1 Did you -- in terms of the distributions,
2 the inputs and the various parameters and in terms of
3 determining the biases, by looking at the
4 relationships between it and various separate effects
5 and stuff?
6 You looked pretty careful at that stuff,
7 and to me, if they got that right then, you know, this
8 other stuff about comparing with the codes really
9 doesn't matter a whole lot, as long as they got that
10 part right and then did the statistics right to end up
11 getting their 95/95.
12 MR. LANDRY: That's right. And Yuri's not
13 here to speak for himself, but in the review that Yuri
14 did a number of questions were asked others, specific
15 points. And through the RAIs and responses Yuri's
16 conclusion was, what they're doing is right.
17 And where he had the difference with them
18 was when he got down to the bottom and was saying
19 whether 59 cases constituted a uni-variate analysis or
20 a tri-variate analysis. And that was where the
21 disagreement arose.
22 He throughout his review and at the
23 conclusion was not indicating any problem with what
24 they had done in assessing bias, whether the
25 distributions were proper or improper. Getting down

1 to the bottom line, yes, they've done an assessment of
2 overall uncertainty, and overall uncertainty and PCT
3 correctly.
4 His difference with them was over whether
5 this applied as a tri-variate analysis or not. So
6 that's the long answer to your question. I think that
7 we did not have problems with what they did in their
8 overall uncertainty analysis, including the biases,
9 this looking at scaling, looking at assessment of
10 uncertainty.
11 It was only at the very bottom end, bottom
12 line that they had a disagreement. So we find the
13 rest of it acceptable.
14 DR. KRESS: Okay.
15 DR. RANSOM: Did you agree to show that
16 one? Why don't you show it? I think it really, to
17 me, summed up.
18 CHAIRMAN WALLIS: I think we need to have
19 you back, then, Ralph, when we see this plot and don't
20 go away. I have no idea what I'm going to be seeing.
21 DR. NUTT: And that's good, since I did it
22 for you.
23 DR. RANSOM: Well, there's a 50/50
24 probability that you'll like it or you won't like it.
25 CHAIRMAN WALLIS: Well, I'm glad you give

1 me credit for being fair.

2 DR. NUTT: Be nice if these were 95/95.

3 DR. KRESS: Now, that's an interesting

4 curve.

5 CHAIRMAN WALLIS: Oh, a LOFT comparison.

6 Good.

7 DR. NUTT: This is LOFT comparisons.

8 CHAIRMAN WALLIS: All right.

9 DR. NUTT: And this is actually an old

10 slide, but I put this together, and I'm going to put

11 some disclaimers on the front of it. It's never been

12 QA'd. So somebody may find that it isn't exactly what

13 I put up there.

14 .And so I wouldn't take copies and show it

15 around too much. And in fact, really, it's an

16 extension of the issue of checking the separate

17 affects results versus the integral effects.

18 Remember, we said everything using separate effects.

19 All the uncertainties were set. All the

20 biases were set. We had originally run cases against

21 some integral effects test for the purposes of finding

22 out what models we should be using. So then we went

23 back to the integral effects test.

24 We ran the cases that, you know, the deck

25 -- the code to compare it, and then we stuck these

1 unbiases in and took the biases out of the code and
2 ran it against it and got good averages. Well, what
3 it got -- it got me started thinking about what you
4 could do that maybe was a little bit more.
5 And I think I've discussed this before
6 with you, so it's not new. I said, you know, you
7 could basically go in and say, oh, I'm going to do --
8 I'm going to treat that test just like a large break
9 LOCA calculation.
10 I'm going to go in and I'm going to run 59
11 cases. I'm going to randomly input them, you know,
12 all the uncertainties in the and I'm going to get a
13 scatter on it.
14 CHAIRMAN WALLIS: I've seen this from some
15 other source. So maybe it's the same as yours.
16 DR. NUTT: It could be the same.
17 CHAIRMAN WALLIS: Someone else got hold of
18 your slide, maybe.
19 DR. NUTT: Oh, you know, I'm --
20 CHAIRMAN WALLIS: Maybe someone else --
21 DR. RANSOM: Let's take a look at it and
22 see.
23 CHAIRMAN WALLIS: Someone else
24 independently.
25 DR. NUTT: IN case, you know --

1 DR. BANERJEE: Bill, can you just --

2 DR. NUTT: Yes, I could, as a matter of

3 fact. So the other slide was not -- you didn't see

4 that too well, but this one is -- I picked ultimate

5 light (phonetic) and FPLB one. The other two have

6 that quench in them and we don't come close to that.

7 So I wasn't going to use that as a

8 statistical basis because I think there's just --

9 there's -- I don't like the cases. I took the bias

10 and uncertainties that were present in the separate

11 text -- separate affects test assessments.

12 I included the power and peaking

13 uncertainties. I plotted the maximum, the minimum and

14 the average of all these 59 cases that I got, of the

15 PCT node temperatures at each time step, and I plotted

16 the maximum, minimum average of the measured

17 temperatures.

18 And this is where I went through and got

19 this 20 some degree windage effect, but I think it was

20 something like a 21-degree F adjustment they wanted to

21 put on them, plus a 29-degree uncertainty on it. So

22 I stuck that into the data.

23 And the S-RELAP5 -- okay. The conclusion

24 is that measurements with the uncertainties are

25 bounded over most of the range. I haven't looked at

1 this in some time. I'm not sure what that next to the
2 bullet was. But here's some of the bottom line on it.
3 If I take the data and I put the range on
4 it and I plot the data -- watch this here -- now, I
5 take the code and of these 59 cases that we run here's
6 the minimum temperature that would have traced through
7 this and here's the maximum temperature.
8 The model now has completely encompassed
9 the data, and that's what you'd like to see, right?
10 You'd like to see that your prediction that you claim,
11 you know, has the range to cover everything, should
12 very clearly cover the test cases.
13 And this is -- this particular one I think
14 we showed you something very equivalent to this, which
15 was the -- this is the mean value.
16 DR. RANSOM: That would be the realistic
17 calculation.
18 DR. NUTT: That would sort of be the
19 realistic calculation.
20 CHAIRMAN WALLIS: So you have a kind of
21 two-sided --
22 DR. NUTT: It's not truly two-sided
23 because it's --
24 CHAIRMAN WALLIS: It's sawed off. It's
25 sawed off.

1 DR. NUTT: Right, because there's 59
2 cases, right.
3 CHAIRMAN WALLIS: But it is up to some
4 level, I mean, it's not like 95/95.
5 DR. NUTT: Right.
6 CHAIRMAN WALLIS: It's 92 --
7 DR. NUTT: It's 9X, 9X, right, something
8 like that.
9 DR. RANSOM: Why is that?
10 CHAIRMAN WALLIS: Because there are two
11 outputs, not one.
12 DR. NUTT: Right.
13 DR. RANSOM: Two what?
14 CHAIRMAN WALLIS: There are two outputs,
15 not one. There's a top and a bottom.
16 DR. KRESS: Each end; each end; top and
17 bottom.
18 DR. RANSOM: Oh.
19 DR. NUTT: The upper and lower limit. I'm
20 taking both in upper and lower limit. I can't claim
21 that -- I could claim this is an upper, but I can't
22 claim that's a lower.
23 CHAIRMAN WALLIS: We saw something almost
24 identical to this in Germany three weeks ago.
25 DR. NUTT: Well, I did this a long time

1 ago, so I --

2 CHAIRMAN WALLIS: I'm not saying that.

3 I'm just saying, probably at some point --

4 DR. NUTT: No, I'm being --

5 CHAIRMAN WALLIS: -- probably somebody

6 else who did it. I'm not sure that it's you.

7 DR. RANSOM: But that to me would tell a

8 lot more about what a code is capable of doing, I

9 think.

10 CHAIRMAN WALLIS: That's much better than

11 just looking at the wiggles and the dots.

12 DR. RANSOM: Yes.

13 CHAIRMAN WALLIS: Yes.

14 DR. NUTT: And this is part of the tilt.

15 Show is another one again. This is LP-LB-1. And you

16 get a very similar result. As you see, this is coming

17 close to having a problem with the code. I mean, if

18 one were to find -- if you were to go through this

19 whole process, set up a range of uncertainties that

20 you claimed would characterize the whole thing and if

21 that range somehow or another found data points when

22 you stretched them both setting outside; that is, if

23 you were to get one of these cute little shapes,

24 hourglasses, sitting completely outside the bounds of

25 this, I think that would be a good indication that you

1 had a problem. You really weren't doing the job.

2 But what we've done here is we've very --

3 you know -- except for the quench again, which we

4 don't quench as well --

5 DR. KRESS: That's quench right there.

6 DR. NUTT: Right. We do not quench as

7 well. I think that's true, you know, we don't quench

8 as well. But over all this range, it's all inside

9 that.

10 CHAIRMAN WALLIS: Except for the very

11 first point.

12 DR. NUTT: Yes. And I'm not sure why that

13 doesn't fit in, but it's closer, see. See, even so,

14 if we --

15 CHAIRMAN WALLIS: If you're down below it

16 could be that you got some conservatism in there

17 somewhere or something. Is that what it would be?

18 DR. NUTT: And if I'd worked on this. I

19 simply ran these cases just as an example.

20 CHAIRMAN WALLIS: Yes.

21 DR. NUTT: So if I were to work on them

22 longer, the assumption is, of course, the longer you

23 work on things the closer you get. You know that,

24 especially when you know the answer, right.

25 CHAIRMAN WALLIS: That's not necessarily

1 true.

2 DR. KRESS: No. No.

3 DR. NUTT: No, I know that. I've had that

4 happen.

5 DR. BANERJEE: The uncertainty on the

6 LOFT, was that as constant as -- sorry. Was it like

7 this narrow band or did it change?

8 DR. NUTT: They just -- all I got was 21

9 degrees -- plus 21 degrees with a 20 -- plus-minus 29

10 degree on it. So basically, this is -- these points

11 are loft measurements with 21 added and then 29 down,

12 20 -- so it's --

13 DR. BANERJEE: I seem to remember that the

14 early trial part was uncertain, but maybe we never

15 quantified it and made it different.

16 DR. NUTT: I took -- and it's probably

17 true. There's probably a detailed write-up of how

18 these things happen. And what I took was essentially

19 the synopsis, sort of like the executive summary, 21

20 degrees, plus-minus 29 is what we were using.

21 And I'm sure that I've seen in there that

22 there were different conditions or transient effects.

23 There's a transient uncertainty, for instance, you

24 apply to these things because of response times, and

25 there are sheer steady state measurement

1 uncertainties, and I think all I took was the steady
2 state measurement uncertainty.
3 DR. KRESS: Now, why would you conclude
4 that the spread on the measurements right outside your
5 bounds? That the test should have been better?
6 DR. NUTT: I think so, yes. And I would
7 also -- it actually wouldn't be a problem here. It's
8 more of a problem if I manage to conclude the answer
9 more accurately than the original set of data, right,
10 it'd be a bigger problem, because this could be a back
11 -- you know -- this could be a much more difficult
12 case to do and the uncertainty on the data might even
13 be higher here.
14 DR. KRESS: What would you call the peak
15 clad picture on that? One way out there on the 80-
16 second time frame?
17 DR. NUTT: Yes. I think it does. It
18 does.
19 DR. KRESS: But you know there's something
20 wrong with the code out there, so you could discount
21 it.
22 DR. NUTT: It didn't quench.
23 DR. KRESS: You could discount that
24 because you know it would never get there because your
25 quench model's not very good.

1 DR. NUTT: On this, yes. On this
2 particular one it does -- you don't usually get this -
3 - this kind of bothered me a little. And this is not
4 a single node. This is -- there's a node out here
5 that was wandering along that I think it was fairly
6 high up in the core and it managed to not quench, and
7 pretty soon it crossed over and it became a dominant
8 curve, so.
9 CHAIRMAN WALLIS: It's disconcerting if
10 that were actually the number which you calculated for
11 a LOCA and that's what you've quoted as your peak clad
12 temperature out there.
13 DR. KRESS: Yes, but you wouldn't --
14 DR. NUTT: Yes. I think that one of the
15 caveats that we haven't stuck in this whole thing is
16 that when you're done you should probably look at your
17 cases and see if they all make some sense.
18 And I think there is a plotting
19 requirement so that one wants to see that they make
20 some sense when you're done.
21 DR. RANSOM: Let me clarify one thing.
22 You're saying those curves are not for a single point.
23 DR. NUTT: No, they're not.
24 DR. RANSOM: Or the envelope. Is that
25 right?

1 DR. NUTT: At each time point I picked the
2 maximum temperature and the minimum temperature.
3 DR. RANSOM: What about the mean? Is it
4 a again --
5 DR. NUTT: It's just the middle
6 temperature in the range.
7 DR. RANSOM: Okay. And data is a single
8 thermocouple?
9 DR. NUTT: Data is a single thermocouple.
10 It's not -- you know -- it's representative. I mean,
11 we would call this PCT, right?
12 DR. RANSOM: Right.
13 DR. NUTT: And this was the node that had
14 PCT.
15 CHAIRMAN WALLIS: If you employed other
16 nodes they would be in there somewhere, too?
17 DR. NUTT: Yes.
18 CHAIRMAN WALLIS: Have you see it plot the
19 other nodes?
20 DR. RANSOM: Well, his curves are a
21 combination of nodes, apparently. They can switch the
22 nodes, you know, as you're going along, because it's
23 always going to follow the --
24 DR. NUTT: And to tell you the -- I hadn't
25 thought of that point. And to make a comparable plot

1 I should have gone through and I should have found
2 here -- here I should have found the highest
3 temperature. I shouldn't have accepted this.
4 CHAIRMAN WALLIS: Right.
5 DR. NUTT: I should have asked for the
6 very highest temperature right here.
7 CHAIRMAN WALLIS: Right.
8 DR. NUTT: And I should have asked for the
9 highest temperature here.
10 CHAIRMAN WALLIS: Right. I thought that's
11 what you did, but you didn't do that.
12 DR. NUTT: No, I didn't. I just took the
13 PCT node and did this. So it doesn't quite compare.
14 But the interesting thing is -- and I have sort of
15 discussed this with us presenting this particular
16 approach -- but we did conclude that what you finally
17 get when you look at it is the answer that, yes, there
18 is enough uncertainty in the code, and yes, it does
19 fit around the whole thing.
20 And these nominal ones are the -- you know
21 -- the nominal biases actually did a pretty good job
22 of fitting the --
23 CHAIRMAN WALLIS: And also, this
24 uncertainty is figured into the decision-making by the
25 NRC. So it's not as if you're just showing that you

1 can envelop the data. It's just that it's actually
2 that that statistic -- that their choice of that 59
3 runs is actually what the NRC's going to use.
4 DR. NUTT: That's the one that we're
5 actually going to see.
6 CHAIRMAN WALLIS: Right.
7 MR. CARUSO: Yes.
8 CHAIRMAN WALLIS: This seems much better,
9 I think, than the old days where this stuff wasn't
10 quantified, and I would think you'd want to make more
11 of that and maybe show that that's the kind of level,
12 at least, that you expect in the future.
13 DR. KRESS: Do you have any ideas on how
14 to approach this question of some sort of formal
15 determination of looking at the oxidation levels and
16 saying there's some -- what the probability is, as
17 you've found the 95 percent on them, based on just the
18 59 runs? Do you have any ideas on how to approach
19 that?
20 DR. NUTT: Oh, in terms of getting --
21 quantifying it?
22 DR. KRESS: In terms of satisfying Yuri's
23 principle, you know. Clearly, the distance away is a
24 good indicator.
25 DR. NUTT: And we could quantify it, and

1 we can quantify the distance away. I think the one
2 thing we can do is go in and quantify the distance
3 away based on -- and we haven't discussed it so this
4 is purely a thought, okay, on this.
5 I think we can quantify the distance away
6 and we can do that by looking at the samples, doing
7 standard statistical tests using T-tests or --
8 DR. KRESS: Yes, that's what I --
9 DR. NUTT: -- I guess it's actually a chi-
10 squared test on it. What I'll basically do is go use
11 a DBO and one-sided upper tolerance and run out and
12 find out when it goes. And basically, I'll take the
13 DBO intolerance out until we find that it's gone to
14 one. I mean, there's a 100 percent probability --
15 CHAIRMAN WALLIS: I think you can do that.
16 DR. NUTT: And we haven't reached it yet.
17 And if we're -- and I think we can do that before
18 we're a third of the way the limit.
19 CHAIRMAN WALLIS: Yes.
20 DR. NUTT: Which then says that given
21 standard -- if I just looked at this -- these data,
22 right, without referring to anything else, if I had
23 just looked at these data and did the standard
24 classical processing of this data, and I pulled out
25 what the probability was that you would have violated

1 it, I'd conclude that with 100 percent confidence, you
2 know, it's virtually --
3 DR. KRESS: And you haven't --
4 DR. NUTT: -- you can get very close to
5 100/100 on that particular one, and that sight, that
6 number. And I'm thinking about that approach and I'm
7 going to discuss it, you know, but that's the first
8 one.
9 CHAIRMAN WALLIS: If everyone was showing
10 you --
11 DR. KRESS: That would be -- that would,
12 you know, it would put on documentation what Yuri's
13 problem is, what is meant by forced statistical
14 analysis. And it would only be important for people
15 who might get closer.
16 DR. NUTT: Right. Yes.
17 DR. KRESS: But those things might have
18 been closer to somebody else.
19 DR. NUTT: And I think it -- and it
20 doesn't address Yuri's concern about the fact that we
21 take the 59 points and then we take sort of the blind
22 approach, and then we take -- we look at what we got
23 as an answer and then change our conclusions a little.
24 I think that's legitimate to do it.
25 I think it's formalistically may be

1 offensive to him, but I think in terms of reality, I
2 think the reality is there and I think it's --
3 CHAIRMAN WALLIS: You know -- so how you
4 evaluate sort of three out, but it's going to be
5 influenced by how these are related to each other.
6 DR. NUTT: Yes.
7 CHAIRMAN WALLIS: If you can learn
8 something about that, then you've got -- I think
9 you've got a -- at the outset you -- say you run 824,
10 but as you learn that these things are correlated and
11 that these are way away from the limit.
12 DR. NUTT: You're actually at the --
13 CHAIRMAN WALLIS: You can do some more
14 analysis, which then, you know, can reduce the amount
15 of information you need in terms of number of runs.
16 DR. NUTT: I think that --
17 DR. BANERJEE: It's called Bayesian on the
18 fly.
19 DR. NUTT: Right, but it wouldn't --
20 CHAIRMAN WALLIS: But let's make it more
21 consistent.
22 DR. NUTT: But even in the worst case it
23 wouldn't be as high as 20/24, so.
24 MR. HOLM: Yes, this is Jerry Holm. I
25 guess I'd have to say we continue to disagree with

1 Yuri that we aren't allowed to use all available
2 information to support our conclusion.
3 Yuri, from my perspective, wants to argue
4 that if I decide to use non-parametric statistics I
5 can't bring any other information to play to help me
6 reach my conclusion.
7 We actually did go off and do the non-
8 parametric 95 percent or 10 percent, and then go off
9 and make a response surface fit for the oxidation and
10 show that we met the criteria with 100 probability,
11 basically doing more of a mathematical statement of
12 that visual picture that we had showing we were, you
13 know, 20 standard deviations away.
14 If you do a -- just take the 59 points and
15 do a fifth --
16 DR. BANERJEE: Standard deviations.
17 DR. NUTT: No, it's actually -- it ranges
18 -- I think it depends on the case, but we were up to
19 74 standard deviations away on one particular case.
20 On the cold weight observation --
21 CHAIRMAN WALLIS: That's the probability
22 of ten to the minus --
23 DR. NUTT: Oh, it's much smaller than
24 that. I knew you were going to -- I wanted to get to
25 100 percent.

