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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 8, 2004

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

514th ACRS FULL COMMITTEE MEETING

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THURSDAY,

JULY 8, 2004

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The above-entitled Committee Meeting commenced at 8:30 a.m. in Room T-2B3 of the Nuclear Regulatory Commission, 11545 Rockville Pike, Rockville, Maryland, Dr. Mario V. Bonaca, Committee Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

MARIO V. BONACA, Chairman

GRAHAM B. WALLIS, Vice-Chairman

STEPHEN L. ROSEN, At-Large

F. PETER FORD

THOMAS S. KRESS

DANA A. POWERS

VICTOR H. RANSOM

WILLIAM J. SHACK

JOHN D. SIEBER

NRC STAFF PRESENT:

IQBAL AHMED
STEVEN ARNDT
JOSE CALVO
JOSEPH COLACCINO
GREG CWALINA
GEORGE DICK
CLIFF DOUTT
HUKAM GARG
CHRIS GRIMES
VICTOR HALL
WES HELD
DAVE KERN
ANDREA LEE
HULBERT LI
WARREN LYON
BILL MACOW
BARRY MARCUS
E.C. MARINOS
JOEL PAGE
LAUREN QUINONES-NAVARRO
PAUL REBSTOCH
JOHN SEGALA
DALE THATCH
JARED WERMIEL

I-N-D-E-X

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

8:35 a.m.

CHAIRMAN BONACA: Good morning. The meeting will now come to order. This is the second day of the 514th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: Proposed generic communication on the use of ultrasonic flow measurement devices for measuring feedwater flow rates in nuclear plants; Future ACRS Activities, a report of the Planning and Procedures Subcommittee; reports by the Chairman of the Plant operations, Thermalhydraulic Phenomena, and future plant design subcommittees; reconciliation of ACRS comments and recommendations; status of the ACRS, members' assessment of the quality of selected NRC research projects and preparation of ACRS reports.

This meeting is conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Sam Duraiswamy is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. A transcript of portions of the meeting is being kept, and it is requested that the speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

If there are no comments from members of the public, I will move to the first item on the agenda for this morning, which is the proposed genetic communication of the use of ultrasonic flow measurement devices for measuring feedwater flow rates in nuclear plants. And Mr. Sieber you're welcome to take us through this presentation.

MR. SIEBER: Thank you, Mr. Chairman. This topic was assigned to the Plant Operations Subcommittee, of which I am Chairman, and this particular discussion has importance because the instrument that is involved is used as a way to determine and, in my view, the primary way to determine what the reactor power output is. The way that's done, if you go back 40 years when I was doing it by hand, you would look at the enthalpy rise between the steam and feedwater flow and multiply that by the feedwater flow, which had a certain accuracy associated with it, and then make some additions and subtractions for pump feed input and radiative heat loss and so forth. And that was the way that you determined reactor power.

And then you set the nuclear instruments to agree with that number. And then the operator would look at his nuclear instruments and determine what the power output was, but that was a secondary reading based on the calorimetric calculation that was performed in advance.

So the key instrument here is basically the temperatures of the steam in the feedwater and the feedwater flow rate. And, of course, the instrument here, the ultrasonic flow measurement system, measures feedwater flow rate.

And so what I would like to do is we're going to go through this discussion of problems that can arise and may have arisen in the use of ultrasonic flow measurements systems and the what the staff intends to do about that. I would point out, however, that the ACRS does not look at the legalities of how the staff performs its function. It looks only at the technical issues involved, and I think that this subject is ripe with technical issues. So I would caution all speakers to stick to the technical issues.

With that, we have with us Chris Grimes, who we all know from license renewal work and a multitude of appearances before us, who will introduce this topic and the staff speakers. Chris?

MR. GRIMES: Thank you, Mr. Sieber. I am Chris Grimes. I am the Deputy Director of the Division of Engineering -- is that better?

MR. SIEBER: That's much better.

MR. GRIMES: And the staff has come before the ACRS today to discuss a generic communication that we are preparing. It is not yet complete. I want to emphasize that we're sharing with the ACRS today our thoughts and reflections on concerns and reflections on operating experience regarding the accuracy of ultrasonic flow meters, as Mr. Sieber described, are used a principal input to a determination of plant power.

In preparation for this meeting, we held a public meeting on July 1 to share with interested stakeholders the presentation that we are about to give you today, and we received some valuable feedback from our stakeholders. The generic communication that we're preparing has been drafted as a bulletin, but we have not yet vetted the proposed action through Management review and the Committee for the Review of Generic Requirements, but we welcome any feedback and observations that the Committee can provide on the technical matters, as Mr. Sieber described.

The significance of this issue is relative to how accurate the power level can be measured but still maintain the plant operation within the licensed power level. The accuracy issues that we're going to discuss today are very small in comparison to the plant safety margins. So this is not an issue that is an immediate threat to public health and safety. This is an issue relative to public confidence in the regulatory process, and so that is the underlying motivation for the resolution of these concerns.

I also want to mention that this is a very controversial issue. This issue has been under study, debate and comment since the middle of 2000. And with that, I'd like to introduce Angelo Marinos who is the Section Chief of the Instrumentation and Control Systems in the Electrical Engineering Branch. He is going to provide a presentation, the staff's presentation.

I also want to point out, Dr. Bonaca, I believe that we have time on the schedule for a representative from Caldon. I think you said that there were no requests from the public for presentations, but a representative from Caldon is going to provide a vendor's perspective. And Jose Calvo has time on the agenda where he's going to put the technical issue into perspective relative to how we're proceeding with the resolution of these issues.

And so with that framework to the staff's presentation -- and I'm peddling just a little bit more until I see Angelos' slides come up on the screen.

MR. SIEBER: Keep going.

CHAIRMAN BONACA: If it fails, we have handouts and you can go to the presentation referring to the pages. I'm saying that if it fails, I mean we have handouts, so you can walk us through the presentation.

MR. MARINOS: I can start with Slide Number 2, which identifies the topics that we're going to discuss --

DR. WALLIS: Do you have the microphone on?

MR. SIEBER: Maybe the handheld microphone would be better.

MR. MARINOS: Can I have the microphone, please?

MR. SIEBER: Just for the record, we have to use the microphones because the court reporter needs to be able to hear --

DR. SHACK: It's better to put it on your necktie up close.

MR. SIEBER: Is it turned on?

MR. MARINOS: Okay? Can you hear me now?

MR. SIEBER: Okay. You're in good shape now.

DR. WALLIS: You have a bottle in the way. It's an AP 1000 on the screen.

DR. SHACK: Would you take that bottle out of the way?

MR. MARINOS: My Slide Number 2 is the presentation of the topics that we're going to discuss. Number 1, of course, is the thermal power measurement, as Mr. Sieber, briefly mentioned, and the various topics as we go along.

In Slide Number 3, I'll give you a quick summary of the type of principal parameters that play an important role in the calculations of thermal power. In the PWRs, thermal power is called calorimetric calculation, and I have listed the principal parameters. Starting with Number 1 is the feedwater flow, which provides about 80 percent of the uncertainty that is attributed to the calculation of the power, thermal power. And various other parameters are listed down below.

With regard to boiling water reactors, the calculation is called a heat balance calculation and has similar parameters with the feedwater being again the principal component that provides the maximum uncertainty with regard to calculations of the thermal power. Unless there's questions on this, I will go on to the next slide.

Appendix K, Part 50, ECCS calculation evaluation models, the Appendix K requirements that have been imposed on licensees until recently, till late 1999, was to assume the plant operating at two times the power calculated to account for uncertainty associated with instrumentation that measures the parameters.

In late '99, the staff decided to reevaluate, reassess the adequacy of that Appendix K requirement in considering of new technologies that were being presented to the staff with more accurate instrumentation that could be utilized to measure feedwater flow. So, therefore, the Item 2 in the bullet was introduced into the Appendix K, and the Appendix K was officially revised and published to account and to allow for licensees to use more accurate instrumentation and claim better accuracy and more power generation. So, therefore, the penalty was reduced to whatever the accuracy of the instrumentation would allow it to become.

In my next slide, Number 6, I have a typical depiction of a flow meter, ultrasonic flow meter that introduced to industry for use in the feedwater flow measurement. And this is a transit time technology instrument proposed by Caldon Corporation and is a clamp-on type instrument. This instrument indicates how the flow is measured by external transmitters and receivers at the other end at some angle from the flow, and two signals are transposed. One signal is going upwards, one downward, and the difference of the two signals received by the respective receivers will calculate the velocity of the fluid. And then, of course, that information will be put into the mass flow calculations of the feedwater.

DR. WALLIS: Now, this method measures the average velocity across a diameter, which is not the same as the average velocity over an area --

MR. MARINOS: Correct.

DR. WALLIS: -- which is what you want.

MR. MARINOS: That with a correction factors associated --

DR. WALLIS: There must be a correction factor.

MR. MARINOS: Correct. The correction factor will be entered to calculate the average velocity of the fluid, but this is merely the velocity.

DR. RANSOM: Is the shape pulse -- what sort of pulse, ultrasonic pulse do they use?

MR. MARINOS: I am not sure what type is a continuous signal. I don't know if it's a --

DR. RANSOM: They measure time and flight, I guess, as opposed to --

MR. MARINOS: The time, yes.

DR. RANSOM: -- phase shift.

MR. MARINOS: Not this one. It does not measure phase shift in this particular time.

MR. SIEBER: Well, let me ask another question. From zero flow to full flow, there is a difference in the amount of time that it takes to go from the transmitter to the receiving transducer. What is that time difference? Is that in the nanosecond range?

MR. MARINOS: As we indicated in the slide, it's one microsecond for measuring the actual flow. I don't know from lower flows to what would be the time.

MR. SIEBER: From zero to full flow,

microsecond.

MR. MARINOS: To my left, I'm sorry, I didn't introduce Iqbal Ahmed. He is working with me for a number of years under my supervision. We have both of us reviewing the technologies that you're presenting here. So we have a background.

MR. SIEBER: So part of the uncertainty associated with measuring flow in this instrument is the measurement of the amount of time that it takes for the signal to go from transmitter to receiver. And I would -- ignoring the fact that the flow is not parabolic and that you really don't know what the flow shape is as you open and close feedwater valves and you have elbows in the pipe and all kinds of things going on, I would presume that the measurement of that time is one of the contributors, one of the major contributors to the error, whatever error there is --

MR. MARINOS: That is the major, yes, indeed.

MR. SIEBER: Okay. And the other one is assumptions you have to make about what the flow shape is.

DR. WALLIS: The correction factor that we mentioned earlier must depend upon whether there are elbows upstream and all sorts of things.

MR. SIEBER: Well, it changes as you change power level, because close to where you measure feedwater is --

MR. MARINOS: Is the velocity purifier that you're referring to. Yes, those things are accounted for.

MR. SIEBER: It's the feedwater regulating valve. And when the valve is closed, you get a different shape than when it's wide open. And depending on whether you have steam-driven pumps or electric pumps, you're going to get a different response.

MR. MARINOS: Those are plant configurations that one has to account for.

MR. SIEBER: Yes. And with a single set of transducers, that's pretty hard to do. I mean you have to make a lot of assumptions to get there.

MR. MARINOS: Now, this instrument has not been approved by the staff for application in feedwater systems as it relates to Appendix K relaxation.

MR. SIEBER: Okay.

MR. MARINOS: As I will discuss later on in other slides, it was used for just merely to accommodate the venturi.

MR. SIEBER: Okay.

MR. MARINOS: So it was just merely used for --

MR. SIEBER: So in this application, the venturi is still the primary way to measure flow.

MR. MARINOS: Correct.

MR. SIEBER: Okay.

DR. WALLIS: Well, the next slide shows one with several transit times, which makes more sense.

MR. MARINOS: The next slide, yes. This is advanced technology by Caldon, and this is an in-line type instrument. Again, it's the transmit time. The principle is exactly the same as the one we just described in the previous slide. The only difference here is, as you see, this is a spool piece, and the transmitters are embedded into the pipe to, of course, minimize the influences of the external pipe effects.

DR. WALLIS: But now they're getting several slices. They're not getting one slice --

MR. MARINOS: Correct.

DR. WALLIS: -- they're getting eight slices.

MR. MARINOS: This is the chordal design, yes.

MR. SIEBER: Well, it has the advantage also of being able to accurately place the transmitter receiver errors so that you really know the distance as opposed to something you would actually clamp on the outside of the pipe.

MR. MARINOS: That's the intent of that design.

MR. SIEBER: Yes.

MR. MARINOS: And as I'm depicting over here, I have two cylinders with a plus sign. This is to enhance the accuracy and of course achieve better power levels and get closer to the two percent penalty of the Appendix K. So the one cylinder is called LEFM Check and the combination is called LEFM CheckPlus, which is down below, indication of the instrument. So both of those configurations have been approved by the staff, the single Check and the CheckPlus, for implementation in the feedwater systems. And the CheckPlus, of course, commands higher accuracy and more power uprates, as opposed to the Check.

Now we come to another technology, which is called the Cross Correlation, Cross flow, proposed originally by CEABB and then purchased or taken over by Westinghouse a couple of years ago. This technology is different in the transit time in the sense that the transmitters, of course, as you see, are in a -- it's an external device, and it has a transmitter and receiver on the other end perpendicular to the axis, and it has two of them, of course, one in transmitting and the other receiving.

The principle here is that the ultrasonic signal will be modulated at the A point, at the receiving end, at the transmitting end and received at the bottom of the receiving end. And then the same signal will be modulated again at -- not the same -- the eddys. There's eddys that flow in the pipe at this particular force. When the flow is turbulent, you will generate eddys. These eddys are modulating the signal, and then when they pass through that signal -- pass through that Point A to Point B, they're received at Point B, then the signal will again be modulated by the same eddys in a phase shift. And, therefore, there will be reconciliation of the two signals at the software to determine the delay time of that eddy. So that, again, will be used to calculate the average velocity of the fluid.

DR. WALLIS: And, of course, the eddys move at different speeds, so there's a whole spectrum of delay times, and there has to be some kind of intelligence signal processing or something to figure out what the errors are.

MR. MARINOS: There's a number of signals, yes. There is a discrimination. The signal is physically shifted by the particular eddy. So whatever the receiving end of that instrument will identify --

DR. WALLIS: It isn't a unique thing, though. There are different eddys, so there's some kind of smearing of the signal. They must be looking for some maximum cross correlation or something.

MR. MARINOS: Cross correlation is exactly what it is.

DR. RANSOM: There's an entire spectrum of eddys across the pipe, so I'm wondering how do you pick out which one?

DR. WALLIS: You don't. You get an average of the whole lot, and then --

DR. KRESS: I think your signal would have a pertebation time to it, and I think the pertebation time may be small compared to 50 milliseconds.

DR. WALLIS: But you see what I mean. Some of the --

DR. KRESS: That allows you to make sort of an average --

DR. WALLIS: Well, some of the eddys take

40 milliseconds to cross, some of them take 60 milliseconds.

DR. KRESS: Yes. Yes. But the difference, the 40 to 60 is small compared to --

DR. WALLIS: It may well be, it may well be, but that's one of the sources of error.

DR. KRESS: Yes. It's an error source.

MR. SIEBER: On the other hand, to interpret what the received signal means you have to make assumptions about the flow shape and the velocity profile.

DR. KRESS: It's a pertebation over the normal signal you get.

MR. SIEBER: Yes.

MR. MARINOS: Again, the velocity profile, it will be determined to generate the correction factor that will be applied with the velocity to generate the average velocity for the fluid.

DR. WALLIS: At the same point, if you have this control valve just upstream, you might have a jet along one wall, which would mean that --

MR. SIEBER: That's correct.

DR. WALLIS: -- the averaging is not very good at all.

MR. SIEBER: Well, they make an effort to not have the measuring venturi in these devices close to an elbow or a control valve. On the other hand, the basic freshman college assumptions about how long and how much distance it takes for flow to straighten out are probably too simplistic for an application like this.

MR. MARINOS: The delay time and the calculation for the average velocity and ultimately, of course, the mass flow rate of the fluid is calculated before the instrument is placed on the -- they have a general idea where they're going to install the instrument.

MR. SIEBER: Right.

MR. MARINOS: They calculate on some assumed values, hopefully close to whatever the conditions are of the fluid, and then the instrument will be placed there and see whether they can match. If not, they will have to evaluate more specifically the parameters that they are assessing, so the instrument may not be in the original place, may have to be moved further away in order to meet those expectations. So that's how it's adjusted.

MR. SIEBER: Yes. Just to give some perspective, my recollection of the size of the feedwater line, there is a line and a control valve for each steam generator in a PWR, and you're basically talking about maybe a 36-inch line. So this is not a small device, and these components are not small; they're big. And so when you talk in terms of downstream pipe diameters, you're talking many, many feet, which doesn't exist in any power plant that I ever worked in. They try to jam ten pounds of stuff into a two-pound box.

Could you use the microphone if you're going to speak, please? There you go.

MR. AHMED: However, in the particular part of this gas flow, revisions have been given that could take care of all these. We cannot say in public because all of them are proprietary.

CHAIRMAN BONACA: All right. So let's move on.

MR. MARINOS: Non-power rate used for all centimeters, as I indicated earlier, with the clamp-on type of the transit time instrument. These instruments were utilized extensively at plants for just assessing the power level without requests for relaxation of Appendix K requirements. And those instruments have been used as a one-time venturi calibration. We don't have any data on where they may be right now or whether they have been used. We believe that they have. Of course the ultimate objective of the bulletin is to find out where they have been used as a one-time venturi calibration. And another area where these instrument have been used is for power recovery for venturis, as we indicated.

We have been notified of various problems with the implementation application of the system in some cases. Maybe the instrument was not properly placed or the instrument was not properly calibrated there. My first bullet indicates the events that we have been notified of and know of in the use of these transit time clamp-on instruments. At River Bend, there was approximately about two percent over power, and at Palo Verde, more recently, we were notified that the instrument was removed because of potential over power between one to three percent. This has not been confirmed yet.

DR. WALLIS: How do they know That? They've compared it with something?

MR. MARINOS: I would say it has not been really confirmed yet. The over power at River Bend, two percent, was stated to us as a final conclusion. With regard to Palo Verde, it is not clear yet whether this --

DR. WALLIS: How do they know it? Do they compare it with some other measurement which is more accurate or something? How do they know that it's two percent over power?

MR. MARINOS: It's a surprise to me. I really do not have the data on this how they determine. We just accepted the fact that there was an overpower, and the instrument was removed.

DR. FORD: So how do we know we have a problem if you don't have a comparison with a more accurate meter?

MR. MARINOS: As we go along, I will speak to the instruments that we have as NRC-approved for use, and then I can speak to this this way. This particular application here was not approved by the staff, so we just merely had received this information on application of these instruments without approval from the staff, so we don't have 100 percent --

MR. LYON: Warren Lyon. With respect to River Bend, our understanding is they discovered the problem with the clamp-on device when they were upgrading to the more accurate in-line Caldon device.

DR. WALLIS: So they were comparing with something which was a more accurate measuring device.

MR. LYON: That is correct. I believe it was with the AMAG device, which, as you correctly noted earlier, takes eight shots and gets basically eight velocities and then feeds that in through the profile to see where they are.

MR. SIEBER: Now, this is a way of putting all this in perspective. If the feedwater flow instrument reads low, that indicates that the reactor is putting out less power than it perhaps actually is, and so the operator would manually increase reactor power. And if the amount that he increases it to get his meter to read 100 percent, that could put him outside the analyzed condition for Appendix K. Now, that makes the licensee in non-compliance and in an unanalyzed condition, which is a serious thing.

On the other hand, I think it's important to understand what this really means in terms of margin. Is the plant instantly going to melt down? The answer is no. If you have an accident, are you going to exceed the final acceptance criteria? That depends on how much margin you have. On the other hand, operating in an unanalyzed condition is forbidden by law, okay? And so that's why this issue becomes significant.

MR. MARINOS: With regard to the Bullet 2 of the cross flow clamp-on type utilization of Byron and Braidwood, there we do have information. We started to be concerned because of differences between Byron and Braidwood. Byron and Braidwood are sister plants and equally designed and expected to deliver the same power, but they were significantly different in power generation, so we started to look into that in Byron and Braidwood.

I am. I am showing the old slides. How did that happen?

MR. GRIMES: I think we should switch back to the paper slides. Those are not the slides that have been handed out to the ACRS.

DR. WALLIS: What's the difference?

MR. SIEBER: Looks the same to me.

MR. GRIMES: This is an earlier version of the slides. There are subtle differences.

DR. WALLIS: Well, that's not a major error. No safety implications.

DR. SHACK: Yes. If that's the biggest problem we have --

MR. MARINOS: So far it wasn't a real problem.

MR. DENVACK: Angelo? Angelo? My name is Steve Denvack. I'm the Section Chief in charge of Palo Verde here at NRC. I just wanted to add the point you didn't know how Palo Verde knew their instrument was inaccurate. Palo Verde was informed by Caldon, the manufacturer of the instrument that there may be a problem with their instrument. That's how they knew.

MR. MARINOS: Okay. Thank you. I'm sorry. So far it wasn't a serious problem.

So with regard to Byron --

DR. WALLIS: So wait a minute. This wasn't necessarily measurement that said they were in this condition, it's they were advised by the manufacturer that they might be in this condition. Is that it?

MR. MARINOS: Palo Verde?

DR. WALLIS: Yes.

MR. MARINOS: I guess. I received that information a week ago. We entered it into the slide for information to all of us.

MR. SIEBER: Well, that's what the manufacturer is supposed to do when they discover a defect, is to notify the licensee.

MR. AHMED: As far as we know, Caldon did go to Palo Verde and they made the determination that this instrument should be taken out because it's not reading correctly.

DR. WALLIS: Thank you.

MR. MARINOS: And with regard, as I said, to Byron, there was a mismatch between Byron and Braidwood, so we started to look into that, and the licensee did and did various tests using a -- actually, they used a tracer test to determine the actual instrument performance. So they arrived at these values of overpower.

MR. SIEBER: Okay.

MR. MARINOS: Again, this instrument was not -- though this instrument has been approved since, in the utilization at Byron it was not and it was prior to the -- so the way it was installed and commissioned it was not clear to us whether they have met the criteria that we have stipulated.

DR. WALLIS: Well, if you have a clamp-on thing, you've got to clamp the thing on so that the ends are within this less than one percent or whatever you want, the right distance apart, which may not be so easy to get it there, less than one percent, the right distance apart.

DR. RANSOM: And also you get dispersion and attenuation through the pipe wall as well as in the fluid. Are all of the details of how these inaccuracies are sorts out proprietary?

MR. MARINOS: They are proprietary. You

have been given copies, I hope, of the proprietary document that we reviewed year 2000.

DR. RANSOM: You mean you have those.

MR. MARINOS: I think we submitted copies to the ACRS.

DR. WALLIS: We saw something several years ago.

MR. MARINOS: No, for this meeting today.

DR. WALLIS: Oh, for this meeting.

DR. RANSOM: We have some reports from --

CHAIRMAN BONACA: Yes. One of them was proprietary.

DR. RANSOM: Yes. Are these NRC reports, I believe, right?

MR. SIEBER: It's hard to tell.

DR. RANSOM: The Allegation Task Group?

MR. SIEBER: It's hard to tell. You can't tell just by looking at the document who wrote it.

