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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

AUGUST 22, 2001

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
(ACRS)

THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE

+ + + + +

WEDNESDAY

AUGUST 22, 2001

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ROCKVILLE, MARYLAND

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The subcommittee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., Doctor
Thomas S. Kress, Acting Chairman, presiding.

PRESENT:

THOMAS S. KRESS, ACTING CHAIRMAN

F. PETER FORD, MEMBER

VIRGIL SCHROCK, CONSULTANT

JOHN D. SIEBER, MEMBER

ACRS STAFF PRESENT:

PAUL A. BOEHNERT

A-G-E-N-D-A

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

(8:30 a.m.)

CHAIRMAN KRESS: The meeting will now please come to order. This is a meeting of the ACRS Subcommittee on Thermal-Hydraulic Phenomena. I'm Tom Kress and I'm Acting Chairman of this subcommittee since our regular chairman can't be here.

The purpose of this meeting is 1) to review the GE Nuclear Energy TRACG realistic thermal-hydraulic code version, particularly for its application for evaluation of anticipated operational occurrences and, 2) review the resolution of issues associated with the EPRI Report TR 113594, resolution of generic letter 9606 waterhammer issues.

The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee. Mr. Paul Boehnert is the designated federal official for this meeting.

The rules for participation at today's meeting have been announced as part of the notices of this meeting previously published in *The Federal Register* on July 30 and on August 15, 2001.

Portions of this meeting will be closed to the public to discuss GE Nuclear Energy and EPRI

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1 proprietary information. A transcript of the meeting
2 is being kept and will be made available as stated in
3 *The Federal Register* notice.

4 It is requested that speakers first
5 identify themselves and then speak with sufficient
6 clarity and volume so they can be readily heard,
7 particularly by the transcriber.

8 We have received no written comments or
9 requests for time to make oral statements from members
10 of the public regarding today's meeting.

11 For the benefit of the members who may not
12 have been here during some of our earlier reviews of
13 TRACG, we did have a few problems -- or not problems,
14 maybe issues, questions, related to the treatment of
15 delayed neutrons, the treatment of rental stresses,
16 the treatment of wall shear and heat transfer
17 partitioning from the wall, flow regime transition
18 treatment and interfacial shear and interfacial heat
19 transfer treatment, among others. I think those are
20 just some of the more important ones.

21 With those comments, I'll ask if our
22 consultant, Virgil Schrock -- I forgot to mention the
23 ACRS members in attendance are Peter Ford, Jack
24 Sieber, and our consultant, Virgil Schrock. If
25 anybody wants to make any comments before we start,

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1 Virgil, I'll start out with you.

2 MEMBER SCHROCK: I'm a little at a loss to
3 know what to say or what depth to pursue the issues,
4 but I found the SER to be a great disappointment. I
5 don't see that it has explained in any way many
6 questions that were discussed at the last meeting of
7 the ACRS on this topic. Some of that may be because
8 some of the things that I thought were important
9 evidently had not been deemed sufficiently important
10 by the full committee to make it on their laundry list
11 of things to have you respond to.

12 But I understand several of these problems
13 as well as anybody in this room, and I can say to you
14 that you have a superficial treatment of real problems
15 in this SER. If that's what you want, that's what you
16 will have. I think it's a disgrace to the regulatory
17 process. I'll give you as much detail as you'd like
18 to have as we go along, but that's what my reading of
19 it led me to believe.

20 CHAIRMAN KRESS: Okay. With that pleasant
21 note, I'll go around this way. Do you wish to add to
22 that?

23 MEMBER SIEBER: I don't think so.

24 CHAIRMAN KRESS: Peter, I think you wanted
25 to make some sort of statement.

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1 MEMBER FORD: Yes. I'm a retired General
2 Electric employee. Although I had nothing at all to
3 do with the TRACG code, I do have to declare a
4 conflict of interest.

5 CHAIRMAN KRESS: Okay. With that then, I
6 don't have any additional statements, so we'll proceed
7 with the meeting, and I guess I'll call on Ralph
8 Landry to begin the inquisition. Did we give you a
9 laundry list of comments and issues? Since I wasn't
10 chairing this subcommittee at the time, I don't know
11 whether we did or not.

12 DOCTOR LANDRY: Okay. For the record, I'm
13 Ralph Landry from the NRR staff.

14 No, Doctor Kress, we did not receive a
15 laundry list.

16 CHAIRMAN KRESS: Did we pass Virgil's
17 written thing on to you?

18 DOCTOR LANDRY: No, I never received a
19 copy of a report from Virgil.

20 CHAIRMAN KRESS: That might explain,
21 Virgil, why the--

22 DOCTOR LANDRY: We were surprised when we
23 saw some of these items.

24 MEMBER SCHROCK: Let me just interject
25 that whether you had it in writing or not, you sat in

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1 this room and heard the arguments. We spent a lot of
2 time.

3 DOCTOR LANDRY: Well, somewhere between
4 all of the discussion and getting the agenda for this
5 meeting, we had missed a number of these points and
6 did not have them down. So this time we didn't have
7 copies of the reports from the consultants, so we
8 missed the specific points. But yes, Virgil, if you
9 do have specifics in addition to what's on the list
10 with the agenda, we'd definitely like to hear your
11 views and specific things that you think should be
12 brought out.

13 What we're going to talk about this
14 morning is give a real brief review of how we got to
15 the SER. The approach that the staff took in the
16 review of the documentation on TRACG, the
17 applicability intended for the code, what transients
18 and where the code is going to be applied. Talk
19 briefly about the assessment of TRACG. We'll talk
20 about the staff evaluation and briefly about the
21 thermal-hydraulics. We'll go into a great deal more
22 depth on the neutron kinetics. Tony Ulses will
23 present his review of the neutron kinetics aspects of
24 the code. Yuri Orechwa will talk quite a bit about
25 the statistical methodology review which he performed,

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1 the uncertainty analysis. We'll talk a little bit
2 about the code user experience. We have been running
3 the code. We've run some cases with the code and
4 tried to look at a few things, so we'll talk about
5 some of our experience in running TRACG. And then
6 review the conditions and limitations that we're
7 suggesting for the code and the conclusions of the
8 staff.

9 Okay. How did we get to this point? In
10 the spring of 1999 and the summer of 1999, TRACG was
11 presented to us in a preliminary fashion by General
12 Electric and General Nuclear Fuels, GNF. Sometimes we
13 use the two interchangeably, GE and GNF. So if we
14 swap back and forth, we mean the same company.

15 The preliminary information was to come in
16 and show us how GE would propose to submit the code
17 for review for AOO analyses, what material they would
18 suggest that we review and how they would like to
19 proceed with a review of the code for operational
20 transients.

21 In January of 2000, we began to receive
22 the materials on the code. That submittal was finally
23 complete in February of 2000. We received manuals and
24 then we received the electronic version of the manuals
25 and finally we received the code itself. General

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1 Electric did submit to us both the source code and an
2 executable version of the code. We installed the code
3 on an alpha machine, a VMS machine which we purchased,
4 so that we could run the code in the same native mode
5 that the applicant ran the code for their own work.

6 We met with the ACRS Thermal-Hydraulics
7 Subcommittee in middle of November of 2000. We've
8 been issuing RAIs informally as we've been performing
9 this review and the applicant has been looking at the
10 RAIs and responding to those RAIs informally
11 throughout the review.

12 In July we finally issued the formal RAIs,
13 those that have gone through our full review by
14 management and have been issued formally to the
15 applicant, and we have received now the formal
16 response from the applicant which is really the same
17 responses which we had in draft but this now puts the
18 response officially on the record.

19 We prepared the draft SER on TRACG in July
20 and we have discussed that draft SER with the
21 applicant. We have provided it to them for review for
22 proprietary content, and I would point out to the
23 committee at this point that the draft SER which you
24 have received from the staff does contain proprietary
25 information. The applicant has determined that there

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1 is proprietary information in there, so we are going
2 to withhold this draft version of the SER from the
3 public. We are going to work on the SER and try to
4 take the draft material which is proprietary out of
5 the SER so that we can publish a non-proprietary
6 version of the SER. So at this point, the SER draft
7 which you have received must be treated as
8 proprietary.

9 CHAIRMAN KRESS: What are the plans for
10 going final with that? What is your time line? Do
11 you have one?

12 DOCTOR LANDRY: We would like to have the
13 final SER ready in September. Assuming that the
14 Thermal-Hydraulic Subcommittee can report back to the
15 full committee at its September meeting, we would then
16 issue the final version of the SER in September.

17 MEMBER SCHROCK: Is there an
18 identification of the version of the code that you've
19 reviewed?

20 DOCTOR LANDRY: It's right at the
21 beginning of the SER. It's TRACG O2A.

22 MEMBER SCHROCK: What does TRACG O2A mean
23 precisely?

24 DOCTOR LANDRY: That's the specific
25 version which was submitted to us for a review. We

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1 realize that the applicant is working on future
2 versions of the code. They have talked with us about
3 submitting a version of the code for realistic LOCA
4 analysis. So we're being very specific that the
5 version we review has been designated as TRACG O2A.

6 CHAIRMAN KRESS: Does the A stand for
7 anticipated?

8 DOCTOR LANDRY: I'd like to ask Jens
9 Andersen from General Electric to answer that one.

10 DOCTOR ANDERSEN: This is Jens Andersen
11 from GNS. The A simply just designates the computer
12 hardware that it's executed on.

13 MEMBER SCHROCK: Well, I had raised that
14 question in the previous meeting, but it seemed to be
15 now several different versions of TRAC as opposed to
16 a version which was reviewed comprehensively in the
17 past maybe, maybe not comprehensively but reviewed in
18 some depth and asked and specifically the fact that
19 the decay power was discussed in terms of the May-Witt
20 estimate which goes back to the 1960s whereas the
21 version of TRACBD1 which was developed by INEEL with
22 cooperation from GE had the 1979 decay standard in it.
23 A world of difference between the two in the sense of
24 the technical approach. One recognizes that the decay
25 power is not the same for different fissile nuclides.

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1 The other does not.

2 In any case, that led me to ask the
3 question in that previous meeting. Has the ANS
4 standard been removed from TRAC and Jens Andersen was
5 unable to answer the question, as I remember, at that
6 time. But I presumed that somebody would look and see
7 what is the status. Now what you have in your SER, in
8 one paragraph you kiss off both that issue and the
9 issue of what procedure is employed to weight delayed
10 neutron fractions according to contributions from
11 different fissile species. Both of those are
12 superficially essentially treated as non-issues, non-
13 questions. So if you don't understand what I'm saying
14 to you, Ralph, I'll try to explain it in greater
15 detail. Is that the problem? You don't understand
16 the issue that I'm addressing?

17 DOCTOR LANDRY: No. I think when we get
18 into the discussion of the neutron kinetics, we'll
19 address that a little bit more.

20 MR. ULSES: We will now.

21 DOCTOR LANDRY: Tony Ulses will address
22 that further when we get into the discussion of the
23 neutron kinetics because he has already looked at
24 that. Yes.

25 MEMBER SCHROCK: Okay. Well, several

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1 related questions are, two technical issues I just
2 mentioned plus the question of what is the code
3 version? How is it defined? How are we understand
4 what the code version is? If it does not have the ANS
5 decayed heat standard in it any longer, then it's not
6 the same code that was reviewed for SBWR. Do you know
7 the answer to that?

8 DOCTOR LANDRY: Let me ask Jens Andersen
9 if he can respond to that.

10 DOCTOR ANDERSEN: Yes, I can comment on
11 that. Most of the models in the codes are the same as
12 what was reviewed for the SBWR and if you compare the
13 model description TRACG 2A -- revision one to the
14 model description, which was what was submitted during
15 the SBWR review, and then revision two, which is what
16 we have submitted for this review, there are minor
17 model differences but the majority of the code is the
18 same. The decayed heat model that is being used for
19 the application to transient is based on a simulation
20 of decayed heat cooks and we can get into that later
21 on.

22 What we have done is, realizing that there
23 were minor differences in the code, is that we
24 submitted a complete qualification of the code as
25 submitted. The material that's documented in the

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1 qualification report is all one with the code as
2 submitted to the NRC.

3 MEMBER SCHROCK: Well, it seems to me that
4 there are guidelines that you have issued for code
5 reviews that are not met by this submittal. Is that
6 incorrect? You needed a starting point, but you had
7 a clearly defined code that you had complete
8 documentation for that clearly defined code. It
9 doesn't appear that you have that.

10 DOCTOR ANDERSEN: Can I make a comment
11 again? This is Jens Andersen. The documentation that
12 has been submitted for this review, model description,
13 qualification, the user's manual, is all specific to
14 the code version TRAC. It's a two way that has been
15 used and that was made available to NRC for
16 installation on their computers. So it's totally
17 consistent.

18 MEMBER SCHROCK: But not the same code
19 that was reviewed for SBWR?

20 DOCTOR ANDERSEN: That's correct.

21 DOCTOR LANDRY: That's correct. It's been
22 built on the version that was reviewed for SBWR.

23 MEMBER SCHROCK: Of course it's been built
24 on it, but unless you define changes and explain what
25 the changes are, how can you expect a technical body

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1 reviewing it to tell you what yes, what you're saying
2 is fine when you haven't even defined what the product
3 is that you're reviewing?

4 DOCTOR LANDRY: But they have defined the
5 product and that is the TRACG O2A version of the code
6 and the documentation which they submitted on this
7 version of the code, the staff believes defines the
8 code.

9 When we did the review of this code, we
10 did build on the work that was done in the review of
11 SBWR version of TRACG. At that time, the contractor
12 which the staff was using, Brooke Haven National
13 Laboratory, did an extensive review of the thermal-
14 hydraulics of the code and a review of the kinetics
15 and other parts of the code.

16 We looked at the review that was
17 performed, compared that with what was being submitted
18 for the review of the TRACG O2A code for A00
19 transients, and we felt that the thermal-hydraulic
20 questions and concerns that had been raised during the
21 SBWR review had been addressed in the material
22 submitted for the TRACG O2A submittal.

23 Because of that review and the depth that
24 that review was taking, the staff made the decision
25 that we would review the material and we only asked a

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1 few requests for additional information on thermal-
2 hydraulic aspects of the code and then concentrated
3 heavily on the kinetic aspects of the code and on the
4 uncertainty analysis, the statistical methodology. We
5 felt that that would be a more productive use of the
6 resources which we had available to us in performing
7 the review.

8 You have to keep in mind what the code is
9 being applied to. The application of TRACG O2A for
10 AOOs is very limited in scope. The code is being
11 applied to only transients in chapter 15. It is not
12 being applied to Atlas, it is not being applied
13 stability analysis, it is not being applied to loss of
14 coolant accidents. It's being applied only to
15 increase and decrease in heat removal by the secondary
16 system, a few transients in those classifications, a
17 decrease in the reactor coolant flow rate. It's being
18 applied to reactivity and power distribution
19 anomalies, increase and decrease in reactor coolant
20 inventory. Those increases and decreases that are
21 short of a loss of coolant accident.

22 When we looked at the assessment that was
23 performed for the code, the first thing we did was
24 step back and look at assessment in the way we always
25 do. How has the assessment been performed? Have they

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1 looked at the phenomenological tests, separate effects
2 test, integral test, plant system information when
3 available, so that they can assess from the level of
4 correlations to the level of models to the level of
5 the entire code.

6 Of course, when you look at plant
7 operational data, because of the way the data are
8 taken, they're not experimental, empirical data, so
9 the data set is much more limited. But the assessment
10 that is performed is a global assessment of the code.
11 Does the code adequately represent the global events
12 occurring in a transient when those transients have
13 been run in a plan?

14 CHAIRMAN KRESS: How do you know when you
15 have enough assessment? I know I've asked this
16 before.

17 DOCTOR LANDRY: The big question for years
18 has been how good is good enough.

19 CHAIRMAN KRESS: Yes.

20 DOCTOR LANDRY: In the case of the code as
21 it has been submitted, since it is doing a statistical
22 uncertainty analysis, has enough assessment been
23 performed is determined by has a phenomena
24 identification ranking table been prepared, a thorough
25 PIRT, that can be reviewed and is thorough, captures

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1 all the phenomena. Do we agree that the PIRT captures
2 all the high and medium importance phenomena? And
3 then have those phenomena been properly assessed
4 against data? Have enough assessments been performed
5 that an uncertainty analysis can be performed and
6 uncertainty be placed on the important phenomena?

7 When we look at codes, as we have in the
8 past, that did not do uncertainty analysis, codes such
9 as LOCA codes meeting Appendix K, we did not put a
10 handle on uncertainty. We simply said does the code
11 meet these set prescriptive requirements and how good
12 is good enough became a much more difficult question
13 to answer because we did not have a definition of
14 statistically what is enough assessment to perform and
15 we would have to look at the assessment and say does
16 it cover an adequate set of the data available. Are
17 there data available from the other aspect to perform
18 an assessment?

19 And we always run into the problem when we
20 get into those assessments that there are events that
21 can occur, there are phenomena that can occur, for
22 which there are no data and for which you can not
23 properly assess. There are a number of aspects in
24 turbulent flow where it's three-dimensional flow
25 effects where you don't have data and you can't really

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1 assess the capability of the code in some of those
2 areas. So I hope this is answering your question.

3 CHAIRMAN KRESS: Yes. I think that was a
4 good answer.

5 DOCTOR LANDRY: When a code is submitted
6 with an uncertainty analysis under a statistical or
7 what we sometimes call best estimate or realistic
8 application, we have a better way of saying how much
9 assessment is enough because now we're zeroing in on
10 the phenomena that are important. We're saying are
11 those phenomena assessed properly so that a
12 statistical basis for the uncertainty can be assigned?

13 This morning later on Yuri is going to go
14 through an explanation of his review of the
15 statistical methodology and he'll give some of his
16 views of what has been performed and has a proper
17 assessment been performed.

18 MEMBER SCHROCK: You have made the point
19 in the SER that the code and its application meets the
20 guidelines of the CSAU methodology. Do you want to
21 comment on how the uncertainty and decay power
22 evaluated -- assessed. -- provided assessment of the
23 uncertainty. Uncertainty indeed is dependent upon the
24 details of the reactor problem that you're addressing.
25 It's impossible to assess such an uncertainty.

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1 The problem may be that a good case can be
2 made that decay power is pretty much a second order
3 phenomenon in AAOs. That case is not made here. It's
4 nowhere to be found in your SER that I can see. But
5 even so --

6 DOCTOR LANDRY: Well, we'll take that into
7 consideration.

8 MEMBER SCHROCK: My recollection, as I
9 said in the previous meeting, of what GE did in using
10 the ANS standard first was to run a lot of Monte Carlo
11 calculations to find a sort of generic decay power
12 curve which they could put some sort of balance on,
13 and I think they take a penalty rather than including
14 that in the assessment. The details are a little bit
15 fuzzy in my mind, but I clearly remember that was the
16 general pattern of what was done. It was not a
17 straightforward assessment of the uncertainty using
18 the uncertainties that are published in the ANS
19 standard for decay power. That would be one way of
20 approaching it. It's not what they did. What they
21 did was found acceptable at the time. I thought it
22 was quite good.

23 My problem with this is that what I see is
24 superficial discussion of real life problems in an
25 SER. This is the government's evaluation of the

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1 safety of that system done in a very superficial way.
2 That frightens the hell out of me.

3 DOCTOR LANDRY: Tony.

4 MR. ULSES: I suppose nobody -- to talk
5 about decay heat. Let's do it rather than wait? The
6 issue of decay heat and --

7 CHAIRMAN KRESS: Go ahead. We'll talk
8 about it now.

9 MR. ULSES: I would say I would certainly
10 agree with you, Doctor Schrock. It was given a
11 cursory discussion in the SER because I believe it has
12 a cursory effect on the problem, and that's my fault.
13 I should have discussed it in more detail and that's
14 a valid criticism and I will definitely change the SER
15 to expand upon that point. I definitely think you are
16 right, and that's an oversight on my part and that is
17 something that will be fixed.

18 MEMBER SCHROCK: More than that, you're
19 reviewing a code which is said to have been adequately
20 reviewed for loss of coolant accidents and other
21 purposes in the context of the SBWR review and now
22 you've not called out in any sense here that what
23 you're going to do is substitute for one particular
24 aspect of the whole calculation, a more simplistic
25 approach because it's more computationally efficient.

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1 That is to invoke the Mae Witt implication for decay
2 heat evaluation.

3 MR. ULSES: Well, again, we were looking
4 at the version of the code that we were given and
5 that's a beyond scope issue. I mean this is not a
6 LOCA code.

7 MEMBER SCHROCK: Do you review something
8 with blinders on or do you review it with an
9 intelligent assessment of how it fits into the whole
10 picture of your dealing with this code?

11 MR. ULSES: Well, I reviewed it with the
12 scope of the application in mind.

13 CHAIRMAN KRESS: If they come back later
14 and want to use this for best estimate LOCA, then you
15 would face up to that problem.

16 MR. ULSES: Yes, sir. We will deal with
17 it in excruciating detail because it is very important
18 for LOCA applications. However, for AOOs, it is not
19 a significant contributor.

20 CHAIRMAN KRESS: You're pretty much
21 constrained to have to review the application as it's
22 presented to you.

23 MR. ULSES: Yes, sir. We're not really
24 allowed to go beyond the scope of the review, and that
25 would have been beyond scope if we would have gotten

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1 into the questions about specific details of the decay
2 heat model because it's not a significant contributor
3 to the answer. But your criticism is certainly valid.
4 On what's written in the SER, it is not clearly
5 spelled out and that will definitely be corrected and
6 for that I apologize. The actual discussion of why it
7 was not reviewed in detail is not there and I will
8 definitely correct that.

9 DOCTOR LANDRY: Let me make one other
10 correction.

11 MEMBER SCHROCK: The description of the
12 code doesn't say we have different options for decay
13 heat evaluation. Those options are used in this way
14 for evaluation of AOOs. We invoke this simpler thing.
15 That's not in the GE documentation. It's not in your
16 interpretation of the GE documentation. But you're
17 telling us now, after all, that is your
18 interpretation, that's your understanding of it. This
19 is the limit of its utilization in TRACG. Is that
20 right?

21 MR. ULSES: Yes, sir. That's all that GE
22 will be able to actually use the code for because the
23 SER will be written not to allow them to use it for
24 any other applications. I believe we have an
25 additional comment.

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1 MR. HECK: This is Charlie Heck from
2 Global Nuclear Fuel. In the documentation that was
3 submitted with the application in Section 9.3 of the
4 model description, it clearly describes what is the
5 model we're using for decay heat and it also provides
6 a comparison of the Mae Witt curves with the ANS
7 standard 5.1 and it describes the model that's being
8 used. That was part of the submittal.

9 MEMBER SCHROCK: In order to make such a
10 comparison, you have to say what the particular
11 reactor state is at the point of this evaluation by
12 the ANS standard. There's not just a single
13 comparison of Mae Witt. Mae Witt is a single entity.
14 That's right. It just relates it to the operating
15 power. But the decay heat standard gives you an
16 evaluation which depends upon the operating history of
17 the reactor and the composition of the fuel. So,
18 Charlie, you can't argue that that was an adequate
19 description. It was a comparison but with an
20 undefined set of circumstances for what the ANS
21 standard part of that comparison was calculated for.

22 MR. HECK: Doctor Schrock, the
23 documentation that was provided indicates that the
24 comparison was made at end of cycle conditions,
25 exposures and radiation time, and enrichment values

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1 that are typical of the application for AOOs, and it
2 was done at that point because that's where the most
3 limiting conditions for AOO occur. So a comparison
4 that we did do -- and I acknowledge your point that
5 it's very specific to what has been the operating
6 history, what was the initial load, what are the
7 fissionable materials. We did provide the comparison
8 at a representative condition for the intended
9 application. But it is a single point evaluation.

