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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING

ISSUES ASSOCIATED WITH CORE POWER UPRATES

(ACRS)

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TUESDAY

JUNE 12, 2001

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ROCKVILLE, MARYLAND

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The ACRS Thermal Phenomena Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:28 a.m., Dr. Graham Wallis, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

DR. GRAHAM WALLIS, Chairman

DR. AUGUST CRONENBERG, ACRS Senior Fellow

DR. F. PETER FORD, Member

DR. THOMAS S. KRESS, Member

DR. GRAHAM M. LEITCH, Member

DR. VIRGIL SCHROCK, ACRS Consultant

DR. ROBERT E. UHRIG, Member

ACRS STAFF PRESENT:

PAUL A. BOEHNERT, ACRS Staff Engineer

JOHN HOPKINS, NRR

RALPH CARUSO, NRR

DONNIE HARRISON, NRR

JACK ROSENTHAL, RES

TONY ULSES, NRR

A-G-E-N-D-A

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

(8:28 a.m.)

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

In attendance are ACRS Members Peter Ford, Graham Leitch, Robert Uhrig, and Thomas Kress; and the ACRS Consultant, Virgil Schrock. We miss Novak Suber, who is usually at these meetings, and we think maybe he is here in spirit, and at least we will try and make up for him.

The purpose of this meeting is for the Subcommittee to discuss potential issues for consideration by the NRC staff pertaining to its review of applications for core power uprates.

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

Paul A. Boehnert is the cognizant ACRS Staff Engineer for this meeting. A portion of this meeting will be closed to the public to discuss General Electric Nuclear Energy proprietary information. That will be this afternoon.

The rules for participation in today's meeting have been announced as part of a notice of this meeting previously published in the Federal Register on May 30, 2001.

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

We have received no written comments or requests for time to make oral statements from members of the public. Now, we are going to discuss the power uprate program and I simply note that these are one of the events in this year and the near future which is likely to have a significant effect upon nuclear generation in this country.

Last week, we heard that the industry plans to go for something like 10,000 new megawatts of uprate power. So we are really looking forward to hearing about this, and I will call upon Mr. John Hopkins, from the NRC's Office of Nuclear Reactor Regulation to get us started.

MR. HOPKINS: Thank you, Mr. Chairman. I am John Hopkins, Senior Project Manager in NRR. With me at the table are Mark Rubin, Donnie Harrison, and Ralph Caruso; and we have more staff members seated obviously.

I appreciate this opportunity to come and talk to the subcommittee about power uprates. We are mainly going to focus on extended power uprates today. Let me briefly again show the main agenda.

As you can see, Ralph Caruso, for Reactor Systems, will talk about our efforts so far in Duane Arnold inspection; and Don Harrison will then talk about PRA risk considerations. Again, mainly focused on Duane Arnold, but additional.

And Jack Rosenthal, from the Office of Research, will give a presentation.

We are prepared to answer other questions that may arise that specific presenters do not cover. As you mentioned, Mr. Chairman, there are many power uprates that are going to be coming in.

The staff has reviewed several smaller uprates, but now the really extended power uprates are starting to come our way, and Duane Arnold is the first big one really, a 15 percent.

And as you can see by the review schedules, all of these reviews are fairly aggressive. The staff anticipated in a review of our topical reports that it would probably take us 12 to 18 months to do a power uprate review, and we are trying to beat that by a few months.

CHAIRMAN WALLIS: And an aggressive review is one that goes quickly?

MR. HOPKINS: Yes, that's right I meant.

CHAIRMAN WALLIS: Well, it probably should be aggressive as well.

DR. HOPKINS: Our staff is competent and I am sure they will be.

CHAIRMAN WALLIS: Thank you.

MR. HOPKINS: Clinton is the last one mentioned, and that is expected to come in next week and will be at 20 percent. Additionally, there are other plants that have expressed interest in extended power uprates that we expect to come in at the end of the year, and that have not -- that I have not bothered to list. Again, Duane Arnold --

DR. LEITCH: These are all boilers, or all they constant pressure uprates?

MR. HOPKINS: Yes, to my knowledge, these are all constant pressure uprates.

DR. BOEHNERT: John how many more are you expecting? Do you have any idea on that?

MR. HOPKINS: I can't recall. Maybe

Mohammed Swaybe could comment on that.

MR. SWAYBE: My name is Mohammed Swaybe. We are generating -- we have a survey underway right now, and we will be giving that information to ACRS hopefully this week.

DR. BOEHNERT: Thank you.

CHAIRMAN WALLIS: Are these all similar kinds of boilers, or are they different kinds of boilers?

MR. HOPKINS: They are really different kinds of boilers. Dresden, Quad Cities, and Duane Arnold are all fairly similar. But Clinton is different from them.

DR. UHRIG: That is a later generation?

MR. HOPKINS: It is just the later generation.

MR. UHRIG: It is a Mark 3 containment.

CHAIRMAN WALLIS: Okay.

MR. HOPKINS: And Clinton is BWR-6 and the others are I believe BWR-3s, and that's all. If there are no further questions for me, I would like to start with Ralph Caruso.

CHAIRMAN WALLIS: What do all those T's mean up there?

MR. HOPKINS: Target.

CHAIRMAN WALLIS: Oh, target.

DR. SCHROCK: The extended uprate program, have these same plants had smaller uprates previously, or these will be the first?

MR. HOPKINS: Duane Arnold, I believe, has had a smaller uprate previously. I don't believe that the others, Dresden and Quad, or Clinton, have had smaller uprates.

MR. CARUSO: Good morning. My name is Ralph Caruso, and I am the Chief of the BWR Nuclear Performance Section and Reactor Systems Branch in NRR. I am talking to you this morning about the audits that were performed in March of this year regarding the Duane Arnold power uprate. If I could have the background slide.

To describe the background here, the Duane Arnold power uprate was submitted in the fall of last year. The staff has been performing a review since then.

The staff review is focused primarily on determining compliance with the topical report, known as ELTR2. That is one of the two licensing topical reports that General Electric has submitted and that the staff has accepted for use in doing these power uprates on a generic mission basis.

DR. KRESS: Your title says that this is an audit result. I am not sure that I know what an audit is in this sense.

MR. CARUSO: Well, this is an audit because it was done in conjunction with an ongoing licensing action, and I will explain a little bit more as I go along about what the individuals did.

And the idea is that we are trying to approve a licensing action, and as part of that approval, we can go to the vendor or to the licensee site and audit their calculations and their methods, and their results.

DR. KRESS: Okay.

MR. CARUSO: Rather than relying upon their submittals, we can actually look at the actual calculations.

DR. KRESS: Okay. Good. Thank you.

MR. CARUSO: And as I said, this was done in support of the power uprate, and I think at several earlier meetings I made a commitment that the staff would be doing these audits for all of these power uprates that involve large power increases on the order of 20 percent.

The audit was performed the week of March 26th by a team of four staff members, and I see three of them here in the room today, and they are here if I get into trouble.

CHAIRMAN WALLIS: Ralph, you were auditing what the vendors do. Is the NRC making independent calculations?

MR. CARUSO: It would depend on the issue. We have the ability to do that, but it all depends on what we find and what we determine is necessary to complete the review properly.

CHAIRMAN WALLIS: But you have not done any yet then?

MR. CARUSO: I can't think of any. No, I don't believe we have done any for this. That's interesting. I have my staff shaking their head no, and I have a licensee shaking their head yes.

MR. ULSES: The containment systems branch is performing an audit.

MR. CARUSO: The containment systems branch. I don't do the containment portion of it, and on the reactor system side, we are not doing it. But I believe the containment people are.a

DR. CRONENBERG: Ralph, is the documentation on the audit and what your staff finds, is it part of a particular license application by Duane Arnold, or will you be documenting it in a separate report a general audit of calculational procedures, or is this going to be tied to each particular plant?

MR. CARUSO: The calculations that are audited for each licensee will be reported as part of the SER for that licensee, okay, because the audit is done to support that application.

We may find issues that have generic applicability, and we will deal with them appropriately, but they are properly dealt with for each licensee as they come up because they are done as part of that review. The next slide, the audit scope.

This audit considered five issues. The first was the SAFER/GESTR LOCA methodology, which is the licensed approved methodology for LOCA at Duane Arnold. It looked at the implementation of what is called long term stability operation IV.

BWR stability is an issue that has been looked at for at least -- well, since BWR's were developed, but over the past 10 years, a number of options have been identified for plants to address the issue of stability, and the detection of stability, and the suppression of it.

And there are a large number of options, depending upon the manufacturer of the detection and suppression equipment that licensees install in their plants.

Duane Arnold has chosen Option 1-D, which I believe is the GE Solomon on-line stability monitoring system; and what we did was that we looked at how that was implemented for Duane Arnold.

We also looked at the GELX14 correlation, which is used for GE12 and GE14 fuel, and heat transfer correlation as part of the design of the fuel.

We also looked at reactor cordizine issues, and the methodology and uncertainties used in the safety limit MCPR establishment, Minimum Critical Power Ratio.

CHAIRMAN WALLIS: When you looked at these did it turn out that stability or fuel design were important issues for operates?

MR. CARUSO: Well, I will give you the findings for each one of these, and then some of the issues that came out of them. Actually, these significant issues. Let's go to the next slide.

For the SAFER code, generally, we found that the analyses for the rated conditions complied with the SER, and the codes were appropriately applied. We looked at the actual calculations, and we looked at the results, and we looked at the inputs.

DR. KRESS: Are there for the Chapter 15 type design basis accidents?

MR. CARUSO: These are the SAFER/GESTR LOCA calculations, the licensing basis calculations for design basis access.

DR. KRESS: Just for the LOCAs?

MR. CARUSO: The LOCAs, SAFER/GESTR; that's what that is used for. One of the findings was that there was a question about the use of uncertainties that are derived from some TRAC calculations and from full power operations.

These uncertainties were developed for normal operating conditions, but then they were applied to analyses of the single loop operation, which we don't think is necessarily appropriate.

However, when you look at how they applied them, and the conservative penalty factors that they apply to single loop operation, we don't think that this is a significant issue. We will be discussing this with the licensee and with G.E., but this is not really a significant issue.

DR. KRESS: How about the LOCA analysis? They showed that they were still below the limit on peak clad temperature and oxidation amount?

MR. CARUSO: Yes.

DR. KRESS: But did they approach it very closely, or did they change --

MR. CARUSO: You mean how close they came?

DR. KRESS: Yes.

MR. ULSES: This is Tony Ulses of the staff. I can't recall the exact numbers, Dr. Kress, but I believe there certainly was an increase in the actual PCT, but I don't know that I would really attribute that to the actual power uprate itself, as much maybe to the fuel design change, if anything else I would say.

But they certainly had a lot of margin to do the PCTs is my recollection for the Duane Arnold situation.

DR. KRESS: Yes, the reason that I asked the question is that if they were already well below the PCT, and changed 15 or 20 degrees, I am not worried much about it.

But if they were pretty close to it, and got even closer, then I might worry about the reduction of margins beyond something that might be acceptable.

DR. KRESS: It sounds like it wasn't much of a change.

MR. ULSES: Yes, sir, that is my recollection. It wasn't much of a change, and I believe they still have quite a bit of margin as I recall.

CHAIRMAN WALLIS: Maybe we can get the answer from GE this afternoon.

MR. CARUSO: This is realized. This was not or is not a simple straight power uprate. I mean, they are changing fuel types as part of this change, and that will induce its own changes in analysis results for all sort of different accidents.

DR. KRESS: Plus, we are changing flow, and are they doing anything to the turbine generator?

MR. CARUSO: I believe they are making significant changes to the secondary side in order to be able to use the power that is coming out of the reactor.

DR. KRESS: So, you know, you get a lot of things that could affect the whole thing?

MR. CARUSO: That's correct.

DR. SCHROCK: The original licensing of Duane Arnold was on the old evaluation model prior to the new rule in '89.

MR. CARUSO: SAFER/GESTR is a -- no, actually, I believe it is an '83.472 method. It is an anomaly in Appendix K evaluation model.

DR. SCHROCK: That was my recollection, but what is the significance --

MR. CARUSO: It is a little bit more complex than that.

DR. SCHROCK: -- of your second bullet here; uncertainties derived from TRAC? That conjures up the new rule in which you have to evaluate the uncertainties.

MR. CARUSO: Tony, can you explain the details of that?

MR. ULSES: The best way to describe the SAFER/GESTR model is that it is sort of a hybrid I would say, Dr. Schrock. Really, what it is, and just like Ralph said, is that they are conforming with Appendix K, but that they are trying to demonstrate a little more realistically what the actual margins are in the LOCA calculation by trying to use the code more realistically.

And when we were working on the review and approval of the code, one of the ways that they attempted to try and demonstrate the accuracy of the method was to compare to some TRAC calculations, but that certainly was not the only thing that they did.

But they also did the calculations to the available experimental data, and what really came out of the TRAC SAFER/GESTR calculations was really basically the uncertainty term which they are adding on to the SAFER/GESTR methods as a penalty if you will.

So I guess I would say that the reliance on TRAC and the SAFER/GESTR method is actually reasonably minimal. But I certainly see where you are coming from. This is not a best estimate LOCA methodology by any means.

DR. SCHROCK: Well, that is what I am getting at, is what is it and where are we in terms of the -- well, I get a little confused on these acronyms, and SAFER/GESTR gets muddled up in my memory with GESTAR. Was it that GESTAR came later?

MR. CARUSO: It is all muddled up together with GESTAR.

DR. SCHROCK: It is, yes. And I remember that we had an extensive review of the GE methodology, which was approved in the '80s, late '80s sometime. I don't remember the date exactly.

But it would be helpful to me to understand what it is that they are doing now, brand new core configuration, and how is this new license going to be qualified against an old Appendix K approach, and against a new approach, which is the one that was reviewed by the ACRS some 12 or 13 years ago. What is it?

MR. CARUSO: This is the approved methodology as it was reviewed and discussed with the ACRS back in the '80s, subject to modifications that have been made over the years to correct errors, and to make changes as is allowed under 50-46 and Appendix K.

So it is the approved model, and that model --

DR. SCHROCK: The model that G.E. developed was in response as I remember it to a SCS paper which allowed the first step in applying the best estimate methodology in licensing.

And it was before the rule change, but it essentially attempted do something like the -- I am having trouble coming up yet with another acronym.

In any case, a best estimate application, as opposed to the old Appendix K. Now what I am hearing is that, no, this is an Appendix K approach.

MR. CARUSO: No, I think Tony explained that I think the topical report that you are referring to, or the Commission paper that you were referring to was SCS 83.472. That was the Commission paper that allowed this to be done, and SAFER/GESTR is an 83.472 method.

