
2 you had to have a -- when you know more you don't need
3 such a big margin. You probably mustn't get the
4 impression that they're somehow producing a safety
5 margin by producing an uncertainty which enables us to
6 make a better decision.

7 MEMBER KRESS: It's a some kind of level
8 of safety. I think you are reducing the margin,
9 because we're going to uprate the power and we're
10 going to put more stuff in, we are reducing the
11 margin. This just tells you you've got enough margin
12 there that you can do that.

13 CHAIRMAN WALLIS: I don't suppose you can
14 tell us what you mean by margin?

15 MEMBER KRESS: The difference between the
16 pressure and the design limit. The actual pressure
17 you get for design limit.

18 CHAIRMAN WALLIS: Actual pressure, not
19 just pressure.

20 So do you move on to the staff, then, or
21 do you want to say a little bit about this?

22 MR. HENRY: Instead of passing out the
23 proprietary slides, let me just say what's really in,
24 because that how we treat the uncertainties, what we
25 will eventually bring back to you. And what's

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1 inherent in the process is that we believe that the
2 way you get closure is that you test against -- you
3 develop your uncertainties with separate effects
4 tests, and you work to these large scale tests for
5 closure. And by closure we're looking for the
6 realistic and the pessimistic and optimistic and we
7 try to stay away from conservative, because sometimes
8 we don't know what that is, given the attribute that
9 you're investigating. And we look to see if we can
10 bracket the data, not bound the data.

11 And once we're able to bracket the data,
12 we feel we have a 100 percent and 10 percent kind of
13 understanding of what's driving the bus and all these
14 analyses and also in the experiments. That's really
15 what's in the proprietary part of how we establish
16 that closure.

17 CHAIRMAN WALLIS: Is this congruent with
18 the CSAU?

19 MR. HENRY: Well, unfortunately I was part
20 of that once upon a time. It is consistent with that,
21 but -- and I was part of it when it was for direct
22 containment heating. And the only thing that's
23 different here from that is I tried to simplify it in
24 my own mind to fewer steps. But I also established
25 closure back to, say, you think you got this model,

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1 are you able to bracket the data with the model, given
2 that uncertainties that comes from something else to
3 allow you to understand the detailed physics with the
4 processes that you're working or you just globally
5 bound it? And we would prefer to be able to bracket
6 it. These guys take it in-house, we want them to have
7 something that the engineers know where it all came
8 from.

9 CHAIRMAN WALLIS: You talk about the 95
10 percentile dosage, or just bracket?

11 MR. HENRY: We prefer to deal with just
12 bracket, but you certainly could take this to a
13 distribution. If you can do it with just bracketing,
14 well again the uncertainty bounds for individual
15 physics come from things like we saw with separate
16 effects tests. If you could live with that, you
17 shouldn't have to do anymore. If you want to look at
18 a distribution, you got to go back to those and define
19 the distribution and you put it into a Monte Carlo
20 kind of approach at a plant.

21 CHAIRMAN WALLIS: Do you have separate
22 effects tests of these circulation velocities?

23 MR. HENRY: You know I'm going to go look
24 for them. For the CFD calculations of flow into a
25 closed node, right?

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1 MEMBER KRESS: This CVTR --

2 MR. HENRY: If I knew, I could find that
3 book called two phased flow, but I don't remember
4 those being in there.

5 MEMBER KRESS: Your CVTR containment
6 model, are there virtual boundaries in it as well as -
7 -

8 MR. HENRY: Yes. I'm sorry, Tom. I meant
9 to make that point when we were there.

10 MEMBER KRESS: Yes. I thought that was
11 the one test where you really had --

12 MR. HENRY: I appreciate that. I'm going
13 to show you a couple. When we get to the HDR there is
14 a virtual boundary, but there's so many nodes, so many
15 rooms in the containment that you need to represent
16 all these -- or least virtually at least half of
17 these. And there's a boundary up here because at
18 E11.2 there was stratification.

19 When we get to CVTR, which I'm glad you
20 made that point, because those virtual boundaries are
21 here, here, here, here and this is treated as a
22 virtual boundary because I can't find out what the
23 grating was as you walk down. They're not very
24 specific about it and all the pictures are above the
25 operating deck. But this definitely is. These are

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1 boundaries here and that is.

