Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

ACRST-2080

Title: Advisory Committee on Reactor Safeguards Joint Meeting: Materials and Metallurgy and Severe Accident Subcommittees

Docket Number: (not applicable)

TR04 (ACRS)
RETURN ORIGINAL
TO BJWHITE
M/S T-2E26
415-7130
THANKS!

Location: Rockville, Maryland

Date: Tuesday, November 5, 1996

9611080210 961105
PDR ACRS
T-2080 PDR

Work Order No.: NRC-900

Pages 1-271

ORIGINAL

080028

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

O/1

D I S C L A I M E R

PUBLIC NOTICE
BY THE
UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

NOVEMBER 5, 1996

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards on NOVEMBER 5, 1996, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

This transcript has not been reviewed, corrected and edited and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARD (ACRS)

+ + + + +

JOINT MEETING

MATERIALS AND METALLURGY

AND

SEVERE ACCIDENT

SUBCOMMITTEES

+ + + + +

TUESDAY

NOVEMBER 5, 1996

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittees met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Robert L. Seale (Chairman, Materials and Metallurgy Subcommittee) and Mario H. Fontana (Chairman, Severe Accidents Subcommittee) presiding.

COMMITTEE MEMBERS:

ROBERT L. SEALE, Chairman, Metals & Metallurgy

MARIO H. FONTANA, Chairman, Severe Accidents

COMMITTEE MEMBERS (continued):

GEORGE E. APOSTOLAKIS
THOMAS S. KRESS
DANA A. POWERS
WILLIAM J. SHACK

ACRS STAFF PRESENT:
NOEL F. DUDLEY
AMARJIT SINGH
THERON BROWN

ALSO PRESENT:
BRIAN W. SHERON
JACK STROSNIDER
EMMETT MURPHY
JOE DONOGHUE
JACK HAYES
MIKE TUCKMAN
CHUCK WELTY
STEVE LONG
TIM REED
RICHARD PEARSON
TOM PITTERLE
DAVID STEININGER
JOHN SMITH

A-G-E-N-D-A

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

(8:33 a.m.)

CHAIRMAN SEALE: The meeting will now come to order. This is a meeting of the ACRS Joint Committee on Materials and Metallurgy and Severe Accidents.

I am Robert Seale, Acting Chairman of the Subcommittee. The ACRS members in attendance are: Mario Fontana, Chairman of the Severe Accidents Subcommittee, George Apostolakis, Thomas Kress, Dana Powers, and William Shack.

The purpose of this meeting is to hold discussions with representatives of the NRC staff, the Nuclear Energy Institute, and the Electric Power Research Institute to gather information concerning the technical approach used in developing the proposed risk-informed, performance-based Rule and Regulatory Guide associated with steam generator tube integrity.

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

Noel Dudley is the Cognizant ACRS Staff Engineer for this meeting.

Copies of the Rule and the Reg Guide are at the back of the room for those who might wish to get their

own.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on October 21st, this year.

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

We have received no written comments or requests for time to make oral statements from members of the public.

The staff briefed this Subcommittee on the status of the activities associated with the development of the proposed rule and reg guide concerning steam generator tube integrity during a June 3 and 4, 1996, meeting. Representatives of EPRI presented the results of the related MAAP code calculations at that same meeting. The minutes of the June 3/4, 1996, Subcommittee meeting are in the notebook.

During the June 12th through 14th, 1996, ACRS meeting the Committee heard presentations by representatives of the staff and the Nuclear Energy Institute on this matter. Today, the Subcommittee will

hear from representatives of the staff, NEI, and industry concerning the latest draft of the proposed Rule, Regulatory Guide, and industry implementing documents. Tomorrow, the Subcommittee will hear from the staff concerning the technical basis for the proposed rule.

Members will note that there is an hour-and-a-half for lunch today, and you might plan to make your schedule accordingly. We have a Planning and Procedures Subcommittee meeting during that time -- three of us do -- so, you might think about that.

We also have a presentation at the full Committee meeting later this week, and the staff hopes that we will be able to formulate a position -- that is, the full ACRS will -- following that. If any of the members identify items that they would like to have included in the presentations of the full Committee as we go along, I'd appreciate it if you'd sort of tag them for us.

I should point out that Dr. Shack is in conflict on this issue and he will not take part in the decision process.

We will now proceed with the meeting, and I call on Brian Sheron of NRR to begin. Brian?

MR. SHERON: Thank you. My name is Brian Sheron. I'm right now the Acting Associate Director for

Technical Review in NRR. I've had this job all of one month, about, and right now I'm not sure how long I'll be in it, so.

Anyway, what I'd like to do right now is just to, if I could, go through sort of an overview of what we'll be talking to you about. I'll give a short introduction; Jack Strosnider, who is the Acting Deputy Director in the Division of Engineering in NRR, will discuss the draft Rule; and then we will go into a discussion of the draft Regulatory Guide.

This is the staff agenda now. I know Mr. Tuckman will be getting up right after I am. Emmett Murphy will talk to you about tube integrity; Joe Donoghue, leakage monitoring; Joe Donoghue also about the risk guidance that we have in the reg guide; and then Jack Hayes will talk about the dose assessment.

And then we do have safety analyses supporting our draft reg guide; Joe Donoghue will be talking to you about that also.

What we would like to get out of the meeting, obviously, is to provide ACRS and the two Subcommittees with the technical basis for our proposed Rule. The proposed Regulatory Guide that will describe an acceptable way to implement the Rule, and then all of our supporting risk work. This is very important and I think merits your

attention when we do discuss it. We've had a lot of internal discussions on it, so I think you'll find it interesting.

And obviously what we would like to end up with is the ACRS's endorsement of the technical basis for going forward with the draft Rule, and your endorsement for the staff to proceed with issuing a proposed Rule for public comment.

Now, as Dr. Seale said, we have previously given a briefing to the ACRS back in June, to kind of familiarize you with what the issues are , so I'm not going to go over them. I presume you're familiar with the problems we've been having on a plant-specific basis dealing with steam generator issues.

The idea of a risk-informed performance-based Rule is to try and get the Staff out of this mode of dealing with these issues on a plant-specific, on an ad-hoc basis; to put in place a structured approach that the industry can follow in dealing with steam generator issues; and by going to a risk-informed, performance-based Rule. Basically it does put a lot more burden on the industry in terms of determining what their acceptance criteria is and so forth.

We've discussed the draft Rule I believe, and the draft Reg Guide, and in September I know there was an

issue with the thermal hydraulic codes. We received the ACRS letter on that, and the Office of Research has discussed the concerns, as I understand, on the ability of these codes to deal with the severe accident sequences that we were concerned about.

We will send you the draft Rule package at the same time it goes out for Office concurrence, and we would like comments back on the draft Rule package.

Now, our schedule for this whole rulemaking has been very tight. We've had a lot of resources that we've put in it. I know Emmett Murphy and Tim Reed have been working full time, as well as I think, Joe Donoghue probably full time. And a number of us, a number of the staff have been working part time on this, so it's a very resource-intensive effort.

We are planning right now to get the proposed rulemaking package to the Chairman by February. As you can see, we're meeting today with the ACRS, and I understand on Thursday we'll be briefing the full Committee. We would like to receive Office concurrence on the complete package by December.

When I say Office concurrence, that would mean all of the affected offices, which would probably be NRR and the Office of Research, and I don't know whether -- I'm not sure if AEOD is involved or not.

We would then forward the package to the CRGR; we briefed them just, I think it was about last week, and gave them a briefing on where we were with the Rule and what some of the issues were. We would like to meet with them in January and hopefully have them recommend to Mr. Taylor, their approval to go forward with this.

We would then propose, hopefully, that the Commission is satisfied, issue the proposed Rule and Reg Guide around March of '97, and depending -- there's a lot of "if's" in here, obviously -- but depending upon the nature and extent of public comment, and our ability to revise the package and get it reissued through the system again, we are shooting for getting final Rule out, March of '98.

Now, one of the interesting things about this rulemaking is, we have not been off developing it by ourselves; we have been interacting extensively with the industry and with the Nuclear Energy Institute. We meet periodically, both at the technical and at the management levels. I think our next meeting at the management with Executive Committee is what, November -- I'm sorry? November 20th.

So we meet probably about once every two or three months with the Executive Committee; Mr. Tuckman is the Chairman, I believe. And then the technical

committees, the technical groups, the staff, meet periodically -- usually about that same frequency -- to try and hash through a lot of the technical issues.

The goal, obviously, is to resolve as many of these technical issues and differences as possible within the time constraints. Now, let me not characterize this as a negotiation process, okay, but rather it is one in which the industry has the opportunity to provide their perspective and their concerns, etc., to the staff, in which we can then see if we need to make any adjustments.

But it is not a give-and-take. I mean, you know, the staff is responsible for developing the Rule, not the industry. But nevertheless, it is much better to try and work a lot of these things out in advance rather than get them all when you put out the Rule.

There are still technical differences, okay. My guess is that we narrowed a lot of them down and eliminated a lot, but there are still some regarding the Rule and the associated Guide and the risk work, and you'll probably hear about these during the presentations.

Nevertheless, you know, we can't keep the process up forever. At some point we have to say, we're going to get this Rule on the street and get going with it. And if the differences -- and particular with the Reg Guide -- I mean, if there are parts of a Reg Guide that do

prove to be a problem down the road, you can change a Reg Guide. You know, you have to go through the process but it's not as difficult as trying to change a Rule.