1 DR. KRESS: You have to smooth out those
2 59 runs in order to do this, though.
3 MR. HOLM: You have to make an assumption
4 for distribution.
5 DR. KRESS: Yes.
6 DR. NUTT: And it's approximate, but we
7 were adding additional information.
8 DR. KRESS: But I think that's legitimate.
9 CHAIRMAN WALLIS: To make an upper bound
10 and a lower bound, it's ten to the minus 70 or ten to
11 the minus 55 or something, but it's still pretty darn
12 small.
13 DR. NUTT: Yes.
14 CHAIRMAN WALLIS: So figure out what the
15 low bound is.
16 DR. NUTT: Oh, I don't think I'd
17 necessarily challenge --
18 CHAIRMAN WALLIS: But do something logical
19 and numerical instead of just looking at it.
20 DR. KRESS: Yes, and that would close the
21 loop on it.
22 DR. NUTT: And I haven't proceeded with
23 that at the time, but we -- but I think this -- you
24 know -- as long as that's agreeable with Framatome,
25 we'll, you know.

1 CHAIRMAN WALLIS: Yes.

2 MR. HOLM: Again, if the staff would want

3 that, we'd provide it. We did provide that in an

4 informal fashion and that wasn't satisfactory at the

5 time, I have to say.

6 CHAIRMAN WALLIS: Okay. Are we finished

7 with this now?

8 DR. NUTT: Yes, I think the slides.

9 CHAIRMAN WALLIS: I'd like to go back to

10 the committee and Ralph, and I'm sure that other

11 members or anyone probably have some questions for

12 Ralph that I didn't cover and we haven't covered up to

13 now.

14 Sanjoy, you have questions for Ralph?

15 DR. BANERJEE: Well, I think, you know,

16 the overall picture is somewhat like Ralph summarized,

17 but there are individual bits and pieces of this that

18 I still need to feel comfortable with. One of these

19 issues which I looked into, this issue of sensitivity

20 to the nodalization things.

21 And the second, I think, is heat transfer

22 is obviously very important in this and I don't know

23 if there has been any adjustment made to the heat

24 transfer correlations or not, or how they are. I

25 assume that Forslund-Rohsenow or whatever is being

1 used as is.

2 Nothing has been adjusted. Nothing has

3 been tuned. Lahey's take on Unow's correlation is

4 being used as is. I haven't had a chance to look at

5 exactly what's in the code, but I would like to know

6 if you have had a chance and you're satisfied that

7 these are not being adjusted or tuned or whatever

8 between runs.

9 And the same goes for the drag

10 correlations, you know, things like that.

11 MR. LANDRY: We have not looked at every

12 single correlation in the code. As I said earlier,

13 what we've done is a snapshot look. And from those

14 that we have examined, we're satisfied that they are

15 in their proper form.

16 The question that we had earlier with

17 Forslund-Rohsenow is, is it proper to use it under

18 certain conditions. But after looking at the plots

19 that we asked for of a heat transfer correlation at

20 the PCT mesh point, throughout a transient, looking at

21 the range of parameters for which the correlations

22 were valid and the range of parameters for which the

23 correlations were being used, and further assessments

24 which were done to say, yeah, those correlations are

25 valid for these conditions, yes, we were satisfied

1 with the heat transfer package overall.

2 DR. BANERJEE: They interact strongly with

3 the drag model, as well, because I guess it depends on

4 how many drops are formed and, you know, entrainment

5 and there's sort of an interaction in the whole

6 package.

7 MR. LANDRY: Well, if you go back and read

8 all the RAIs. I don't know if Paul has provided all

9 the RAIs to you and responses. If you go through

10 those RAIs there are a number of questions which we

11 raised with regard to some of the heat transfer

12 modeling, the droplet modeling.

13 We raised a number of questions with

14 regard to droplet size and whether the appropriate

15 sizes are being used. Yes, we've raised a lot of

16 questions. I think when we look overall at the

17 performance we're able to say, okay, the performance

18 overall is reasonable, the biases are understood,

19 uncertainties are understood.

20 DR. BANERJEE: Right. The feeling I get

21 looking at this is that this is what -- maybe it was -

22 - a lot of the things are historical that were put in

23 RELAP5 way back.

24 MR. LANDRY: It's not only RELAP5, it's --

25 DR. BANERJEE: Maybe RELAP4.

1 MR. LANDRY: It's not only the RELAP
2 family. A lot of these correlations and models are
3 industry-wide.
4 DR. BANERJEE: Right. I remember that
5 when LOFT got the early rewetting and we didn't know
6 it was the thermocouples, the codes were almost
7 immediately able to predict simply by changing the
8 correlation slightly, making it L2-2 or something.
9 MR. LANDRY: Well --
10 DR. BANERJEE: So I worry about these
11 things a little bit. And of course, it wasn't true.
12 MR. LANDRY: No, it wasn't. And in fact,
13 when we ran L22, in fact, you and I were sitting next
14 to each other --
15 DR. BANERJEE: Right.
16 MR. LANDRY: -- when that test was run.
17 DR. BANERJEE: Right.
18 MR. LANDRY: And both moved to the monitor
19 pretty fast, what in the world is going on; who
20 screwed up the test.
21 DR. BANERJEE: Right.
22 MR. LANDRY: Within two days we had a
23 calculation done with another code by another
24 laboratory than the laboratory that ran the test,
25 which --

1 DR. BANERJEE: Shall remain nameless.

2 MR. LANDRY: -- remain nameless, which 'lo

3 and behold predicted the quench right down to the

4 right amount.

5 DR. BANERJEE: Exactly.

6 MR. LANDRY: And we said, what in the

7 world did they do. Well, overnight they had installed

8 another heat transfer correlation and model and fluid

9 flow model into the code and got the prediction.

10 In the weeks that followed when we started

11 looking at what they were doing we came to the

12 conclusion that they were getting the right answer for

13 the wrong reason. They had fluid flow conditions that

14 weren't even on the same sheet of paper as were

15 occurring.

16 It was by jerry-rigging a model that they

17 could get the answer. So we knew that it's not a

18 matter of getting the right answer. It's a matter of

19 getting the right answer for the right reason.

20 DR. BANERJEE: Right.

21 MR. LANDRY: And that's when we started

22 looking very heavily at the thermocouple effect and

23 started looking at the fin effect and realized that

24 the uncertainty due to the fin effect on the

25 thermocouples was over 20 degrees K in our first

1 assessment.

2 And there have been various and various

3 numbers quote since then of what the real effect is.

4 So there's really not much purpose in trying to

5 predict that quench, because it's not a quench that's

6 phenomenological to the transient.

7 It's phenomenological to the design of the

8 thermocouples and the fuel elements for that test.

9 DR. BANERJEE: Yes. That's right. The

10 point I was trying to make was more that, you know,

11 predicting peak clad temperature, the right one, is

12 important, but it's also important to get a bunch of

13 other things right, you know.

14 But this may be one output; it's an output

15 which may not be particularly sensitive, though it's

16 what you need for licensing. And it's one also that

17 can be -- you know -- correlations can be easily

18 adjusted to try to give you whatever answer you want.

19 In fact, it's relatively easy to do it.

20 It doesn't mean that it'll scale to full-scale

21 properly or whatever. So I feel more comfortable when

22 a whole lot of things go sort of right in the test.

23 If they're getting, say, the carryover awfully right,

24 which is not measured, of course, in most of the

25 tests, unfortunately, or some other parameters like

1 the inlet flow is right, whatever has been made.

2 MR. LANDRY: Or the level.

3 DR. BANERJEE: Or the levels, something,

4 you know.

5 MR. LANDRY: That would be -- sensitive.

6 DR. BANERJEE: I don't know. If I really

7 sat down, I could probably think of it, and I'm sure

8 you guys have. But if they get a bunch of things

9 right with the code then it just gives you a higher

10 comfort level, I think, than just a single parameter

11 like the peak clad temperature.

12 And really, that's one of the questions

13 I'm asking you, whether there were other parameters

14 they got right in these experiments.

15 MR. LANDRY: That's correct. And that's

16 why earlier when I was talking about the assessment

17 and individual assessment cases, I was trying to

18 indicate that it's not only getting a whole bunch of

19 things right in a particular test.

20 It's getting a whole bunch of things right

21 in a lot of different assessments so that you can say,

22 well, this one particular assessment, they got this

23 thing wrong, but they got a lot of other things right.

24 And when you look at this whole spectrum of

25 assessments, overall, they got a lot of things very

1 well predicted.

2 Then we get a feel for overall the code is

3 performing correctly. We might be able to find one

4 test where we can go in and look atone parameter and

5 say, no matter what code we're looking at, it's lousy.

6 We can find -- for any code we pull in we can find

7 something that's lousy or a particular test.

8 What we have to look at is overall, do we

9 get a bunch of the parameters right? Do we get

10 important parameters right and do we get them right

11 for a lot of tests over a spectrum of sizes and a

12 spectrum of conditions.

13 And that's where we're coming down to in

14 the conclusion in saying, yes, overall we believe that

15 the code is performing well.

16 DR. BANERJEE: Well, if that's the case

17 then, you know, the fact that they all heat

18 transferred back here or dragged back here or whatever

19 is used is not very relevant. I mean, if a whole

20 bunch of different things are got right over a whole

21 bunch of scales and, you know, different parameters,

22 that's pretty reassuring.

23 And you've really looked at this in some

24 detail, and have you written some sort of assessment

25 of this or put this all together or even in your own

1 minds, case for it?

2 MR. LANDRY: I think we've pretty well put

3 it together in our own minds. We may not have put it

4 together on paper adequately, and as I indicated

5 earlier, we are going to be revising the SER draft,

6 trying to incorporate more of our thoughts and more of

7 our experience and conclusions.

8 And in particular, based on the discussion

9 of the last two days where we've seen a number of the

10 questions that have been raised and items which the

11 members of the subcommittee and the subcommittee's

12 consultants have raised as important issues and

13 concerns, so that we can pull together a stronger,

14 more cohesive --

15 CHAIRMAN WALLIS: I think it's one thing

16 we miss in an SER, is enough explanation for the

17 outside or of the -- you know -- someone who's reading

18 it for the first time about why you reach these

19 conclusions, some of the breadth of the (coughing) and

20 all that.

21 You may need to dig into it and you can

22 remember things you've forgotten, and say, yes, we

23 actually did that, and tell us because it gives us

24 much more confidence in your final conclusion.

25 MR. LANDRY: It's a matter of being too

1 close to it.

2 MR. SCHROCK: There seemed to be quite a

3 few places where you are struggling with some

4 particular feature of the code, and finally, you give

5 in and say, well, you think it's okay because it's

6 conservative, you believe it's conservative.

7 And this seems strange to me, I guess.

8 It's a realistic code and yet, the judgment of the

9 acceptability still in many levels appears to hinge on

10 whether you believe it's conservative or not

11 conservative.

12 MR. LANDRY: Well, that doesn't bother me

13 quite so much when I consider that the code is not a

14 perfect tool and has a number of assumptions in it, in

15 addition to being basically a one-dimensional code.

16 It has some 2D capability in places, or even pseudo-2D

17 capability.

18 It's not a pure three-dimensional, first

19 principles capable tool in every respect. There have

20 to be assumptions made and you're dealing with

21 assessment against data, which have uncertainty in

22 data which are not pure, either.

23 So in cases where we have to come back and

24 say, it's conservative and that's good enough, really

25 doesn't bother me too much. It's when we get to a

1 conclusion where we've got to say over and over and
2 over and over again, it's conservative and that's good
3 enough, then we have to say, wait a minute, I thought
4 we were realistic.
5 When we can back up and say in a lot of
6 these parameters and a lot of these tests, yes, it is
7 very close to reality that we can say, okay, it's
8 realistic but it does still have some conservatisms.
9 DR. RANSOM: Well, certainly, if I put my
10 hat on as the general public it disturbs me a great
11 deal that after all these years of work the NRC does
12 not have a standard that they can compare the results
13 of a code to this and be in the position of an auditor
14 and say, that's good enough or not. And what I'm
15 hearing right now is that you people do not have this.
16 MR. CARUSO: But we do have RELAP5, the
17 conversion. We do have TRAC-M coming along.
18 DR. RANSOM: Whatever you want to use.
19 MR. CARUSO: In this case it's a little
20 bit different code to apply a -- you know -- our codes
21 to do the audits because they're developing a
22 methodology that they're going to apply to a
23 particular plant.
24 If we -- I mean, I guess we could model
25 the three-loop and the four-loop plants.

1 DR. RANSOM: I'm not sure whether they're
2 attracting --
3 MR. CARUSO: Right.
4 DR. RANSOM: -- a fine line that you could
5 use.
6 MR. CARUSO: Right.
7 DR. RANSOM: To do a calculation and
8 compare where the results of this go. And I always
9 thought that was the mission of the NRC, to be the
10 auditor.
11 MR. CARUSO: And we do --
12 DR. RANSOM: To set the standard.
13 MR. CARUSO: And we do that. We do use
14 our codes to audit other people's calculations, but I
15 guess in this case what we're looking at is we're
16 looking at their code calculations against data. They
17 have actual assessment data, and at this phase in the
18 process we're assessing -- we're looking at the
19 assessment of their code against data.
20 At some point if they -- when it gets
21 applied to a plant, then we'll get a chance to use our
22 code against their code for the plant. But right now
23 I'm not sure how much -- how valuable it would be for
24 us to do our code calculations, because what we're
25 really looking at right now is how well do they

1 predict the data from the test facilities.

2 CHAIRMAN WALLIS: The ACRS is very much

3 encouraged in development of your own code.

4 MR. CARUSO: We think that's a good thing.

5 CHAIRMAN WALLIS: We've been impatient to

6 see it used and would like -- love to see it used for

7 some of these auditing calculations. And also, when

8 you use it you learn thing about codes which you can

9 then use in assessing how other people have used

10 codes, which is very, very valuable.

11 MR. CARUSO: We agree, and that's why

12 you'll find that the people who are doing these

13 assessments are the same people that use our codes.

14 CHAIRMAN WALLIS: And we'd like you to put

15 this TRAC-M on platforms which label it to run rapidly

16 and give a lot of results and be transportable to

17 other platforms and all those good things.

18 MR. CARUSO: Here, here.

19 CHAIRMAN WALLIS: And we're dying to have

20 this happen. We've been waiting for this and --

21 DR. KRESS: On this issue of the noding

22 that's been brought up a few times, I'm sure by virtue

23 of precedent and the way the regulations are written

24 that it will be an issue here. But it seems to me

25 like there is a -- what I'd call a confirmatory

1 research issue here.

2 It seems to me like there ought to be

3 something referred over to research to say, okay, do

4 something to assure us that the way we do this noding

5 is a proper way to do it. Now, I don't know what that

6 is that they should do, but it seems to me like there

7 is an issue of confirmatory research.

8 You've assumed it's all right and that

9 it's mostly based on precedent and other things, but.

10 MR. LANDRY: Well, that's a part of what

11 the CSAU team was trying to get at also, that at the

12 time the NUREG CR-5249 was written virtually every

13 modeler with every code for every different

14 application used their own --

15 DR. KRESS: Their own nodes.

16 MR. LANDRY: -- idea of what nodalization

17 was to be.

18 DR. KRESS: Right.

19 MR. LANDRY: And a big part of the

20 approach in CSAU was to try to come to some standard

21 or some consistency in an approach to nodalization.

22 DR. KRESS: Yes. But it's this question

23 of, I'll take the noding I did for the full size

24 integral test and map it one to one, basically, on the

25 full scale. That's the issue I'm dealing with.

1 Is that the proper way to do it and that's
2 the assumption that we've had and that's what the
3 directions are and by precedent, the way it's been
4 done. But you know, I think there's a legitimate
5 question there that something, research could look in
6 a mostly analytical sense and decide whether that's
7 the right way to do it.
8 You know, it has some basis in what Vic
9 said about the noding, but you know, I think there's
10 a confirmatory research issue here.
11 DR. BANERJEE: I think with the CSAU,
12 though, we clearly understood at that point that you
13 could get -- were almost very wide range of answers by
14 adjusting the noding, and that's the idea of freezing
15 the noding as much as possible to remove this degree
16 of, you know, ability to tune the results by tuning
17 the noding.
18 MR. LANDRY: And also, in modeling
19 nodalization for a plant analysis with nodalization
20 from the assessment analyses through a different
21 scale.
22 DR. BANERJEE: Right.
23 MR. LANDRY: To the plant so that you use
24 a consistent philosophy; not necessarily a consistent
25 nodalization, but a consistent philosophy in

1 determining the nodalization as you move from one to
2 another.
3 DR. BANERJEE: Right. And I think that's
4 the idea. The problem is I don't know, you know, in
5 retrospect after many years, whether -- how that is to
6 be actually applied in practice, you know.
7 I mean, I can -- I think the idea's clear
8 that you have to do this in a very consistent way.
9 But within that consistent way there's a certain
10 degree of freedom, you know. You can node the lower
11 plenum in a certain way.
12 You can nose it in a different way, and
13 you can get different results, I'm sure, because at
14 the end it determines what the reflood will do, you
15 know. So it's still a subject I'm concerned about and
16 we are going to take a look and see what you've got
17 already, and maybe it's fine, you know, at the moment.
18 But what Tom was saying, is -- I think it
19 might be worth taking -- you know -- having research
20 take another look and sort of giving us some feedback
21 on that.
22 CHAIRMAN WALLIS: We could if we feel
23 strongly enough about it put it in an ACRS letter.
24 DR. KRESS: Yes, indeed.
25 DR. RANSOM: Well, you know, there is some

1 evidence on it. I think back in the days of Charlton
2 at the INEL they ran some from ten nodes, you know.
3 I don't know what the exact numbers were, but they
4 increased the number of nodes, you know.
5 MR. LANDRY: Sure.
6 DR. RANSOM: And there is a study that's
7 documented, I'm sure.
8 DR. BANERJEE: Well, they did it on a
9 straight five --
10 DR. RANSOM: And it told you roughly what
11 the nodalization sensitivity was for a PWR
12 application.
13 DR. BANERJEE: Well, did they do it on a
14 PWR?
15 DR. RANSOM: It was either a PWR or a
16 LOFT, you know. It was -- and I am sure that can be
17 found. But these kinds of studies have been made.
18 It's not like no one has ever studied that.
19 DR. BANERJEE: No. I'm sure that it's
20 been studied enormously, that there's been --
21 DR. RANSOM: Well, I mean, just repeated
22 calculations to see what is the affect of increasing
23 the density of nodes.
24 DR. BANERJEE: It's been studied but I
25 don't think there has been some sort of definitive set

1 of conclusions that have come out of it.