MR. MARINOS: No. That's not what I'm referring. I'm referring to the actual topical report received by us for review, formal review in year 2000 by ABBCE for this estimate with the specific formulations for addressing the issues that you are --

DR. RANSOM: I don't know. We haven't seen those, I don't think.

MR. SIEBER: Well, one of the unfortunate things about this presentation is there was no subcommittee meeting on this subject. And the documents came piecemeal, the latest of which was this morning. And so it's difficult for us to follow what goes on in this meeting when there's no advance preparation for it.

CHAIRMAN BONACA: Why don't we let them -- I mean do you have more information provided? I understand they're not providing proprietary information, but, certainly, you can give us general statements about what kind of factors or parameters you're taking account of or they are taking account of.

MR. MARINOS: Well, we can tell you that, yes, there's a determination of profiles that are extremely proprietary. There are mathematical formulations that are novel, and so we can -- that's about all we really can say in an open meeting. In a closed meeting, we can delve into more details about how those things are addressed and the uncertainties that you are referring to are accounted for.

CHAIRMAN BONACA: Well, then let's proceed and then see if in fact this lack of information on our part makes it hard for us to come to any conclusion or if in fact the issues that you're going to present here, and I understand you have several presentations, are going to be -- we can deal with them without specific information.

MR. AHMED: In a nutshell, it is about 85 percent proprietary.

MR. GRIMES: Dr. Bonaca? This is Chris Grimes. I mentioned at the outset that this is work in progress and that we know we've fed some information to the ACRS in a piecemeal fashion. Angelos is going to describe a certain amount of the evolution and timing and the references, and we will go back and we'll put together a more complete chronology and reference list that we can provide to the Committee that you can review in the future and then let us know which specific matters that you want us to present to the Committee at a later time.

DR. WALLIS: Well, Chris, what are we being asked to do? It seems that you approved some instrumentation which now may not be up to quite the accuracy that you thought it was? Is that the problem?

MR. GRIMES: Yes, sir.

DR. WALLIS: Now, what are we supposed to do about that? Are we supposed to do a technical analysis of these instruments?

MR. GRIMES: We're here to inform the Committee about a generic communication in process.

DR. WALLIS: Okay.

MR. GRIMES: And we welcome your feedback, but we're not requesting the Committee make a specific recommendation or write a letter or take an action at this point.

DR. WALLIS: So you want to know that you are on sound technical grounds; is that what you're --

MR. GRIMES: We expect to find out whether we're on sound technical grounds when we present our final recommendation to the CRGR. And in the normal process of a generic communication, we would then come to the ACRS and present the final action that's proposed. In this case, because the CRGR review and decision would occur in August and the Committee doesn't meet, we didn't want to unnecessarily delay the completion of the generic communication, so we're actually coming to you out of sequence, because the Committee doesn't meet in August.

MR. SIEBER: And, basically, you've chosen the generic vehicle to be a bulletin, which just asks for information from licensees.

MR. GRIMES: The form of a generic

communication in a bulletin, it requires that the licensee make an affirmative response in finding that the staff can then follow up with verification inspections where and if appropriate. If it were just to inform the licensees of an issue that they need to deal with, it would take the form of a regulatory information summary or at the minimum an information notice. And it's conceivable that during the course of the evolution of this recommendation, as Jose will describe, it may change its form. Right now we're proposing a bulletin.

MR. SIEBER: Well, the other choice you could have had was to use a generic letter, and even though generic letters and bulletins do the same thing, it seems to me back in the days when I was an addressee that I read the bulletins first and then the generic letters right after that. So there is an implied degree of importance that goes to the choice of what the staff decides to use to communicate with licensees. And perhaps later on you could tell us why you chose the bulletin as opposed to a generic letter.

CHAIRMAN BONACA: Okay.

MR. MARINOS: This is staff review of topical reports, and I'm coming to you now about the two technologies. First, we reviewed the Caldon in-line type, the one that is in spool with the instrument inside the pipe. We reviewed that report in 1997, and we issued a safety evaluation report in March of '99 approving the document demonstrating the accuracy of the instrument, as submitted to us.

DR. WALLIS: And this is the one that just has one ultrasonic beam and not a --

MR. MARINOS: This is the LEFM Check. This is the spool type with the --

DR. WALLIS: The simplest one. This is the simple one.

MR. MARINOS: No.

DR. WALLIS: Oh, this is the eight one?

MR. SIEBER: Four

MR. MARINOS: I will go back.

MR. SIEBER: But they didn't cross.

MR. MARINOS: How do I go back?

DR. WALLIS: The Check is the simple one. The first one is just a simple one.

MR. MARINOS: If you look at the Slide Number 7 --

DR. WALLIS: But the first one is the simple one.

MR. MARINOS: -- it would be the LEFM Check.

DR. WALLIS: That's the second one. That's the second bullet. The first one is just simple LEFM by itself.

CHAIRMAN BONACA: I mean you have an SER for all of them, right?

MR. MARINOS: Not for this one. I'm just putting it on the board.

DR. WALLIS: You don't? Because that's what it says.

MR. MARINOS: This was not submitted for approval by the staff, so we never did.

DR. WALLIS: Am I looking at the wrong slide then? If it has a little checkmark, the written check, it's the --

UNKNOWN: The CheckPlus is written, and the Check is just checked.

DR. WALLIS: Okay.

MR. SIEBER: Obviously, you didn't read my draft letter. I didn't know how to make a check on my computer, so I spelled it out.

DR. WALLIS: Okay.

MR. MARINOS: We reviewed the LEMF Check and we issued an SER in '99, March of '99, approving the claim accuracy, and a follow-up report with the CheckPlus, as I showed in the slide, with the two put together more transmitters are placed there, so higher accuracy is claimed. And we also approved that particular accuracy claim in December of 2001.

Next, we reviewed the CEABB topical report that was presented to us in August of '99, and that refers to the technology, the cross correlation, which is different technology than the Transit Time, and we issued an SER in March of 2000 accepting the documented accuracy.

DR. RANSOM: What were those accuracies based on? Calibrations made at the manufacturer's facility or -- I mean they must have had some primary way of measuring the amount --

MR. MARINOS: There is a number of ways. Some are proprietary. I can only say that for this particular, the AMAG instrument, there's a number of data that were collected from actual applications to compare against venturi application in the in situ tests.

DR. RANSOM: Comparison to venturis?

MR. MARINOS: Yes. Clean venturis with the known accuracy, right.

DR. RANSOM: There was also some implication that weight tank methods were used?

MR. MARINOS: Yes. Yes. Yes. And other

methods. I don't know how far we can go, Iqbal, in proprietary space.

MR. AHMED: Well, in general, what we can say that first they developed this family which are all proprietary, theoretically. Then they established that the curves follow on the lab, and then they also tested at the power plants and the curves follow. That is what --

DR. RANSOM: At the power plant, they would use the venturi measurement, I guess, for comparison?

MR. AHMED: No. First, they developed a curve, theoretical curves. Then it was -- the only thing I can say that there were the three steps. If I go in detail --

MR. MARINOS: Yes. We'll delve into the proprietary nature we're concerned about.

MR. AHMED: I told you 85 percent of this is proprietary.

DR. WALLIS: So we get into the usual situation where you give us slides which are a whole list of historical events and letters and reports, and there's no technical information and no data. So how can we evaluate anything?

MR. AHMED: We were under the impression

that this has been --

CHAIRMAN BONACA: Well, let's -- I think you're finally talking about the public concerns, and we understand the extent of the concerns and what has been called the allegations, because we had two allegation documents in our hands. So maybe we have to go through those and see what those issues are.

MR. SIEBER: Well, one of the things we don't have, or at least I can't find it in the package of materials that I got today, is the SERs where the staff approved these instruments in the first place, and I think that would be helpful.

MR. MARINOS: You did not receive them, the SERs?

MR. SIEBER: No. Well, I don't know. You gave me a bunch of papers and --

MR. MARINOS: George Dick was the liaison between your staff and us, and --

MR. SIEBER: Did I get that?

MR. DICK: I didn't bring that with me.

MR. SIEBER: Well, see, that's the starting point. How did the staff make the determination in the first place, what factors did they consider and how valid was that determination? Then I think we can go from there and look at what has evolved since then.

CHAIRMAN BONACA: But the reason why I would like to hear about the allegation is that central to the whole issue from the perspective of the ACRS is the safety issue. Is it a safety issue and what significance do we assign to it? What errors has been alleged to be introduced, what factors are there that have been considered by the manufacturer as conservatism, because I understand there were assumptions made? And so at least we get a sense for --

MR. MARINOS: We will address this as we go along in our presentation.

CHAIRMAN BONACA: I would like to hear that so at least I get a feeling for why a conclusion was made at the beginning by Mr. Grimes that this is not such the issue of immediate concern. And so I would like to have an appreciation for that, and I think you have enough information at least you can communicate to us of the extent of that.

MR. AHMED: It may be helpful to put in two sentences, that when we approved the topical reports, we still believe that both instruments had the accuracy. At the end of the presentation, you will find that they have the application problems which have come up, and because of those problems, there were allegations on the application problems.

MR. GRIMES: Dr. Bonaca and Mr. Sieber, I would suggest let Angelo go through the chronology of the evolution of the concerns, and I've made a note that we'll go back and look -- we'll make sure that we provide you with a complete list of references, and we'll point you at where you can find the technical information associated with the accuracy issues in those references that Dr. Graham referred to, and we'll lead you to where the information is that you --

MR. MARINOS: The SERs are good road map to guide you. Of course, it will refer to sections of the document that are proprietary, but, unfortunately, you don't have it.

MR. SIEBER: Well, on the other hand, we're cleared for proprietary information. The SER is important, the topical reports are important, because you can't work with one without the other. And it would be better if you provided us with copies of the documents rather than point us. I'm too old to take pointing very well.

MR. GRIMES: Mr. Sieber, I'm sorry. I meant to say we'll provide you with copies of all the reference materials and, in addition, show you where you can find the information so you don't have to review all of it to find the information you're interested in.

MR. SIEBER: Right. Well, don't give me any more than I need.

(Laughter.)

Thank you.

DR. WALLIS: So what are we supposed to do? Are we supposed to review all this stuff and make a decision which is --

MR. ROSEN: I think what Chris Grimes just asked us to do is to listen, and I would really like to do that. I would like the other ACRS members --

DR. POWERS: I wonder if the leadership of the Committee could speak with one voice instead of two.

CHAIRMAN BONACA: Okay. I'm saying that let's hear the rest of this presentation and then make a judgment at that point.

MR. SIEBER: Okay.

CHAIRMAN BONACA: Because there is a history of actions here that is being presented, and they may address some of the issues we have discussed her.

MR. SIEBER: Okay.

MR. MARINOS: This is Slide Number 12. It just indicates the number of plants that have been granted power uprates for both technologies. But anticipating that we will have a number of licensees taking advantage of these technologies and ask for the relaxation of Appendix K, we engaged industry a number of times in workshops and we developed regulatory information summary where we identified specific criteria and requirements that they should address for us to make the evaluations more efficient and quick. So we issued that regulatory summary in January 2002.

Subsequently, we have evaluated a number of plants, and the second bullet identifies 21 plants that presently employ the Caldon in-line instrument. In some cases, the Check; others the CheckPlus. And the bottom bullet identifies 12 plants that have been using the AMAG cross flow clamp-on type instrument for power uprates. They range between 1.4 to 1.7 power uprate.

Public concerns of the UFM accuracy. On March 8, 2000, the NRC met with Caldon at the request of Caldon where Caldon expressed concerns with the technology of the cross correlation, cross flow instrument that Westinghouse -- pardon me, Combustion and AMAG had submitted to us for review. Over the process of reviewing that instrument, they've known all that, and raised concerns about the technology and wanted to give us information ahead of time so that we would consider it in our evaluations of the technology.

DR. WALLIS: Now, this was a week before you issued an SER which accepted the accuracy of the --

MR. MARINOS: Correct.

DR. WALLIS: So this had no effect on the SER.

MR. MARINOS: It had no effect on the SER. Prior to March 8, they had communicated with us with some public information technical documentation that dates back to February 16, actually. I didn't place it in this list because I didn't think it was that important, but as early as February 16 is when Caldon contacted the staff with some documentation of a public technical information in a binder that was provided to us. We evaluated that, and we granted them a meeting of March 8, and they followed up with letters reaffirming their position that this technology has questions. On March 15, they restated that the bounding value claimed by the Westinghouse AMAG cross flow instrument of 0.5 percent is not accurate, and in a March 17 letter, they restated that the instruments could be -- there are estimations that could be as high as three percent inaccurate. And then we issued the minutes of that meeting on March 17, internal documentation, and on March 20, we issued that SER, as we indicated.

DR. RANSOM: What were those memos based on? Now, Caldon is a competitor to Westinghouse; is that right?

MR. MARINOS: Right.

DR. RANSOM: But they had done independent testing of the Westinghouse meter?

MR. MARINOS: I don't think so. From public pronouncements, it was stated -- we have it in the chronology that they do not have much knowledge about the cross flow. The statements that were made prior to that and reported in the press it was that they have knowledge of the cross correlation technology but not about the cross flow. Cross flow is a cross correlation but with specific technical features that are specific to AMAG. So there are those, so I really --

DR. RANSOM: And what did they base their statements on?

MR. MARINOS: Their statements are that

the velocity profiles cannot well be defined. There's too many uncertainties associated with this type of technology to accurately account for uncertainties associated in establishing velocity profiles for correction factors to the time that we indicated between the transmitters on the eddy.

DR. RANSOM: Is that just a professional opinion or --

MR. MARINOS: In the meeting of March 8, there was a number of technical consultants that were -- Caldon brought a number of consultants to support their claim that this technology cannot be implemented accurately. And we listened to the technical arguments and decided that we had, as Iqbal indicated, 85 percent of this technology is not publicly available, it's proprietary. So how uncertainties were accounted for we could not share that with the public or any one of the consultants that participated in the public meeting. So we decided that we were satisfied with the information we had to issue the SER accepting the technology.

DR. WALLIS: Well, I would think that these uncertainties could be determined in the form of some mathematical relationships, which would not be proprietary since they could be deduced by anybody with appropriate expertise.

MR. MARINOS: There are mathematical formulations that they generated that are not available in the public --

DR. WALLIS: But anybody with sufficient knowledge should be able to deduce these mathematical formulations.

MR. MARINOS: That's correct. But there's also other data there that --

DR. WALLIS: So you could find a suitable consultant who could do that.

MR. MARINOS: There is proprietary information to clarify your question.

MR. SIEBER: Okay.

MR. MARINOS: This is a continuation of the public concerns Caldon submitted to us in January of 2002, an engineering report for ER 262 in which they had identified a phenomenon that they had not accounted for previously as it relates to their instrument in the earlier Check instrument. And that was the swirl velocity phenomenon that caused the instrument to exceed its bounds.

MR. ROSEN: Would you say that again? What phenomenon?

MR. MARINOS: Swirl velocity.

MR. ROSEN: Swirl velocity.

MR. MARINOS: Correct. And led them to a reevaluation of the instrument's performance and led them into the reevaluation of the clamp-on type instrument, which was not approved by the staff, and realized that inaccuracies or uncertainties related to the instrument based on that phenomenon could be higher than they expected before. So they nullified some of their licensees who were using the clamp-on type instrument to either remove it or reassess the application of the instrument.

They submitted this report, however, to also notify us. It was voluntary information to us that other clamp-on instruments, such as the cross flow, would have the same -- would be affected equally by this phenomenon, as they indicated. It was not submitted to us formally for review for us to submit -- to write an SER. We informally informed them back that, yes, we agree with their conclusions that the instrument -- the LEFM in-line instrument used for power uprates could correctly account for this if the bounding value for the instrument is placed correctly in an alarm. So, therefore, we took no further action with the report.

Caldon contacted us again and requested

that we formally review this topical report, this report of theirs, and the staff charged them for that, because any formal review we do the licensees or any vendors would have to be charged for it. We conducted this review. In the meantime, this document was a public document. Westinghouse voluntarily submitted an unsolicited report challenging the conclusions and insinuations, so to speak, by Caldon regarding the cross flow instrument.

We evaluated that document also, and we finally issued a formal safety evaluation report of the ER 262 reaffirming our conviction -- conclusion that the LEFM in-line instrument would not be affected in its performance as Caldon applies it for power uprates and at the same time indicated to them that the phenomenon that they identified that affected their instrument had no relationship to the AMAG cross flow instrument because the technology does not -- that's it, I'm not going to say anymore.

MR. ROSEN: That is the swirl velocity phenomenon.

MR. MARINOS: The swirl velocity.

DR. WALLIS: Well, it seems to me, I was thinking here that if you have swirl in the pipe, that it has everywhere a velocity component in the direction of this transmitted beam, and therefore it's bound to affect the reading.

MR. MARINOS: They identified that, correct.

DR. WALLIS: Yes. And this has been sorted out by some suitably competent expert? It seems a very straightforward thing to do.

DR. POWERS: It definitely does not seem like a straightforward thing to me to do.

MR. SIEBER: Let me ask an additional question. The title of your slide and the previous one is, "Public Concerns of UFM Accuracy." Now, in the nuclear world, there are three people. One of them is the licensee, another one is the staff, and the third one, which encompasses everybody else, is the public. But the documents that you showed here seem to me to be an argument or letters between Caldon and Westinghouse. Is there any other public interest where you have gotten letters or what have you or are these two entities the public of which you speak?

MR. MARINOS: Yes. I have no knowledge of anybody else's --

MR. SIEBER: Okay.

MR. MARINOS: -- concerns.

MR. SIEBER: That helps me understand a

little bit.

MR. AHMED: On the previous question that was about the swirl not affecting the cross flow, it is very clearly explained, defined in the proprietary section of 15689 double gap.

MR. MARINOS: Again, we cannot discuss the details because of the proprietary nature.

MR. SIEBER: Okay.

MR. GRIMES: Mr. Sieber, and I would like to point out in addition to the controversy surrounding the views of the two vendors involved, there also have been throughout the course of this dialogue some allegations raised by individuals who work in the industry related to the performance of these devices.

MR. SIEBER: Okay.

MR. GRIMES: So there is that source of information as well.

MR. SIEBER: Okay. That's helpful. So they're either licensee employees or vendor employees. Who knows, right? Okay. Go ahead. Thank you.

MR. MARINOS: Staff concerns of UFM accuracy. The agency, given all this background over the number of years, decided to take an independent review -- conduct an independent review of these instruments of both vendors, and this task force was commenced in February and issued the reports in mid-April.

In June of 2004, the list of bullets identifies their observations and recommendations. It says Bullet 1, "Identify issues with regard to one-time use of the instrument, power recovery and power uprate applications." They have, based on the information that they collected in meetings that they had with Westinghouse, they identified sensitivity of plant configurations and based on performance, of course, at Byron. Byron demonstrated to the staff that there were configuration situations where the instrument will not perform as expected to if the configurations were not properly accounted for or bounded. More importantly stated is that they should have been bounded.

And based on the limited time that they had to do these evaluations -- as you understand, it was only a few months -- they were left with the impression that the instrument may provide the expected accuracy if properly implemented. And so the emphasis would have to be placed on the actual implementation application and configurations that the instrument is being applied at.

They identified that some Caldon clamp-on instruments had not provided the accuracy, as we indicated, at some of the events that occurred with the clamp-on type of the Caldon instrument. And the Caldon LEMF Check and the CheckPlus appear less sensitive installation and configuration clamp-on than the clamp-on designs.

DR. RANSOM: One clarification on the Caldon clamp-on. Is that just one single beam as opposed to the Check which has three beams and the CheckPlus has six beams?

MR. MARINOS: Yes, only one. Yes.

DR. RANSOM: But its clamp-on has just one beam; is that right?

PARTICIPANT: No, that's not correct.

MR. MARINOS: Is that correct? Let me see here what we have. I think we can -- yes. We may have the wrong picture up, because when we had the public meeting, Caldon informed us that this was a generic --

MR. GRIMES: Herb, there's a microphone right over there on the other side of the post.

MR. ESTRADA: Just to correct the information, there are four, not three, beams -- Herb Estrada of Caldon. On the facts, there are four beams in the LEFM Check and eight in the LEFM CheckPlus. And in caldon external meters, which has been pointed out are not used for uprates, there are typically four beams. They're not obviously -- there are two diagonal beams, usually located at right angles to each other so that transfers to velocities do not affect the measurement. And then there is a cross path that's directly across two cross paths. The purpose of that path is to get an accurate measurement of the sound velocity unaffected by law, so to speak, so that you can get an accurate reading.

The ACRS was correct earlier when they said that type of meter is in fact sensitive to velocity profile. You don't in fact require knowledge of the velocity profile to translate those two diameter readings of velocity into a volumetric flow.

DR. RANSOM: So the situation is somewhat more complicated than simple views, I guess, right?

MR. SIEBER: It appears to be the case.

MR. MARINOS: Another observation the task group named was that it did not information based upon recent insights that demonstrates all UFMs are providing accuracy, which leads us, of course, to the recommendation at the bottom where a recommendation was made that the bulletin be issued so that we can resolve all these concerns that we have.

MR. SIEBER: Okay.

MR. GRIMES: Mr. Sieber, this is Chris Grimes. The task group was headed up by Jerry Wermiel. Jerry and two of the task group members, Cliff Doubt and Warren Lyon, are here and can respond to any particular questions about the review that they did. But we want to emphasize that you'll notice that their efforts extended from February in 2004 until mid-April of 2004, and so the lack of information available to them was primarily a result of the compressed review time that they had to look at this particular issue. And we want to make sure that the point was clear in the task group findings.

MR. MARINOS: And you lead us to the last slide, which is the recommendations for our bulletin. We have identified key elements of the bulletin where we advise the licensees that plant operating experience at some installations has led to the staff to conclude that both of the instruments may be -- we have questions about the application and the performance of the instruments.

MR. SIEBER: Let me ask a brief question. Let's say I was a plant operator and I decided to buy one of these instruments. Would that automatically presume that I would use that instrument as the primary and sole indication of feedwater flow for the calculation of calorimetric power?

MR. MARINOS: If they want to use it for the benefit of relaxation for Appendix K, yes, if I were to buy the instrument, I will use it because of the fact that the NRC has approved a certain accuracy which is higher than the conventional instrumentation that has been applied over the number of years. So it is to their benefit to do exactly that.

MR. SIEBER: Okay. I can't think of any other reason to buy one other than to use it as the primary instrument. Did anyone buy one and not use it in that fashion other than to experiment with it?

MR. MARINOS: Yes. Many plants have used the instrument without having asked for relaxation of Appendix K.

MR. SIEBER: Okay.

MR. MARINOS: So they use it in place of the venturi just for recovery. The venturi, of course, when it fouls it gives you false information in a conservative direction, so you assume more power than you're actually generating.

MR. SIEBER: Right.

MR. MARINOS: So it's extensively been

used, both technologies, for recovery from venturi fouling. That's one significant application. But other licensees that I listed in one of my slides, they have asked for the relaxation for Appendix K.