10 MEMBER SCHROCK: Well, I think the point
11 that I'm making is that the documentation of these
12 issues is something that needs to be of concern to the
13 NRC. It's treated in the SER as though the problem
14 would never arise. That's what I have great
15 difficulty with.

16 DOCTOR LANDRY: Well, this is a draft SER
17 and we'll take your comments back and address them.

18 In looking at the assessment that has been
19 performed through the uncertainty analysis, we did
20 find that all the medium and high ranked phenomena
21 have been taken into account in the uncertainty
22 analysis and, on that basis, we feel that the proper
23 assessment has been performed that does show the
24 capability of the code to represent the experimental
25 and operational data as necessary for the application

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1 to AOO transients.

2 CHAIRMAN KRESS: Did decay heat show up as
3 important in that PIRT?

4 DOCTOR LANDRY: No.

5 MR. BOLGER: This is Fran Bolger from GE.
6 We did identify it as a high phenomena for the loss of
7 heat water transient.

8 CHAIRMAN KRESS: For what are the AOOs
9 only.

10 DOCTOR LANDRY: Okay. Just to briefly
11 recap some of the thermal-hydraulic aspects of the
12 code because this was, as I said, more of a review of
13 what was done during the review of the SBWR
14 application of a version of TRACG. This was an
15 extensive review. As I said, it wasn't performed to
16 be a complete review because the code was withdrawn.
17 The whole submittal was withdrawn before the review
18 could have been completed. So it was not a complete
19 acceptance review of the code. But it was an
20 extensive review for thermal-hydraulic aspects.

21 TRACG is just basically like the TRAC
22 code. It's a two fluid, six conservation equation
23 code. Has boron transport, non-condensable mass
24 equation in it. It's a two regime unified flow map
25 instead of some of the other codes that we see

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1 typically for PWRs that will have multiple regimes.
2 The regimes that are in the code are adequate to cover
3 the normal operating and anticipated regimes that
4 occur in a BWR. We're saying for AOOs the four
5 regimes that are covered are adequate.

6 There's a two phase level tracking model
7 which was criticized during the SBWR review because it
8 uses approximations for void fraction above and below
9 a mixture level and uses a cut point for level
10 detection. We feel that because there is not a high
11 degree of mixture tracking going on in AOOs that the
12 shortcomings of this model are acceptable for AOOs.
13 However, to go beyond AOOs, we are going to look at it
14 extensively.

15 When the application comes back for the
16 LOCA, we will look at this model again.

17 CHAIRMAN KRESS: Could you refresh my
18 memory on bullet one about the boron transport
19 equation. Is that a K epsilon turbulent transport
20 model or was that empirically based on the tests that
21 were done with salt and thermal?

22 DOCTOR ANDERSEN: This is Jens Andersen
23 again. We have a boron transport model in the code
24 but let me first clarify one thing is that this
25 particular submittal is for AOO transients, and it

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1 does not include Atlas. It does not involve the boron
2 transport model. The model does assume that the boron
3 is transported with a fluid model. Fluid velocity.
4 So it's a relatively simple model. If we make a
5 submittal of TRAC for Atlas, that's one issue that we
6 would have to address in more detail.

7 CHAIRMAN KRESS: Thank you very much.

8 DOCTOR LANDRY: In the TRACG code, the
9 kinetic energy term has been put back into the energy
10 equations. The kinetic energy term was removed in the
11 TRACB version of the code that the NRC had supported,
12 and that introduces energy balance errors. By putting
13 the kinetic energy back in, there's better
14 conservation of energy with this version of the code.

15 CHAIRMAN KRESS: That's merely to keep
16 people from asking questions about why the energy
17 didn't balance because it was a small discrepancy.

18 DOCTOR LANDRY: -- will have it back in
19 and get rid of those problems. Reduce errors wherever
20 possible.

21 MEMBER SCHROCK: When was it removed?

22 DOCTOR LANDRY: That was in the early
23 stages of the TRACB development at INEEL.

24 MEMBER SCHROCK: It was not in BD1, didn't
25 include kinetic energy?

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1 DOCTOR LANDRY: No. An issue that did
2 come up during this review that is not a TRACG
3 specific issue but came up during the power up rate
4 review is an issue concerning the GEXL heat transfer
5 correlation. The NRC staff review and the power up
6 rate found that data were generated using COBRAG for
7 assessment of the GEXL 14 correlation rather than
8 using up skew, down skew experimental data.

9 We raised a number of questions on the use
10 of artificial data instead of empirical data for doing
11 a statistical analysis on the MCPR safety limit. The
12 staff is involved with the applicant in resolution of
13 that issue on the power up rate concerns at this
14 point.

15 CHAIRMAN KRESS: Wouldn't your perception
16 of that depend on how well you thought the other code
17 had been validated?

18 DOCTOR LANDRY: If the other code was
19 truly independent and was properly validated. Yes.
20 The staff view is we don't like using one code to
21 validate another code rather than data. If the other
22 code has not been validated against data, then --

23 CHAIRMAN KRESS: You would always prefer
24 data.

25 DOCTOR LANDRY: We always prefer data.

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1 CHAIRMAN KRESS: But if you have places
2 where you don't have data, it seems like --

3 DOCTOR LANDRY: But if there are data but
4 they're owned by another entity, then --

5 CHAIRMAN KRESS: Oh, that's a problem.

6 DOCTOR LANDRY: This is a very involved
7 question.

8 CHAIRMAN KRESS: Yes, I can see that.

9 DOCTOR LANDRY: This is a question that
10 has come up through the power up rate reviews, but
11 we're only pointing out in the TRACG review that yes,
12 if the GEXL 14 correlation is applied in this code for
13 a transient, this issue must be addressed and that
14 whatever the resolution of the GEXL 14 issue is, we
15 expect that to be applied in the TRACG application
16 also.

17 CHAIRMAN KRESS: I don't know if we have
18 a statistician here or not but it seems to me like if
19 you have a measure of the uncertainty for the base
20 code and you can use that along with comparison with
21 calculation of the TRACC, TRACG, then you can actually
22 develop the uncertainty in the TRACG based on the
23 uncertainty in the other code.

24 DOCTOR LANDRY: If you have a thorough
25 uncertainty analysis of the other code.

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1 CHAIRMAN KRESS: Yes. What I'm saying, it
2 seems like philosophically it's a reasonable thing to
3 do is to use another code if you know enough about
4 that code and uncertainty is known about it to develop
5 the uncertainty in another code if they are
6 independent, just as a philosophical statement. Seems
7 like an approach that's probably reasonable,
8 especially in places where you can't get access to
9 real data or real experiments.

10 DOCTOR LANDRY: We did not want to get
11 into that issue--

12 CHAIRMAN KRESS: I understand.

13 DOCTOR LANDRY: -- other than to point out
14 that there is an issue which is being dealt with
15 independently of this review but will impact the
16 application of this code when it is finally resolved.
17 I call that out in the SER for that purpose to ensure
18 that the resolution of the GEXL 14 issue is properly
19 addressed in the application of TRACG.

20 CHAIRMAN KRESS: Yes. I just wanted to
21 give you a hint as to how the ACRS might feel about
22 that issue. I can't speak for the ACRS. Some of the
23 ACRS members --

24 DOCTOR LANDRY: One of the ACRS members.

25 CHAIRMAN KRESS: At least one of them.

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1 DOCTOR LANDRY: In looking at the TRACG
2 code, the basic component models are very much the
3 same as in the TRACB version of the code. Models are
4 used as building blocks to construct physical input
5 models for a plant. We did note that the
6 applicability to isolation condensers needs to be
7 demonstrated should the code be applied to transients
8 for which the isolation condenser is important.

9 We feel that the steam separator model
10 that is in the code has been validated very well
11 against full scale performance data. This issue of
12 steam separator/steam dryer keeps coming up whether
13 we're talking about PWRs or BWRs because there's so
14 much lack of data. But here the applicant has a great
15 deal of full scale data.

16 CHAIRMAN KRESS: You'd think GE would know
17 more about steam separators and dryers than anybody.

18 DOCTOR LANDRY: Right, and they have a
19 great deal of full scale performance data which they
20 have used to validate their separator model. We just
21 wanted to call out that yes, they've done a very good
22 job and we feel that the model is very well-
23 documented.

24 CHAIRMAN KRESS: Where does it show up in
25 PWRs?

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1 DOCTOR LANDRY: We're talking about steam
2 generator performance.

3 CHAIRMAN KRESS: In generator problems.
4 Okay.

5 DOCTOR LANDRY: It has default, fully
6 implicit integration for hydraulic equations and heat
7 conduction equation is used. Predictor -- technique
8 is used. There's implicit coupling between the heat
9 conduction and coolant hydraulics and this code is
10 less prone to error on phase shift in thermally
11 induced oscillation. So we feel that the numerics
12 have been improved in going from the TRACB to the
13 TRACG version of the code.

14 MEMBER FORD: Can I ask a question? I'm
15 trying to come as quickly as possible onto the issues
16 on this particular subject. As I understand it,
17 there's a whole lot of questions about the specifics
18 of the modeling Virgil has brought up. And also there
19 could be presumably some questions about how good the
20 model is to predict the observations. Are we going to
21 see any data at all today on resolving some of these
22 modeling questions and are we going to see any data
23 against which the model is calibrated?

24 DOCTOR LANDRY: There will be some
25 material presented by Tony. Tony will be coming up

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1 next to talk about the kinetics modeling which he has
2 examined.

3 MEMBER FORD: We'll see some data points.

4 DOCTOR LANDRY: We'll see some data
5 comparisons which Tony has prepared.

6 MR. ULSES: Ralph, I want to interject.
7 We actually aren't going to discuss the data because
8 the data is proprietary to GNF. We obviously can't
9 get into it in open session this morning.

10 MEMBER FORD: I have a fundamental problem
11 then. Again, I'm learning about this whole process.

12 CHAIRMAN KRESS: You come into this issue
13 a little late, but there is a validation part of the
14 submittal that includes the data they have and their
15 comparisons with the code. We may not have gotten you
16 all that information yet. But it is part of the
17 submittal.

18 DOCTOR LANDRY: Tony is going to talk
19 about some comparisons with the code which he has
20 performed and the neutronics. Yuri is going to talk
21 about the statistical methodology that's been set up.

22 CHAIRMAN KRESS: That's largely based on
23 data.

24 DOCTOR LANDRY: We're trying not to
25 utilize proprietary information in our presentations,

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1 so we're trying to stay away from the actual data but
2 by showing some analyses which we have performed how
3 we feel the code is performing.

4 MR. ULSES: And there also is an extensive
5 assessment manual which was given to the staff and I
6 believe the ACRS as well by GNF and that has a great
7 deal of data in it. It's like an inch and a half
8 thick if I recall. It's an extensive manual.
9 Unfortunately, I don't have it here.

10 MEMBER FORD: I can see some of the
11 problems. I personally would not like to see some of
12 that data.

13 DOCTOR LANDRY: We'll try not to show it
14 to you then.

15 DOCTOR LANDRY: The next person to talk is
16 going to be Tony Ulses. Tony will talk about the
17 neutron kinetics analysis which he has performed, and
18 then Yuri Orechwa will follow Tony and talk about the
19 statistical methodology, and then I'll come back up
20 and talk a little bit about some of the user
21 experience with the code and the conditions and
22 limitations on the code and our conclusions. I would
23 ask during the next two presentations if GE sees stuff
24 coming up that they think is proprietary to alert us
25 so that we can take appropriate action.

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1 MR. BOEHNERT: Yes. We can close the
2 meeting if we need to.

3 DOCTOR LANDRY: We don't think that what
4 we're going to say is proprietary, but if it looks
5 like we're getting in a proprietary area, let us know.

6 MR. ULSES: As Ralph said, I'm Tony Ulse
7 of the staff. What I'd like to do is I'd like to try
8 and address your concerns, Doctor Schrock, before I
9 get into the actual details of my presentation because
10 I don't have any specific discussions in there about
11 your questions. But I'd like to make sure that I
12 address them. There's one question you had about beta
13 that I know we haven't discussed. We can talk about
14 decay heat more if you'd like and if there's anything
15 else you'd like to discuss, I'd like to do that now
16 just to make sure I address your questions before I
17 get into the presentation, just to make sure they
18 don't get lost.

19 MEMBER SCHROCK: You can explain that now
20 or you can explain it wherever you plan to if you did
21 plan to. But I would like to hear it.

22 MR. ULSES: It's not in the presentation.
23 That's why I'd like to discuss it now.

24 MEMBER SCHROCK: How you deal with the
25 calculation of beta for -- fissile fuel.

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1 MR. ULSES: This actually goes back to the
2 discussion we had in the past in the RETRAN review.
3 The question of beta within the scope of this review
4 is that it's viewed as input value into TRACG. It's
5 calculated by the upstream codes and it's going to be
6 fuel type specific.

7 MEMBER SCHROCK: You haven't read my
8 December report and, therefore, you couldn't have
9 responded to that but in that report I said, and I
10 believe this to be absolutely essential in what you do
11 in the regulation, that you have to know what the
12 source of information is for inputs. You can't
13 extract a physical problem from a computer code and
14 say, now, this code doesn't deal with that issue any
15 more because it's input. The fact is it has to be
16 evaluated in order to get a completed calculation
17 using this code and, in fact, the input or whatever is
18 preparing the input has to be based upon the
19 conditions that you're doing the calculation--

20 MR. ULSES: You're certainly correct,
21 Doctor Schrock, and the reason why it's not reviewed
22 in these contexts is that GE has and uses a licensed
23 code which has been reviewed and approved by the staff
24 for doing lattice physics type calculations and also
25 core analyses.

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1 MEMBER SCHROCK: What I heard is an
2 oblique way of telling me it's not my business to know
3 this. What I'm saying to you is that you, the NRR,
4 has gone on record as saying you have conditions for
5 review of computer codes and those conditions we've
6 reviewed. A lot of time has been spent on that.
7 You're not following the advice that you prepared for
8 industry.

9 MR. ULSES: I'm not particularly sure I
10 know what advice we're not following.

11 MEMBER SCHROCK: This is a part of the
12 calculation. I raised the issue because I read things
13 in some other documents, as I explained previously,
14 that planted the seed of the possibility that maybe
15 this distinction is ignored in such calculations which
16 seems incredible.

17 MR. ULSES: Well, I can assure you that it
18 is not ignored in the GE analysis. We do specific
19 fuel type analysis based on exposure.

20 MEMBER SCHROCK: I don't think it is
21 either, and Fran Bolger and Charles Heck gave a lot of
22 assurance last time that it is done and it's done
23 well. I'm not challenging that. What I'm saying is
24 that if you're going to review the code, if you're
25 going to ask us to review the code, if you're going to

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1 ask me to review the code, don't tell me it's none of
2 my business how this gets calculated.

3 MR. ULSES: If that's the impression I
4 left with you, I apologize. That was not my point.
5 The issue is is that we have a scope of review which
6 has been defined for us and it's very difficult for us
7 to go beyond that scope and if you look at the
8 application that we were reviewing, it was for one
9 code -- in this case, the TRACG code, which uses beta
10 as an input value. We know because we have access to
11 all the previous reviews that the staff has done that
12 there is an approved code that GE uses for doing those
13 types of calculations and that they do treat all the
14 relevant physics, all the relevant parameters.
15 Unfortunately, that information was not made available
16 to you and actually, I don't know if we could have
17 made it available to you or not. I really don't know
18 actually in this context because again, it really is
19 beyond the scope of the question we were asked to
20 answer. Other than to assure you that it is dealt
21 with and it is dealt with through all the relevant
22 parameters.

23 CHAIRMAN KRESS: How do you determine
24 what's in scope because it seems to me like the
25 determination of any input value in the code could

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1 reasonably be said to be in scope. I don't know how
2 you determine what's in scope.

3 MR. ULSES: In this case, it's determined
4 because we know that GE has an approved method which
5 the staff has already reviewed and approved. There's
6 an SER written on it that says it's acceptable for
7 doing those types of calculations.

8 CHAIRMAN KRESS: Okay.

9 MR. ULSES: That's the finding the staff
10 has made.

11 MR. CARUSO: Doctor Kress, this is Ralph
12 Caruso from Reactor Systems Branch. I think there may
13 be a little bit of concern here that in the regulatory
14 context there's no opportunity for the staff to review
15 these inputs that are generated for these codes.
16 Realize that reviewing the code itself is just one
17 part of the regulatory fabric. We do, as we've been
18 doing for the power upright reviews, we've been doing
19 a number of audits of the actual calculations where we
20 send people like Tony out to GE to look at the actual
21 design record files to look at the actual input values
22 that are put into these codes and that is the context
23 in which we would verify that they were using the
24 appropriate value of beta, if they were calculating it
25 appropriately with the lattice physics code and then

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1 appropriately inputting it into TRACG.

2 The code review itself does not
3 necessarily include a review of all of the steps of
4 the surrounding methodology because we just don't have
5 the resources to completely review a methodology every
6 time we do a review of a particular part of it. We
7 understand that the other parts are there and we take
8 them into consideration as we do the review, but we
9 don't necessarily review them entirely. We have other
10 regulatory means to verify that they will be done
11 properly.

12 CHAIRMAN KRESS: You can review it at the
13 time of an application.

14 MR. CARUSO: We can review it when an
15 individual licensee applies for permission to use this
16 code for their plant. We can review it when we --

17 CHAIRMAN KRESS: Will part of the
18 limitations on the use of this code for this
19 particular aspect specify that the -- I guess it's the
20 ODYN code must be used to determine this beta.

21 MR. ULSES: No. Actually, the lattice
22 code G uses is called TGBOA. I don't know where that
23 came from, but that's what they call it.

24 CHAIRMAN KRESS: But will you specify in
25 your limitations that to determine this input you will

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1 have to use that code or if somebody uses a different
2 code to determine that input, you'll have to review
3 that one at the time of the application. Is that the
4 approach?

5 MR. ULSES: Well, at the time of the
6 application, what'll happen is the applicant in this
7 case -- it would actually be the utility coming in for
8 the proposed application -- they would have to
9 identify what methods that they used.

10 MR. ULSES: And if they had a method that
11 was not reviewed and approved, we would have to make
12 the choice of whether we're going to review it or
13 whether we're going to say we don't have the resources
14 to review it because it would require an additional
15 code review.

16 CHAIRMAN KRESS: Does the code have a
17 default value for this particular input?

18 MR. CARUSO: Does TRACG have a default
19 value? Is that what you're asking?

20 CHAIRMAN KRESS: Yes, because I understand
21 part of the problem is you have to -- the input value
22 depends on the power history and the loading of the
23 code and so forth, so you can't just have one input
24 value. You have to know what the particular state of
25 the core in order to get it.

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1 MR. ULSES: Sure. Well, there certainly
2 will be default values in the code. However if you
3 look at the application of this particular code -- in
4 this case, TRACG -- it's not really designed to be
5 used outside of the automation mechanism that they use
6 at GNF which basically would require that you have
7 input files which are calculated to the appropriate
8 exposure points for the appropriate reactor being
9 analyzed and, therefore, that's going to be imposed by
10 their QA program which is going to require them to do
11 the analysis with the correct input.

12 MR. CARUSO: And this actually applies to,
13 I would think, any calculation that is done. The QA
14 procedures Appendix B requires there to be a
15 documented description for every input value that goes
16 into the code and the way we regulate that is we do
17 inspections, we do audits to verify that they have
18 chosen the appropriate value and that they have a
19 basis for it. So even though there may be a default
20 value in the code, if they use that default value
21 without a basis, then they subject themselves to the
22 possibility of this being discovered during an audit
23 or an inspection and appropriate regulatory action can
24 be taken for noncompliance with Appendix B.

25 MR. ULSES: As an example, what I would

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1 expect is--

2 CHAIRMAN KRESS: Aren't things like that
3 flagged in the SERs and when you get around to --

4 MR. CARUSO: Because of the large number
5 of input values, we don't flag in the SER every
6 individual input. That's a requirement of Appendix B
7 is that every value that's used in a calculation
8 should have a basis for it.

9 CHAIRMAN KRESS: Okay.

10 MR. ULSES: Just as an example, I would
11 expect when I would go down to, say, the GNA offices
12 in Wilmington and I would audit a design record file,
13 I would expect to see a discussion in there if the
14 analyst, say, made the choice to use the default
15 values and they would say why they did it, why it has
16 no impact, and then the reviewer of that design record
17 file would have to either say I agree with this, I
18 challenge you on this, and this is why I think this is
19 right or wrong. That entire deliberation ought to be
20 documented in the records that are kept on the
21 analysis. That's the QA trail for those types of
22 questions, and those are things that we will audit
23 when we go down to the site.

24 MEMBER SCHROCK: What is the required
25 detail of the input data?

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1 MR. ULSES: I don't think I understand the
2 question.

3 MEMBER SCHROCK: Does the input provide
4 spatial distribution of beta?

5 MR. ULSES: It's handled on a fuel type.
6 Yes, it does. Let me just say yes to that question.
7 I can go into more detail if you want as to how it
8 actually works. Hopefully, I won't tread on any
9 proprietary information here. But it certainly does.
10 You have the information on a node-wise basis which
11 basically means it's a six inch by six inch by six
12 inch square portion of the reactor. Each one of those
13 nodes will have individual values of beta which are
14 appropriate for the exposure points that are being
15 analyzed. That's correct. Yes.

16 Do you have another question, Doctor
17 Schrock, or shall I go ahead and proceed here? Okay.
18 Let's see. I think I'll skip my name because I think
19 we all know who I am now.

20 What I'd like to do in this discussion is
21 I'd like to focus really and discuss basically the
22 conclusions of the review and then I'd like to go
23 through what I call sort of a lessons learned on this
24 particular review because this review was very
25 challenging. There were some areas where I ran into

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1 some difficulties, and I'd like to discuss those and
2 I'd like to go through some areas where I think I can
3 do a better job the next time and areas where we can
4 improve upon what we've done. That's essentially what
5 I'd like to try and do today.

6 These are the areas where the review was
7 focused. We obviously reviewed the documentation
8 which was given to us by GE.

9 CHAIRMAN KRESS: Did you find the
10 documentation sufficiently good and detailed for you
11 to make your reviews?

12 MR. ULSES: Well, the documentation is
13 acceptable for use internally by GNF. It's not
14 information that I would consider to be acceptable for
15 public dissemination because it's not a discussion
16 from the cradle to the grave on how this code works.
17 But if you use it in the context of the organization
18 that's actually using it, I feel the documentation is
19 acceptable. There actually are some areas where it
20 was kind of disjointed and actually, I plan on
21 discussing those a little later. There were some
22 models that were described in one document whereas I
23 think they should have been in another one, etcetera,
24 etcetera. There were some areas where there were some
25 difficulties, but I think if you put it in the context

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1 of the application and who's going to be using this
2 code, I feel that it's acceptable for internal use by
3 the applicant.

4 As part of the documentation review, we
5 went through a discussion of the actual model
6 development itself, the theoretical development. What
7 I refer to as an auxiliary model is, say for example,
8 like moderator heating effects, heating of structure,
9 that those are discussed in the documentation and, of
10 course, we also reviewed the validation that was
11 presented and we also went through a sample problem
12 which was derived -- this is very similar to what we
13 did in the RETRAN review.

14 Basically we derived a problem on which we
15 ran the TRACG code. This is actually the staff ran
16 the code and we also ran our own methods and then we
17 tried to do a comparison. Essentially, what we're
18 trying to do there us we're trying to sort of bridge
19 the gap between the data that we have available which
20 is very old data. It's on reactor designs and fuel
21 designs that aren't really in use any more. I wanted
22 to sort of bridge the gap there and try and get an
23 understanding of how the code will perform if we use
24 a more modern fuel design. That's effectively the
25 point of the data analysis.