2 DR. RANSOM: Well, the conclusion that

3 came out of that one is the relatively -- you know --

4 100 or so nodes I think they concluded was adequate.

5 There was no real improvement beyond that. Really, we

6 should go back and look for some of that.

7 MR. BOEHNERT: But that doesn't -- you

8 know -- maybe you ought to repeat it, though. I mean,

9 it's --

10 DR. BANERJEE: Well, I don't know if it

11 affects Ralph here, but in a general sense this is

12 something that needs to be brought together and the

13 experience polymerized (phonetic) in some concrete --

14 MR. BOEHNERT: Because Vic's right. I

15 mean, I remember some of this stuff.

16 DR. RANSOM: Yes.

17 MR. BOEHNERT: We had discussions here

18 where people talked about looking at the noding and so

19 forth, but you're right. No one ever really pulled it

20 all together and sat down and thought about it from

21 the idea of -- standard criteria.

22 DR. BANERJEE: It would be really nice to

23 have a white paper put this thing to bed at least

24 temporarily, for awhile.

25 CHAIRMAN WALLIS: Sure, and while we're

1 looking at sensitivity to noding it seems to me we
2 could also say, let's put this momentum thing to bed
3 by saying let's look at sensitivity to the terms you
4 put in your momentum equation and multiply the inertia
5 terms all by two and by a half and maybe nothing
6 happens at all.
7 And then we would stop worrying about the
8 fact that you've made guesses and estimates in
9 evaluating those terms. And if it turns out that the
10 answers are quite sensitive to how well you evaluate
11 what the terms -- you know -- that are approximate,
12 then we need to know that.
13 That would change the way in which you
14 consider whether or not this is a problem or what
15 needs to be done about that. So rather than arguing
16 about it every time we meet I think it'd be good if
17 someone would do a sensitivity study to some of the
18 terms and finish -- wrap up the answer to the problem.
19 DR. BANERJEE: It looks like it would take
20 some tracking --
21 CHAIRMAN WALLIS: Yes, that's right. When
22 we get this thing, you know, it's like waiting for
23 Godot or something.
24 (Laughter)
25 DR. BANERJEE: Waiting for God.

1 CHAIRMAN WALLIS: Now, we have to make
2 some decision, and the first thing we have to -- this
3 subcommittee has to do is say, is this thing far
4 enough along that it should go to the full committee
5 next month.
6 DR. KRESS: I think we'd better. I think
7 we should.
8 DR. RANSOM: Did you say you think it does
9 not?
10 DR. KRESS: I think it does. In fact, I
11 think the staff is close to saying this thing's ready
12 to be blessed and I think it's -- if we got a
13 difference of opinion I think it'd be timely to
14 express it.
15 CHAIRMAN WALLIS: And if they need to do
16 more, we need to know what it is they need to do.
17 DR. KRESS: Yes. So I think definitely we
18 need to come back to the full --
19 DR. BANERJEE: Well, you know, as I said,
20 tomorrow I'm going to spend time looking at something.
21 Ralph is very kindly making available some
22 information, and I'll write it down. But my sense of
23 it from talking to Ralph is that it would be okay to
24 go forward.
25 DR. KRESS: So given that, we have to

1 decide what to do.

2 CHAIRMAN WALLIS: Which I would -- well,

3 I did -- yes, what do you think, Vic? Is this ready

4 to go?

5 DR. RANSOM: Well, you know, my aspect is

6 I'd like to see some hard evidence at how it behaves.

7 And the only thing I've seen so far is that one curve

8 that Bill Nutt showed that gives me any feeling of

9 satisfaction at all.

10 And I know there's a lot of assessment in

11 the document. I don't know if it's my job to dig

12 through that and come to some judgment or whether the

13 staff should summarize that. And you know, I'm sure

14 the ACRS would like to see at least a few examples of

15 how good it is.

16 CHAIRMAN WALLIS: Why is it --

17 DR. RANSOM: Otherwise, I don't know how

18 you'd make any kind of conclusion.

19 DR. KRESS: Are you saying we need another

20 subcommittee meeting to see that or --

21 DR. RANSOM: Well, I'm just telling you

22 what my feelings are. I don't know what I'm

23 recommending.

24 CHAIRMAN WALLIS: Well, you can certainly,

25 between now and December, dig into the documentation.

1 DR. KRESS: Yes, that would be one
2 approach.
3 DR. RANSOM: Well, that'll satisfy me, I
4 guess, and all that.
5 CHAIRMAN WALLIS: And then I think we can
6 -- if we agree that this should go to the full
7 committee, then we can give Ralph advice about what he
8 needs to show. And I think it's much more impressive
9 to show the full committee the kind of thing that Bill
10 Nutt showed than to show a lot of stuff about the
11 chronology of the -- how the regulations were
12 satisfied or something.
13 I mean, that's -- we assume that's
14 happened. We don't really care about the year 2001
15 something happened and something else happened. We
16 can go through that very, very quickly.
17 The thing is, what's the real hard
18 evidence on which you base your conclusions and how
19 can you put that across to the full committee so they
20 say, yeah, he's made the right decision for the right
21 reason. That I think is what we need to think about
22 in giving you some advice.
23 MR. SCHROCK: Well, there's a loose end of
24 this question of whether the break size should be
25 included in this --

1 DR. KRESS: Yes, I think definitely that
2 ought to be discussed.
3 MR. SCHROCK: And so do you think you want
4 to take it to the full committee before you get that
5 resolved? That's a question I have. I don't know.
6 CHAIRMAN WALLIS: Ralph, would you take it
7 to the full committee if you had not resolved that?
8 MR. CARUSO: I would be reluctant. I
9 think we have to have that resolved before we go.
10 MR. LANDRY: I agree.
11 MR. CARUSO: To the full committee.
12 CHAIRMAN WALLIS: And you are going to --
13 is there a high probability, since we're in that sort
14 of a world, a high probability --
15 MR. CARUSO: You're asking for a 95/95 or?
16 CHAIRMAN WALLIS: Well, you know.
17 DR. BANERJEE: How many test cases do you
18 have to do, 59?
19 MR. BOEHNERT: Joking aside, we need some
20 definitive answer fairly soon, because we have this
21 scheduled, and if I'm going to knock it off the agenda
22 I should know very quickly.
23 MR. CARUSO: I understand. We will be
24 trying very hard to resolve this.
25 CHAIRMAN WALLIS: We need to -- if we're

1 going to look at the next version of the SER we need
2 that two weeks before the committee meeting or
3 something. I mean, the committee doesn't like to
4 evaluate things that it hasn't seen for long enough to
5 evaluate.
6 MR. BOEHNERT: Yes. That's the question.
7 Are you going to give us another draft on the SER
8 before the ACRS meeting? Is that a goal or --
9 MR. LANDRY: Yes.
10 MR. BOEHNERT: -- is that -- yes?
11 MR. LANDRY: Yes.
12 MR. BOEHNERT: Oh, dear.
13 CHAIRMAN WALLIS: It should be two weeks
14 before.
15 MR. BOEHNERT: It should be now.
16 CHAIRMAN WALLIS: Isn't that what we just
17 -- it should be now; it should be now.
18 MR. LANDRY: Okay. Make it tomorrow.
19 MR. CARUSO: W#hat, we have three weeks
20 before the committee?
21 MR. BOEHNERT: Yes.
22 MR. CARUSO: So we have a week.
23 MR. BOEHNERT: Yes.
24 MR. CARUSO: Okay.
25 MR. BOEHNERT: And when we -- well, yes.

1 CHAIRMAN WALLIS: Now, so it looks as if
2 this is going to go before the committee in December
3 and this is where they will make a decision, write a
4 letter and praise or castigate or whatever they want
5 to do.
6 DR. KRESS: If we don't go before the
7 committee in December then the next point we could do
8 it in would be February.
9 CHAIRMAN WALLIS: That's correct.
10 DR. KRESS: And you know, that's getting
11 down the line.
12 MR. CARUSO: We understand.
13 CHAIRMAN WALLIS: So this means that we
14 need very concise and relevant and persuasive
15 presentations by both Framatome and the staff at the
16 committee meeting.
17 MR. BOEHNERT: Right now, we have a total
18 of an hour and a half dedicated to this. I'm trying
19 to get it to two hours. I think we really need two
20 hours, given what I'm hearing here.
21 CHAIRMAN WALLIS: Normally, we give
22 Framatome a bit longer?
23 MR. BOEHNERT: Yes.
24 CHAIRMAN WALLIS: We give them, say, an
25 hour and we're off half an hour?

1 MR. BOEHNERT: That probably -- that's
2 what I was thinking, if we could pull that off.
3 CHAIRMAN WALLIS: I think then we have to
4 advise Framatome on what it is that they should
5 emphasize in their presentation.
6 MR. BOEHNERT: Absolutely.
7 DR. KRESS: Well, I think the key to me is
8 how you assess the biases and the uncertainties in the
9 plan. I mean, that's what all this assessment is all
10 about. So you know, I would focus on that part of it
11 somewhat.
12 CHAIRMAN WALLIS: And then show us some
13 data,
14 DR. KRESS: Yes, data wouldn't hurt at
15 all.
16 MR. CARUSO: Data is correct.
17 DR. KRESS: Curves or whatever.
18 MR. SCHROCK: Well, Framatome has promised
19 to improve the documentation. I don't know what
20 impact that would have on conclusions --
21 DR. KRESS: I'd -- yes, I --
22 MR. SCHROCK: -- made by the full
23 committee, but --
24 DR. KRESS: Yes. I don't think we need to
25 go through that whole presentation where they showed

1 all the equations.

2 MR. SCHROCK: Yes.

3 DR. KRESS: And the control volumes. I

4 think we can probably not --

5 MR. SCHROCK: What I'm wondering is if you

6 don't want something more specific regarding that --

7 CHAIRMAN WALLIS: Or something which would

8 close the loop.

9 MR. SCHROCK: -- obligation that you can

10 present to the full committee.

11 CHAIRMAN WALLIS: Close the loop so that

12 it insures that this is actually done. Well, we will

13 all see this again. We will see this again in

14 connection with BWRs and BWR LOCAs and realistic LOCAs

15 and so on.

16 And I would think that although we're

17 extraordinarily patient people, you might try that

18 patience if you were to come back with something which

19 was not in good shape. So we do have a check on it at

20 that time.

21 DR. BANERJEE: I guess Virgil's critical

22 flow questions need to get answered.

23 MR. SCHROCK: What's that?

24 DR. BANERJEE: Your critical flow

25 questions need to get answered.

1 MR. SCHROCK: Seems to be lost in the
2 noise, but I'd sure like to see them take those
3 comments a little more to heart and address them in
4 the revision of the documentation.
5 CHAIRMAN WALLIS: Well, there's another
6 thing that this full committee will get, is that I
7 expect you will all submit a report, particularly the
8 consultants, which they won't be at the full committee
9 meeting.
10 And this will be available to the full
11 committee and it may have some significant influence
12 on what they do.
13 DR. RANSOM: Whatever we write up from
14 this meeting you're going to put together, then?
15 CHAIRMAN WALLIS: Paul will put it
16 together for the full committee, and I will put
17 together a draft letter of what I think the full
18 committee might consider deciding, and it will be
19 influenced by what I hear from you folks. And the
20 other --
21 MR. BOEHNERT: I need more guidance for
22 Framatome. All I've got right now is assessment of
23 bias and uncertainty, and maybe some discussion of
24 documentation.
25 CHAIRMAN WALLIS: Not -- just a really

1 convincing statement that they're fixing the
2 documentation, isn't it?
3 MR. BOEHNERT: Yes.
4 CHAIRMAN WALLIS: You don't need to go
5 into the details of the documentation.
6 MR. BOEHNERT: No.
7 MR. MALLAY: Yes, this is Jim Mallay. I'd
8 certainly be prepared to make a statement there that's
9 similar to what I did this morning.
10 MR. BOEHNERT: Yes. Okay.
11 CHAIRMAN WALLIS: Right.
12 MR. MALLAY: I think, you know, that's two
13 minutes' worth. I think what we would like to do is
14 address the uncertainties, the validation process.
15 CHAIRMAN WALLIS: Well, we have Larry's
16 presentation. It took --
17 MR. MALLAY: Yes.
18 MR. BOEHNERT: Yes. I was going to say
19 something along the lines --
20 CHAIRMAN WALLIS: Something like what
21 Larry said. It took, what, a couple of hours?
22 MR. BOEHNERT: Yes.
23 CHAIRMAN WALLIS: It didn't take all that
24 long.
25 MR. MALLAY: No.

1 CHAIRMAN WALLIS: And I think you should
2 step through the CSAU, which I think the committee
3 probably needs to be reminded about. I think saying
4 about half as much or less than you did say, when we
5 figure out what really, really is important in it.
6 MR. MALLAY: Yes, I believe we can do
7 that.
8 DR. RANSOM: Well, along that line, I
9 think I would find it much more insightful if you
10 would list the parameters, you know, that you're
11 including or have you found, you know, just a summary.
12 CHAIRMAN WALLIS: They did that in the
13 past.
14 DR. RANSOM: The uncertainties.
15 CHAIRMAN WALLIS: Yes.
16 MR. MALLAY: Yes, I think we could be more
17 explicit in that regard and I think we can also show
18 some validation specifically similar to what we did
19 with Dr. Nutt.
20 DR. RANSOM: And I think some -- a few
21 examples of validation.
22 CHAIRMAN WALLIS: Excuse me. The
23 subcommittee or at least some members have seen these
24 things before, but not all the members. And then as
25 far as the full committee goes, I don't think they

1 have seen these.

2 MR. BOEHNERT: No, because we don't --

3 MR. MALLAY: No.

4 CHAIRMAN WALLIS: Evaluation. So I think

5 the plan where you actually found the effect of all

6 these various things on PCT and what was it most

7 sensitive to. I think that was very, very useful.

8 You didn't present that here at all, but

9 that sort of thing is going to be useful to the full

10 committee. What other advice can we give them?

11 MR. BOEHNERT: Well, that's probably going

12 to more than fill an hour right there.

13 MR. MALLAY: Yes, that's -- yes, we'll be

14 challenged.

15 CHAIRMAN WALLIS: I would cut down the

16 words in the slides and show more figures or some

17 such, which sum up something.

18 MR. MALLAY: Right. I think we understand

19 the thrust.

20 CHAIRMAN WALLIS: And you know, you have

21 to put your really best foot forward. This is the

22 real show. This isn't a rehearsal or anything. This

23 is it.

24 MR. MALLAY: We understand.

25 CHAIRMAN WALLIS: There's no replay.

1 MR. MALLAY: This is extremely important
2 to us and I've given dozens of presentations to the
3 full ACRS. So I'm familiar with the drill.
4 MR. BOEHNERT: And I'll be allotting about
5 60 plus minutes for ANP Framatome and about 30 for the
6 staff.
7 CHAIRMAN WALLIS: Right.
8 MR. BOEHNERT: And then the rest for you
9 and wrap-up, so.
10 CHAIRMAN WALLIS: I think we've told Ralph
11 what he needs to do, and the main thing is that, why
12 do you make these decisions that you make and what are
13 the reasons and why should we have confidence that
14 you've done it right. Okay. We're doing certainly
15 well on time. It's because it's a subcommittee.
16 MR. BOEHNERT: Yes.
17 CHAIRMAN WALLIS: Right.
18 MR. MALLAY: Would it be appropriate for
19 me to make a comment or two on the --
20 CHAIRMAN WALLIS: Yes, I think it's be
21 very appropriate. I'd really love you to do that.
22 MR. MALLAY: Okay.
23 CHAIRMAN WALLIS: Please do.
24 MR. MALLAY: First of all, we appreciate
25 very much the confidence the subcommittee has

1 apparently shown today. We take your comments very
2 seriously, specifically, the critical flow that Virgil
3 continues to remind us of, the documentation situation
4 and so on.
5 But I think generally we appreciate very
6 much the confidence that you've shown in our model and
7 the presentations that we've made. There's a couple
8 things I think I need to point out. First of all, we
9 feel very, very confident about our statistical
10 approach.
11 We feel it's appropriate, that it's well-
12 founded. And as Jerry Holm mentioned a few minutes
13 ago, we feel it's important to exercise a reasonable
14 level of engineering judgment, specifically on the
15 case of the three parameters that we're looking at,
16 peak cladding temperature, local oxidation and total
17 oxidation.
18 We all know that they're very closely
19 correlated. You don't get significant oxidation
20 without elevated temperatures, for example. So we
21 know they're correlated and we appreciate your
22 understanding of that.
23 Secondly, in the application of our
24 statistical approach we are also very confident that
25 it's appropriate to look at the break size as part of

1 those parameters. We feel it's not only appropriate,
2 but I think we meet the regulation, namely that we
3 examine the full spectrum of break sizes.
4 And even though I'm not prepared to quote
5 specific numbers, it's pretty clear that the large
6 break size dominates the results from the 59 cases.
7 We typically get anywhere from .8 to .9 or so break
8 size that will dominate. So I'm hopeful and I'm
9 confident, frankly, that the staff and us can reach a
10 resolution of this.
11 Dr. Wallis, you had mentioned also about
12 the conclusion here in the draft SER, the fact that at
13 the end of that first bullet it said something to the
14 effect that addresses the regulation. I would
15 certainly second your comment that the conclusion
16 should be very clear that the model is acceptable, for
17 whatever reasons.
18 Addresses certainly doesn't do that in our
19 opinion. We also recognize at this point that
20 unfortunately the SER is sort of in a dynamic
21 situation. It's our commitment to work very closely
22 with the staff over this next week to reach resolution
23 on a -- there's probably a half a dozen minor items of
24 what I'll call clearing up the language in the SER
25 itself.