MR. SIEBER: Okay. So you really don't care about licensees who may own the instrument and have applied it but don't use it for --

MR. MARINOS: We care very much right now, and this is why we sent the bulletin, because, as we indicated in the earlier slide, the instrument, if misapplied, you could get the wrong values, and you can overpower beyond the Appendix K penalty, which covers all uncertainties. And this is where we indicated earlier in the slide that we have events like at Byron and at River Bend where they were using the instrument for no power uprates and we have realized they have been reporting to us --

MR. SIEBER: And still they ran over power.

MR. MARINOS: And they run over power, over the two percent penalty. So that is a concern to us.

MR. SIEBER: Okay. That helps me understand the scope of what the issues are. Thank you.

MR. GRIMES: Mr. Sieber, I thought I had originally heard your question to be we don't care about uses that are different or separate from measuring power --

MR. SIEBER: That's right.

MR. GRIMES: -- and demonstration compliance with the license. To the extent, we're less concerned, but the generic communication is intended to inform anyone who uses an ultrasonic flow meter of the potential concerns regarding the intended or achieved accuracy.

MR. SIEBER: Okay.

MR. GRIMES: And our focus here is to try and take an affirmative action to have licensees provide a demonstration of the achieved accuracy in its installed condition. And that's what underlies the recommendation for confirmation of the accuracy. And that is a very controversial point in terms of doing a comparison of this superior instrument to an ASME flow nozzle or venturi which even in a clean condition has its own accuracy. And so that's a part of the controversy that we will continue to pursue.

MR. SIEBER: Okay. Thank you.

MR. MARINOS: And, furthermore, the task group identified concerns with regard to the Caldon

Check and CheckPlus instrument because of plant configuration sensitivities also identified. As we indicated before, the swirl velocity was another indication of problems. The pump or valve alignments may have created a configuration issue that the instrument may be sensitive too and to some degree, some technical data that can support instrument performance. So based on all these considerations, we felt that the Check and CheckPlus instruments of Caldon should be included in the bulletin.

DR. WALLIS: But wouldn't you Bullet 3? I mean it seems to me that to get a really good measurement with an orifice, you have to have a huge number of LOVD upstream and all this kind of stuff. Are you going to insert this in the plant with all these LOVD requirements. You can't do that, there's no room to do it. It says in operational plant conditions. You're going to put an ASME flow nozzle in the plant?

MR. MARINOS: They are there.

DR. WALLIS: But you don't have all the --

MR. MARINOS: Okay. We've come to the recommendations. Okay. The recommendations, we say to them that every plant has either a nozzle or a venturi, of course, because that's how they calculate power presently prior to this instrument. And in the case of Westinghouse's instrument, AMAG, that venturi or nozzle is actually -- we apply a correction factor to it, so the information coming out of the instrument does not go directly into the calorimetric calculations or the heat balance calculations. It goes to a correction of the venturi, so it maintains the proper flow.

With regard to the Caldon LEMF, in most of the situations, they go directly to the calorimetrics. However, again, the venturi is relied upon for allowed outage times. When that instrument is not available, the Caldon instrument will continually provide a correction factor, and it will freeze at the point where the instrument is no longer available for a period of time that we have accepted in individual licensee applications. So it's per licensee application. So it may go from two days to three days, four days or whatever the number is. I don't have exactly what it is. So the venturi is relied upon for the power calculations with a correction factor fixed until the instrument is put back in the line. So the venturis are there, or nozzles, for use.

DR. WALLIS: But they're not as accurate as these other ones, and you're trying to check.

MR. MARINOS: The knowledge we have -- I beg your pardon? The knowledge we have of a venturi, clean venturi, that's tested is between 0.25 to 0.3 percent accurate.

DR. WALLIS: That's upstream conditions and everything, but you don't have that in the plant, do you?

MR. SIEBER: No.

DR. WALLIS: You've got to be very careful with a venturi or nozzle to have a straight pipe and no swirl and no valves and all that kind of stuff, all the things that you have in the plant.

DR. RANSOM: Do any of these installations use flow conditioning or flow straighteners upstream of the flow measuring device?

MR. MARINOS: I don't know of any. They use -- do you have any knowledge of that?

MR. AHMED: In the plant, they could be, because I have seen some reports where they created the plant mockup where they have put these kind of things. I cannot be sure.

DR. RANSOM: That would seem like an approach that would tend to reduce effects of swirl and asymmetry in the velocity profile.

MR. SIEBER: Yes. One of the problems,

though, is it also introduces a pressure drop and that costs money to overcome. You need a bigger pump to put more energy into the pump. So if you generate one extra megawatt per hour, that's $34 or something like that back in the days when I was doing it, and you need to do that for a long time in order to start talking about big money.

MR. GRIMES: This is Chris Grimes. First of all, I'd like to clarify a point with respect to the second bullet. The task group specifically describes the laboratory calibration of the Check-CheckPlus device, and the questions that they raised relative to how well that information is used then to demonstrate plant-specific installation. But they put a lower priority on that and did not recommend a specific action. So there is a distinction to be made between the degree of demonstration of installed capability between the Check and the CheckPlus device and the clamp-on devices, which is described in the task group report.

With respect to the confirmation of installed accuracy for any ultrasonic flow meter, Angelo has described a rationale that we've tried to put together that is a means of trying to verify the installed capability relative to the flow profiles and knowledge and capability that either or any of these devices attempt to achieve and a means of trying to at least do a sanity check, if you will.

This isn't the underlying technical basis upon which the staff's evaluation concluded that these accuracies are achievable, but the experience goes back to has it been installed and is it being operated consistent with the assumptions and the underlying safety evaluation basis upon which the staff made a finding that these accuracies are achievable.

And so to that extent, we're not trying to now use an ASME nozzle anything more than a referenceable standard in the way that you'd try to use any referenceable standard to go back to verify that you're doing things the way that you intended.

So there is also that distinction to be made with respect to -- but this is a very controversial subject with the industry in terms of the costs and the effort involved and implementing this kind of recommendation, but what we've come up with is a means of trying to settle the controversy about whether or not the as-installed, as-operated conditions are at least close to what the expectations were and the theory and the safety evaluation basis.

MR. MARINOS: And as we say, the bottom of that recommendation, that we will acknowledge any other standard of known accuracy. And one that we know of is a tracer test that has been conducted in other places. So if the nozzle or the venturi could not meet the accuracy requirements to check the instrument, there is other standards. I only brought up tracer because I know tracers are other things that may be available to them.

MR. SIEBER: What is that, a sodium test?

MR. MARINOS: Could be sodium, yes.

MR. SIEBER: Okay.

DR. WALLIS: And there's all kinds of problems with tracer tests too, with axial diffusion and all sorts of things.

MR. SIEBER: Well, every measurement you take no matter what it is has some error associated with it and some uncertainty.

MR. MARINOS: If we can reconcile the error, we can normalize the values, of course, and you can compare the instrument against that standard knowing its accuracy, and then if the values come out to be consistent with that accuracy, then -- with a number of data, not just one -- then you can make adjustments about the instrument's performance. That's where we're really coming from.

MR. SIEBER: Right.

DR. RANSOM: Is there any concern with off-nominal operation of these devices or are you mainly just interested in full power, full flow conditions?

MR. MARINOS: It's a full flow condition, I guess.

MR. SIEBER: Right.

DR. RANSOM: That's the main one.

MR. MARINOS: That's the main -- that's the important thing for them, right.

MR. GRIMES: This is Chris Grimes. The last bullet there refers to confirmation from the licensee relative to full power operation. If they're using the device at less than that, we don't have a regulatory concern.

MR. SIEBER: I would imagine this device is not suitable to use in a control system, because during transience it will not perform as expected. So there you would have to rely on a venturi or a nozzle or an orifice or something like that to measure flow, for example, the control of the feedwater valve. So this is truly an instrument that has no control function.

MR. MARINOS: Right.

DR. RANSOM: Well, along that line, is there any time-bearing change in the flow rate that you control in terms of this power measurement?

MR. SIEBER: Not really. There are certain -- when you make a calorimetric measurement to adjust your nuclear instruments, you do some things to the plant so that you can make the plant operate in accordance with the assumptions that go into the calculation of calorimetric power, you know, the letdown rate, cooling water rates, and you keep the plant as steady as you possibly can during that period of time at a known, supposedly known power level at a steady state.

DR. RANSOM: Is that a demonstration that you just have to do once or periodically or --

MR. SIEBER: You can do it -- we used to do it every day. Now with computers you do it all the time. But in the old days, you had to walk around with your clipboard and your copy of Keenan and Keys and fill out a sheet and actually use a slide rule.

DR. RANSOM: If you're doing it hourly, it could still be in a -- you do a little bit of load falling, I guess.

MR. SIEBER: Now, you can fix the output of the station. Very few nuclear plants do load falling.

CHAIRMAN BONACA: I understand we have two more presentations, maybe three.

MR. SIEBER: Yes. Are we done?

MR. MARINOS: I'm through if you have no more questions.

MR. GRIMES: Unless there are further questions, Jose Calvo has a presentation to put this issue into perspective, followed by a presentation by Caldon and their views about the nature of the problem and the action.

MR. SIEBER: I'd like to thank the speakers for their presentations. Thank you.

Will you need the microphone?

MR. CALVO: We can put it in just in case.

MR. SIEBER: Makes for a better transcript.

MR. CALVO: My name is Jose Calvo. I'm the Chief of the Electrical Instrumentations and Control Branch. I would like to present for your consideration a different approach other than the bulletin for addressing the ultrasonic flow meter issue that causes nuclear power plants sometimes to operate above the licensed thermal power.

I believe that the proposed bulletin

ratchets this issue to a level higher than is necessary, and the NRC needs to portray a strong regulatory position, but most importantly, the NRC needs to be fair. Without being fair, the agency may damage its credibility. Furthermore, the bulletin is not needed, and it will not fix the problem to remedy overpower conditions, as I will explain later.

There is no proprietary information involved in my presentation, so you don't have to worry. Next slide.

The topics for my presentation are here, and I will address the following topics, which I hope will place the issue of ultrasonic flow meters in proper perspective.

Safety significance. First, the plant process computer in boiling water reactors and in pressurized water reactors in nuclear power plants are used to calculate thermal power. The calculation is displayed to the operator. There are no systems which act automatically upon calculating thermal power output by the plant computer. The operator verifies independently of the PC, using other secondary plant parameter readings and expected process values correlated to thermal power, that the current calculated thermal power output is acceptable and thus it will not exceed the licensed power level. The operator can then increase or decrease the power level very slowly in the boiling water reactors by --

DR. WALLIS: So he knows -- your fourth bullet

MR. CALVO: I'm sorry?

DR. WALLIS: -- he will know -- if the calculated thermal power is two percent too high from the flow meter, the secondary plant information will tell him that it's two percent too high?

MR. CALVO: I think it's a correlation between thermal power and first stage pressure in correlation, and they've got values knowing that by that time for that first stage pressure this is what my thermal heat --

DR. WALLIS: So he will see that there's some inconsistency?

MR. CALVO: He will see some inconsistency. And I will explain as I go later.

DR. WALLIS: Okay. You will. Okay.

MR. SIEBER: Have you asked operators --

MR. CALVO: Oh, yes.

MR. SIEBER: -- if they look at first stage pressure to assure themselves the calorimetric power is accurate?

MR. CALVO: After being involved with some presentations by the licensees who came to the NRC to discuss this, and they showed some curves, some trends, and they're here today. If you wanted to get a little more detail into that, they can tell you about it. So this is something that I'm not saying. It's a correlation, and I think to some degree it's how accurate is that secondary plant variable, and I think we can get to that one. What I'm trying to bring out is the safety significance of this issue.

MR. SIEBER: Yes. I understand that. I spent many years as a licensed operator, and first stage pressure was not my prime indication of what reactor power was.

MR. CALVO: Well, it becomes a correlation to know that --

MR. SIEBER: I understand that, but I would trust the calorimetric calculation before I would trust first stage pressure.

MR. CALVO: In some kind of way you need to verify that a calorimetric calculation is giving you the correct value. You've only got one flow meter, you've only got one plant computer, and, as you know, no single channel -- and you can argue the fact that they're also going to fail on a condition that you always know.

MR. SIEBER: Just to let you know --

MR. CALVO: Yes, that's fine.

MR. SIEBER: -- I question your fourth bullet.

MR. CALVO: That's fine.

MR. SIEBER: Thank you.

MR. CALVO: Okay.

DR. RANSOM: Well, one question would be I thought I heard you say electrical output. Can the electrical output be measured with good accuracy?

MR. CALVO: Yes. That's the one that you put in the --

DR. RANSOM: Power output?

MR. CALVO: Yes, the megawatt hour meters. That will give you some value.

DR. RANSOM: What kind of accuracy is that known with compared to the accuracy that you're trying to achieve in the thermal power?

MR. CALVO: If I may, you're all getting ahead of me on this one. I'm changing courses later. I'm just giving to you what I have. I think if you bear with me for a minute, I will answer that question, okay?

The boiling water reactors adjust to the speed of the reactor water pumps, and the PWR adjusts to the turbine control valves or adjusts in the boric acid concentration of the reactor via the letdown omega system. The computer continuously computes the thermal power and displays the output of the calculation to the operator to verify that the power adjustments provide the expected result.

You asked that question before, how often do you calculate this thing, I understand based on the information that I got from the licensee, sometimes about eight seconds. When it's convenient you have some kind of running average of all the variables and you put them together and you come out with some kind of smooth reactor thermal output. All of that factors into the picture.

Keep in mind that if you want to go for 100 percent power to give you the 101.5, you poke it just a little bit at a time, okay, and you see you've got to wait a while until you get a feedback with your calorimetric, and it will tell you how much the thermal power is there. You know that the thermal power is equivalent to 101.5 percent, so you can watch for those things, okay? But the one correlation to get there is the flow meter, the accuracy of the flow meter, but you know that you're getting there into the ballpark.

Now, like I said, you computer thermal power and displays the output to the area. This practice to verify independently the sanity of the PC calculated are indicated in plant procedures and are followed irrespective of whether the nuclear power plant has a UFM or venturi delta P or both installed in the nuclear power plant. That's what they do today. I have discussed it in phone conversations before this meeting with many licensees and that's what they tell me they do. I don't really agree with them to a point, and I'm going to bring that in a minute.

So the accuracy of the UFM or the venturi delta P cannot be assumed all the time. You've got only got one sensor. I mean one sensor. That particular UFM is not only the start point, you've got computers, you've got hardware, you've got software, you've got all kind of things in there, and there's no assurance that some of this will fail and it will fail -- it cannot fail in such a manner that's always fail-safe. You cannot conclude that.

Now, you've got some diagnostics, you've got some alarms, but those cannot work one day, all right? However, when there's only one channel made up of single components, it cannot be concluded that all the functions in that channel will lead to fail-safe conditions. In the reactor protection system, we've got four channels, sometimes two channels, and the reason we do that is if we want a high degree of availability and we're concerned about the safety consequences, we put more than one so we can check one against the other and you've only got two. However, as I indicated later, I don't know if we can do that or not.

However, since the operator makes the final decision to manually increase or decrease power, irrespective of the performance of the UFM or venturi via independent means, it can be concluded that the failure of the flow devices, including the loss of accuracy, can be successively mitigated, and thus the consequences of the failure have no safety significance. That's the point I was trying to make.

MR. SIEBER: Well, if it fails, the ultrasonic flow meter, if it fails, the operator doesn't do anything. What happens is the calorimetric power on the computer will go berserk, and he's relying for minute-to-minute operation on the nuclear instruments and not calorimetric power.

MR. CALVO: But you're postulating a

failure. I don't know what kind of a failure. It could be a failure that's two percent over power. Some kind of way you've got to detect those failures. There's only one channel, and you cannot depend on that one channel. Maybe the flow meter is accurate, the software is fairly complicated. They've got very sophisticated algorithms in there.

Yes, I'm going back again. This is important enough, the concern about overpower. We are looking at only one channel. Maybe we should look at more than one channel. That's what I'm saying.

Now, the other part of my presentation was genetic implications. We heard what Westinghouse product line and we also got Caldon product line. With respect to Westinghouse, the overpower event at Byron 1 and 2 and Braidwood was caused by an apparent misapplication of the instrument. This is what he told you a minute ago. The event at Fort Calhoun was discredited by the tests in the proposed bulletin because the expected accuracy of the UFM is required to be confirmed during commissioning of the instrument before the final acceptance of the UFM by the licensee. This requirement is stipulated in the staff SER for every power uprate application for each nuclear power plant.

As related to Caldon product line, the two events have been identified at River Bend and Palo Verde. These events have already been characterized by members of my staff. No other plant information was directly assessed by the UFM Allegation Task Force. The Task Force closed the door to business in mid-April 2004.

What I'm saying if you look at the bulletin, the bulletin talks about the Byron and Braidwood and the Fort Calhoun. It's mute on nothing else, so I do not believe that there is sufficient basis to justify a bulletin for either Westinghouse or Caldon flow meters. Extrapolation for field questionable events are not such good reasons to propose a bulletin.

Now, it should be noted that Westinghouse and Westinghouse owner's groups have provided information since May 2004. I know the door was closed in mid-April, but that demonstrated that there are no generic implications with Westinghouse product line. I'm sure that Caldon can make the same case with its product line.

And I know you don't like to talk about licensing basis, but I'm just going to go quickly through them, because we are expending a lot of resources in here focusing to a problem. If the problem is not what it's supposed to be, we cannot move forward trying to resolve the problem. I think you're wasting your time, and my staff is wasting my time. And for four years a lot of wasting time. I've been going through it trying to put this particular issue in perspective.

Now, the procedures used by the operator to verify that the licensed power level is not exceeded based on secondary plant information form the licensing basis. There are backfit implications to enforce these procedures as requirements, and these procedures were not addressed during the original review of the application or the subsequent amendments.

The equipment used to calculate thermal power has always been considered non-safety related, and as a result the staff reviews are very limited in scope in some type of system. We had to focus our resources on the important things, so we didn't focus on this one in all the applications. I was the reviewer, we never looked at these things. All we know that those venturis was university calibrated and that's it, and we accepted what was put in the computers.

I used to work for Westinghouse many, many, many years ago, and I say many, many, many. I'm the one who programmed into the computer the product 250s, the calorimeters that you all are using today in this power plant, and it was not very --

DR. WALLIS: Can I ask you about this non-safety related. If you calculate your loss of coolant accident with this two percent extra power and you calculate that the temperature of the cladding, which is 2199 degrees, and then you have an error in power, so you've actually got more power and more decay heat, it may well be that the temperature of the cladding and a LOCA and the worst LOCA would reach 2205 degrees and you'd not be in compliance with 50.46. And, technically, there is a safety problem.

MR. CALVO: I'm saying --

DR. WALLIS: It's not real in terms of this danger to the public, but in terms of satisfying the regulations, there is a problem.

MR. CALVO: But I'm making a statement of fact. It was non-safety related. Maybe after all these things are put on the table you will determine that maybe we should be doing more with these particular overpower situations and do some other things there, but we're going to have to put it in perspective.

DR. WALLIS: But they might not be in compliance with 50.46. That's the issue, isn't it?

MR. CALVO: To a certain degree, yes, it is.

MR. GRIMES: As I mentioned at the outset, the accuracies that we're talking about here are small in comparisons to the margins, even for best estimate analysis.

DR. WALLIS: We know that, yes.

MR. GRIMES: So the underlying regulatory interest here is compliance with the thermal license power level.

DR. WALLIS: Absolutely. Absolutely.

MR. CALVO: And my question is that you can get there from what you have today installed in the power plants. You've only got one channel and one channel only. If we are truly concerned about safety, we'd better put more than channel, and we're going to have to make that case.

MR. ROSEN: But we don't have a concern about safety.

MR. CALVO: Well, I don't because I feel there are other things to do it.

MR. ROSEN: And Chris Grimes seems to

indicate he doesn't have a concern about safety either. It's about compliance with the regulation.

MR. CALVO: That's fine. And the question is what you have today you're complying with the regulations. Otherwise you should be raising the concern about all the plants out there not complying with the regulations. So we are not going to issue any order, so therefore we assume that they're complying with the regulation. But, anyway, let me continue.

DR. WALLIS: But it's like driving at 61 miles an hour in an 60 mile and hour speed limit. There's no real danger to anybody, but you're still illegal.

MR. SIEBER: And it's only $141.

(Laughter.)

MR. CALVO: Let me continue for a minute. The bulletin suggests that the licensees confirm UFM accuracy by comparing the instrument performance in operating plant conditions against a standard test of known accuracy. That's what we do. Now, we have to ask ourselves were these tests part of the licensing basis? We've got rules that we've got to play with. If they are not, is this an adequate protection case or a compliance case? Now, you're getting into the adequate protection, how are you going to make the case?

Anyway, these are the questions that we should be asking ourselves. And, again, we came to you out of sequence. The process that we had this debate, information that is put on the table for your consideration, that we should have had internally before coming in here. So all I'm doing is telling you what I should have been telling others when we go to the CRGR.

Now, the possible solutions is ensure that the accuracy of the secondary plant instrumentation readings and expected process values correlated to thermal power are accurate enough to verify the accuracy of the calculated thermal power for the PC. Now, the expected accuracy of the secondary plant instrumentation that is used to validate the calculated thermal power based on a venturi is the same. With a venturi or UFM it's the same. Nobody's going to put better first stage pressure, better delta Ps or anything else.

The accident analysis, pursuant to 10 CFR Part 50, assumes that the reactor can operate at this rate, at 102 percent of licensed power level. The two percent power margin, as you all know, is the power uncertainty value that was intended to address uncertainties related to heat sources in instrument measurements. In June 2000, the Commission published a rule allowing licensees to justify a smaller margin for power measurement uncertainty. This margin has been reduced today by the application of UFMs. When the thermal power is calculated by the plant computer based on the UFM, a higher degree of accuracy from the secondary plant instrumentation will be required to ascertain whether the calculated thermal power level is within approximately 0.5 percent from the overpower limit.

Can this be accomplished? The staff should ask the licensees that question. We're getting close to the 0.5. I wouldn't be surprised today you've got all the plants up there trying to get within the 0.5. They may be over powering maybe by one percent. Eventually, you will catch it. The question is the little bit that you've got in there that you cannot detect it because either your UFM has malfunctioned or the software has a glitch in it and it gave you that indication or you bounced some kind of way they've been corrected by the software. How can we determine those kinds of things?

We cannot depend on a single device to

tell you everything that is going on in that particular device. We've got to have something else to do it. Now, if we can't depend on the operator, then we should be insisting on something else. If this is important enough for safety and we're worrying about there is no other way to detect it, we should be doing something else more than we're asking right now.

Another approach is to get another redundant channel for calculating thermal power. I will be killed by the licensee. The staff has no regulatory basis to enforce such a requirement but it sounds right. But I leave it up to them. If they feel that the only way that they can ascertain that accuracy and that comfort, not only that you read the accuracy not only today, it has to be tomorrow, next week and next month, next year.

MR. ROSEN: The problem with adding another one is now if they don't agree, which one is right?

MR. CALVO: Then you do the safe thing, you do nothing. You have to have 100 percent power.

So I guess the whole thing was to the staff needs to engage the licensees in a cooperative manner, not in a adversary manner, and together we can resolve the issue and at least clarify it.

DR. RANSOM: I'm a little confused by what you mean by secondary plant instrumentation. Do you mean like steam generator instrumentation or --

MR. CALVO: First stage pressures, feed balance, anything that you do today has --

DR. RANSOM: So you're dividing it into a primary instrumentation and secondary instrumentation.