And I think the Rule framework is very general, as you'll see. So within the context of a Reg Guide I think that there are further refinements if we get new information. They can be accommodated down the road.

But we would also recognize that during the public comment period we would have opportunity to make any more adjustments.

My last slide -- before Mike comes up here -- I want to point out two significant policy considerations that the Staff is dealing with now, and I think would be important that the ACRS be made aware of these, and if you have any input on these we would appreciate it.

One is the severe accident risk. This is a performance-based, risk-informed Rule. When I say risk-informed it means we have to consider risk in terms of what we are allowing the industry now to do within this framework.

This Rule obviously, could allow some relaxation of the current criteria, current tech specs for steam generator repair. For example, the 40 percent through wall. You know we've already gone to a voltage-based for the Westinghouse plants with the drilled hole

tube support plates, which doesn't really depend on actually being able to physically measure a type of degradation or a depth, okay. It's based on a voltage, okay, and the correlation between the voltage and parameters such as burst pressure and so forth.

That could allow, in theory, cracks to exist that are beyond 40 percent through wall, okay. But we've rationalized the acceptability of that based on other parameters. It's very likely that the industry -- I know that Commonwealth, for example, has been pursuing a voltage-based approach for circumferential cracks. They're not there yet, but nevertheless, somewhere down the road I think they will be pursuing that, trying to get staff acceptance and so forth.

Within the framework of a Rule they would be able to do that provided they demonstrated that they had the supporting database and so forth. The question is, is have they affected risk? As you know, you may say, well this may work fine for the design base -- within the current design basis, which would be like steam line break and so forth and the differential pressures -- but have I done something that makes the risk go unacceptable when I look at a severe accident?

And so the question is, how should we address that within the framework of this Rule, as a risk-informed

Rule? You'll be hearing a lot more of that from Joe Donoghue, but I think it's something that's very important because we believe that at least, for part of the Rule, risk assessments will have to be done by the industry.

The second issue is one which I -- in my probably two-and-a-half years now -- two-and-three-quarter years since I've come back to NRR, became aware of -- and that is, when one goes to a performance-based approach -- as I said before, right now the way we work is that if the industry wants to use a new repair criteria, new plugging criteria or the like, they come into the Staff; they have to get our approval before they can use it.

They'll have to submit information, we review it, we write a safety evaluation report -- it can be plant-specific or generic -- but the point is, is that the Staff has reviewed and approved it and found it acceptable before it gets used.

In a performance-based Rule, the industry basically now, assumes that responsibility. They set the performance criteria and they demonstrate that they meet the criteria. But in terms of developing new methodologies and applying them, this now falls on the industry's shoulders, and the staff does not get involved other than through an inspection process or through inspecting to confirm that they've met the performance

criteria.

One of the problems is, is that the industry has submitted a number of proposals in the past for alternate repair criteria, or plugging criteria. And none of these the staff has found acceptable first-time out. It has required extensive review by the staff, the industry has been usually asked to provide substantially more information to support, technically support their proposal, and in some instances the end product was a substantial scale-back on what the staff actually would allow versus what the industry originally wanted.

So one of the concerns is that if we are not doing a review up front, most of -- you know, I would argue that a lot of the proposals that the industry has put forth in the past would be in place today if the Rule were there. Because the Staff would not have reviewed this in advance and the industry would have found it acceptable if they, you know, felt it met the criteria.

That's not necessarily bad, okay. I don't think we could point to any one case and say that if the industry proposed what they wanted to -- except in one case which I just found out about -- but if the industry went forward with their criteria that they had originally proposed, say a utility did, that it would have resulted in failures.

I do know that at Braidwood, they did not want to perform a mid-cycle inspection at Braidwood; we could not accept that. They did perform the mid-cycle. My understanding is -- and this is just new information -- that they did perform in situ pressure testing and they had a number of tubes that then leaked. And the question is now, why?

They were trying to convince us that they felt that they would be able to show that they had demonstrated tube integrity up through the next inspection cycle. And some of these leaked at a lower pressure -- I think 1300 pounds or so -- so there's a question here now.

But the real question we have is, how much flexibility is the staff really willing to give away to the industry in terms of being able to go forward with alternate repair criteria and the like, before we get involved. Again, if somebody says, you know, we don't get involved until the plane already crashes.

Maybe that's a crude way of putting it but the fact is, is that we would get involved now as part of an inspection program. In which case we would be inspecting licensee's programs to determine, hopefully, that they met the intent of the Rule, and then we would be also inspecting when did their inspections, to make sure that they met the performance criteria.

But again, it's after the fact. If they didn't meet the performance criteria it indicates there's something wrong with their program, you could be in enforcement space, but again, it's after the fact, it's not before the fact.

This is a question that we're struggling with right now. How much latitude do we want to really give up? I point out that the industry right now as you know, in a deregulated environment, is under severe financial pressures.

There's a tendency for plants to want to shorten their outages as much as they can, therefore -- and usually you don't know what you find in your generator until you open it up and take a look. A lot of plants have gotten surprised during an outage, and is, you know, if they want to get back online in a week they're usually in asking us for some approval for some new method and they want approval within a week. We just can't do it.

So I think there's an overall question here of how much flexibility are we willing to give up at this point with a performance-based rule. And I'm not really advocating one way or the other; I just want to make sure that the Agency goes into it with its eyes open and understands, when we do promulgate the Rule, what the responsibilities of the industry are versus the staff,

compared to what they used to be.

Because right now people are satisfied that, you know, if the staff has reviewed and approved it before it gets put in place, we feel comfortable with it. In this case now, the industry will have done that and we will be doing it more on an audit monitoring basis and during the inspections.

With that, let me turn it over to Mike, unless you have any questions.

CHAIRMAN SEALE: Yes. You very rightly point out the rather different relationship between yourself and the licensee, if and when this Rule is adopted and then put into place. It strikes me that that mode of operation will call for a much more decision-oriented role for the in-plant inspectors, because they'll have to be familiar with the specific implementation of the Rule at that plant, and have gone through some kind of rationalization of that particular program relative to the overall intent of the Rule.

Have you looked -- and it's probably a little early for it except to recognize that it's a problem -- somewhere down the road it seems to me that there has to be some consideration to the special demands that are going to be put on the inspectors in the plant, and some concern for the license, if you will, that you give them.

How do you prepare them for this somewhat different role?

MR. SHERON: Well, we have two approaches right now. One is that we will be preparing an inspection module for inspectors that are going out to inspect the implementation of the Rule. The second is that hopefully -- and this is what we would hope -- and that is that with a performance-based rule out there, we will not have as much of a Staff back here at headquarters -- spun up around the axle you might say -- trying to work on plant-specific proposals that keep coming in during outages.

We would have more staff -- I won't say a lot -- but we would have some of the Headquarter's staff now that normally was typically reviewing these plant-specific submittals, available to go out on the inspections with the Regional Inspectors. This will provide some training, you know, some help for the Regional Inspectors as well as the residents, okay.

And then the third is that we are holding basically, I guess annual workshops with the regions. We held one last February at Charlotte near the EPRI NDE Center, and we touched on certain aspects of NDE to get them familiar with that. We have another one scheduled, I think -- is that right? Coming up?

MR. STROSNIDER: We're in the process of scheduling it.

MR. SHERON: Okay. But we decided we would hold these -- it was agreed by all that were there -- that these were very beneficial, so we're looking at holding another one soon, which we would touch on another aspect of this.

So you know, it's sort of a several-pronged approach. One is that we will be training the relevant inspectors, you know, the inspectors that will be assigned to this at the regions through these workshops; we'll be preparing an inspection; and we just put out for example, an enforcement guide to the regions of the current approach. That will obviously have to be revised. There will be an enforcement guide.

And then as I said, we will have the Headquarter's staff, a lot of them like, probably Emmett and Ken Karwoski and so forth, that have been intimately involved in this Rule, going out on inspections with the Regional Inspectors and helping them along, at least initially.

CHAIRMAN SEALE: Are there any other questions by any other members of the Subcommittee? Okay.

MR. TUCKMAN: Good morning, gentlemen. My name is Mike Tuckman. Can you hear me okay?

CHAIRMAN SEALE: Yes sir.

MR. TUCKMAN: My name is Mike Tuckman; I'm

Senior Vice President for Duke Power Company. I'm the chief nuclear officer for the company and I'm here in a number of capacities. One, I'm the owner of more steam generator tubing than any other utility in the United States, every one of which is a concern of mine.

I've also been plant manager during steam generator tube leaks, and we've also had at least one steam generator tube rupture within our company. So I think I understand the significance of steam generator performance with the industry.

CHAIRMAN SEALE: You're also buying some new steam generators.

MR. TUCKMAN: Yes sir. I also have three units that either have or will have new steam generators, and four units which we will be trying to maintain the life of, if you will. Our first unit has been replaced. It is in operation and it's wonderful.

I also am the Vice Chairman of the EPRI steam generator management program; I think you're familiar with that organization. I've had the opportunity to Chair the NEI steam generator working group for some time now. I'd like to just give a moment or two of background.

The industry, through EPRI steam generator management program, has been working on steam generator integrity issues and improvement issues and reliability

issues now for probably 18 years. Through EPRI alone we've probably spent well over a hundred million dollars of industry resources, through that mechanism alone, not counting what each individual utility has been spending relative to their specific steam generators.