DR. SCHROCK: And wasn't Arnold licensed before that took place? When was Arnold originally licensed?

MR. HOPKINS: I'm sure it was in the '70s.

MR. CARUSO: That's correct, and it was licensed before those methods, but it has since started using the SAFER/GESTR methodology.

DR. SCHROCK: So the new license will be on the new basis then?

MR. CARUSO: Yes.

DR. SCHROCK: Okay. Thank you.

MR. ULSES: Well, actually, they are currently licensed for SAFER/GESTR, Dr. Schrock. They would have come in with a plan specific licensing topical report, and I would say sometime in the '90s probably to actually make the change fro the old evaluation into the SAFER/GESTR method.

MR. CARUSO: We don't know offhand when they made the change. I don't know if there is anyone from Duane Arnold who knows that. If someone there --

MR. BROWNING: My name is Tony Browning, and I am from Duane Arnold. Yes, we converted to the

SAFER/GESTR LOCA methodology in 1986.

MR. CARUSO: Okay.

DR. LEITCH: The term rated conditions as used on this viewgraph, is that -- are you referring to the present license level or to the uprated conditions?

MR. CARUSO: The uprated conditions. When I say uprated, that means not the nominal full-power rated conditions. With single-loop operation, you generally can generate full-power on a single-loop operation.

DR. LEITCH: These comments all refer to the uprated conditions?

MR. CARUSO: Yes. These were audits of the calculations that are used to support the power uprate.

CHAIRMAN WALLIS: And what is a single loop operation with a BWR?

MR. CARUSO: BWRs have two recirculation loops and it is possible --

CHAIRMAN WALLIS: You mean the pumps?

MR. CARUSO: One of the recirculation pumps will stop.

CHAIRMAN WALLIS: Okay. So it is not really a loop. It is part of the one loop?

MR. CARUSO: No, there are two loops, each has a --

CHAIRMAN WALLIS: Oh, they are actually separate?

MR. HOPKINS: Yes.

MR. CARUSO: Yes.

CHAIRMAN WALLIS: Okay. There is some baffles or something that separates the loops?

MR. CARUSO: No, they have --

MR. HOPKINS: The loop really does not isolate. It is just two loops and one pump goes off.

DR. KRESS: And two pumps.

CHAIRMAN WALLIS: The pumps pump through both loops don't they?

MR. CARUSO: No, one pump in each loop.

CHAIRMAN WALLIS: They are separate, absolutely separate??

MR. CARUSO: Yes.

CHAIRMAN WALLIS: I'm sorry. But it is the same circuit? The loop is external, and it is the external look that you are talking about, and insider the reactor vessel, there is just one loop, right?

MR. CARUSO: That's correct.

CHAIRMAN WALLIS: So it is different from the usual idea of a loop in a BWR situation. Well, I don't know if we want to go on with this, but SAFER/GESTR has very different models for things like slip velocity, and so on than TRAC does, and I am not quite sure how you use one code to estimate uncertainties than another.

MR. CARUSO: Tony, do you have any information about the details?

MR. ULSES: Well, what they were really trying to do if I recall was that they were trying to sort of bridge the gap between the experimental evidence, and down to the SAFER/GESTR methodology. That is my recollection of what they were trying to do. It has been a while since we actually looked at the methodology.

But the method is certainly not exclusively based on the TRAC-SAFER/GESTR comparisons. It is one, I believe, of eight uncertainty terms that they add into the results from SAFER/GESTR.

CHAIRMAN WALLIS: I guess what I am getting at is the rationale for taking the code of a different structure and using it to estimate uncertainties in some other code. I am not quite sure how you justify that with some kind of logical thread of thought.

MR. ULSES: Well, unfortunately, it is

difficult for me to discuss what they did in 1986, or actually '83, because I wasn't here, but based on what I have read in the record, it is basically sort of -- it is not really discussed, the actual rationale.

The assumption really that I made is that they are trying to sort of bridge like I said between the experimental evidence down to the SAFER/GESTR methodology.

CHAIRMAN WALLIS: So they are bridging the gap with no rationale?

MR. ULSES: Well, I think the argument would have been that the TRAC method would have been more accurate, and it would have been based on more fundamental principles. But that is a little bit of speculation on my part.

CHAIRMAN WALLIS: Thank you.

MR. CARUSO: The next item that I am going to talk about is stability, and the auditor, the staff member who did the audit, looked at the implementation of Option 1-D to Duane Arnold.

And generally he found that it was still applicable and still acceptable for use of Duane Arnold.

DR. UHRIG: Could you describe what you mean by Option 1-D? What is involved?

MR. CARUSO: Well, once again I am going to call on my staff because there are a lot of differences between the different options. Tony, do you --

MR. ULSES: Yes, sir. The fundamental principle behind Option 1-D is that you make the assumption that the reactor will not have an out-of-phase instability due to the small reactor size. In other words, it is going to remain tightly coupled.

And so all they do really is they apply an administratively controlled exclusion region, which basically tells the operator that you cannot operate here.

And then they use an on-line monitor, in which we are referring to in the second bullet, which is basically a backup, which will tell the operator if they had an indication of the onset of an instability. And that is basically the option in a nutshell.

DR. KRESS: And that is a core wide monitor, and it is not a local monitor?

MR. ULSES: Well, actually what it does is that it will tell them whether -- it is actually going to give them an indication of an out-of-phase or an in-phase instability.

DR. KRESS: But they could see an out-of-phase instability?

DR. UHRIG: They could see an out-of-phase instability from something. Actually, what they are doing is they are actually doing a calculation. It is not actually looking at the LPM signals themselves.

What is doing is they are taking those as an input, and it is using the Odyssey code, which they use for calculating the K ratios to actually make a prediction of what it would be.

So it is not actually looking at the signals themselves, which is usually an input into an algorithm.

DR. KRESS: Does it call for a SCRAM?

MR. ULSES: No, it does not. It does not. But they rely on the operator to take action in this particular scenario.

DR. UHRIG: And the fact that this is a smaller core compared to, let's say, LaSalle, where there was as I recall a stability incident a few years ago, is a favorable indication here that there is less likelihood of an instability?

MR. ULSES: Well, what it tells us is that there is less likelihood of an out-of-phase instability, yes, sir, due to the core size. Actually, in 1988, the LaSalle incident was actually a core-wide instability.

We had an out-of-phase instability in 1992 in WMB2 as I recall, which again is a larger size reactor, but if you look at all of the evidence that we have up to this point, all the evidence will tend to suggest that the reactor size is a large contributor to whether or not you have an out-of-phase instability.

DR. UHRIG: What are the inputs to the stability monitor? Is it pressure?

MR. ULSES: It is going to take reactor flow and reactor power, are the primary inputs to the Solomon system.

DR. UHRIG: Is there a core monitoring system of any sort of this, a new Trans-lex monitoring?

MR. ULSES: Yes, sir, it uses in-core PRMs.

DR. UHRIG: Is this a series of detectors at different levels?

MR. ULSES: Yes, sir, and also radially in-core.

DR. UHRIG: And what might the total number be?

MR. ULSES: I can't recall the actual

number. I would say in the order of 50 max, and that is an estimate. It is going to depend obviously on reactor size.

DR. KRESS: When you uprate the power and up the flow also, does it change the instability region?

MR. CARUSO: Yes.

DR. KRESS: It does that in an absolute sense, but does it on a relative sense, relative to percent power and --

MR. CARUSO: Yes, it does, and that was one of the findings, was that the instability region would increase relatively for this reactor, and therefore, the operator, or this finding that I have got here, the next finding that I have got here, is that operators will have to rely more on this on-line stability monitoring system.

DR. KRESS: And do you have to change the tech specs also?

MR. CARUSO: I don't know. Well --

MR. ULSES: This would not impact the tech specs at all, Dr. Kress.

MR. CARUSO: But one thing that is important is that the operators, because they are going to have to rely on this system more, they need to be better trained in its use.

They need to believe it more and they push a button to get the results and the recommendations of the system, but they have to start believing that, because they will find that the --

DR. KRESS: Does that mean that they didn't believe them before?

MR. CARUSO: No, it is a matter of -- well, how can I explain this. The calculations to determine the power to flow the regions of instability are done using a lot of very conservative results.

The on-line stability monitor is actually using the way the plant operates. The operators may find themselves in an area where the map says you may be in trouble, and they will push the button.

And they will have the on-line stability system tell them, no, your decay ratio is much lower than those design engineers told you it was going to be, and they may not believe that. And actually what they might do is that they come to not believe the Solomon system because it conflicts with the written down design details.

So we want to make sure that the operators use this, and that they believe it when it tells them that there is a problem, and that they believe it, and that they do something about it.

DR. UHRIG: Now, is Solomon a brand name, or is it a specific type of --

MR. CARUSO: Yes, it is the G.E. system that is installed at Duane Arnold.

DR. UHRIG: Is this a common system throughout many of the BWRs?

MR. CARUSO: I would have to ask G.E. how many plants have it installed.

MR. ULSES: It would only be used in the Option 1-D plants, which is a very small percentage of the fleet. I believe there are only four plants that actually would qualify for Option 1 to the reactor size.

DR. UHRIG: So because this is a small plant, it is a simpler system than is used in the others?

MR. ULSES: Yes, sir, because they can demonstrate that they will have a high likelihood for having a core wide instability, as opposed to an out-of-phase instability.

DR. UHRIG: There is an indication here that the operators are going to have to pay more attention to this. Does this mean an increase in their load and the things that they have to do?

Do they monitor this every hour, every day?

MR. CARUSO: No.

DR. UHRIG: Or when there is an alarm?

MR. CARUSO: No.

DR. UHRIG: How do they know to go push the button?

MR. CARUSO: This is not really a matter of monitoring on a continuous basis because the only time they have to worry about stability is when they are in the region where the instabilities might occur.

And this would be during a power increase, power ascension, or a power descension, when they are maneuvering the plant. Normally when they are operating at full power, they will be far away from these regions. So they won't have that as an issue.

I don't know offhand what the actual text spec requirement is when you are operating at full power whether they have to monitor stability to use this system. Do you know, Tony?

MR. ULSES: Well, I guess I would defer more to the reactor operators themselves, but I would say no, because it wouldn't make a lot of sense to be looking at this system when you are at full power, because it is not going to give you any information that you can really use.

But again I would say that I would have to defer to Duane Arnold for the answer specifically to what they do.

CHAIRMAN WALLIS: Do you have something?

MR. BROWNING: This is Tony Browning again for Duane Arnold. Yes, when you are at full power, there is not requirement to do the monitoring. As Ralph said, it is primarily used when you are doing start-ups and shut-downs.

The system will also automatically initiate if there is a dramatic change in power. For example, if a pump trip occurs, the system will turn itself on, and will start performing the calculations at that time when it sees a Delta-N power or flow of greater than a certain magnitude.

DR. LEITCH: Let me make sure that I understand then. What we are saying is that there is a region of the power flow map where the operators are trained to be sensitive to issues of stability, particularly so when they are in single loop; that is, when they have lost a recirc pump.

And the Solomon system takes no action, but just confirms to the operator that he is doing the right thing. And with this core power uprate, this region of the power flow map, this region of sensitivity is somewhat larger than it would be at the current power levels.

MR. CARUSO: That's correct.

DR. LEITCH: Is the Solomon system -- is there just one of these, or is there any redundancy in the system?

MR. CARUSO: I believe there is only one.

DR. LEITCH: And what about its reliability or availability? Do we know anything about that?

MR. CARUSO: QA --

MR. ULSES: Well, again, I would have to defer to the Duane Arnold folks, because the system has been in use for several years, and based on all the information that I have, it is a fairly reliable system. Basically, it is there when they need it.

However, for actually any specific information, I would say I would have to refer to the Duane Arnold folks, because they have been using it for several years.

DR. LEITCH: I guess what I am saying is that we are saying there is an increased dependence on it, and there is a bigger area of the core power flow map that may be -- where stability may be a concern.

I am just wondering about the reliability of the instrumentation if the operator is going to be dependent on it to make operating decisions more frequently than in the past.

MR. CARUSO: Realize that the -- that when we say that the operator is more dependent upon it, we mean that during these periods, such as during power increases and power decreases, which is a relatively small percentage of the time that the plant is operating, the operators will have to be more vigilant.

And this is one of those tools that they use during those time periods to make sure that the plant is operating safely. It is a relatively small window of time, and this is a tool to help them.

DR. UHRIG: Is this a safety grade system?

MR. ULSES: I would say no, but again i would have to defer to the Duane Arnold folks for a specific answer.

MR. BROWNING: No, it is not, but the primary mechanism that the operators use for detect and suppress are their in core neutron monitoring. Because we are a 1-D plant, we only see the fundamental mode of oscillation.

They will see it readily on their core wide detection system, and that is their primary means of instrumentation that they will use to take operator action when they believe they have an instability event.

DR. UHRIG: So if this system failed, the operator still has the means of --

MR. BROWNING: Right. This is only a backup.

DR. UHRIG: It is a only a backup and a convenient system because of being able to push the button and get information that would otherwise have to be discerned by the operator's knowledge of the behavior of the core?

MR. BROWNING: Right. As Ralph alluded to, the exclusion zone on the power flow map has a number of conservatisms built into it to account for the computer code predictions and other margins.

So it is a fairly large area of that corner of the power flow map, and a high flow, low power, region. So during the startup, they have to maneuver -- normally they try and maneuver around it.

Because of the uprate and the size of the increase of the region, they are going to be challenged to be able to maneuver it. So we are going to have to maneuver through it after the uprate.

Hence, the reason why the increased

reliance on Solomon, because by our tech specs, we are only allowed to operate in the region if Solomon is available.

DR. UHRIG: Is this a tech spec requirement that this instrument be available during the start up and running through or moving through this region, as opposed to maneuvering around it?

MR. BROWNING: What we are allowed is that if the Solomon system is not available, there is an additional buffer region applied to the exclusion zone that we have to apply by the tech specs.

So when the back up system is not available, we administratively increase the size of the exclusion zone, where we are allowed to steady state operate. We are allowed to pass through it, but we just are not allowed to stay there for any period of time. But we are allowed to operate through it.

DR. LEITCH: Must Solomon be operable prior to taking the load switch to run?

MR. BROWNING: No, it is not.

CHAIRMAN WALLIS: When they operate through it what happens? You do get oscillations, but they never get very big; is that what it is?

MR. CARUSO: You won't necessarily get oscillations. It is possible and you might. These are regions where it is --

CHAIRMAN WALLIS: So Solomon tells you if you have?