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1 MEMBER FORD: Just for clarification, your
2 use of the word validation is not validation of a code
3 to make sure that operator A gets the same results as
4 operator B on the code. It's on how well the code
5 predicts experimental observations.

6 MR. ULSES: Yes, sir. Right. This is a
7 mixture of experimental data and there's also some
8 plant transient data as well which has been validated
9 against it. Again, it's all in that report which I
10 understand you haven't seen so it's very difficult to
11 get into and it's certainly proprietary so I can't get
12 into the details of the actual results. I don't know
13 if we want to maybe do it this afternoon. I don't
14 know if that's possible and if it would be interesting
15 to anybody, we could put some cards up this afternoon
16 in closed session just to show you some of the
17 information. That's something you can think about.

18 CHAIRMAN KRESS: I think for Peter's
19 benefit and even Jack, he hasn't seen that either, it
20 might be worthwhile to do some of that. I don't know
21 how much time we've got.

22 MR. ULSES: Perhaps we can think about it
23 and if we have enough time, we can maybe do it this
24 afternoon. That would obviously be up to GNF if they
25 want to do that because it's their data.

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1 MEMBER SCHROCK: Also, I had understood
2 that you had difficulty matching GE calculations in
3 some instances.

4 MR. ULSES: And that's something I want to
5 discuss. Yes, that's exactly one of the things I
6 wanted to discuss which is why I constructed the
7 presentation as I have. I want to get to the bottom
8 line, and then I want to discuss the problems that I
9 had which basically have been resolved. There were
10 some issues where basically I made a mistake is what
11 happened, and that's why there were differences. I'll
12 say my mea culpa right now. That's what I want to get
13 into, and I want to discuss how that happened, and I
14 want to discuss some areas where we can improve in the
15 future.

16 So let me move on here. I think I've
17 already discussed most of this. Basically, what we're
18 doing now in these days when we're actually reviewing
19 the code by having the code and executing the code is
20 we're focusing more on the performance of the code
21 rather than just looking at the presented written
22 material. This is a model that we found has worked
23 well for us in the past, and I think it actually
24 worked well in this case, I'd say even when one
25 considers the difficulties that we had along the way.

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1 I'd say this was an effective review model. I don't
2 know if GNF would agree with that, but I think it was
3 an effective review model from the staff's
4 perspective.

5 CHAIRMAN KRESS: That's interesting to
6 know because ACRS has pretty much been advocating that
7 approach for a long time.

8 MR. ULSES: One thing that was certainly
9 useful with the way we did it this time is it actually
10 led us into reviewing some models that we probably
11 wouldn't have reviewed which actually were more
12 important than I originally suspected. So I guess in
13 a sense that was certainly an effective outcome of
14 this review process and again, I'll discuss that in
15 more detail after we get to the SER conclusions.

16 Basically, all the information at the
17 beginning of the presentation is all contained in the
18 SER. It's just sort of ground out of there.

19 These are the validation studies that are
20 in the assessment manual. These are the areas where
21 they have data. Obviously, the Peach Bottom turbine
22 trip tests which are validated against. And the rest
23 of this information is -- there's start-up testing in
24 there and there's also some data from planned events
25 which has been assessed and it is in the manual. I

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1 just wanted to put this up here to show you that they
2 do have actual data that they compare their code to.

3 CHAIRMAN KRESS: Is this the proprietary
4 data?

5 MR. ULSES: Yes. If we actually wanted to
6 show the actual results, that would be proprietary.

7 These are effectively the conclusions that
8 are in the SER. We felt that the theoretical
9 development captured the relevant physics necessary to
10 predict an AOO type transient.

11 CHAIRMAN KRESS: It captures them to
12 sufficient degree?

13 MR. ULSES: They provided reasonable
14 assurance that the code will accurately predict these
15 answers for application to licensing.

16 And again, what I refer to as auxiliary
17 models which are basically gama heating of the liquid
18 in the structure. I felt them to be very well
19 developed, and that they would be effective in the
20 proposed application. And again, the decay heat
21 modeling. I felt it was adequate for the proposed
22 purpose and, again, Doctor Schrock, I definitely think
23 your criticism is valid, and I will definitely change
24 what's written in the SER to describe the constraints
25 on the review.

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1 MEMBER SCHROCK: I don't know what you
2 mean by you feel it's adequate. I mean you need some
3 quantitative --

4 MR. ULSES: Well, let me say that it is
5 adequate for the proposed application because decay
6 heat is at best a second order effect, perhaps even a
7 third order effect, for the application that's been
8 proposed.

9 MEMBER SCHROCK: Well, I don't know that
10 it's a third order effect but --

11 MR. ULSES: It's definitely a second order
12 effect, at best.

13 MEMBER SCHROCK: Yes. What I'm saying is
14 that we haven't heard evidence of such conclusions,
15 and I think we should.

16 MR. ULSES: Interesting.

17 CHAIRMAN KRESS: What do you do about loss
18 of feed water with respect to that?

19 MR. ULSES: Well, it's A) not a limiting
20 transient. It's one that's analyzed because it's
21 required by Chapter 15.

22 CHAIRMAN KRESS: It's a low frequency.

23 MR. ULSES: It's usually a low effect
24 transient. Correct me if I'm wrong here. I think
25 it's usually not one that sets any limits on the plant

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1 and, therefore, the decay heat, if it's high for that
2 particular scenario, the uncertainty in the model
3 would not have a significant effect on plant
4 operations. Again, correct me if I'm wrong but I
5 believe that's correct. And that again would be why
6 that was dispositioned as it was.

7 Again, this goes back to a discussion of
8 documentation we had earlier, Doctor Kress. It's
9 acceptable for use by the applicant, and that's
10 obviously the intended audience of the documentation.
11 It certainly isn't documentation that I would expect
12 somebody who didn't have a great deal of knowledge of
13 the methodology to pick up and be able to fully
14 understand it. But again, that's not the intended
15 audience of the documentation.

16 This goes on to our test problem that we
17 derived. Essentially, like I said, what we were
18 trying to do here is we were trying to bridge our
19 understanding of the code's ability to handle the
20 reactors that are being run and used right now in this
21 day and age. The core is based on an ABWR reactor.
22 It was designed to be as easy a model as we could. A
23 zero exposure so we didn't have exposure effects.

24 MEMBER SCHROCK: That may be because in
25 the SER you do not include ABWR as the reactor types

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1 to which the code may be applied.

2 MR. ULSES: Well, the issue though is that
3 that was a model that GNF already had available and it
4 was based on modern GE fuel. That was the reason that
5 was chosen. And all we modeled there was the reactor
6 core itself. We did not model the rest of the steam
7 supply system at all.

8 MEMBER SCHROCK: Well, I asked myself the
9 question in the opposite sense as I read that. Why is
10 ABRW excluded from what the code is approved to do?

11 MR. ULSES: Well, I'd say right now off
12 the top of my head we're not running any ABWRs in the
13 United States and plus that's a good question. I
14 think that's something that we were asked to review
15 and approve more than likely.

16 MEMBER SCHROCK: Is it necessary to call
17 it out?

18 MR. ULSES: Well, it's going to be trying
19 to identify the source.

20 MEMBER SCHROCK: Or exclude it from the
21 list of those for which it could be applied.

22 DOCTOR ANDERSEN: Jens Andersen from GNF.
23 When we made the submittal to the NRC, we made the
24 submittal to be valid for operating BWRs in the United
25 States. There are no ABWRs in the United States.

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1 Clearly, the difference --

2 MEMBER SCHROCK: So it's GE's choice, not
3 NRC's choice.

4 DOCTOR ANDERSEN: It is our choice. The
5 difference in the ABWR design and the conventional BWR
6 design is mostly in the recirculation system. There's
7 clearly no relevant significant differences in the
8 core design. We chose NABWR core design because it
9 would simplify the process of generating the nuclear
10 input that would allow us to do the comparisons
11 between the NRC codes and the GE codes because it was
12 an initial core at zero exposure. It greatly
13 simplifies the process.

14 MR. ULSES: And it's just discussed in the
15 SER because we were trying to identify it.

16 MEMBER SCHROCK: You could manage to have
17 the approval cover the SBWR, but that's your business,
18 not ours.

19 MR. ULSES: I was just simply trying to
20 identify the source of the model. That was the reason
21 it was discussed in there. And again, obviously we
22 looked at the steady state results to make sure that
23 we didn't have any gross discrepancies between the
24 application in TRACG and the application with our
25 methods, and we didn't see any differences. Well, we

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1 didn't see any large differences. The codes compared
2 well. And we also ran some small perturbation
3 transients to look and make sure that we didn't see
4 any gross discrepancies in the way the model would
5 respond to, say, a small perturbation in pressure, a
6 small perturbation in flow.

7 I just want to briefly put up again. This
8 is all in the SER. This is the initial steady state
9 power distribution out of the two models, the two
10 codes, and they compare very well. There are some
11 discrepancies on the periphery due to the handling of
12 the modeling of the reflector. However, for this
13 case, we feel that this is a pretty good comparison
14 and that the model is working very well in both cases.

15 MEMBER FORD: You said the model was
16 working well. What is your definition of working
17 well?

18 MR. ULSES: Well, in this case, since
19 we're trying to compare one code to the other, if we
20 get good comparison, we feel that both codes are
21 modeling the problem in the same way and giving the
22 same answers. That was a figure of merit.

23 MEMBER FORD: Validation of those models
24 is based presumably on data from off-shore reactors?

25 MR. ULSES: Actually, the data for TRACG

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1 is based on all data, I believe -- actually, there's
2 a couple of data stats from overseas reactors but, for
3 the most part, it's based on U.S. data.

4 MEMBER FORD: That's not ABWR.

5 MR. ULSES: Right. Again, it was just
6 intended to make everyone's life easy. That's the
7 reason why that reactor was chosen, because it was
8 available, there was zero exposure, and all we're
9 trying to do here is examine the response of the code
10 to a perturbation, not necessarily the ability to
11 actually model the steady state characteristics of the
12 reactor which would be burn-up, for example. That's
13 basically a steady state response, and that's not
14 really modeled in TRACG. I mean it's handled as an
15 input parameter to the code. So what we're trying to
16 do is we're trying to examine the code's ability to
17 model the effect of a pressure perturbation.

18 MEMBER FORD: The number of ABWRs against
19 which this prediction would be compared were not
20 large.

21 MR. ULSES: But this reactor will never
22 exist. This is a hypothetical reactor that we made
23 up. This is a sample problem. This reactor will
24 never exist.

25 MR. HECK: Excuse me. This is Charlie

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1 Heck from Global Nuclear Fuel. The loading, the core
2 specification bundle designs here, one of the
3 constraints was that it be an initial core so that
4 there would be no issues regarding how exposure
5 differences possibly in lattice physics. And that was
6 Tony's specification. He said initial core as
7 realistic as possible, so we chose a real design which
8 was an ABWR core.

9 The only initial core we have these days.
10 And we took it and we trimmed it so it's really not
11 ABWR core per say. This is actually a 560 bundle
12 core. ABWR is much larger than that. Eight hundred
13 and twenty, I think. We trimmed it to the right size
14 maintaining the same proportions and the calculation
15 that's being done here is just for the core model
16 hydraulics. The vessel boundary conditions above and
17 below the core are specified. So this is a problem
18 designed specifically to focus on the neutron kinetics
19 and coupling of that with the hydraulic models.

20 CHAIRMAN KRESS: Tell me what I'm looking
21 at. This is one quarter of the core.

22 MR. ULSES: It's one quarter steady state
23 power distribution.

24 CHAIRMAN KRESS: Steady state full power
25 distribution and if I were to ask how to compare the

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1 two code calculations in terms of some figure of
2 merit, would I be asking what the differences were in
3 terms of some root mean square area or would I be
4 asking how the differences affect peak clad
5 temperature of the hot model? How do you compare two
6 curves like this and ask yourself whether they're the
7 same or close enough? I see very little difference.
8 I can see the parts around the periphery where you say
9 there's some difference but it's a little hard for me
10 to figure out how good the comparison actually is. It
11 looks almost identical.

12 MR. ULSES: Well, the real figure of merit
13 for this study was the energy deposition which is
14 calculated by this code following a simulated
15 pressurization transient.

16 CHAIRMAN KRESS: You started at steady
17 state and then you ran through --

18 MR. ULSES: What effect are any
19 discrepancies you see here going to have on the effect
20 of the analysis with these two codes on the energy
21 deposition following a pressurization transient.

22 CHAIRMAN KRESS: It's a total energy
23 deposition.

24 MR. ULSES: Right. That's what's going to
25 lead to changes in MCPR. That's going to lead to

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1 changes in the calculated changes in critical power
2 ratio which are clearly the figure of merit for an AAO
3 analysis. So that's basically the bottom line. What
4 we're trying to do here is make sure that the models
5 had no gross discrepancies at the steady state point.
6 That was the only point of doing this particular
7 figure.

8 MEMBER SCHROCK: TRAC/Nestle has been used
9 previously for AAOs.

10 MR. ULSES: No. It was used -- the staff
11 code that we used for these types of simulations, we
12 used it in the RETRAN work where we worked on RETRAN
13 3D. And it's a code that's used by the staff for
14 these types of audit type of calculations. It's not
15 a licensing code. It's not an industry code.

16 MEMBER FORD: I shouldn't be reading
17 anything more into that draft than to say that there's
18 little difference. Whatever the difference between
19 those two models are if it's an input -- it has no
20 impact at all on the resultant prediction.

21 MR. ULSES: I wouldn't say no impact but
22 there's a small impact on the final bottom line.
23 That's the only point of this curve is to make sure
24 that there are no gross discrepancies in the initial
25 conditions.

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1 MEMBER FORD: I may be a devil's advocate
2 here but the model could be completely wrong because
3 I don't see any data, observed data.

4 MR. ULSES: Right. Both codes have the
5 potential to be completely wrong. You're correct.
6 And that's why you need to fold in the existence of
7 experimental data into these types of studies.

8 MEMBER FORD: For ABWRs, whatever the fuel
9 configuration is, there's very little data existing.

10 MR. ULSES: Well, I can see it was a
11 mistake to put ABWR on here. The only point of this
12 study, this reactor, like I said, is hypothetical. It
13 will never exist. It will never run. It's just on
14 paper.

15 MEMBER FORD: I'm trying to understand
16 what may take away from that

17 MR. ULSES: What we're trying to do is
18 we're trying to design a sample problem which would be
19 easy for both organizations to set up and what we want
20 to do is we want to isolate the kinetics modeling from
21 the reactor system modeling as much as we can.
22 Obviously we can't do it entirely. So we stripped out
23 all the rest of the vessel model. There's no
24 separators. There's no recirc flow. There's nothing.
25 All it is is the reactor model and it's got a velocity

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1 boundary condition at the lower tieplate and the
2 pressure condition in the upper plenum.

3 So that's the point in this. The
4 existence of this model was used because it already
5 existed and they were able to take it, they were able
6 to scale it down and make a smaller core out of it
7 without doing a great deal of work. That was the only
8 point of using this model. It's not intended to
9 validate against the ABWR at all. It was used because
10 we were able to isolate the kinetics modeling from the
11 rest of the reactor system. That's the point of this
12 study.

13 MR. BOLGER: This is Fran Bolger from GE.
14 I just wanted to point out that the model that you see
15 under the TRACG is based on the GE steady state
16 simulator. Now that steady state simulator is the
17 same simulator that is run at the plants and those
18 simulators are compared to LPRM and trip data
19 regularly. So that's the same model that's validated
20 on a day to day basis in the fleet.

21 MR. ULSES: Let me move on here.

22 MEMBER SCHROCK: Let me make one last
23 point. The TRAC/Nestle is what version of TRAC?

24 MR. ULSES: It's using the NRC version of
25 TRACB which we all know and hopefully love or don't

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1 love. It's the version that came out of INEEL.

2 MEMBER SCHROCK: But you have other
3 experience to tell you how good or not good that
4 should be expected to do on a typical problem like
5 this.

6 MR. ULSES: That's correct. TRACB itself
7 has validation. It's not an unvalidated model.
8 Obviously it's not validated against the same data
9 that they validated TRACG against obviously because
10 most of the data they use is going to be GE
11 proprietary information. But it is a validated method
12 for things like, say, void fraction predictions,
13 density predictions, fuel temperature predictions,
14 things that are going to be relevant for this
15 particular study.

16 MEMBER SCHROCK: But you don't use its
17 kinetics model.

18 MR. ULSES: No, not using its kinetics
19 model.

20 MEMBER SCHROCK: Because it's not multi-
21 dimensional.

22 MR. ULSES: It has a one-dimensional
23 model, but it's not being used. All it's doing is
24 it's giving Nestle density fuel temperatures. That's
25 it's only function for this study.

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1 I just wanted to put up again the axial
2 void fraction profile radially collapsed, one-
3 dimensional. The only difference is this little
4 change here and that comes in because of the existence
5 of the part length rods and that's the TRACB modeling.
6 There's a difference. You could go into the part
7 length rod and region. But again, as you'll see, it
8 does not have an effect on the overall bottom line
9 answer.

10 CHAIRMAN KRESS: Is this integrated
11 radially across the core?

12 MR. ULSES: Yes. This is radially
13 collapsed, one-dimensional average axial power
14 distribution. I'm sorry. Average in channel void
15 fraction. Okay.

16 This is just a brief description of how we
17 set the problem up. What I did was I ran an input
18 deck that had the entire reactor system model to get
19 the boundary conditions which were then imposed on our
20 simpler model and that enabled us to do the transient
21 modeling. And then we modeled the case in TRACG using
22 multiple options available in the code. We turned
23 switches on and off to see if they had effects on the
24 results.

25 MEMBER FORD: Again, I keep coming back to

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1 this and you gave the key answer. This tells me
2 nothing at all how good the model is.

3 MR. ULSES: Right. All this is telling us
4 is -- well, it's telling us that we're able to bridge
5 the gap and that we have an understanding that we have
6 multiple codes which can model a reactor using modern
7 GE fuel. It's telling us an area where we do not have
8 any data because there is no data that exists.

9 MEMBER FORD: But the critical question is
10 any of these codes, they all seem to give the same
11 results. Are there operational data against which you
12 can have a one to one comparison between the
13 prediction and the observation? What you've told me
14 is there is.

15 MR. ULSES: For pressurization transients
16 with modern fuel, it's my understanding that there is
17 no data available. We have data from the '70s using
18 fuel that's no longer run in reactors which allows us
19 to do validation against or verification if you want
20 to look at it. The only point of this particular
21 study was to attempt to understand the ability of
22 TRACG when compared to another method, whether there's
23 anything unique about modern fuel designs which will
24 lead the staff to believe that the code is not capable
25 of modeling a modern reactor. That's the only point

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1 of this study because there is no data with modern
2 fuel, as I understand it, for pressurization
3 transients. Correct me if I'm wrong here.

4 DOCTOR ANDERSEN: This is Jens Andersen
5 from GNF. I understand that you're a little at a
6 disadvantage but if you remember from Ralph Landry's
7 presentation, we have one of the reports that was
8 submitted to the NRC and also to the ACRS was the TRAC
9 qualification report which is about an inch and a half
10 thick and it has an extensive qualification consisting
11 of basically four sets of qualifications.

12 One was a set of separate effects test
13 where we had isolated individual phenomena and tried
14 to qualify those phenomena like could we predict a
15 given heat transfer core regime? Could we predict a
16 void fraction in the fuel bundle? Then it has more a
17 complicated section on component performance like how
18 well do we predict a steam separator performance? How
19 well do we predict a jet pump performance? This is
20 all based on data and full scale data wherever full
21 scale data was available.

22 Then we have a section in the report which
23 is what we call integral system effects test which is
24 basically scale simulation of an entire BWR typically
25 scaled down to a few bundles that are simulated

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1 through electrical heating. That gives us a
2 qualification of how well the code predicts system
3 interactions between various components in the
4 systems. And then we have the final section is a
5 section of comparison against plant data where we have
6 full scale plant data, typically data taken during
7 plant start-up tests.

8 That includes data like the Peach Bottom
9 turbine trip test. Those are, as Tony Ulses
10 mentioned, all the data based on 7 X 7 and 8 X 8 fuel.
11 We have later data with more modern fuel types like
12 the Nine Mile Point pump up-shift test which contains
13 predominantly GE11 fuel which is typical of the modern
14 fuel with a large central water rods and the part
15 length rods. So we do have qualifications for modern
16 fuel types, and it shows how the kinetic reacts to
17 changes in the hydraulic conditions in the core.

18 So all of that is in the qualification
19 report and it's based on comparison to actual plant
20 data. Now, we have taken that a step further in the
21 application methodology report, and that's where we
22 apply the statistical methodology is that we have gone
23 in and done a statistical analysis of all the
24 qualification data and quantified what are the
25 uncertainties in predictions of the individual data so

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1 that we can properly account for this uncertainty in
2 the application methodology.

3 So all of that is in the report and,
4 unfortunately, I understand you haven't seen these
5 reports, and we'll be happy to show one of the
6 reports. We can do it during the break.

7 MEMBER FORD: I'll look at it like this.
8 (Indicating blindness with his hands.)

9 MR. ULSES: Well, anyhow, I'd like to move
10 on to the next slide. Basically the next slide is the
11 results of the sample problem. Again, the ABWR
12 problem which is not a real reactor which is intended
13 just to allow us to bridge the gap between the areas
14 where we have data for the pressurization transients
15 which are typically limiting AOOs and BWRs to the
16 reactors that are operated in the year 2001. That's
17 the only point of this problem, again.

18 Actually, what I'm going to do is put up
19 another slide that's not in your handout. I apologize
20 for this. I'll get to this to you, Paul. This is a
21 slide that actually is in the SER. Essentially, these
22 are the results. These are the relevant results.
23 What you see here is the power on the top one, the
24 total power from the reactor. Obviously, there are
25 some discrepancies there between the codes. We have

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1 a couple of hundred megawatt difference in the peak
2 power between the TRACB calculations and the TRACG
3 calculations. But if you look at the effect --

4 CHAIRMAN KRESS: Under a pressurization
5 transient without scram, you're basically checking the
6 void coefficient effect and the temperature
7 coefficient effect.

8 MR. ULSES: That's correct. That's what
9 we're doing. What we're doing is looking at the
10 balance of the reactivity from the void effect and the
11 fuel temperature effect.

12 CHAIRMAN KRESS: The voids get collapse
13 and that adds power and the temperature goes up
14 because of the increased power and it turns it around.

15 MR. ULSES: That's exactly what happens
16 and you also have a trip of the recirculation pumps as
17 well.

18 CHAIRMAN KRESS: Okay.

19 MR. ULSES: Which will also significantly
20 drop the power. That's what's going to happen. But
21 if you look at the bottom curve, which is just simply
22 the interval of the top of the curve, what you're
23 going to see is that the effect on the energy, which
24 is really the figure of merit for an AOO transient, is
25 effectively -- well, it's not nil. It's obviously

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1 very difficult to see on this scale. But it's very
2 small which would mean that the actual calculated
3 change in the critical power ratio from these multiple
4 simulations would be very small which tells us that
5 these two codes obviously are able to predict that
6 this model is the same, if you will, in effect.
7 Obviously, there are some differences.

8 CHAIRMAN KRESS: What are the differences
9 between the blue and the red?

10 MR. ULSES: That's using a different model
11 in the TRACG code which I'd like to discuss next
12 actually. That's one of the things that I discovered
13 going through this review which was very intriguing.

14 CHAIRMAN KRESS: What's the cause of that
15 little plateau on the right?

16 MR. ULSES: Right here?

17 CHAIRMAN KRESS: Yes.

18 MR. ULSES: This is, in effect, the
19 competition of the void reactivity and the fuel
20 temperature reactivity and how it's affecting the
21 power. That's what's causing that.