MR. CALVO: That's correct. And I'm told that you maintain trends, where the thermal -- where the reactor thermal output is. And they look at those trends. Are you increasing small increments of power? That's got to be controlled, because even if the UFM is working, how do you know it's working? How do you verify that it's working? Only got one channel, okay?

So, anyway, I think we're going to have to have a dialogue with the industry.

DR. RANSOM: It sounds like we've got two ways, at least: Electrical power output, you've got secondary, what you call, instrumentation.

MR. SIEBER: You can't rely on that. If you look at first stage pressure, the outside air temperature and the humidity and all kinds of things affect what that pressure means relative to the power output. Same way with the electrical power. If you run the reactor at 100 percent every day and then plot the electrical power, you'll see it go up and down because the heat sink temperature goes up and down. The amount of VARS that you're pumping through the system goes up and down, and so these secondary ways of measuring reactor power are not as good as doing a secondary calorimetric calculation.

DR. RANSOM: Aren't there also steam line nozzles or venturis?

MR. SIEBER: Yes, there are. All the plants can't come equipped with them because you need to have some kind of flow measuring instrument to feed your three element feedwater control system. And so your balance is steam flow against feed flow and then biasing that by looking at steam generator level.

MR. CALVO: It is many ways to --

MR. SIEBER: Right. Yes, we can just move on.

MR. CALVO: Conclusions. First of all, there is no serious significance, there is no generic implications. The proposed bulletin, instead of focusing on compliance, brings into the arena the inadequate protection issue. It is highly improbable that the bulletin can be legally justified. It doesn't address the potential causes of overpower concerns. The proposed bulletin is an overkill.

MR. SIEBER: Has OGC reviewed the bulletin?

MR. CALVO: No.

MR. SIEBER: Well, they will --

MR. CALVO: Not yet. Not yet. Not yet.

MR. SIEBER: -- tell us whether it is justified or not.

MR. CALVO: But I think like Chris Grimes told you before, we're out of sequence in the process. We'll go back into sequence, and then we're going to have the other -- now, it's like trying to kill a fly with a cannon ball issuing the bulletin -- or a cruise missile. That's the way I look at it. But, again, I believe that what we should be doing is the generic informative communication, such as like an information notice, a letter of information summary that raises awareness of the questions raised about the applications of UFMs in nuclear power plants. It will be more than sufficient.

Tell the licensee, "These are the problems that we have. The basic responsibility for you, the safety, is yours." You're trying to figure out how to do it, because we can't tell them to do anything. We can't tell them to do tests that was not a requirement. We're going to be at it for another four years before we can resolve that. It's up to them. They're responsible for safety. Let them know that they are not exceeding the overpower limits.

The generic communication, you also challenge the licensees to determine whether the calorimetry surveillance intervals specified in the technical specifications reflect the reduction in monitoring. You're getting a small margin from on the UFM based on the UFM and the 10 CFR Appendix K limit. The system nuclear instrumentation today which includes escort detectors, they're very inaccurate, in PWRs and boiling water reactors are compared against the computer calculated power. The previous plant technical specifications surveillance was based on a two percent drift. Now we're talking about 0.5 percent drift. So the calorimeter you were doing before at a certain rate now some kind of way you've got to do it faster because now you're going to get out with a 0.5 percent. So you've got that problem.

Well, as you can see, there's a lot of questions that need to be explained before the agency moves forward with any type of generic communications. As I said before, the staff needs to engage the licensees in a cooperative manner and to get --

DR. WALLIS: How do you challenge the licensees to determine something without sending out something like a bulletin or a generic letter or something?

MR. CALVO: Well, today, they got the -- the licensees on their initiatives they have formed groups. I don't know about Caldon but Westinghouse established a Westinghouse Owner Group, and they established a task force who is looking into the generic implications of the flow meters. And once the information I heard a presentation given by them in here, so they can sense the problem. Generic communications you can't tell them a bulletin. You don't have to hit them on the head with a hammer. You tell them, "This is what has happened. This is your plant. You've got a problem in here. If you don't fix it and this continues this way, we're going to have to do something else more than what you had."

So the responsibility is with them. We have not had that kind of dialogue yet. We have taken adversarial role and say, "Okay, there's something wrong with it. We're going to show bulletin," but the bulletin is only going to fix the problem for one day, that one day that you do it. How do you know next week or the next month or the next year how do you know that the integrity remains that way?

Anyway, that's my -- nothing I can get into the accuracy but you've got to put into the context that it's not only the accuracy. You're worrying about other things in there, and because you've got only one channel and one channel only, you cannot conclude that all the failures on that channel are going to be in a safe situation. So solving this way you only solve it for today. Tomorrow, you've going to continue to hit overpower conditions until you fix the problem once and for all. And that fix belongs to the licensee, not with the staff. That's all. I complete my presentation. Thank you very much for listening to me.

MR. SIEBER: Thank you. Next on the agenda is Mr. Hastings from Caldon.

MR. HASTINGS: I hope you won't object if I ask Herb Estrada, the Chief Engineer, to join me.

MR. SIEBER: No problem. We are behind schedule, so if you could speak faster.

MR. ROSEN: Perhaps we could let him make his presentation without interruption, and that would speed things up.

MR. HASTINGS: Good morning. Can you hear me? I'm Cal Hastings, the President and CEO of

Caldon. I'm pleased to have this opportunity to speak before the ACRS this morning. I was seated in the back of the room, and I could not see which of you is speaking, but I became suddenly aware that some of you have more knowledge about these matters than I do.

Caldon is a technology company specializing in precision ultrasonic flow meters. As you might expect, we have amassed a great deal of know how in the design, application and performance of such meters. I would like to use this time today to share some of our perspectives on measurement uncertainty, recapture uprates and the ultrasonic meters used to achieve them.

To avoid the risk of misspeaking, I would like to read from my notes that I prepared during some quiet, thoughtful time. I would like to inject here, however, that at the end of my remarks, you will see that I was going to request an opportunity to come before the ACRS at your next meeting and to provide an in-depth technical presentation. It may be more appropriate, from what I heard this morning, that we come before your subcommittee. And if you would kindly later advise me what you think might make more sense, I will certainly accept your advice.

MR. SIEBER: Give us a chance to review

the documents, and if that's appropriate, we'll let the staff and you know.

MR. HASTINGS: Okay. Thanks. I have two reasons for speaking today. First, at Caldon, we regard an overpower incident as a serious event. The licensees that we work with do too. This is not because we believe the event itself necessarily brings great risk to the safety and well being of the public. It is simply because operating a nuclear plant over its licensed thermal power limit is in violation of the regulations.

To treat such events lightly undermines the public perception of safety in the nuclear power industry. It may even serve to undermine the practice of safety within the industry itself by allowing operation outside of analyzed conditions. Consequently, we have worked hard to provide flow meters to the nuclear power industry that are calibrated accurately and whose errors remain within clearly established and acceptable limits.

Second, I believe MUR uprates are important to our nuclear power industry and to our country. Many Americans, and my wife is one of them, is still recoiling from the surges in prices at the gas pumps this spring. We would like to reduce our dependence on foreign oil, and if nuclear power plants generate more power, they can help this objective. These uprates are very important, and I believe they can and must be achieved without violating important regulations.

Two types of ultrasonic flow meters are used to measure feedwater flow in nuclear plants. Caldon produces both types. One type mounts externally on the pipe. External meters measure the velocity essentially in the middle of the pipe and require that a factor be applied to determine the bulk flow rate. The other type employs a flow element that is welded into the pipe. It is known as a chordal meter because it samples the velocity profile along four chords and integrates it to determine the volumetric flow. Chordal meters are inherently more accurate than external meters, because the chordal meter provides a direct measurement of the bulk flow rate.

If I have counted correctly, external ultrasonic meters are installed in 33 United States nuclear power plants today. Eleven of these use meters supplied by Caldon. The number of Caldon external meters in service was greater but it has declined as some of them have been replaced more recently with chordal meters. Chordal ultrasonic meters are installed in 26 U.S. nuclear power plants. All of these are supplied by Caldon.

Licensee event reports, prepared since the beginning of the year 2000, show that ten nuclear power plants have gone over power because of errors in ultrasonic flow meters. All of these were associated with external ultrasonic flow meters. In two cases, the error was as great as 2.7 percent. We know of no case where rose because a licensee misapplied the meter, and none of the overpower events was caused by a chordal meter.

These incidents have raised two important questions: What causes such errors in external ultrasonic flow meters, and how can these errors be bounded or contained within acceptable limits? The answer to the first question is relatively simple. External meters are very sensitive to velocity profiles. Our chordal meters measure profiles. In the past several years, we have learned that the velocity profiles in feedwater lines are often different from what traditionally has been assumed. When the profile is different from the one assumed, a bias error will result in an external meter.

We know that the velocity profile was a

principal contributor in one of the plants where a 2.7 percent overpower incident occurred. And it is likely that it is a major contributor in most of the other overpower incidents. The errors were created when the velocity profiles changed from their assumed shape.

The challenge for external meters is made even more difficult because velocity profiles in feedwater lines are not constant. Data from the past several years show that velocity profiles often change in feedwater lines, sometimes gradually and sometimes suddenly. One nuclear plant recently withdrew its request for an MUR uprate because of calibration changes occurring in the external meter that was installed. It is likely that the calibration changes are the result of changes in velocity profile.

The second question regarding how to bound the errors is not so easy to answer. Since external meters cannot measure velocity profiles, they cannot recognize if and when they are in error. Neither can they determine the magnitude of their error at any given time. And it is no easy matter to predict just what the worst case errors might be.

At Caldon, we have believed for some time that the calibration procedures we developed during the early 1990s assured us that we could easily contain the errors in our external meters within the bounds of plus or minus one percent. The LERs, some of which were caused by Caldon external meters, show this to be wrong. We didn't contain them all. I will come back to this question in a moment.

Chordal meters have a significant advantage external meters with respect to the effects of velocity profiles. In the first place, chordal meters are less sensitive to velocity profile effects by a factor of 20, and as I pointed out, our chordal meters measure the velocity profile and consequently recognize when they are operating under conditions different from those under which they were calibrated. They can also determine the magnitude of the actual error.

The question on how to bound the errors is much easier to answer for a chordal meter also. The uncertainties in the flow measurements of this meter can indeed be bounded reliably within tight limits as small as plus or minus 0.3 percent. This can be accomplished if a laboratory calibration procedure traceable to NISD is followed, if a plant-specific full-scale hydraulic model is employed for the calibration and if the meter sensitivity to variations of velocity profile is measured and accounted for.

Applying Caldon external meters to measuring feedwater flow certainly has given us our share of challenges. We now know that there is an even greater requirement for basing an external meters calibration on hydraulic models that mimic the plant-specific piping. We now know that the models must be more comprehensive than those used for chordal meters. And we now know that the calibration procedure must determine and take into account the sensitivity of the meter to velocity profiles. But only if we do these things can we be assured that the flow measurement readings of Caldon external meters will be within one percent of the true flow.

But where does this really leave us on the matter of calibrating external meters and bounding their errors in general? The NRC staff have been trying to work through this issue for some time. They have told us this morning something of the actions they intend to take. We at Caldon support a number of the ideas proposed; we disagree with some others.

For instance, we believe the staff should require licensees to provide data and other information that proves their external meters' calibrations are valid and traceable and that their meters' uncertainties are bounded and that when used for MUR uprate that the size of the uprate is entirely consistent with the meters' uncertainty balance. I think this is a point of agreement.

We also believe that this is a big challenge and a huge responsibility for licensees who have only limited depth of experience in the hydraulic and ultrasonic technologies that are necessary to make these evaluations. We are prepared at Caldon to provide the users of our external meters with the data, the analyses and other support they may need. This includes sharing our up-to-date knowledge in calibration procedures.

As a vendor, Caldon has an obligation to understand how our products work, how well they perform and what their limitations are. We also have an obligation to share this understanding with the industries we serve. We should not give them a false promise of performance that our meters cannot achieve.

The velocity profile issue is not new for external ultrasonic meters. It is a generic issue. It has been with us for many years, and I expect it will remain with us for some time to come. While some of us would prefer otherwise, we must understand and accept that under the best of conditions, which do not always exist in feedwater lines, the accuracy of an external meter might achieve is on the order of plus or minus one percent.

During the preceding presentations, mention was made of a possible overpower at Palo Verde attributable to Caldon external meters. This is one of those cases where we now know that the model we used for the calibration was deficient. Fortunately, we have results from more recently conducted calibrations that provide the data to help us sort out the magnitude of the flow meter error. This analysis is still underway. It appears that the error and the resultant overpower is approximately one percent, which is at the outer bound of the meter's design basis.

When we are finished, we will provide the people at Palo Verde with a new calibration that removes the bias error and we'll also give them the documentation justifying the new calibration and bounding the total meter uncertainty.

We also have a responsibility to the licensees who use Caldon chordal meters, known as LEFM Check and LEFM CheckPlus. We have already provided them with comprehensive design basis documentation. We have also provided them with meters that have not experienced a single incident of exceeding their design basis, nor they have caused any nuclear power plant to go over power.

I believe there is no basis for including these licensees in a generic 50.54 memo that the staff is proposing. It is not appropriate that licensees be just subjected to this burden when there is no evidence that any problem -- that there is any problem in the performance of the meters.

Measuring flow in feedwater lines is not as easy as we would like it to be. In 1998, we conducted a survey of reported sustained overpower events occurring in the period from 1981 through 1997. We were able to identify 51 such events. Thirty-three of them were caused by errors in the flow measurements from nozzles. There were at least four different causes for the errors, and one error was as great as three percent.

I am aware that there is much misinformation and debate pertaining the use of ultrasonic meters flying about at the moment. This is not helpful and in fact places licensees in a terribly difficult position. I've heard that some people claim that the problem with errors in external ultrasonic meters should not be addressed because it is site-specific rather than a generic issue.

Of course, the magnitude of the errors is site-specific, but the inability of external meters to measure velocity profiles and their sensitivity to velocity profile effects are inherent characteristics of this type of mater. Velocity profile issues are not new for external meters, and, as I think I had said, they have been with us for many years and will remain for some time to come.

I've also heard that some people believe that nozzles can be used to check the calibration of ultrasonic meters. There is a preponderance of data showing that in general nozzles can only be counted on to measure accurately within an uncertainty of plus or minus 1.5 percent or so. This is of course is not good enough for collaborating a calibration of meters used for measurement uncertainty recapture uprates. To adopt such a practice would invite additional overpower events. It is easy to make probablistic calculations that show this.

I've made statements here this morning without providing evidence or analysis to back them up. This was necessary owing to the time available to me. I would like to request that Caldon be included on the agenda for the September ACRS meeting or some other subcommittee meeting. In particular, I would like to have the opportunity for our Chief Engineer, Herb Estrada, to give a technical presentation that shows more clearly why LEFM Check and LEFM CheckPlus systems should not be included in the generic communication and why it is not a good idea to use less accurate feedwater nozzles to verify the calibration of ultrasonic meters. I might add, we would be prepared to bring other material if there are other questions that you would like to have addressed in such a meeting.

And if I could make one more point that's not in my written remarks, we do a lot of debating. We're a small company, we're dominated by engineers. And my wife has learned you get two or more engineers in a room, you don't get much agreement. And usually what happens, at some point, Herb Estrada will get up and will be rather upset with the way the meeting is going and he'll say, "Get out of my way, it's time to make numbers." What Herb means is we're in a world at times it gets very complicated, but as engineers the way we must deal with this, we must deal with theories, we must deal with data, we must deal with calculations, we must make numbers. The bottom line, that's the truth that we see. And so that's what I would say I would like to bring to you the next time we come, the numbers that we make.

MR. SIEBER: Well, when you do that, you'll be singing to the choir since I think most of us are engineers. I appreciate your remarks. They were very clear and straightforward.

UNKNOWN: Mr. Chairman?

MR. SIEBER: Yes.

UNKNOWN: May I make a statement, please?

DR. WALLIS: Can we ask this other man to say something first before we hear the next one? Can we say something about his presentation?

MR. SIEBER: Sure. Go ahead.

DR. WALLIS: What's frustrating me today is I haven't really seen numbers. I haven't seen scientific evidence, so it's difficult for me to make any conclusions. What I do pick up, though, is what I believe is that it doesn't really make much sense what the staff is proposing which is to use nozzles which are not accurate to test something which is more accurate. It's just not a very scientific way to go about things. Thank you.

MR. SIEBER: Sir, could you introduce yourself?

MR. McINERNEY: Yes. Thank you. Thank you for the opportunity to address the Committee. My name is John McInerney. I'm the Director of Systems and Safety Analysis for the Westinghouse Electric Company. I'd like to make a comment relative to Mr. Hastings' presentation.

First, I'll leave it to the Committee to draw their own conclusions whether his remarks apply to all kinds of external meters or not, but one point I would like to clarify, he did indicate that one licensee had withdrawn a submittal using the Westinghouse external meter for an MUR uprate. That isn't true fact. He also implied that they withdrew because of velocity profile issues. That in fact is not the reason for the issues for which that submittal was withdrawn and in fact that utility is going to make a resubmittal to the staff based on the work done by Westinghouse, by AMAG and by that utility to address the issue after detailed root cause investigation.

Second comment I would like to make is that Westinghouse stands behind the technology and the integrity of the system and that Westinghouse, based on our role in the nuclear industry, focuses on our technology and its merits, and we choose not to comment on the capability of our competitors, whether it's a small competitor like Caldon or a large competitor from France, relative to any type of nuclear component or service, whether it's fuel, LOCA analysis or whatever. Thank you.

MR. SIEBER: Any questions from the Committee or any comments? If not, Mr. Chairman, I'd suggest that we ponder what we've heard during this session and discuss it during our letter and report writing time as to what our position is. We are not required to write a letter or a report, at least the staff has not asked for one. On the other hand, I think that we should develop a thought process of our own to decide what it is our position would be when the time comes for us to respond.

So with that, I would apologize for being so late, and I turn the meeting back to you.

CHAIRMAN BONACA: Yes. I think that I agree we should probably wait to decide whether or not we're going to write something or -- and also what further actions we want to have regarding presentations and meetings on the subject.

With that, if there are no further questions or comments from the staff or the public, we will recess now for a break until ten after 11.

(Whereupon, the foregoing matter went off the record at 10:51 a.m. and went back on the record at 11;09 a.m.)

CHAIRMAN BONACA: Before we move to the next item, AP 1000 --

DR. POWERS: Actually, I heard some live protestation yesterday about how we were going to reserve this fine period of time for an elaborate introduction.

CHAIRMAN BONACA: We will get to that, yes.

DR. POWERS: Oh, I see.

CHAIRMAN BONACA: We heard yesterday a presentation from Ms. Sterrett and raised a number of issues regarding the AP 1000 application, and we have distributed information to the members and we read it, and Dr. Kress is going to take us through discussion of those items, and we can present our views and distribution of those.

DR. KRESS: You have this letter in the background information that was given to us yesterday, and we've had a chance to look them over, I'm sure you've read them.

We've had access to these issues in past meetings and have discussed them in the past. We haven't really brought forth the issues to the point of having an expressed position on them in any of our letters, although we have expressed positions on them in meetings in our discussions on these. So now is the time to look at these issues brought forth by Ms. Sterrett and decide what our position is on these and how to deal with them in our letter on AP 1000.

The issues that we have before us here are basically three of them. One of them is if you look at the letters, the effect of heat of solar radiation on the passive containment cooling system. The second one has to do with the proof that the fluid system parameters and the design certification are what they were set out to be. And the third one is a question about the document control process.

These second two are what the ACRS calls process issues, and we normally, as a Committee, don't deal with those type of issues unless they represent to us a real clear and significant safety problem. And I think our judgment has been on those particular two issues that they do not represent a significant safety problem. So we prefer to leave that kind of issue up to the staff to resolve, and so I think that's basically the position we've taken on those two issues.

The first issue, on the other hand, is more technical and unclear whether it has safety implications or not, and this is the issue of whether or not solar radiation has an influence that's possibly unacceptable on the containment passive cooling system. As I see it, there are three possible influences, and one is that the water that's used to flood the outside of the containment is in a tank on top of the containment, on top of the shield. And if it absorbs a significant amount of solar radiation on a hot day, then it could be hotter than the assumed value that Westinghouse uses to calculate the compliance with the Chapter 15 design basis accidents. The figure or merit here, of course, is the internal containment pressure.

The second possible influence that solar radiation could have is on the inlet higher temperature. If the shield gets significantly hot due to radiation -- significantly hotter than the outside air, then the air could naturally convect up, pick up energy and enter the inlet to this passive containment cooling system at a higher temperature than one would -- than the assumption by Westinghouse.

And the third possible influence is that the shield itself could get hot enough that the internal temperature seen by the convecting air going up is hotter than the calculations as shown by

Westinghouse so that the cooling air heats up to a higher temperature. Therefore, you have a lessening of the effectiveness of the heat transfer from the containment.

Now, with respect to those three possible effects, what we've done is we've looked at the staff's determination that the large quantity of water in the tank above would have only negligible rise in its temperature over the time that the solar heating would be present. We found that, I think, to be acceptable, that you make heat transfer calculation and you can show that there's enough water there and the absorption capacity is such that it won't get much higher than the assumed 120 degrees fahrenheit, which is a pretty conservative assumption in the first place.

MR. ROSEN: Because even at the hottest latitudes, the temperature is not high enough to drive it above that level?

DR. KRESS: Not much above it. You know, the question is how conservative do you have to be in design basis space. I think we can dispense with that part of it.

MR. ROSEN: Before we do, can we talk about it a little bit?

DR. KRESS: Sure. That's what the purpose of this meeting is.

DR. POWERS: When you do this calculation, we assume the water starts at one temperature, you put the solarplex on it and rises up to some other steady state temperature. The next day do you bring it back down to the starting temperature and do it again or does it come down a little bit and then go up even yet higher the next day, thinking of a five- or six-day heat wave.

DR. WALLIS: It cools off at night, presumably, too.

DR. POWERS: That's what I'm thinking of is does it -- the argument for not going too high is the large mass of water. Therefore, it's not going to --

DR. KRESS: Well, the argument also involves the fact that the solar radiation over and above the outer temperature itself is only effective for a given fraction of the day. It doesn't hit the whole water tank, and the solar radiation goes away at night, and it has time -- whatever solar radiation over and above the 120 degrees assumed does have a chance to reradiate to the cold atmospheric night air. It's pretty clear that the reradiation rate over a time period that is in excess of what the solar radiation is is going to exceed the effect of the solar radiation. So the assumption is that the nighttime radiation cooling would offset the daytime solar radiation, that you would just go through a fluctuation, even though we had an extended number of days of heating.

DR. POWERS: Well, I think that's probably true if you put the plant up in New Mexico here. Based on my inspection of the nighttime temperatures in recent days, suggests the reradiation term may be negative.

(Laughter.)

MR. ROSEN: Well, I think -- let's follow this now to its logical conclusion. Let's assume that Dana's exactly correct, which is the wise thing to do in his case, and that the tank heats up a little bit in the daytime, it gets to 120 degrees and that night it gets down to 119.5. The next day it gets up to 120.5 Now, it's outside its technical specifications, am I correct?