MR. CARUSO: I believe it measures decay ration, correct?

MR. ULSES: Well, actually, it is not making a measurement at all. It is using an algorithm, and so it is making an actual analysis calculation, a prediction of what it thinks the core decay ration will be.

CHAIRMAN WALLIS: It is testing something about the stability of the magnification?

MR. ULSES: Yes, sir, and I guess I would say that I wouldn't expect to see a power loss or oscillation during a power ascension. That is not the normal mode of operation for a BWR.

DR. UHRIG: As long as you keep moving through it, then there is very little likelihood of any significant difficulty?

MR. ULSES: Yes, sir.

DR. UHRIG: And if you stopped while you were in this region and operated for a period of time, then there might be the possibility; is that the implication here?

MR. ULSES: Well, it is an implication,

but I would say that due to the number of variables that you have to put into this analysis that there are a lot of things that you would have to do wrong in order to have a power oscillation under these conditions.

DR. KRESS: I don't think it is related how long you are in there, and the time constant for setting up this instability is very, very short.

MR. ULSES: Yes, sir.

DR. KRESS: But there has to be a lot of other things.

DR. UHRIG: At what power level do you hit this regime; is it 20 percent, or 30 percent, 50 percent?

MR. ULSES: I don't know. Do you know the actual numbers, Tony? I don't recall what they are.

MR. BROWNING: I generally recall it in terms of load line than actual power level. The lower end of the region is about the 75 percent load line, which is about 50 percent power roughly.

MR. ULSES: Right. It starts off with the natural circulation line, and then it works right into the power and up to about that power.

DR. UHRIG: And Duane Arnold operates at full power all the time, and does not do much maneuvering during normal operations?

MR. BROWNING: We only downpower occasionally to do required testing. Our capacity factors have been pretty high the last few cycles, above 90 percent, and so we stay at full steady stay power most of the time.

DR. UHRIG: Thank you.

MR. CARUSO: Any other questions about stability? If not, the next item is the GEXL14 correlation. This is a correlation used to determine boiling transition and DWR fuel bundles, and specifically G.E. 14 and G.E. 12 fuel.

And the staff reviewed the development of this correlation, and during the course of the review, we identified that G.E. had used some data generated by a code called COBRAG, which is the G.E. version of COBRAG, or COBRA, to add to the GEXL14 database to use in the correlation.

We are not entirely convinced of the appropriateness of this data, and we are conducting discussions with GE right now about whether it is appropriate and whether it is acceptable, and what has to be done as a result.

CHAIRMAN WALLIS: Code generated data?

MR. CARUSO: That's why we have a concern.

CHAIRMAN WALLIS: Well, maybe this is the new world, and codes generate data.

MR. CARUSO: That's why we have a concern.

CHAIRMAN WALLIS: When you say in boring transition, you mean transition to --

MR. CARUSO: Dryout.

CHAIRMAN WALLIS: DNB; is this what we call DNB?

MR. CARUSO: No, it is DNB. It is dryout.

CHAIRMAN WALLIS: So it is reduced heat transfer?

MR. CARUSO: Yes. We also did a review of core design methods, and the reviewer there determined that the methods that are being used for cord design are appropriate, and we also looked at the Safety limit MCPR which we determined were being used appropriately.

DR. BOEHNERT: Ralph, before you leave that, on the GEXL14, what is the outcome of this if you guys don't like what they are doing by the code generating data? What happens then?

MR. CARUSO: It would be possible that -- I mean, I don't want to get into the details of the discussion between us and G.E., okay? Some of the potential outcomes are that we could possibly approve the use of COBRAG to generate data for GEXL.

I think that would require us to do a review of the code and the way that it is applied. Another possibility is that G.E. could remove the data from the database, and that would cause them to take some sort of a penalty in using the correlation, and it would increase uncertainty by a certain amount, and that would be applied.

DR. KRESS: What data are we talking about that this COBRA is generating?

MR. CARUSO: It is trying to predict dryout in a fuel bundle.

MR. KLAPPROTH: Ralph, can I make a statement? This is Jim Klapproth. So that there is no confusion, there is a lot of test data on GEXL14. Basically, it is an issue of the power shape. We do a lot of thermal-hydraulic testing to develop hydraulic very brisk bundles, using some power shapers.

What COBRA does is then extend that database for a different power shape. So it is not just that we have the code data. We have a bunch of -- thousands of data points from hydraulic testing, and we are just extending that data to predict the response, the GEXL correlation to other power shapes.

DR. KRESS: I am not sure I understand how the power shape affects this at all. With BWRs, you have the channels, and so it is not radiation heat transfer, and --

MR. KLAPPROTH: Well, as we move through the cycle, our power shape changes, and it will move from a low of --

DR. KRESS: I understand that, but I don't understand what that does to the correlation at all.

MR. CARUSO: The correlation takes into account the nominal code signing shape and whether it down skews or up skews, where the power has peaked higher at the outlet or peaked higher at the bottom of the channel.

DR. KRESS: But doesn't that just determine the location of where you can do these things? It doesn't affect the correlation at all.

MR. CARUSO: I have my experts here to give you some more --

MR. ECKERT: I am Tony Eckert from the Reactor System Branch. Usually when they develop a correlation, they take data in what they consider the operational range of the fuel, and so they look at co-signed data basically and all down-skewed data, or they look at the power shape at the bottom end of the core and at the top end of the core.

And then they correlate to all that data, and typically what every vendor does, okay? It is typically what every vendor does. And in this case in particular, it is important in the top part of the core because this fuel has poplin rods (phonetic) that stop about 8 feet up the core.

So you would really like to know what is going on up there with regard to all kinds of face changes going on and so forth. So what we found is that there was no data taken specifically in that part of the core.

And so what in essence they did is that they used COBRAG to predict the behavior of the fuel in what we consider to be a very critical region of the fuel, which we had not seen there before.

DR. SCHROCK: Isn't the correlation necessarily employment a subchannel analysis methodology, which becomes an integral part of the correlation? Isn't that the way that this works?

MR. ULSES: Well, it has the concepts of a subchannel code because it does attempt to deal with the radio power distribution. But what we have seen in the past is that these correlations have always been based strictly on experimental data that was taken from their facility.

But this is the first time that the staff has specifically encountered the use of a code to try and augment the data.

DR. SCHROCK: The experiment is incapable to giving localized thermal-hydraulic conditions within the rod bundle, and in order to accomplish the correlation, I think there is a need to operate a subchannel analysis code, together with -- and put that together with the experimental data to get what is the GEXL correlation.

DR. KRESS: That is exactly what was confusing me.

DR. SCHROCK: So it is a little unclear to me what the new thing is that COBRA is doing. What is the subchannel analysis code that normally is a part of the G.E. correlation scheme, and how this COBRA application different from that?

MR. ULSES: Well, actually, Dr. Schrock, I would say that what they do is that they test an actual prototypical bundle and use electrical heaters.

And when they do that, they can actually vary the actual local subchannel conditions in the experimental facility itself. So they are relying on the experimental data.

DR. SCHROCK: But there is no way in the world that they would have sufficient instrumentation to know thermal-hydraulic conditions locally within the rod bundle and throughout the bundle?

MR. ULSES: Well, that is not what they are after. All they are after is they are after -- when they see the boiling transition on the thermal couples, with that, they can tell at what axial and radial location that happens, and that is what they are trying to find out out of this correlation.

And they are using information from the in-let of the channels; is that right?

MR. CARUSO: That's right.

DR. SCHROCK: And correlated against what?

MR. ULSES: It is correlated against the in-let conditions of the fuel channel, which is a known quality.

DR. SCHROCK: I think you need to clarify what the scheme is, and then discuss it in terms of this COBRA TRAC generated data.

CHAIRMAN WALLIS: Is there some way we can get the evidence to Dr. Schrock so that he can look it over and so that he can understand what is really being done?

MR. ULSES: Well, we don't have it here

ourselves.

DR. SCHROCK: I thought what I did hear and what I am hearing and that I understand it to be is that it is not consistent with what I hear.

MR. CARUSO: I don't know how much time you want to spend on explaining GEXL14 and now it is applied.

CHAIRMAN WALLIS: Well, if it is important, and I don't know what yet is important, and what are the important issues in uprates, but if it turns out that this is an important issue, then it should be resolved.

MR. CARUSO: We don't think this is an important issue for power uprates, per se. It is an issue for G.E. 14 and G.E. 12 that is used wherever it is used.

But we don't think that this is a power uprate specific issue. This is one of those issues that I mentioned which has generic applicability.

CHAIRMAN WALLIS: Unless in some way the power uprate was pushing the limits of applicability of some method.

MR. CARUSO: That we don't think is the case here. I'm sorry, Tony.

MR. ULSES: Well, what we are seeing with these new G.E. fuel bundles is that they have more thermal margin, and they are basically using that for these power uprates.

So in a sense, it is hard to say in actual real specific terms whether the power uprate itself is actually driving this, or whether, say, an operator who is not using a power uprate might seek to use some of this margin to minimize the number of bundles they have to buy, for example.

So I guess I would agree with you that it is not a power base specific issue, but it has implications in that direction.

MR. CARUSO: Let us talk about what we can provide to you, and can I get back to you a little bit later in the day on this?

CHAIRMAN WALLIS: Sure.

DR. SCHROCK: Is this the new fuel?

MR. CARUSO: Yes.

DR. SCHROCK: This is 14?

MR. CARUSO: Yes.

CHAIRMAN WALLIS: There is nothing in your list about neutron flux here? Are you getting enough power to operate? This is achieved presumably by greater neutron fluxes at various places, and this changes the fluents and things like value dense? You have not said anything about those issues.

MR. CARUSO: No, vessel fluids. Is that what you were --

CHAIRMAN WALLIS: Whatever, but there is greater neutron flux associated with presumably greater power.

MR. CARUSO: That's correct.

CHAIRMAN WALLIS: And in some places, depending on how they flatten the power into the flux and so on. Are there any effects that need to be mentioned?

MR. CARUSO: I believe that that was considered to some extent in the reactor core design issue. Ed, did you look at flux shapes and flux calculations?

MR. KINDER: This is Ed Kinder, Corrective Systems Branch. In our review of both the equilibrium cycle, which is full G.4. 14 core, and the transition cycles, which go from the current fuel design, we looked at flux shapes and power shapes.

And as was mentioned, the G.E. 14 bundle is designed with more thermal margin. It is also designed so that the bundle of power itself, and the radial core power is flatter. And each cycle has a design enrichments, vendable poisons, and core loading, to essentially flatten the power.

One of the neutron flux is higher, and the vessel fluence is an issue which is also looked at in this area.

DR. FORD: Could I ask a further question? There is a whole range of materials degradation issues which could potentially impact on this; fluence use corrosion, vibration, and there was mention of the flux at the core shroud, and pressure vessel. Are these going to be audited at all? Are we going to hear about that today?

MR. ELLIOTT: Excuse me. This is Barry Elliott, of the Materials and Chemical Engineering Branch of the NRR. The issue of neutron irradiation and embrittlement affects the stainless internals and the alloy steel pressure vessel.

For the pressure vessel, alloy steel pressure vessels, the neutron fluence affects the pressure temperature limits and the upper shelf evaluation.

But those evaluations are evaluated by our staff and calculations are done in order to assure that the pressure temperature limits in the upper shelf energy for the reactor vessel meets Appendix G, 10 CFR 50 requirements.

As far as the internals are concerned, the BWR VIP program is carried forward, and whatever the program has for the fluence and for the vessel would be the program that we would use for the power uprate.

MR. CARUSO: We have existing programs in place that account for whatever fluence is generated by the vessel, by the core, on various structural components, whether it is internal or the vessel, and those are accounted for.

At the higher power levels the flux or the fluents accumulates faster, and that is taken into account.

DR. FORD: And would the current VIP methodologies attack, for instance, a radiation that is cracking at H-4 weld? Would it attack that, and fluences be expected to have the power uprate and license renewal?

MR. ELLIOT: The BRR VIP programs are what they are. I mean, they were approved for -- and as you run the plant, they are approved for the life of the plant.

We have approved power uprates and we have approved license extension 20 years so that it is built into the program.

DR. FORD: So we are taking into account

the synergistic effect of increased fluents with license renewal?

MR. ELLIOTT: Yes.

DR. FORD: Plus, increased flux?

MR. ELLIOTT: The documents are evaluating the impact of fluents, and have an inspection and repair programs accordingly.

DR. FORD: And how about fluence with accelerated corrosion and vibration use corrosion, which have been problems? For instance, Susquehanna and Calloway power outrates?

MR. ELLIOTT: I have to say that I don't know all the details that you are describing, but with irradiation, and since there is this stress corrosion and cracking issue, it is built into the BWR VIP program.

DR. FORD: And that is taken into account in the VIP documents?

MR. ELLIOTT: Radiation assisted stress corrosion cracking is.

DR. FORD: Yes, but I am talking about fluence assisted corrosion?

MR. ELLIOTT: I would have to look that up. I don't have that information. With flow assisted corrosion, I would have to find out how we evaluated it as part of the BWR VIP program. I would have to look at that, at flow assisted corrosion.

DR. FORD: Okay. And the zircloid-F swelling be a problem?

MR. ELLIOTT: That is considered. It is part of the BWR VIP program.

MR. CARUSO: You were asking about zirculoid corrosion of fuel cladding?

DR. FORD: Yes, cladding.

MR. CARUSO: Fuel cladding is considered as part of the fuel design, and the fuel design -- well, actually, that is a matter of fuel burnup. And fuel burnup limits are not changing as a result of the power uprates.

So the fuel that is rated to a certain burnup level will not be allowed to go any higher than that as a result of the power uprates. So we are working within the existing database, and it doesn't matter if they raise the power.

They might burnout fuel elements faster, but they still can't burn them beyond where they are currently allowed to burn them and where the experienced database ends.

DR. FORD: I am showing my ignorance on this particular part, but when they come up with a design criteria, that was made at the time of licensing, and maybe we didn't understand some of the phenomena that have since come to the fore.

MR. CARUSO: Are you talking about in terms of fuel?

DR. FORD: Fuel, or ISEC, for instance. It was not a known phenomena when these things were -- when the design basis was --

MR. CARUSO: I can't address the issue of the ISEC, but I can talk about fuel, and I do know that we are not using fuel acceptance criteria now that were used in 1972 when the plant was licensed. We are using current knowledge-based acceptance criteria, and current standards for fuel.

DR. FORD: Is there going to be a presentation on these specific TLAs later on today or not?

MR. CARUSO: No, not on fuel. No.