In the early 1990s, through the work we've experience in Europe, the ODSCC at the tube support plate issue was dealt with in the mechanism we call steam degradation specific management. And several plants in the early '90s came into the NRC and received approval for a voltage-based inspection correlation, if you will, which allowed something different than the 40 percent through wall which is in your standard tech spec -- or, that each utility is dealing with.

Those successes I guess, in coming to an alternate approach in dealing with steam generators, led the industry to meet with the NRC in July of 1993 down at the EPRI Center. That meeting was with senior NRC management as well as individuals in staff that are associated with steam generator maintenance.

The industry at that time through EPRI, was proposing a solution, if you will, to those folks which would need an alternative repair criteria. And that was, you can maintain your existing tech specs which have the 40 percent through wall criteria, or you can put an "OR"

gate or an "OR" function into your tech specs which allowed the use of a specific steam generator degradation-specific mechanism in a way of kind of characterizing that mechanism, if you will.

During the meeting in July '93, the NRC staff felt that the "OR" gate was inappropriate. They felt that more could be gained for the industry and the NRC by having a specific rule -- performance-based, risk-informed rule -- relative to steam generator integrity. The reasons were really two-fold.

The first reason -- as you know, in this whole process there are conservatisms that are placed on virtually every chunk, if you will, as you go through from inspection to a repair mechanism, and when you totaled all that up the amount of conservatism that we were applying were huge. The thought was that --

MEMBER POWERS:: When you say "huge" --

MR. TUCKMAN: I can't characterize a number.

MEMBER POWERS:: Well then, how do you know it's huge?

MR. TUCKMAN: The NRC staff felt it was large because of the cumulative effect. There was no statistical basis for applying the conservatisms. I'll probably yield to somebody who's more technically proficient if you want to pursue this line.

MEMBER POWERS:: It's just that, I mean, "huge" means something and I'm trying to understand how huge "huge" is. I mean, are we working in the 99.99 percentile range, or are we working in the 90 percentile range?

MR. TUCKMAN: I can't give you a number on that, sir.

MEMBER POWERS:: Okay.

MR. TUCKMAN: But suffice it to say that there were conservatisms that were stacked up and there was no intent to try and statistically deal with those uncertainties in a way which might give a more realistic number; let me put it that way.

The other concern that the NRC staff had at the time was that everybody was complying to their tech specs and there were plants, quite frankly, that were not going further than the tech specs in adopting some industry guidance that we already had. And the NRC had concerns on dealing with each specific licensee in dealing -- trying to get a tech spec changed, and it was felt that a Rule would be a more effective way of getting the entire industry involved, if you will, to a new level.

I might add at that discussion back in July '93, the concept of severe accidents was really not raised. That was something which has come along after as

we got into the rulemaking process.

One of the other things that we hoped that a Rule would do would be to encourage the development of new technologies and we'd be able to reap some benefit as a result of having a newer technology if you will, so there's an incentive to develop that newer technology. And I'll be the first to tell you that none of us in this room, NRC or the industry, are happy yet with the degree of technology that we have for sizing every single mechanism that we have. But we have put considerable resources on it and we have made a lot of progress, but it's not a perfect inspection technique yet.

Brian expressed some concern relative to the appropriateness, potentially, of a performance-based Rule, and I think he did a very good job of explaining his rationale for it. I think some of your concerns deal with when the industry has come in, typically the submittals have not been approved on the first go, if you will; some have been rejected.

Certainly, the issue of mid-cycle outages has been a topic of conversation and concern and interest between the two parties. I think that's kind of a natural thing to have happen, when you have a regulator and a regulatee. It's unusual for them to see exactly eye-to-eye with the degree of conservatism and comfort they might

feel.

In sort of a discussion or thought I guess, I kind of come up with two reasons as to why that is, if you will. First, there has not been a specific guidance out there for what the performance criteria and objectives we're trying to achieve, are. So consequently when a utility comes in with a proposal for how they would implement something, there's obviously questions that arise for the process.

The other and probably more important, is that, just a lack of understanding on our part of the types of information that was necessary to make the regulator feel comfortable with the decision that he would have to make.

So not having a criteria what you're shooting at, and not understanding the level of comfort, probably played a part in the reason that a lot of these have not been approved on the first go.

I think it is fair to say however, that many of the proposals which have come in after sufficient questioning goes on, the regulator has felt comfortable with the proposals we have made and have in fact, approved those; whether it be in some cases to eliminate a mid-cycle outage on a plant-specific basis, or to approve a voltage which is one volt or two volts or potentially

three volts in the process.

So as we gain understanding of each other, with the plant not really changing, we have gotten approval, if you will, on a number of mechanisms that we use.

MEMBER SHACK: Just let me ask --

MR. TUCKMAN: Yes.

MEMBER SHACK: Performance-based is always a thing that confuses me. Why does it necessarily follow in a performance-based approach that if you have the criteria -- the performance criteria specified, the licensee has the flexibility to propose a means of meeting those criteria -- does it necessarily follow that the NRC can't review the proposed means?

MR. TUCKMAN: Let me talk about that a little bit. Clearly, what we would like to see happen is that the Rule -- and I just saw a copy of it just this morning -- we'd like to see the Rule have some performance objectives in it; probably a Reg Guide have performance criteria in it, and then the industry would be responsible for meeting those criteria, if you will.

If you think about several other areas -- like the Maintenance Rule is an example. It's supposedly a risk-informed performance-based regulation. The Rule itself is about that long as you know; the Reg Guide is

about two pages. The industry document that the industry has been using to implement that Rule is -- well, it's thinner than the Reg Guide, the proposed Reg Guide you have today and considerably less detailed -- and the onus is upon the industry to figure out how to meet that rule in a way consistent with the guideline.

You certainly have the opportunity to inspect and if you have an enforcement policy that deals with whether or not we are accurately or appropriately implementing that Regulatory Guide. Clearly, the onus is on the utility.

A specific slide for another purpose -- but what was intended I guess, when we met back in July '93 was that there would be a Rule -- theoretically a short Rule, a page or so -- which gave some performance objectives. It would be a Regulatory Guide which would, we thought, describe the Rule to some extent but kind of give some approval, if you will, to a NEI regulatory document, or an industry document as we're calling it.

This industry document would be the process that you would use for implementing the objectives and criteria that are in the Rule and the Reg Guide; that's what was intended. And certainly the process that you used would be available for NRC review and approval similar to the way the NEI document on the Maintenance

Rule has taken place.

Another example I'm working on, I also Chair the License Renewal Working Group and there's presently a draft Reg Guide of about three pages to implement a Rule, and the industry guideline document has some degree of detail to it; then the utilities are in turn, implemented.

The thought was that there would be a series of industry documents down here that would be developed by the industry under the process that was called out in the regulatory -- the industry document. And that process would be things like the inspection guidelines. It would give you a process of how these guidelines would be developed and applied.

The primary to secondary leakage guidelines is another document that the industry has developed, and again, under -- if you chase from the Rule down, which the Rule says you have to deal with operational leakage, a Regulatory Guide would have some criteria associated with it. The industry document would tell you how you do it, and then give you a detailed, fairly specific document on how you would in fact, monitor for primary to secondary leakage for a specific criteria -- in this case ODSCC -- but it could be a different type of mechanism would be in place.

The thought being that the NRC would review

and approve the process documents, if you will, and certainly would issue the criteria; but these documents down here would belong to the industry. They would be documents which could be changed as needed, as new technology develops. It's a whole lot faster, even though the industry is not super-fast, I'll admit that. It's a lot faster for the industry to change and improve the documents that we have for dealing with our issues, than it is to go through the regulatory process in either a Reg Guide or a Rule.

Now Dr. Seale, one of the things that you asked about, the enforcement, if you will, of this -- while we're putting a big onus on the resident inspectors of the plant, you already have specialists at the region -- at least I do in Region -- Region 2 does that, inspects my plants -- that look at steam generator inspections; they look at a lot of the metallurgical things.

The other thing we have done as an industry is, we have involved Institute of Nuclear Power Operations. They've done, I think about eight assessments, if you will, of plants already, to see how their steam generator management program is in fact, performing. And those assessments are typically done by using a couple of INPO people, but also utilizing experts throughout the industry to go and inspect or assess the

plants. And INPO has agreed to continue that process.

So there's a tremendous onus on the industry to do the right thing relative to their steam generators.

MEMBER APOSTOLAKIS: So -- excuse me -- you would not have the NRC review the four documents at the bottom?

MR. TUCKMAN: No, it's really four plus several more documents -- but no, we would -- they're certainly available for NRC review but we would not be specifically asking for an SER, if you will, on each document as it comes up. You have the performance criteria and objectives and a process. We would be asking the utilities, the utility industry if you will, to develop these documents through a process that was laid out in the documents.

MEMBER APOSTOLAKIS: But isn't it one of the main ideas behind performance-based regulation that the licensee will have flexibility to prove that -- to make its case using acceptable methods -- acceptable in advance. So these methods down there would not be approved in advance?

MR. TUCKMAN: Not by the NRC, no.

MEMBER APOSTOLAKIS: Not by the NRC.

MR. TUCKMAN: There's a performance criteria out here, and the performance criteria is not waiting for

the plane to crash, obviously, and we've had that discussion. We obviously cannot wait for an accident to occur or anything else, for the NRC to be involved. If you lay out performance criteria up here, you ought to be able to look at a plan, see whether or not you are in fact, meeting your performance criteria.

One of the things we talked about is condition monitoring, and operability evaluations for the future, and that's certainly something that is available to look at in inspections that would go on at the plant.