DR. KRESS: Yes. And the technical specs would require them to shut down or do something --

MR. ROSEN: Do something.

DR. KRESS: -- to bring it back into

compliance:

MR. ROSEN: The technical specs wouldn't require a shutdown, it would require them to restore the tanks to its range.

DR. KRESS: So there is a tech spec control on the problem too.

MR. ROSEN: Right. And so how do they do that? How is that done in the AP 1000?

DR. KRESS: Well, perhaps we could ask the Westinghouse representative to --

CHAIRMAN BONACA: Yes, but the first question I have is how do you get 800,000 gallons to 120 degrees --

MR. ROSEN: I don't want to address that mechanistically. I just want to know what would happen if. I mean how --

MR. SIEBER: Maybe I can help a little bit.

MR. ROSEN: Well, why don't we let Westinghouse gives us a fact first.

MR. SIEBER: All right.

MR. VIJUK: Yes. In normal operations, there is a small recirculation flow rate through the tank. I'm not sure whether we can cool the water, but we can condition the water, so there is some --

MR. ROSEN: What do you mean condition? You mean polish it?

MR. VIJUK: Well, the main concern is heating, keeping it warm, and I think we have a minimum temperature on the water too.

MR. ROSEN: Are you balking the question? The question is can you put in cool water, water from a groundwater source or something?

MR. VIJUK: There are makeup sources and you could let down and feed the tank to keep it at a cooler temperature, yes, with demon water or water from the fire system, for example.

DR. KRESS: So there is a way to bring it back into the tech spec compliance.

MR. VIJUK: Yes.

DR. RANSOM: Well, is there really much concern about the temperature of the water? I mean the main cooling mechanism is evaporation when you spray it onto the containment and get phase change, which is a much bigger effect than just the sensible heat.

DR. POWERS: Is that really the biggest term?

DR. RANSOM: Huh?

DR. POWERS: Is that really the biggest

term?

DR. RANSOM: Absolutely.

DR. POWERS: I don't know that for a fact? How do I determine that?

DR. RANSOM: Just the heat vaporization of the water.

DR. POWERS: Well, I know what the heat vaporization of the water is. I don't know that that's the biggest term here.

DR. KRESS: This is a question of mass transfer.

DR. WALLIS: It's kind of strange to me. You're writing about a simple homework problem and Lightfoot somewhere. Why just talk about it? It just makes no sense to me. Calculate it.

DR. SHACK: Well, the analysis is done for 120.

DR. KRESS: The analysis is done for 120 degree inlet temperature and 120 degree water temperature, and the question is how conservative do you have to be in design basis space, because you know the probability of that event actually occurring is so low that the design basis space -- you know, you always make these judgments in design basis space as to how conservative you have to be. And that, in my judgment, is a fairly conservative estimate.

CHAIRMAN BONACA: And to put your limit there. I mean you have a risk as an operator that you would have to shut down the plant.

DR. KRESS: Yes. You have control over it.

MR. ROSEN: I don't think it would shut down. I think it would simply cool it off.

CHAIRMAN BONACA: I think that the reason why they use 120 is because they'll never get there.

MR. SIEBER: Yes. Let me put it in perspective. In existing plants, there are some big tanks that require temperature control, the most important of which is the RWST, which is the injection source for safety injection. And if you watch the temperature of that tank, which operators do, through the year, it doesn't go up and down day by day or day to night to day to night.

DR. KRESS: It gets hotter in the summer than it does in the winter.

MR. SIEBER: In the summer, the tank gets warmer; in the winter, the tank gets colder. And I havE never in 30 years seen the tank over 100 degrees. In fact, we would have had to shut down had it gotten that hot.

DR. KRESS: But you weren't in Phoenix, Arizona.

MR. ROSEN: That was just one plant you're talking about.

MR. SIEBER: Yes, but I think the effects are not so much latitude driven as air temperature driven, okay?

MR. ROSEN: But we're prepared to -- we're getting ready to certify this plant for a location in all places except certain seismic areas with no control on --

MR. SIEBER: Okay.

DR. KRESS: And it seems to me like the 120 degrees cover a pretty --

MR. SIEBER: Hundred and twenty is pretty high.

DR. KRESS: Pretty high.

MR. SIEBER: Pretty high, because I think the air temperature has more to do with it than the solar absorption.

DR. KRESS: Well, let's look at the other two possible effects. One of them is does the inside surface temperature of the shield see the outside problem enough to affect the heat transfer? I made a quick calculation there using square root of alpha T to see how long it would take to penetrate -- the shield is three-foot thick, and if you had a quick change in the surface temperature over a ten-hour period, you would penetrate halfway through that three-foot concrete. So that doesn't seem to be a problem to me, using guesses for the alpha for concrete.

DR. POWERS: So I guess -- I mean, again, what you've done is a calculation that says, okay, we have one day and then everything resets at the beginning of the next day. I'm just not sure you can do that.

MR. SIEBER: It will cycle over an entire year's time. In the summer, it's hot; in the winter, it's cold. But why do you care? I agree with Vic that evaporation, the phase change is the biggest influence, and all the air does is remove all this excess humidity. You can go in the inlet and out the outlet or vice versa as long as you're pouring water on it.

DR. SHACK: But still you're looking at a licensing basis, so you do have to make that concern.

MR. SIEBER: That's true.

DR. SHACK: But I agree with Tom. It just seems to me the likelihood of doing that, maybe if you were building this in Madraz, you might have a concern, but there's certainly a wide range of places --

DR. KRESS: There are things like this in all the licensing design basis accidents, and a lot of these are judgment as to are you conservative enough? And the question is 120 degree assumption on the water and the inlet air a conservative design basis assumption? I think it is, but this is a judgment based on some of these type of assessments about how long it takes to heat up the water and how long it takes to penetrate through the thick shield concrete and the effect of natural convection on the inlet air temperature itself, and the fact that you're not likely to have these kinds of temperatures in very many sites very long and by the fact that you have a tech spec control over it.

DR. POWERS: And when we worked on the California aqueduct, the Central Valley of California is a concrete ditch, runs the length of California, and it gets hot enough in that ditch that when you measure things you have to measure the temperature of the measuring device because it gets longer than what you think it is, and you have to put a correction on it. And it was not uncommon for the temperature of the concrete there to be 140 degrees. Our chaining thermometer went to 160, and we broke it one day.

MR. ROSEN: I'm going to ask the analogous question to the one I asked about the water tech spec. Is there a concrete temperature or an air inlet temperature tech spec?

DR. KRESS: No, I don't think so. We can, once again, ask Westinghouse to -- I don't think there is on that.

MR. VIJUK: I'm sure there's not one on concrete temperature. I think we have a site temperature, air temperature restriction. I know the one percent exceedance value or something like that for a site.

MR. ROSEN: So if the air temperature entering the passageway exceeded whatever that temperature is, you would have to take corrective action of some kind, which --

MR. VIJUK: Well, you would determine this at the siting time. You couldn't site in a place that had one percent exceedance. Wet ball temperature I think is the way they usually specify it above the stated value.

DR. KRESS: So you couldn't site at this location Dana was talking about where the --

MR. VIJUK: Well, I don't know what that location is. I don't know the specifics on that.

MR. ROSEN: But at least conceivably, there are some locations where the air temperature exceedance values might be too high given this concern. Okay. So there is a control there.

MR. VIJUK: I believe so.

DR. KRESS: Well, I think Dana's point on the concrete was that it wasn't the air temperature that got it up to 140, it was the fact that it was sitting out there in the sun, which was sort of conservative.

DR. POWERS: Yes. I mean the truth of the matter is the heat capacity of the concrete per unit mass is just a heck of a lot less than the heat capacity of air per unit mass.

DR. WALLIS: Yes. This is a lot of mass.

DR. POWERS: Well, it's a lot of mass, yes.

DR. RANSOM: The other aspect of this is that you're always going to get the solar radiation on one side. It's either directly over the maximum conditions or on one side or the other. And so one side is not seeing the solar radiation and will be cooler. So that will cause asymmetric flow within the passages, which --

DR. POWERS: Solar swirl.

DR. WALLIS: It's all going to be swamped by the water running down, which is going to --

DR. RANSOM: And it's going to be 212 degrees that you're producing there or somewhere around that maybe. But it seems like a simple enough effect that maybe Westinghouse ought to have taken a look at this. Now, we'll put these kind of fears to rest, I would say, a day or two of work on the part of an engineer could pretty well quantify what you're going to see.

DR. KRESS: Do we let that influence what we say about our letter, though?

DR. POWERS: Well, if somebody can point to me where the analysis of the behavior of this natural convection occurs in the Westinghouse analysis, other than the statement that we did this by the Gothic Code, I would be delighted to finally read this. I've asked three times for this. Each time I'm told it's there. Enormously lengthy documents are delivered and so far all I've ascertained is they do it with the Gothic Code. But things like inlet resistances, fiction factors and stuff like that, that presumably are input to that Code, I'll be darned if

I can find them.

DR. KRESS: I think you're right. It was done by the Gothic Code.

MR. VIJUK: That's correct.

DR. POWERS: Well, of course, then the question comes up is there any reason to believe the Code is correct?

MR. ROSEN: Well, is there any reason to believe the Code is applicable to those circumstances?

DR. POWERS: Yes.

MR. ROSEN: I thought Gothic was for subcompartant analysis. I'm not sure --

DR. POWERS: I think you can use Gothic Code to analyze everything short of the big bang if you're willing to go in and horse with the input and notarization.

DR. KRESS: Well, you can get down to about half a second with a big bang too.

DR. POWERS: You probably can get down to within a half a second. As we know, after the big bang, everything else was thermalhydraulics.

DR. KRESS: That's right.

MR. ROSEN: I think that, Tom, your question is a good one. I mean how should we condition this approval based on this or is there some other way to get someone to provide us with some sort of response to the question of what happens here? Not the water question, but the air question, the concrete temperature question.

DR. KRESS: Well, my feeling is personally that when design basis space was analyzed by the NRC-approved code that we reviewed and said was okay and the conservatisms that are there are appropriate conservatisms for design basis space. So it should not, in my mind, influence our approval -- I don't think approval is the right word -- but our acceptance that AP 1000 --

MR. ROSEN: Should be certified.

DR. KRESS: -- should be certified. That's personally my opinion. I appreciate us bringing this point up, and I think it's a good point, but I think it does not change my opinion that AP 1000 does not pose undue risk to health and safety of the people. And so I think the staff is a bit remiss in not addressing the issue properly. I think the staff should have done more on this particular issue. We shouldn't penalize the certification of AP 1000 because the staff didn't do their job on this one issue.

MR. ROSEN: But I think -- and this is

also a site-specific issue.

DR. KRESS: It's site-specific.

MR. ROSEN: Because if you --

DR. POWERS: Can we keep --

MR. ROSEN: -- go to a site in Minnesota, this is probably not a problem.

DR. POWERS: Can we keep track of the number of one issues that we find that the staff doesn't do a good job on so that we can have the integration?

MR. ROSEN: Let me finish up. If that is a site-specific issue, and I think we'd all agree that it is, can we have a discussion of this as the COL stage when the site is picked? I mean should we suggest to the staff that that is an appropriate matter for the COL? I don't know how we'd do it. I'm not sure we'd do it in our letter but at least in some other way?

DR. KRESS: I don't know if it's called part of the COL, but I think our site parameters would have to be met. I don't know if you'd call them at the COL stage or what.

MR. ROSEN: Early site permitting. But an early site permit doesn't specify the design, so you wouldn't say early site -- not every site -- this wouldn't matter for some designs. It only matters for a site in a very hot region for the AP 1000, maybe. So I'm searching for a regulatory hook, something that --

DR. WALLIS: I've calculated the insulation on this containment, and I got two megawatts when the sun is shining brightly. I mean a kilowatt per square meter over 2,000 square meters is quite a lot of energy.

DR. KRESS: You just did the square root of alpha T?

DR. WALLIS: No, no. I didn't do any alpha T. I just did the solar constant and area of the thing. I was a bit surprised to get to megawatts. I mean that's a --

DR. KRESS: Did you use 360 degrees?

DR. WALLIS: I just took the rough exposed area perpendicular to the sun.

DR. POWERS: I don't know. I bet you'd probably have to be reasonably careful about how you argue that one side's shielded and one side's not, because the adjacent buildings would reflect on to the concrete and so --

DR. WALLIS: You get a bit more --

DR. POWERS: -- you get a bit more than

saying only half is illuminated.

DR. WALLIS: I mean it's solar.

DR. KRESS: Well, what does the Committee wish to do about this particular issue?

DR. FORD: It seems that there's two. One is raise it in relation to the COL in the letter or this issue, lessons learned that we're talking about is not AP 1000-specific, which relates to various submissions done by the staff.

MR. LARKINS: There's another option. I think you could always forward these comments to the staff and ask the staff to respond to these issues.

DR. WALLIS: But they already have.

CHAIRMAN BONACA: Well, they really haven't.

DR. POWERS: They have them and they haven't.

MR. ROSEN: They judge it negligible.

DR. KRESS: Well, they just looked at the water temperature.

MR. ROSEN: Yes. And I don't think the water temperature is an issue because of the tech spec.

CHAIRMAN BONACA: No. No.

DR. KRESS: I really don't think it's an

issue either. Some of the things they didn't recap here.

DR. WALLIS: What's a kilowatt on what grounds?

DR. POWERS: You mean relative to this space? Depends on what your --

CHAIRMAN BONACA: Well, I think that's all we should be doing. I think we should address it to the staff.

MR. LARKINS: Yes. I agree with Tom that I don't think you want to necessarily raise this in the certification letter. I think it ought to be something you put in as an aside or as part of the appendix to it. Or I wouldn't even do it that way, I would just send it over under a separate heading, maybe a Larkins-gram.

CHAIRMAN BONACA: Asking that they deal with this, review this.

DR. KRESS: Well, I think, certainly, Ms. Sterrett's contributions will be referenced on the list of references.

CHAIRMAN BONACA: In fact, in her presentation yesterday, it did not address effect of concrete wall temperatures.

DR. POWERS: Tom, you certainly quoted

accurately the way we view most process issues, but I think there is an issue in understanding how AP 600 documentation relates to AP 1000. I mean one is an evolution from the other, and I would presume that there's probably a pretty good care there, but I think the documentation in 1000 has been decidedly superior to what we saw for 600. Just for our own edification, it would be nice to know just exactly how all that -- I mean staff usually does not make a mistake in that sort of thing, but it's nice to know do we upgrade, have we upgraded any of these or are we maintaining or keeping track of things and stuff like that. It's confused on my mind. I know I certainly --

DR. KRESS: I must say I'm a little confused on that too.

DR. POWERS: Yes.

MR. ROSEN: But it is a process issue, like you said.

DR. KRESS: It's a process issue.

MR. ROSEN: And we are not either capable or prepared to delve into those to the degree that you need to to get to the bottom of it. I think that's the staff's job.

DR. KRESS: Well, where are we?

DR. POWERS: Oh, I think we ought to

absolutely reject the SER till all the issues, including those raised by outsiders, are clarified, with special emphasis on those dealing with iodine.

DR. KRESS: I say we've discussed this enough --

CHAIRMAN BONACA: I think so too.

DR. KRESS: -- and I will accept any suggestions on what to do in the letter when we're getting to write it and read it.

MR. ROSEN: And that's the only thing we'll do, and we're not going to send a separate communication to --

DR. KRESS: Well, I'm willing to do that too as part of it.

CHAIRMAN BONACA: Send communication to the staff.

MR. ROSEN: That says that the answer -- that they did not address this worthwhile question on solar heat load on concrete, and they need to do better than that.

DR. KRESS: I think that's probably the thing to do.

CHAIRMAN BONACA: And I think I could be on record, and, actually, this is our record.

DR. KRESS: Okay.

CHAIRMAN BONACA: All right?

DR. KRESS: Thanks for the guidance.

MR. EL-ZEFTAWY: Are you satisfied with the COL action items that the staff has proposed on sump?

MR. ROSEN: Yes. We want to understand the 6.3.8.2. What does that refer to? What is that numbering? What document is it from?

MR. COLACCINO: This is Joe Colaccino of the staff. This is DCD, Westinghouse's DCD, Section 6.3.8.2. It's in the combined license information that Westinghouse will provide, and just to refresh everybody's memory, last night Westinghouse proposed modifying this combined license action item to incorporate any subsequently approved NRC guidance with regard to the sump strainer issue. So they provided us that information this morning, we brought it to the staff and to assess its acceptability, and the staff says that this change is acceptable.

MR. ROSEN: I think that resolves my concern too.

CHAIRMAN BONACA: All right. So we will write a letter to the staff for this issue.

MR. ROSEN: On the concrete issue.

CHAIRMAN BONACA: On the concrete issue.

MR. ROSEN: We're mixing things up here.

CHAIRMAN BONACA: Okay. So at this stage, I believe we can get off the record.

(Whereupon, at 11:41 a.m., the ACRS Public Meeting was concluded.)

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Silberman

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

6.3.8.2 Verification of Water Sources for Long-Term Recirculation Cooling Following a LOCA

The Combined License applicants referencing the AP1000 will perform an evaluation consistent with Regulatory Guide 1.82, revision 3, and subsequently approved NRC guidance, to demonstrate that adequate long-term core cooling is available considering debris resulting from a LOCA together with debris that exists before a LOCA. As discussed in DCD subsection 6.3.2.2.7.1, a LOCA in the AP1000 does not generate fibrous debris due to damage to insulation or other materials included in the AP1000 design. The evaluation will consider resident fibers and particles that could be present considering the plant design, location, and containment cleanliness program. The determination of the characteristics of such resident debris will be based on sample measurements from operating plants. The evaluation will also consider the potential for the generation of chemical debris (precipitants). The potential to generate such debris will be determined considering the materials used inside the AP1000 containment, the post-accident water chemistry of the AP1000, and the applicable research/testing.

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July 31, 2003

To: ACRS Subcommittee on Future Plant Designs

Subject: Heat of Solar Radiation and AP1000 Ultimate Heat Sink

Although I did not make an oral statement on the subject topic at the ACRS Subcommittee on Future Plant Designs held on July 17th and 18th, 2003, I am taking the opportunity afforded members of the public to file a statement on subjects associated with the topics discussed at ACRS meetings. This statement is related to the AP1000 safety systems and the recently-issued AP1000 Draft Safety Evaluation Report (DSER).

The AP1000, unlike operating PWRs, uses the outside air as the ultimate heat sink. The Passive Containment Cooling System is responsible for transferring heat to the ultimate heat sink in the event of a design basis accident. The question I have is: whether (and if so, how) the heat of solar radiation is taken into account in the design of the AP1000 Passive Containment Cooling System.

As described in the DSER, heat removal from the containment after a design basis accident is to be accomplished by the Passive Containment Cooling System (PCS). The PCS uses the water in the PCS water storage tank located atop the containment, along with the flow of air through the spaces between the primary steel containment and the surrounding concrete building, to cool and depressurize the containment. It is the means by which heat is transferred from the reactor to the ultimate heat sink (the outside air) in the event of a design basis accident.

Thus, the temperature of the water in the PCS water storage tank and the temperature of the concrete walls affect the heat removal capabilities of the PCS. Since the heat of solar radiation can cause the temperature of objects to exceed that of the surrounding air, it seems to me that its effect on:

(i) the temperature of the concrete building, whose walls form the air passages relied upon for the efficacy of cooling by the PCS, and

(ii) the temperature in the PCS water storage tank, ought to be addressed by the AP1000 design. The effect will vary with geographical location (i.e., one of the coefficients involved is a function of geographical latitude) and will also depend upon the surface geometry, the properties of the concrete and/or the surface coatings used, and the humidity of the outside air.

The site parameters do not include geographical latitute, so I am wondering whether the heat of solar radiation was considered or quantified. I do not see the effect of the heat of solar radiation accounted for explicitly in the DSER. However, it is clear that, unless the heat of solar radiation is shown to make only a negligible contribution, this heat source is relevant to the design of the safety features of the plant. The question does not arise for operating PWR plant designs, since those designs do not use the method of containment cooling employed on the AP1000. It appears to me that some of the regulations and criteria related to ultimate heat sink assume that the ultimate heat sink is a body of water; thus I would not expect them to have specifically addressed the effect of heat of solar radiation on the temperature distribution in concrete walls.

Perhaps this was already addressed at earlier stages of the project. However, even if this is so, there should be some discussion in the DSER of the rationale and assumptions used in making the determination that the effect of the heat of solar radiation on the structures used by the PCS for containment cooling could be neglected.

If in fact the effect of the heat of solar radiation on PCS performance is not determined to be negligible, the assumptions regarding PCS water storage tank temperature and PCS efficacy in heat removal used in the AP1000 PRA (Probabilistic Risk Assessment) Report should also be examined to see if the heat of solar radiation might need to be taken into account in the rationales employed there.

I have raised this question with the NRC staff. I do not know what the response will be. However, due to the late point in the licensing process (the DSER is already issued), the safety significance of the ultimate heat sink, and the finality of design certification which limits opportunities to raise the issue later, I am raising it in a statement to the ACRS now.

Respectfully submitted,

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July 30, 2003

To: ACRS Subcommittee on Future Plant Designs

Subject: AP1000 Fluid Systems Design & QA Procedures

1. Purpose

At the July 18th Meeting of the ACRS Subcommittee Meeting on Future Plant Designs held in Monroeville, Pennsylvania, I took advantage of the opportunity afforded members of the public to remark on a topic discussed at that meeting: the NRC's review of QA control of processes used in the AP1000 design currently under licensing review. At that meeting, the NRC staff (Ms. Joelle Starefos) responded by saying that the NRC staff would reply in a letter.

As I did not know which open items were going to be discussed, my remarks were impromptu and I did not have a prepared text. The purpose of this letter is to provide a written statement of the concerns I expressed at that meeting, which made reference to concerns I had expressed earlier, at the 501st ACRS meeting. (References 6 and 7) For completeness, I also include a chronology of the questions and responses already received from other members of the NRC staff in sections 2.1 and 2.2 below. The statement incorporating the concerns I raised at the July 18th, 2003 ACRS meeting appears in section 2.3 below.

According to the policy on Advisory Committee Meetings (10CFR7.12 (b)), " Any member of the public who wishes to do so shall be permitted to file a written statement with an NRC advisory committee regarding any matter discussed at a meeting of the committee." I am filing this letter as such a written statement, as a member of the public, unaffiliated with any organization.

I am currently a professor of philosophy at Duke University in Durham, North Carolina. Prior to my academic career, I worked in the nuclear power industry, including a few years in the mid-nineties on the AP600 fluid systems design as a consultant to Westinghouse. My involvement with the nuclear power industry ended in early 1998 when I began my academic career in philosophy full-time.

I began following the NRC licensing review of the AP1000 in mid-2002 by reading the information publicly available via the NRC's electronic reading room. My knowledge about the AP1000 design and licensing review comes from reading these publicly available documents. I decided to make use of the provisions for public participation in the AP1000 licensing process (References 8, 9) in part because, according to the 10CFR52 licensing process under which the AP1000 is being licensed, opportunities for public participation are extremely limited once design certification is granted. Thus, as a member of the public, providing this input about the AP1000 design and licensing review is a "now-or-never" situation.