DR. FORD: Well, on any materials or construction?

MR. HOPKINS: Well, that's why we had Barry Elliott here to respond to questions. We didn't have a specific presentation planned for that area.

DR. FORD: It is a fairly important area though isn't it, given the fact that for the last 20 years we have had a pretty abysmal record in terms of materials integrity. We have now started to change two things, license renewal and power uprate, which can be synergistic.

We are going to be attacking those two things in that format, in that synergistic format, aren't we?

MR. ELLIOTT: I would say that this is a power uprate portion, and the fluence for the power uprate is going to be much less than the fluence for BWRs who have license extension. I mean, that's just the way it is going to be.

DR. FORD: I guess my question --

MR. ELLIOTT: Ultimately, we are going to have both added on, and when get to our license extension, we will address both of those things when it occurs, but right now we are just power uprate.

And I think the BWR VIP program would encompass all these issues that have come up within the last couple of years, and would not be impacted significantly by the power uprate.

DR. FORD: I guess my frustration is that I keep hearing these terms, but I don't see any data and that is my frustration.

MR. CARUSO: Would you like a presentation on fuels?

DR. FORD: No, not particularly fuels, but any materials of construction. I would love to hear an analysis of the expected degradation, time dependent degradation of the materials of construction; core-shroud, pressure vessel, weldments, as a function of increased power uprates.

CHAIRMAN WALLIS: Well, I guess it applies to all of these issues, and we keep being told that the methods are being used approximately, and it would be good if there could be a technical presentation or something, and where here is a graph of X versus Y.

And this is what you have without power uprates, and this is where you might be pushing some limit, and this is where you go with the power uprates, and sort of a quantitative comparison in some technical terms.

MR. CARUSO: Actually, I believe you are going to get some of that later on today from GE.

CHAIRMAN WALLIS: Okay. We will look forward to that.

MR. CARUSO: Let me see. My last slide is conclusions, and unfortunately, Dr. Wallis, I am going to give you a conclusion without any details. That the approved methods continue to be used appropriately at the uprated power levels.

That the GEXL14 correlation database evaluation issue we are continuing to discuss with GE and the licensee, and we hope to resolve that soon. We would like to resolve that as soon as possible.

We intend to continue to do these audits for Dresden and Quad Cities later on, I believe, this month, and for Clinton later on in the year once the Clinton application has been received.

CHAIRMAN WALLIS: I don't think it has come in yet has it?

MR. CARUSO: And we find these to be particularly useful. And we will probably vary the areas that we do audits on. This time we did SAFER/GESTR, and we did stability.

Dresden and Quad Cities will probably do a different stability option, because I believe that they may be using a different stability option. We will look at maybe ATWS, and we will look at other scenarios. We will look at other issues.

CHAIRMAN WALLIS: I think we are going to ask questions about ATWS this afternoon, and is that when we will get the answers?

MR. CARUSO: I see G.E. nodding yes.

DR. UHRIG: This work that you have done

so far has been exclusively Duane Arnold?

MR. CARUSO: It has been focused on Duane Arnold, but realizing that some of the things that we look at have generic applicability, like the GEXL14 correlation is not just for Duane Arnold.

It applies to anyone who has G.E. 12 or GE 14 fuel.

CHAIRMAN WALLIS: And the follow on plants, Duane Arnold, as I understand, is one of the smallest plants of BWRs, and if not the smallest, and then the next sort of size up is the Quad Cities, and then it goes on to Clinton as the biggest.

And size then, is there anything else besides stability, core stability, that is related to size? Are there any new issues that you expect to come up in the later plan reviews that is not inherit other than the difference in the stability issue?

MR. CARUSO: Off the top of my head, I can't think of anything, but possibly ATWS performance, or ATWS response, might be an issue. Containments. Containment is probably one area where we should look because that is very plan specific.

The relationship between the size of the containment and the decay heat loads is very much plan specific.

DR. UHRIG: It is pretty much related to

whether it is a Mark III or Mark II?

MR. CARUSO: I think it probably depends on whether it is a Mark I, Mark II, or Mark III, but it also depends on the actual size, because I don't think that all Mark IIs are the same size, or the same sized relative to the power well.

CHAIRMAN WALLIS: If all these methods continue to be used appropriately, how much uprate is tolerable, and what limits -- when do we first hit a limit if we set an uprate to 30 percent or 40 percent, 50 percent? When do we say you can't go any further?

MR. CARUSO: I have a sense of deja vu when I hear that question.

CHAIRMAN WALLIS: Well, you see, the methods can still be used appropriately.

MR. CARUSO: Well, I think you will get a chance to ask G.E. that question this afternoon, and I think you should ask them that, because we have asked them that question and they tell us, well, the first thing or limit that you run into is the turbine because you can't use the power.

CHAIRMAN WALLIS: So you put in a bigger turbine. That is not really an issue.

MR. HOPKINS: Let me mention for Clinton briefly. I mean, they have not made their application yet, but they are going for 20 percent, and they will be basically changing out the high pressure and low pressure turbines, and getting a new main power transformer, and new reserve alt transformers, and doing feed water heater work, and doing main generator work for more efficient cooling.

And doing main condenser work, and all this is a constant pressure uprate, but all of this is try to get 20 percent, and it is a substantial amount of modifications.

CHAIRMAN WALLIS: It is not really an issue with the right to safety.

MR. HOPKINS: I know, but it has an effect on dollars and now much you spend for how much you get.

DR. KRESS: I think the question is more philosophical along these lines. As you do things like the power uprates, and license extensions, et cetera, you do change the margins.

And the Chapter 15 margins on certain figures of merit and even risk acceptance margins on things like CDF and LERF, they are changed. Now, the question that I would have is that I think there is a question to ask, and that is, is there a significant decrease in the margins is a question that one would ask.

Well, what is meant by the word significant in there? Is the view that as long as you meet these figures of merit at all, then the change or decrease in margin is acceptable, and thus not significant. Is that the staff's philosophical view on this, or is there more to it than that?

MR. CARUSO: I guess I am jumping to the middle of Donnie Harrison's presentation, but the simple answer to that is yes. We have limits that come from regulations, and we have a 2,200 degree limit, and we have limits that come out of approved topical reports, where we approve methodologies.

DR. KRESS: And as long as you meet those limits --

MR. CARUSO: As long as you meet those limits, that is the important thing.

CHAIRMAN WALLIS: So that is the answer, it is not really a philosophical question. You can keep operating until you hit one of those limits.

MR. CARUSO: Until you hit one of those limits, yes, and the question is which limit are you going to hit first. I mean, there may be other limits that are not necessarily regulatory limits.

I imagine that there are probably internal design constraints on fuels that people might run into before they run into any regulatory limits.

CHAIRMAN WALLIS: But 20 percent seems to be according to the story here so easy, you wonder why it is not 30 percent.

MR. CARUSO: I think that is what I was trying to answer. I think there are practical considerations for how much you can get.

CHAIRMAN WALLIS: So apparently there is no limit on the reactor side.

MR. CARUSO: Not yet. My speculation would be that they will probably run into containment limits first, because that is not something that is changeable, and I have seen the curves for containment performance, and they are very close to the limits.

CHAIRMAN WALLIS: And what has changed them? Why is it that years ago these were designed, or they were approved at a lower power level? Has there been some great new insight into fuel design or materials behavior, or thermal-hydraulics which makes it now possible to uprate by 20 percent?

MR. CARUSO: I am not sure which Tony mentioned it, as there are three Tonys in the room who have spoken. One of the Tonys mentioned the fact that we have gone through -- that G.E. has gone to this better fuel.

CHAIRMAN WALLIS: Is it better fuel?

MR. CARUSO: It is better fuel. It is designed in a way which allows them to get more steam out of this bundle.

CHAIRMAN WALLIS: Better fuel in terms of thermal-hydraulics?

MR. CARUSO: Yes, part-length rods, cleverness in using thermal-hydraulics.

DR. FORD: My guess is that you are going to come across a materials degradation problem, which is going to be limiting, and it scares the pants off me when I think --

DR. KRESS: Well, the trouble is that there is a very limited or lack of knowledge on how power affects what you are talking about, except with the acceptance of the fluence problem. But the other degradation problems you can't relate to power very well.

MR. CARUSO: I know about the fluence issue because the fellow that does the fluence calculations used to work for me, and he educated me on this. And it is -- we do account for that.

DR. KRESS: Yes, it is fairly straightforward.

MR. CARUSO: They have this bucket, and they keep throwing fluence into it every year, and they have to measure the height of the level in the bucket.

DR. KRESS: That's exactly right. It is pretty straightforward.

MR. CARUSO: And if you raise the power the bucket gets full faster, and there is a limit on how much you can throw in the bucket. And if they run out of space, that's it. You have to go out and kneel the vessel or they will have to do something else. I don't know what.

DR. KRESS: And then when you get to other materials degradation issues, like intragranial or stress corrosion cracking, that is hard to relate that to power.

MR. CARUSO: That I don't know. That is out of my area of expertise.

CHAIRMAN WALLIS: The thermal-hydraulics, the outside of the fuel is at about the boiling temperature and the heat transference is so good. And if you go to a higher power, does that mean that you get a higher set of center line fuel temperature, or is it something done to make that better?

MR. CARUSO: That is a good one. I don't

know the answer.

CHAIRMAN WALLIS: It is a big temperature drop from on-line fuel to the wall, a huge drop. What is happening inside this fuel at these higher powers?

MR. CARUSO: I don't know what center line fuel tempers do.

CHAIRMAN WALLIS: Is that another criterion of some sort, that it cam go to any value it likes?

MR. CARUSO: As far as I know, that is not a regulatory criteria, but I would imagine it is probably a design criteria that the fuel vendor uses.

DR. UHRIG: But it pushes you towards the 2,200 limit --

MR. CARUSO: Probably, yes, higher lineal heat generation, right, is going to reduce the margins if you assume that everything else stays the same, and it is going to reduce margins, yes.

CHAIRMAN WALLIS: And it makes products more mobile inside the fuels so they can move around and accumulate in places? And maybe move to the outside and maybe holds the cladding?

DR. KRESS: That is one of our questions, is does the gap inventory increase, for example, and the thinking was that thermal diffusion might -- in the first place, you are going to have more inventory because of the higher uprate of some of the gap --

MR. CARUSO: Actually, inventory depends on burnup.

DR. KRESS: Yes.

MR. CARUSO: And the burnup limits hasn't changed.

DR. KRESS: Yes, but normally you reach the equilibrium with some of the shorter lives, and things that you worry about, like the iodines, and the --

MR. CARUSO: Maybe the distribution will be slightly different.

DR. KRESS: But I don't know of any data that relates to center line temperature, operating temperature, to the gap. For example, where you have might have thermal diffusion pushing things in that direction.

So that was the nature of one of the questions that we asked, is there some evidence or is there a need for additional research on what is actually in the gap that relates to these higher temperatures of the fuel. And then the higher burnup.

CHAIRMAN WALLIS: Well, this has been done before and we know all the answers.

DR. KRESS: Right, or is there some data that tells us not to worry about it? And is it important to know what is in that gap from a risk standpoint?

MR. CARUSO: I don't have an answer for you on that.

MR. HARRISON: But we will have a slide for that half-way through mine.

DR. KRESS: Okay.

CHAIRMAN WALLIS: You are taking too long, Ralph, and we need to move on.

MR. CARUSO: I can talk all day.

CHAIRMAN WALLIS: But talking isn't the issue. It is transferring information. We could all talk. Try to get a sufficient transfer of information. Would it be best to move on, you think?

MR. CARUSO: I think so.

CHAIRMAN WALLIS: I'm sure that we will come back to many of these questions when we talk to G.E.

MR. CARUSO: I think so. I would like to hear G.E.'s answers to some of these questions.

CHAIRMAN WALLIS: We thought you had asked all these questions before and didn't get answers.

MR. CARUSO: A lot of them, yes, but some of them -- the fuel center line temperature is one that I have not heard before.

CHAIRMAN WALLIS: So maybe we should move on.

DR. LEITCH: Just before we leave, I would like to go back to the Solomon and the instability issue for just a moment. If the operator lacks confidence in this system, it is usually with some justification if the operator lacks confidence.

Are we saying that this is a training issue or is Solomon's ability to predict instability in question?

MR. CARUSO: I am not sure I would say it is necessarily an ability of the system. I used to be an operator, and I am a former Navy operator, and I think about the instruments that we used all the time; and you watched them go up and you watched them go down.

You believed them because they moved a lot and you had ways to check them. The ones that you never really believed were the ones that sat there in the corner and never used until the one time that they went off, and you said wait a minute, that never goes off.

And you hit it hard. You hit it with

something, and make sure that there is nothing wrong with it.

DR. KRESS: And which ACRS member is that?

MR. CARUSO: The classic example is the water level instrument in a PWR. You know, for 30 years it reads peg high, and then one day is comes down off the peg, and the operator says, wait a minute, no, no, no, that can't be. It is never like that. And they don't believe that they have lost the water level in the core.

CHAIRMAN WALLIS: That's the problem. They don't believe.

MR. CARUSO: But I don't know how you can solve that problem except to educate the operators to think about what it means, and say, well, maybe there is some other way that I can check this.

And as the Duane Arnold people say, this system is not the only way that they use to determine instability. They are supposed to use this system to tell them when they are likely to have an instability, and then they are supposed to go look at the actual power range instruments to determine whether they do have an instability.

DR. LEITCH: I seem to recall that Duane Arnold has a plant specific simulator. Is Solomon stimulated?

MR. CARUSO: I see Tony noddiNg his head yes. I don't know how to address your -- I think it is a valid question. It is something that we really have brought up as part of this, and we think it will be up to the licensee to try to get the operators to use the equipment that they have got. And the operators do strange things. I know because I used to be one.

DR. LEITCH: I know that it is difficult getting folks to rely on instrumentation that is normally out of range, let's say.

MR. CARUSO: Right. But if that instrumentation is reliable and believable when it comes down into range, then the operators ought to believe in their instrumentation.

DR. LEITCH: They should. And I guess my question is whether it is believable or is it something that if it doesn't work, then we are confusing data in front of the operators.

MR. CARUSO: We think it is believable. We think it is good instrumentation. We think it should be there.

DR. LEITCH: Okay. So training the operators to rely on that when it is in range?

MR. CARUSO: Yes, to use it.

DR. LEITCH: Thanks.

CHAIRMAN WALLIS: Would it be best to take a break now or move on?

MR. HOPKINS: This would be a good time.

MR. HARRISON: We will be moving on to PRA issues next.

CHAIRMAN WALLIS: How long is that going to take?