CHAIRMAN FONTANA: If the NRC has access to some of those bottom four boxes, and they look at them and there's something in there they don't like, do they have any regulatory authority to do anything about it?

MR. TUCKMAN: I've rarely been able to keep the NRC out of anything that the NRC has interest in. I would suspect that -- what I would expect to have happen is, certainly the NRC would be aware of these documents; if they have disagreement, major disagreement, bring them up to the industry and say hey, we have a concern here and have some more dialogue to explain or discuss or give their point of view.

Through this whole process we continually revise these documents on the basis of information that we gained, predominantly from utilities that have gone

through the approval process or industry experience.

MEMBER APOSTOLAKIS: So there would be some sort of a review then?

MR. TUCKMAN: Yes. I have no problem with the NRC having access, commenting, etc.

MEMBER APOSTOLAKIS: Your regulatory guide there, has three to five pages, and the one I have here has 74.

MR. TUCKMAN: Yes.

MEMBER APOSTOLAKIS: What would you throw out?

MR. TUCKMAN: There's a lot of specifics in that document, and again, I have not seen the document in toto. We saw parts of it, back several months ago. But in general the significant level of detail relative to inspection, how you do the inspection, specific guidelines potentially, on how you do leakage monitoring, that sort of thing, could be incorporated in the industry document.

MEMBER APOSTOLAKIS: Do you think this is a risk-informed Rule?

MR. TUCKMAN: I would say that this is more of an addition to -- I don't see the industry gets the benefit out of this particular -- and I have not read the Reg Guide. I just saw it and just did that here, but it appears to me that the Reg Guide has so much detail in it that it has become a very prescriptive regulator.

MEMBER APOSTOLAKIS: So is it -- I'm trying to understand the disagreement -- is it the level of detail that bothers you --

MR. TUCKMAN: Yes.

MEMBER APOSTOLAKIS: -- or also the performance criteria that are being proposed?

MR. TUCKMAN: I don't believe the performance criteria caused us concern. I believe they're very similar to the performance criteria we would have and have proposed. It's a level of detail which exists in the document and the requirement for pre-approval of virtually everything, because it will be in the Regulatory Guide.

MEMBER APOSTOLAKIS: Do you have an example of how the Regulatory Guide of five pages would look?

MR. TUCKMAN: Could I defer that to this afternoon when we talk about the industry document?

MEMBER APOSTOLAKIS: Sure. All right.

MR. TUCKMAN: We'll talk this afternoon. You can talk about it, Richard? That was the view that we had back in July of '93 when we discussed this topic with the NRC, and that's kind of where the industry is.

MEMBER APOSTOLAKIS: I have one more question.

MR. TUCKMAN: Sure.

MEMBER APOSTOLAKIS: Do you think that in a risk-informed Rule one should see requirements that are

based on postulated accidents and on severe accidents?

MR. TUCKMAN: The premise in going to this performance-based rule is that we are doing something which is more risky and has more risk inside --

MEMBER APOSTOLAKIS: It's not risky; has risk.

MR. TUCKMAN: Has risk; I'm sorry. Has more risk than the existing regulatory framework that we are presently inspecting our steam generators to. I don't necessarily agree that what we are going to has more risk than the existing -- I would call it somewhat arbitrary -- 40 percent through wall guideline that we presently have. I'm not --

MEMBER APOSTOLAKIS: I guess the question is -- I mean, in a PRA we don't talk about design basis accidents. I mean, it's free-for-all. You develop event trees and whatever comes out will be dominant. So in a risk-informed framework, shouldn't we follow the same philosophy then? Why do we need to maintain the idea of design basis accidents and then on top of those, put the severe accidents? I mean --

MR. TUCKMAN: [illegible].

MEMBER APOSTOLAKIS: -- what is the position of the industry with respect to that?

MR. TUCKMAN: I think the position of the industry was, we were trying to go from the existing

technical specifications to a Rule, and just doing that did not, by our view, require the consideration of severe accident.

MEMBER APOSTOLAKIS: So you're going the other way? You don't want severe accidents but you would --

MR. TUCKMAN: We would prefer not to have severe accidents, no.

MEMBER POWERS:: What you're saying is, you want to take the risk out of the consideration?

MR. TUCKMAN: I don't know that I'm capable of answering your question.

MEMBER APOSTOLAKIS: So, I'm a bit confused now, because I thought risk-informed meant to look at, basically a PRA -- the framework we have -- and then define performance criteria that control the risk.

MR. TUCKMAN: The performance criteria that would be utilized --

MEMBER APOSTOLAKIS: Would be risk-informed?

MR. TUCKMAN: They are risk-informed to the extent that you are trying to quantify the amount of risk --

MEMBER APOSTOLAKIS: Right.

MR. TUCKMAN: -- that steam generators contribute.

MEMBER APOSTOLAKIS: Right. So it seems to me

that in such a framework one should not talk about postulated accidents. Should one? But you seem to be going the other way. You would still like the idea of postulated accidents, but not risk.

MR. TUCKMAN: We are basically keeping the same set of accidents that we presently have to consider.

MEMBER APOSTOLAKIS: The design envelope, yes. So then the question is, what is it that makes it risk-informed?

MR. TUCKMAN: Maybe I'll --

MEMBER APOSTOLAKIS: Keep that.

MR. WELTY: We weren't asking for risk-informed Rule --

MR. TUCKMAN: You were asking for performance-based, I guess. You're right.

MR. WELTY: We wanted --

MR. TUCKMAN: I'm sorry, this is --

MR. WELTY: Chuck Welty from EPRI. As Mike said at the start, what we thought we were going to be doing was dealing in design-basis space, where -- meaning with inspection, repair, and design-basis space, and in the existing tech specs. Going to a risk-informed, performance-based Rule has been an evolutionary process that we've gone forward with at the behest of the staff.

So we really, when we started this whole thing

we were looking at staying in design-basis space for inspection and repair.

MEMBER POWERS:: But it's not at the behest of the staff; it's at the behest of the Commission.

MR. WELTY: Yes, the Commission. Fine. Again --

MEMBER POWERS:: The staff is just their tool for implementing a decision they've made. I mean, it's policy. We don't disagree with you.

MEMBER KRESS: I don't think we've ever had a good definition of what risk-informed means. And in this context, I suspect it means that if you prevent tubes from leaking too much, that if you prevent tubes from failing under both severe accident conditions and just normal operations within your inspection procedure, then your intuition tells you that you've managed risk.

It doesn't tell you what the risk is; it doesn't tell you whether it meets an acceptable risk level. In my view, in a performance-based Rule system, that's what risk-informed means. You can't really go through the PRA and tie down the risk level. You have to accept that your performance criteria does it for you and it's a faith acceptance. You don't have a good technical basis for saying so.

MEMBER APOSTOLAKIS: But, then, with this

definition, Tom, it seems to me that the current system we have is risk-informed because our intuition tells us that --

MEMBER KRESS: It's a risk-informed standards-based. I would not disagree with that at all.

MEMBER APOSTOLAKIS: Yes. But I think the new idea of a risk-informed system really includes risk, the quantification of risk.

MEMBER KRESS: Well, what you're trying to describe is what I would call risk-based regulation but performance-oriented, which is another way to go. I mean, there you can pin down the risk and have acceptable risk criteria. You can define your performance criteria in terms of that risk, but that's risk-based.

MEMBER APOSTOLAKIS: Well, it's risk-based if I don't include anything else, but risk-informed means I just take the results of a risk assessment. And I consider other factors as well. That is how I see it.

But this is not really the issue here. It seems to me that if we say that -- if our intuition tells us that this controls the risk, then that's risk-informed. I mean, that's such a broad concept that anything is risk-informed. So I don't see what --

MEMBER KRESS: Now you know my problem with using performance-based regulation because this is

precisely it.

MEMBER APOSTOLAKIS: Let's go beyond the intuition now. Isn't it -- one of the things we learned from PRA the last 25 years or so is that we just started to analyze the plant without really considering these legal terms, such as postulated accident, design basis accidents, and so on. You just analyze the risks.

So to have a risk-informed rule that still relies on postulated accidents and then adds something else to severe accidents, that to me is a bit inconsistent with the idea of risk, is it not?

And I thought the industry was going to say, "Don't look at the design basis accidents. Do it on a risk basis." But then they're telling you, "No. It's the other way."

MEMBER KRESS: It's not necessarily inconsistent. See, what you do, you have these performance or standards that have to be met. And there's a lot of them, not just steam generator tube. And you make sure those are met.

Then you look at the plant from a PRA standpoint. And you say, "Oh, okay. So its risk status is acceptable." You can't connect the two between -- you don't know which of these regulations is important or how they are important through the PRA in determining that

risk status, but your risk status is met.

Your intuition is what connects the two. And that's the system we have now. That's precisely what we have now. And all we're doing is saying, "Well, we're going to determine these -- put these standards in terms of performance."

MEMBER APOSTOLAKIS: Well, when you define the performance, though, the performance criteria, it seems to me you start from the risk, from risk.

MEMBER KRESS: If you can. If you can.

MEMBER APOSTOLAKIS: Well, at least you try to see if you can.

MEMBER KRESS: You try. You try, but you can't always do that. Sometimes you just pick performance standards that you think will manage the risk. And that's something like, "Well, let's limit the leakage rate. And let's limit the probability it will burst during the next inspection period." And you don't really know. You can't really tie those necessarily.