22 I'd like to just move on to the review
23 conclusions which again are in the SER. Effectively,
24 what we concluded is that we have reasonable assurance
25 that TRACG can model AOO transients. This is based on

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1 obviously evaluation of the GNF validation,
2 benchmarking, if you will, comparison to actual plant
3 data and also based on the sample problem which we
4 derived. And again, this is just simply stating what
5 we've already stated, that the code that's being
6 applied to Chapter 15 transients and that is the scope
7 of the SER.

8 MEMBER SCHROCK: In the SER you address
9 difficulties that you had in predicting results from
10 the SPERT 3 tests. You've not commented on that. Is
11 that because you're excluding RIAs?

12 MR. ULSES: That's basically the bottom
13 line. RIA is not included in the scope of review, but
14 actually I do plan on discussing --

15 MEMBER SCHROCK: Why is it in the SER?

16 MR. ULSES: Well, because it was in the
17 validation documentation which was given to us by GNF
18 and, therefore, I wanted to discuss it. And that's
19 one of the things I plan on discussing in the
20 discussion of review challenges which is what I'd like
21 to go to next.

22 CHAIRMAN KRESS: I was wondering. We need
23 to take a break some time right about now. Would this
24 be a good time?

25 MR. ULSES: This would be a great time.

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1 This is sort of a change in the focus, but I do plan
2 on discussing really the why. I didn't discuss the
3 SPERT test and the SER because it really is not
4 relevant for the proposed application. You are
5 correct.

6 MEMBER SCHROCK: Well, if I read your SER
7 conclusions correctly, you have a very different view
8 of that than I have. It seems to me that SPERT 3's
9 very small core has essentially nil spatial
10 difficulties.

11 MR. ULSES: Very little, if any.

12 MEMBER SCHROCK: It's practically a point
13 reactor calculation and for what reason, I can't
14 imagine that a more sophisticated code shouldn't be
15 expected to give good results on that.

16 MR. ULSES: And that's a very good
17 question and that's the question that I had in my mind
18 and that's one of the reasons why I decided to discuss
19 it, and I do plan on talking about that in this
20 presentation a little bit later.

21 CHAIRMAN KRESS: In that case, I'm going
22 to declare a recess for 15 minutes. So be back 20
23 minutes after 10.

24 (Off the record for a 15 minute recess at
25 10:07 a.m.)

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1 CHAIRMAN KRESS: I think we can go back in
2 session now. Talk about challenges. Is that what you
3 were going to do?

4 MR. ULSES: Right. This is basically the
5 mea culpa I referred to earlier in the presentation.
6 Effectively, the differences that you were talking
7 about, Doctor Schrock, in that one draft RIA that I
8 prepared which showed those major discrepancies in the
9 code results. Basically, the bottom line of why that
10 was there is I made a mistake in the input stream of
11 my analysis. It was discovered, and the differences
12 went away. The mea culpa is that I made the wrong
13 conclusion based on what I saw and that's what led to
14 that draft RIA which hasn't made it into the final
15 RIAs, by the way, because it was not pertinent because
16 it was incorrect. But that's basically the issue. If
17 you want, I can go into more detail as to why the
18 differences were there or we can leave it at that. I
19 will pose that as a question.

20 CHAIRMAN KRESS: Are you asking Virgil or
21 me?

22 MR. ULSES: I'm asking any of the members
23 and consultants if they have any interest in going
24 into more detail as to why there was a large
25 discrepancy in the initial analysis.

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1 CHAIRMAN KRESS: You know, I think in the
2 interest of clarity, I would like to hear a little
3 more. Yes.

4 MR. ULSES: Well, basically what it really
5 boils down to is the way the moderator density is
6 handled in the TRACG code versus in the methods that
7 I used traditionally. I think I'm probably going to
8 tread on proprietary ground here.

9 CHAIRMAN KRESS: Yes, be careful.

10 MR. ULSES: With the modeling, you will
11 halt me. Okay. Basically, the way GE handles the
12 modeling of moderator density is they use a weighted
13 average of the in-channel density. In other words,
14 the water that's inside the box with the water that's
15 in the bypass region where the control blades run.
16 That's an average parameter which is passed between
17 the kinetics and the thermal-hydraulic solver.
18 Hopefully, that wasn't proprietary. That's not the
19 way I traditionally model that in the methods that I
20 use. I usually base it on the in-channel density
21 alone which for AOO analysis is perfectly adequate
22 because you don't expect to see any changes in the
23 bypass. It's going to start off as water and it's
24 going to stay solid water throughout the transient.

25 What I had to do was go into the codes

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1 that I had and modify the algorithm to handle that and
2 I made a mistake in the way that was done and that was
3 discovered and the error went away. That was the
4 bottom line.

5 CHAIRMAN KRESS: So the difference was in
6 the void coefficient effect --

7 MR. ULSES: Right. And that's what was
8 leading to that huge discrepancy which one would
9 expect because obviously this transient is definitely
10 void dominated.

11 CHAIRMAN KRESS: Okay.

12 MEMBER SCHROCK: So that part of the SER
13 will be corrected.

14 MR. ULSES: I don't think it's in the SER.

15 CHAIRMAN KRESS: It was an RAI.

16 MR. ULSES: It was an RAI. It was a draft
17 RAI which is not going to be in the final RAIs because
18 it was incorrect. That's basically the bottom line.
19 Anyhow, one thing that I think was good out of all
20 this is that it did lead me down a path that I
21 wouldn't have gone into originally which leads me to
22 the next slide which discusses how GE and I would say
23 probably every other organization in the United States
24 uses the MCMP code for validation and verification of
25 lattice physics methodologies. It's widely used,

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1 widely accepted in most organizations that I'm
2 familiar with and probably the ones that I'm not
3 familiar with. It's used to check the results from
4 lattice physics calculations in the absence of data if
5 the MCMP is accepted as a very accurate methodology
6 and it's used for that purpose.

7 CHAIRMAN KRESS: That's a Monte Carlo.

8 MR. ULSES: Right. It's a Monte Carlo
9 solver which was written by Los Alamos and has been
10 extensively used for these types of applications over
11 the years.

12 This leads me in to a discussion of what --

13 MEMBER SCHROCK: I ask you to look at page
14 eight of your SER.

15 MR. ULSES: I'm going to have to ask you
16 for a copy of it. I don't have one in front of me
17 here. Okay.

18 MEMBER SCHROCK: I mean you don't need to
19 review it now but I mean --

20 MR. ULSES: If there's something in there
21 that I have an error in, I'd like to see it.

22 MEMBER SCHROCK: The paragraph that
23 addresses the SPERT 3 report.

24 MR. ULSES: And that I'm going to discuss
25 more in the end of this presentation, Doctor Schrock.

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1 I have a slide on it. I'd like to discuss that.
2 Certainly you are right. I agree with you that I
3 would expect a more modern accurate method to be able
4 to handle the E-core experiment because if you look at
5 the documentation that was written up on that
6 experiment back in the '60s, they were using point
7 kinetics models and they were very sufficient to model
8 that reactor. But I'd like to defer that until a
9 couple of slides from now if that's possible because
10 I certainly think that needs to be discussed.

11 Basically what this led me to was the
12 discovery of a model that I've dubbed the PIRT 18
13 model for lack of a better word. I don't think that's
14 what GE calls it, but I sort of made that up because
15 I needed a word to write in the SER. And what that
16 basically does is using MCMP and then based on MCMP
17 results they have a model in TRACG which effectively
18 modifies the void reactivity which they would have
19 calculated out of their licensing basis tool to better
20 compare to the MCMP results. That's effectively how
21 the model works in a nut shell. I hope that's a
22 correct characterization of the model.

23 DOCTOR ANDERSEN: This is Jens Andersen.
24 If I can just make one comment. You are right in this
25 characterization. This particular model is described

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1 in the application methodology report and the reason
2 it's described there is that this was part of the
3 effort that we undertook to quantify the accuracy of
4 the various models in TRAC to determine what is the
5 bias and what is the uncertainty of all the models in
6 TRAC in order to know what these uncertainties are in
7 order to apply these uncertainties in the application
8 methodology.

9 We have quantified all the model
10 uncertainties for the models that we thought were
11 either of high or medium importance based on our
12 tables. The void coefficient is one of these models
13 and the benchmarking against the MCMP calculations
14 were how we quantified the uncertainty in the void
15 coefficient. So this is part of the process of
16 quantifying what bias and uncertainty of the models
17 are so we could account for it in the application
18 methodology.

19 We can go into details on that particular
20 model, but we probably would want to do that as part
21 of the proprietary session in the afternoon.

22 MR. ULSES: Sure. Well, one thing I
23 definitely want to point out though is I just want to
24 point out the area where the staff had difficulty with
25 the model, as we understand it.

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1 DOCTOR ANDERSEN: Yes.

2 MR. ULSES: And the issue basically boils
3 down to the fact that when you run a Monte Carlo code,
4 as I'm sure you're all well aware, you don't get a
5 point answer out of that code. You don't get an
6 answer. You get a range of answers. And the way GE
7 has applied the MCMP results within this uncertainty
8 methodology, they're using the mean value of the
9 predicted eigen value without consideration of the
10 error or of the uncertainty in the analysis.

11 The issue that I had with that, I mean
12 let's go to a couple of plots here. I don't think any
13 of this is going to be bad. This is basically --
14 these are the comparisons of the lattice physics
15 results of the code that I used compared to the one
16 that GE used for the sample problem. In other words,
17 the ABWR test reactor that's fictional that's never
18 going to be run.

19 And then these are some calculations that
20 I did with MCMP myself here at NRC looking at the
21 lattices that were used in that problem with the
22 uncertainty bounds. These are the 95 percentile
23 confidence intervals which are plotted here as error
24 bars. And again, that has it on there. The issue
25 that I really had with this model is that let's say we

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1 choose a mean value to do our comparisons with the
2 TGBLA results and we say that there's a difference
3 between the results and let's say we're going to
4 believe the MCMP results and what we're going to do is
5 we're going to change the TGBLA results to match the
6 MCMP results.

7 But if you look at this plot, it would be
8 equally valid to take the prediction down here versus
9 the prediction up here because again, this is a value
10 which is not a point value. All these values here
11 have been deemed to be effectively the same number
12 within the way that MCMP is usually applied. And if
13 you take this difference and you span this across this
14 curve, it will have an effect on the predicted power
15 response.

16 It's not going to be significant, but
17 there'll be an effect, and that's not accounted for in
18 this model and that's basically the problem that I had
19 with it, and that's why the SER is written as it is on
20 this particular model. It doesn't have a significant
21 effect on the bottom line answer, which is energy
22 deposition, but I don't believe that it's well enough
23 quantified in this context simply because of the lack
24 of the consideration of this uncertainty band.

25 MEMBER SCHROCK: Isn't there a probable

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1 value in some distribution?

2 MR. ULSES: That's basically what this is
3 but the way these codes are usually applied is that
4 you don't simply take the most probable value. Let's
5 say I was going to use this and I was going to do like
6 a criticality safety analysis, for example, which
7 obviously is not really applicable here but that's
8 just an example. What I would do is I wouldn't take
9 this as the answer. I would usually take the upper
10 bound because what MCMP is telling me is that it can't
11 give me an answer with any better accuracy than with
12 what's within this error bar. That's what I'm getting
13 out of MCMP. And the point, that's just simply a mean
14 value, but the code is really telling me that I can't
15 give you an answer with any more accuracy than what's
16 within the error bound and, therefore, I question why
17 the mean value was chosen as opposed to the upper
18 bound versus the lower bound.

19 CHAIRMAN KRESS: Those error bands, are
20 those one sigma, two sigma?

21 MR. ULSES: I actually don't recall when
22 I plotted here. I apologize for that. I should have
23 had that in front of me.

24 CHAIRMAN KRESS: It's probably one sigma.

25 MR. ULSES: It probably is, I think. Yes.

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1 CHAIRMAN KRESS: Standard.

2 MR. ULSES: That's what usually is
3 plotted.

4 MR. HECK: Excuse me, Tony. This is
5 Charlie Heck, Global Nuclear Fuel. I think you said
6 those are 95 percent confidence bands. Those would be
7 equivalent to two sigma.

8 MR. ULSES: That's right. This is the
9 confidence interval. You're right, Charlie. Thank
10 you for correcting me.

11 MEMBER SCHROCK: So they're not bounds at
12 all.

13 MR. ULSES: This is the confidence
14 interval which is what's applied or which is what's
15 usually used as the output for Monte Carlo codes.

16 MEMBER SCHROCK: You're calling it bounds
17 and they're not bounds.

18 MR. ULSES: Well, that's probably the
19 wrong choice of terminology. You're correct. But
20 this is a confidence interval which is what the code
21 is telling us. This is the highest level of
22 confidence that the user should put obviously on any
23 number that's in that range. And the way these
24 methods are usually applied is they're not used to
25 derive a point value. If I was simply going to run my

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1 lattice code and I wanted to compare it to MCMP, then
2 I would say if I had an answer which landed anywhere
3 within this error bound, I'd say I'm happy with that.
4 But I wouldn't go in and modify the results of my
5 lattice code based on that comparison. That's the
6 area where the staff is a little uncomfortable here.
7 Everybody goes out and they modify and they actually
8 validate their code against this number with the error
9 bars on it and if they say that the answer landed in
10 the error bars, I'm satisfied with that. But this is
11 the first application that the staff has come across
12 where they actually use this result to go in and
13 modify the results of the licensing tool within the
14 framework of a code application. And that's the area
15 where we had some questions. And this was the first
16 what I would call challenge of this review.

17 CHAIRMAN KRESS: So what was the final
18 resolution of this challenge?

19 MR. ULSES: Well, the final resolution is
20 that it does not significantly effect the energy
21 deposition. However, I do not feel that the model has
22 been adequately justified and I wanted to make sure it
23 was pointed out in the SER as such in case it's ever
24 reviewed again. If in the context of that review it's
25 determined that the model would have a significant

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1 impact on the result, then a future reviewer would
2 know to look at it. That's the reason why it's
3 documented in the SER, for future reference.

4 CHAIRMAN KRESS: I was trying to figure
5 out how I would use that distribution and convert it
6 into an uncertainty on the other calculation. I'm not
7 sure how I would do that. But that's what you said
8 you did. You used this distribution to determine the
9 uncertainty in the other calculation.

10 MR. HECK: This is Charlie Heck, Global
11 Nuclear Fuel. We did use the mean value from MCMP.
12 Those do not get used directly. It's rather the slope
13 of the value versus a void fraction which is what
14 defines void coefficient and we use that to quantify
15 the bias in the void coefficient and the uncertainty
16 in the void coefficient as a function of two
17 parameters that are proprietary in nature that we'll
18 discuss this afternoon.

19 CHAIRMAN KRESS: But basically you're
20 saying the MCMP is truth and you use that to look at
21 a bias in the thing you got then.

22 MR. HECK: I acknowledge the point that we
23 are using the mean value from MCMP as the basis for
24 quantifying the void coefficient that MCMP would get
25 for purposes of comparing it to the void coefficient

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1 that our TGBLA lattice physics method would predict
2 for the same conditions.

3 CHAIRMAN KRESS: Okay. I'm not sure I
4 have a problem with that. I'll have to think about it
5 a while.

6 MR. ULSES: I don't think I have a problem
7 with using it to validate. The issue I had a problem
8 with is using it to modify the output of the licensing
9 basis tool. That's the area of contention. I have no
10 problem actually using MCMP as a validation tool
11 because I believe it's a very accurate code. The
12 issue the staff had was that those results are used
13 then to actually modify the output of the TGBLA
14 results for application in TRACG. That's the area
15 where we had contention. It's not the application of
16 the code as a validation tool. I think that's very
17 acceptable.

18 MR. HECK: This is Charlie Heck again. I'd
19 just like to put this a little bit in perspective.
20 What we're talking about here is about a three percent
21 bias in void coefficient and about a five percent
22 standard deviation in void coefficient and the results
23 of that on the impact for calculating CPR. So I think
24 we need to consider it within that framework. We're
25 looking at basically the bias and the uncertainty

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1 associated with these inputs. In this case, the
2 lattice physics captures these inputs and it
3 propagates from upstream so it's really looking at the
4 variability and the inputs.

5 I want to emphasize that the variation
6 lattice to lattice across the fleet and the different
7 kinds of lattice configurations. This is just one of
8 hundreds of thousands that that variation that's
9 accounted for on an exposure point by point for each
10 specific core condition is much greater than any sort
11 of bias that we're seeing here on a particular lattice
12 by lattice. It's much, much larger.

13 And so I would contend that consideration
14 of the fact that the Monte Carlo variation is
15 uncertain within this band is more than washed out by
16 much larger and more important variations associated
17 with modeling the specific problem.

18 MR. ULSES: What I'd like to do is move on
19 if there's no other questions, comments.

20 MEMBER SCHROCK: Have I got the right
21 interpretation of the Monte Carlo code? It's a
22 transport theory level code?

23 MR. ULSES: Yes. You could characterize
24 it as such. Yes. Without going into painstaking
25 details, yes.

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1 That's a good lead-in to the next
2 discussion of the validation which is where I'd like
3 to discuss the SPERT question that you raised, Doctor
4 Schrock. The emphasis in the review was on the
5 validation which was presented against the
6 pressurization transients because those are what are
7 typically limiting. We certainly considered all the
8 validation, but if you look at the SER you're going to
9 find a discussion only on the pressurization
10 transients mainly because that's where the emphasis
11 was placed in the review.

12 And we discussed the SPERT results in the
13 SER and obviously those are like an RIA type of
14 experiment. They're not really applicable to AOO.
15 They're really beyond scope. But the point of
16 discussing them in the SER was to ensure that if TRACG
17 is ever applied to a situation where they would be
18 significant, that they're reviewed in detail because
19 I agree with you, Doctor Schrock, I believe that with
20 a code like TRACG you should be able to accurately
21 model the SPERT tests, and that's the reason why it's
22 in there. To make sure that in the future if this
23 code is ever reviewed for an RIA type application that
24 it is reviewed and also point out that the staff right
25 now would not be satisfied with those results in that

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1 application.

2 As an example, we've demonstrated that you
3 can model. Let me just put a slide up here. This is
4 from our RETRAN work where we modeled SPERT. You can
5 model the SPERT reactor experiment. This is what I
6 was showing you before. This is what the Nestle code
7 comparing to a SPERT test. It's possible to model
8 that test very accurately with these types of codes.
9 These are the kinds of results that I would have
10 expected to see and that's again why it was pointed
11 out in the SER. Simply to ensure that if it's ever
12 reviewed in the future that it's looked at in greater
13 detail than what it was looked at in this case because
14 it was considered beyond the scope.

15 CHAIRMAN KRESS: The SPERT just pulls out
16 a control rod and--

17 MR. ULSES: Right. Yes. It was a rod
18 ejection type experiment. It was a very small
19 reactor. There were no spatial effects. Basically
20 what you're modeling is the ability to balance the
21 reactivity of the system. That's really all you're
22 after here. Which is why point kinetics models do
23 very well on SPERT because the reactor is very small.
24 But the point here is simply that these types of
25 modern, multi-dimensional methods can and ought to be

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1 able to model this reactor. That's the point. And to
2 make sure that in the future it is reviewed.

3 CHAIRMAN KRESS: What did the results look
4 like with the GE code?

5 MR. ULSES: Well, they're proprietary
6 obviously, but they did okay on the energy.

7 CHAIRMAN KRESS: The bottom line.

8 MR. ULSES: Right. Did okay but the power
9 curve was off.

10 CHAIRMAN KRESS: Shifted?

11 MR. ULSES: I think it had the peak, if I
12 recall, in the right point but they missed the
13 magnitude by a pretty large percent and then they
14 undershot the tail which is why the energy came out
15 okay in the long run. And again, I can't put the
16 curve up here because I'm sure it's proprietary. But
17 that's the recollection that I have in generalities.

18 MEMBER SCHROCK: I'm afraid I still have
19 to contend that this paragraph on page eight in the
20 SER--

21 MR. ULSES: Let me look at this. I
22 apologize. I haven't actually looked at it yet.

23 MEMBER SCHROCK: It's a totally different
24 picture than you've just described. It's attributing
25 difficulties that you were unable to resolve to the

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1 challenging nature. I mean SPERT 3 E-core is a
2 challenging experiment to model. That's what you just
3 said.

4 MR. ULSES: And the reason why I put that
5 in there is because it is a challenging experiment to
6 model. There was a great deal of effort that went
7 into the results I'm showing you right here. It's not
8 something that you can sit down and model just right
9 off the bat. You're going to have to do code changes
10 in order to do it. It's not going to be something
11 that you're going to be able to handle very easily.
12 It's a very challenging model. It's very challenging
13 to set the input up generating cross-sections.
14 They're very challenging. This thing used control
15 rods.

16 MEMBER SCHROCK: You could say that of any
17 calculation. I mean if you don't have the proper
18 inputs to match the experiment, you're not going to
19 get --

20 MR. ULSES: Right, but if you try to apply
21 say like a licensing basis lattice physics tool which
22 you use to model a standard in a light water power
23 reactor, it's going to have a very hard time trying to
24 model this reactor because it used control rods that
25 are the flux trap style. Very difficult to model.

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1 And that's going to be a very large challenge for code
2 model. It's not very easy to do.

3 MEMBER SCHROCK: I don't find any
4 relevance of that to your purpose in review.

5 MR. ULSES: Well, the intent of the
6 sentence was to concede the fact that it is a very
7 difficult and challenging experiment to model.
8 However, the point that I'm trying to make here and I
9 believe I make in the end here is that we expect that
10 they should have been able to do a better job and that
11 we would expect to see a better job if we ever had to
12 do a review where we had the results of the
13 discrepancies between TRACG and SPERT which in this
14 case we felt we did not because of the scope of the
15 application.

16 MEMBER SCHROCK: I read this paragraph and
17 I came away with the interpretation that you're saying
18 that you got poor results and you're not sure why you
19 got poor results but there may be something here for
20 investigation.

21 MR. ULSES: Right. That's basically the
22 point of this paragraph. To make sure that in the
23 future if the scope of review or whatever include
24 these types of simulations, that the staff would give
25 it the level of review necessary and would then have

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1 to resolve the question of why TRACG predicted one
2 thing and the experiment was something else. There
3 are literally a whole host of possible explanations
4 which we didn't delve into in this review because we
5 didn't need to because this was beyond the scope. But
6 I wanted to make sure we reenforced it because it was
7 in the documentation which we reviewed. I wanted to
8 make sure that it had the proper emphasis.

9 MR. HECK: This is Charlie Heck, Global
10 Nuclear Fuel. I'd just like to comment a little bit
11 more on what you're saying, Tony, about the
12 difficulties in modeling this SPERT core. I'll first
13 of all make the point that it's a code core, so any
14 comparison relative to AOO applications would be
15 questionable at best.

16 Secondly, it has a much different rod
17 configuration than anything in light water reactors so
18 that again introduces variability. Also, I'd make the
19 point that modeling it in point kinetics where many of
20 the things are of unknown nature and are collapsed
21 down to a single point is perhaps easier than trying
22 to actually model the lattice physics, especially, as
23 you pointed out, Tony, the lattice physics codes
24 themselves have to be modified to handle this
25 particular geometry. In which case you'd have to

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1 question whether or not -- well, certainly they're not
2 the same code that's being used to model the AOO
3 events.

4 Thirdly, I think you make the point right
5 up there on your very slide where you indicate the
6 control rod worth for this particular experiment plus
7 or minus five percent. That's probably very
8 optimistic when you take a look at the data and not
9 even knowing how quickly the rod was ejected and some
10 variations on the speed.