MR. HOPKINS: Oh, 2 or 3 minutes. We could just mow through it.

CHAIRMAN WALLIS: Let's take a break until 10:00.

(Whereupon, the meeting was recessed at 9:51 a.m., and resumed at 10:00 a.m.)

CHAIRMAN WALLIS: The meeting will come to order. We are looking forward to hearing about risk in the next topic.

MR. RUBIN: Good morning. I am Mark Rubin from the PRA branch. I have someone new to introduce you to this morning, Donald Harrison, who joined our branch, the PSA branch of NRR a number of months ago.

And sine the previous reviewer, Sam Lee, has been made an offer that he can't refuse, he has moved on to another assignment, and Doug Harrison will be one of the people working on the risk PRA reviews for the power uprate plants.

MR. HARRISON: I just want to let you know what the scope of my discussion will be, will be to walk through first just some slides on Duane Arnold, and let you know the information we received from them, the topic areas.

And then we will proceed right into the topics and the six questions that were provided by the ACRS. We are still reviewing Duane Arnold. I just want to make it clear that this presentation part is essentially the Duane Arnold information that we have received, either directly in their submittal, or in response to questions the staff has asked.

I do want to put us into a perspective that Duane Arnold in their submitted as made it very clear that this was not submitted as a risk-informed licensing action. However, the staff is reviewing it using the criteria of Delta-CDF and Delta-LERF that is Reg Guide 1.174.

If we look at the question on PRA quality, it is really a question of do you reflect the design and operation of the plant, and Duane Arnold has submitted that it does reflect their plant configuration.

They have been through a BWR owners group peer review, and the staff is considering if we need to take a look at the peer review to get a good feel for the areas that we typically look at.

DR. KRESS: Is that peer review different from the certification process?

MR. RUBIN: No, it is the identical BWR certification peer review, yes.

MR. HARRISON: There are four areas that we typically look at; initiating event frequencies, and success criteria, component reliability, and operator actions. So we will walk through those four, and the responses that Duane Arnold has provided.

On initiating event frequencies, Duane Arnold doesn't expect any changes to that frequency for those things that would cause reactor SCRAMS or set point pump failures, and that type of thing.

They have stated that they feel that they have adequate margin so that they don't expect there to be any kind of an increase in that area. They are making modifications and design changes to the -- I think it is the main transformer, and some electrical breakers.

And that is to capture margin or extend the margin that they already have, and because of that, the potential for, say, a plant loss of all site power is believed to be not effected either.

DR. LEITCH: Are they taxing the margin in BOP equipment such as condensate pumps, reactor feed pumps, such that -- well, let me come at my question another way.

Often times a plant has enough margin in those that when you are operating at a hundred percent power that you can lose a major auxiliary like that, a condensate pump, for example, and get down under the capacity of the remaining condensate pumps, and ride it out without a SCRAM.

Whereas, it seems to me that if you are operating further up on the capability of those major auxiliaries that if you lost one of those that you might be more inclined to take a SCRAM.

And I guess I am wondering is that the case as you see it at Duane Arnold?

MR. HARRISON: At Duane Arnold? I don't -- from my part of the review, I have not seen that. I know at other plants that require, say, adding another operating condensate pump to get the flow they need -- and then you may have a run back design change that you have had to install, that would be an area where you would then have to look at what is the effect of a spurious trip, and that would be a new condition. And I don't believe that Duane Arnold has that condition.

DR. LEITCH: But by saying there are no changes in the initiating event frequency, you don't see any change in that? For example, in the SCRAM frequency, in the situation that I described.

MR. HARRISON: Right. The projection is that the SCRAM frequencies would stay essentially where they are at.

DR. CRONENBERG: What about small break LOCA, like Susquehanna and the recirculation line after they had the power uprate there? The initial interpretation of that even was that it was a flow induced vibration effect, and hence, in the recirculation line, and that caused that rupture in the recirculation line.

Also, to come back to Peter's question, all of this due to corrosion, and this is a direct cycle plant, and the main steam line is higher post, and did you find it that there was a no change anticipated, and do you find that a little suspect? How did they calculate the small break LOCA frequencies?

MR. HARRISON: I don't believe -- and may

I can ask Duane Arnold to correct me if I am wrong here, but I don't believe that they necessarily went out and recalculated new LOCA numbers, considering an increased flow for like -- well, the argument on the primary system LOCAs is that you have got condition monitoring programs, and you have got a fact program.

And those programs are being relied on to maintain the system. Now, you may expand that program monitor for that, but I don't believe that would affect the LOCA numbers.

MR. ECKERT: This is Gene Eckert from G.E. Can I just make one comment and we will talk again this afternoon, but in the Susquehanna case, they made two changes, and a little contrary to what our standard programs have been, that they came in with a power uprate.

And with an increase in their maximum core flow allowed for the plant; and then the things that they got into appeared to be associated with that increase in core flow above where they had run before.

All the plants like Duane Arnold and the ones that you saw on the list up here today are coming into the uprate program without increasing their maximum core flow, and they are keeping the same limits on what their external drive loop flows will be in the recirc loops.

DR. KRESS: Speaking of incidents, has there been any look at past upgrade uprates? Of course, none have been as significant as this, but to see if -- well, for example, the AEOD people, would they have looked to see if there was any change in these initiating event frequencies due to the uprate?

I suspect that he experience has been the other way, and it has gone down, but for other reasons.

MR. RUBIN: We have not looked directly. I did talk to the AEOD section chief, Steve Mayes, and his view was that there wasn't going to be enough time history to establish anything. So we have not proceeded on that.

MR. HARRISON: We will touch on that towards the end of the presentation as part of one of the questions.

DR. FORD: Could I just make a comment, and it is more for education on my part. When you are talking about initiating event frequencies, as I mentioned before, there is a lot of potential material degradation issues.

And I say potential, because we haven't had them occurring so far. But history unfortunately has told us that it can occur in the future. Does that proactive future possibility, which can be analyzed, does that come into your methodology?

Do you understand what I am saying? Such as the large cracking of large pipes was not anticipated before they occurred, and then they occurred, equally you can expect in the future that there is to be some occurrences of, let's say, vibration induced or flow induced vibration effects, and an effect on the CUF.

If you expect there to be increases in flux, and therefore on fluence, and that might have an effect, a predictable effect, how does that proactive thinking come into your decision making?

MR. RUBIN: Well, clearly, there is not a one to one mapping into the risk models. They don't have a scope like that. As Donald said, we are relying on the condition monitoring programs, the in-service inspection programs, the augmented inspection programs.

What I would reflect on though is that -- well, two items. The mechanistically determined break frequencies on these plants through probablistic fracture mechanics are generally far below the assumed LOCA frequencies in the models.

If we started to see a large swing that would encroach on those differences, I think it would be probably picked up. But it certainly is an area beyond the current modeling, and in a sense beyond the state of the art.

But I have not -- well, I will ask Donald to reflect on where the small LOCA contributions came in the risk profile of Duane Arnold. I think it is probably pretty low.

MR. HARRISON: Yes, there was -- there wasn't a driver in any of the change in risk that they reported as part of the power uprate.

MR. RUBIN: How about the residual, the baseline?

MR. HARRISON: I don't recall. I would have to look that up.

MR. RUBIN: Would expect it to be quite small. There are other things driving the risk at the plant. So it certainly is something that could conceivably occur, and hopefully through the programs in place to watch for performance in those areas, it would be caught and an appropriate response would be made.

But of course I am hypothesizing there, but I think the primary issue is that right now with the current plant profile that the LOCA frequencies as they are in the model aren't controlling risks, or aren't driving risks, or other things that are much closer.

DR. FORD: Just to take Gus' comment a bit further. For instance, fatigue usage factors. There will be presumably some flow induced vibrations, and that will affect the fatigue u sage factor, which will be even more exacerbated if you go to license renewal. Now, has that thought process come into these analyses?

MR. RUBIN: I think it certainly comes into the analysis from our colleagues in the division of engineering in assessing the uprate.

DR. FORD: Okay.

MR. RUBIN: And if they would care to comment on that. Do we have anyone still here?

MR. WU: Yes. My name is John Wu from the chemical engineering branch. I would like to comment on this. The flow induced vibrations has been --I think the gentleman from G.E. mentioned that for this, 20 percent power uprates, and the maximum rate does not change at all.

So for flow induced vibrations, we have been closely looking at this phenomena. The maximum flow rate does not change and so we don't have that from the flow induced vibration concern.

And the only concern is probably that the flow goes through the main steam in the free water line, because of a 24 percent flow increase, and in this case, there are some vibration concerns because flow induced vibrations which is proportionate to the density of the root, also is proportionate to the square of the velocity.

But for this program, they have some kind of monitoring program, and so they will monitor this program very closely, such as inside the containment there are remotes, and some kind of monitoring device, vibration sensor.

And outside, they have people walking around and probably use hand-held monitors to monitor the vibration level. And their criterion is that any vibration that occurs besides the audit, then they are to make sure that the vibration level, the insurance level, is below the endurance limit.

And the endurance limit is the limit that the material can vibrate and that there is no concern about the vibration. And also I think Peter's comments about the collation between the power break and license renewal problems.

The license renewal, we have now the 10 limit aging analysis, and it has been very closely reviewed by the chemical engineering branch. So nobody is very small, especially for a big usage factor and it is below .5 and so it is very small for the intent of the component. And for others, those are small, and normally we don't have a problem, you know.

DR. LEITCH: I have another question in that area. Even with core flow staying constant, the separator and dryer will see different flows or at least different quality steam as it comes up there. Have you taken a look at the impact on the dryer and separator?

MR. WU: Those separators are -- I think this is probably alleged, but the point of view is that it is very, very small with the separator. So we don't have a big usage problem.

Even the steam flow is higher than the power uprates. But because there are separators out there, the insurance level is very, very small.

DR. LEITCH: And how about the dryer? Is it the same thing?

MR. WU: The dryer is the same thing. The dryer and the shroud top, they are together and the same thing, right, and is very small. They combine with others, and it is very small. So it is not a concern.

DR. LEITCH: Again, it is a question of quantification of very small.

MR. WU: I do not recall the numbers of the quality usage factor, but they did calculate the usage factor based on the power uprates and especially for the dryer, and for this higher presentation of the power uprates.

CHAIRMAN WALLIS: We can get numbers from G.E., I expect, this afternoon.

MR. WU: Right. It is very small.

DR. LEITCH: Thank you.

CHAIRMAN WALLIS: Again, I would like to know what very small is, too.

DR. FORD: An initiating event, I assume that operational performance also comes into that particular category; is that true?

MR. HARRISON: Actually, not as much as -- you will have a separate look strictly at the operator response to initiating events. But typically we are talking about the occurrence of a LOCA, or --

DR. FORD: But the response time will be shortened?

MR. HARRISON: The response time will be shortened, and that is on my next viewgraph, or the one after that.

CHAIRMAN WALLIS: We have spent longer on the first bullet of the whole presentation than we were promised the whole presentation would take.

MR. HARRISON: If we can proceed then. On success criteria, Duane Arnold ran thermal-hydraulic evaluations, and the result of that rerun was to establish and confirm that their success criteria was still the same.

They did not identify any impacts on their success criteria as used in the PRA.

DR. KRESS: These are things like how many ECCS pumps get started?

MR. HARRISON: And how many pumps do you need, and how many RSVs do you need for depressurization.

DR. KRESS: Right.

MR. HARRISON: Right.

DR. KRESS: And things associated with containment, like the suppression pool, and --

MR. HARRISON: The heat and the suppression pool.

CHAIRMAN WALLIS: And temperatures.

MR. HARRISON: Right. They did recognize plant parameters were changing, and that you will have more decay heat, and you will be producing more net than the model.

DR. KRESS: Essentially when you ask the question about the PRA and how many pumps start and things like that, the same number would do the same, would prevent a core melt.

MR. HARRISON: Right. You still end up with the same success criteria, and you need -- there could be a change, and like in SRVs, you could go from needing 3 out of 6 to 4 out of 6. They didn't find that.

I think that their deterministic analysis that they do on the DBAs actually did change that. Their PRA though success criteria shows that 3 out of 6 was still adequate for that.

DR. KRESS: Is there some analysis that you guys had planned to do with something like the SPAR models that says that if I had a power uprate of this much, and X is an unknown quality, then my success criteria would change so that I have some pre-conceived notion of when to start really worrying about success criteria, that is really when you get an impact on CDF, is when you change those success criteria.

MR. HARRISON: And actually that is an observation where at Duane Arnold that they held the success criteria, and where they would not give them the power uprate.

DR. KRESS: But that was actually their condition on it?

MR. HARRISON: That was their condition, and they saw that as a key point to hold. We don't have that criteria necessarily, but if the success criteria did change, we would take a stronger look at that particular area to make sure what the effects were and what the change was in the CDF.

DR. KRESS: It would be reflected in your CDF changes for sure. Okay.

DR. LEITCH: I noticed that the expectation is that in certain situations that the suppression pool temperature would be higher.

MR. HARRISON: Higher, yes.

DR. LEITCH: In some plants, I believe that suppression pool water is used to cool bearings and other support equipment for ECCS systems. Did you take a look at whether that impacts the reliability of IPSY-RIXY or -- well, in other words, is that higher temperature water from the suppression pool adequate to provide appropriate cooling for IPSU and RIXY bearings?

MR. HARRISON: I have not looked at that, and that is something that I could take back and look at.

DR. LEITCH: And in fact I am not a hundred percent sure that at Duane Arnold that is the source of water for those bearings, but I think it may be.

MR. RUBIN: I am not familiar with that cooling mode. If they did employ anything like it, the suppression pool temperature limits should be constrained by the design basis requirements for cooling those systems.

And within that perimeter, I would expect no impact on reliability, and certainly you would exceed the qualified temperatures of components, and then you still have margin to failure off of it, but I think if you are still within the design basis, and they would have to be to get approval for the uprate.

I wouldn't expect to see an impact, but if we started to see it, it would be picked up by the performance monitoring or the performance indicator program.

DR. LEITCH: But that supply to the

bearings though, if it exists, is an subtlety that I just want to be sure has not escaped us in our thinking.

CHAIRMAN WALLIS: Do seals get involved in this, too?

DR. LEITCH: Yes.

MR. HARRISON: Bearing seals, yes. As was indicated, there are impacts to operator response times. Again, they run the thermal-hydraulic codes to establish what those times are. Typically what you see is impacts on the ATWS sequences in dealing with SLIC initiation, or inhibiting ADS.

As an example, for Duane Arnold that time changed from -- for early SLIC initiation, it changed from 6 minutes to 4 minutes, and the human error probability changed from about 10 to the minus 1 to about almost .2.