MEMBER APOSTOLAKIS: Shouldn't there be a convincing case that indeed you can't do certain things; therefore, you do this, rather than say, "This is the rule"? In other words, I don't --

MEMBER KRESS: I think there should be, yes.

MEMBER APOSTOLAKIS: I don't see, for example,

why by setting criteria on a number of tubes failing under design basis accidents is necessary. There was no convincing argument that you need that. There may be one, but I didn't see it. I don't understand that.

Why should the probability of one or more be this, two or more be that, ten or more be this? I mean, you know, if we just say that's my intuition, then we might as well forget about risk-informed, performance-based regulation. Intuition allows for a lot of things.

I think this gentleman wants to say something up here.

MR. LONG: I'm Steve Long with the staff and NRR in the Risk Assessment Branch. At least my own interpretation I think evolves a lot on the distinction between the regulation that we used to do, the regulation we're trying to do now that's risk-informed, and then the regulation that you might call risk-based has to do with who does the risk assessment and how they use it.

Previously we had design basis accidents. They were postulated without much thought about the frequency. And as we gained the ability to do risk assessments, we started checking to see if things were really being controlled adequately. And in some places we found they weren't, and we increased our regulatory

efforts in those areas.

As we've tried to change regulation, the risk-informed process in my opinion involves doing the risk calculations as best you can and recognizing they're incomplete, there's knowledge which you had that you don't have about the things that you have realized you need to evaluate but can't evaluate very well yet.

But the NRC tries to ask, "If I make a particular regulatory change, what's the effect on risk?" And it is not departing from the design basis/postulated accident approach, but is asking, "What is my effect on a PRA when I make this regulatory change?"

When you cross the line and say, "I'm putting it into the regulation a number that comes out of a risk assessment," I think you've crossed the line from risk-informed to risk-based regulation.

If one of your performance standards is that the number that is produced by PRA not exceed a certain frequency, I would call that a risk-based regulation. But if the NRC is, instead, saying, "We have gone through the risk calculations, and we believe we can change this two-strength requirement. And that will still give us a low enough number in our risk assessments," I think you're in a risk-informed but not a risk-based regulatory approach there.

MR. TUCKMAN: Steve, kind of like the maintenance rule. You use the PRA to gain insights. You don't quantify specifically, but you use it to gain insights as to which equipment you're going to deal with under the rule. So it's kind of risk-informed. But then you are dealing in performance-based relative to the way the equipment performs.

MR. LONG: I'd put your issue a little bit off to the side of the distinction we were trying to make. We're using that to guide an implementation process there, really.

MEMBER APOSTOLAKIS: I don't know how much PRA was used, though. The conditional probability of rupture of one or more tubes under postulated accident conditions should not exceed the following.

So where is the frequency of these things? I mean, we're just told that you look at PRA, and you say, "Well, gee, I have the postulated accidents," but I would also look at their frequencies.

Well, this is very clear that conditional probability postulated they occur and then make sure the probability is low. So where is the risk insight? There's no risk insight here.

That's not your fault, by the way. It just came up.

MR. LONG: I appreciate the discussion.

MEMBER APOSTOLAKIS: But when I saw the three to five pages, I got a bit excited. I thought you were going to agree with me. But you were going the other way. You would rather not see risk at all.

Now, the gentleman earlier from EPRI said that at the beginning you were not requesting a risk-informed rule, you just wanted to work with design accidents. Are you still at the beginning or have you changed your views now? You would still like to see a rule based on postulated accidents plus other things? And your objection is to the severe accident addition here; right?

MR. WELTY: Well, again, this is Chuck Welty.

I guess we're not objecting right now to much of anything. We have just now seen the risk part of the reg guide. We'd like to look at it. Again, as I said when we started this entire process, we were thinking along the lines of dealing in the design basis tech spec arena and in getting a way of using alternate tube repair criteria to deal with some of the issues that we saw were possibly overly conservative in this country.

And that was the severe accident discussion in the risk-informed part of this has come along subsequent to our initial thinking on this whole thing. And we have been trying to work with the staff to understand what

risk-informed is going to mean to us and what it might ultimately mean.

As I said, this is the first time we have -- today is the first we have seen of the details of how the risk-informed part is going to be put in the reg guide.

MEMBER APOSTOLAKIS: One last comment. The thing that really worries me about this is that if this sets a precedent about what risk-informed regulation is, we'll be in trouble because here you have a 76-page document. And the first 68 pages really have nothing to do with risk. And then at the end, it says, "Now you do this, too."

Now, nothing to do explicitly with risk. I'm sure intuitively several probabilities are there, but frequencies of accidents and so on are not there unless there was some analysis somewhere else that did that and I haven't seen it. That is possible, too. But in the document that I saw, I don't know where the numbers came from.

MR. WELTY: And we would say we essentially agree with --

MEMBER APOSTOLAKIS: Who agrees?

MR. WELTY: EPRI.

MEMBER APOSTOLAKIS: Oh, I thought it was --

MR. SHERON: At the risk of confusing this

maybe even more, let me just interject. And this is on risk-informed. That is, the way we look at it, it's a balance. You have to look at various factors. Okay?

For example, if one could argue that on risk alone the probability of a severe accident was less than 10^{-6}, for example, I don't think this agency would go forward and allow plants to be built without a containment.

One has to take into account other factors besides just risk. And I think to me that's what risk-informed means, and that is that risk is one factor of many. I think, George, you said that. You have to look at a balanced approach. You have to look at what the deterministic defense-in-depth type of criteria are. You have to recognize that a PRA is not an end state. There are uncertainties associated with it.

And you take all these factors into consideration. And then you make an informed decision on how you wish to proceed. Now, that decision may include some deterministic approach, but you also have factored probablistic thinking into it.

Let me give you an example of an area where we're still dealing with the industry on risk-informed where, I'll be quite honest, they very much embrace the concept of risk-informed. And that is on the in-service

inspection and testing. They are proposed risk-informed or risk-based, whatever they want to term it, in-service inspection, in which they would base how you would go about inspecting, where you would inspect, how frequently you would inspect on risk insights.

If you ask them on their process, you will notice that all of the conclusions they reach are that you need to do less inspection. If you ask them, "Are you using the risk-informed approach to determine where you might need to increase inspection?" they will tell you the ASME code is our wall. In other words, that's good enough. Whatever the ASME code says, in other words, that's okay, but we will use risk-informed to back off from that.

But if you ask them what the basis is for the ASME code, it starts getting a little jumbled right there. And we have told them that they need to look at this. When one goes to start using risk, as George said, you've got to look at the whole picture. Okay?

You just don't sit there and arbitrarily assume some upper limit and say, "Well, that's the ASME code" or "That's what a Chapter 15 design basis analysis calls for, and we won't look beyond that."

When one goes to risk-informed and wants to use risk to back off from current requirements, you've

also got to look. And you've got to go the other direction. Okay? We're doing that for severe accidents with the steam generator rule. We're looking and seeing what it means if we were to promulgate this rule.

If we were to allow the utilities to use alternate repair criteria, which may be a relaxation, which may allow greater through-wall cracks and the like, what does this mean in risk-based?

And we're doing a lot of calculations. You've heard some of these where we look at the station blackout scenarios, where you have the high temperature and high pressure.

If we were to find out that, for example, a plant in their PRA, their IPE, for example, walked in and said, "We have a frequency of 10^{-4} for the station blackout," and we found out that it was a virtual certainty that every time they got that with their proposed repair criteria, they'd fail tons of tubes and have basically a bypass scenario every time, would that be acceptable? Probably not.

So what we're saying is that when the industry goes forward and implements this rule and gets the flexibility that they're looking for for repair criteria, they need to consider risk.

They have to look at it for their plant, what

it means for their plant. They have to look at what, for example, their station blackout frequency is, what their frequency is for the high-pressure, high-temperature scenarios.

They have to determine if the flaw distributions that they are now proposing to allow to exist in their generators will produce an unacceptably high risk from the standpoint of bypass and off-site release. They have to make a determination.

In other words, we're not saying they have to do something. It doesn't necessarily mean they're going to have to go out and fix their plant, but what it means is they're going to have to consider it and make an informed decision whether or not they've got a problem or whether they can live with what they're proposing.

Staff will review that as part of the inspection process. And if we have difficulties with it, we'll deal with it. But that's all we're saying. Industry has to account for risk when they go forward with this.

CHAIRMAN SEALE: Well, I think it's pretty evident that there's considerable agony about and somewhat differences of opinion with regard to the implementation of this whole process. But I think we'd better try to get on with it at this point and perhaps --

MR. TUCKMAN: Let me just close with saying we have been making suggestions. We have not been negotiating with the NRC for about three and a half years on this particular topic. In many areas the comments have been fruitful, and a number of the industry documents are being revised to reflect that progress we have been making. This afternoon we'll kind of go through the industry approach, if you will, on how we'd like to see it.

Thank you very much for your attention.

CHAIRMAN SEALE: Well, thank you very much, Mr. Tuckman. I think everyone kind of understands maybe what the sort of problem here is in this whole discussion. And so as we hear now from the staff for a bit and then hopefully from the industry as well, perhaps we can draw a finer bead on exactly what it is we're trying to accomplish here.

I certainly don't want to cut off everybody as long as we're having fruitful and useful discussions. On the other hand, there are only so many hours in the day. So let's proceed.

Mr. Strosnider, I understand?

MR. STROSNIDER: Yes. Jack Strosnider. Is the microphone working?