11 I make the point that the experimental
12 description itself is not of a fidelity that allows it
13 to be terribly useful. Plus or minus five percent is
14 probably a pretty low number. One of the reasons we
15 over-predict the peak in TRAC is because our control
16 rod worth is \$1.23 instead of \$1.16 or .17 as you show
17 there. We get a higher peak and a narrower pulse.
18 And that thing depends on a lot of conditions all
19 specific to the lattice physics, all of which have
20 been modified in order to accommodate this particular
21 problem. I question its validity for application to
22 AOO events and, in fact, I question its validity for
23 purpose of quantifying rod drop backs events, but it's
24 all we have.

25 MR. ULSES: Well, I don't think I question

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1 the validity for RIAs myself personally but I don't
2 really want to get into that discussion right now.
3 This experimental uncertainty is out of the
4 documentation from the experimenters. I'm not in a
5 position to question that, whether or not it's
6 accurate or not at this point. As for control rod
7 speeds, when I took a look at the documentation, I was
8 able to derive a number that I used for this
9 particular case. This was not an easy experiment to
10 model. This represents a couple of months worth of
11 work.

12 CHAIRMAN KRESS: The actual rod worth
13 doesn't depend on speed, does it?

14 MR. ULSES: No. The actual instantaneous
15 value will but the actual final value will not. It's
16 a static analysis.

17 The point I wanted to make here is that I
18 believe that this particular reactor can be
19 successfully modeled with these methods and at this
20 point, if I was reviewing TRACG for RIA calculations,
21 I would not have been satisfied with those results.
22 But in the context of an AOO review, I believe that
23 it's not applicable for this particular point but I
24 wanted to be sure and emphasize the fact that it would
25 need to be looked at in further detail if the

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1 application for RIAs was ever proposed. That's the
2 bottom line. That's the bottom line conclusion and
3 that's the point of having it in the SER because it
4 was in the documentation that was given to us by GNF.

5 CHAIRMAN KRESS: Does this put into
6 question stability analysis at all?

7 MR. ULSES: No, I don't think. I think
8 what you're seeing here is I think you're seeing an
9 issue of the rod speed that was used in the analysis
10 myself personally. That's the place that I would look
11 first if I was --

12 CHAIRMAN KRESS: It would affect the
13 whole--

14 MR. ULSES: If I was GNF trying to
15 evaluate this, I would look at the assumed rod speed
16 myself.

17 MEMBER SCHROCK: Because you haven't show
18 us how different your result was from the experiment.

19 MR. ULSES: Well, these are my results
20 here. This is experimental data. The Xs are
21 experimental data and the red is the Nestle prediction
22 for this particular experiment. What I haven't shown
23 you are the GNF results which are proprietary and I
24 can't put up here right now.

25 CHAIRMAN KRESS: But you know the peak is

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1 higher and the tail is lower.

2 MR. ULSES: Tail is lower so the energy is
3 in reasonable agreement with the experiment. The only
4 point of putting this particular curve up here is to
5 emphasize the point that the staff believes that it is
6 possible to model this reactor. That's the only point
7 of putting this up here.

8 CHAIRMAN KRESS: With the same kind of
9 neutronics actually that's's in the GNF code.

10 MR. ULSES: Well, I'd say generally
11 speaking that's true. This method here is a little
12 newer than the GNF methodology but generally speaking,
13 they're similar.

14 CHAIRMAN KRESS: Yes, but my conclusion
15 may be different than everybody's. I'm looking at
16 Nestle and I'm saying this has got basically the same
17 kind of neutronics as GNF. Therefore, GNF ought to be
18 usable for these kind of transients. There's just
19 something wrong with the way they model it.

20 MR. ULSES: Exactly. That's basically my
21 conclusion. That's what I would have concluded had I
22 had the need to get into it in further detail. That's
23 the only point of putting this curve up here is just
24 simply to emphasize that point.

25 MEMBER SCHROCK: You talked about the

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1 uncertainty in the rod worth. Have you done the
2 calculation for the limits on how much effect would
3 Nestle tell you it has?

4 MR. ULSES: No, I have not but it would be
5 very large. This reactor is very small and very
6 sensitive to rod worth. Extremely sensitive to rod
7 worth.

8 CHAIRMAN KRESS: Well, your Nestle
9 predicted \$1.16 rod worth.

10 MR. ULSES: Right.

11 CHAIRMAN KRESS: So you did calculate it.

12 MR. ULSES: Well, I calculated the value
13 but I didn't assess what would be the effect if I
14 actually increased it by five percent.

15 CHAIRMAN KRESS: You didn't do a
16 sensitivity analysis.

17 MR. ULSES: Right. I didn't do a
18 sensitivity analysis because that was not the point of
19 this study. This was simply to see whether or not the
20 code could model the reactor. Again, this was out of
21 the context of the RETRAN review where they were
22 trying to do RIA analysis. That was the point of that
23 review.

24 CHAIRMAN KRESS: I would have guessed
25 about a five percent effect on the --

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1 MR. ULSES: I don't know whether it would
2 be linear or not but it would definitely be there. It
3 should be there and it would be fairly significant.
4 Anyhow, I'd like to not dwell on this because this is
5 just simply to emphasize a point.

6 CHAIRMAN KRESS: But the message I get out
7 of that is that this kind of code can calculate SPERT.

8 MR. ULSES: And that was the point.

9 CHAIRMAN KRESS: And the GE code ought to
10 be able to do it, too. They just did something wrong
11 with the analysis somewhere.

12 MR. ULSES: And again, we're just simply
13 trying to emphasize the point for future if it's ever
14 looked at again.

15 This is almost some philosophy as much as
16 anything else. Obviously, difficulties in this case
17 led to a success, I would say, in that we actually
18 were able to get into the MCMP modeling which is
19 something that I wouldn't have looked at had I not had
20 these problems. Obviously, this is almost a personal
21 pep talk. Work harder at trying to define a problem
22 where we can eliminate any of these cross-section
23 issues at all. That was not something I was
24 successful at in this case, and that's what led to a
25 lot of these issues. I was trying to find a problem

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1 where I can give the applicant cross sections. So
2 that is not a question at all. So all we're doing is
3 looking at the results of the diffusion theory solver
4 with absolutely no effect on the input stream which
5 was an effect here that was very difficult to try and
6 resolve.

7 And I think it would be very important for
8 the staff when we're trying to review these codes --
9 like, for example, TRACG -- to have access to the up-
10 stream codes which are used to generate input. That
11 would allow the staff to do further sensitivity
12 studies and to try and answer some of these questions
13 about the input stream as well as it would also help
14 us to eliminate input stream issues which is really
15 the bigger reasons.

16 And obviously the bottom line conclusion
17 is think before I jump to conclusions and write out
18 these RIAs which end up being incorrect. So that's
19 the bottom line philosophy. And that's really all I
20 had to say today. If there's any other questions, I
21 certainly can entertain them now or we can talk later.
22 But that's the bottom line conclusion of the staff
23 review of TRACG kinetics. And I believe now we're
24 going to hear from Yuri to discuss statistics.

25 CHAIRMAN KRESS: That ought to be

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1 interesting. Thank you, Tony. Appreciate it.

2 MR. ULSES: I didn't know your water over
3 or hit my head on your television screen.

4 DOCTOR LANDRY: Doctor Kress, while Yuri
5 is getting set, I think this has again shown us that
6 this move to insist on the applicant's code being in-
7 house for our own use has been a good move to make.

8 CHAIRMAN KRESS: Yes, I agree with you.

9 DOCTOR LANDRY: Much of this would not
10 have occurred had we not had the code and done this
11 experimenting with the code. If we had not done this
12 experimenting with the code, we would not have seen
13 much of this. Whether you go down the right path or
14 the wrong path, you're learning something about the
15 code and the methodology that's being used and we've
16 been gaining experience through this whole process.
17 This has in some ways been a little painful. Tony
18 said mea culpa. But it's been good in that we have
19 learned a great deal in the process. I think that,
20 all things considered, it has enabled us to perform a
21 better review than simply looking at documentation.

22 CHAIRMAN KRESS: I think that's a good
23 perspective. I'm glad to hear you say that. We'll
24 continue to support that type of review.

25 Yuri, I don't think we've met you before.

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1 DOCTOR ORECHWA: No. I'm a new kid on the
2 block. My name is Yuri Orechwa. I'm from NRR in the
3 Reactor Systems Branch and the staff.

4 What I want to review is the uncertainty
5 evaluation that was presented to us for evaluation
6 with TRACG analysis of anticipated operational
7 occurrences. What I'm going to focus on is the
8 methodology. I can't repeat all their calculations.
9 So the question is if they did the arithmetic
10 according to the rules which they presented, then we
11 can judge the results accordingly.

12 So what we're going to look at, the review
13 topics that were requested, was to look at the model
14 uncertainties and biases. TRACG is a deterministic
15 code. So what we're saying is the models are
16 imperfect. Those imperfections, we need to express
17 them somehow in the results. Once that's established,
18 how do we combine that in order to make statements
19 concerning design limits and operating limits?

20 Let me give a heuristic overview so that
21 you see where I come from, where I'm going, and some
22 of the notation that I'm using. I have to apologize.
23 I'm of the old school. I still write things down. I
24 have a tough time with the modern software which is so
25 helpful that it takes you an hour to find one symbol

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1 that you need.

2 CHAIRMAN KRESS: To tell you the truth, I
3 prefer this. I'm used to seeing them like that.

4 DOCTOR ORECHWA: All right. Let me say
5 then what's TRACG in the context of what we're going
6 to do. We can write down in operator notation the
7 neutronics model and the thermal-hydraulic model.
8 Those are coupled through the thermal-hydraulic
9 conditions and the power of that. Both operators are
10 dependent on parameters. Those parameters, like in
11 the neutronic model, the reactivity coefficients of
12 course are important. In the thermal-hydraulic model
13 it would be from correlations and things like that.
14 In my notion, the theta and phi set are the things
15 that are the beginning and are at issue at the
16 starting point.

17 TRACG is deterministic. You put in your
18 input, you specify theta and phi. You will get a
19 number when you do your computation. If you put the
20 same input, the same phi and the same theta, you're
21 going to get the same number. Whether that number is
22 right or wrong, Tony discussed. We're assuming that
23 that's done. Now the question is what are the theta
24 and phi going to do? We have also initial conditions
25 where there are also some parameters usually and stuff

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1 like that.

2 So at issue is the determination of the
3 distribution of those parameters. In order to do
4 anything statistically, you've got to have sample from
5 somewhere and you have to characterize that sample.
6 To determine the model uncertainties, we need to
7 always estimate some distribution and the parameters
8 for that distribution. That represents then, it
9 summarizes the state of knowledge. And GE has
10 presented in my view, an enormous amount of data from
11 tests, from qualifications and all that.

12 Now, suppose we get our distribution of
13 those parameters of theta and phi. Then we know that
14 the solution, the TRAC solution -- that is the
15 parameters that are the output of the TRAC -- will be
16 dependent on the theta and phi. Because those come
17 from the distribution, will give us a distribution of
18 TRAC solutions. So in the TRAC solution which I kind
19 of write like a vector. It's not really a vector in
20 the mathematical sense but the set parameters. Each
21 parameter will be distributed. Given that
22 distribution, you can then make some kind of
23 determination of the confidence you can put into a
24 design limit. So that's the issue. How do I get then
25 to the design limit?

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1 MEMBER SCHROCK: Yuri, could I ask, how
2 does the selection of the node size enter into what
3 you're describing, or does it, for a specific --

4 DOCTOR ORECHWA: Because it was
5 considered, but I don't think it's big. I don't
6 consider it here. It's not a statistical issue.

7 CHAIRMAN KRESS: It seems like the only
8 way you could incorporate it is to change it and see
9 what effect it has on the distribution you get out.

10 DOCTOR ORECHWA: That's a question of
11 algorithm. It's not a statistical issue.

12 DOCTOR ANDERSEN: This is Jens Andersen.
13 We did do a fair amount of nodalization sensitivity
14 studies that are documented in the qualification
15 reports. We did it both for simple tests as well as
16 for full scale plant cases. What we did was that we
17 basically looked at the simpler test to determine what
18 was an adequate nodalization. We then ran a plant
19 case and we did nodalization studies around what was
20 considered an adequate nodalization and we basically
21 quantified how large the sensitivity were on the
22 critical safety parameters, and we were able to show -
23 - and this is actually documented in the qualification
24 report -- that with the nodalization we had chosen,
25 doing further refinement to the nodalization had very

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1 little impact on the calculated results.

2 DOCTOR ORECHWA: Nodalization is a
3 convergence issue. It's not a statistical issue.

4 MEMBER SCHROCK: Well, I'll have to think
5 about that a little more. I think the distributions
6 are influenced by the nodalization.

7 DOCTOR ORECHWA: The distribution of the
8 basic parameters has nothing to do. Once you do a
9 solution to the TRAC equation, it will be.
10 Nodalization will enter a bias, you might say, but
11 that should come out given some parameter. If I pick
12 a theta and a phi, then I can compare a TRAC for
13 different nodalizations and see if I'm going to a
14 solution. I converge to this level. Now this level
15 will vary because I choose different parameters for my
16 models. So it's a convergence issue.

17 CHAIRMAN KRESS: There may be a question
18 about when you use nodalization to determine the input
19 as to whether or not that might affect the
20 distribution.

21 DOCTOR ORECHWA: I think, at least in my
22 experience, any code that's been nodalized is in a
23 fine mess. Once you get it, somewhere there has to be
24 in the manual documented what the effect of
25 nodalization is. That's a verification and validation

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1 issue. The models that enter for the specific
2 versions is a different issue. Just say with respect
3 to thermal-hydraulics.

4 CHAIRMAN KRESS: So so far you're saying
5 that there are specific inputs to the code that have
6 to have a distribution.

7 DOCTOR ORECHWA: That's right.

8 CHAIRMAN KRESS: And that distribution has
9 to be determined.

10 DOCTOR ORECHWA: That has to be
11 determined.

12 CHAIRMAN KRESS: And it's generally
13 determined as much as possible by data and GE has a
14 lot of data.

15 DOCTOR ORECHWA: Right. I will go through
16 each of these points again.

17 CHAIRMAN KRESS: And the input has to be
18 propagated through the system to get these outcome
19 design limits.

20 DOCTOR ORECHWA: That's what I want to
21 step through afterwards.

22 CHAIRMAN KRESS: Okay.

23 DOCTOR ORECHWA: I was just going to say
24 with regard to nodalization and convergence, one of
25 the millennial problems in mathematics is the

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1 uniqueness of the Navier-Stokes equation. So we don't
2 even know if the solution exists.

3 MEMBER SCHROCK: We don't solve Navier-
4 Stokes equations here so that's not a problem.

5 CHAIRMAN KRESS: We bypass that.

6 DOCTOR ORECHWA: We can all run out and
7 solve the how the existence and come home with a quick
8 million dollars. But those are the issues.

9 Okay. Now, suppose we have the
10 distribution of the TRAC output. Then the third basic
11 figure of merit which is used by GE is based on
12 critical power ratio. And that's defined as the GEXL
13 correlation as a function of what the thermal-
14 hydraulic conditions are that TRACG gives over the
15 power given by TRACG.

16 Because our TRACG solution has a
17 distribution, the critical power ratio will have a
18 distribution and there again then we can talk about
19 what is the confidence level with which we pick some
20 limit or operating limit?

21 CHAIRMAN KRESS: Is there a distribution
22 on the GEXL part of that?

23 DOCTOR ORECHWA: No, because the input --
24 this is the thing that has a distribution. It has its
25 own uncertainties.

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1 CHAIRMAN KRESS: I know. There are
2 parameters in it.

3 DOCTOR ORECHWA: Right, but that's a
4 separate issue.

5 CHAIRMAN KRESS: That's a separate issue.

6 DOCTOR ORECHWA: I don't want to touch
7 that one. But the point is that we start with
8 parameters in the TRACG. Varying those, we get a
9 distribution of the output, the thermal-hydraulic
10 conditions and the power distribution. Putting that
11 into this correlation, we can get a distribution of
12 the CPR and we can then make statistical statements
13 about it. So that's the basic name of the game.

14 So the first thing is model uncertainties.
15 That's in my notation theta and beta. GE follows the
16 CSAU methodology for that and begins with what I would
17 call the delphi method. People see what phenomena are
18 important in the TRACG calculation, the relative
19 importance, and identifies those. Those are then the
20 phenomena that are associated with parameters that
21 will have the highest impact on the solution and,
22 therefore, we need to go out and get them.

23 The next step then is, having identified
24 what phenomenon there are and what parameters are
25 associated with those, you establish the nominal

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1 values and uncertainties for these parameters. There
2 is an enormous amount of data that is presented from
3 separate effects test facility data, integral test
4 facility data, components qualifications, BWR plant
5 data, and these are all analyzed and the statistical
6 analysis for each is presented in the report.

7 For some parameters for which there is no
8 data, code comparisons are made. In particular, for
9 the void coefficient, for example, which Tony
10 discussed, code comparisons need to be made. And also
11 everywhere there always lurks engineering judgment, no
12 matter what you do.

13 Now, let me just comment with regard to
14 the void coefficient, the analysis there. Overall,
15 the evaluation of the experimental plant, etcetera,
16 data is done by standard techniques. Look at the
17 distribution. You assess whether it's normal. They
18 use a test which I had never heard of before, the
19 Anderson-Darling test, but that's neither here nor
20 there. And goes through, presents the data, shows
21 everything in regular fashion so it can be assessed.
22 And it looks proper.

23 In the void coefficient analysis, the main
24 variation comes with the variation across assemblies
25 or fuel types, whatever they call it. There is an

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1 enormous number of them in the GE stable. There's 11,
2 Charlie, or nine? Eleven. Eleven are chosen as
3 representative of variation. These aren't chosen by
4 random. These are chosen to be representative because
5 there are so many. If you get down to the nitty-
6 gritty, you should have chosen them by random but that
7 would have been an extremely small sample. Probably
8 would have had a big bias. So the natural tendency is
9 we would like to choose something which is
10 representative. I don't have a problem with that, but
11 it is not according to the rules of sampling
12 statistics, and I don't think -- with small samples,
13 you will always have a problem of bias and I think by
14 trying to be representative you're probably moving in
15 the right direction. I just want to comment on that
16 issue. So the spirit is there.

17 CHAIRMAN KRESS: When an application comes
18 in to use this, the variation in fuel types across the
19 core won't be random.

20 DOCTOR ORECHWA: There are a lot of
21 different fuel types in the core.

22 CHAIRMAN KRESS: Yes, but they'll know
23 what they are.

24 DOCTOR ORECHWA: Oh yes, but you're
25 putting in one number to say the uncertainty is. The

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1 uncertainty is not being associated with each lattice,
2 type of lattice. Okay. It's across lattices.

3 MEMBER FORD: Would you mind going back to
4 your previous slide, please. Maybe I missed the
5 discussion of the very first bullet. Have an impact
6 on what?

7 CHAIRMAN KRESS: On the important outputs.

8 DOCTOR ORECHWA: Looking at anticipated
9 operational occurrences, these are measured with
10 what's happening to the power pressure and things like
11 that in a transient. What will affect those the most?
12 You have a huge equation. Some parameters will be
13 more important than others.

14 MEMBER FORD: So if I was worried about a
15 materials problem -- just for instance -- for
16 instance, what is a fast neutron flux of the core
17 shroud? Outside this --

18 DOCTOR ORECHWA: No, it's not a transient
19 issue of materials.

20 MEMBER FORD: I'm still learning here.

21 DOCTOR ORECHWA: Okay. Then, of course,
22 as I said, for all of these different phenomena that
23 have been rated, the normality of the distribution is
24 assessed, which is nice, and then there's an estimate
25 made.

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1 Do you have a question?

2 CHAIRMAN KRESS: Yes, on the "evaluate the
3 normality." That's based on the assumption that the
4 distribution will be normal and you'll want to check
5 to see if your assumption is correct.

6 DOCTOR ORECHWA: Yes, there are
7 statistical tests.

8 CHAIRMAN KRESS: Yes, I understand the
9 test.

10 DOCTOR ORECHWA: You look at the data and
11 it gives you a statistic for various --

12 CHAIRMAN KRESS: And suppose that
13 statistic makes you question your assumption of
14 normality. What do you do then?

15 DOCTOR ORECHWA: Statistic tells you at
16 what confidence you can say and those chose at the 95
17 confidence level that it is normal. You never have
18 100 percent.

19 CHAIRMAN KRESS: But suppose I only had 70
20 percent confidence in my normality. What do I do
21 then?

22 DOCTOR ORECHWA: Okay. You can approach
23 it in different ways with non-parametric statistics
24 and stuff like that. I think this is experimental
25 data and this is traditionally normal because there

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1 are so many other small things that come in. I think
2 in what GE has presented invariably it is. In a few
3 cases, it looks kind of ---

4 CHAIRMAN KRESS: So it's just kind of a
5 hypothetical question.

6 DOCTOR ORECHWA: Later on it becomes a
7 little bit more of an issue.

8 Let me just say that although in the
9 report it's almost parenthetical that they do a
10 sensitivity analysis, but I think it's very important
11 in the long run that the sensitivity of CPR in the
12 turbine trip event with respect to each parameter as
13 to what the sensitivity to that is and it's diligently
14 done for each case.

15 CHAIRMAN KRESS: You'll already have a
16 distribution.

17 DOCTOR ORECHWA: Yes.

18 CHAIRMAN KRESS: But you don't know what
19 particularly caused that distribution or what the most
20 important parameters are so you go back and do a
21 sensitivity study to find out which of those
22 parameters had the biggest effects.

23 DOCTOR ORECHWA: How big the effect is if
24 I vary that one parameter only.

25 CHAIRMAN KRESS: That one only. It gives

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1 you just additional information.

2 DOCTOR ORECHWA: It gives you very
3 important information later on, at least the argument
4 that I will make. So that's important.

5 Design limits. The parameters are
6 combined by random sampling from each of the
7 parameters. Now, GE just does straight random
8 sampling. There are methods where you can kind of
9 tighten up by using choice of sampling.

10 CHAIRMAN KRESS: Latin Hypercube test.

11 DOCTOR ORECHWA: Latin Hypercube is the
12 one in KSU and things like that. Let me jump ahead a
13 little bit. I think for this application it's
14 probably okay because things are kind of -- the
15 transients are slow and things like that.

16 CHAIRMAN KRESS: The only issue that
17 generally comes up with strict random sampling is how
18 many do you need to get the right --

19 DOCTOR ORECHWA: How many. For small
20 samples, it's an issue because you introduce bias
21 right away in a small sample. So it's just something
22 that needs to be noted but if you have rapidly
23 changing functions as you would have in a severe
24 transient, you might want to pay a little bit more
25 attention as to your sample size and its behavior in

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1 that case, I think. But it's something that has no
2 definite yes or no answer again, as usual. So I want
3 to bring that up.

4 So you sample from these parameters, you
5 stick them in TRAC, you compute values. We get those
6 values and then we do our usual normal theory. Put
7 them in the frequency table and we again check
8 normality. If it's normal, we can then make a
9 statement concerning at 95 percent level various
10 design parameters, temperature, pressure, etcetera,
11 whatever you want to do, and you can set those.

12 Note greater than or equal to 59. Why is
13 that? As you said, suppose it's not normal. Then
14 what do you do? I still want to talk about setting a
15 limit with this level of confidence. And GE does the
16 usual thing. You look at order statistics. What you
17 do is you sequentially by size put your sample down,
18 59 out, and then the 95th limit is the 95th one. So
19 if I random sample all those, it comes from the theory
20 that 59 is -- it's not 60, it's 59.

21 Now note though. This isn't mentioned.
22 You can't get blood out of a turnip. Because when you
23 say you have a normal distribution, that's an enormous
24 amount of information so the non-parametric interval
25 is going to be usually significantly larger and then

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1 it might be so large as being not very meaningful at
2 times. So just because you have an interval that's
3 95, your data may really be somewhere else or
4 something. Just because you're using order statistics,
5 that's fine and you can talk about it but you still
6 have to be careful as to exactly what you're doing
7 underneath that. This is just a comment on that.