2. Chronology of Questions and Statements

2.1 Two Issues Raised with NRC Staff in July 2002 -- Systems Design & AP1000 QA

In mid-2002 (July 10), after the AP1000 design certification submittal, I asked questions about the general 10CFR52 process and the AP1000 licensing review in particular in an email exchange with Jerry Wilson of the NRC. (Reference 3) One question was: what ensures that, by the close of the licensing process, the design process for some components was not still at the stage wherein only preliminary sizing of components had been performed.? In particular, I asked:

> "(i) Are there supposed to be signed-off, proof-of-design calculations, (using the actual piping sizes, equipment parameters, and layout) for the flows reported for all the systems in the AP1000 DCD submitted? Or, performance analyses for the more complex pieces of equipment such as the pressurizer, the steam generator, large control and relief valves, etc.?
>
> (ii) Does the submittal of the DCD imply that the things in (i) are done?
>
> (iii) Does the NRC verify or ask for proof that the things above are in fact completed and signed off by the appropriate functional groups, and that they justify the design details in the DCD? If so, when does this occur? [Reference 3]

In reply, Jerry Wilson cited 10 CFR 52.47(a)(2), and explained that the level of detail required for a DCD (design control document) submittal was sufficient information to support a safety finding in any technical area, and that this level of information corresponds to the level that, under the previous two-step 10CFR50 process, was available at the operating license stage. However, he qualified this by saying that, since design acceptance criteria were to be used in the "piping design area", that "we [NRC staff] didn't expect that signed-off, proof-of-design calculations will need to be completed to support construction." [Reference 10]

This reply made me wonder whether the NRC was in practice approving delaying performing the proof-of-design calculations for system flows, temperatures, and pressures to later stages as well, without explicitly meaning to do so. The rationale for accepting the (DAC) approach for "the piping design area", which was articulated in SECY-02-0059 [Reference 2], was based on the ability to specify piping stress and piping structural analysis acceptance criteria; that rationale does not support delaying the fluid system design to the later COL stage. It is in fact important that the finalized fluid system design be performed prior to or in conjunction with specifying pipe sizes and valve characteristics to be used in the final design. It is always possible to use preliminary calculations to size piping, valves and equipment in order to obtain values to be placed in a design certification application. Proof-of-design calculations differ from preliminary sizing calculations in that they are a set of calculations chosen to take into account all the system criteria that must be met in order for the system to perform the capabilities that are claimed for it. As explained in followup emails, in lieu of using complete piping layout information as input to "proof-of-design" calculations, L/D criteria can be specified based upon "proof-of-design" calculations; these can then be used in piping layout to ensure that the considerations underlying the "proof-of-design" calculations are met. This kind of criteria would be the fluid systems design analogue of piping DAC. My worry was that unless some attention was paid to ensuring that the "proof-of-design" kinds of analyses are done, whether in the form of calculations using "as-built" data or in the form of L/D layout criteria, that the NRC would actually be certifying a design that was based on preliminary sizing considerations rather than on proof-of-design calculations that document that the various fluid systems have actually been designed to provide the system capabilities claimed for them. Since such fundamental things as the classification of initiating events assumes that even many non-safety systems actually do provide the capabilities attributed to them by the design documents, the issue is related to the safety basis of the plant even for the design of non-safety systems.

The problem is particularly acute on the AP1000 because much of the AP1000 makes reference to AP600 documentation. This makes it especially difficult to discern whether a particular pipe size and equipment parameter is merely inherited from the AP600 design or whether final "proof-of-design" kinds of calculations specific to the AP1000 have been performed to support it. Further, there is the danger of making the false assumption that if a system configuration has not changed, the fluid system performance has not changed either. This is not always true; a system temperature or pressure in one system can affect the fluid system performance in another. Thus reasoning about the similarity to AP600 layout that applies for piping stresses and loads does not necessarily extend to fluid systems performance. A comprehensive review of the AP1000 fluid systems designs is called for, similar to the kind of review appropriate when reviewing an extended power uprating.

In further email exchanges with the NRC (Jerry Wilson and Larry Burkhart), I tried to clarify my first question about the fluid system design. These emails are references 11 and 12 and are attached to this letter.

The second question I asked in my July 10, 2002 email to Jerry Wilson concerned the QA program covering the engineering design processes. I wrote there:

> The AP1000 design processes cannot be exactly the same as for the AP600, simply in virtue of the fact that the AP1000 refers to so many design documents for the previously certified, yet different, AP600 design. If the quality assurance program covers the engineering design processes, it seems it needs to be looked at (and maybe revised or supplemented) to ensure that it appropriately covers the case of producing a new design that references another, different, certified design, and to explicitly state what is required in such a case. Here's why I think it is a very important issue:
>
> The AP1000 DCD claims that many of the AP600 documents are applicable to the AP1000. The crucial question is, who (in Westinghouse) makes the determination that a particular AP600 document does in fact apply for the AP1000? It seems to me crucial that the same engineering functional group (preferably the same individual engineer) that was responsible for producing and signing off the document for the AP600 pass judgement on its applicability to the AP1000. Is there a guarantee of this? If not, I suggest that there be such a requirement and that it be made explicit.
>
> Otherwise, there is a gigantic loophole that can be used to circumvent the whole intent of the quality assurance provisions covering the engineering design process -- i.e., otherwise, individuals in other functional groups such as marketing, licensing, or project management, can circumvent the engineering process by simply stating that a certain AP600 engineering report or design document applies to the AP1000. (I don't think I need to explain the conflict of interest involved were this to be permitted.) [Sterrett to Wilson July 10, 2002 Reference 3]

Jerry Wilson replied to this question as well [Reference 10]. He referred me to the NRC's letter on the AP1000 Design Certification Review Schedule [Reference 4], and explained that the NRC staff did plan to inspect Westinghouse's implementation of its design control program for the AP1000 design "in the future." Mr. Lyons's letter of July 12, 2002 stated that the NRC planned to perform these inspections "as necessary", adding that "These inspections will be coordinated with Westinghouse to support the design certification schedule." [Reference 4 , p. 4]

2.2 Clarification & Discussion of Issues with NRC Staff -- December 2002

In December 2002 Larry Burkhart, who was then the NRC's AP1000 Project Manager, held a telecon to discuss my questions. Jerry Wilson, Dave Terao, and other members of the NRC technical staff were present. In this telephone conference call, I clarified my question about fluid system design. Nothing was resolved other than the clarification of the question. However, it was agreed that we should get in contact again to revisit the issues closer to the time the DSER was about to be issued.

Subsequently, after unsucessful attempts to reach Larry Burkhart in March 2003, I learned that there had been a change in management of the NRC's AP1000 Licensing team. The entire team had been replaced with the current team (John Segala, Joelle Starefos and Joseph Colaccino).

2.3 Concerns Raised at ACRS Meetings (April & July 2003)

Soon thereafter, I requested time to speak at the 501st ACRS meeting held on April 11th, where I read a statement presenting the first question I had raised in the original July 10th email. My oral presentation followed the draft text of my comments fairly closely [Reference 7 , included as Attachment II to this letter] and was included in the summary report for the 501st ACRS meeting [Reference 6].

The second question raised in my original email (regarding quality control procedures governing the design processes used in the AP1000) was brought up at an ACRS Subcommittee on Future Plant Designs held on July 18th, 2003, shortly after the NRC issued the Draft Safety Evaluation Report (DSER), and almost a year after I sent the original email expressing concerns about the QA process on the AP1000.

The list of AP1000 DSER Open Items included Open Item17.3.2-2, which reads in part:

> Westinghouse stated that a project-specific quality control plan was used to implement the requirements of the Westinghouse QMS program. The staff plans to conduct an inspection of the implementation of the project-specific quality plan to verify that design activities conducted for the AP1000 project complied with the Westinghouse QMS and the requirements of 10CFR Part 50, Appendix B. [Reference 5]

However, the "project-specific quality control plan" Westinghouse refers to is just the AP600 plan. Although Open Item 17.3.2-2 indicates "N/A" for the original RAI corresponding to the open item, there was an RAI about the AP1000-specific quality assurance plan [RAI 260.008-1 dated May 13, 2003]. Westinghouse's response to that RAI had been to claim that the AP600 document applied to the AP1000. The rationale given in Westinghouse's response to RAI 260.008-1 was:

As the DCD identifies: " The plan ... is applicable to work performed for the AP1000 design." Westinghouse considers that it has identified a project specific quality plan (i. e., WCAP- 12600) for the AP1000 design.

There is also a discussion of the use of the AP600 project quality plan in Chapter 17 of the DSER, which states:

> A project-specific quality plan was issued to supplement the quality management system document and the topical reports for design activities affecting the quality of structures, systems, and components for the AP6OO project . . . This plan addresses the NQA-1-1989 edition through NQA-lb-1991 addenda and is applicable to work performed for the AP1000 design. [Reference 1, page 17-1]

These statements raise concern, for the reasons mentioned in my original July 10, 2002 email and excerpted in section 2.1 above. When I attended the ACRS Subcommitte Meeting on Future Plant Designs held on July 17th and 18th, I did not anticipate that the subject open item would be mentioned, and did not request time to speak beforehand. However, when I saw that the NRC's presentation included mention of the issue of an inspection of Westinghouse's QA plan during the meeting, I asked to make some impromptu remarks along the lines of the concern raised in my email. There was not time to gather the previous correspondence, relevant Open Items, RAIs, and RAI responses at that time. Therefore, I provide a more complete statement of the situation and my concerns about it here.

My concerns regarding QA of the AP1000 design process are:

A. Integrity of design process for the singular kind of project that the AP1000 is

The kind of process by which the AP1000 design was produced resembles an uprating in some ways, in spite of the fact that it is not regarded as an uprating. That is, one constraint was to use the AP600 design details insofar as possible. An uprating involves activities and considerations not addressed by the kind of design control procedures intended to address design of a plant where the design process starts with the specification of plant parameters and detail is filled in as the design progresses from functional specifications to detailed equipment specifications. Thus I would not expect the AP600 design control procedures to cover all the design processes on the AP1000.

<u>Of special concern is QA control of the overall plant parameters, both in terms of the design process by which they were obtained, and the design processes that use them as input.</u> (Perhaps this question was dealt with in the pre-application phase, but in case not, I raise it here.) I believe the generation of overall plant

parameters, whether for a new plant design, an uprating, or other changes to an existing plant design, is typically very tightly controlled, with oversight by an interdisciplinary committee whose membership is established independently of any particular project.

An important question here that needs to be asked is whether there are additional oversight or formal procedures over and above those addressed in the AP600 QA plan that would be appropriate for an uprating in that they would assure that the parameters are communicated to the affected functional design areas, would see that the right agents identify the specific changes that are required, and would keep track of their implementation. My worry is that due to its special nature (the criterion of keeping the AP600 design details as much as possible), the implementation of the AP1000 project plant parameters would really call for the additional oversight or the kinds of procedures applicable to an uprating.

If design control procedures intended for new plant designs were used in implementing the AP1000 plant parameters, rather than the design control procedures written to cover upratings, this raises a concern about the way that the AP600 information was used on the AP1000 project. This is because, for an uprating, the plant parameters are an input into a design process where an already existing plant is modified under the constraints of keeping much of the design unchanged. All kinds of QA design control questions arise in this case: for instance, who determines what information originally generated for the AP600 applies to the AP1000 or whether it needs to be reviewed? And who reviews it? Whose decision is final? It seems to me that the integrity of the design process relies upon keeping the design functions separate from project management functions. When a design group reports administratively to the project management and on a matrix basis to engineering management, the integrity of the design process depends upon the matrix connection being strong enough to ensure that technical aspects of management initiatives receive their due.

This kind of situation is not explicitly addressed in 10CFR50 Appendix B, but there is a statement on the general topic of who gets to decide such things in the event of design changes: "Design changes . . . shall be approved by the organization that performed the original design unless the applicant designates another responsible organization." Now, on the AP1000, where so many AP600 features are to be inherited, there is a kind of implicit change to an unspecified number of system capabilities in that the plant parameters have changed. Meeting the spirit of the subject criteria would mean that the judgement as to whether an AP600 design or document applies to the AP1000 or not should be made by those responsible for that design or document on the

AP600 design. Since the DCD references many AP600 documents, it is not always clear that the author of the AP600 document or design has approved its applicability to the AP1000. I think an important question is: who has determined that a certain AP600 document is applicable to the AP1000?

B. Organizational Differences Between AP600 and AP1000 affecting design control

The AP600 design control procedures reflected the involvement of ARC, the Advanced Reactor Corporation, a consortium of electrical utilities. I do not have access to the relevant procedures, but I recall from my previous involvement with the AP600 project that representatives of the ARC did have a formal role in the approval of design changes. Thus, beyond the straightforward point that the design control procedure for the AP1000 can not be exactly the same as the AP600 in terms of the letter of the law, there is the more significant point that the involvement of such an agency provided checks and balances on the AP600 project that may not exist on the AP1000 project.

There may be other organizational changes since the AP600 QA inspection was performed that affect the quality and the strength of the ties between technical and engineering design personnel in the AP1000 organization and the technical department managers reported to on a matrix basis. It would seem to me that these would need to be examined in order for the NRC's review of Quality Control to conclude that the assurance provided by the procedure when applied on the AP1000 project is the same as the assurance it provided on the AP600 design.

C. It seems late in the process should problems be detected

The NRC Letter accepting the Design Certification application dated July 12 2002 (Reference 4) stated that QA inspection would be done "as needed".

The fact that a QA inspection is an open item is reassuring in that it means this item will be tracked. However, the fact that it is an open item is cause for concern as to whether the appropriate inspections were performed "as needed" in the area of review of the fluid systems design. It is a concern because of the possibility that the QA inspection might reveal that some design activities need to be performed. Should these design activities result in design changes, it is very late in the process. Further, it seems that the comprehensive fluid system design of the AP1000 plant --- deriving the basic plant parameters from the AP600 design --- as well as the design details of specific systems appropriately designed for the AP1000, should be covered by this item.

The issue here is the QA control on information that is in the DCD: was there design control guaranteeing that the generation and implementation of the basic plant parameters for the AP1000, as well as the fluid systems design details (e.g., equipment parameters, piping size, valve specifications) were the result of design work of the appropriate kind (i.e., not merely preliminary sizing calculations), performed in a context where there was proper control of design information input into the design process, and where there were the appropriate checks and balances that provide assurance of the integrity of the design process? If it turns out there were areas where it was not, it seems there is not a lot of time to allow review and comment on the required design changes if the design certification schedule is to be adhered to.

3. Additional Remarks -- Schedule for Resolution of DSER Open Items and Role of Public Review and Participation

In general, the AP1000 design certification schedule seems to permit a number of potentially significant open items at the DSER stage. This limits the time available for review and comment by the public after the open item is resolved. Considering the finality of a design certification, it seems that the time available for public review and comment should not be abbreviated in the only stage provided for it.

Respectfully submitted,

Susan G. Sterrett
Assistant Professor of
Philosophy
Duke University, Durham, NC

Attachment I Email correspondence Sterrett to NRC dated September 15, 2003.

Attachment II Draft Text of Comments Read at 501st ACRS Meeting --Dr. S. G. Sterrett

References:

1. AP1000 Draft Safety Evaluation Report (DSER)
   Chapter 17 "Quality Assurance"

2. SECY-02-059 April 1, 2002
   "Use of Design Acceptance Criteria for the AP1000 Standard Plant Design"
   William D. Travers to The Commissioners

3. Email S. G. Sterrett to J. N. Wilson,
   "AP1000 Review/ 10CFR Part 52 Process"
   Wednesday, July 10, 2002

4. Letter July 12, 2002 James E. Lyons to W. E. Cummins
   "AP1000 Design Certification Review Schedule (TAC NO. MB4682)"

5. Letter May 27, 2003 James E. Lyons to W. E. Cummins
   "Westinghouse AP1000 Draft Safety Evaluation Report
   Potential Open Items Chapter 17 Quality Assurance"

6. Letter May 7, 2003 M. Bonaca to Nils J. Diaz
   "Summary Report of 501st Meeting of the Advisory Committee
   on Reactor Safeguards, April 10 - 12, 2003"

7. Draft text of comments by S. G. Sterrett at 501st ACRS Meeting
   (Attachment II to this letter. No transcript of April 11th meeting was made; oral statement followed written draft closely)

8. Nuclear Regulatory Commission Policy Statement
   "Enhancing Public Participation in NRC Meetings; Policy Statement"
   Federal Register May 28, 2002 (Volume 67, Number 102; Page 36920-36924)

9. 10 CFR7.12 Public Participation in and public notice of advisory committee meetings.

10. Email J. N. Wilson to S. G. Sterrett
    "Re: Followup on Questions: AP1000 Review/ 10CFR Part 52 Process"
    August 13, 2002.

11. Email S. G. Sterrett to L. J. Burkhart
    "Thanks for RAIs"
    September 15, 2002
    (included in Attachment I to this letter)

12. Email S. G. Sterrett to J. N. Wilson
"Piping Layout L/D Criteria for Fluid System Performance"
September 15, 2002
(included in Attachment I to this letter)

cc:

Mr. John Segala, Lead Project Manager, AP1000 Licensing
New Reactor Licensing Project Office
Office of Nuclear Reactor Regulation
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Mr. Joseph Colaccino, Project Manager, AP1000 Licensing
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Ms. Joelle Starefos, Project Manager, AP1000 Licensing
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ATTACHMENT I

Emails Sterrett to NRC (L. J. Burkhart; J. N. Wilson) dated September 15, 2003

....

This first email clarifies a question sent earlier to Jerry Wilson and discussed by telephone with Larry Burkhart. In it, I explain why the question is not addressed by the considerations provided in the rationale used in accepting DAC for the AP1000, nor covered by the RAIs sent to Westinghouse as of that date. The email below is followed by a longer one addressed to Jerry Wilson and cc'd to Larry Burkhart and Marsha Gamberoni.

Date: Sun, 15 Sep 2002 16:21:36 -0400 (EDT)
From: sterrett@duke.edu
To: Lawrence Burkhart <LJB@nrc.gov>
Subject: Thanks for RAIs

Dear Larry,

I have looked over the RAIs, and don't see any that address the question I asked Jerry Wilson about paying attention to fluid system performance in doing the piping layout. The RAIs do mention thermal-hydraulic loads, but that isn't what I meant; thermal-hydraulic loads are still related to the mechanical loads on the piping and concern the piping structural-mechanical analyis.

What I meant is the fluid system performance -- flowrates, pressures and temperatures that are achieved by the combination of driving head and fluid piping resistance. The fluid piping resistance is affected by the piping layout. In an email to Jerry Wilson, which I put you on cc for, and which I will send immediately after this one, there is more explanation. The bottom line is that even though the piping layout isn't final, the piping resistance criteria ("L/D criteria") for the AP1000 should be computed and provided at this point. In that email, following this one, there is also an explanation as to why the L/D criteria for the AP1000 will be different in many cases from the AP600.

In our conversation, you mentioned that the AP1000 is so similar to the AP600. That may be, but the question is, should the piping layout really be so similar? It is the fluid system's performance that sets the requirements of the design, and the layout has to meet those criteria. That's the point. One has to check, not just assume it will all turn out okay.

I imagine that there are people at the NRC whose reviews will address this, perhaps on a system-by-system basis. And whether or not the L/D criteria (piping resistance layout criteria) differ much for the AP1000 vis a vis the AP600 for a particular system may be a design detail. However, the overall point that L/D criteria for the AP1000 should be calculated at the DCD application stage is a plant-level issue. It's a very general point. In the email that follows, I explain why I think it is a policy issue about the new licensing process.

I am asking these questions as an individual member of the public, unaffiliated with any organization.

Sincerely,
Susan G. Sterrett
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The "email that follows" referred to in the above email is appended below. It is: Email dated September 15, 2002 from Sterrett to NRC staff (Jerry Wilson, cc to Larry Burkhart and Marsha Gamberoni)

Date: Sun, 15 Sep 2002 16:46:21 -0400 (EDT)
From: sterrett@duke.edu
To: Jerry Wilson <JNW@nrc.gov>
Cc: LJB@nrc.gov, MKG@nrc.gov, sterrett@duke.edu
Subject: Piping Layout L/D Criteria for Fluid System Performance

To: Jerry Wilson, Senior Policy Analyst, NRC
cc: Larry Burkhart, AP1000 Project Manager, NRC
Marsha Gamberoni, Deputy Director, New Reactor Licensing

Subject: Piping Layout L/D Criteria for Fluid System Performance

Dear Jerry,

In a previous email, you responded to a question I asked regarding whether proof-of-design calculations of fluid system performance were performed for the AP1000. This email is to (a.) clarify the question I was asking, and (b) explain why I think L/D criteria is an issue of policy regarding the 10CFR52 design process, not merely a minor design or schedule detail.

In spite of the length of this email, the two points are simple; I am just including the text of the things I reference to avoid any possible ambiguity.

(a) Clarification of Question Re: Calculations Supporting Fluid System Performance

To recapitulate, the question I asked (July 10) was:

``1. What point of maturity is the design supposed to have at the stage the AP1000 application is presently at? I take it that by the time a design is certified, it is not supposed to be one for which only preliminary sizing calculations have been performed to size the equipment. What ensures this doesn't happen?

(i) Are there supposed to be signed-off, proof-of-design calculations, (using the actual piping sizes, equipment parameters, and layout) for the flows reported for all the systems in the AP1000 DCD submitted? Or, performance analyses for the more complex pieces of equipment such as the pressurizer, the steam generator, large control and relief valves, etc.?

(ii) Does the submittal of the DCD imply that the things in (i) are done?

(iii) Does the NRC verify or ask for proof that the things above are in fact completed and signed off by the appropriate functional groups, and that they justify the design details in the DCD? If so, when does this occur?" [excerpt from email of July 10, 2002 Sterrett to Wilson]

In your response (August 13) you explained why proof-of-design calculations for fluid system performance were _not_ expected to have been performed at the time of DCD submittal:

``With regard to question #1,
the Commission expects that when submitted, the design maturity is equivalent to the level of design information available at the operating license stage under the old 2-step process in Part 50 (Final Safety Analysis Report). The NRC's requirement for the level of detail of design information supporting an application for design certification is set forth in 10 CFR 52.47(a)(2). Specifically, it is sufficient information to support a safety finding in any technical review area. However, with regard to piping design, Westinghouse is proposing to use design acceptance criteria in lieu of detailed design information for design

certification. The Commission found that approach acceptable for the ABWR and System 80+ designs. Therefore, for questions #1(i) and (ii), we did't expect that signed-off, proof-of-design calculations were complete when the DCD was submitted. However, piping design calculations will need to be completed to support construction and the NRC will do verification inspections of the design andconstruction activities [#1(iii)]. ``
[excerpt from email of August 13, 2002 Wilson to Sterrett]

I would like here to clarify my earlier question: by ``proof-of-design calculations", I was referring to proof-of-design calculations for fluid system performance, rather than to piping design calculations. By ``piping design calculations", I assume you are referring to calculations concerning things such as piping stress, fatigue and mechanical loads. But, of course, the proper flow performance of fluid systems sets another kind of criterion: that is, in addition to the criteria that aim to ensure that the structural/mechanical behavior of the piping is acceptable, piping layout activities also have to take into account criteria that ensure that the piping flow resistances will result in the flows through the system called for by the fluid system design (and for which the design of numerious interfacing systems may take credit). In addition, pressures (and, sometimes, temperatures) in the system at various key points, such as at heat exchangers and control valves, are influenced by the piping layout. And here i am including normal system operation. Your response to the question of whether there have been proof-of-design calculations for fluid flow performance was that you did not expect them to be done, because the piping layout wasn't final.