CHAIRMAN SEALE: Yes, sir.

(Slide)

MR. STROSNIDER: I'm Jack Strosnider. I'm with the Division of Engineering in NRR. I guess from that introduction, you want me to answer all of the questions that --

CHAIRMAN SEALE: Clearly, clearly. Yes, sir.

(Slide)

MR. STROSNIDER: What I had planned on doing was to try to go through first some of the attributes that we were striving to build into this rule, make a few comments about those. Then I want to actually go through the text of the rule itself, and I want to give some big picture rationale as to the various parts of the rule and why it's there.

There will be follow-on technical discussions, which I think will provide some more of the technical basis. And, in fact, with regard to risks, there are a number of -- there's a lot of calculations, a lot of analysis that has been done that will be covered in some of the later presentations. And ultimately it will be published.

So to start off with some of these attributes, some of these you have been discussing, performance-based, you will see when we go into the rule that we're talking about monitoring against established performance criteria.

One of the things I want to emphasize when you look in the rule is that it's not prescriptive. If you look at the current regulations, current requirements; for example, Code of Federal Regulations referencing certain parts of the ASME code, when you go into that, there are very prescriptive ways, manners in which you do inspection, for example. You won't find that in this. We don't tell people how to do inspection. Okay.

There's guidance on -- in the rule, the expectations that inspection -- when you hear more about the reg guide later, you'll see that there's guidance on how you qualify inspection methods, but it doesn't tell you what method to use: eddy current, ultrasonic, radiography. Whatever you can get in there and make it work, that's fine.

So I want to emphasize it's not prescriptive.

CHAIRMAN FONTANA: Who demonstrates the particular inspection procedure, how it relates to the probability of that tube failing on the various loads that are imposed on it?

MR. STROSNIDER: The licensee.

CHAIRMAN FONTANA: That's his job? Okay.

MR. STROSNIDER: And the guidance in the reg guide is basically that you have to take in -- you have to quantify uncertainty, for example, in sizing defects and

take it into account in your assessments.

CHAIRMAN FONTANA: Okay.

MR. STROSNIDER: But that's up to the licensee. They have to perform that.

Risk-informed. Okay. We consider safety functions under design basis and severe accident conditions and from the numbers which are in the regulatory guide and in these performance criteria are based on PRA insights.

They're based on risk assessments that have been performed and confirmed that those numbers provide an acceptable level of risk.

MEMBER APOSTOLAKIS: Where can I find that information?

MR. STROSNIDER: Well, you're going to hear some of it presented later in the presentations. And I believe there is a NUREG report in preparation. It's not in your package now.

MEMBER APOSTOLAKIS: It's not in the package?

MR. STROSNIDER: Yes, you're right. You haven't seen it. You'll hear some more of it later today.

MEMBER APOSTOLAKIS: So this conformed, then, could include design basis?

MR. STROSNIDER: Yes. I wanted to actually comment on that. You brought it up earlier.

Risk-informed. If you look at the Commission policy, risk-informed -- and it emphasizes maintaining defense-in-depth. Right?

If you go back and you look at how you maintain defense-in-depth, you have a licensing basis for the plant, which assumes that you're going to meet certain general design criteria. And the intent is that the licensing basis and the GDC need to be satisfied.

It's a compliance issue. And you can't ignore the compliance issue based solely on a PRA. That would be risk-based. This is not completely risk-based. It's risk-informed.

So we're looking at the results of PRAs to give us insights on whether we have established appropriate criteria and whether there are weak spots, whether there are places where there's too much margin, trying to use that to make informed decisions.

But in a regulatory space, you have to deal with compliance issues also and licensing basis. And that's part of what's in this rule.

MEMBER APOSTOLAKIS: But the licensing basis can be changed. I mean, we have been talking with the staff. Last week we had a meeting talking about proposed changes in the current licensing basis. So it's not that --

MR. STROSNIDER: It's certainly true, but it is not the intent of the steam generator rule to change the basis upon which the plants are licensed. I think that's a bigger question.

MEMBER APOSTOLAKIS: Let's say that someone goes crazy for two minutes and asks you to make this rule as prescriptive as you can. How will you change it? Now you say it's not prescriptive. What would you put in here that would make it prescriptive?

MR. STROSNIDER: I wouldn't. There's a real down side to prescriptive regulation. We're trying to avoid it. A prescriptive regulation is a regulation which -- I gave the example earlier -- says, "Go use a certain type of eddy current method and calibrate it in this way. And do as follows." We don't want to do that.

History has shown that that is not the best way to go because what happens is the technology improves, and you have frozen it. The type of degradation changes. And you're not using the best technology to address it. So --

MEMBER APOSTOLAKIS: When is this --

MR. STROSNIDER: That's an example of what you could have in a prescriptive regulation, but we certainly don't want to do that.

MEMBER APOSTOLAKIS: When is this NUREG coming

out?

MR. STROSNIDER: The schedule calls that it would go out for public comment -- oh, the NUREG?

MEMBER APOSTOLAKIS: Yes, NUREG.

MR. STROSNIDER: It would be part of the reg impact analysis. I'd have to refer to --

MEMBER SHACK: George, just on a philosophical point of view -- I mean, I know you object to mixing severe accident design basis. But suppose -- and I actually thought this was the way the argument went -- when you looked at the design basis, that bounded many of the scenarios you would worry about in your PRA.

The thermally induced severe accident was added because that was something that wasn't accounted for that was a significant contributor to risk that wasn't controlled by looking strictly at design basis accidents.

So the notion of the design basis accident was there, not because it's the design basis accident, but because, in fact, it does control risk for a great many scenarios.

The thermally induced severe accident one was added one because that was a scenario that wasn't accounted for. But it's risk-informed in the sense that you've now added that because there was something missing in the old rule which focused on design basis that missed

the significant risk contributors assuming that all of this is true.

MEMBER POWERS: And it also prunes out a lot of your event trees, things that you don't have right now. For instance, you don't have to worry if the ECCS induces an accident by looking at the design basis.

MR. STROSNIDER: I think just to follow on on that thought, if you look at design basis accidents, main steam line break, for example, I think you basically view that as a surrogate for all the other sorts of transients and events that might occur and you're trying to bound them with, for example, a main steam line break.

It doesn't mean that you expect the main steam line break is going to happen. We recognize it's a low frequency. But it bounds all of these other events, which you may not have accounted for in your risk assessment because you're just not smart enough to see them.

Dr. Shack brought up the additional issue of thermally induced; that is, severe accident in thermally induced tube failures, which are not covered by the design basis accident. When we look at the risk assessment, if we see that that's a significant contributor to risk, then we need to address it. That's risk-informed.

CHAIRMAN SEALE: But, again, it's a surrogate for all bypass events. So in a sense it's that accident,

but it also covers all of those things or at least it addresses the issues that are involved if you have any kind of containment failure.

MR. STROSNIDER: Well, I don't want to suggest that there's a design basis severe accident. There's a number of different transients that were evaluated.

CHAIRMAN SEALE: I understand. I understand. Yes.

MR. STROSNIDER: But yes, you try to gain some insights from that and say, "Am I missing something that's significant?"

MEMBER APOSTOLAKIS: So the insights from the PRA can only be negative?

MR. STROSNIDER: No, not true. PRA could also show that you have a very low risk in certain areas. One of the issues that was brought up by Mr. Tuckman was the idea that you had a lot of conservatisms built on top of each other. I don't know that anybody has really been able to quantify that.

But if you look, for example, at calculating leak rates at a 95/95 level and then you look at doing your dose calculations for each parameter at 95/95 and you end up with -- I don't know what it comes out, but you can look at that from a risk point of view using best estimates, using Monte Carlo methods, et cetera, and

perhaps determine that that's too conservative a way to do it. And then you go back and you adjust those parameters.

So risk-informed can go either direction. It can suggest that you need to have more stringent requirements. It can suggest that there are some areas where things can be relaxed.

MEMBER APOSTOLAKIS: So when you look at the design basis, you have that attitude and say maybe some of the requirements are not really needed?

MR. STROSNIDER: I'm not going to change the licensing design basis GDCs for the plants. Okay? We're going to have to satisfy that. And that's a bigger issue. If somebody wants to change the way we do that --

MEMBER SHACK: But you have a change. You've gone from a conditional probability of failure for a tube, rather than a 40 percent crack. I mean, between the two, I find it much easier to draw the connection between risk and the conditional probability of failure than I do a 40 percent crack.

MR. STROSNIDER: But we also went through the thought process to convince ourselves that with those numbers, we were still satisfying the GDC.

MR. SHERON: You also did it for the structural criteria; right? There's an option?

MR. STROSNIDER: Yes, there is an option.

When we get into this, we'll talk about them a little more.

MR. SHERON: No need to meet the ASME code. There's an option for meeting probablistic criteria.

MEMBER SHACK: Yes, but George's point was that probablistic criteria seemed to float out of space somewhere.

MR. SHERON: Yes.

MEMBER KRESS: But you're going to tell us it's not.

MEMBER SHACK: You're going to tell us where it came from.

MR. STROSNIDER: Yes, there needs to be more discussion on that.

(Slide)

MR. STROSNIDER: Adaptable. Here we're talking about and in the last presentation that we made in June, I guess it was, we talked about the changing forms of degradation and how the inspection methods might have been adequate back in the late '70s or early '80s, that you need to be using different methods today based on the type of degradation; also adaptable to new inspection technologies.