1 And so in addition to reaching resolution
2 on the break size situation, we'll be working with
3 them to clean up these other pieces of language. I
4 think that's all I had. I don't know whether Jerry
5 Holm has anything to add. But again, we appreciate
6 your time.
7 CHAIRMAN WALLIS: Jim, you mentioned that
8 you felt very strongly about your statistical
9 approach.
10 MR. MALLAY: Yes.
11 CHAIRMAN WALLIS: I think you should come
12 armed with the best evidence you have. I mean, that
13 business of showing the statistical distribution of
14 the O2 versus -- if you're not going to show it
15 directly, you certainly should have it ready to show.
16 And I think you really need to show that
17 evidence in the best form you can, not in lots of
18 different forms, but if you've got a certain plot that
19 shows the message most clearly, please show it. Don't
20 be bashful about it.
21 MR. MALLAY: We will certainly do that.
22 CHAIRMAN WALLIS: Thank you. Anything
23 else? Well, I would thank Framatome. Thank you, Jim,
24 and all your folks for coming here and making your
25 presentations and submitting to our interrogation and

1 everything, and the same for the staff.

2 Thank you very much for coming here and

3 making a presentation. And we will then look forward

4 to seeing you in about three weeks. If there's not

5 anymore we have to do, I will close this meeting.

6 Thank you.

7 (Whereupon, the Open Session was concluded

8 at 5:15 p.m.)

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CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards Thermal-Hydraulic Phenomena Subcommittee - Open Session

Docket Number: N/A

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.

/s/Rebecca Davis

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

FRAMATOME ANP

Statistical Methods - BACKUP

Advanced Nuclear Power

Statistical Methods - BACKUP

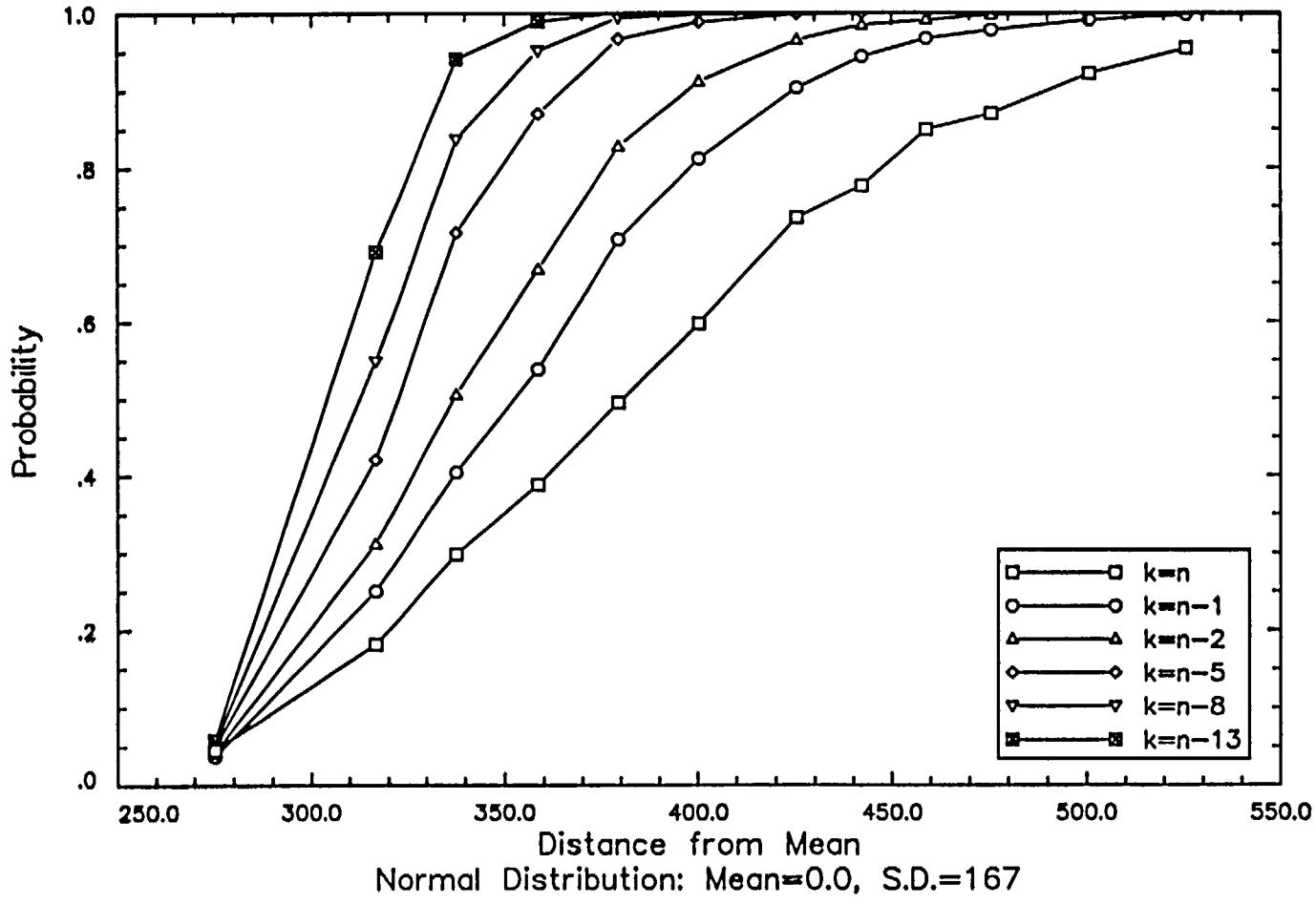
Sampling Test

Set up a normal distribution with an upper 95% limit of 275.

Calculate the upper 95/95 using the non-parametric approach for sample sizes from 59 to 410 using this known distribution

Repeat this 2000 times and calculate the fraction below 5%, the fraction below 10%, etc.

Statistical Methods - BACKUP



STAFF SAFETY EVALUATION REPORT
FRAMATOME-ANP S-RELAP5
REALISTIC LARGE BREAK LOCA METHODOLOGY

ACRS T/H SUBCOMMITTEE

RALPH R. LANDRY
REACTOR SYSTEMS BRANCH, NRR

PRESENTATION OUTLINE

- MILESTONES IN THE REVIEW
- SER STRUCTURE
- THERMAL-HYDRAULIC REVIEW
- UNCERTAINTY ANALYSIS REVIEW
- STAFF PARAMETRIC STUDIES
- CONCLUSIONS

MILESTONES IN THE REVIEW

- RECEIPT OF CODE AND DOCUMENTATION: AUGUST 2001
- ACCEPTANCE OF CODE FOR REVIEW: OCTOBER 3, 2001
- PRESENTATION TO STAFF BY FRAMATOME-ANP: OCTOBER 30, 2001
- PRESENTATION TO ACRS T/H SUBCOMMITTEE: JANUARY 17/18, 2002
- REQUESTS FOR ADDITIONAL INFORMATION: JULY 2002
- RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION: AUGUST 2002
- ACRS T/H SUBCOMMITTEE PRESENTATION OF DRAFT SER: NOVEMBER 14, 2002
- ACRS FULL COMMITTEE: DECEMBER 2002
- FINAL SER: DECEMBER 2002

SER STRUCTURE

- SER FORMAT FOLLOWS CSAU STEPS AS DEFINED IN NUREG/CR-5249
- OVERVIEW OF PIRT STRUCTURE PROVIDED
- OVERVIEW OF THERMAL-HYDRAULIC PHENOMENA MODELING PROVIDED
- OVERVIEW OF SELECT ASSESSMENTS PROVIDED
- OVERVIEW OF CODING EXAMINATION PROVIDED
- OVERVIEW OF STAFF PARAMETRIC STUDIES PROVIDED
- OVERVIEW OF UNCERTAINTY DETERMINATION METHODOLOGY PROVIDED
- CONCLUSIONS OF THE STAFF REVIEW

RLBLOCA METHODOLOGY REVIEW
PIRT

- OMISSIONS OF NUREG/CR-5249 STANDARD PIRT INCLUDED IN FRAMATOME-ANP RLBLOCA METHODOLOGY PIRT, I.E., PIRT ADDRESSES HOT BUNDLE CONTAINING HOT ROD, PLANT CALCULATIONS AT REALISTIC PLHGR, AND CALCULATIONS HAVE BEEN PERFORMED AT REALISTIC AND LOW CONTAINMENT BACK PRESSURES

- PIRT REPRESENTS PHENOMENA BY TRANSIENT PHASES:

➢ BLOWDOWN – FROM INITIATION TO ACCUMULATORS OR SIT INJECTION

➢ REFILL – FROM ACCUMULATORS OR SIT UNTIL MIXTURE LEVEL REFILLS LOWER PLENUM

➢ REFLOOD – FROM LOWER PLENUM FILLING UNTILE TEMPERATURE TRANSIENT HAS BEEN TERMINATED

➢ POST-CHF HEAT TRANSFER – DEFINED BY TRANSIENT PHASE

➢ REFLOOD HEAT TRANSFER – DEFINED BY REFLOOD PHASE

➢ REWET – DEFINED BY TRANSIENT PHASE

SAFETY EVALUATION REPORT REVIEW
FROZEN CODE VERSION AND DOCUMENTATION

- FRAMATOME-ANP HAS SPECIFIED THE CODE VERSION AND SUPPORTING CODES TO BE UNDER CONFIGURATION CONTROL AND FROZEN

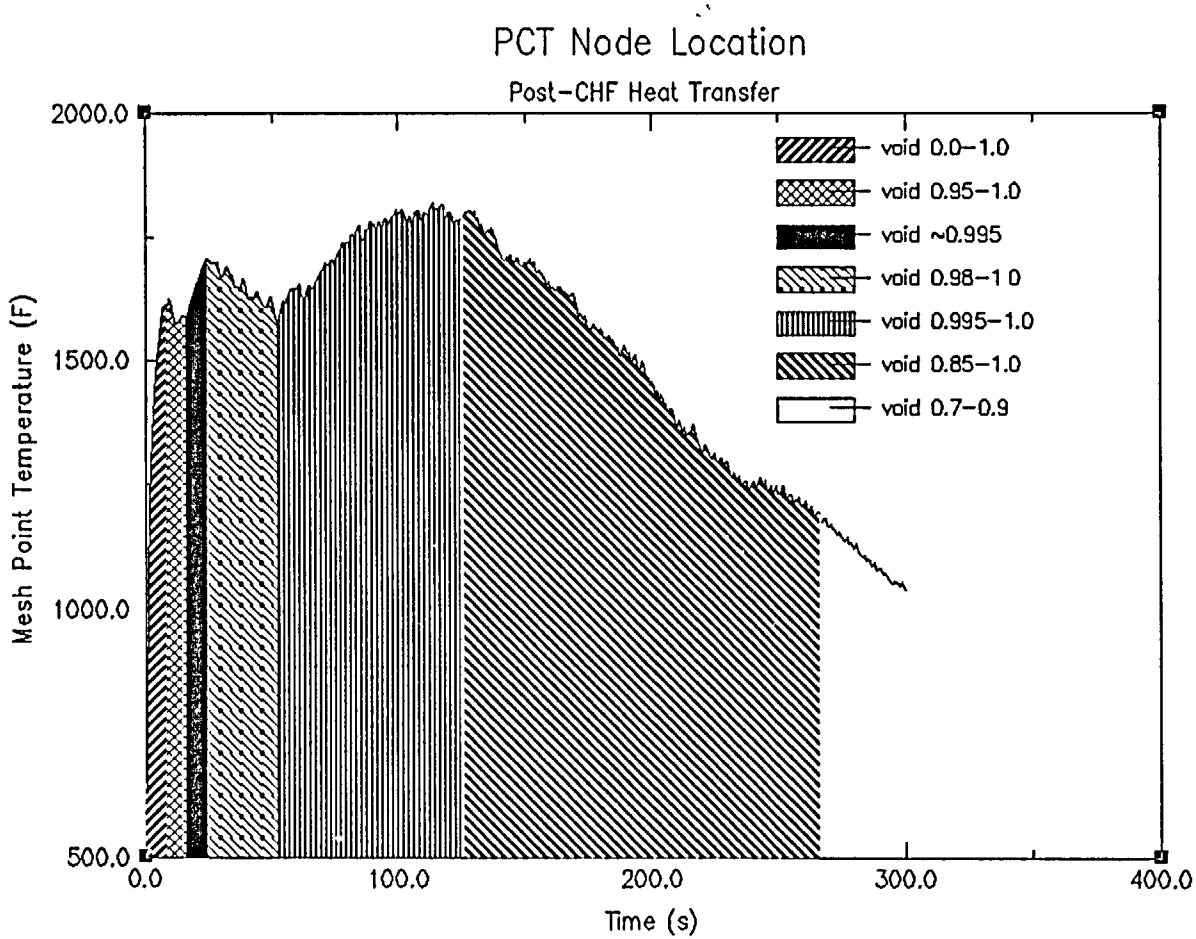
- FRMATOME-ANP HAS PROVIDED DOCUMENTATION ON THE FROZEN CODE VERSION SUCH THAT EVALUATION OF THE CODE'S APPLICABILITY TO THE POSTULATED LBLOCA TRANSIENT SCENARIO COULD BE PERFORMED

SAFTEY EVALUATION REPORT REVIEW
THERMAL-HYDRAULIC MODELS

- HEAT TRANSFER MODELING WAS EVALUATED BY REQUESTING THAT FRAMATOME-ANP IDENTIFY THE HEAT TRANSFER CORRELATIONS USED FROM TRANSIENT INITIATION TO QUENCH AT THE HOT SPOT. FRAMATOME-ANP PROVIDED TABLES THAT LISTED THE PHASE OF THE TRANSIENT VS THE TIME WITH THE CORRELATIONS, RANGE OF VALIDITY OF THEIR DATA BASE AND THE THERMAL-HYDRAULIC CONDITIONS PRESENT.

- PLOTS WERE ALSO PROVIDED GIVING TEMPERATURE VS TIME WITH APPROPRIATE VOID FRACTIONS IDENTIFIED FOR THE PCT LOCATION, AS WELL AS A LOWLEVEL ON THE HOT ROD.

SAFETY EVALUATION REPORT REVIEW
THERMAL-HYDRAULIC MODELS



SAFETY EVALUATION REPORT REVIEW
THERMAL-HYDRAULIC MODELS

- DOMINANT PHASE IN LBLOCA IS REFLODD, AND IN PARTICULAR, DISPERSED FLOW FILM BOILING HEAT TRANSFER

- SLEICHER-ROUSE SINGLE PHASE VAPOR CORRELATION HAS REPLACED MORE COMMONLY USED DITTUS-BOLTER CORRELATION

- DISPERSED FLOW REGIME USES BROMLEY CORRELATION AND FROSLUN-ROHSENOW CORRELATIONS, WITH LINEAR INTERPOLATION BETWEEN THE TWO

- STAFF QUESTIONS THE USE OF FORSLUND-ROHSENOW DISPERSED FLOW CORRELATION WHEN THE WALL TEMPERATURE IS ABOVE THE MINIMUM FILM BOILING TEMPERATURE. FRAMATOME-ANP PERFORMED CALCULATIONS IN WHICH FORSLUND-ROHSENOW CORRELATION WAS MULTIPLIED BY ZERO WHEN THE WALL TEMPERATURE EXCEEDED THE MINIMUM FILM BOILING TEMPERATURE. THIS RESULTED IN A VARIANCE IN TEMPERATURE OF -5 TO +18°f, EXTENDED THE QUENCH TIME, BUT HAD NO EFFECT ON PCT.

SAFETY EVALUATION REPORT REVIEW
THERMAL-HYDRAULIC MODELS

- DECAY HEAT MODEL USES ANSI/ANS-5.1-1979
- COUNTER-CURRENT FLOW LIMIT MODEL IS USED IN THE CORE REGION BUT NOT IN THE DOWNCOMER. FRAMATOME-ANP WILL INSTALL A WARNING FLAG TO ALERT THE ANALYST SHOULD CCFL VIOLATIONS OCCUR IN THE DOWNCOMER.
- DOWNCOMER BOILING SENSITIVITY STUDIES WERE PERFORMED AND INDICATED THAT THE PCT WAS AFFECTED BY LESS THAN 100°F WHEN CONSIDERING NODALIZATION, CROSS-FLOW FORM LOSS, AND CONTAINMENT PRESSURE.
- FRAMATOME-ANP CONFIRMED THAT THEY DO NOT INCLUDE A DIRECT, NEGATIVE BIAS IN THEIR UNCERTAINTY METHODS SIMULATING ECCS BYPASS, THUS THEY ARE CONSERVATIVE AND ACCEPTABLE.

SAFETY EVALUATION REPORT REVIEW
UNCERTAINTY ANALYSIS

- UNCERTAINTY ANALYSIS REVIEW DESCRIBED BY Y. ORECHWA

SAFETY EVALUATION REPORT REVIEW
ASSESSMENT MATRIX

- AN ASSESSMENT MATRIX WAS DEVELOPED INCLUDING SEPARATE EFFECTS TESTS, INTEGRAL SYSTEM TESTS, AND THE LATEST FULL-SCALE TESTS FROM THE NRC SPONSORED 2D/3D PROGRAM
- STAFF REVIEW INCLUDED SPOT CHECKING OF CODING AND COMPARISON WITH THE DOCUMENTATION
- STAFF REVIEW INCLUDED RUNNING NUMEROUS PARAMETRIC STUDIES USING THE S-RELAP5 CODE
- DESCRIPTION OF WORK TO BE GIVEN BY S. COLPO

SAFETY EVALUATION REPORT REVIEW
CONCLUSIONS

- THE STAFF CONCLUDES FROM REVIEW OF THE DOCUMENTATION, CODE AND INPUT MODELS SUBMITTED BY FRAMATOME-ANP THAT THE S-RELAP5 RLBLOCA METHODOLOGY IS STRUCTURED CONSISTENT WITH THE GUIDELINES OF THE CSAU METHODOLOGICAL PROCESS AND ADDRESSES THE LICENSING REQUIREMENTS FOR A VARIETY OF SIMILARLY DESIGNED NUCLEAR POWER PLANTS.