DR. KRESS: They used 10 to the minus 1 for their human error probability on that?

MR. HARRISON: On that one.

DR. KRESS: Good. They didn't use 10 to the minus 3.

DR. LEITCH: Right.

DR. KRESS: And is this a plant that copes with ATWS by reducing the water level going into the core pretty far?

MR. HARRISON: Yes. I don't know how far, but they do lower water level to control power level.

CHAIRMAN WALLIS: This 10 to the minus 1, is this just somebody's guess or is there some evidence on which it is based?

MR. HARRISON: It is using a --

DR. KRESS: Do they use the EPRI model?

MR. HARRISON: I am getting a shake of the head. Yes, they use an EPRI model for that.

CHAIRMAN WALLIS: Because every time I see a round number like 10 to the minus 2, or to the minus 1, I assume it is error, and that it is a factor or 2 or 3 anyway.

MR. HARRISON: But I am rounding off. Their numbers were really 1.1 and 1.8, but --

CHAIRMAN WALLIS: Oh, I see. So they weren't just one-tenth of something.

MR. HARRISON: Right.

DR. KRESS: Which is false and misleading in terms of the --

MR. HARRISON: Right. When you are dealing with these limited times, you either make it or you don't make it.

CHAIRMAN WALLIS: When they evaluate this do they actually talk to operators?

DR. KRESS: Well, the models are based on operator simulation.

CHAIRMAN WALLIS: Simulation responses?

DR. KRESS: Yes.

CHAIRMAN WALLIS: So it is real data then?

DR. KRESS: It is a data based model, but it really has not been quantified very well, and they treat them as if there is no error in them.

DR. LEITCH: I assume that Duane Arnold doe snot have automatic SLIC initiation, or are these numbers --

MR. HARRISON: Right. These are manual initiation of SLIC, and they have an early and they have a late. So if they don't do it early, within the first four minutes of the power uprate, then they have until about 12 minutes, which is late for SLIC initiation.

As part of this, I indicated that it was driven by the operator actions of an increase in their CDF of about 10 to the minus 6, and an increase in their LERF value of 1.39 to the minus 7 per year.

DR. KRESS: Just out of curiosity, what is the Duane Arnold CDF and LERF?

MR. HARRISON: The CDF at Duane Arnold,

post-uprate, is 1.29, 10 to the minus 5 per year; and the post-uprate LERF is 9.9 to the minus 7 per year. So you are getting about a 9 percent increase in CDF, and approximately a 16 percent increase in LERF.

CHAIRMAN WALLIS: And most of that is due to ATWS is it?

MR. HARRISON: Most of that is driven by ATWS. There is some contribution from the transient non-ATWS, where you have high pressure failure and the operator fails to depressurize.

CHAIRMAN WALLIS: What is the uncertainty in the prediction of this water level during the ATWS?

DR. KRESS: It is pretty uncertain because it is tied into the actual calculation of what power you have got, and its relationship between power and water level.

CHAIRMAN WALLIS: And maybe G.E. can respond to that this afternoon.

DR. KRESS: Well, in fact, there has been a big argument over the years about how to make that calculation and what it actually ought to be. So there is a lot of uncertainty there.

DR. LEITCH: There is also uncertainty in how the water level is measured in those situations as well.

DR. KRESS: Yes.

DR. LEITCH: And whether where the water level is measured is indicative of what is really happening inside the core is another question.

MR. HARRISON: The final bullet on this slide is just to recognize that they did look at external events, such as fires and earthquakes. The same operator actions carry through into that analysis, but it has a minuscule contribution.

DR. KRESS: Yes, I guess that is not surprising.

MR. HARRISON: Right.

DR. KRESS: Did they include any shutdown considerations in that?

MR. HARRISON: We will get to that.

DR. KRESS: Oh, okay.

CHAIRMAN WALLIS: The next page.

DR. KRESS: I'm sorry. I didn't read ahead.

MR. HARRISON: Okay. The next category is component reliability, and again they don't expect any changes. They maintain functionality reliability by monitoring programs, and they identify the few there, such as maintenance rule, erosion and corrosion program, condition monitoring, similar to the initiating events, such as the frequency discussion.

On shutdown risks, they did not do a shutdown risk model. What they did talk about was the fact that they followed the guidance of New Mark 91.06, where they control the five conditions.

They monitor to get heat removal capability, and inventory control, and availability of electrical power, containment control, and reactivity control.

And they just talk about maintaining those controls and being aware of the condition they are in before they remove equipment out of service. The other point they did make was that at the increased power level and decay heat, you are going to take longer to shut down. You are going to have to run your decay heat removal system longer.

DR. KRESS: That was one of my questions was going to be; is are they going to use their same schedule for shutdown maintenance, or are they going to extend it out based on the new power limits?

MR. HARRISON: The number of hours in order to get down.

DR. KRESS: So if they wait long enough, then they are back to the same risk level essentially?

MR. HARRISON: If you wait long enough for the decay heat to go away, then yes, and that just seems to be straightforward.

DR. CRONENBERG: Under RAI ability, you accept that there is no change anticipated, or do you have additional information pending, or what is the status of your review on the component reliability?

MR. HARRISON: In the are of component reliability, we have noticed this I think in the other reviews that we have done, that there really doesn't tend to be an impact in this area from these uprates, and so we have not pursued any additional questions in this area.

DR. CRONENBERG: Including the balance of the plan?

MR. HARRISON: And for Duane Arnold, that is correct. For our other submittals, we are pursuing as part of initiating event frequencies and related component reliability of the uprates that they are doing to the balance of plant site, that could impact the PRA model.

MR. RUBIN: This is an area where we really need to see some data if there is an impact, and we can't identify a mechanistic change, like a variation success criteria or fluid conditions.

It is really is not possible to predict it in a way to build it to the risk model. However, if we do start to see changes, most of these items, or I think all of these items will be captured by observations in other programs.

Plant trips will be caught by the firm's indicator program, and they will be monitored for the assessment program, and the reliability and availability of safety systems is monitored through the maintenance rule as was mentioned, as well as by the performance indicator program.

I certainly would be very interested to see the impact, and as was mentioned before, we should probably at some point in the future follow up to see if there is a change. But it is not envisioned that there is right now,.

DR. CRONENBERG: Your response relies on the monitoring program and after the fact as an indicator, when you know you have uprates of 17 percent, and 15 percent, and 20 percent, you know that you are doing changes to your balanced plan before the systems and so forth.

It seems to me that I would have things on corrosion and erosion for plants that are 30 years old, and I would have some questions at to those.

MR. RUBIN: I am sure there are questions in that area from the division of engineering. It is not an area where the risk assessment would have it in the model.

DR. CRONENBERG: Okay. I am asking the wrong people then, I suppose?

MR. RUBIN: In a sense, yes.

MR. HARRISON: And keep in mind that the information that I am sharing is strictly a PRA perspective. You are going to see it on another slide as to plant systems, and other groups will be tracking things that we don't track.

This is just a transition slide, and the next things that we are going to talk about is that we will quickly talk through PRA quality, and we will just give you a quick information dump on what we see as the risk impact that shuts down operations.

And then we will jump directly in to the six questions from the ACRS. PRA quality seems to be a topic that is catching everyone's attention these days, and I do want to point out again that at least with the Duane Arnold submittal that they made it very clear that they were not a risk-informed licensing action.

The staff is reviewing the risk and pursuing that angle, but just to understand that the licensees don't necessarily see this as risk informed.

DR. KRESS: Their PRA license certification process, that gives it some level of assurance that it is a pretty good PRA.

MR. RUBIN: The certification isn't a pass/fail. It is a --

DR. KRESS: It gives you a classification and that these can be used for these things.

MR. RUBIN: It gives you evaluations in various areas, and I am not sure which -- well, there is no overall assessment I guess is the way that I would like to leave it.

DR. KRESS: Well, did you guys go to the certification review findings just to see what they said?

MR. HARRISON: That is the last bullet on this page. We are talking there about possibly sitting down and taking a look at the peer review that was performed.

DR. KRESS: I'm sorry, but I didn't read ahead.

MR. HARRISON: Shame on you for jumping ahead.

CHAIRMAN WALLIS: I guess our view of quality in peer review is how much you can rely on the answers you are getting, and that is within a certain context. So it is a measure of how uncertain are your answers compared with how certain you need to be in order to make a decision.

MR. RUBIN: Right.

CHAIRMAN WALLIS: I don't see that at this point in your discussion on PRA quality.

MR. HARRISON: The point that I am making is that I am trying to make that point with the second one, is that the licensees are still meeting their deterministic requirements, and they are still meeting the regs.

They are saying essentially, if I can put words in their mouth, that they are not relying on the PRA to make these decisions for that.

DR. KRESS: So you are constrained to have to go by that, but you have one panel to get a hold of, and that is that there is a significant risk associated with that.

MR. HARRISON: We have a way in.

DR. KRESS: You have a way in, and so you need to see if there are significant risk changes.

MR. HARRISON: Right.

DR. KRESS: You need some sort of PRA.

MR. HARRISON: And that is my third

bullet, that the staff is assuring there is no significant risk change, and that there is no new vulnerability identified that we didn't know before.

We want to make sure that we are not on a cliff and a power uprate takes us from being in a safe condition to being in an unsafe condition. So that is a perspective.

DR. UHRIG: Does Duane Arnold have an on-line risk monitor like some plants do?

MR. HARRISON: They have -- is it ORAM? I don't think that is on-line, but that is a shutdown part of the model. I don't think -- I really don't know.

DR. UHRIG: That is just part of the PRA.

MR. RUBIN: I guess we don't have the answer to that question. We would have to check with the plant if they have a real time --

DR. UHRIG: There are some plants that do have it and use it extensively.

MR. RUBIN: There are also plants that have fast running models that they can requantify every morning in addition to the ones that have actual real time monitors, and I don't know where Duane Arnold falls. Perhaps we could ask them if they know.

MR. BROWNING: Again, this is Tony

Browning of Duane Arnold. We are closer to the middle category. We use the PRA to do our on-line maintenance planning surveillance testing, and we get a field there for where we are in risk space.

And then it is color-coded, and it is part of the plan every day when we go out and do maintenance so that we know exactly where we are at. And emergent issues that come up can be factored back into the model and tell us do we need to make changes from what we planned.

But, no, we don't have the full-blown continuous on-line risk meter if you will.

DR. UHRIG: This will be upgraded with the increase in power?

MR. BROWNING: Yes, the models will be upgraded as we make the changes, and in particular like they said on their slide, we have a living PRA, and as the modifications are put into place those effects will be modeled.

DR. UHRIG: Thank you.

MR. RUBIN: If I could give an observation that when we were doing the baseline maintenance inspections, the plants that had the capability for a quick running quantification PRA model, it was certainly a significant strain in their ability to monitor the plant operations. A number of plants essentially rerun the model every morning.

DR. FORD: If I could make a comment. The PRA, I recognize that there are limitations with the PRA methodology, especially when it comes to time dependent phenomena. And when in the last couple of months, it has been drummed into us time and time again that the public perception of this whole business is very important obviously.

It just concerns me when you look at time limiting and aging events, which we know historically occur, and the public knows that it occurs, that I am not hearing crisp answers to these particular issues when it comes to aging concerns, and when it comes to these particular out uprates.

I guess my question is more a comment, but my question is at what time do we hear crisp answers to these aging concerns? Like, for instance, an informed person in the technical public could say that you should have a concern for fluence corrosion, or you should have a concern for flow induced vibration.

You should have a concern for irradiation effects on core shrouds, for instance.

These are all reasonable topics, and they can all be put to rest.

MR. RUBIN: Well, they certainly are. They are in the areas of materials, chemical engineering. We have a group that is involved in the review, I think, and perhaps we should get their views --

DR. FORD: I guess my question is when do we hear it.

MR. HOPKINS: I guess I thought we had already made a presentation on erosion and corrosion previously to the subcommittee.

DR. FORD: I apologize to the group then.

DR. KRESS: He was not here during that, but you did make such a presentation.

MR. HOPKINS: I think a better answer is the staff has to complete its review of Duane Arnold's submittal before we can really give that answer to you, per se, and we are still reviewing that.

DR. KRESS: I think that your answer is that you are concerned with those things, and you have programs to look at them. There are concerns for operating reactors that aren't being upgraded, but the question is does an uprated power do significant change to those.

And the answer that I am hearing is probably not, but we don't have good data to back that up on some of them. Some things like chemical effects, we don't know if a power uprate is a significant effect.

We know how to deal with flow accelerated corrosion to some extent, and we know how to deal with fluences, but intergranular stress corrosion cracking, I don't know power uprate would do that.

So the answer is that I think that you are concerned with it, and you have programs looking at them, and the power uprate may not significantly change the concern. You are still concerned, and I don't know what else you can say about it.

MR. HOPKINS: Well, to some extent a power uprate is different from license renewal. I mean, they each have the same concerns, but some are more concerned about power uprate than they are with license renewal, let's say.

So there are separate concerns, and in each case we look at those issues, be they time aging, or increase in fluence, or a small increase in fluence, and increase in flows, and that sort of thing for each review, to reach a satisfactory answer.

Duane Arnold is the first extended power uprate review, and we are not complete. So I guess I am still back to when we complete the Duane Arnold review, that is when we are in a better position to decide.

DR. FORD: I guess it is a question of timing that I was bringing up, you know. I don't doubt that these questions are being addressed that we brought up, but you are saying that this is going to be finished in the year -- well, later this year, 2001.

MR. HOPKINS: Yes.

DR. FORD: So when it comes to this committee, is it not a wee bit late for us to be saying suddenly, well, what about this, or what about that? Doesn't that completely put a stone in the works as far as timing is concerned?

MR. HOPKINS: Yes, it may. But I don't see any way around it. The staff has to do its review when we do our review. The fact that the licensee may have requested a schedule and trying to meet it, and how much time we have to present to the ACRS, I think the ACRS should take its time to consider things that they can.

But we can't work faster than we are working. So I'm sorry about that.

CHAIRMAN WALLIS: I am not suggesting that. I was wondering when you were asking for crisp answers if you were asking about the confidence in the expertise of the staff in evaluating things.

DR. FORD: No, I am not questioning the competence of the staff.

MR. WU: I will try to answer Peter's question. This is John Wu again. I think I mentioned before, sir, about life extensions in the power rates, and the corrosion between them. Peter mentioned the corrosion and erosion, and also mentioned the flow induced vibrations.

In the life extension programs, the review includes, for example, the corrosion and erosion, and also review the aging management program, which is management controlled or managed by inspection, and also the chemical control.