2 These are not -- obviously as you can see,
3 these aren't annular rings, these are just slices
4 through the containment. So, this is half of a
5 cylinder and this is half of a cylinder here.

6 MEMBER KRESS: How does MAAP deal with
7 creating stratification when you got light gas and a
8 heavy gas.

9 MR. HENRY: You can accumulate gas in the
10 node just because it eventually gets transferred up
11 and you slow down the condensation and slow down,
12 therefore, the energy transfer rate. Or you could
13 have it come in as it does in HDR at this kind of
14 location and it has a plume model that evaluates its
15 ability to mix if all this is really just relatively
16 quiescent system. Mix and rise to the top, but if
17 it's not completely mixed by the time it gets to the
18 top, it accumulates. And those virtual boundaries,
19 and even when we get to the plume model, that
20 entrainment rate goes back to the Recue Spalding
21 entrainment model, and then the kind of entrainment
22 coefficient that we use is defined by their model is
23 0.1, which is basically what they say to look at real
24 tiny gas-to-gas. But if you go look at volcanoes it's
25 roughly 0.1. It's the best estimate of the

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1 entrainment rate of surrounding material.

2 Now we have bounding values on the other
3 side of it that are pessimistic and optimistic,
4 whichever the influence of the specific attribute that
5 you're looking at.

6 CHAIRMAN WALLIS: At 0.1 it's like you're
7 mixing when you get a plume that produces --

8 MR. HENRY: That's exactly what it is.
9 That's where it all came from. If we got something
10 that's an extremely powerful jet what's it doing.

11 MEMBER KRESS: In these containments, both
12 of them have sprays?

13 MR. HENRY: Yes.

14 MEMBER KRESS: If those are working all of
15 this gets overwhelmed by the sprays. The sprays do
16 everything. So this is only if the sprays are assumed
17 not to work?

18 MR. HENRY: No, the sprays don't always do
19 everything. But they eventually get into plant
20 specific analysis. But main steam line breaks, the
21 sprays do part of it but it's still pressurizing. The
22 only thing that turns around eventually is the M&E
23 stops.

24 MEMBER KRESS: What is the time for the
25 sprays?

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1 MR. HENRY: The typical time for sprays is
2 anywhere from 45 seconds to a minute. But for main
3 steam line breaks, the M&E may last for 100, 200
4 seconds.

5 MEMBER KRESS: -- the time that you get
6 into the recirculating mode.

7 MR. HENRY: Well, we're still in the
8 injection mode, but it's still the sprays are not
9 necessarily turning the pressure around, they're just
10 slowing down its rate of pressurization. But the
11 spray momentum is also part of this whole thing here.

12 CHAIRMAN WALLIS: I understand some folks
13 have to go to the airport.

14 MR. HENRY: I appreciate that, Mr.
15 Chairman.

16 CHAIRMAN WALLIS: I don't want you to go
17 to the airport with too much momentum.

18 MR. HENRY: I'm going to spin out of here.
19 I apologize, but we do have to leave because I do want
20 to -- I will touch base with Rich, but the people from
21 the sites will be here also.

22 CHAIRMAN WALLIS: The people from the
23 sites are going to be here? I thought they were going
24 to leave first.

25 MR. HENRY: Excuse me. Tom Beach has to

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1 leave.

2 Thank you for all your consideration.

3 CHAIRMAN WALLIS: That was very
4 interesting presentation and interaction.

5 MR. HENRY: I enjoyed it.

6 MR. LOBEL: My name is Richard Lobel, I'm
7 with the Plant Systems Branch in NRR I didn't come
8 prepared to make a presentation because the submittal
9 hasn't been made. There was question about how we
10 were going to proceed with the review, and we had a
11 short preliminary meeting this morning to talk about
12 that.

13 The review will be done in conjunction
14 with Research. In fact the Office of Research will do
15 most of the review because they, we felt, had the
16 expertise and the others and also had the resources to
17 do this. We wanted to make sure that we could do a
18 very thorough complete review of this, and the
19 expertise that's available in Research helps us do
20 this.