- SPECIFICALLY, THE METHODOLOGY IS APPLICABLE TO 3- AND 4-LOOP WESTINGHOUSE AND CE DESIGNED SYSTEMS.

- THE MODEL APPLIES TO BOTTOM REFLOOD PLANTS ONLY. IF A TOP DOWN QUENCH OCCURS, THE MODEL IS TO BE JUSTIFIED.

- THE MODEL DOES NOT DETERMINE WHETHER LONG TERM COOLING HAS BEEN SATISFIED AS THIS IS DETERMINED BY THE INDIVIDUAL LICENSEE AS PART OF THE APPLICATION OF THIS METHODOLOGY.

Assessment and Ranging of Parameters (CSAU Element 2)

> Effects of Scale (CSAU Step 10)

- Potential code scaling effects must be quantified for bias and deviation
  - Scale effects address two issues
    - First is the scalability of the tests to a NPP
    - Second is the scalability of the code models from the tests to the NPP
  - Scalability of tests
    - Blowdown
      - Power-to-volume scaling demonstrated applicable for blowdown phase
    - Refill
      - Power-to-volume scaling demonstrated not applicable to refill phase
      - Full scale UPTF tests used to address refill phase
    - Reflood
      - Power-to-volume scaling demonstrated applicable for reflood phase

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Assessment and Ranging of Parameters (CSAU Element 2)

> Effects of Scale (CSAU Step 10)

- Potential code scaling effects must be quantified for bias and deviation
  - Scalability of Code models
    - Single-phase vapor heat transfer model demonstrated scalable
    - Film boiling heat transfer model demonstrated scalable
    - Core entrainment model demonstrated conservative and scalable
    - Critical flow model demonstrated by application to full scale tests
    - Carry-over to steam generator demonstrated conservative
    - Pump model uses full scale pump data with two-phase degradation
    - Cold leg condensation model validated on full scale UPTF test
    - ECCS downcomer bypass demonstrated conservative for full scale UPTF tests
    - Lower plenum sweep-out demonstrated conservative for full scale UPTF tests

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Sensitivity and Uncertainty Analysis (CSAU Element 3)

> Total Uncertainty (CSAU Step 14)

- The statement of total uncertainty for the analysis is given as a statement of probability for the limiting value of the primary safety criteria
- For the 4-loop sample problem the limiting values for the primary safety criteria are:

Criteria	Case 22
95/95 PCT	1686 F
Maximum Nodal Oxidation	0.8 %
Maximum Core Oxidation	0 02 %

50/50 PCT = 1375 F

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Sensitivity and Uncertainty Analysis (CSAU Element 3)

> Total Uncertainty (CSAU Step 14)

- The statement of total uncertainty for the analysis is given as a statement of probability for the limiting value of the primary safety criteria
- A 3-loop licensing analysis with 15x15 fuel has also been performed and the limiting values for the primary safety criteria are:

Criteria	Case 41
95/95 PCT	1853 F
Maximum Nodal Oxidation	1.3 %
Maximum Core Oxidation	0.04 %

50/50 PCT = 1500 F

FRAMATOME ANP

2D/3D Assessment Documentation Comparison Parametric Studies

Sarah E. Colpo
Reactor Systems

Code Assessment Against 2D/3D Tests

UPTF-CCTF-SCTF

- UPTF
- CCTF
- SCTF
- Bottom Line: Mostly "conservative"

Code/Documentation Comparison

Selected Line by Line Comparison

- Subroutines Reviewed:
  - CHFCAL
  - DITTSG
  - DITTUS
  - FILMBL
  - PREDNB
- Bottom Line: Changes needed for consistency

Parametric Studies

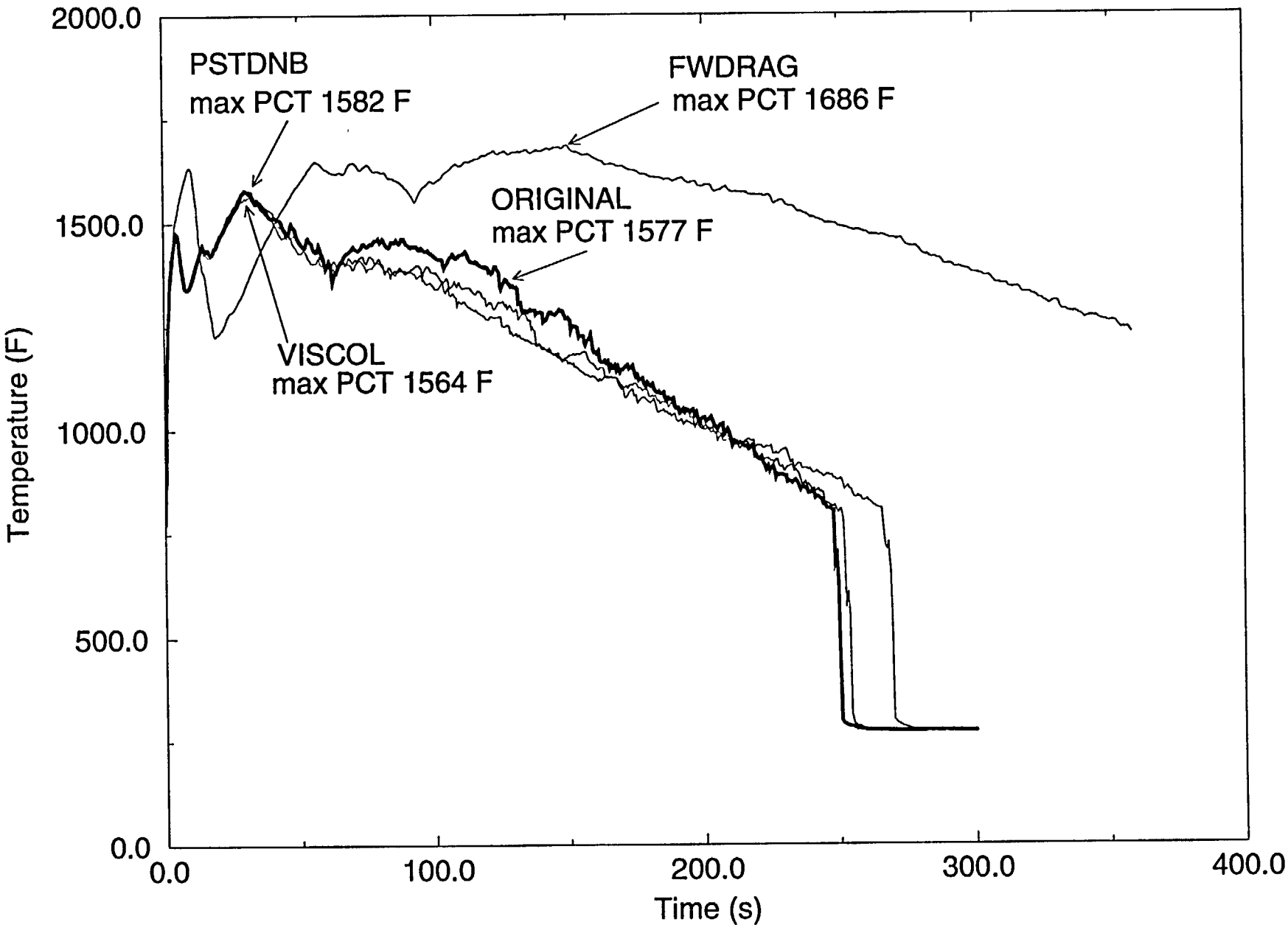
- FWDRAG, VISCOL and PSTDNB subroutines altered
- Bottom Line: FWDRAG had the most significant impact on PCT

Parametric Studies

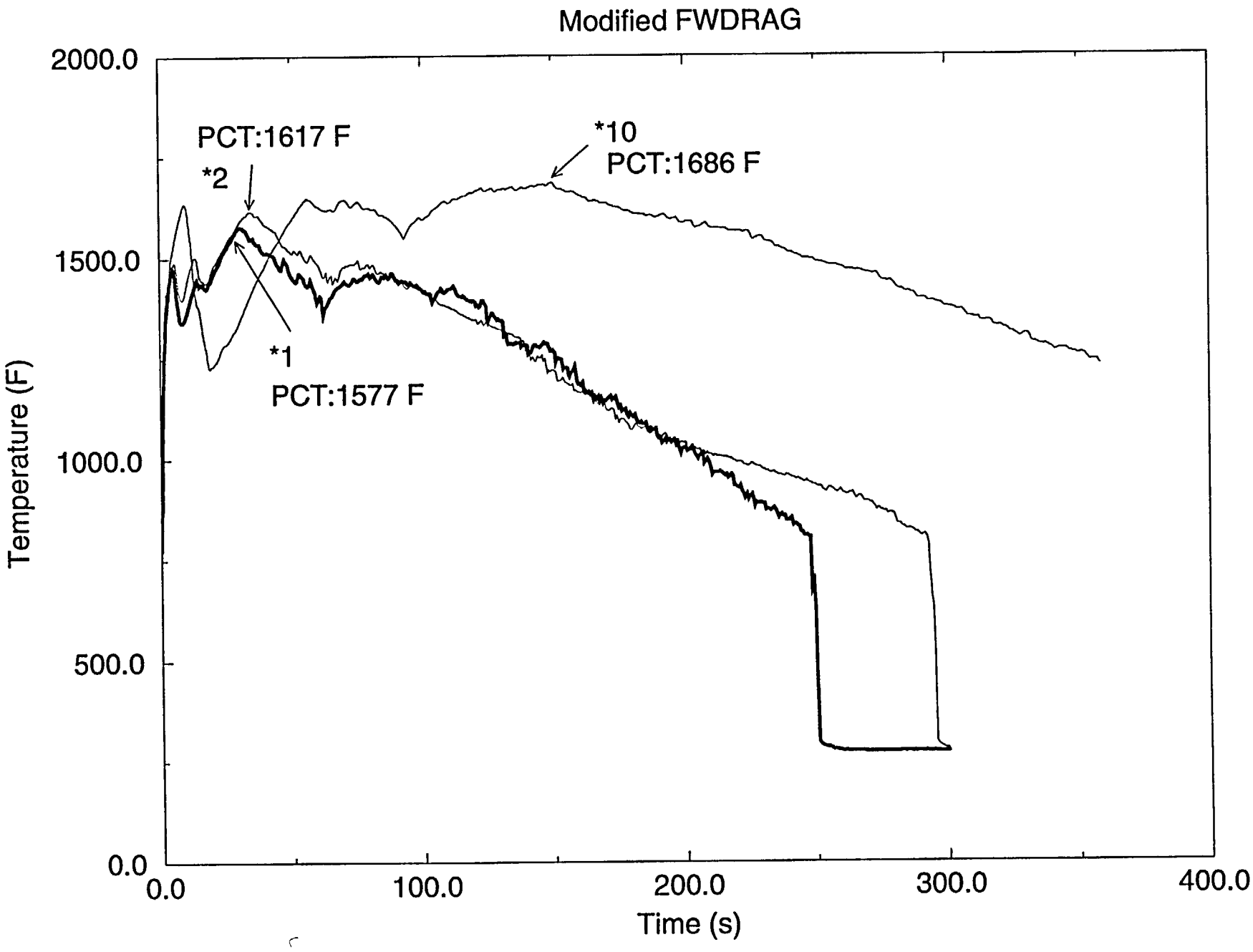
FWDRAG

- Wall drag multipliers of 1, 2, and 10 for PWR case
- Wall drag multipliers of 0.1, 1, 2, and 10 for FLECHT-SEASET Test 31504