8 CHAIRMAN KRESS: The bottom line is for
9 realistic code applications the rule calls for a 95/95
10 -- figures of merit?

11 DOCTOR ORECHWA: Yes, that's what people
12 usually talk. And for that you need 59 samples.

13 CHAIRMAN KRESS: You need 59 samples and
14 you reached it then.

15 DOCTOR ORECHWA: Yes. And even for normal
16 that's my experience is it's getting to be. Okay. So
17 using that, you can get your design limits. But what
18 we want in order to assess the transient is what GE
19 does is talks about the operating minimum critical
20 power ratio. It has two components. The safety limit
21 critical power ratio, which is the value of CPR which
22 is less than .1 percent of the rods and the core
23 expected to experience. That's just a definition.

24 In the transient, delta CPR is the
25 contribution from the transient itself and then the

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1 equation says that steady state CPR basically equals -
2 - you have the absolute limit plus the contribution
3 from the transient. So that's the relationship on
4 which we base.

5 The key element in the computation is the
6 computation of the probability of rod experience in
7 transition or boiling. There are two things that GE
8 focuses on. The two ingredients, I should say, that
9 are in the computation that they use. Experimental
10 data from the Atlas facility which gives you a
11 distribution of experimental CPR. This is defined
12 this way and because it is experimental data, it will
13 give you a distribution.

14 Now, then you have a computed by TRACG for
15 a specific reactor. Minimum critical power ratio. I
16 have an intellectual disagreement with GE on their
17 computation of the probability. Let me first, because
18 this dates back, I think, 30 years. Let me just point
19 this out. The probability is the integral over a
20 distribution function of CPR. What is done is the
21 computation, if this is your experimental data, this
22 value that they put on to compute the probability,
23 this is determined by TRACG. You're mixing two
24 distributions. The TRACG value is in your limit and
25 you're integrating over an experimental value. So you

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1 can do this only if this is true that the two
2 distributions are the same.

3 Let me give an analogy that's extreme.
4 Let's take the price of bananas, 1.25 per pound or
5 something. I can put it on here and calculate a
6 number, a probability. You say you're crazy, price of
7 bananas has nothing to do with CPR, which is true, and
8 to a more limited extent, the computation of TRACG and
9 the experiment, there is a difference. This is the
10 heart of the matter that we're getting at and you
11 can't just slough over this intellectually.

12 CHAIRMAN KRESS: Experimentally. Can you
13 extract a CPR out of that?

14 DOCTOR ORECHWA: Let me go on.

15 CHAIRMAN KRESS: Okay.

16 DOCTOR ORECHWA: Fundamentally, this is
17 strictly verboten to mix.

18 CHAIRMAN KRESS: I can see that.

19 DOCTOR ORECHWA: You can do it in the
20 context of Bayesian statistics but then you're going
21 to have to find a loss function in order to get your
22 point estimate of the probability. That would be the
23 correct way to go, blah-blah-blah. But you still have
24 to then-- you can mix the distributions and then say
25 I have --

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1 CHAIRMAN KRESS: The problem I have is
2 experiments don't actually measure the critical power
3 ratio. You have to derive it somehow.

4 DOCTOR ORECHWA: Excuse me.

5 CHAIRMAN KRESS: I'm trying to figure out
6 how you would overcome your objection.

7 DOCTOR ORECHWA: Let me go on. I will
8 overcome my objection.

9 CHAIRMAN KRESS: I'll let you go on.

10 DOCTOR ORECHWA: Let me say we apply
11 statistics and there are certain assumptions for all
12 these things. We will never meet the assumptions
13 exactly. So you got to have a little bit of judgment.
14 So given that in principle, what we're doing is
15 strictly verboten. GE doesn't do this but let me try
16 to argue the following. This will be my argument and
17 you can give me a grade on it. With classical
18 statistics you come through the back door and you
19 bring engineering judgment.

20 Point one is if we take the experimental
21 value and we just expand it -- I mean we live by that.
22 Here is all the sensitivity. Now they've computed all
23 the sensitivities. I can use just chain rule and get
24 all the sensitivities through there. The
25 sensitivities are all very, very small if you look at

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1 them down the line. The qualification examples that
2 they give and I think what Tony showed, that this is
3 pretty good. So the correction that differentiates
4 these from what we know of the real world and TRACG
5 and all that is probably okay.

6 My other argument would be we're talking
7 about .1 percent probability and less. So we're way
8 out in the tail end of the distribution. The
9 contribution to the probability of a difference in the
10 CPRs out there will be almost negligible. So either
11 one or both will, I think, support that what they are
12 doing is, I think, within our engineering judgment.

13 MEMBER SCHROCK: The experimental CPR from
14 Atlas is for one bundle.

15 DOCTOR ORECHWA: Is it for one? I thought
16 it was for many bundles.

17 MEMBER SCHROCK: A small number, in any
18 case.

19 DOCTOR ORECHWA: There are thousands, I
20 thought.

21 DOCTOR ANDERSEN: This is Jens Andersen
22 from GNF. We have measured the critical power for
23 each single fuel design that we have developed in the
24 Atlas test facility, 7 X 7, 8 X 8, 9 X 9, 10 X 10
25 fuel. For each fuel design, we run a large number of

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1 tests, typically anywhere from 500 to 1,000 tests in
2 order to characterize the critical power as it depends
3 -- pressure inlets, up-cooling. So we have typically
4 a database of 500 to 1,000 data points in order to
5 determine the experimental uncertainty or the
6 uncertainty in the jet fuel correlation in predicting
7 the critical power. That's an ECPR distribution.

8 MEMBER SCHROCK: So you've put together
9 many tests to build up a core characterization of CPR.
10 Is that the picture?

11 DOCTOR ORECHWA: Yes. Right.

12 MEMBER SCHROCK: The reason I ask the
13 question is that you're defining minimum critical
14 power in terms of one-tenth of one percent of rods in
15 core. I didn't think that you had that kind of
16 capability in the experimental determination, but I
17 see that you do.

18 DOCTOR ORECHWA: There's a tree you're
19 barking up on that I'd like to address that should
20 really be looked at. And I think it's mentioned in
21 CSAU methodology, which is when you have a lot of
22 parameters, which you do in this case, in order to
23 really represent the response surface for that, you
24 quickly need a lot of data because it goes by the
25 number of values on each axis to the power of the

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1 dimension that you run out of data very quickly in
2 order to give a characterization and, here again, I
3 think what saves this case, at least my view of
4 looking at the data, is the transients are mild,
5 response is smooth.

6 Once you get into something else where you
7 may be getting into instabilities or something like
8 that, you're not going to have smooth functions, and
9 I think there you're going to have to very carefully
10 look at that issue. So this case, yes. Another case,
11 it's not going to be so smooth.

12 Any other questions? What grade do I get?

13 CHAIRMAN KRESS: On your proposed fixed,
14 you get an A.

15 DOCTOR ORECHWA: Thank you.

16 CHAIRMAN KRESS: That's a good fix.
17 Expect I really don't think you need a fix.

18 DOCTOR ORECHWA: All right. Since I got
19 an A, we can now determine the operating limit
20 critical power ratio. Let me just make a comment
21 here, one comment concerning the submittal. This is
22 probably one of the most critical parts and it gets
23 one page in the write-up and it's pretty
24 undecipherable. Things should be written up a little
25 bit better, I think, for us even to review. So I made

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1 my best stab at it.

2 I think the spirit of the thing is that we
3 can't track any of these large codes which take a half
4 a year to set up. You're not going to run random
5 sampling on them. It will take an enormous amount of
6 runs. You'll be there forever. So how do you divide
7 and conquer? How do you compartmentalize some of the
8 calculations to maximize your information so you can
9 make a statement with a little bit less effort by
10 emphasizing certain things?

11 GE's approach, the way I read it, is that
12 you first look at the generic behavior of transients
13 for classes. You have a transient class, you have this
14 type of BWR, you have this type of fuel, etcetera, and
15 you can develop a distribution of the CPR for that.
16 So the ingredients are first by class a distribution.
17 The other one then is for a specific case you run a
18 specific transient all the way through. Then you can
19 also for the specific case just in steady state, your
20 initial condition because it's not a transient, it's
21 an easier calculation, you can do sampling on that and
22 run them through.

23 You can then combine them via this
24 equation by sampling the two distributions that you
25 have and you get a distribution of MCPRs for which you

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1 can then compute the value which is the criteria for
2 setting your operating limit minimum critical power
3 ratio. To my mind, that looks legitimate. I think it
4 accomplishes the purpose. You do capture the
5 uncertainties present both in transient, both in the
6 initial state and you kind of bridge them with a
7 calculation which is specific to the case under
8 consideration. I don't think that that's an
9 unreasonable approach.

10 Now, I think now having gone through the
11 methodology and it looks okay, GE does present a lot
12 of qualifying data where they look at actual
13 transients, the uncertainty band which is generated
14 using this methodology and I believe that there is
15 sufficient agreement to be able to use it for analysis
16 of AAOs given the background of all the back when we
17 started with the uncertainties that today we associate
18 with the input parameters to the TRAC calculation.

19 CHAIRMAN KRESS: So your bottom line is
20 that uncertainty methodology is pretty good with the
21 possible exception of the philosophical difference
22 which probably doesn't make much difference.

23 DOCTOR ORECHWA: Yes. I wanted to bring
24 that up because it can make a difference in some
25 situations.

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1 CHAIRMAN KRESS: Could later.

2 DOCTOR ORECHWA: I think in that case it
3 has to be -- because for 30 years that calculation has
4 been done as if those two distributions are identical.
5 And I just want to put a flag out there not in
6 principle because if they're not in principle, then
7 you have to make an argument for why you think you can
8 get away with it and I passed the argument by you guys
9 why I think they can get away with it.

10 CHAIRMAN KRESS: Are there any other
11 questions? You're getting hungry? Well, thank you
12 very much for a tutorial on how to do uncertainties,
13 Staff us not through yet.

14 MR. BOEHNERT: It should be short.

15 CHAIRMAN KRESS: Why don't we go ahead and
16 hear it then and that won't give such a gap in
17 between. Sorry, I thought that was it.

18 DOCTOR LANDRY: I'd like to cover just a
19 couple more items before we break and go on after
20 lunch to the applicant's presentation. You've heard
21 a great deal of the experience that Tony has had
22 running the code and some of the work that he has
23 done. We've also been running the code on plant decks
24 and to look at the overall experience of a user in
25 applying the code to an analysis of an AOO transient.

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1 That experience has shown us that TRACG
2 uses input decks that are very closely related to the
3 decks that are from the original TRACB code which
4 really means that if you have a knowledgeable TRAC
5 user, that person can come in and pick up work with
6 TRACG with a minimal level of additional education or
7 retraining.

8 Major changes from TRACB to TRACG are
9 well-described in the model description report
10 appendix. We're pleased with that. We did note that
11 the execution structure of control blocks though has
12 been retained from the TRACB. In other words, the
13 control box must be executed in numerical order and if
14 you want to go back and use the same control block,
15 you have to put it in again. There's no ability to
16 select control blocks according to the use within the
17 input stream. You have to continue in a numerical
18 sequence.

19 We did feel that additional guidance could
20 be provided to the user on time step size. The time
21 step size selection. But on the other side of that
22 issue, the applicant has developed a set of standard
23 input decks for all of their plants which takes the
24 user effect out very much, that the user doesn't have
25 too much option and doesn't have too much effect on

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1 the calculation with TRACG.

2 We also noticed that TRACG determines the
3 correct flow regimes during the steady state
4 initializations, unlike some other codes where the
5 user can select flow regimes randomly or for different
6 stages, different components. The user doesn't have
7 that option with TRACG so we're pleased that this
8 removes the user effect from the code.

9 CHAIRMAN KRESS: Is the time step checked
10 internally in the code to see that it meets stability
11 criteria?

12 DOCTOR LANDRY: There are time step checks
13 but we thought that in looking at the material it
14 would be useful if the user had a better definition of
15 proper selection of time step.

16 CHAIRMAN KRESS: I was trying to figure
17 out what you thought was needed as additional guidance
18 there.

19 DOCTOR LANDRY: There are checks and
20 balances there but we thought that the user would
21 benefit by having it better defined. But then again,
22 as has been said a couple of times already, the code
23 is used internally within the General Electric
24 corporation where they have the ability to educate the
25 user beyond what the documentation would say. They

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1 have an ability that if the documentation is not
2 adequate for the general public, they can cover for
3 that by making it part of their training program.

4 MEMBER SIEBER: Is that institutionalized?

5 DOCTOR LANDRY: Yes. They have a training
6 program within the corporation.

7 MEMBER SIEBER: It has a QA program
8 attached to that so that you can carry on?

9 DOCTOR LANDRY: Right. That all comes
10 under the QA program also. The use of the code, the
11 ability of the user, all gets checked and balanced
12 through the QA program.

13 MEMBER SCHROCK: Does this imply the
14 utility user is less skillful?

15 DOCTOR LANDRY: Well, the utility doesn't
16 use the code.

17 MEMBER SCHROCK: Not at all?

18 DOCTOR LANDRY: Unless General Electric is
19 licensing the code to their utilities, all the
20 calculations are done by General Electric.

21 MEMBER SCHROCK: Okay. I didn't
22 understand that.

23 DOCTOR LANDRY: Some of the conditions and
24 limitations that we identified in the SER. We have
25 already discussed the GEXL 14 correlation and the

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1 issues surrounding GEXL 14. Again, to emphasize that
2 once resolution of those issues is arrived at, that we
3 expect that to be applied within the use of TRACG.

4 We've also pointed out in the
5 presentations already this morning and in the SER that
6 TRACG, if it is to be applied to stability analysis,
7 will have to be submitted for staff review for that
8 application. We are not approving the code for a
9 stability analysis. They haven't asked for that
10 either. It has not been reviewed for Atlas. They
11 have not asked for that, but we want to call out.
12 Since Atlas is considered a transient, we want to
13 identify that if it is applied to Atlas, we want to
14 re-review it.

15 The discussion that Tony presented, the
16 PIRT 18 model needs further justification before
17 application to reactivity insertion or control rod
18 ejection accidents. Tony raised that question. How
19 can Monte Carlo model reliably predict point kinetic
20 answers? Of course, the code is not being applied for
21 that at this point anyway, but if it should be, these
22 are issues that are going to have to be addressed.

23 We also identified in the review that for
24 isolation condensers further justification or review
25 may be necessary.

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1 MR. BOEHNERT: What's the deal there,
2 Ralph? What's the problem?

3 DOCTOR LANDRY: This was identified back
4 when the in-depth thermal-hydraulic review was
5 performed. There was a feeling that the modeling of
6 isolation condensers was not adequate and needed
7 further review. So again, we did not see where that
8 had changed and we felt that we needed to point out to
9 future reviewers, as has been said a couple of times
10 this morning, this is a flag to reviewers of
11 applications of the code that if it is applied to a
12 plant with an isolation condenser, they need to look
13 carefully at this condenser to see if it is critical
14 to the transient progression. Then they need to look
15 at it more carefully. If it's irrelevant or low
16 meaning for the transient, we're not so concerned.

17 MEMBER SCHROCK: You had another proviso
18 in the SER which says that if the level tracking model
19 is invoked where there is significant void, it will
20 have to be re-evaluated.

21 DOCTOR LANDRY: Right. That's an
22 identification to the staff also when this code is
23 submitted for LOCA, which we anticipate in the not too
24 distant future, that we want to look at that level
25 tracking model. There is not significant voiding for

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1 the transients for which it is being applied, but when
2 they get into LOCA space, then we want to look
3 carefully and we want the staff involved to look
4 carefully at the level tracking model.

5 MEMBER FORD: On the staff evaluation and
6 conditions limitations, there's a whole series of
7 questions arising out of the earlier subcommittee
8 meeting here. Are these conditions/limitations you
9 have there, would they be changed if you took into
10 account these questions?

11 DOCTOR LANDRY: We could put in more but
12 we have looked at and discussed with the applicant
13 those concerns that were brought out and identified on
14 the agenda and this afternoon General Electric is
15 going to present information dealing with those
16 specifically. We have been discussing with General
17 Electric what they're going to present and we do not
18 have problems. We are not in conflict with them at
19 this point.

20 MEMBER FORD: So these are merely points
21 of detail which get washed out.

22 DOCTOR LANDRY: Well, they're points of
23 detail that may not affect the application to AOO
24 transients, but they are some points which we will be
25 looking at carefully when we see the code for LOCA

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1 analysis. Some of those are not important for AOOs
2 and will be important for LOCA.

3 MEMBER FORD: But that will be discussed
4 this afternoon.

5 DOCTOR LANDRY: Yes.

6 MEMBER FORD: The justification for that
7 statement will be discussed this afternoon.

8 DOCTOR LANDRY: General Electric is going
9 to present information on those this afternoon.

10 Staff conclusions. Again, GEXL 14 will be
11 acceptable when it is handled in accordance with
12 agreement with the staff. The kinetic solver is
13 adequate to support the conclusion that the models are
14 correctly derived and account for phenomena involved
15 in AOO transients. Kinetic solver benchmarking
16 demonstrates that TRACG adequately predicts results
17 for AOO transients. Staff analyses provide confidence
18 that TRACG is acceptable for AOO transients.

19 Uncertainty analysis follows accepted CSAU
20 analysis methodology. Uncertainties and biases have
21 been identified and all highly ranked phenomena based
22 on experimental data have been validated. The process
23 is acceptable and the quantities are reasonable.

24 MEMBER FORD: I guess my frustration with
25 all these conclusions. If you are reading those

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1 conclusions from a paper, certainly there's been no
2 support from any of those conclusions given today.

3 DOCTOR LANDRY: No support?

4 MEMBER FORD: Well, the last one, the
5 process is acceptable and the quantities are
6 reasonable. We haven't seen any detailed
7 documentation to support those conclusions. I'm
8 assuming that the back-up for those conclusions are
9 given in other documents.

10 DOCTOR LANDRY: In the documentation on the
11 code, but that's what Yuri was going through, that
12 yes, the process that they went through in their
13 analysis, he had some philosophical differences, but
14 for the application the conclusion was it's
15 acceptable.

16 MEMBER FORD: I guess I'm learning about
17 this process as to what we're signing up to approve.
18 That's where I'm -- if I was a reviewer of a paper or
19 of a report, I wouldn't sign off on it based on what
20 has been presented today.

21 CHAIRMAN KRESS: No, you have to do it in
22 connection with all of the documentation we've been
23 supplied which is a lot of stuff to go through.

24 DOCTOR LANDRY: We don't reiterate all of
25 the submittal. What we're doing is saying what our

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1 findings are based on a review of the submittal
2 without going through a reiteration of everything that
3 was submitted to us.

4 We also have concluded that the standard
5 input has been developed for the classes of BWR
6 systems for which TRACG is to be applied, BWRs 2
7 through 6, and that the staff finds TRACG 02A code --
8 again, that's designation of which version this is --
9 is acceptable for application to the AOO transients
10 presented in the submittal that's dated in January of
11 2000.

12 So those are the conclusions that the
13 staff has arrived at. Based on our review, we feel
14 that the code is acceptable for application to the AOO
15 transients. We've identified areas of concern and
16 we've identified items that we would call out as flags
17 for future applications, that if it goes outside the
18 scope of AOO transients, other things need to be
19 looked at.

20 CHAIRMAN KRESS: Thank you. Are there any
21 other additional comments from either members or from
22 GE before we break for lunch? I propose we come back
23 at 1:00 and hear the rest of the story. Recess.

24 (Whereupon, off the record at 11:55 a.m.
25 to reconvene at 1:00 p.m.)

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

(1:00 p.m.)

CHAIRMAN KRESS: Okay. We are now back in session again and you guys may proceed. Here's the part where you're going to answer all of our previous questions. Right?

DOCTOR ANDERSEN: My name is Jens Andersen and I'm going to give a brief presentation on the TRAC application for anticipated operational occurrences for transient analysis. If you'll go to the second slide, Charlie.

Let me just introduce the people that are here for General Electric. Over there we have Jim Kapproth who is the manage of engineering and technology. This is myself. We have Fran Bolger who's sitting here who's team leader for the transient analysis. Charlie Heck is helping me who's the responsible engineer for TRAC. Brian Moore who's team leader for technology and development who is our nuclear expert and we have Antonio Possolo from corporate research and development who is a statistician that has helped us out. And then finally we have Bharat SHiralkar who is the project manager for the application of TRAC to LOCA which is the submittal that we are planning.

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1 What I'm going to talk about is the
2 submittal of TRAC. We submitted fairly extensive
3 documentation of TRAC to the NRC. We have had a long
4 review of TRAC. We have had numerous meetings and
5 communications with the NRC, phone conversations,
6 emails, meetings. There were a number of requests for
7 additional information, and GE Has provided responses
8 to these questions and I'll get into details on that.

9 We've also had review with the ACRS
10 Thermal-Hydraulic Subcommittee. We had a meeting on
11 November 13 last year. I'm going to address some of
12 the comments that we have received from the ACRS and
13 I'm also going to comment on some of the issues that
14 came up at the end of the SBW review. And finally,
15 I'm going to go into some concluding remarks.

16 Just to reiterate. The scope of the
17 application was to apply to operating boiling water
18 reactor in United States and that would be BWR 2 to
19 BWR 6. The events that we applied for are the
20 anticipated operational occurrences, also called
21 transients, which are basically operational events
22 that deals with either increase or decrease in reactor
23 pressure, increase or decrease in core flow, increase
24 or decrease in reactor coolant inventory and decrease
25 in core coolant temperature. These are the so-called

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Chapter 15 events.

The documentation that has been submitted for TRAC is that we first had a document that was called the TRAC licensing application framework for AOO transient analysis. That was actually submitted to the NRC in 1999 and that was basically a document that laid out the entire plan for how we would apply TRAC to transient events. And then later towards the end of 1999, we submitted the model description. In early 2000 in January, we submitted the qualification document and the application methodology.

In addition, we submitted the TRAC user's manual and we made the TRACG 02A source code available to NRC and, together with the source code, we made a number of sample problems and test cases available.

The scope of the review has been to review the application of TRAC to transient and the objective was to get a safety evaluation report for the application and evaluation of the TRAC's capability for AOO transients and evaluation of the qualification we have supplied to support that application and finally, an evaluation of the application methodologies which is how we apply TRAC for transient events.

The time line. As I said, we submitted

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1 the road map, the plan for the whole process in May of
2 1999. All the LTRs were submitted to the NRC by
3 February of 2000 and we had a kick-off meeting that
4 involved a meeting both with the NRC and the ACRS
5 Thermal-Hydraulic Subcommittee on March 16 of the year
6 2000. In April of 2000 the NRC issued the acceptance
7 review which is basically that the documentation that
8 was provided was sufficient to allow the review to go
9 on.

10 We had first a major meeting with NRC on
11 NRC review concerns in September of the year 2000.
12 The ACRS Thermal-Hydraulic Subcommittee was in
13 November of 2000. And then we had numerous other
14 communications. During this period, we have received
15 23 requests for additional information and we have
16 provided responses to all these requests and all
17 issues have been resolved. The draft safety
18 evaluation report, we received that in July 2001 and
19 we're having this meeting today on August 27, 2001
20 and, of course, what we are hoping to get out of it is
21 closure by September and get the safety evaluation
22 report by September.