However, if the piping layout isn't far enough along to permit proof-of-design calculations to be performed, the calculations related to fluid system performance should still be done -- the only difference is that they would result in piping fluid flow resistance criteria, or ``L/D criteria."

From your response, I wasn't sure if ``L/D criteria", or piping fluid resistance criteria were included in the DAC. After looking at various meeting transcripts and the RAIs regarding DAC attached to the meeting notice for September 9, 2002 (Reference 3), it doesn't appear to me that the ``L/D criteria" are addressed in these places.

So, the question is whether L/D criteria have been provided for the AP1000 fluid systems. Even if the piping layout for the AP1000 were _exactly_ the same as the AP600 layout, new L/D criteria would need to be calculated for the AP1000. For, anytime the design flowrate for a system changes, the

L/D criteria need to be re-calculated, since piping flow resistances vary with flowrate. Even for those systems, if any, where the fluid flowrate of the system is exactly the same for the AP1000 as it was for the AP600, there is still the question whether there are differences in the inlet or outlet pressures -- i.e., in the pressure in the system or piece of equipment to which it connects and from which the fluid enters the fluid system or to where it discharges. Hence the fluid flow performance would be different for the same layout. Thus, the layout criteria would differ between the AP1000 and the AP600 for cases where a system's inlet or discharge pressures differ. (An example here of such a difference in the AP1000 is the significant change in main steam pressure: obviously L/D criteria will be different between the AP600 and the AP1000 for the inlet piping to the steam relief valves, for example.)

Thus, to rephrase the question in my July email:

``(i) Are there supposed to be signed-off, L/D criteria and supporting calculations, (using the AP1000 fluid system functional requirements and equipment parameters) for the system flows and pressures reported for all the systems in the AP1000 DCD submitted? Or, L/D criteria for the piping associated with the more complex pieces of equipment such as the pressurizer, the steam generator, large control and relief valves,etc.?

(ii) Does the submittal of the DCD imply that the things in (i) are done?

(iii) Does the NRC verify or ask for proof that the things above are in fact completed and signed off by the appropriate functional groups, and that they justify the design details in the DCD? If so, when does this occur?"

This is the question I have now, given your repsonse that you did not expect ``proof-of-design calculations" to be performed due to the fact that the piping layout is not final at the DCD application stage.

(b) Previous process versus new 10CFR52 process

It is simply good common sense to provide L/D criteria for the preliminary piping layout, in order to have confidence that when the final piping layout is in fact completed, the design will be such that the fluid performance functional requirements of the system are in fact met, avoiding major changes to the preliminary layout. As you may be aware, this is the process that was followed on the Westinghouse standard plants.

As I see it, requiring that L/D criteria for performance of fluid system functional requirements be provided at the DCD submittal stage in the AP1000 design process is also a _policy_ issue. Here is why: under the older process, L/D criteria were provided to the architect-engineer for use in laying out piping, that is, in the preliminary layout. Thus they were performed PRIOR to the application for an operating license under the old process. L/D criteria can be provided now, as they do not depend upon the piping layout, much less on the piping layout being final. (They are criteria calculated for use in laying out piping such that the fluid system functional requirements (which should be final at the DCD submittal stage) are met.) The L/D criteria are criteria that apply for _preliminary_ layout as well as final layout.

Certainly the ITAACs and other operational tests are going to provide a checkpoint where deficiences in system performance are found, but, I trust, it certainly isn't the intent of the new 10CFR52 process to increase the surprises encountered during operational testing! I assume that everyone agrees that the intent is to have confidence that the certified design results in fluid systems that meet their functional requirements in terms of flowrates, pressures, and temperatures, even if the piping layout for the certified design may not be final in every detail.

Thus, it seems clear that the L/D criteria should be provided at the DCD submittal stage in the 10CFR52 process. It's an issue of policy because, otherwise, the 10CFR52 process would result in the NRC certifying a design for which there was less confidence in the design than existed under the old process at a comparable stage.

It would be great to hear the answer that L/D criteria for all the AP1000 systems have in fact been calculated and provided, but, in any case, I look forward to your reply. As with my previous inquiry, I am asking these questions as an individual member of the public, unaffiliated with any organization.

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ATTACHMENT II

Draft of Remarks by Dr. S. G. Sterrett - 501st ACRS meeting, April 11th, 2003, Rockville, MD

I'm Susan G. Sterrett. I am currently a professor at Duke University in Durham, North Carolina. I should perhaps mention that, prior to my academic career, I worked as a design engineer in the commerical nuclear power plant industry, including on fluid system design of the AP600 and EPP plants in the mid-nineties. I am making these remarks as a member of the public, unaffiliated with any organization.

I'm here today because I have some questions about the NRC's review of the AP1000. Put briefly, my question is whether the NRC verifies or asks for proof that the system parameters reported in the AP1000 design certification application (and used in the analyses) are actually justified by a detailed design, as opposed to the AP1000 system designs being at the stage of conceptual system design or justified only by preliminary equipment sizing calculations. I'd like a few minutes to explain the relevance and the significance of the question.

According to the rules under which the AP1000 is being licensed by the NRC, the level of design information required in a design certification application is, with a few explicit exceptions, the level of information that was required at the operating license stage under the previous two-step licensing process. I think this requirement makes sense, too, inasmuch as what the NRC is licensing in approving the AP1000 is an actual plant design that is certified to be constructed and operated.

In following some of the AP1000 licensing activities via the NRC's website, I have noticed that much is often made of the similarities between the AP1000 systems and the AP600 systems. This can be misleading: the performance of the various fluid systems in the plant -- that is, the flows, temperatures, and pressures that obtain at various points within a system are affected by many kinds of differences in a plant design. As I am sure everyone here realizes:

--- Anytime a system flowrate changes, pressure drops in the system will change.

--- Likewise, anytime the pressure at some point in a system changes, flowrates in it or some other system can be affected.

--- Thus, even for those systems that are exactly the same physically speaking (i.e., same pipe size and layout) for the AP1000 as for the AP600, there is still the question of whether there are differences in the inlet or outlet pressures in a system or piece of equipment to which it connects. Different inlet or outlet pressures will result in differences in fluid system performance.

For example, suppose the main steam system pressure is different on the AP1000; then, on the AP1000, there would be a different driving head for lines connected to it than there was on the AP600. So, even if the system hardware and layout of a system connected to the main steam system, say, is exactly the same on the AP1000 as it was for the AP600, the resulting values of major fluid system parameters -- e.g., the mass and volume flowrates and the pressures that result -- could be quite different. Obviously the effects on things like the flow capability of relief valve piping and valve arrangements would need to be looked at. Accomodating these changes could require resizing piping or control valves in order to achieve the flowrate claimed for the system.

I've given the main steam system as an example, but the general point holds for every system in the plant. To infer from the fact that the hardware and layout on an AP1000 system is exactly the same as on the AP600, to the conclusion that the performance is the same, is incorrect. The various AP1000 analyses now under review are only as valid as the assumptions made in them about the performance of the plant systems.

What does this point mean for the review of the AP1000 design, which makes frequent appeal to the certified AP600 design? In many aspects of the safety analyses, the NRC has been very alert to the differences between the AP1000 and the AP600. The point of my examples is that this awareness ought to be extended to plant fluid system performance, specifically, that some reassurances should be sought that the fluid system design details for all the plant systems have been properly attended to, and that, given that the level of detail required at this stage is supposed to be the same as that at the operating license stage, these should not be just preliminary sizing calculations. I worry about the complacency with which the AP600 design is referenced in justifying the AP1000 system designs.

The AP1000 is sometimes referred to as an uprating of the AP600 design. Of course this would be significantly larger than any uprating that the NRC has licensed so far, and of course it differs from most upratings in that there is no AP600 operating experience to draw upon. To the extent that thinking of the AP1000 as an uprating of the AP600 is appropriate, however, it would make sense to require that all the plant system reviews that would be required for an extended power uprating be performed for the AP1000. As there is now a draft review standard for extended power uprates that could be used to guide such a review of the AP1000 (RS-001, dated December 2002), this seems a natural thing to do. I wonder whether there has in fact been a review of this sort for the AP1000. So let me ask: has there?

For those systems whose layout is finalized at this stage of the AP1000 design certification application, there should be formally signed-off engineering calculations justifying the claims that the AP1000 system flow, temperature, and pressure parameters will actually be achieved using the AP1000 equpment and layout. These are often referred to as fluid system "proof-of-design" calculations. I gather from the NRC's approval of the use of DAC (design acceptance criteria) for structural piping analysis on the AP1000 that there may be some systems for which the layout details will not be completed until after design certification. For those systems, what is needed as far as ensuring proper fluid system performance is to provide layout criteria related to the piping flow resistance, so that the fluid flowrates claimed for the system will actually be achieved. Such criteria are commonly called "L/D criteria" and are considered part of the fluid system design. In fact, for the Westinghouse standard plant designs licensed under the previous two-step process, L/D criteria were provided for various fluid systems prior to construction so that the architect engineer could properly perform the piping layout. As I see it, at least this level of design detail is required at the time of the DCD submittal.

Why not just rely on the ITAACs (Inspections, Tests, Analysis, and Acceptance Criteria) to provide such reassurance? Certainly the ITAACs and other operational tests provide a checkpoint where some deficiences in the plant design would show up. However, I trust that it isn't the intent of ITAACs to relieve the designer of the responsibility of the engineering design work of designing the plant systems so that the system parameters crucial to safety are achieved. Certainly increasing the number of surprises encountered during plant testing is not part of the intent of the new one-step licensing process! I assume that everyone agrees that the intent of design certification is to provide confidence that the certified design will result in fluid systems that meet their stated functional requirements in terms of flowrates, pressures, and temperatures, even if the piping layout for the certified design may not be final in every detail.

In conclusion, I am asking whether the review of the AP1000 design has included ensuring that the design details upon which the analyses that the ACRS has been reviewing depend, have in fact been attended to. In particular, I think it is clear that L/D criteria should be provided at this stage for systems whose layout is to be finalized at a later date, and "proof-of-design" calculations be provided for those whose layout is determined at this stage. Otherwise, there is no assurance that the analyses you are reviewing so carefully and thoughtfully apply to the plant design you are certifying.

Thank you for listening.

Respectfully submitted,

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April 20, 2004

Dr. Susan G. Sterrett, Assistant Professor
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SUBJECT: RESPONSE TO CONCERNS ABOUT THE AP1000 DESIGN CERTIFICATION

Dear Dr. Sterrett:

The purpose of this letter is to respond to your concerns regarding the NRC's design certification review of the AP1000 advanced reactor plant. Specifically, in your letters dated July 30 and July 31, 2003, you expressed concerns with the AP1000 fluid systems design and quality assurance (QA) procedures and the impact of solar radiation heat on the ultimate heat sink. Both of these letters were addressed to the Nuclear Regulatory Commission (NRC) Advisory Committee on Reactor Safeguards (ACRS) Subcommittee on Future Plant Designs. We appreciate your initiative in writing these letters and letting us know of your concerns regarding AP1000 design certification.

Public involvement is a key element in NRC's reactor licensing process. The NRC is committed to enhancing public confidence, and we regard public outreach as a top priority in the work we do. Meetings with the licensees or applicants on safety issues are typically open to the public and documented for public access. We wish to make your letters (as well as all electronic communications between you and the NRC staff) publically available in the Agencywide Documents Access and Management System (ADAMS). If you have any concerns or reservations about your letters, and e-mail communications being made available to public, please contact Raj Anand by phone at 301-415-1146 or by e-mail to rka@nrc.gov by April 23, 2004.

As you are aware, the NRC is responsible for licensing and regulating the operation of nuclear power plants. The following provides a general overview of the standard design certification process. The NRC certifies and approves a standard plant design through a rulemaking, independent of a specific site. An application for a standard design certification must contain information and proposed inspections, tests, analyses, and acceptance criteria (ITAAC) for the standard design. Additionally, the application must demonstrate how the applicant complies with the Commission's applicable regulations. The ACRS reviews each application for a standard design certification, together with the NRC staff's safety evaluation report, in a public meeting. Upon determining that the application meets the applicable standards and requirements of the Atomic Energy Act and the Commission's regulations, the Commission utilizes the rulemaking process to issue a standard design certification in the form of a rule which becomes an appendix to the 10 CFR Part 52 regulations. In addition to participating in the design certification rulemaking, members of the public may submit written or oral comments on the proposed design certification rule. The Commission may, at its discretion hold a hearing. The issues that are resolved in a design certification rulemaking are subject to a more restrictive change process than issues that are resolved through the issuance of a license. The NRC can only change certified design requirements in limited circumstances.

Several of your concerns were related to the differences between the AP600 and AP1000 design reviews. The NRC considers the review and design certification of the AP1000 to be largely independent of the previous AP600 design review. The AP1000 design is not a power uprate of the AP600 design. The NRC's review of the AP1000 design is conducted in accordance with 10 CFR Part 52 requirements, and in accordance with the applicable review procedures, and acceptance criteria of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants." In some cases, the staff referenced AP600 design information; however, there is an independent review of all AP1000 safety parameters to verify that they meet NRC regulations.

The safety review of the AP1000 application is based primarily on the information submitted by the applicant under oath and affirmation. An application must contain a level of design information sufficient to enable the Commission to reach a final conclusion on all safety questions associated with the design. In general terms, a design certification application should provide an essentially complete nuclear plant design, with the exception of site-specific design features such as intake structures and the ultimate heat sink. The application presents the design criteria and design information for the proposed reactor and includes information that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of structures, systems, and components of the facility as a whole. The scope and contents of the application are equivalent to the level of detail found in a final safety analysis report (FSAR) for a current operating plant. The NRC staff prepares a safety evaluation report (SER) which describes how the staff performed the review of the plant design, and how the design meets applicable regulations.

The following sections address your specific concerns.

AP1000 Fluid Systems Design

You were concerned whether the NRC verifies or asks for proof that the system parameters reported in the AP1000 design certification application (and used in the analyses) are actually justified by a detailed design, rather than only by a conceptual AP1000 system design or by preliminary equipment sizing calculations.

To support design certification, system parameter information must be at a level of detail such that the NRC can make a determination of reasonable assurance of safety at the time the design is certified. The NRC requirement for the level of design information detail supporting an application for design certification is set forth in 10 CFR 52.47(a)(2). Specifically, the applicant must provide sufficient information to the Commission to reach a final conclusion on all safety questions associated with the design before the certification is granted.

In addition, should an applicant reference the AP1000 design, the NRC will conduct independent design verification inspections during the pre-combined license review phase. In SECY-94-294, "Construction Inspection and ITAAC Verification," the staff stated that design descriptions and functional system drawings available for review during the design certification and combined license application stages are adequate for licensing reviews and final safety determinations, but not for actual construction or construction inspection activities. The NRC will inspect and review the adequacy of licensee design engineering early in a construction project, possibly beginning soon after receipt of a licensing application; first-of-a-kind engineering for the lead plant of each certified design will be assessed during these inspections. The NRC will also assess the effectiveness of the licensee's design change process in maintaining the fidelity of high-level certified design information that is translated into construction drawings.

One specific concern you raised was that head loss coefficients (e.g. L/D criteria) should be provided for systems whose layout is to be finalized at a later date, and that "proof-of-design" calculations should be provided for calculations whose layout is determined at this stage. With regard to piping design, Westinghouse is proposing to use design acceptance criteria (DAC) in lieu of detailed design information for design certification. The NRC staff defines DAC as a set of prescribed limits, parameters, procedures, and attributes upon which the NRC staff relies, in a limited number of technical areas, in making a final determination to support a design certification. The Commission found that approach acceptable for General Electric Advanced Boiling Water Reactor (ABWR) and ABB-Combustion Engineering System 80+ designs. Therefore, the NRC did not expect signed-off, proof-of-design calculations to be completed when the design control documents (DCDs) were submitted. However, piping design calculations will need to be completed to support construction and the NRC will verify the calculations through appropriate use of ITAAC of the design and construction activities. The acceptance criteria for DAC become the acceptance criteria for ITAAC, which are part of the design certification. In addition, the NRC reviews the applicant's safety analysis report, which describes the plant's final design, safety evaluation, operational limits, anticipated response of plant to postulated accidents, and plans for coping the emergencies to determine whether there is reasonable assurance of safety.

Quality Assurance Design Control Measures for the AP1000 Plant

You also raised concerns about the design control process used by Westinghouse for the preparation of AP1000 design documents. Specifically, in your February 11, 2004, statement to the ACRS you questioned who is entitled to make the decision about which features, calculations, and documents for the AP600 need to be reviewed for changes in uprating of the AP1000. In accordance with 10 CFR Part 52, an application for design certification is required to provide a description of the quality assurance (QA) program to be applied to the design of systems, structures, and components (SSCs). In its application for design certification of the AP1000 plant, Westinghouse stated that a continuous QA program spanning the AP600 design and the AP1000 design has been used. Since March 31, 1996, activities affecting the quality of items and services for the AP1000 project during design, procurement, fabrication, inspection, and/or testing have been performed in accordance with the quality plan described in "Westinghouse Energy Systems Business Unit - Quality Management System." The Quality Management System (QMS) establishes design control measures for preparing, reviewing, and approving design documentation for safety-related SSCs. As documented in an NRC evaluation letter dated February 23, 1996, from S. Black (NRC) to N. J. Liparulo, the Westinghouse QMS was reviewed by the staff and found to meet the requirements of 10 CFR Part 50, Appendix B. Subsequent revisions to the QMS have also been reviewed by the staff and found to be acceptable.

To provide additional assurance that Westinghouse implemented the measures described in the QMS, the staff performed a quality assurance implementation inspection at the Westinghouse engineering offices in Monroeville, Pennsylvania, during the week of September 15, 2003. The inspection activities included a sampling review of QMS activities related to the QA organization, supplier evaluation and qualification, the corrective action program, audits and self-assessments, and the design control process. The results of this inspection were documented in NRC Inspection Report No. 99900404/03-01, dated November 4, 2003. The inspection report can be found on the NRC public Website http://www.nrc.gov/reading-rm/adams.html under ADAMS Accession No. ML033090510. With the exception of the methods used to evaluate and qualify certain suppliers of safety-related design analyses, the staff determined that Westinghouse complied with the requirements of 10 CFR Part 50, Appendix B, for the areas reviewed. Subsequent to the inspection, Westinghouse described the corrective actions taken to evaluate, and qualify suppliers of safety related items and services for the AP1000 design. As noted in a January 13, 2004, letter from T. Quay (NRC) to W. Cummins, the staff determined that the corrective actions were responsive to the staff's concerns.

During the QA implementation inspection, the staff determined that Westinghouse established project-specific quality-related procedures to implement the QMS requirements for the AP1000 project. These project-specific procedures established a design control process for AP1000 that included preparation, review, and approval of AP1000 design information. Although the AP1000 design was derived from the AP600 design, the AP1000 project-specific design control process specified that all documents generated to describe, portray, specify, or report on the AP1000 design were subject to independent verification and approval reviews. Independent verification was intended to confirm that the design document accurately reflected supporting design information. The NRC inspectors concluded that the design control measures described in the AP1000 project specific quality procedures met the design control requirements of 10 CFR Part 50, Appendix B.

Although certain weaknesses in the areas of QA audits and self-assessments were identified during the inspection, the staff concluded that, in general, internal audits and self-assessments for the AP1000 project met the requirements of the QMS. Following the inspection, Westinghouse provided additional docketed information related to the conduct of QA audit and self-assessment activities for the AP1000 project. The staff reviewed this information and concluded that Westinghouse had identified a reasonable cause and corrective actions for the failure of QA audit activities to identify weaknesses in the supplier qualification program. It should be noted that the quality assurance requirements of 10 CFR Part 50, Appendix B, do not include the performance of self-assessments. Furthermore, the staff does not rely on the performance of self-assessments to provide reasonable assurance in an applicant's design control processes. Therefore, although the staff noted certain weaknesses in self-assessment activities, reasonable assurance of the adequacy of design control measures is provided by the applicant's compliance with the quality assurance requirements 10 CFR Part 50, Appendix B.

Impact of Solar Radiation Heat on the Ultimate Heat Sink

You raised a concern about the impact of solar radiation heat on the passive containment cooling system (PCCS) water tank located on top of the containment building.

The passive containment cooling water tank is a large reinforced concrete structure located above the containment building. The tank contains a large volume of water (800,000 gallons). Because the volume of water in the tank is so large, the rise in the water temperature due to solar radiation heat is negligible. The Westinghouse analyses and evaluations assumed initial containment conditions of 120 °F and 1.0 psig. The PCCS water temperature is also assumed to be 120 °F. The analyses provided conservative peak calculated containment pressure and temperature response following postulated design basis accidents. The PCCS is designed to meet the requirements of 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 38, "Containment heat removal," and GDC 40 "Testing of heat removal system." Technical Specification (TS) 3.6.6, "Passive Containment Cooling System" verifies the water storage tank temperature remains less than 120 °F every 24 hours during normal operation of the plant. If the temperature is observed higher than 120 °F, the PCCS would be declared inoperable, and the licensee will be required to take corrective actions to restore water storage tank to operable status within 8 hours or be in hot standby within 6 hours and in cold shutdown within an additional 78 hours. In reviewing the detailed design information and the analyses for the PCCS, we believe the TS requirements and actions taken will bound any possible solar radiation effects.

In summary, the NRC has followed all of the applicable rules, regulations, and technical review processes in reviewing the AP1000 design certification application. Please contact us if you have additional information regarding the AP1000 design certification that you believe we have not captured through our review process.

Thank you again for your interest in AP1000 design certification. If you have any questions regarding this correspondence, please feel free to contact Raj Anand, Project Manager. He can be reached at 301-415-1146 or by e-mail to rka@nrc.gov.

Sincerely,

/RA/

James E. Lyons, Program Director
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 52-006

cc: See next page

Caldon Remarks
ACRS Meeting
Two White Flint North
July 8, 2004

Good morning. I am Cal Hastings, the CEO and President of Caldon. I am pleased to have this opportunity to speak before the ACRS.

Caldon is a technology company specializing in precision ultrasonic flowmeters. As you might expect, we have amassed a great deal of know-how on the design, application and performance of such meters. I would like to use this time today to share some of our perspective on Measurement Uncertainty Recapture Uprates and the ultrasonic meters used to achieve them. To avoid the risk of misspeaking, I would like to read from notes that I prepared during some quiet thoughtful time.

I have two reasons for speaking today. First, at Caldon we regard an over power incident as a serious event. The licensees we work with do too. This is not because we believe the event itself necessarily brings great risk to the safety and wellbeing of the public. It is simply because operating a nuclear plant over its licensed thermal power limit is in violation of the regulations. To treat such events lightly undermines the public perception of safety in the nuclear power industry. It may even serve to undermine the practice of safety within the industry itself by allowing operation outside of analyzed conditions. Consequently, we have worked hard to provide flowmeters to the nuclear power industry that are calibrated accurately and whose errors remain within clearly established and acceptable limits.