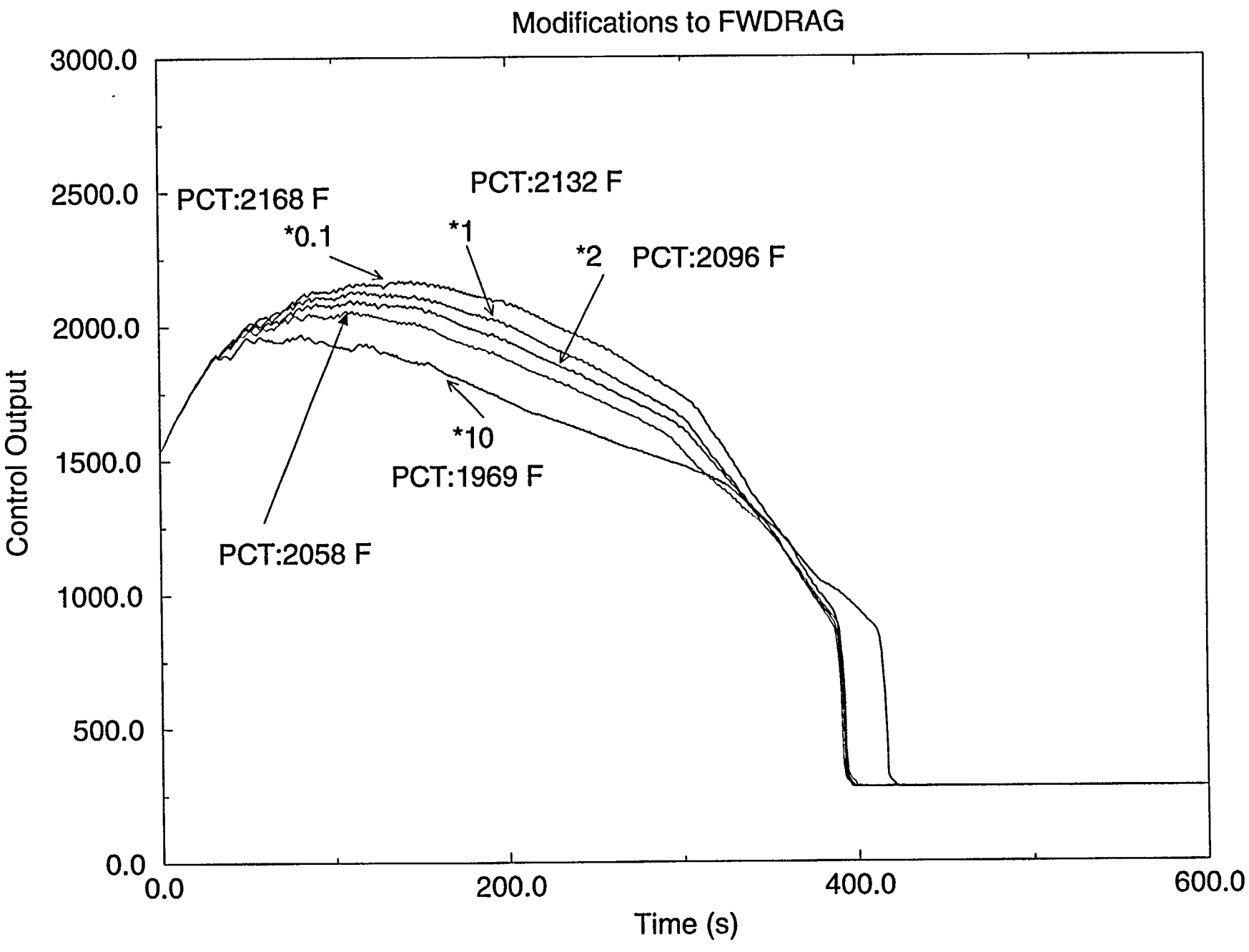
PCT Independent of Location – PWR



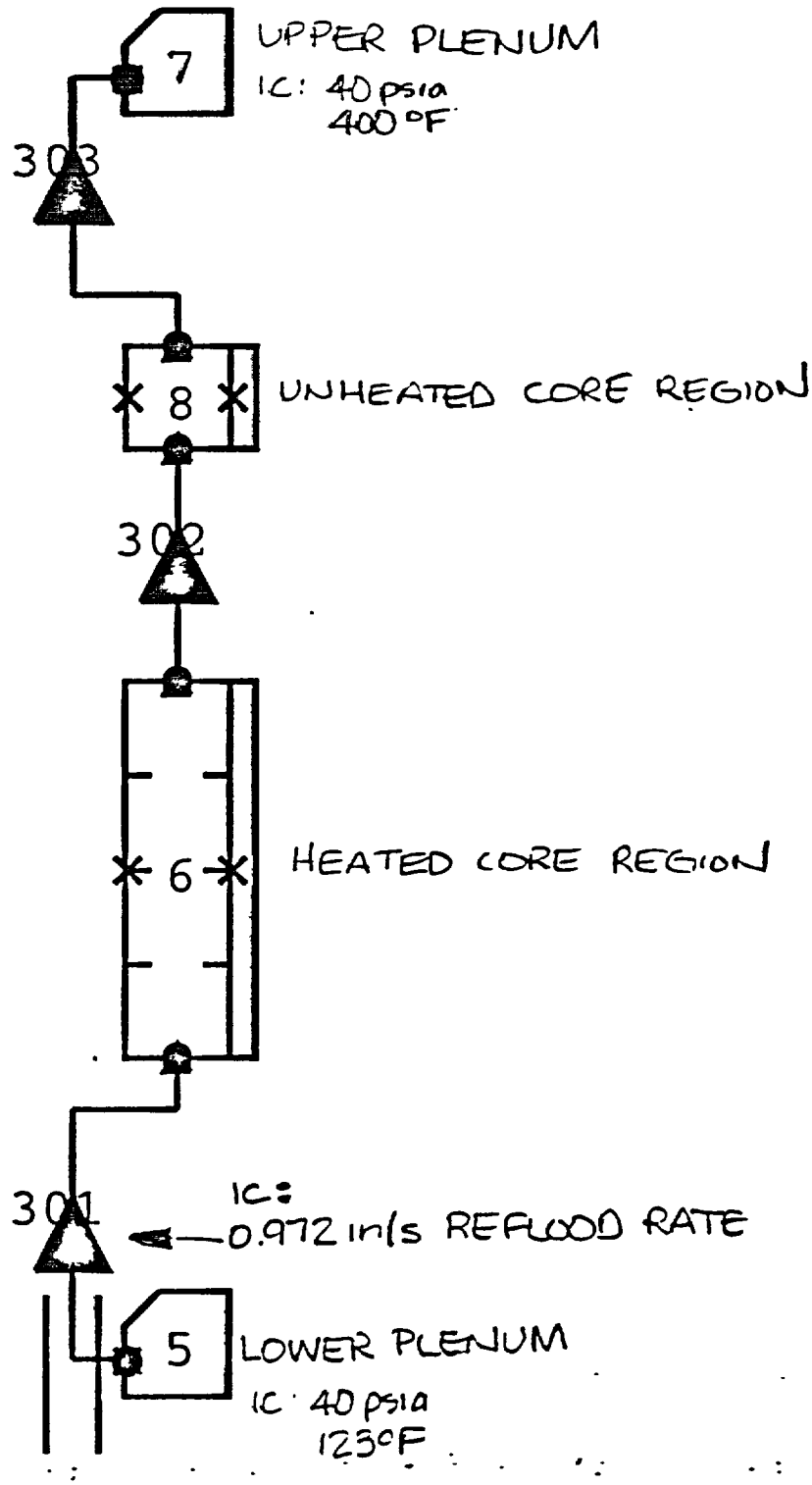
PCT Independent of Location – PWR



Peak Clad Temperature – FS 31504



FLECHT-SEASET 31504
NODALIZATION DIAGRAM

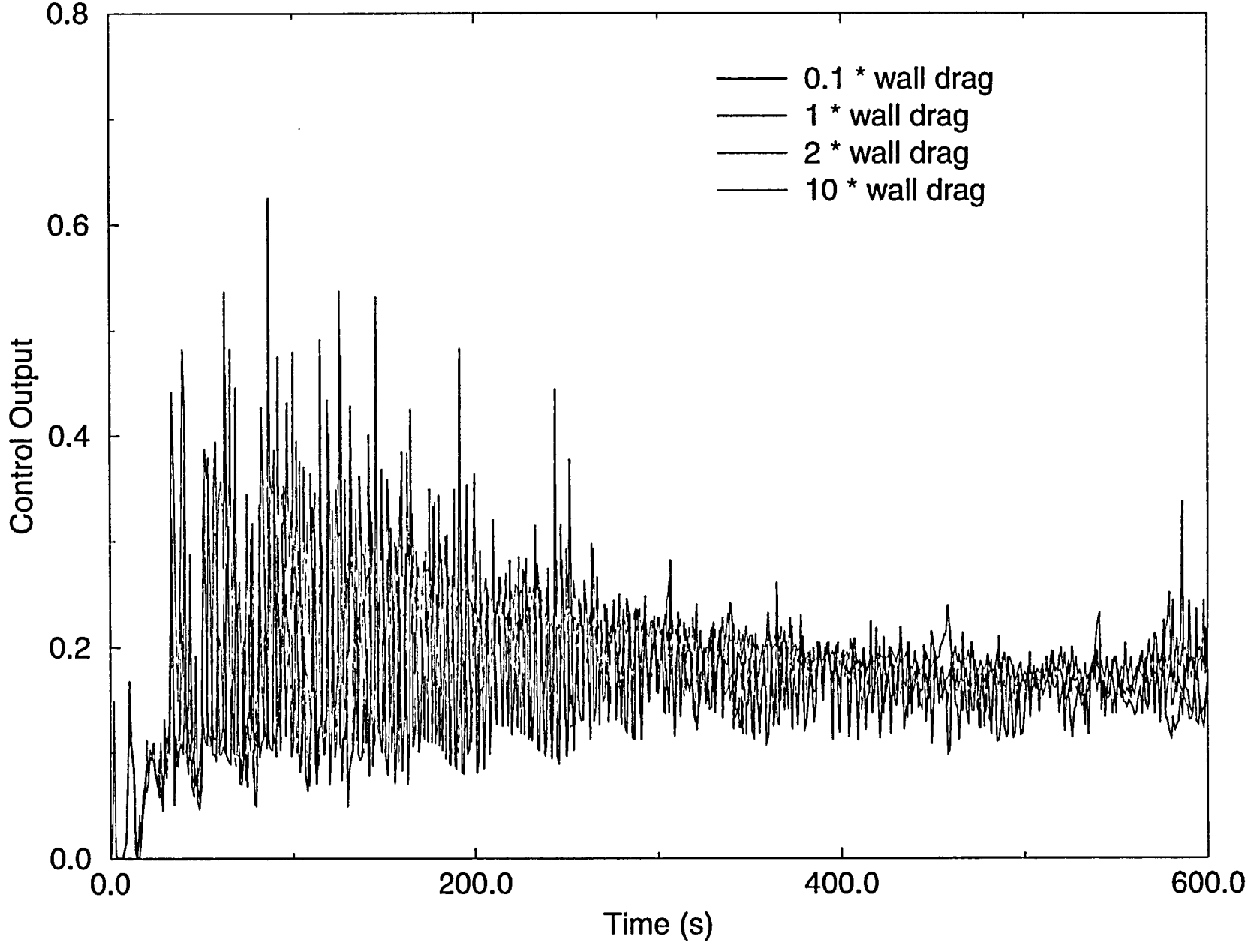


FLECHT-SEASET CORE

VOLUME	ELEVATION
	12.0 ft.
620	
	11.4
619	
	10.8
618	
	10.2
617	
	9.6
616	
	9.0
615	
	8.4
614	
	7.8
613	
	7.2
612	
	6.6
611	
	6.0
610	
	5.4
609	
	4.8
608	
	4.2
607	
	3.6
606	
	3.0
605	
	2.4
604	
	1.8
603	
	1.2
602	
	0.6
601	