21 We will do contained calculations. We will
22 ask probably both licensees for the input to their
23 specific calculation in one form or another, whatever
24 is convenient for them and for us to use. When we do
25 an audit, that's usually how we work things out. We

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1 have a conference call and ask them to submit it in
2 whatever form is convenient for the people here who
3 are going to be doing the calculations.

4 We also will be doing a little more of the
5 study of the uncertainties in the containment
6 experimental data. A lot of work has already been
7 done by Research, and that was another reason for
8 getting the Office of Research involved in what
9 normally would be just an NRR review. Because they
10 have a lot of expertise from work they've done in the
11 development of the contained code and comparing with
12 experimental data. And since Bob Henry didn't go into
13 it very much because a lot of that was the proprietary
14 part, but his method depends a lot on the use of
15 experimental data in the calculation of procedure
16 itself. And so we wanted to look in more detail at
17 the experimental uncertainty, too.

18 We haven't thought about it in a whole lot
19 more detail than that yet. We plan to do an
20 aggressive review when we get the submittal.

21 The plant specific submittals aren't due
22 until May. We're going to try to get the plant
23 specific information before the submittals are made if
24 that's possible so that we can start doing the
25 calculations earlier and identify the significant

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1 issues as soon as we can.

2 That's about it.

3 MEMBER LEITCH: Have you used the MAAP5
4 before? In other words, are we looking at -- there's
5 two things we talked about was basically the change
6 from MAAP4 to MAAP5 and also the nodal concept. Has
7 the change from 4 to 5 been reviewed previously?

8 MR. LOBEL: No, I don't think we even have
9 MAAP5 in-house yet. They will be submitting that at
10 the same time. I understand from talking to Bob Henry
11 just before this session started that they will be
12 giving us a copy of that at the same time they make
13 the submittal.

14 MEMBER LEITCH: I see.

15 CHAIRMAN WALLIS: When you say a copy, do
16 you mean a copy of the -- the modern copy of the code
17 or you mean the documentation?

18 MR. LOBEL: No, the documentation.
19 Documentation.

20 CHAIRMAN WALLIS: Do you actually a
21 running copy of the code in electronic form?

22 MR. LOBEL: We may, and we may use that,
23 but we'll probably -- the plan is now to concentrate
24 more on using contained and comparing with their
25 analysis and let them run --

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1 CHAIRMAN WALLIS: with other codes the
2 policy has been to endeavor to get an electronic copy
3 of the source code so you can run it.

4 MR. LOBEL: Well, we may do that and, you
5 know, we're certainly interested in your
6 recommendations and suggestions.

7 CHAIRMAN WALLIS: Well, we definitely
8 thought it was a good idea.

9 MEMBER KRESS: Well, this may be an
10 exception. MAAP I think belongs to EPRI and it's not
11 the licensee's code. It's not their privy to even
12 give it to the staff I don't think --

13 MR. LOBEL: But on the other hand, if we
14 really wanted that and considered that part of the
15 review, the licensees would have to try to accommodate
16 that as part of the review.

17 Let me say, a lot of this isn't going to
18 be a detailed review of MAAP. What we're going to try
19 to do more is review the method, because MAAP is a lot
20 more than just the containment. And what we were
21 going to try to do is -- the thinking is in NRR that
22 there's a couple of different options for the review
23 of MAAP that's still being talked about, as I
24 understand, in the office. And what we would do is
25 what we've been calling option one, which is look at

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1 the models that are pertinent to the containment and
2 see that they're reasonable but concentrate mostly on
3 doing an independent analysis and a review of the
4 methods that are used in this procedure, which is a
5 lot more than just the code. It's their use of
6 uncertainty and experimental results. You saw that a
7 little of that from the pictures he was showing.

8 So, it's not going -- the plan was not
9 going to have this be much of a review of MAAP itself
10 except the specific containment models that are
11 involved and to concentrate mostly on audit
12 calculations and correlations, and that.

13 MEMBER KRESS: I presume this is a changed
14 licensing basis. Does that open the door for all
15 other PWRs to come in and do the same thing?