23 As I said, we had submitted extensive
24 documentation on TRAC and the previous slide listed
25 the number of documents we have submitted. We have

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1 relied on prior NRC reviews and acceptance of TRACG
2 application. There has been numerous application of
3 TRAC where it has been applied for LOCA, transient,
4 ATWS and stability applications that have been
5 accepted by the NRC and the thermal-hydraulic model of
6 TRAC was substantially reviewed during the SBWR
7 project. That project was canceled in 1996 and that
8 review was then subsequently stopped. However, NRC
9 issued a letter documenting the status of the review
10 when the SBWR program was stopped.

11 Anyway, we have had numerous interactions
12 with the NRC. We have supported the TRAC
13 installations of the NRC computers and the
14 benchmarking against the NRC codes. We've had the
15 review with the ACRS Thermal-Hydraulics Subcommittee
16 in November. We received a total of 23 requests for
17 additional information including an RIA that was
18 generated from ACRS comments. Most of these RIAs
19 dealt with providing additional information and
20 clarification of issues and we have provided all of
21 these responses and I would like to make the comment
22 that I feel that we have had a very good interaction
23 with the NRC reviewers. We have had a very
24 professional and open candid communication with the
25 NRC and I personally have been very pleased with how

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1 this review has progressed.

2 Now is probably the time where we are
3 getting into some of the proprietary material.

4 MR. BOEHNERT: So we close the meeting.
5 We'll go to a closed meeting transcript.

6 (Whereupon, at 1:10 p.m., the proceedings
7 went into Closed Session.)
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1 CHAIRMAN KRESS: Does the staff wish to
2 make any additional comments at this time? I'll tell
3 you what. Let me go around the table here and see if
4 we have comments from the consultants or the members,
5 and then you might want to respond to some of those.
6 I guess I'll start with you, Virgil. You have any
7 comments in the way of wrap-up comments you'd like to
8 make now or would you prefer to wait until you digest
9 it?

10 MEMBER SCHROCK: I think I'm going to have
11 to write the comments. I just don't see any way I can
12 summarize them all now. In some respects, the report
13 that I submitted in November has been addressed. In
14 some respects, it's not.

15 CHAIRMAN KRESS: Yes. I think that was
16 what I was looking for.

17 MEMBER SCHROCK: I could try to sort those
18 out for you.

19 CHAIRMAN KRESS: I think it's a little
20 premature. Why don't you think about it and do it in
21 your second report. There's no use doing it now.

22 MEMBER SCHROCK: My comments on the SER at
23 the beginning of this meeting may have been more
24 severe than they should have been, but I do think the
25 SER should be written in clearer language than it is.

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1 I think it needs to be more technically correct than
2 it is. I think there are still some problems that I'm
3 going to comment on in my final report.

4 CHAIRMAN KRESS: That would be helpful.

5 I guess you're not allowed to comment at
6 this stage. Do you wish to make any more comments?

7 MEMBER SIEBER: No, I don't think so.

8 CHAIRMAN KRESS: I don't have any
9 additional ones, so I think I'll see if the staff has
10 any additional comments they want to make before we
11 decide what to do for the full meeting.

12 DOCTOR LANDRY: I think we've tried to
13 make it clear that this is a draft SER. There are
14 areas in which we intend to make some revisions. We
15 had intended some revisions coming in. There are
16 areas that we felt could be bolstered and we'll, of
17 course, take into consideration the comments and views
18 of the subcommittee in making those revisions to the
19 draft SER so that our goal is to have a complete
20 product.

21 CHAIRMAN KRESS: Okay.

22 DOCTOR LANDRY: We would appreciate
23 getting a copy of Professor Schrock's comments.

24 CHAIRMAN KRESS: We will. That was an
25 omission and that shouldn't have happened. We'll be

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1 sure you get the next one.

2 How much time do we have on the agenda?

3 MR. BOEHNERT: We have an hour and 40
4 minutes.

5 CHAIRMAN KRESS: On the full committee.
6 An hour. Almost two hours. Right?

7 MR. BOEHNERT: 10:20 to 12:00 noon on the
8 6th of September.

9 CHAIRMAN KRESS: Okay. My suggestion
10 would be, #1, that this GE presentation we just heard,
11 answering the previous questions I think would be
12 valuable for the whole committee to hear. So I would
13 want to see that from GE. From the staff, I think the
14 committee is pretty familiar with the way the
15 uncertainty analysis was done so we don't really need
16 much on that. But I would like to see sort of a
17 shortened overview of the SER because we really have
18 to have that. Not necessarily the full thing but at
19 least talk about the limitations and the code
20 assessment part. Something like slide seven on or
21 something in Ralph Landry's.

22 I think we would want to hear a little
23 bit, an abbreviated version of the kinetics part. I'd
24 like particularly to have a little bit of that where
25 you talked about your experience with the use of the

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1 code itself. I think that was helpful. And maybe
2 some abbreviated discussion of the use of MCNP and, of
3 course, your final wrap-up slide of your findings. I
4 think that would be my impression. Do any other
5 committee members want to comment?

6 MEMBER SIEBER: I'd start with slide five
7 rather than seven so that people understand what the
8 scope really is. Slide five actually states that.

9 CHAIRMAN KRESS: Let's see. Maybe the
10 staff would have about 45 minutes and GE 35. Do you
11 think you can fit it into that kind of time frame?

12 MR. BOEHNERT: That's total time so allow
13 some time for questioning.

14 CHAIRMAN KRESS: Yes, that's total time.
15 Normally we say presentation time is 50 percent of
16 total time. So if there are no more comments or
17 questions, I'd like to thank everyone. GE, thank you,
18 and thanks to staff, particularly those from Frank
19 Rosenfeld for coming back and helping us out. Hope
20 you can make it to the September meeting, too.

21 MR. ULSES: Absolutely no problem. It's
22 always a pleasure.

23 CHAIRMAN KRESS: Okay. Thank you very
24 much. With that, I guess this is a recess because
25 tomorrow is a continuation of the same subcommittee.

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1 MR. BOEHNERT: That's right.

2 CHAIRMAN KRESS: So tomorrow we hear about
3 water --

4 MR. BOEHNERT: That's correct.

5 CHAIRMAN KRESS: Okay. I'll call this
6 subcommittee meeting recessed until tomorrow.

7 (Whereupon, the meeting was recessed.)
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Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

**TRACG CODE FOR
ANTICIPATED OPERATIONAL OCCURRENCES**

DRAFT SAFETY EVALUATION REPORT

ACRS THERMAL/HYDRAULIC SUBCOMMITTEE

**RALPH R. LANDRY
REACTOR SYSTEMS BRANCH
AUGUST 22, 2001**

TRACG DSER

TOPICS

- **REVIEW TIMELINE**
- **APPROACH TO REVIEW**
- **CODE APPLICABILITY**
- **CODE ASSESSMENT**
- **STAFF EVALUATION**
 - **THERMAL-HYDRAULICS**
 - **NEUTRON KINETICS**
 - **STATISTICAL METHODOLOGY**
 - **CODE USER EXPERIENCE**
- **CONDITIONS AND LIMITATIONS**
- **CONCLUSIONS**

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REVIEW TIMELINE

- **MAY 25, 1999 - PRELIMINARY INFO MEETING**
- **JULY 15, 1999 - PRELIMINARY INFO MEETING**
- **JANUARY 2000 - TRACG SUBMITTAL**
- **NOVEMBER 13, 2000 - ACRS T/H
SUBCOMMITTEE**
- **JULY 2001 - FORMAL RAIs ISSUED**
- **JULY 2001 - DRAFT SER**

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STAFF APPROACH TO REVIEW

- **EXTENSIVE T/H REVIEW DURING SBWR REVIEW EFFORT FOR LOCA APPLICATION**
- **STAFF BUILT ON THAT REVIEW FOR AOO REVIEW**
- **EMPHASIS ON NEUTRON KINETICS AND STATISTICAL METHODOLOGY**

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TRACG AOO APPLICABILITY

- **INCREASE IN HEAT REMOVAL BY SECONDARY SYSTEM**
 - ▶ **DECREASE IN FEEDWATER FLOW**
 - ▶ **INCREASE IN FEEDWATER FLOW**
 - ▶ **INCREASE IN STEAM FLOW**
 - ▶ **INADVERTENT OPENING OF SAFETY RELIEF VALVE**

- **DECREASE IN HEAT REMOVAL BY SECONDARY SYSTEM**
 - ▶ **LOSS OF EXTERNAL LOAD**
 - ▶ **TURBINE TRIP**
 - ▶ **LOSS OF CONDENSER VACUUM**
 - ▶ **CLOSURE OF MAIN STEAM ISOLATION VALVE**
 - ▶ **STEAM PRESSURE REGULATOR FAILURE**
 - ▶ **LOSS OF NON-EMERGENCY AC POWER**
 - ▶ **LOSS OF NORMAL FEEDWATER**

- **DECREASE IN REACTOR COOLANT FLOW RATE**
 - ▶ **LOSS OF FORCED REACTOR COOLANT FLOW**
 - ▶ **FLOW CONTROLLER MALFUNCTION**

- **REACTIVITY AND POWER DISTRIBUTION ANOMALIES**
 - ▶ **STARTUP OF INACTIVE OR RECIRCULATION LOOP**
 - ▶ **FLOW CONTROLLER MALFUNCTION CAUSING INCREASE IN BWR CORE FLOW RATE**
- **INCREASE IN REACTOR COOLANT INVENTORY**
 - ▶ **INADVERTENT OPERATION OF ECCS**
 - ▶ **CVCS MALFUNCTION**
- **DECREASE IN REACTOR COOLANT INVENTORY**
 - ▶ **INADVERTENT OPENING OF PRESS RELIEF VALVE**

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CODE ASSESSMENT

- **ASSESSMENT PERFORMED BY COMPARISON WITH DATA FROM:**
 - ▶ **PHENOMENOLOGICAL TESTS**
 - ▶ **SEPARATE EFFECTS TESTS**
 - ▶ **INTEGRAL SYSTEMS TESTS**
 - ▶ **PLANT OPERATIONAL DATA**
- **PLANT NODALIZATION IS TO BE CONSISTENT WITH ASSESSMENT MODELING**
- **PIRT PREPARED CORRELATING PHENOMENA WITH TESTS AND QUANTITATIVE ASSESSMENT PERFORMED**
- **ALL MEDIUM AND HIGH RANKED PHENOMENA ASSESSED**
- **ASSESSMENT SHOWS CAPABILITY OF CODE TO REPRESENT EXPERIMENTAL AND OPERATING DATA**

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STAFF EVALUATION THERMAL-HYDRAULICS

- **Two-fluid model, six conservation equations, boron transport equation, noncondensable gas mass equation.**
- **Two-regime unified flow map - covers normal operating and anticipated regimes for BWR.**
- **Two-phase level tracking model uses approximations for void fraction above and below mixture level with cutpoint, α_{cut} , for level detection. Acceptable for AOO, but will be reevaluated for LOCA application.**
- **Kinetic energy term retained in energy equations. Avoids energy balance errors due to nonconservation of energy.**
- **GEXL heat transfer correlation:**
 - ▶ **NRC staff review related to power-uprate found data generated by COBRAG code used for GEXL14 correlation instead of experimental data.**

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STAFF EVALUATION THERMAL-HYDRAULICS

- ▶ **Use of artificial data instead of empirical data called into question validity of statistical results used to establish MCPR Safety Limit.**
- ▶ **Resolution pending - when NRC staff approves critical boiling length correlation uncertainty, it will be applied in use of TRACG.**
- **Basic component models are used as building blocks to construct physical models.**
- **Applicability to isolation condenser needs to be demonstrated should the code be applied to transients for which the condenser is important.**
- **Steam separator validated against full-scale performance data for two-stage and three-stage steam separators.**
- **Default - fully implicit integration for hydraulic equations and heat conduction equations by predictor-corrector iterative technique. Implicit coupling between heat conduction and coolant hydraulics. Less prone to error on phase shift in a thermally induced oscillation.**

TRACG DSER
STAFF EVALUATION
NEUTRON KINETICS

TONY ULSES

TRACG DSER
STAFF EVALUATION
STATISTICAL METHODOLOGY
YURI ORECHWA

TRACG DSER

STAFF EVALUATION USER EXPERIENCE

- **TRACG uses input deck closely related to input deck specification of original TRAC-B code.**
- **Knowledgeable TRAC user can readily understand structure and design of TRACG input.**
- **Major changes from TRAC-B to TRACG well described in Model Description report appendix.**
- **Execution structure of control blocks retained.**
- **Additional guidance to the user on time step size would be useful.**
- **TRACG determines correct flow regimes for components during steady-state initialization.**
- **Standard input has been developed for classes of BWRs and transients. Reduce user introduced errors in code results.**

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STAFF EVALUATION CONDITIONS AND LIMITATIONS

- **USE OF GEXL14 CORRELATION IS ACCEPTABLE PROVIDED THAT WHEN NRC APPROVES THE CRITICAL BOILING LENGTH CORRELATION UNCERTAINTY IT IS APPLIED IN USE OF TRACG.**
- **SHOULD TRACG BE APPLIED TO STABILITY ANALYSIS, THE METHODOLOGY IS TO BE SUBMITTED FOR STAFF REVIEW.**
- **TRACG HAS NOT BEEN REVIEWED FOR ATWS.**
- **PIRT18 MODEL NEEDS FURTHER JUSTIFICATION BEFORE APPLICATION TO RIA ANALYSES. HOW CAN A MONTE CARLO MODEL RELIABLY PREDICT POINT KINETIC ANSWERS?**
- **SEPARATE ISOLATION CONDENSER MODEL OR ABILITY TO ADEQUATELY MODEL THE CONDENSER NEEDS TO BE DEMONSTRATED SHOULD APPLICATION BE MADE TO ISOLATION CONDENSER IMPORTANT TRANSIENTS.**

TRACG DSER

CONCLUSIONS

- **USE OF GEXL14 CORRELATION ACCEPTABLE PROVIDED NRC APPROVED UNCERTAINTY APPLIED.**
- **KINETICS SOLVER IS ADEQUATE TO SUPPORT CONCLUSION MODELS ARE CORRECTLY DERIVED AND ACCOUNT FOR PHENOMENA INVOLVED IN AOO TRANSIENTS.**
- **KINETICS SOLVER BENCHMARKING DEMONSTRATE TRACG ADEQUATELY PREDICTS RESULTS FOR AOO TRANSIENTS.**
- **STAFF ANALYSES PROVIDE CONFIDENCE TRACG ACCEPTABLE FOR AOO ANALYSES.**
- **PIRT18 RESULTS DO NOT SIGNIFICANTLY AFFECT AOO ANALYSES.**
- **THE UNCERTAINTY ANALYSIS FOLLOWS ACCEPTED CSAU ANALYSIS METHODOLOGY.**
- **UNCERTAINTIES AND BIASES HAVE BEEN IDENTIFIED AND HIGHLY RANKED PHENOMENA BASED ON EXPERIMENTAL DATA VALIDATED.**
- **THE PROCESS IS ACCEPTABLE AND THE QUANTITIES ARE REASONABLE.**

TRACG DSER

CONCLUSIONS CONT'D

- **STANDARD INPUT HAS BEEN DEVELOPED FOR THE CLASSES OF BWR SYSTEMS TO WHICH TRACG IS TO BE APPLIED.**
- **THE STAFF FINDS THE TRACG02A CODE ACCEPTABLE FOR APPLICATION TO THE AOO TRANSIENTS PRESENTED IN THE SUBMITTAL, NEDE-32906P, "TRACG APPLICATION FOR ANTICIPATED OPERATIONAL OCCURRENCES (AOO) TRANSIENT ANALYSES," DATED JANUARY 2000.**

TRACG Kinetics Review

Tony P. Ulises
USNRC
August 22, 2001



Outline

- Topics Covered
- Method of Review
- Review Conclusions
- Lessons Learned / Detailed Description of Specific Review Areas



Areas of Review

- Documentation
- Theoretical Development
- Auxiliary Models
- Validation



Method of Review

- As in the past, performance based
- Documentation and theory were reviewed
- Emphasis on execution of code and comparison to relevant benchmarking
- Executing the code led the staff into review subjects that would have been missed had we not run the code



Review Summary

- Modeling captures relevant physics
- Auxiliary models (i.e. direct moderator heating, structural heating, etc.) well theoretically developed
- Decay heat model adequate for proposed application
- Documentation acceptable for internal GNF use. Some models undocumented or documentation is weak.



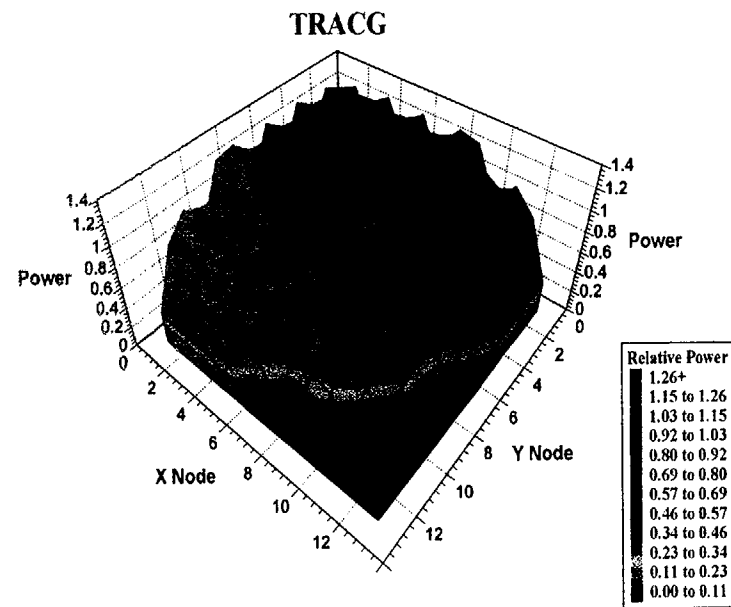
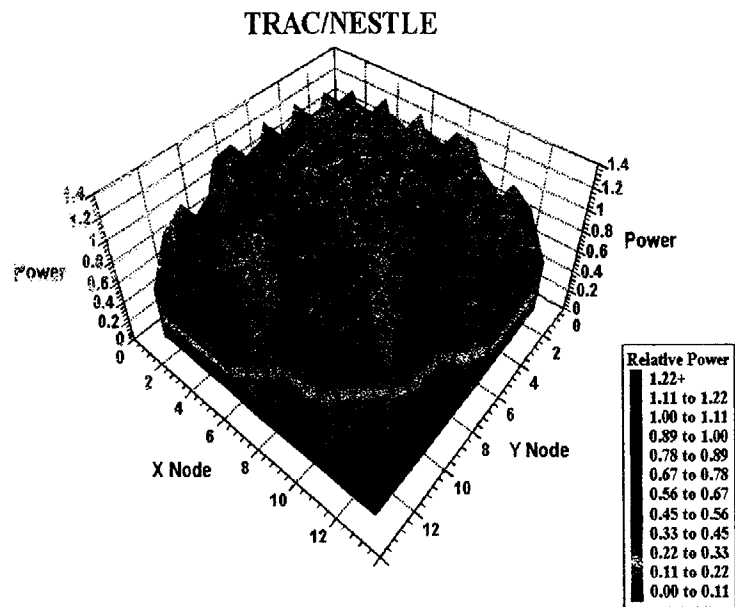
GNF Validation Studies

- Peach Bottom Turbine Trips
- Hatch 2 pump trip and MSIV closure tests
- NMP2 Pump Upshift
- Leibstadt Loss of Feedwater Event
- Numerous stability events



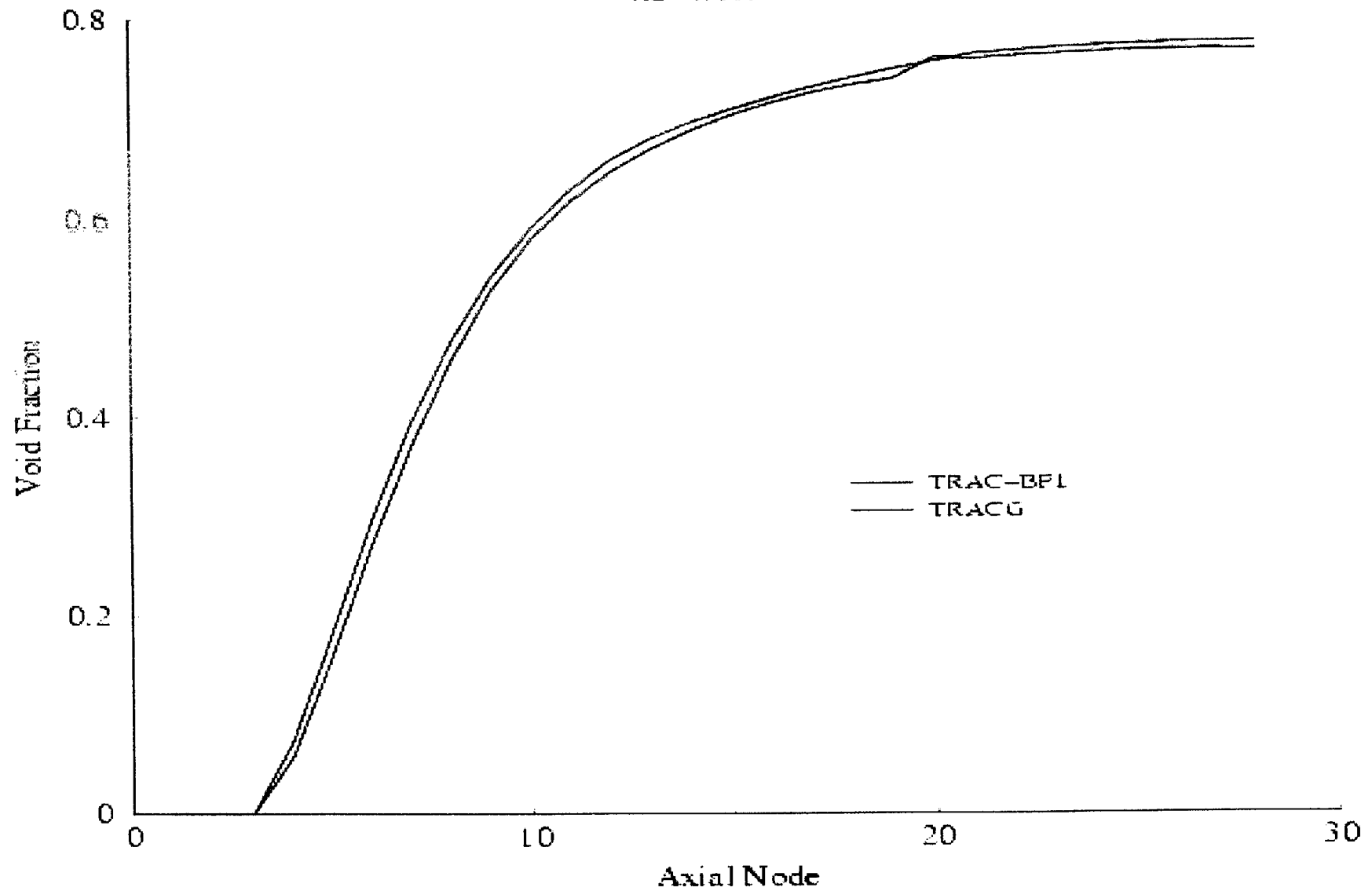
Test Problem

- Intended to improve staff's understanding of TRACGs ability to model a core with modern fuel design
- Based on ABWR core design
- Only models reactor - no balance of plant
- Steady-state results compare well
- Small perturbation transient results compare well



Steady State In-Channel Axial Void Fraction

ABWR Test Core





Simulated Pressurization Transient

- Simulated MSIV closure without SCRAM using complete deck to generate boundary conditions
- Modeled transient with different modeling options