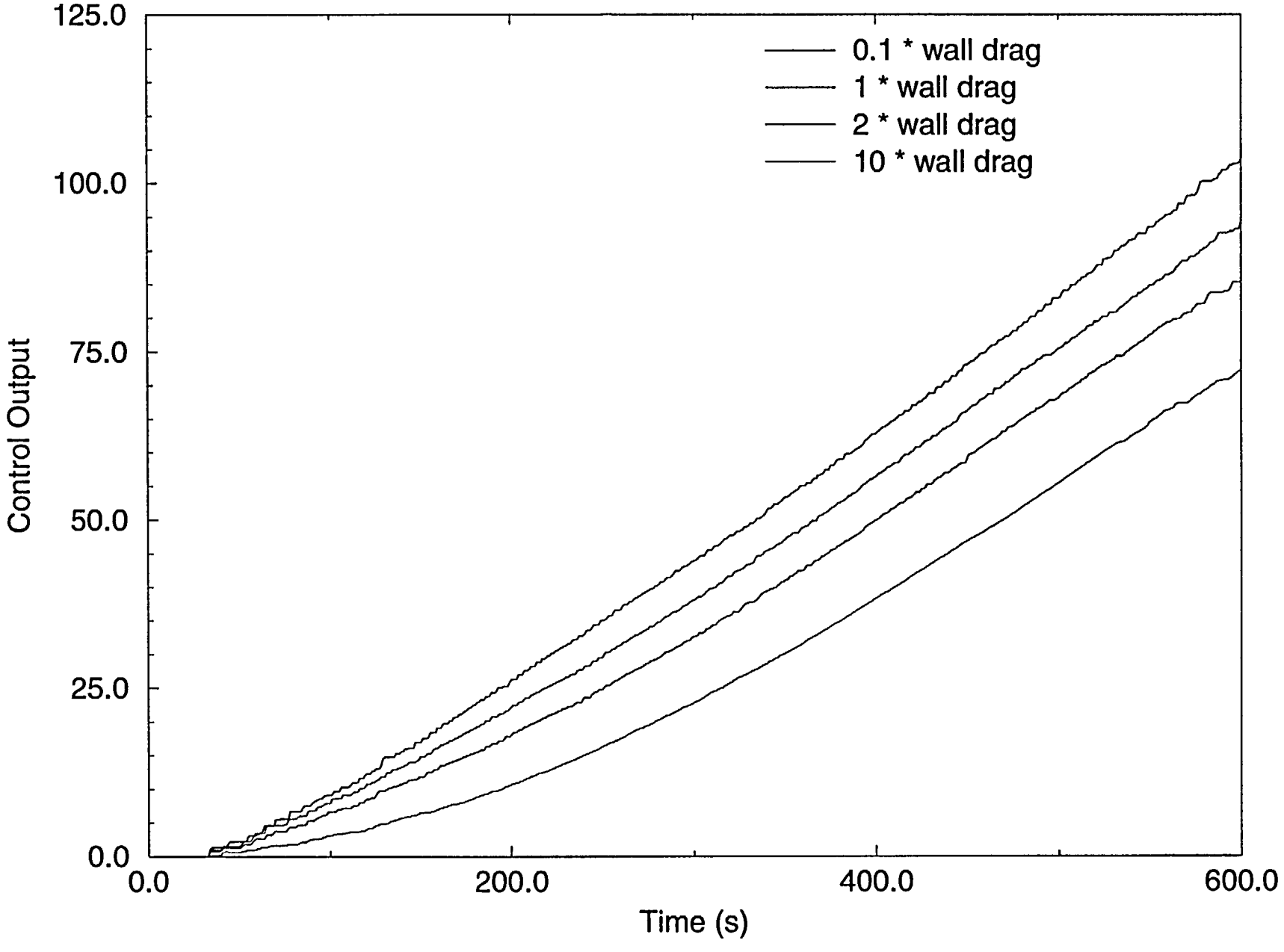
Steam Outflow Rate

Flecht–Seaset Test 31504



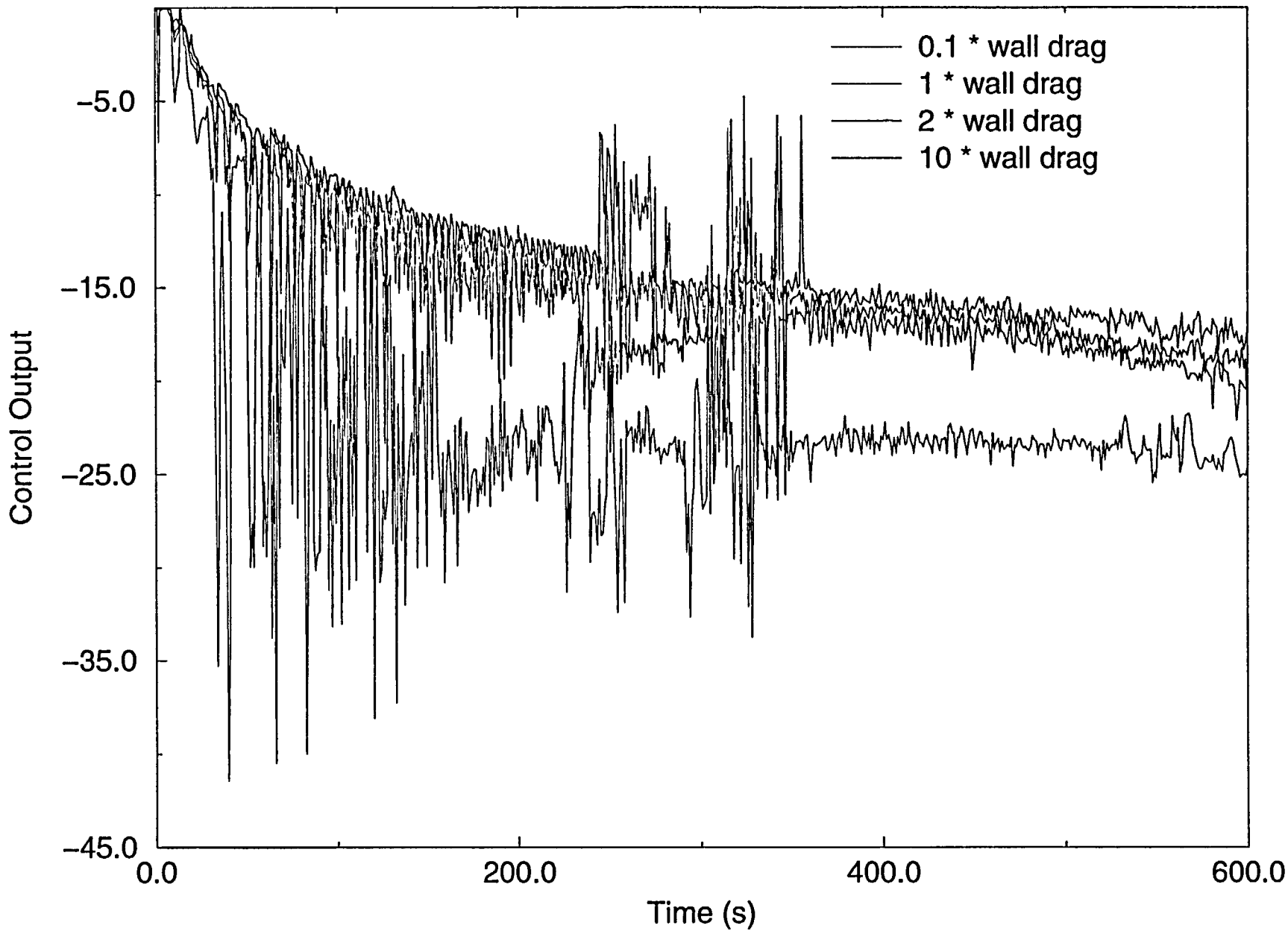
Liquid Outflow

Flecht–Seaset Test 31504



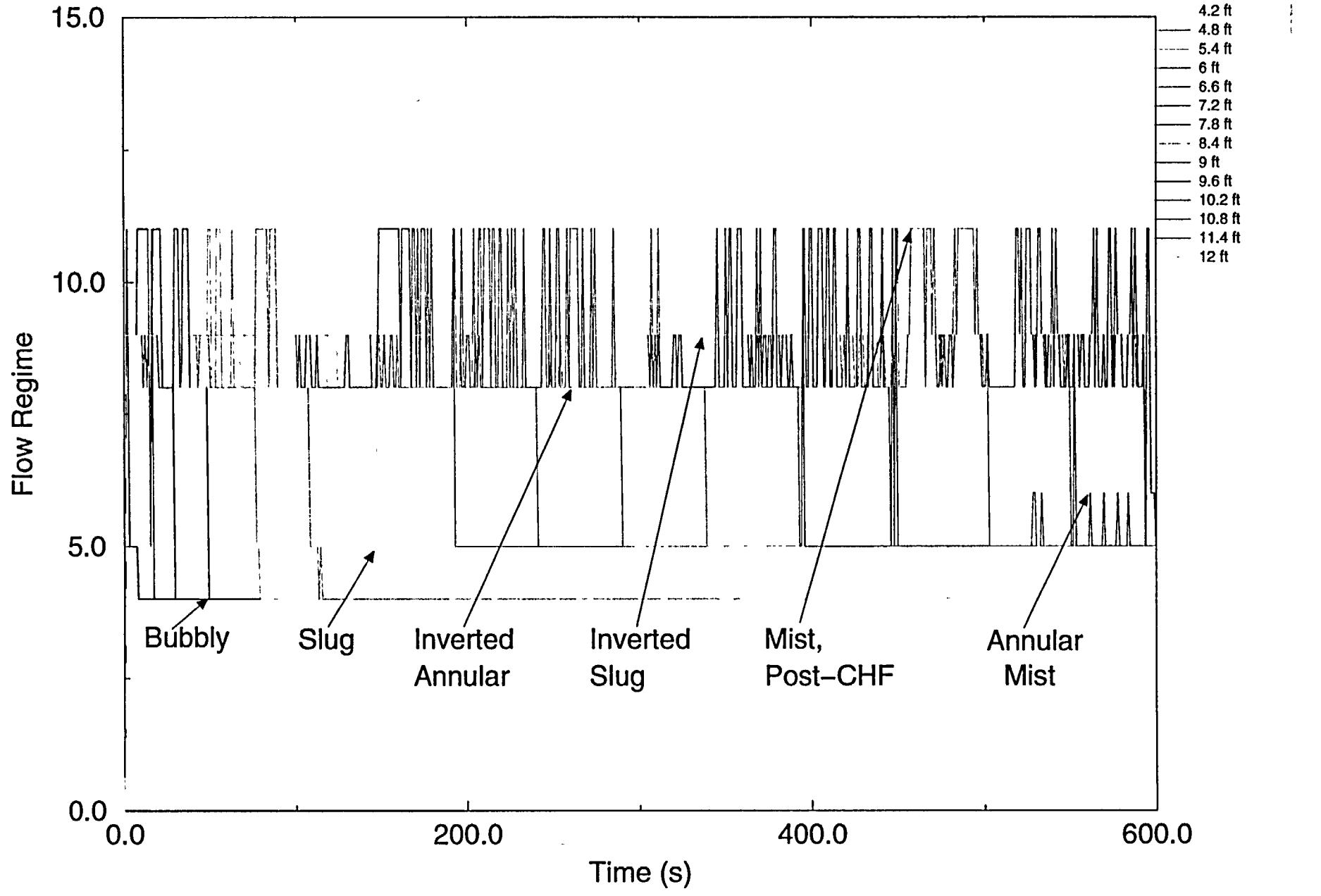
Differential Pressure

Flecht–Seaset 31504, 0–1 ft

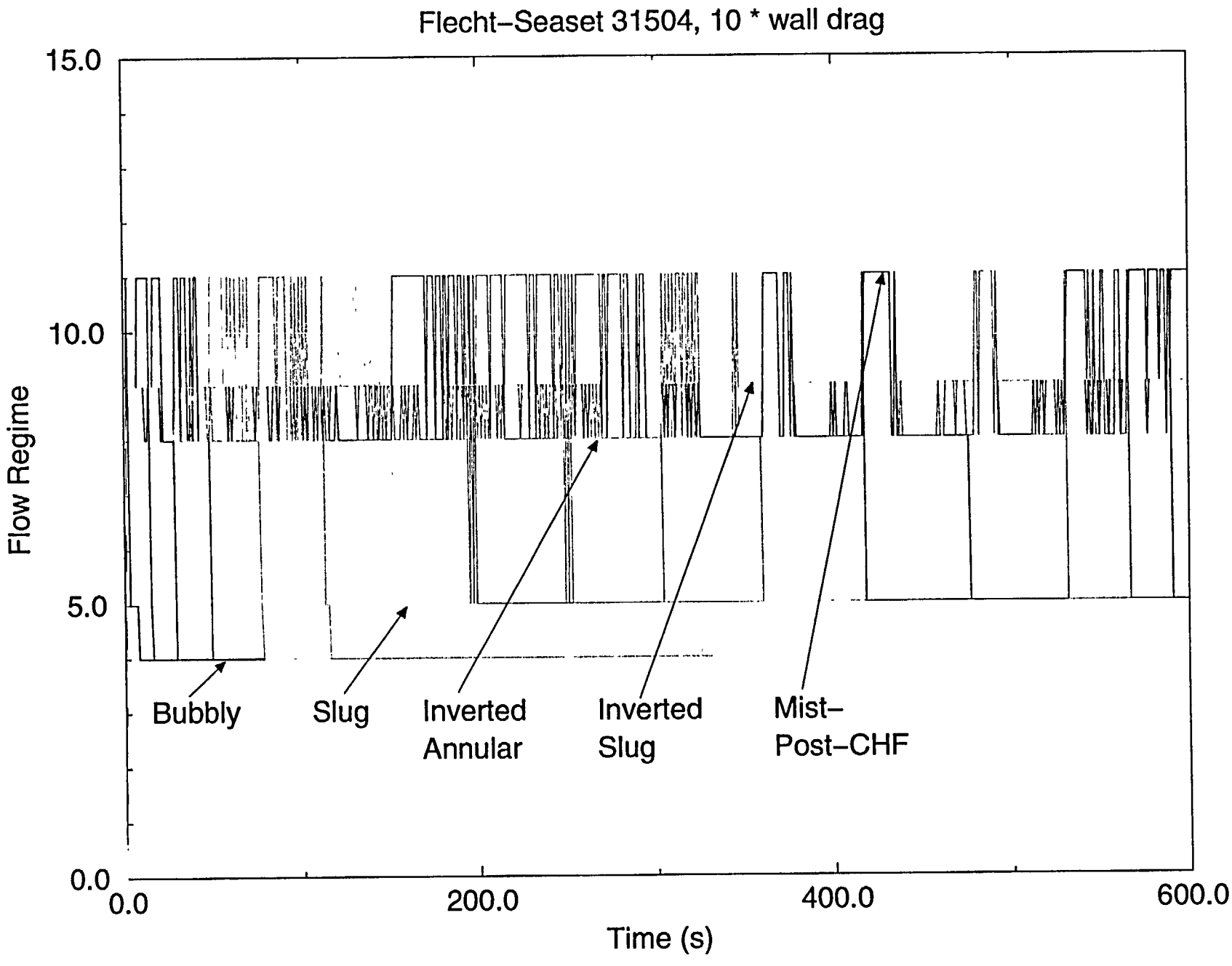


Flow Regimes

Flecht–Seaset 31504, 0.1 * wall drag

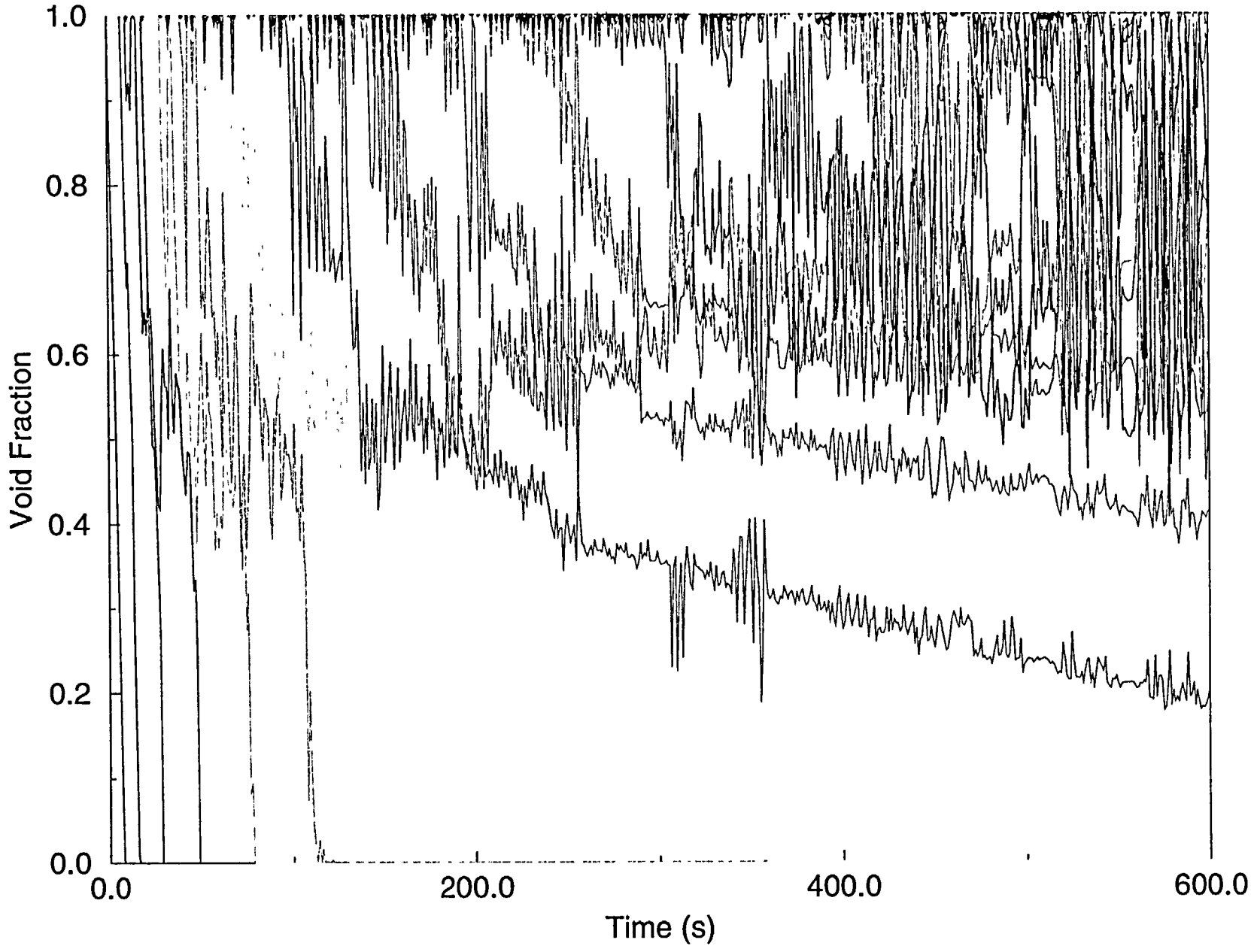


Flow Regimes



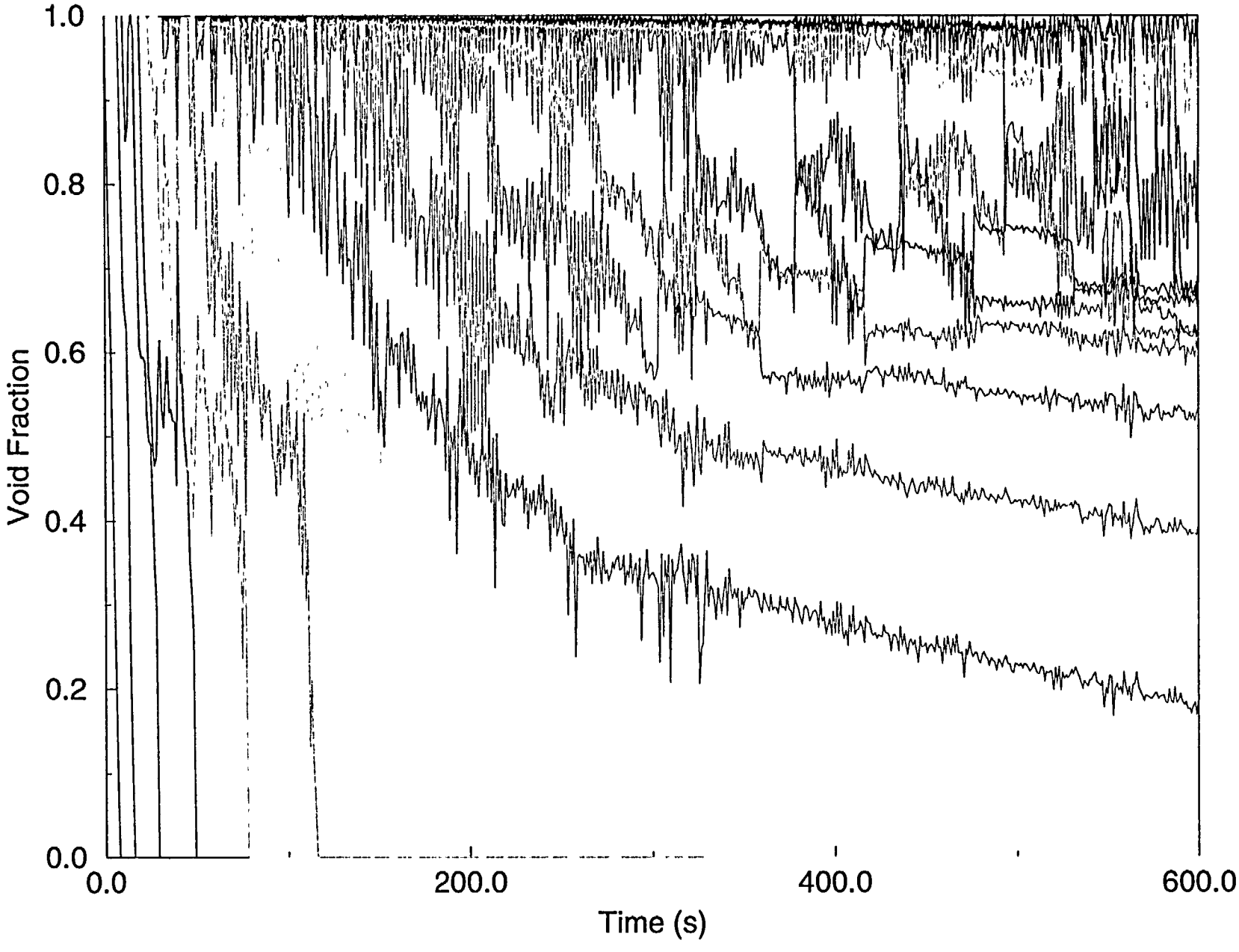
Void Fraction in Core

Flecht–Seaset 31504, 0.1 * wall drag



Void Fraction in Core

Flecht–Seaset 31504, 10 * wall drag



FRAMATOME ANP

Realistic LBLOCA Methodology Roadmap

November 13, 2002
Washington, D.C.

FRAMATOME ANP

Realistic LBLOCA Methodology Roadmap

> Purpose: The Methodology Roadmap will provide an upper level overview of the complete methodology

Realistic LBLOCA Methodology Roadmap

> Agenda

- Methodology Roadmap
  - Requirements and Capabilities
    - CSAU Element 1, Steps 1 through 6
  - Assessment and Ranging of Parameters
    - CSAU Element 2, Steps 7 through 10
  - Sensitivity and Uncertainty Analysis
    - CSAU Element 3, Steps 11 through 14

Requirements and Code Capabilities (CSAU Element 1)

> Specify Scenario (CSAU Step 1)

- Selection of the transient to be analyzed dictates the processes that must be addressed
  - Specified the large break LOCA scenario

> Select Plant (CSAU Step 2)

- Selection of plant type influences the dominant phenomena and their interactions
  - Selected W 3- and 4-loop plants and CE plants
  - All three plant types have inverted U-tube steam generators, a pressurizer connected to a hot leg, and ECCS injection into the cold legs
  - Experience with Appendix K LBLOCA analyses indicate that all three plant types behave similarly in the blowdown, refill, and reflood phases of a LBLOCA

Requirements and Code Capabilities (CSAU Element 1)

> Identify and Rank Phenomena (CSAU Step 3)

- Develop Process Identification and Ranking Table (PIRT)
  - Performed by experts who are knowledgeable of specified LBLOCA scenario
  - The PIRT identifies and ranks the important phenomena for the specified LBLOCA scenario and plant types
    - The important phases of the LBLOCA scenario are defined
    - The important plant components are identified
    - The important phenomena in each component during each phase are identified
    - The relative importance of each phenomenon during each LOCA phase is identified

Requirements and Code Capabilities (CSAU Element 1)

> Identify and Rank Phenomena (CSAU Step 3)

- The PIRT provides the basis for
  - Determining code applicability (does the code model the important phenomena and plant components)
  - Establishing the assessment matrix (identifying test data that contain the appropriate phenomena during each accident phase)
  - Identifying important phenomena to be quantified and ranged for evaluating uncertainties

Requirements and Code Capabilities (CSAU Element 1)

> Identify and Rank Phenomena (CSAU Step 3)

- PIRT Development Process
  - Initial PIRT developed from Compendium
    - Average of expert and analytical hierarchy process ranking
  - Initial PIRT reviewed by three independent experts
    - Additional phenomena and ranking changes recommended
  - Final PIRT generated through peer review (Table 3.4 of EMF-2103(P))
    - Framatome ANP personnel
    - External experts (Dr Hochreiter and M J Thurgood)
    - Consistent definitions applied for LBLOCA phases and phenomena

Requirements and Code Capabilities (CSAU Element 1)

> Identify and Rank Phenomena (CSAU Step 3)

- LBLOCA Phases
  - Blowdown: Defined as the time period from initiation of the break until flow from the accumulators or safety injection tanks begins
  - Refill: Defined as the time period from end-of-blowdown until the mixture level in the vessel refills the lower plenum and begins to flow into the core
  - Reflood: Defined as the time period from initiation of flow into the bottom of the core until the temperature transient is completed

Requirements and Code Capabilities (CSAU Element 1)

> Identify and Rank Phenomena (CSAU Step 3)

- Final PIRT
  - Numerous minor changes to phenomenon rankings
  - Single-phase natural convection deleted from PIRT
    - Covered in post-CHF heat transfer
  - 3D flow, void distribution and generation combined into single phenomena
    - Flow and void distribution directly related
  - Accumulator discharge added to PIRT
    - Discharge rate significant parameter in determining refill and reflood rates
  - Upper head component
    - Initial upper head temperature expected to have some impact on blowdown

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- Frozen versions of computer codes used for consistency throughout process
  - Selected frozen versions of RODEX3A and S-RELAP5
    - ICECON containment code included into S-RELAP5
  - RODEX3A code version UJUN00 used in all fuel rod analyses
  - Two versions of S-RELAP5 used in reported analyses, UJUL00 and UMAR01
    - UMAR01 included the addition of the final set of multiplication factors for the uncertainty analysis and corrections to the RODEX3A implementation in S-RELAP5
      - RODEX3A corrections were the result of the RODEX3A implementation verification
    - UJUL00 used for many of the assessments with electrical heater rods
    - UMAR01 used for some of the assessments with electrical heater rods and all analyses with nuclear fuel rods

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- S-RELAP5 Development
  - Initial code was RELAP5/MOD2 Cycle 36.02
  - Revisions to create ANF-RELAP from RELAP5/MOD2
    - For SBLOCA
      - Addition of Moody critical flow model as required by Appendix K
      - Revised nucleate boiling correlation to remove interpolation between regimes
      - Addition of a new mixture level model
      - Installed new Kutateladze CCFL limitation at core upper tie plate
    - For steam line break
      - Extended Biasi CHF correlation for steam generator secondary
      - Addition of model to restrict steam only flow out the break
    - No specific changes made to support other non-LOCA transients

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- S-RELAP5 Development (cont.)
  - Revisions to create S-RELAP5 from ANF-RELAP
    - Two-dimensional treatment added to hydrodynamic field equations
      - Typically applied in core, downcomer, and upper plenum
    - Improved energy conservation calculation when a large ΔP is calculated
      - Required to calculate containment pressure for LBLOCA
    - Replaced numerical solution with algebraic solution for the reduction of finite difference equations to a pressure equation
      - Provides more robust solution
    - Modified state of steam-noncondensable mixture
      - Allows pure noncondensable below ice point
    - Hydrodynamic constitutive models
      - Modified interphase friction and interphase mass transfer models consistent with published correlations and modified flow regime transitions to obtain smoother solution
      - Vertical and horizontal stratification models were improved
      - Better approximation for Colebrook wall friction factor

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- S-RELAP5 Development (cont.)
  - Revisions to create S-RELAP5 from ANF-RELAP
    - Heat transfer model
      - Lahey corrections for vapor generation in the subcooled boiling region were implemented
      - Replaced Dittus-Boelter correlation with Sleicher-Rouse correlation for single-phase steam convection heat transfer
    - Choked flow
      - To determine state at break, iterative scheme replaced use of old time step values
      - Smoothed subcooled single phase critical flow transition to two-phase critical flow
    - Counter-current flow limiting
      - The Kutateladze type CCFL correlation was replaced with the Bankoff form

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- S-RELAP5 Development (cont.)
  - Revisions to create S-RELAP5 from ANF-RELAP
    - Fuel models
      - RODEX2 fuel models incorporated for SBLOCA
      - NUREG 0630 cladding swelling and rupture models were added
      - Blockage flow diversion model from TOODEE2 code was added
      - Baker-Just metal water reaction calculation was added
      - Calculation of total transient generated oxidation
      - RODEX3A fuel models incorporated for Realistic LOCA model
      - Cathcart-Pawel metal-water reaction calculation added for Realistic LOCA model

Requirements and Code Capabilities (CSAU Element 1)

> Select Frozen Codes (CSAU Step 4)

- S-RELAP5 Development (cont.)
  - Revisions to create S-RELAP5 from ANF-RELAP
    - Component models
      - Pump head in field equations made semi-implicit
      - Implemented CE/EPRI two-phase pump degradation model
      - Capability to run concurrent containment calculation using ICECON was added
    - RELAP5/MOD3 changes
      - Code structure for S-RELAP5 modified to be essentially the same as RELAP5/MOD3 for code portability
      - Reactor kinetics from RELAP5/MOD3
      - Control systems from RELAP5/MOD3
      - Trip systems from RELAP5/MOD3

Requirements and Code Capabilities (CSAU Element 1)

> Provide Complete Documentation (CSAU Step 5)

- Documentation supporting the codes must be consistent with the frozen code versions
  - Developed models and correlations document, programmers guide, and user manuals for frozen codes
  - Code verification performed to insured consistency between codes and associated documentation
    - Performed with a combination of Framatome ANP and external personnel
    - Verification consisted of going through the coding to ensure that the models in the documentation were actually in the code and were coded correctly
    - Performed for RODEX3A and S-RELAP5 (including ICECON) models

Requirements and Code Capabilities (CSAU Element 1)

> Determine Code Applicability (CSAU Step 6)

- Confirm presence of code models for important phenomena in PIRT
  - Verification performed on S-RELAP5 confirmed presence of documented models
  - Presence of PIRT required conservation and closure equations confirmed in S-RELAP5
  - Code numerics demonstrated through the performance of code sensitivity studies, assessments, and sample problem analyses
  - Code ability to model selected NPP confirmed by comparison of required NPP components and code component modeling capabilities
- S-RELAP5 demonstrated to meet requirements

Assessment and Ranging of Parameters (CSAU Element 2)

> Assessment Matrix (CSAU Step 7)