Second, I believe MUR Uprates are important to our nuclear power industry and to our country. Many Americans are still recoiling from the surge in prices at the gas pumps this spring. Most would like to reduce our dependence on foreign oil. If nuclear power plants generate more power, they can help achieve this objective. These uprates are very important; I believe they can and must be achieved without violating important regulations.

Two types of ultrasonic flowmeters are used to measure feedwater flow in nuclear plants. Caldon produces both types. One type mounts externally on the pipe. External meters measure the velocity essentially in the middle of the pipe and require that a factor be applied to determine the bulk flow rate. The other type employs a flow element that is welded into the pipe; it is known as a chordal meter because it samples the velocity profile along four chords and integrates it to determine the volumetric flow.
Chordal meters are inherently more accurate than external meters because the chordal meter provides a direct measurement of the bulk flow rate.

- If I have counted correctly, external ultrasonic meters are installed in 33 US nuclear plants today; 11 of these use meters supplied by Caldon. The number of Caldon external meters in service was greater but has declined as some have been replaced with chordal meters.

- Chordal ultrasonic meters are installed in 26 US nuclear plants today. All of these were supplied by Caldon.

Licensee Event Reports prepared since the beginning of the year 2000, show that 10 nuclear power plants have gone over power because of errors in ultrasonic flowmeters. All of these were associated with external flowmeters. In two cases the error was as great as 2.7%. We know of no case where the error arose because a licensee misapplied the meter. And none of the overpower events was caused by a chordal flowmeter.

These incidents have raised two important questions. What causes such errors in external ultrasonic flowmeters? And how can these errors be bounded or contained within acceptable limits?

The answer to the first question is relatively simple – External meters are very sensitive to velocity profiles. Our chordal meters measure profiles. In the past several years we have learned that velocity profiles in feedwater lines are often different from what traditionally has been assumed. When the profile is different from the one assumed, a bias error will result in an external meter. We know that the velocity profile was the principal contributor in one of the plants where a 2.7% over power incident occurred, and it is likely that it is a major contributor in most of the other overpower incidents. The errors were created when the velocity profiles changed from their assumed shape.

The challenge for external meters is made even more difficult because velocity profiles in feedwater lines are not constant. Data from the past several years show that velocity profiles often change in feedwater lines, sometimes gradually and sometimes suddenly. One nuclear plant recently withdrew its request for an MUR Uprate because of calibration changes occurring in the external meter that was installed. It is likely that the calibration changes are the result of changes in velocity profile.

The second question regarding how to bound the errors is not so easy to answer. Since external meters cannot measure velocity profiles they cannot recognize if and when they are in error. Neither can they determine the magnitude of their error at any given time. And it is no easy matter to predict just what the worst case errors might be. At Caldon we had believed for some time that the calibration procedure we developed during the early 1990's assured us that we could easily contain the errors in our external meters within the bounds of $\pm$1%. The LERs, some of which were caused by Caldon external meters, show this to be wrong – we didn't contain them all. I will come back to this question in a moment.

Chordal flow meters have a significant advantage over external meters with respect to the effects of velocity profiles. In the first place, chordal meters are less sensitive to velocity effects by a factor of 20. And as I have pointed out, chordal meters measure the velocity profile and consequently recognize when they are operating under conditions different from those under which they were calibrated. They can also determine the magnitude of the actual error. The question on how to bound the errors is much easier to answer for a chordal meter. The uncertainties in the flow measurements of these meters can indeed be bounded reliably to within tight limits, as small as $\pm 0.3\%$. This can be accomplished if a laboratory calibration procedure traceable to NIST is followed, if a plant specific full scale hydraulic model is employed for the calibration, and if the meter's sensitivity to variations in velocity profile is measured and accounted for.

Applying Caldon external meters to measuring feedwater flow certainly has given us our share of challenges. We now know that there is an even greater requirement for basing an external meter's calibration on hydraulic models that mimic the plant specific piping. We now know that the models must be more comprehensive than those used for chordal meters. And we now know that the calibration procedure must determine and take into account the sensitivity of the meter to velocity profiles. But only if we do these things, can we be assured that the flow measurement readings of Caldon external meters will be within 1% of the true flow.

But where does this really leave us on the matter of calibrating external meters and bounding their errors in general? The NRC staff have been trying to work through this issue for some time. They have told us this morning something of the actions they intend to take. We at Caldon support a number of the ideas proposed. We disagree with some others. For instance, we believe the staff should require licensees to provide data and other information that proves that their external meters' calibrations are valid and traceable, that their meters' uncertainties are bounded, and that when used for an MUR Uprate, that the size of the uprate is entirely consistent with the meters' uncertainty bounds. I think this is a point of agreement. We also believe that this is big challenge and a huge responsibility for licensees who have only limited depth of experience in the hydraulic and ultrasonic technologies that are necessary to make these evaluations. We are prepared at Caldon to provide the users of our external meters with the data, analysis and other support that they may need. This includes sharing our up-to-date knowledge and calibration procedures.

As a vendor, Caldon has an obligation to understand how our products work, how well they perform and what their limitations are. We also have an obligation to share this understanding with the industries we serve. We should not give them a false promise of performance that our meters cannot achieve. The velocity profile issue is not new for external ultrasonic meters. It is a generic issue. It has been with us for many years and I expect that it will remain with us for some time to come. While some of us would prefer otherwise, we must understand and accept that under the best of conditions, which do not always exist in feedwater lines, the accuracy that an external meter might achieve is on the order of $\pm 1\%$.

During the preceding presentation mention was made of a possible ever power at Palo Verde attributable to Caldon external meters. This is one of those cases where we now know that the model we used for the calibration was deficient. Fortunately, we have results from more recently conducted calibrations that provide the data to help us sort out the magnitude of the flowmeter error. This analysis is still underway. It appears that the error, and the resultant over power, is approximately 1%, which is at the outer bound of the meters' design basis. When we are finished, we will provide the people at Palo Verde with a new calibration that removes the bias error and we will also give them the documentation justifying the new calibration and bounding the total meter uncertainty.

We also have a responsibility to the licensees who use Caldon chordal meters, known as LEFM Check and LEFM CheckPlus. We have already provided them with comprehensive design basis documentation. We have also provided them with meters that have not experienced a single incident of exceeding their design basis nor have they caused any nuclear plant to go over power. I believe there is no basis for including these licensees in a generic 50.54f memo that the staff is proposing. It is not appropriate that these licensees be subjected to this burden when there is no evidence there is any problem in the performance of their meters.

Measuring flow in feedwater lines is not as easy as we would like it to be. In 1998 we conducted a survey of reported sustained overpower events occurring in the period from 1981 through 1997. We were able to identify 51 such events. Thirty-three of them were caused by errors in the flow measurements from nozzles. There were at least four different causes for the errors. One error was as great as 3%.

I am aware that there is much misinformation and debate pertaining to the use of ultrasonic meters flying about at the moment. This is not helpful and in fact places licensees in a terribly difficult position. I have heard that some people claim that the problem with errors in external ultrasonic meters should not be addressed because it is a site specific, rather than generic, issue. Of course the magnitude of the errors is site specific. But the inability of external meters to measure velocity profiles and their sensitivity to velocity profile effects are inherent characteristics of this type of meter. Velocity profile issues are not new for external ultrasonic meters. They have been with us for many years and I expect that they will remain with us for many years to come.

I have also heard that some people believe that nozzles can be used to check the calibration of ultrasonic meters. There is a preponderance of data showing that in general nozzles can only be counted on to be accurate within an uncertainty of ±1.5% or so. This of course is not good enough for corroborating the calibration of meters used for MUR Uprates. To adopt such practice would invite additional overpower events. It is easy to make probabilistic calculations that show this.

I have made statements here this morning without providing evidence or analyses to back them up. This was necessary owing to the time available to me. I would like to request that Caldon be included on the agenda for the September ACRS meeting. In particular I would like to have the opportunity for our Chief Engineer, Herb Estrada, to give a technical presentation that shows more clearly why the LEFM Check and LEFM CheckPlus Systems should not be included in the generic communication and why it is not a good idea to use the less accurate feedwater nozzles to verify the calibration of ultrasonic meters.

I thank you very much for your kind attention.

Statement to ACRS
Ultrasonic Flow Meter Input for Thermal Power Calculation Issue in Perspective

José Calvo

Office of Nuclear Reactor Regulation

July 8, 2004

Topics

- Safety significance
- Generic Implications
- Licensing/Design basis
- Possible Solutions
- Conclusion

Safety Significance

- Plant comptr. receives UFM & ΔP inputs.
- Thermal Power Calc. Output- Displayed to operator.
- No automatic action.
- Operator verifies calc. thermal power using secondary plant information.
- Operator manually increase or decrease power level.
- Operator verifies that power adjustments provide the expected results.

Safety Significance (cont.)

- UFM is one of many components in a single channel – it cannot be concluded that all malfunctions in that channel would lead to fail-safe conditions.

- Since the operator makes the final decision to adjust the power level, irrespective of the performance of the UFM or venturi/ΔP, it can be concluded that the loss of accuracy of the flow devices can be successfully mitigated and thus the consequences of their failure have no safety significance.

Generic Implications

- W's flow device
  * Byron 1&2 and Braidwood 1&2 overpower – misuse of the instrument.
  * Fort Calhoun event discredited.

- Caldon flow devices
  * River Bend overpower.
  * Palo Verde 1&2 overpower.

- No other plant information was directly access by the UFM Allegation Task Force.

- Insufficient basis to establish generic implications.

Licensing/Design Basis

- The procedures used by the operator to verify independently thermal power calc by the PC formed the licensing basis.

- Backfit implications since these procedures were not addressed as part of the staff reviews.

- Equipment used is non-safety related, and the staff may have performed only coarsely reviews

- The bulletin suggests new requirements which will not pass the backfit rule.

Possible Solutions

- Ensure that the accuracy of secondary plant instrumentation readings and expected process values correlated to thermal power are accurate enough to verify the accuracy of the calculated thermal power by the PC.

- Or consider adding another redundant channel for calculating thermal power.

- Otherwise overpower conditions may continue to occur.

Conclusion

- There is no safety significance.
- There is no generic implications.
- It is highly improbable that the Bulletin can be legally justified.
- It does not address the potential causes of overpower concerns.
- The proposed bulletin is an overkill.

Conclusion (cont.)

- A generic informative communication raising awareness of the questions raised about the application of UFMs in NPPs would be more than sufficient and it could bring to the attention of the licensees the importance of verifying the accuracy of the calculated thermal power before any manual action is taken.
- It should also challenge the licensees to determine whether the calorimetric surveillance intervals specified in the TS reflect the reduction in margin between the new thermal power based on the UFM and the 10 CFR 50 Appendix K limit.

NRR PRESENTATION TO ACRS ULTRASONIC FLOW METER (UFM) FOR MEASURING FEEDWATER FLOW USED IN DETERMINING REACTOR THERMAL POWER

July 8, 2004

Evangelos C. Marinos, Section Chief

Instrumentation and Controls

Electrical & Instrumentation & Controls Branch

Division of Engineering, NRR

U. S. Nuclear Regulatory Commission

PRESENTATION TOPICS

REACTOR THERMAL POWER MEASUREMENT

PWR Calormetric Calculation Principle Parameters

- Feedwater Flow
- SG Blowdown Flow
- SG Blowdown Liquid Enthalpy
- Feedwater Density
  - Temperature
  - Pressure
- Feedwater Enthalpy
  - Temperature
  - Pressure
- Steam Enthalpy
  - Temperature
  - Pressure
- Net Pump Heat Additon

REACTOR THERMAL POWER MEASUREMENT (Continued)

BWR Heat Balance Calculation Principle Parameters

- Feedwater Flow
- Feedwater Temperature
- Main Steam Pressure
- Reactor Water Cleanup Flow
- Reactor Water Cleanup Temperature
- Control Rod Drive Temperature

APPENDIX K TO PART 50 – ECCS EVALUATION MODELS

Source of heat during the LOCA

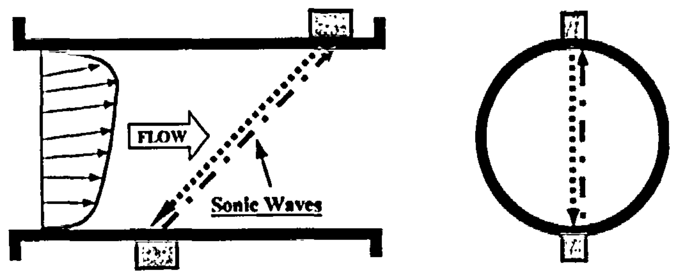
- Reactor assumed operating continuously at a power level at least 1.02 times the licensed power level (to allow for instrumentation error)

- An assumed power level lower than 1.02 times the licensed power level may be used provided the proposed alternative value has been demonstrated to account for uncertainties due to power level instrumentation error.

ULTRASONIC FLOW METER TECHNOLOGIES

Transit Time Technology - Leading Edge Flow Meter (LEFM) (Caldon)

- **Clamp-On Type Instrument**



$$\text{Angle of the Sonic Wave to Flow} = \alpha$$

$$V = {L(T_1 - T_2)} \Big/ {(2T_1T_2\cos\alpha)}$$

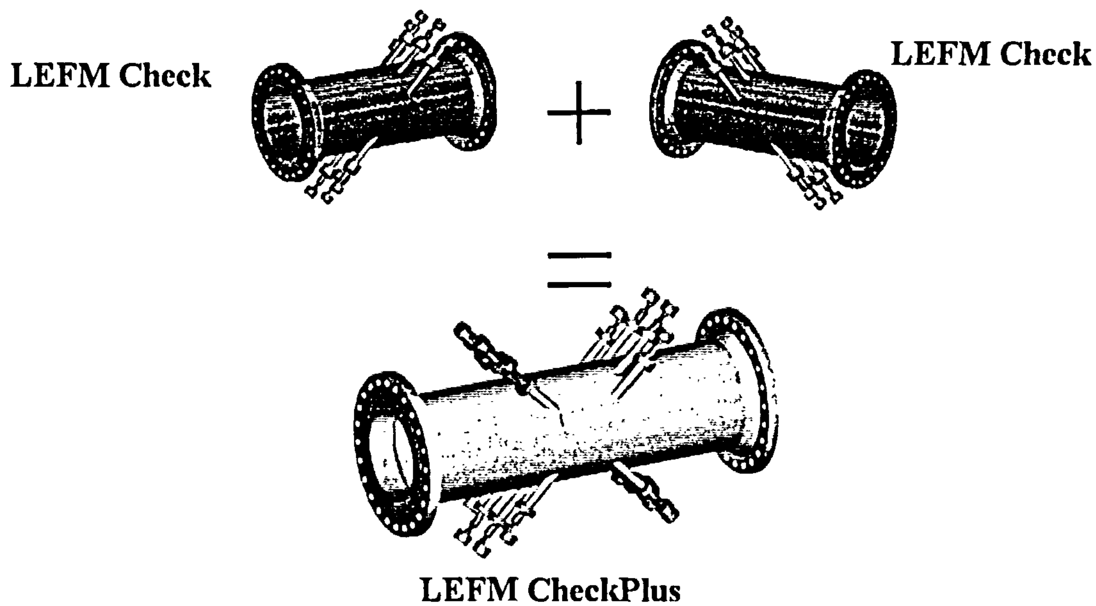
$$\Delta T \cong 1\mu Second$$

- **Fluid velocity (V) is determined by the difference in time of two sonic waves traveling in opposite directions.**

ULTRASONIC FLOW METER TECHNOLOGIES (Continued)

- **In-Line Type LEFM Instrument**

LEFM Check + LEFM Check = LEFM CheckPlus

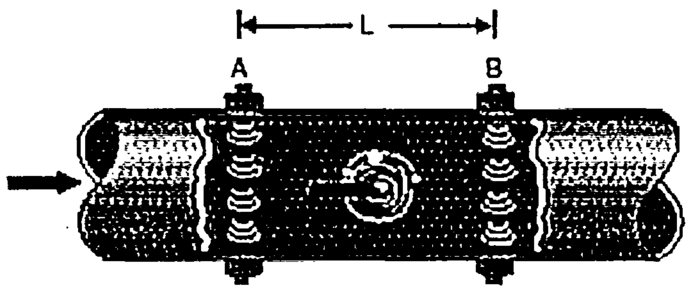


Operates on same principle as Clamp-On Type

ULTRASONIC FLOW METER TECHNOLOGIES (Continued)

Cross Correlation Technology - Westinghouse / Advanced Measurement and Analysis Group (W/AMAG)

- **Clamp-On Type (Crossflow) Instrument**



$$V = L/\tau$$

$$\tau \cong 50ms$$

Fluid Velocity (V) is determined by the time difference of two modulated signals shifted in phase by unique pattern of eddies in the fluid.

NON POWER UPRATE USE OF ULTRASONIC FLOWMETERS IN NUCLEAR POWER PLANTS

One-time venturi calibration.

Power Recovery from fouled venturies.

- Use of Transit Time Clamp-On-Type, LEFM instrument, resulted in over 2% overpower at River Bend and approximately 1% - 3% at Palo Verde 1 & 2, caused by the instrument not meeting its expected accuracy.

- Use of Cross Correlation Clamp-On-Type Crossflow instrument resulted in over 2% overpower at Byron 1 and approximately .8% - 1% at Byron 2 and Braidwood 1&2 caused by an apparent misapplication of the instrument.

STAFF REVIEW OF VENDOR TOPICALS

Caldon In-line Type LEFM Instrument

- Topical Report ER-80P, "Improving Thermal Power Accuracy and Plant Safety While Increasing Operating Power Level Using The LEFM✓™ System," Revision 0, dated March 1997, submitted for staff review
  - Staff issued Safety Evaluation Report (SER) dated March 8, 1999, accepting documented accuracy of instrument.
- Topical Report ER-157P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate with the LEFM✓™ or LEFM Check Plus ™ System" Revision 3, dated February 2001, submitted for staff review
  - Staff issued SER dated December 20, 2001 accepting documented enhanced accuracy of instrument.

STAFF REVIEW OF VENDOR TOPICALS (Continued)

Westinghouse / AMAG Clamp-On Type Crossflow Instrument

- Topical Report CENPD-379-P-A, “Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology” Revision 0, dated August 1999 submitted for staff review
  - Staff issued SER dated March 20, 2000 accepting documented accuracy of instrument.

STAFF LICENSING REVIEWS

Plant Applications for Measurement Uncertainty Recapture (MUR) Power Uprates (1.4-1.7%)

- Regulatory Information Summary RIS 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Application" dated January 3, 2002 issued to licensees to provide consistent guidance for application submittals.

- Uprates granted by the staff to plants using Caldon LEFM In-Line Instrument for Feedwater measurement:
  - 21 power plants

Beaver Valley 1	Indian Point 3	Sequoyah 2	Beaver Valley 2	Peach Bottom 2
Comanche Peak 1	Point Beach 1	Susquehana 1	D. C. Cook 1	Peach Bottom 3
Comanche Peak 2	Point Beach 2	Susquehana 2	D. C. Cook 2	River Bend
Indian Point 2	Sequoyah 1	Watts Bar	Grand Gulf	H. B. Robinson
				Waterford 3

- Uprates granted by the staff to plants using Westinghouse / AMAG Crossflow Clamp-On Instrument for Feedwater measurement:
  - 12 power plants

Pilgrim	Hope Creek	San Onofre 2	Hatch 1	South Texas 1
Kewaunee	Salem Unit 1	San Onofre 3	Hatch 2	South Texas 2
Fort Calhoun	Salem Unit 2			

PUBLIC CONCERNS OF UFM ACCURACY

March 8, 2000: NRC met with Caldon in a public meeting to address Caldon's concerns with pending staff SER approving use of W/AMAG CrossFlow instrument.

- March 15, 2000: Letter from Caldon reaffirming their conclusion that the CrossFlow instrument could not achieve a bounding value of 0.5%.

- March 17, 2000: Follow-up letter from Caldon stated that uncertainties with CrossFlow instrument can be as high as 3%.

- March 17, 2000: Internal NRC memorandum from Jack Cushing to Stuart Richards summarizing public meeting with Caldon on March 8, 2000.

PUBLIC CONCERNS OF UFM ACCURACY

Caldon Engineering Report ER-262, Revision 0, "Effects of Velocity Profile Changes Measured In-Plant on Feedwater Flow Measurement Systems" dated January 2002, submitted to the staff for information.

- Staff informal review confirmed Caldon's determination that accuracy data of the Transit Time Clamp-On LEFM instruments do not invalidate the accuracy of the LEFM In-line instruments approved by the staff.

- On February 12, 2002 Caldon requested formal staff review of ER-262 to address Caldon's concern previously stated that the W / AMAG CrossFlow Clamp-On instrument does not meet the accuracy approved by the staff.

- On September 12, 2002 W / AMAG submitted unsolicited report WCAP-15689-P, Revision 1, "Evaluation of Transit-Time and Cross-Correlation Ultrasonic Flow Measurement Experience with Nuclear Plant Feedwater Flow Measurement" dated September 2002, addressing concerns raised by Caldon in the ER-262 report.

- On January 28, 2003 the staff issued evaluation of ER-262 reaffirming that the accuracy data of the Caldon Clamp-On Transit Time instrument do not invalidate the accuracy of the In-Line LEFMs approved by the staff and the data have no relationship to the W/AMAG Crossflow instrument.

STAFF CONCERNS OF UFM ACCURACY

NRC independent Task Group formed on February 2, 2004 to address concerns regarding accuracy of W/AMAG Crossflow instrument. Task Group considered information available through mid-April, 2004. Reports issued June 7, 2004.

- Identified issues with (1) one time UFM, (2) power recovery, and (3) power uprate applications.
- Crossflow sensitive to plant configurations and has not provided intended accuracy in some installations. The reasons have not been fully demonstrated to the staff.
- Crossflow may provide expected accuracy if properly implemented.
- Some Caldon clamp-on UFMs have not provided intended accuracy. Caldon LEFM√ and LEFM CheckPlus UFMs appear less sensitive to installation configuration than clamp-on designs.
- Task Group does not have information based upon recent insights that demonstrates all UFMs are providing intended accuracy.
- Recommended bulletin to obtain information to demonstrate that UFMs are providing the intended accuracy consistent with the plant license.

STAFF CONCERNS OF UFM ACCURACY (Continued)

Draft Bulletin 2004-XX being proposed to:

- Advise addressees that plant operating experience at some installations has led the staff to conclude the W/AMAG Crossflow and Caldon LEFM (both Clamp-On-Type) UFM have not provided the intended Feedwater flow rate accuracy to maintain plant operation within the licensed thermal power.

- Advise addressees that there are potential questions regarding application of Caldon LEFM ✓ and LEFM Check Plus UFMs, because of plant configuration sensitivity and lack of technical data that can support instrument performance.

- Recommend that licensees may confirm UFM accuracy by comparing the instrument performance in operational plant conditions against measurement values of a fully clean ASME flow nozzle or venturi, of known accuracy, or any other standard test of known accuracy, and

- Require addresses to provide a written response to the NRC in accordance with the provisions of Section 50.54(f) of Title 10 of the *Code of Federal Regulations* (10 CFR 50.54(f), to verify that actions have been taken to ensure that each addressee's plant(s) is (are) not operated above the licensed thermal power level or outside the licensed design basis.