There's the capability to collect and process a lot more data today than there was 20 years ago, which

allows you different sorts of assessments.

Also, there's improving sensitivity in some of these inspection methods. So we want the rule to be adaptable. So we don't want to prescribe exactly how the inspection should be done, just how to qualify it.

We want to provide an incentive to provide the best inspection technology. This has proven to be a very difficult area. There's a real dilemma here. All right? And I think it gets down fundamentally that if you look at NDE technology, the way it progresses is you typically develop the capability to detect defects before you develop the capability to size them. All right?

Now, I think from the industry's point of view, there's value in going in with more sensitive methods to know what's in your generator, to be able to plan. There's economic incentive certainly.

But then you look from the regulator's perspective, and you say, "Hey, if you detect something, I need to analyze it. I need to assess it. I need to determine its significance."

If you can't size it, the situation we have been in is pretty much plug on detection. So there's a dilemma in the sense that we want to encourage people to use the best inspection technology, but there is often a down side in that you end up plugging a lot of tubes,

which people might argue they don't all necessarily need to be plugged. Unfortunately, you don't have the technology in hand to make the case why not. So that's been a difficult area.

(Slide)

MR. STROSNIDER: Okay. Then another attribute which we feel is very important -- and there was some discussion earlier this morning with regard to the role of inspectors in the region and inspection and enforcement.

We do believe that it's very important to have a rule which is enforceable. We think that's part of the key to performance-based regulation because if you look at the overall framework, the onus is now on the industry. And we're basically; that is, the NRC, is looking at it after the fact. There needs to be some enforcement basis.

And this needs to be very clearly specified. I think not only for the NRC's interest so that we can have a clear nexus in our enforcement but also so that the industry recognizes what the expectations are.

And we heard earlier about making submittals when you don't know what the criteria are. So I think it's important that we lay out some enforcement basis. And you'll see in the rule where, in fact, we put some portions in that rule which are directed at this. And I'll point those out.

(Slide)

MR. STROSNIDER: So the next I guess dozen or more viewgraphs basically have broken the rule into various parts. And I'd like to just go through and indicate what's in each of those sections and then provide some of our rationale.

The first paragraph deals with applicability. It's fairly straightforward. The rule applies to all pressurized water reactors. And we heard some discussion earlier. We believe that the requirements need to be updated for all plants. This is the way you capture all the plants.

But I do want to point out that the rule and the process here allow flexibility to address both old and new designs. I think it's very important to point out that some of the replacement generators, the newer design generators are performing quite well compared to some of the earlier vintage steam generators. And there could well be differences in how you manage degradation in those different plants.

MEMBER POWERS: Can I come back and say, "I want to do it the way we've always done it" and you guys say "Fine"?

MR. STROSNIDER: Yes. The regulatory guide actually has a default position in it in terms of plugging

criteria. However, there are some other areas where now we're not saying it's fine; for example, qualification of inspection methods.

Under a performance-based approach, we think it's very important to understand, quantify the reliability of your inspection methods. So there are some additional requirements there.

There's also an additional requirement in terms of performing a forward-looking what we call operational assessment to give yourself some confidence that you'll satisfy performance criteria at the end of the upcoming cycle.

Current regulations and tech specs say you can plug it 40 percent. You don't have to take into consideration growth rate, NDE uncertainty. They're implicit in that 40 percent. But you don't need to look at your plant-specific values. Under the new rule, you'd have to assess that.

So there are some differences. There are some things that are more stringent than what currently exists.

MEMBER POWERS: And why wouldn't I think that's a backfit? It is?

MR. STROSNIDER: They will be a backfit. Then it has to be assessed as a backfit. That's the applicability.

MEMBER SHACK: I mean, it is a backfit; right? And it will be assessed as a backfit?

MR. STROSNIDER: Yes, is and will.

(Slide)

MR. STROSNIDER: Looking at the requirements, this first paragraph provides the objective of the rule. And then it goes on to talk about the safety functions.

MEMBER APOSTOLAKIS: That's not the requirement, is it?

MR. STROSNIDER: Excuse me?

MEMBER APOSTOLAKIS: It seems to me the requirement, the statement of the requirement ends at the fourth/fifth line. I don't see why the rest of it is a requirement. "Intended safety functions," period. The rest --

MR. STROSNIDER: Well, "Requirements," basically that's a title that comes out of the regulations. There's a whole bunch of paragraphs in here that are lumped under "Requirements." But I agree. They involve some discussion as well, yes.

(Slide)

MR. STROSNIDER: The requirement is based or our objective in this is to provide reasonable assurance that the tubes are able to perform their intended safety functions. But then, as you point out, there is some

discussion, but it does seem appropriate to define what those safety functions are. And that's what the rest of the paragraph does.

CHAIRMAN FONTANA: That slide you just took off, the last sentence is a potential can of worms.

MR. STROSNIDER: Yes. I was going to get to that.

CHAIRMAN FONTANA: You were going to get to that. Okay.

MR. STROSNIDER: I wanted to point out a couple of other things first. In terms of safety functions, steam generator tubes perform as part of the reactor coolant pressure boundary, also containment function. This is one of the things that's been pointed out before. They have a dual role, which is unique.

They also form a heat removal function during accidents to allow you to get the plant cooled down and keep it cooled. You have to be able to mitigate design basis accidents, which involves doing all of those things.

Severe accident consideration is specifically addressed. Okay?

(Slide)

MR. STROSNIDER: Tubes are relied upon to maintain their integrity consistent with containment objectives venting uncontrolled fission product release

under conditions resulting from core damage severe accidents.

Risk-informed. This is our intent here. Most of this discussion up here or a lot of it is driven by design basis considerations, but we also recognize that there's a potential for the thermally induced, which could lead to containment bypassing and could present some risk.

So what this is indicating here is that you need to consider at least what the risk is associated with this.

CHAIRMAN FONTANA: There are 2 ways of -- more than 2 ways, probably 100 ways, of looking at that, one of which is there is a containment objective that says that a containment failure will be 10 percent. The probability of a containment failure, a consequential containment failure, is 10 percent, which I don't think anyone at this table really likes very much.

Another way of looking at it is that there shouldn't be a release to the environment beyond a certain number which has a probability beyond a certain value. To do that -- you know, to do a PRA, you do a mechanistic analysis, first as a probability of failure, then a fission product release, fission product release, through the tube failure that you calculate, then the attenuation of the fission products as they go from the core through

the tube failure through the secondary system and so on. And that depends on whether you've got a main steam line break or what other failures you've got.

So the only real way of looking at this, I think, is to do a PRA with good mechanistic analysis of fission product release and transport and then see where you start drawing the lines.

MR. STROSNIDER: I understand. I'd like to defer some of that discussion to when the systems people are talking about the reg guide and approaches here.

CHAIRMAN FONTANA: Yes.

MR. STROSNIDER: But I would make the comment with regard to the rule that we're not specifying how this is accomplished. We're not specifying whether it's the type of analysis you just described, whether you try to accomplish this by managing the distribution of defects in your generator or whether you demonstrate this by doing the risk assessment, which includes frequencies and mechanistic assessments of tubes.

There's a number of ways you can get here, and I think you'll hear some more discussion about that. it's really: How do you implement this? And some of that is discussed in the reg guide.

CHAIRMAN FONTANA: Okay. thanks.

MR. STROSNIDER: Okay. Moving on to the next

paragraph, basically you have some reporting requirements. And we're looking for prompt notification if the performance criteria are not met, talking about 24 hours after the licensee makes that determination consistent with some other reporting requirements in the regulations.

It allows the NRC to take appropriate actions, which basically is to talk to the licensee and understand, first of all, what the situation is. There could potentially be enforcement follow-up on that depending on the circumstances that led to it.

The licensee obviously is responsible for any corrective actions, but we want to know about that quickly so we can respond and be involved in the assessment.

(Slide)

MR. STROSNIDER: Now, the next paragraph we get into performance criteria. These were all on one sheet at one time, but they got reformatted. I want to point out they provide reasonable assurance the tubes are performing their safety function based on a comparison with NRC-approved performance criteria.

Now, there's a significant difference here between this and the maintenance rule, which is one of the performance-based regulations that people like to look at. We're saying here that the performance criteria will be approved by the NRC, as opposed to licensees establishing

performance criteria themselves. All right?

Our rationale here, if you go back and look at the maintenance rule and you look at the components that are covered by that, those most safety-significant components -- and there can be some definition discussion there, but the most safety-significant components are covered in the technical specifications. There are already requirements.

And the maintenance rule didn't take those things out of the technical specifications. All right? There are other components that were not addressed in the technical specifications, balance of plant, et cetera, where the licensees established their own performance criteria.

Steam generator tubes are covered by the technical specifications. All right? And we believe it's appropriate if they're going to be maintained to a certain performance criteria for NRC to review and approve those criteria.

So that's our rationale for saying that it should be approved, reviewed and approved. There are some other arguments that go in there in terms of looking at consistency between plants and things like that.

Now, if you look at --

CHAIRMAN SEALE: In the range of events you

identify there specifically, you do include design basis accidents and the like.

MR. STROSNIDER: Yes.

CHAIRMAN SEALE: So you're drawing a pretty broad loop there.

MR. STROSNIDER: I'm sorry? I didn't understand.

CHAIRMAN SEALE: You're covering a pretty broad range of --

MR. STROSNIDER: Right.

CHAIRMAN SEALE: Yes.