16 MR. LOBEL: It could, it depends on the
17 results of the review. What we've been asked to do
18 now is just to do the review of a general report and
19 then two plant specific analyses. But there was talk
20 at the June meeting about maybe having them come in
21 with a topic report that applied to more than just the
22 two plants. There wasn't any talk of that yesterday,
23 so I don't know what they're planning to do for that.

24 The broader the review is now, the easier
25 it will be on us in the future. We won't have to keep

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1 going through this for four loop plants and ice
2 condensers and what else it may apply to.

3 CHAIRMAN WALLIS: Have you reviewed their
4 momentum equation formulation?

5 MR. LOBEL: No.

6 CHAIRMAN WALLIS: You've heard the
7 discussion here?

8 MR. LOBEL: Yes.

9 CHAIRMAN WALLIS: It would be unfortunate
10 if we had a code which seemed to work in comparison
11 with data but which had somewhat bizarre
12 interpretations of momentum balances.

13 MR. BOEHNERT: Extraordinary.

14 CHAIRMAN WALLIS: Yes. I'm sure Bob Henry
15 is smart enough to fix that up, but what appeared here
16 looked very strange. Maybe we're just being stupid.
17 It just looked very strange. We don't want to get
18 into a situation where something seems to work but the
19 theoretical basis justification doesn't really stand
20 up.

21 MR. LOBEL: Well, I think that we all can
22 agree that the phenomena is there certainly --

23 CHAIRMAN WALLIS: For other reasons than
24 the way that the math is actually sort of encoded in
25 the momentum equation. Maybe that the phenomena going

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1 on which caused it are well represented by the way
2 things come together. And then maybe then it's up to
3 the person to bring together the documentation to give
4 a technically believable justification then for what
5 they do.

6 MR. LOBEL: The philosophy we've used in
7 other reviews is to try to not get in a position that
8 you were just talking about where the code may be
9 predicting data but have something in it that isn't
10 physically real.

11 CHAIRMAN WALLIS: That's the last thing
12 ACRS wants to have to fight regarding the --

13 MR. LOBEL: I guess we've already answered
14 this a little bit, I thought it would be worthwhile
15 for them to come and give you a presentation because
16 this is so new. It's a completely different approach
17 than what's in the standard review plan now for the
18 most part. We didn't have any plans to ask them to
19 come back again, but it sounds like to hear from them
20 after a point where we've gotten into the review
21 ourselves, so maybe a presentation on what they've
22 done and what we think of it after a round of
23 questions.

24 CHAIRMAN WALLIS: Then you've got the
25 submittal. They're going to have much more detail

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1 about the technical basis because, again, what we've
2 seen so far doesn't really explain it well enough.

3 MR. LOBEL: Yes. I'll share that with you
4 if you want to see the submittal when it comes in.

5 CHAIRMAN WALLIS: Does the committee have
6 some other points at this time?

7 So what we need is just to -- the full
8 committee meeting we need an oral presentation --

9 MR. BOEHNERT: We make a subcommittee
10 report, or you're scheduled to make a report.

11 CHAIRMAN WALLIS: -- progress and that we
12 have some questions.

13 MR. BOEHNERT: Yes.

14 CHAIRMAN WALLIS: And I don't think we
15 need much time with the full committee.

16 MR. BOEHNERT: I think we've got a half
17 hour scheduled.

18 CHAIRMAN WALLIS: All right. We're going
19 to make it on time unless Professor Schrock has a lot
20 of questions.

21 MEMBER SCHROCK: No, I'm going to my taxi.

22 MEMBER KRESS: Now we know how to fix it
23 so Virgil doesn't have any comments.

24 CHAIRMAN WALLIS: Any reason why I should
25 not recess -- okay. I close the meeting, is that

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1 okay.

2 MR. BOEHNERT: That's fine.

3 (Whereupon, at 5:27 p.m. the meeting was
4 adjourned.)

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

Name of Proceeding: ACRS Thermal-Hydraulic

Phenomena Subcommittee

Docket Number: (Not Applicable)

Location: Rockville, Maryland

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



Debra Wilensky
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