- Select assessment matrix of separate and integral effect tests (SET/IET)
  - Support code evaluation of important PIRT phenomena
    - Defined as those phenomena ranked 5 or higher
  - Provide validation of selected NPP nodalization
  - Support demonstration of code scalability from experimental facilities to NPP
  - Support demonstration that even if compensating errors exist in the code, the code is capable of reliably predicting the selected scenario

Assessment and Ranging of Parameters (CSAU Element 2)

> Assessment Matrix (CSAU Step 7)

- PIRT Phenomena
  - Sensitivity analyses were performed for all phenomena ranked 5 or higher
    - Over 250 analyses performed using the input decks for the 3 and 4-loop NPP
    - Sensitivity results classified as high, medium, and low
  - Based on the results of the sensitivity studies
    - Experimental facilities and specific tests were chosen for the important phenomena
    - Required plant data identified

Assessment and Ranging of Parameters (CSAU Element 2)

> Assessment Matrix (CSAU Step 7)

- Nodalization
  - Based on the assessment matrix generated from the PIRT, only the SCTF was added to specifically address nodalization
- Scaling Considerations
  - The assessment matrix generated for the PIRT covered a scaling range from 1:1500 to 1:1
  - Counter part LOFT and Semiscale integral effect tests were selected to specifically support scaling

Assessment and Ranging of Parameters (CSAU Element 2)

> Assessment Matrix (CSAU Step 7)

- Compensating Errors
  - Occur if/when an error in one code model is compensated for by an error in another code model
  - May result in the code being able to predict some assessments but not others or produce different results in the assessments and the NPP calculations
  - Addressed by including integral effect and larger scale separate effect tests in the assessment matrix
    - FLECHT, FLECHT-SEASET, SCTF, CCTF, and THTF for core phenomena
    - UPTF for most other NPP components
    - LOFT and Semiscale for integral LBLOCA scenario evaluation

Assessment and Ranging of Parameters (CSAU Element 2)

> Final Assessment Matrix

> Facility	Tests	Assessment Purpose
THTF Heat Transfer	35	Heat transfer
THTF Level Swell	3	Void distributions
GE Level Swell	1	Void distributions
FRIGG-2	27	Void distributions
Bennett Tube	2	Heat transfer
FLECHT-SEASET and FLECHT	9	Heat transfer, Nodalization, Axial power distributions, Scalability, Upper plenum and hot leg entrainment
PDTF/SMART	4	Spacer effects
Marviken	9	Break flow

Assessment and Ranging of Parameters (CSAU Element 2)

> Final Assessment Matrix (continued)

> Facility	Tests	Assessment Purpose
W/EPRI 1/3 Scale	9	Cold leg condensation, Interfacial heat transfer
Mini-loop CCFL	3	Upper tie plate CCFL
Multi-dimensional flow	3	Core flow distributions
UPTF	14	ECCS bypass, Steam binding, CCFL, Scalability, Nodalization
CCTF	4	Steam binding, Nodalization, Scalability
SCTF	6	Nodalization
ACHILLES	1	Accumulator nitrogen discharge

Assessment and Ranging of Parameters (CSAU Element 2)

> Final Assessment Matrix (continued)

> Facility	Tests	Assessment Purpose
LOFT	4	Overall code performance, Nodalization, Scalability, Compensating errors
Semiscale	2	Blowdown heat transfer, Nodalization, Scalability, Compensating errors

15 SET facilities and 130 tests evaluated

2 IET facilities and 6 tests evaluated

For all electronic data sets, validated data versus published reports

Assessment and Ranging of Parameters (CSAU Element 2)

> Nodalization (CSAU Step 8)

- Select common nodalization for use in SET, IET, and plant analyses
  - Selected nodalization must
    - Preserve dominant phenomena
    - Minimize code uncertainty
    - Support NPP design characteristics
    - Remain economical

Assessment and Ranging of Parameters (CSAU Element 2)

> Nodalization (CSAU Step 8)

- Select common nodalization for use in SET, IET, and plant analyses
  - Initial nodalization selected based on previous industry and Framatome ANP experience
  - Revised based on initial plant model studies
  - Further revised based on peer review
  - Final nodalization validated/refined based on performance of SET and IET assessments
    - UPTF, SCTF, CCTF, and FLECHT-SEASET
    - LOFT and Semiscale

Assessment and Ranging of Parameters (CSAU Element 2)

> Nodalization (CSAU Step 8)

- Select common nodalization for use in SET, IET, and plant analyses
  - Key features of the RLBLOCA plant nodalization is the use of 2-dimensional components in the reactor vessel model
    - Downcomer
    - Core
    - Upper plenum

Deconstruction of the S-Relap5 Realistic Large Break LOCA Best-Estimate Analysis Methodology

Y. Orechwa

NRR/DSSA/SRXB

Mtg. of the ACRS subcommittee on thermal-hydraulics (Nov. 14, 2002)

I. " The basis for the analysis of a RLBLOCA is the entire methodology being used, not just the base code, S-Relap5. "

II. "The FRA-ANP RLBLOCA methodology is a statistics-based methodology"

III. "A non-parametric statistical approach was selected"

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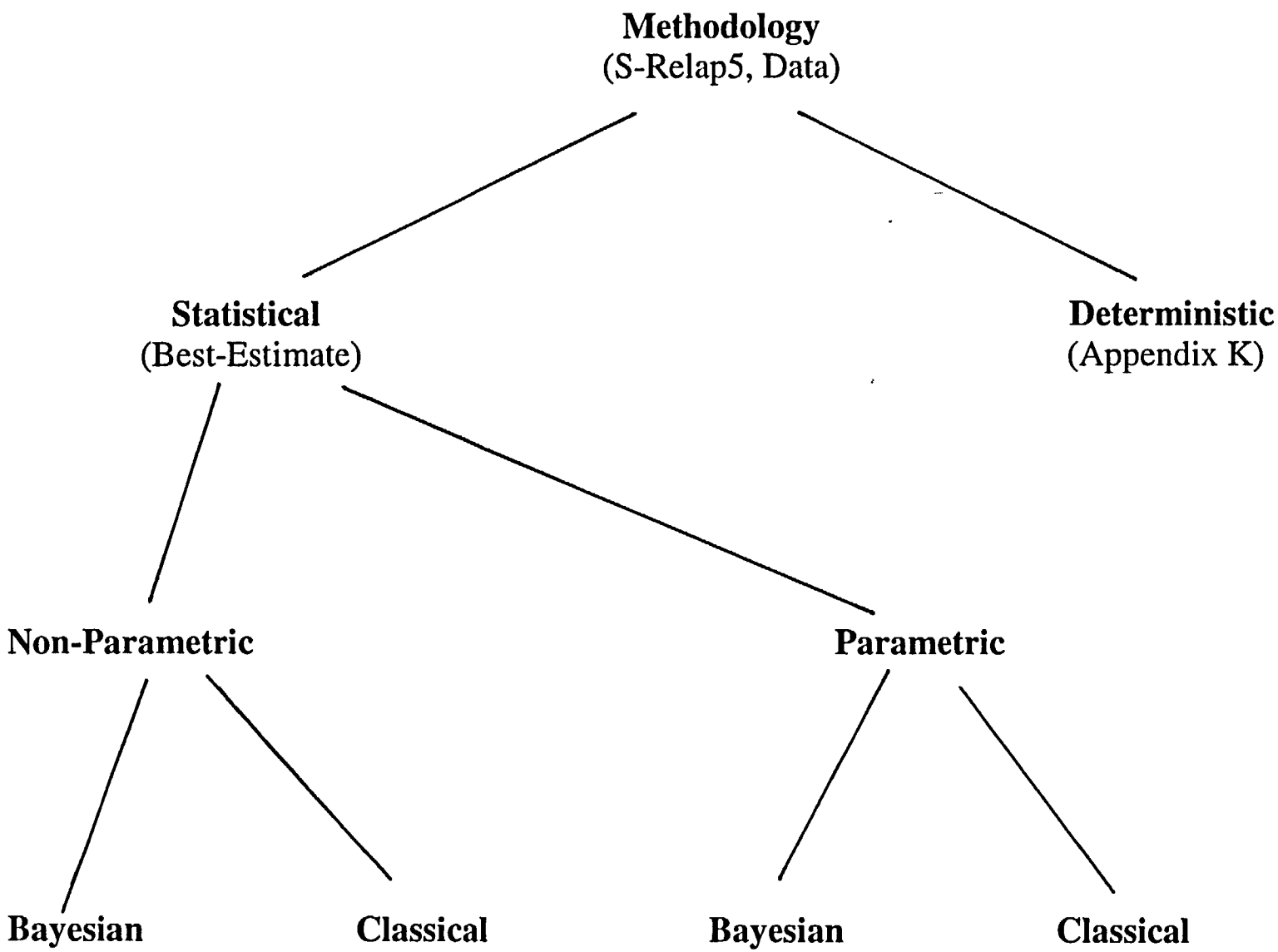
Methodology
(S-Relap5, Data)
Statistical
(Best-Estimate)
Deterministic
(Appendix K)
Non-Parametric
Parametric
Bayesian
Classical
Bayesian
Classical

Tolerance Limit $\leftrightarrow$ [β, γ, n]

$\beta \equiv$ fraction of population, probability
$\gamma \equiv$ confidence level
n $\equiv$number of observations in the sample

A. Non-parametric

Assumption: Population distribution is continuous

Statistical Theory: $F[\beta, \gamma, n] = 0$

1. Choose (β, γ) $\Rightarrow$ n
2. Take sample $\{x_n\}$
3. $x^{(n)}$ = tolerance limit (β, γ)

B. Parametric

Assumption: Population distribution is "known"

Statistical Theory: Estimate population distribution (ex. N, μ, Σ)

1. Choose n and take sample $\{x_n\}$
2. $\{x_n\} \rightarrow \mu, \Sigma$, test normality
3. Based on (N, μ, Σ) compute tolerance limit (β, γ)

Framatome's RLBLOCA Analysis Methodology:

Objective: Estimate the performance figures of merit $P(\theta)$ at the thermal-hydraulic conditions θ.

Tool: S-Relap5

Ingredients:

Measured results of a test	≡	meas@test
S-Relap5 computed results of a test	≡	calc@test
Measured results of a LOCA	≡	meas@LOCA
S-Relap5 computed results of a LOCA	≡	calc@LOCA

We can express the quantity of interest $P^{meas@LOCA}$ as a product of three terms:

$$P^{meas@LOCA} \approx P^{calc@LOCA} * (P^{meas@test}/P^{calc@test})$$

$$* (1 + (1/P)(\partial P/\partial\theta)|_{meas@test} \Delta\theta - (1/P)(\partial P/\partial\theta)|_{calc@test} \Delta\theta)$$

Scaling vs. Validation

meas@test	$\longleftrightarrow$	**meas@LOCA**		
$\updownarrow$		$\updownarrow$	$\updownarrow$	**validation**
calc@test	$\longleftrightarrow$	**calc@LOCA**		

$\leftarrow$ **scaling** $\rightarrow$

We interpret the three terms as follows:

- **$P^{calc@LOCA}$ is the S-Relap5 computed parameter for the LOCA (Applicability)**

- **($P^{meas@test}/P^{calc@test}$) is the bias estimate. The measurement uncertainty in the tests is the source of uncertainty in this bias, and, therefore, also the source of the random uncertainty in $P^{meas@LOCA}$. (Uncertainty)**

- **$(1 + (1/P)(\partial P/\partial\theta)|_{meas@test}\,\Delta\theta - (1/P)(\partial P/\partial\theta)|_{calc@test}\,\Delta\theta)$ can be interpreted as the scaling bias (i.e. if the measurement scaling, 2nd term, and the code scaling, 3rd term, are equal there is no scaling bias). (Scaling)**

Issues in FRAMATOME's Methodology

What are the contributing components to and sources of information in FRAMATOME's estimate of the figure of merit $P^{meas@LOCA}$?

I. Applicability

$P^{calc@LOCA}$	-	S-Relap5

II. Uncertainty

$(P^{meas@test}/P^{calc@test})$	-	Separate effects and integral tests

III. Scaling

1	-	SEMISCALE, LOFT, UPTF tests

Framatome's first submission:

" The final results for the 4-loop sample problem can be summarized as follows:

- The 95/95 calculated PCT was 1686 °F which compares to the criterion for maximum PCT of 2200 °F.

- The 95/95 calculated maximum nodal oxidation was 1.1% which compares to the criterion for maximum nodal oxidation of 17%.

- The 95/95 calculated maximum total oxidation was 0.02% which compares to the criterion for maximum core oxidation of 1%. "

Note: These results are based on a sample size of n = 59

Regulatory Guide 1.157: "Best-Estimate Calculations of Emergency Core Cooling System Performance"

I. "The revised paragraph 50.46(a)(1) (i) requires that it be shown with a high **probability** that none of the **criteria** of paragraph 50.46(b) will be exceeded, and is **not** limited to the peak cladding temperature criterion.

II. However, since the other **criteria** are strongly dependent on peak cladding temperature, explicit consideration of the **probability** of exceeding the other **criteria** may not be required if it can be demonstrated that meeting the temperature criterion at the 95% **probability** level **ensures** with an equal or greater **probability** that the other **criteria** will not be exceeded."

Framatome's current submission:

The final results for the 4-loop sample problem can be summarized as follows:

- The 95/95 calculated PCT was 1686 °F which compares to the criterion for maximum PCT of 2200 °F.
- The maximum nodal oxidation for the 95/95 PCT case was 0.8% which compares to the criterion for maximum nodal oxidation of 17%.
- The maximum total oxidation for the 95/95 PCT case was 0.02% which compares to the criterion for maximum total core oxidation of 1%.

Note: These results are based on a sample size of n = 59

Non-Parametric Results

Number of runs	Number of criteria	β	γ
59	1	0.95	95%
124	3	0.95	95%
59	3	0.57	95%
59	3	0.95	90%

Conclusion

- The key regulatory criterion is in the clause " if it can be demonstrated that meeting the temperature criterion at the **95% probability** level **ensures** with an **equal or greater probability** that the other **criteria** will not be exceeded."

- Framatome's methodology based on 59 runs of S-Relap5 does not " ensure a **probability** ≥ 0.95 that the **other criteria** will not be exceeded ". It only gives an example that in one case of 59 runs the maximum observed values of the other criteria are less than their maximum acceptable values.

Applicability of Forslund-Rohsenow to Dispersed Flow Film Boiling

November 14, 2002
Washington, DC

FRAMATOME ANP

Introduction

> This presentation addresses the question, 'Why is Forslund-Rohsenow a dry-wall contact model?'

- Purpose of Forslund's experiment
- Observations by experimentalists
- Experimental procedures
- Forslund's data compared to T_{min}

Purpose of Forslund's Experiment

> Forslund observed that the liquid core in the film boiling regime would break up into filiments and droplets
  - Occurs between 10% to 20% quality from observations and references

> Forslund observed that droplets are prevented from touching the surface by the Leidenfrost effect

> Forslund stated a more appropriate terminology for this region would be post burnout dispersed flow heat transfer
  - The term 'film boiling' is also applied to the high quaility region since it is assumed that a film of vapor covers the heating surface

> 'It is this high quality dispersed flow region that is the subject of this current investigation'

Observations

> Forslund observed minimum heat fluxes for the experiment

Mass flux (lbm/hr/ft^2):	70,000	190,000
Diameter (in):	0.228	0.323
Heat flux (Btu/hr/ft^2):	3300	5000

> Hynek measured the minimum heat flux that would support film boiling
  - Heat flux = 2,200(Btu/hr/ft^2), Mass Flux = 40,000 (lbm/hr/ft^2)
  - T_{min} = 220°R, at 30 psia

Experimental Procedure

> Forslund observed that stable film boiling was consistently obtained by

- Applying heater power until the test section was above the Leidenfrost temperature
  - Room temperature sufficed since nitrogen was used
- After desired temperature was reached, nitrogen flow was initiated
- Full length of test section was in film boiling
  - CHF occured in the nitrogen supply line to the test section

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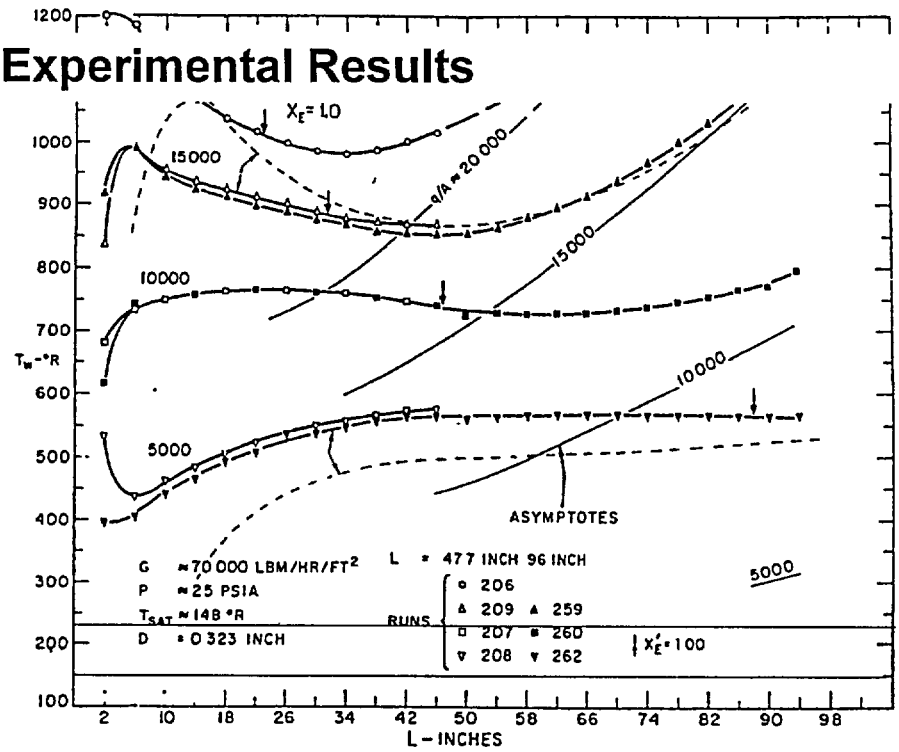
Experimental Results



- T_{crit} min
- T_{sat}

Fig. 3(a) Tube wall temperature profiles

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Conclusions

> Forslund observed droplets approaching, but not touching wall

- Dry-wall contact

> Forslund measured Q_{min} for his experimental conditions

- Data was taken above Q_{min}, therefore, no wet wall contact

> Forslund's data exceeded T_{min}, as measured by Hynek

- Therefore, no wet wall contact

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