And in flow induced vibrations, we look at the usage factor. Say the usage factor now and then for 60 years, and see how much it is going to be, and what is the factor and we are including that in the review. So that has been done. The review has been done.

DR. CRONENBERG: Why don't do you a cumulative usage factor for power uprates?

MR. WU: We do have the cumulative factors. You mean including the lab extension?

DR. CRONENBERG: No, not for lab extension.

MR. WU: For the power uprates, yes.

DR. CRONENBERG: As part of the review procedures for licensing, do you have to do a time aging analysis.

MR. WU: If they have the power uprates, they also include in the reviews for the time limiting aging reviews, aging analysis. They include it in the usage factor.

DR. CRONENBERG: I looked at a number of reviews, like in the '90s when we did 4 or 5 percent type of increases, and I never saw a cumulative usage factor estimate in those reviews. It is something new for these major, major increases.

DR. CRONENBERG: Is this something that you knew that the licensee is required to do for the 15 percent?

MR. WU: Are you talking about the extension, the lab extension?

DR. CRONENBERG: The time limitation on the CUF factors or estimates, cumulative usage factor estimates. I never saw them before.

MR. HOPKINS: I don't know. We don't have Barry Elliott here anymore, and this may be more in his bailiwick.

DR. CRONENBERG: They certainly weren't in the SERs that were talked about.

MR. WU: I will find out about the lab extension on this cumulative factor, but for the power uprates, we have reviewed the cumulative usage factor.

DR. CRONENBERG: And it is based on --

MR. WU: On 40 years.

DR. CRONENBERG: -- historical data and number of plants, and --

MR. WU: Yes.

DR. CRONENBERG: -- all those sorts of things?

MR. WU: Yes. Yes, that's right.

DR. CRONENBERG: And that is impacted by the uprates?

MR. WU: Yes, sir.

MR. HOPKINS: Well, I think we got a little sidetracked, but I am back to the staff trying to review Duane Arnold and the staff is doing that as efficiently and as fast as we can. And I think maybe to give you more specifics, we have to complete that review.

DR. KRESS: Do you have a standard review plan for power uprates?

MR. HOPKINS: No, we do not. We considered that and at this time we have not felt it to be worth the effort, but no.

DR. KRESS: But with all these predictions about what might come in for power uprates, are you thinking about reconsidering that?

MR. CARUSO: Dr. Kress, BWRs have approved topical reports when you describe the uprate process.

DR. KRESS: Well, actually we reviewed a couple of those.

MR. CARUSO: Right, and those serve the same purpose as a standard review plan for BWR power uprate reviews. They identify the key issues, and they identify what has to be looked at, and what has to be done by the licensee by the vendor, and by the staff.

So to a certain extent, for the BWRs, yes, we do have -- we don't have an actual standard review plan, but we have a surrogate.

DR. KRESS: This almost looks like a standard review plan.

MR. CARUSO: That's why I say it is really the substitute surrogate.

DR. KRESS: And you don't expect this magnitude of power uprate for PWRs do you? Aren't there limitations there that keep them down a little lower maybe?

MR. HOPKINS: Yes. I think most PWR uprates will be on the order of five percent and it maybe if they replace steam generators, it might be 10 or something.

DR. BOEHNERT: Yes, some are coming in at 10 or thinking about 10.

MR. HOPKINS: But aren't those that have replacements involved?

DR. BOEHNERT: I think so.

CHAIRMAN WALLIS: We seem to be falling behind.

MR. HARRISON: Okay. I will pick up the pace. The last part is just to let you know that the staff is looking at the change in CDF and the change in LERF.

Most of these -- some of those we expect them to have peer reviews done on them at some level, and there is always the option for us to review either the peer review or the PRA itself.

MR. RUBIN: Perhaps I should ask the committee if they want to go through each of the questions, or do you just want to select some that you want to hear? We were planning to go through them, of course, but to save time --

DR. KRESS: There are some interesting questions here.

CHAIRMAN WALLIS: Well, I guess since we asked them, and you can answer if you like.

MR. HARRISON: Okay. I will run you through shutdown real quick, and then we will jump to the questions. You are going to get increased decay heat and so that is going to extend the time the KE heat removal system is going to have to run, and remain in service.

As a result of the increased decay heat, you are going to have reduced upper response times. There is going to be a lower time to boiling. The main effect is to PWRs that have a mid-loop operation, where the time is restricted to start with.

Those operations would be a higher risk than for BWRs that tend to have more inventory and more time to respond to things.

CHAIRMAN WALLIS: Is this a significant change in the stored energy?

MR. HARRISON: In the stored energy?

CHAIRMAN WALLIS: Well, the fuel is hotter.

DR. KRESS: It is almost a percent change, and not quite, but you can almost do it that way.

DR. SCHROCK: What I heard them say is that the linear power is not changed. They are just getting a higher power through flattening. So if the linear power is unchanged, then the center line temperature is unchanged.

CHAIRMAN WALLIS: But there is more stuff on the outside that is hotter than it was before. So there is integrated decay and also integrated --

DR. SCHROCK: The average temperature is higher than it was, right.

MR. HARRISON: And I believe it is considered proportional to decay heat.

DR. KRESS: The decay heat is proportional.

CHAIRMAN WALLIS: And so all the effects are the same.

MR. HARRISON: Right.

CHAIRMAN WALLIS: Because it is a shorter duration.

MR. HARRISON: Right. I will skip the next slide. It just lists the six questions that the ACRS asked, and I will jump to the first question.

The first question basically was asking if we needed additional acceptance criteria to address the frequency of releases of all magnitudes, and just to state that Reg Guide 1.174 philosophy is that increases in CDF and risk are small and consistent with the Commission's safety code policy.

DR. KRESS: Well, the intent of the question was to challenge the Reg Guide 1.174 philosophy.

MR. HARRISON: I think we were aware of that.

MR. RUBIN: Well, we certainly concurred with the advisory committee when they endorsed the criterion in the reg guide. To look at it now for uprate, I don't think we see anything that calls the reasonableness of those criteria to question.

DR. KRESS: Well, let me ask a couple of questions about that since this is one of my questions. Let's talk about LERF. Now, LERF was in the Reg Guide 1.174, and there is an acceptance criteria that is based on the actual absolute value of LERF.

You know, the closer that you get to the absolute value, the more regulatory attention one pays. And that absolute value that they stuck in there was a surrogate for fatalities.

Now, if you uprate the power by, say, 20 percent, and if you also have maybe three plants or two on a site, that is a 40 percent uprate on site power.

So to me that means that the consequences or the probability of -- well, they are not exactly linear, but the probability of fatalities has gone up to 40 percent at that site.

And it would make sense to me to reduce the acceptable LERF value to be a surrogate for that by 40 percent. So I am questioning, number one, here you have a fixed LERF as the acceptance criteria, when in reality the LERF ought to depend on the power. So that is question number one.

And question number two is LERF and CDF don't capture all your risk matrix, and it doesn't capture any suicidal risks, in the sense of total deaths or land contamination. And it doesn't capture releases of fission products of all frequency, short of causing deaths.

And one of the studies in Europe showed -- and I forget which plant it was for, but it showed that there was a significant increase in fission product release at lower frequencies, although it would not have affected LERF at all.

It was a significant concern to them, and so those were the nature of the questions that were in my mind when this was formulated, and it is actually challenging the 1.174 guidelines and criteria, and not that I don't think that they are relatively good, and I do support them.

But I am not sure that they are universally applicable under all conditions is my problem.

MR. HARRISON: I think we would agree that of course they are not universally applicable. But within the bounds of the issues that were considered when the criteria were developed, I think they are still applicable for a power uprate of this kind, and I will be more specific.

When the 1.174 criteria were developed, whether with absolute criteria, or really guidelines rather than criteria, but absolute guidelines, percentage guidelines.

A lot of things were debated, and a number of members here were in on those debates. And the ultimate decision was to have guidelines that were site and plant independent.

And within the spectrum of the currently operating power plants, we have plants at 700 megawatts, electric, and ones at almost 1,200. And the risk between those two plants will be -- the differential will be larger than what we are talking about here for the uprated plant.

Does that mean that we are not considering the relative risks? Well, there is a lot of margin in the safety goal between many of the plants with the frequencies of large release and core damage.

I think that you will find that a lot of the boilers have themselves on the lower end of the spectrum on overall core damage frequency. Sometimes initial containment failure tends to be somewhat higher.

But we still are seeing a lot more variability on just the range of currently operating plants than in the change that we would be applying here.

DR. KRESS: That was another debate that we had. The line that was drawn through the pump fatality scattered curve was the mean, and we wondered whether that might not be somewhat higher. I mean, not to capture more of the plants. But that was the -- it ended up being the mean.

MR. HARRISON: But I think the underlying assumption is that regardless of where your plant is sited, and regardless of what your base risk is, that the increases need to be small.

DR. KRESS: And I think that is a good guideline, and the other that I was actually expecting you to say is that the rest of 1.174 says that you meet all the other regulations.

And since this was a non-risk informed submission, clearly it meets all the other regulations, because that is the philosophy behind that.

And that would control in my mind these lower frequency releases for this particular application. But the question was more general; that if you actually had a risk informed application would you have problems along those lines somewhere.

MR. HARRISON: I think if we started to see power uprates well beyond the upper range of currently operating plants, and well above 3,900 megawatts, that might be the time to maybe take another look at the LERF guideline to see if it needed to be reassessed.

And in fact if you look at the upcoming revision to Reg Guide 1.174, you will see that concept reflected in that.

DR. KRESS: That's right. We are dealing with a revision aren't we?

MR. HARRISON: Yes, sir.

DR. KRESS: And I look forward to seeing that. But anyway essentially 1.174 is all you have now, and so you are pretty much constrained to say that is what we would use.

MR. HARRISON: And if you want, we can jump to the very last slide on the study that you --

DR. KRESS: I think that was the one that I referred to.

MR. HARRISON: It is the very, very last page of the package there. They did a 15 percent power uprate and they stayed the same four areas as the NRC does in the area of PRA upper reactions, and success criteria, issuing event frequency, et cetera.

The one thing that the regulator did was put a hold on success criteria and said that it will not change. You will lower your power level if it does, and so that was one condition that they put on there.

DR. KRESS: What do you think about that? You don't have a position on that?

MR. RUBIN: No, but if it was a significant change, it would be reflected in the risk analysis, and then we would be in a position at least to know what the impact did, and to make an educated decision.

DR. KRESS: Rather than just absolutely making --

MR. RUBIN: It could be a trivial change, and it could be a significant change. I think modeling it and looking at the impact makes more sense.

CHAIRMAN WALLIS: But that's if LERF stays the same, but the release goes up, and the overall risk does go up by something like -- well, more, and how do you assess that?

MR. HARRISON: What this study gave was a frequency, a time, and it wasn't really a frequency. It was a time period of a period content, and so the inventory goes up, and it gets released a little earlier.

So you have a shift, and so what they did find was none of the release categories changed. So late stays late, and early stays early, and small stays small, and large stays large.

Everything just kind of shifts a little earlier, and you are getting a 15 percent increase in inventory. So, yes, there is an absolute --

CHAIRMAN WALLIS: So with the effect of public safety, what is the measure of small? It's not that it goes up by 25 percent, but it goes up by something, and integrates overall frequencies and so on to get some measure of change in public risk, and how much does it go up?

MR. HARRISON: This study did not take it to that level. It did not take it to a dose consequence.

CHAIRMAN WALLIS: Then how do they know it was small then?

MR. HARRISON: We are talking about --

CHAIRMAN WALLIS: The overall risk, and looking at all possibilities and all frequencies, and all releases, what is the net change by some measure? They don't do that?

DR. KRESS: There is no acceptance criteria that I know of.

CHAIRMAN WALLIS: Well, there might be one in this one.

DR. KRESS: Well, the Swedes have an actual acceptance criteria based on frequency of release of all risk, and there you have something to gauge to, but we don't have anything like that.

MR. HARRISON: Right. What they did show was that when you go through the level two analysis that the binning stays the same, and so your release categories don't change. Your exit sequences don't change. It is a matter of timing and just basic inventory.

CHAIRMAN WALLIS: Well, when you have release increases of 25 or 30 percent, what does that -- how does that affect your conclusion about overall risk? There must be some mathematical way of going from 25 to 30 percent to something which you think is small?

DR. KRESS: Well, it is not linear, and the consequences are -- well, this is related to consequences, and they have already said the frequency is not going to change very much.

So it is frequency times consequences, and the consequences of that kind of increase is not linear at all, but you could almost say that it is bounded by 25 or 30 percent.

CHAIRMAN WALLIS: So it couldn't be bigger than 30 percent?

DR. KRESS: It can be, but it is not much bigger. It is all in your consequence model, and what iodine does to you, and things, but it is going to increase at least 30 percent and you can say that, but that is not much of an increase if you are already down to 10 to the minus 7.

And a 30 percent increase in 10 to the minus 7 is not --

CHAIRMAN WALLIS: I would like to have that sort of rationale than just a statement that it is small.

MR. HARRISON: And again I would say that the definition that they use for risk is increase of source term, and it is not necessarily a dose to somebody. It is really just a stretch of the level two.

DR. KRESS: Yes.

CHAIRMAN WALLIS: Yes, but I think the answer should be crisp rather than discursive. That there is some sort of rational mathematical model that gets you from the 30 percent or whatever you use as a button line --

DR. KRESS: It is a delta-LERF is what it is.

CHAIRMAN WALLIS: -- to say that he overall risk is small.

DR. KRESS: Well, they use delta-LERF and that's it.

CHAIRMAN WALLIS: And it is not affected at all by the release.

DR. KRESS: It's probably not, that's

right.

MR. RUBIN: That is the point of the question, Dr. Kress.

DR. KRESS: And that is basically the point of my question.

MR. RUBIN: In a sense, it is a limitation of the method, but it also reflects the reality that the source term is just the same as a source term for a similar power plant next door that was running at 70 megawatts higher of power.

DR. KRESS: But I don't like that question, because a source term is fraction of inventory, and that is not a good answer I don't think.

MR. HARRISON: And the overall result of that study was basically the conclusion that they were -- that this risk increase is still within the uncertainty band of the phenomenology.

DR. KRESS: That's for sure.

MR. HARRISON: So we are going to have to have a much larger increase impact than that to even get outside of the --

CHAIRMAN WALLIS: So what you are saying then is that you apply the rule that everything is now fine, and you are a little bit uncertain about how you take care of this thing, which is not really accounted for by the rule, but you are not really too worried because the effect is not really big as far risk is concerned.