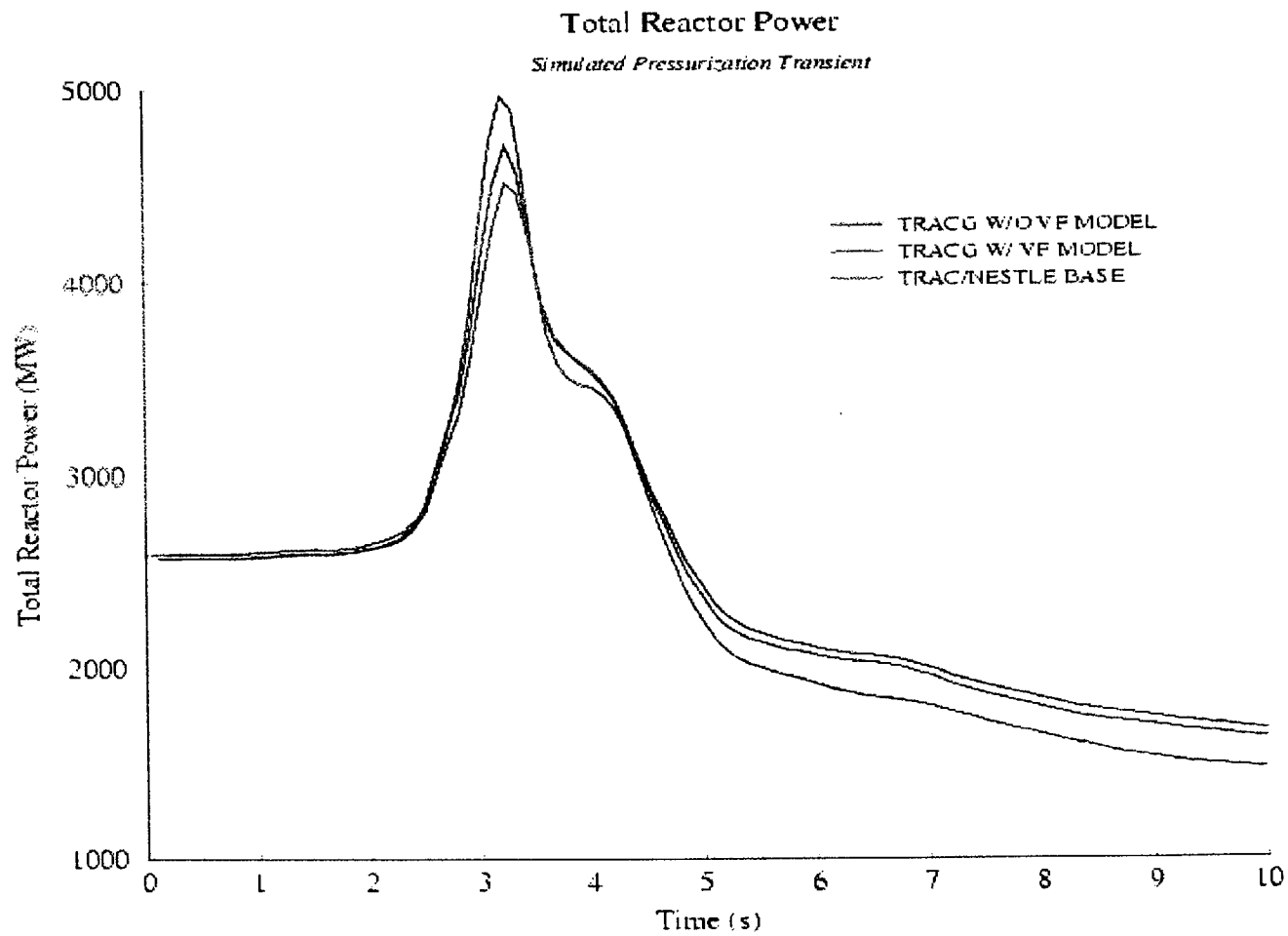


Figure 5 Total Reactor Power for Simulated Pressurization Transient



Review Conclusions

- Reasonable assurance that TRACG can be used as an AOO analysis tool
- Based on staff analyses and evaluation of GNF benchmarking
- Not reviewed for licensing application to any non-AOO transient (i.e. stability, RIA, etc.)



Challenges!

- First time that the staff was unsuccessful defining a problem to eliminate cross section effects
- Difficulties identifying reasons for differences
- Improper conclusion regarding the source of differences
- Problems led staff to review items that would have not been fully reviewed



Use of MCNP

- GNF relies heavily on MCNP
- MCNP used to validate TGBLA code results
- MCNP results used to tune TGBLA results in TRACG
 - PIRT18 model
- Everyone uses MCNP to validate; staff knows of no other organization using MCNP results to modify licensing code predictions



PIRT18 Model

- MCNP, like all Monte Carlo codes, does not provide user with single valued results
- Predicted eigenvalues are statistically derived and have uncertainty
- Uncertainty represented by the 95th percentile confidence interval needs to be accounted for
- Staff predicted uncertainty bands would lead to small differences in TRACG predictions if applied to results
- Effect of model is minimal - not well justified

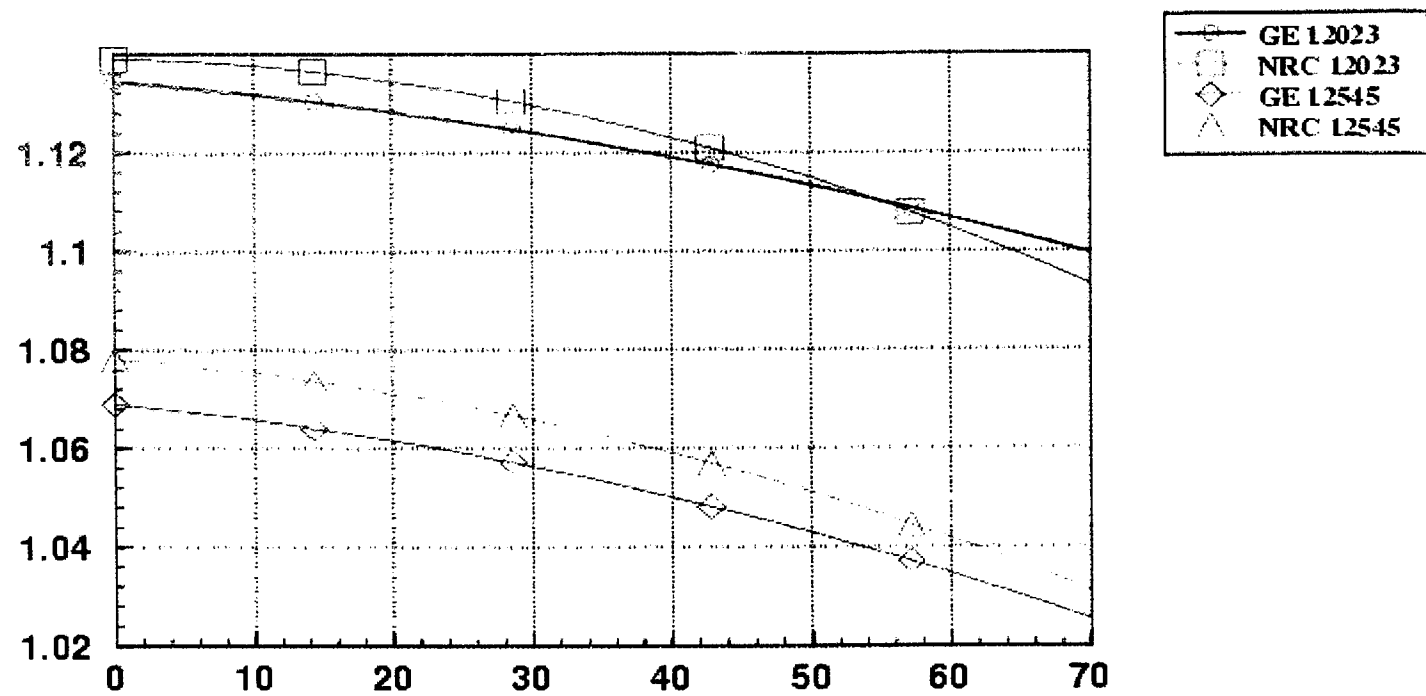


Figure 2 Comparison of Void Reactivity between NRC and GE Methods for Sample Core

Void Reactivity Prediction for GNF Lattice

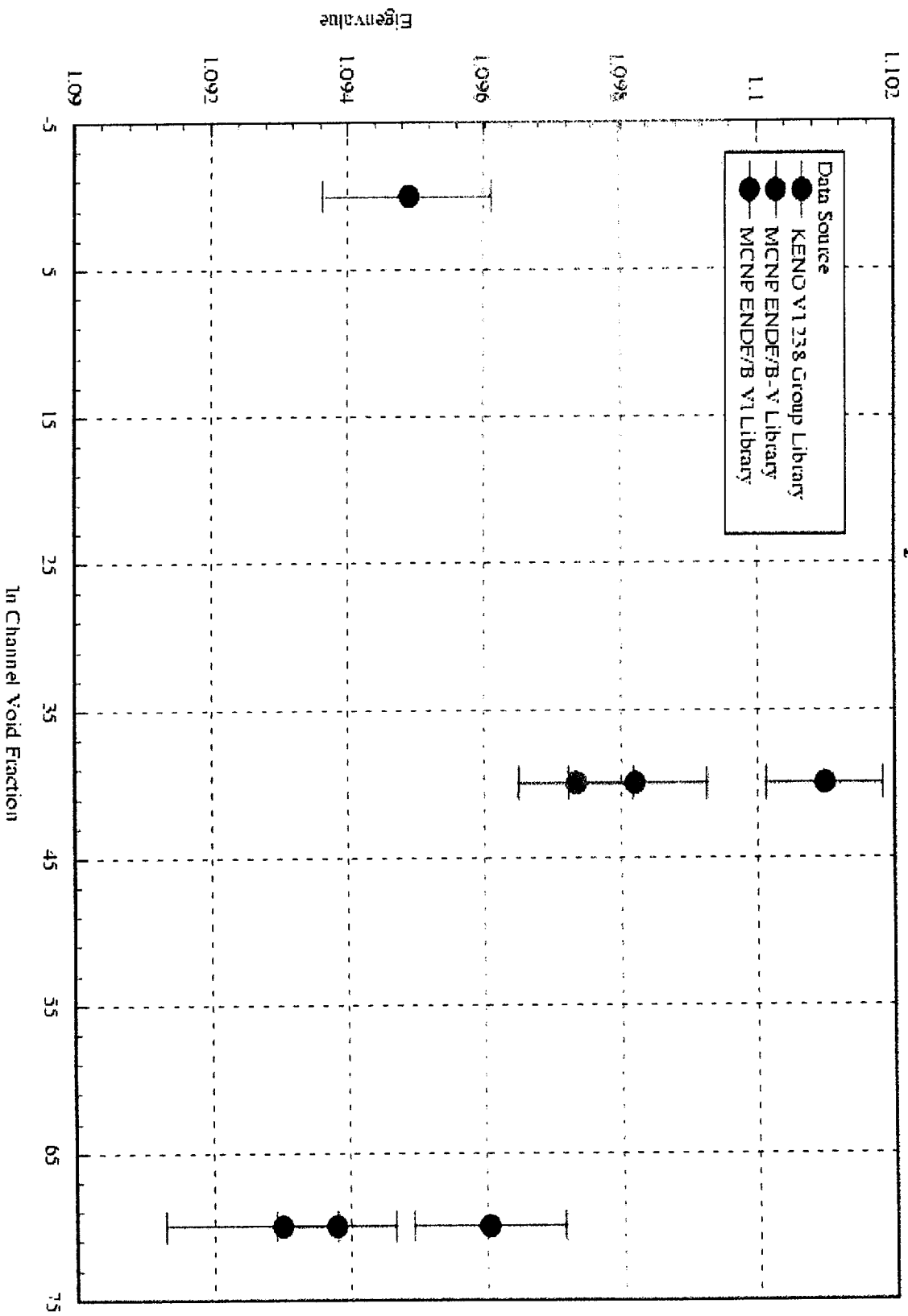


Figure 6 Comparison of Different Monte Carlo Evaluations of the Same GNF Lattice



Validation

- Non-valve closure transients were considered, but did not form a large part of our review conclusion
- Staff conclusions regarding SPERT predictions differ from GNF
- Staff's own methods validate very well against SPERT demonstrating that three-dimensional diffusion theory codes can predict test
- GNF results do not compare well with experiment - not considered in our review because of proposed application



Lessons Learned

- Even difficulties can be successes
- Work harder at defining problems that eliminate cross section effects
- Require that upstream codes needed to properly perturb input stream information be supplied
- Don't jump to conclusions - THINK!

TRACG Analysis of Anticipated Operational Occurrences

Review of Uncertainty Evaluation

Y. Orechwa

NRR/DSSA/SRXB

Review Topics

- **Model Uncertainties and Biases**
- **Combination of Uncertainties to Estimate Design and Operating Limits**

TRACG

Neutronic Model:

$$\underline{A}(\underline{\theta}, \underline{\psi}) \underline{P}(r, t) = \underline{S}(r, t)$$

Thermal-Hydraulic Model:

$$\underline{B}(\underline{\phi}, \underline{P}) \underline{\psi}(r, t) = \underline{Q}(r, t)$$

Initial and Boundary Conditions

$$\underline{\theta} \sim f_N(\mu_\theta, \sigma_\theta^2) \quad \underline{\phi} \sim f_{TH}(\mu_\phi, \sigma_\phi^2)$$

∴ Determination of Model Uncertainties and Biases

$$\Rightarrow \text{estimate } f(\mu, \sigma^2)$$

TRACG Solution:

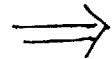
$\psi^{TRACG}(\underline{r}, t | \underline{\theta}, \underline{d}) \equiv$ thermal-hydraulic conditions at (\underline{r}, t)

$\psi_k^{TRACG} \sim$ distribution function



Design Limits

$$CPR = \frac{q_{crit}^{GEXL}(\psi^{TRACG})}{q^{TRACG}(\psi^{TRACG})}$$



Operating Limits

Model Uncertainties and Biases of θ , ϕ

- **Identify Phenomena that have an impact**
- **Establish nominal values, biases, and uncertainties for the model parameters in TRACG associated with the phenomena identified above.**
 - Separate effects test facility data
 - Integral test facility data
 - Component qualification test data
 - BWR plant data
 - Code comparisons
 - Engineering judgement

- Evaluate normality and estimate distribution parameters for $\underline{\theta}$ and $\underline{\phi}$.

- Sensitivity of $\Delta CPR / ICPR$ to variation in each model parameter for a turbine trip without bypass.

Combination of Uncertainties

A. Estimation of Design Limits

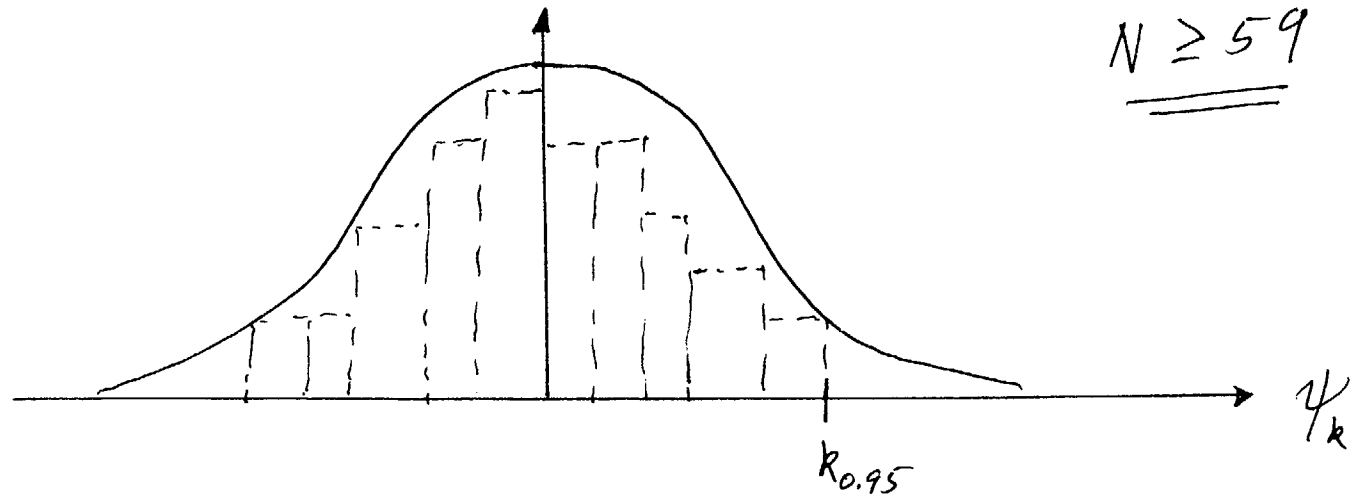
Design Parameters

$$\psi_k = \psi_k(\underline{r}, t | \underline{\theta}, \underline{\phi})$$

where

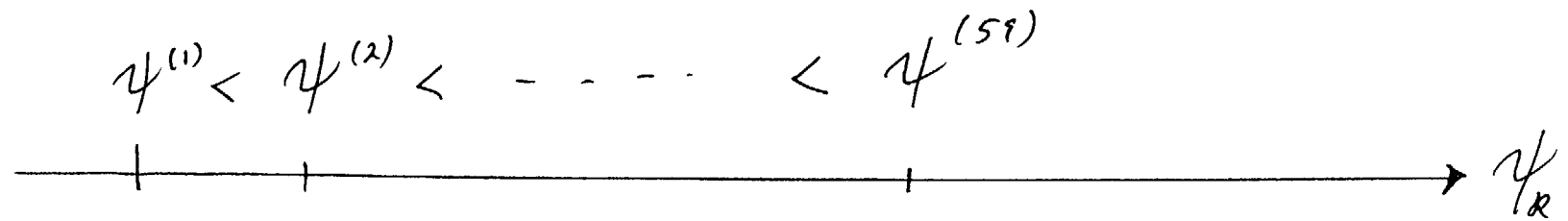
$$\underline{\theta} \sim f_{\theta}(\mu_{\theta}, \sigma_{\theta}^2) \quad \underline{\phi} \sim f_{\phi}(\mu_{\phi}, \sigma_{\phi}^2)$$

I. Normal Theory



$$\psi_k \leq \bar{\psi}_k + z_{0.95} \times \sigma_{\psi}$$

II. Order Statistics



$$\psi_R \leq \psi^{(59)} \quad \text{at } 95\%$$

Note: Normal Theory intervals are likely to be much smaller than the Order Statistic estimates.

B. Determination of Operating Minimum Critical Power Ratio

- **Safety Limit Minimum Critical Power (SLMCPR)**

“Value of CPR at which less than 0.1 % of the rods in the core are expected to experience boiling transition”

- **Δ CPR**

“Change in CPR due to transient event”

- **$OLMCPR = SLMCPR + \Delta CPR$**

Computation of the Probability of a Rod Experiencing Transition Boiling

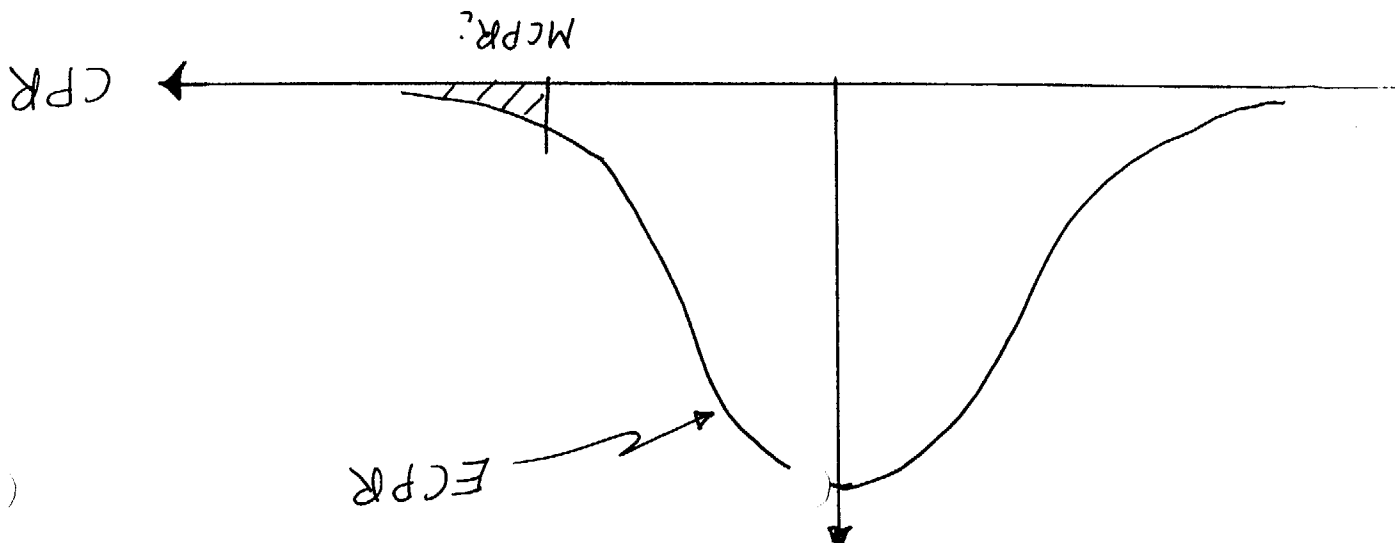
- Experimental Data (Atlas facility):

$$ECPR \equiv \frac{q^{GEXL}(\psi^{Exp})}{q_{exp}^{crit}}$$

- Computed by TRACG (Reactor):

$$MCPR \equiv \frac{q^{GEXL}(\psi^{TRACG})}{q_{TRACG}}$$

$$P_i = \int_{-\infty}^{M_{CPR,i}} f_{ECPR}(CPR|\mu, \sigma) dCPR$$



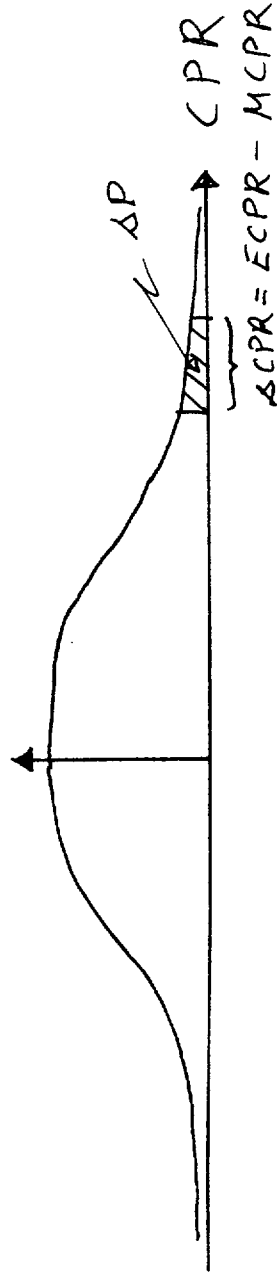
only if $f_{ECPR} = f_{M_{CPR}}$

Engineering Judgement

I.

$$ECPR \approx MCPR + \underbrace{\frac{\partial MCPR}{\partial \psi_{TRACG}}}_{< 1.0} \underbrace{(\psi_{TRACG} - \psi_{exp})}_{\approx 1.0}$$

II.



$$\Delta P = \int_{\Delta CPR}^{ECPR} f(CPR/\mu, \sigma) dCPR \approx 0$$

Determination of OLMCPR

- Generic (by class and type) distribution of $\Delta\text{CPR}/\text{ICPR}$ via TRACG trials
- Nominal (reactor specific) TRACG transient calculation of $\Delta\text{CPR}/\text{ICPR}$
- Random trials of ICPR

$$\text{MCPR}_i = \text{ICPR}_i \left[1 - \left(\frac{\Delta\text{CPR}}{\text{ICPR}} \right)_i \right]$$

Compute the Number of Rods Subject to Boiling Transition (NRSBT)

if $\overline{\text{NRSBT}} = 0.1\%$

Initial minCPR = OLMCPR