DR. KRESS: And they still meet all the figures of merit in Chapter 15, which is a level of comfort to some extent with respect to this.

CHAIRMAN WALLIS: So question two.

MR. HARRISON: We will go back to question two. Question Number 2 dealt with margins.

DR. KRESS: I think you basically answered my question on that one, and that is the bottom line, that you can use margins all the way up to the limit.

MR. CARUSO: One of the questions that you raised during the earlier session was about fuel center line temperature. We talked a little about that at the break and these power uprates are not raising fuel center line temperatures.

What they are doing is they are flattening power profiles throughout the core so that you don't -- so that the limiting bundle is still operating where it was before.

But what you are having is that you are having other bundles which were previously well below that operating much closer to that limiting value.

And the other question you raised about operating. Even if you were operating with a higher center line temperature, fuel melting is not allowed. There are design criteria that prevent that, and we were also thinking about the fact that even if you were operating with higher fuel temperatures, realize that through its life that the fuel doesn't maintain its monolithic character. It fragments quite a bit.

So it is not clear to us how much additional release of fission products you would have from the fuel because you are operating a little bit hotter, because I would have to go back and see how much additional fragmentation would occur.

And I am not sure that the increase in that temperature really would increase the fission product release into the gap by that much other than the linear race due to the fact that you are burning up faster, and so you would have a higher inventory.

And other than that, I am not sure that the power uprates are really changing gap activities.

DR. KRESS: The gap activity is probably not risk significant anyway. I mean, it has to do with operational things, and how fast you close isolation valves and stuff like that.

But it is probably not a risk significant thing, unless you are talking about PWRs, and if the gap inventory actually has some effect on the iodine spike, and you have a steam generator to rupture, which is all speculation on my part that it would. But I can't see any problem with BWRs frankly.

MR. HARRISON: And we will hit that portion, and I think that is question number four on the gap fraction of the iodine spiking.

DR. KRESS: The other thing about the margins that occurred to me when we asked this question was you have margins now for these figures of 2,200 degrees, and that are met generally well below the value, and it has been deemed an acceptable margin because you have some idea that the calculations to get those involved build in conservatisms.

And as you approach that margin more and more, I think that your level of comfort about what those built-in conservatisms do for you, since they have never really be quantified about how much conservatism there is added into the calculation, that your level of comfort about having conservatisms in your calculations is eroded somewhat.

And to me it says that when we get closer and closer to those margins, maybe we ought not to rely on Appendix K, and ought to go to the best estimate approach. And actually quantify the uncertainties.

MR. CARUSO: That is what is happening.

DR. KRESS: And once you quantify the uncertainties, then I see a missing element, and that is how to factor that in to how close you can get to these many figures of merit.

I don't see that missing link, you know. I have got the conservatisms, and I have got a calculation of the mean or the distribution and how close it is to the margin. So now what is acceptable to me.

CHAIRMAN WALLIS: Well, you are getting at the bottom line here. I think what the bottom line says is that they control up to the -- well, it is not really limits on margins. The limits are on things like temperature, like 2,100 degrees.

But there is nothing that says that you have got to have a margin of so much, which is in some approved way.

MR. CARUSO: Margin was used to establish the limit.

CHAIRMAN WALLIS: Margin simply means that the prediction is below the limit, that's all.

MR. CARUSO: The prediction is below the

limit.

CHAIRMAN WALLIS: And there is no quantification of margin whatsoever in the regulations.

MR. CARUSO: It depends on what it is that you are calculating. As I said, we are seeing more and more people trying to do statistical quantifications.

The SAFER/GESTR method actually is a very early attempt to do that, and if you look at the SAFER/GESTR methodology, you will find that they meet the 2,200 degree limit, but the staff has imposed actually I believe a 1,600 degree limit on SAFER/GESTR on a separate non-licensing calculation as part of SAFER/GESTR, which is called the upper bound PCT, which includes a certain uncertainty factor.

So it is a way of -- I don't want to get into the details of explaining this, but they have two limits; one which is much lower, and which is where they actually believe the plant operates.

But then they take a penalty because of difficulties in quantifying the uncertainty to make sure that they stay below 2,200.

CHAIRMAN WALLIS: So does anything change with uprates then? This is what you have been accepting. Is there anything different about uprates? Are their margins significantly reduced or anything?

MR. HARRISON: They are coming closer to these limits.

CHAIRMAN WALLIS: But not by much. Are we going to hear that from G.E.?

MR. HARRISON: I think so.

CHAIRMAN WALLIS: From my reading of it, it didn't look like much of a change, but I am not the regulator. You are much more experienced than me about whether it is significant or not.

MR. HARRISON: Well, one of the things that -- well, remember what I said when I started just now was the peak limiting bundles on changing, and what they are doing is flattening the power shape throughout the core.

And so there are lots of areas in the core right now that aren't carrying their loads so to speak.

CHAIRMAN WALLIS: I guess the think that - - the question really to ask is not what the licensees and vendors are doing, but what you will decide to accept as a margin. What is your criterion for accepting a margin, and not what the licensees and vendors are controlling.

MR. HARRISON: Well, we have one li mit in Appendix K, and the other limits come from reviews of the topical reports. We had some old limits that were very deterministic, and very conservative, and now we depend on the vendors and the licensees to come to us with proposals and we talk to them.

CHAIRMAN WALLIS: And you negotiate?

MR. HARRISON: And we negotiate.

CHAIRMAN WALLIS: And you use your judgment?

MR. HARRISON: That's right.

CHAIRMAN WALLIS: But you don't have a sort of spelled out --

MR. HARRISON: And we call on our friends in the Office of Research to help us, and we call on our friends in the ACRS to help us.

CHAIRMAN WALLIS: But you have not got spelled out criterion for margin approval?

MR. HARRISON: You would have to look at the details of each individual topical report.

DR. SCHROCK: Is it true that the limiting bundle power isn't changed? That implies that all the flattening is radial and none axial.

MR. HARRISON: I think there is also flattening in the axial direction.

DR. SCHROCK: Then there would need to be a higher bundle power.

CHAIRMAN WALLIS: We will get that from G.E., I guess.

MR. HARRISON: I am hearing only radial.

CHAIRMAN WALLIS: Well, it's not too obvious from this material here. I mean, if that is what they are doing, then it needs to be said up front, because then you stop asking all the questions. We probably need to move on. We are not making much progress with margins.

DR. SCHROCK: Marginal progress.

MR. HARRISON: Question Number 3 was a question relating to the need to reflect the increase burnup.

CHAIRMAN WALLIS: There isn't any increased burnup is there?

DR. KRESS: There is an increase in the average burnup, but they are still within the limits.

MR. HARRISON: And also if you changed your operating cycle or whatever, and to extend the cycle, then that would have an effect on your burnup as well. But it is indirect, and not a direct effect of the power uprate.

The use of the thermal-hydraulic codes

that are used to establish the success criteria and the operator timing, the staff feels that should be reflected what your core is. That is part of PRA quality; do you reflect your current design or your projected design in operating conditions.

However, I will point out, and as I think you are all aware, that the delta-LERF will probably not reflect the increase in inventory and that is the prior question.

DR. KRESS: That is the same thing you said before. I was wondering if -- well, it does give a potentially bigger insult to the containment.

MR. HARRISON: Right.

DR. KRESS: And that is calculated.

MR. HARRISON: That would be calculated. That would be passed through from --

DR. KRESS: So, delta-LERF would reflect that.

MR. HARRISON: Right. And actually on Duane Arnold, even though the CDF went up by 9 percent, the LERF went up by 16 percent, and it had to do with the predominance of it being ATWS events. So that pushed you -- you had a disproportional amount of the scenarios being pushed earlier.

DR. KRESS: And ATWS is the dominant

sequence for doing Arnold isn't it?

MR. HARRISON: Yes, it is.

CHAIRMAN WALLIS: I am sort of assuming that you are going to be finished by 11:30, and then we can have Jack Rosenthal so that we can get to lunch before noon?

DR. KRESS: It all depends on us.

MR. HARRISON: We only have two more questions really. So we if can walk through them quick. And question four had to do with the impact on the design basis analysis source term.

As we said before the fission product inventory will increase. There was a question on gap fraction, and it is considered -- well, the power uprate has no direct impact on the gap fraction. It is a function of the burnup of the fuel.

DR. KRESS: And it doesn't have any effect on the gap fraction, but it does have an effect on the total amount.

MR. HARRISON: On the inventory. And on the second part of that dealing with the iodine, I think it was mentioned earlier that the appearance rate and spiking factor are based on the tech spec equilibrium activity, and I believe the staff believes that the 500 times multiplier that is used compensates for any uncertainty that is in the iodine spiking.

DR. KRESS: Well, that is one of the things. This was Dr. Powers' question, that part of it anyway, and that is one of the things that he will stand up and make a few statements about.

We had a lot of discussion about this 500 with respect to the differing professional opinion, and we weren't very pleased with it. But that is all you can have is what is in the books, and it is not a question related to Duane Arnold. It is something for the future.

MR. HARRISON: I think there is a plan to reevaluate the iodine spiking.

DR. KRESS: Yes.

MR. HARRISON: The last two slides. Operator time required. I think we have made it clear before that this is the one area that really does get impacted by a power uprate. You end up with shorter response times that are available, and that results in a larger error probability for the operators.

DR. KRESS: And when I heard you generally using .1 for the error probability, that gave me a lot of comfort with respect to this question.

MR. HARRISON: Okay.

CHAIRMAN WALLIS: You get confident when the probability of error is 10 percent?

MR. HARRISON: No, it gives him confidence that the results aren't artificially low.

DR. KRESS: That's right.

CHAIRMAN WALLIS: I would hate to be an airplane with that sort of human error probability.

MR. HARRISON: Again, that particular scenario was the early initiation of SLIC. I think you only had under the uprate, there is only four minutes, and that's why you get --

DR. KRESS: It was originally six.

MR. HARRISON: It was originally six and so you didn't gain that much. You didn't lose that much, but you still have that. Are there any questions on operator actions?

CHAIRMAN WALLIS: Well, to solve this problem could it be reduced by better training?

MR. HARRISON: In the modeling?

CHAIRMAN WALLIS: No, in reality.

MR. RUBIN: They are trained. They are trained well, but it is a very short period of time, and to diagnose an ATWS is, I guess, somewhat complex in a cognitive sense, and that's reflected in the model.

CHAIRMAN WALLIS: So you are reaching the limit of human capabilities here, and it is not a question of better training?

DR. KRESS: You are getting close. You have four minutes to decide if you have an ATWS, and go to the emergency guidelines and do what it says to do for an ATWS. That is getting pretty close.

DR. LEITCH: They are trained on it on almost every training cycle.

DR. KRESS: It is training as soon as you can.

DR. LEITCH: I think the problem is as was indicated, that it is relatively short time, and also somewhat counterintuitive, in spite of your training.

DR. KRESS: It is one of those places where instead of saying get water on the core, it is going ahead and lower the water level.

MR. CARUSO: Well, I guess it is figuring out if you have an ATWS or something else going on, and diagnosing what is happening.

DR. KRESS: That is part of it, but I think that ATWS gets to be pretty clear very fast.

CHAIRMAN WALLIS: You would say a minute maybe that you know that you have got an ATWS?

DR. KRESS: Less than that.

MR. RUBIN: The first thing they do is check the bottom lights.

DR. KRESS: That is a pretty good indicator.

MR. HARRISON: And given that you do know that you have shorter time, there is actually almost an argument that it has got your attention. For example, in shutdown operations, if you are in mid-loop shutdown operations, you know you have only got a few minutes to do things and you are going to watch it a little closer.

So you can almost have an improvement on operator performance in some situations.

DR. LEITCH: In some plants, ATWS is automatically initiated, where there is a SCRAM signal, and if the power is not down in five seconds, in goes SLIC.

MR. HARRISON: I just put up this last slide on question 6A, which was the need to assess operational data. Again, licensees currently track and trend their operational data, and they have the maintenance rule, and they have a corrective action program, and they have condition monitoring programs.

The staff believes that any significant

impact resulting from a power uprate would be self-revealing. If Duane Arnold starts getting 3 or 4 trips a year, it is going to catch someone's attention.

If all of a sudden pumps start becoming unreliable, it is going to get somebody's attention. And the staff is --

DR. KRESS: How many trips per year is in the performance indicator now?

MR. RUBIN: I didn't bring the little chart with me, but to get red, you need 20.

DR. KRESS: And to go out of the green, you need three?

MR. RUBIN: Yes, three. I think it is three.

MR. HARRISON: But the point is that the staff is trying to figure out a way to use the performance indicators and the monitoring programs to look back and see are there any impacts. We don't expect there are, and the PRA says there is not, but we still need some kind of confirmation to look back.

So we are talking and discussing on how we can use that to get an early indication that maybe there is an impact that we hadn't expected to see.

DR. KRESS: That is a great idea, I think.

DR. LEITCH: I think the -- if I am not mistaken, I think the present criteria is a three year rolling average, too. So you may early on in the process want to take a look and see whether there is something more immediate happening.

Sometimes a three year rolling average can sort of disguise something that is going on.

MR. HARRISON: And we do have the -- I believe in looking at the cute little charts that you can actually get where they are at that point. So you can break down the data to see that Duane Arnold is going from 1-to-2-1/2, or 1 to 2.

It is really not the initiating events that would be -- those I really do believe would be self-revealing. The harder ones would be component reliability, where you may be taking a pump down for maintenance more than you were before, and that is a harder one to get the information to track.

MR. RUBIN: But they do have the maintenance rule on availability criteria, the A1A2 demarcation, and maintenance unavailability will be flagged directly if they exceed their goal.

CHAIRMAN WALLIS: Are we at the end of y our presentation?

MR. HARRISON: I am at the end.

CHAIRMAN WALLIS: I would ask Mr. Hopkins if we can have a summing up from you, and would you prefer to do it now before we hear from RES or do we need to hear from RES before we hear from you again?

MR. HOPKINS: I could do it now and it is very short. I understand the questions and mainly from our perspective in reviewing Duane Arnold, and that is the first extended power uprate, that we are trying to work the Duane Arnold schedule of completing it by October, which would be a full committee briefing in September.

And so we are trying to have as much communication with ACRS to get this done as we can, and I understand some of the concerns and questions here today.

CHAIRMAN WALLIS: Well, it's not really where the ACRS is on this. It seems to me that you are still reviewing and some of these questions have not been resolved, and until we see something more definite, I am not sure that we want to write a letter, because your opinion may change.

And we don't want to write something on this that is not based on something that is -- well, that is based on something that is too uncertain at this point.