MEMBER APOSTOLAKIS: Is consistency a requirement only? Let's see. You said that you want to have consistency among plants. How about the guide itself? Is it supposed to be self-consistent?

MR. STROSNIDER: There's no requirement for consistency. That's why I said there are some other arguments. They're not requirements. And certainly the implementation of this when you look at it could vary from plant to plant.

As I pointed out, a plant with replacement steam generators could have a program that looks significantly different from almost some older vintage generators. Performance criteria wouldn't change, but the program itself might.

(Slide)

MR. STROSNIDER: If you look at the areas, then, saying you should have performance criteria that addressed tube integrity, operational leakage; that is, leakage that might occur during normal operating conditions, and also accident-induced leakage. So those are the areas that we're saying you need to have performance criteria established in.

I'll say a little bit more about each one of those. And when we get into the regulatory guide discussion, I'll give you some specifics on what we think they should be.

MEMBER POWERS: This is a one-time approval? I mean, I come in and say, "Here are my criteria." And you guys approve it, and I'm good for those until I want to change them?

MR. STROSNIDER: Right, yes. But to change them, you would have to request NRC review.

MEMBER POWERS: But I don't have to come back every time I go into an outage or anything like that?

MR. STROSNIDER: Not to change performance criteria or not to get the performance criteria approved. Once they're approved, they're there.

But these are fairly high-level. Performance criteria are fairly high-level. That's one side of the

equation which you wouldn't expect to change. Now, I'll say something later about how you measure the performance of the tubes against those criteria.

CHAIRMAN SEALE: Dr. Apostolakis has --

MEMBER APOSTOLAKIS: Are the conditional probabilities listed in the guide calculable? And this is what you meant by the last line there?

(Slide)

MR. STROSNIDER: Right, yes. Structural integrity criteria we talk about here --

MEMBER APOSTOLAKIS: No. I'm referring to the previous viewgraph.

MEMBER SHACK: The criteria said "measurable," then in parentheses "calculable."

MEMBER APOSTOLAKIS: "Measurable" and "calculable." Are these conditions of probabilities here performance criteria?

MR. STROSNIDER: I'm glad you pointed that out because I certainly didn't want to pass that up. That's a very key point. In fact, this, I believe, is one of the most important aspects of performance-based regulation. We use the word "measurable," which may actually -- "calculable" might be a better word.

When we describe the performance criteria -- I'll give an example: structural integrity criteria,

which says you should have certain factors of safety against structure. In fact, we're referencing the ASME code.

Well, when a licensee shuts down a plant and does their inspection, they have to determine whether they actually have those margins. That can be done within NDE method, in which they measure a defect size and then do some fracture mechanics calculations, whatever is necessary, to demonstrate they actually have those factors of safety. So there are some calculations involved.

If you look at the leakage criteria under accident conditions, it's even more obvious. When you look, for example, at Generic Letter 95-05 on the voltage-based criteria, which is the sort of thing that might occur under this framework, you need to look at the distribution of defects in the steam generator, the probability that each indication might leak. You need to integrate all of that and come up with some estimated leakage, which you're going to compare to the performance criteria.

So, first of all, the performance criteria have to be measurable. You have to establish a criteria which you can actually go in and say, "Yes, I meet it" or "I don't." It doesn't make sense to have performance-based regulation if you can't.

This "measurable" and "calculable" I'll come back to later because this ties into: How do you have to qualify your inspection methods? How do you have to qualify your calculational methods? And that's where some of the philosophical discussion comes up of: Does the NRC need to look at how this is being done?

Tolerable. And I think there were some comments the last time I presented this that that's not a very good choice of words. What this means is there has to be margin beyond the performance criteria. If you fail the performance criteria, that should not be an unacceptable catastrophic situation. All right?

And if you look at what we're posing in here; for example, ASME code factors of safety on the structural integrity, it's a factor of safety of 3 under normal operating condition, roughly 1.4 in accidents.

So if you exceed it, it doesn't mean you've ruptured a tube. It doesn't mean you would have ruptured a tube under main steam line break conditions. But it means you need to look at what's happening and say, "Do I understand what's going on in my steam generators? Are some corrective actions appropriate?"

So measurable and tolerable performance criteria, that's a key part to performance-based regulation.

MEMBER APOSTOLAKIS: So are these conditional probabilities, then, calculable, you think? I don't know.

MR. STROSNIDER: Well, if you look, for example, at Generic Letter 95-05 on the voltage-based criteria, yes. All right? And the industry put in a lot of effort to develop the database and the methodology that was necessary to do that.

What the regulatory guide indicates draws a box around: How do you go calculate those things? It doesn't tell you how to do it, but it says, for example, if you're going to use certain correlations, that you have to take into account the parameter uncertainty. You have to demonstrate that you really have a correlation. All right?

CHAIRMAN FONTANA: In practice, after the Maine Yankee experience, don't you think the NRC will have to review the calculational approaches?

MR. STROSNIDER: Well, that's one of the questions that's come up. The proposal that you argue in favor of performance-based -- well, you can argue it either way. And there are discussions going on as to: Does the NRC need to review and approve the calculational methodology so that we're comfortable, we have some confidence that the performance criteria are really being met?

That's one of the policy issues that Brian Sheron raised. I think it was the second policy issue he raised in his opening statements. And it's an area where we're looking for some feedback. We'll probably be soliciting comments from the public, too, when we put this out for public comment.

MEMBER SHACK: Now, Brian implied in his presentation that you weren't going to review those.

MR. STROSNIDER: The way it's currently written, we would not.

MEMBER SHACK: Okay. That's the current position, then, not to review the methods?

MR. STROSNIDER: Yes, but I believe the discussions we've had is that when we put this out for public comment, we're going to ask for some comments in this area.

MR. SHERON: It's also anticipated that we would probably on an audit basis, I think -- I would like to see it when utilities implement this to go out and inspect, have the technical staff go out and look at what they have done to see to what extent they are actually meeting the intent to the rule.

Basically, we want to ensure that no one is playing fast and loose with the rule and the like -- just want to put it that way and the like. To answer Mario's

question, I don't think we would be in the same position with -- for example, you alluded to Maine Yankee.

Because the regulations there specifically say that they will use an approved evaluation model. And the question was, did the staff review and approve what they were actually using. If we don't specify that it has to be a staff approved model, then we're not on that same situation.

CHAIRMAN FONTANA: You're not in the same boat.

MR. SHERON: Right.

CHAIRMAN SEALE: Well, you don't expect to get any more leaks through the weak kind of phenomena. It seemed like every once in a while, it had a new process that came along and introduced another mode of potential cracking into the tubes. Presumably, you've got the flexibility in this rule -- or you expect the flexibility in the performance specs to accommodate any phenomena that begin to show up.

But I'm sure that if they're not there, you would -- I would assume you would remedy that situation or ask the licensees to.

MR. STROSNIDER: Yes, the intent in fact -- and I don't want to get into a lot of detail in the regulatory guide, but the guidance in there is that the

licensee would assess the potential types of degradation that might occur in the plant and use appropriate inspection methods.

Now, nobody has a crystal ball, so you'd have to also look at monitoring primary, secondary leakage.

CHAIRMAN SEALE: Sure.

MR. STROSNIDER: That could still occur.

MEMBER APOSTOLAKIS: Is there a document some place that shows how to calculate these probabilities with one or more, two or more, ten or more? I mean --

MR. STROSNIDER: The regulatory guide provides guidance on how these calculations should be done.

MEMBER APOSTOLAKIS: Well, actually, what it says is, you know, there is a number of uncertainties that you have to include in your calculations. But is there a model some place that actually shows how to get these probabilities?

MR. STROSNIDER: It depends -- the answer is that there is a model, for example, right now for the voltage based ODSCC criteria. It's in a topical report that was reviewed and approved by the NRC. This framework would allow new models to be developed as new types of degradation or as sufficient data are collected to develop a model to address the new type of degradation.

The industry has already -- you know, they're

interested in developing an alternate criteria for circumferential cracks at the top of the tube sheet or axial cracks in the roll transition. If they get sufficient data that they can put together a model that satisfies the guidance in that reg. guide, then they would be able to use that to establish different repair criteria.

The way this is currently structured, the NRC would not review and approve that model. If it's done with the context of the reg. guide, it should be acceptable. That's the reason that reg. guide is as long as it is, all right; because our attempt was to draw a box which says if the licensees operate within this box in terms of establishing repair criteria, we don't need to review and approve it.

The question is, have we adequately captured it in that regulatory guide.

MR. SHERON: Yes, Mr. Tuckman said before that, you know, one of the problems he had or he saw with the fact that the staff had never approved a lot of these correlations and so forth, you might say, that the licensees first come in with is they don't know what we're looking for or they don't know what the criteria are.

This was -- one of the attempts was to put down on paper what it is the staff would find acceptable.

Okay, and presumably, if they come in with a correlation or a model that follows, you know, what's in the reg. guide, this is presumably what we would find acceptable. And therefore, we would not have the problem that we're dealing with right now.

MEMBER APOSTOLAKIS: Now, this issue about the methods, I thought one of the hallmarks of performance based regulation was that you don't tell the licensee what method to use; but, there is a set of acceptable methods or approaches acceptable in advance. Now you're saying that you may not want to review these methods in advance.

So you will do it on a case by case basis? I mean, you have to convince yourself that what they're doing is correct, right? So, at some point, you have to review.

MR. STROSNIDER: The way this is currently structured, we don't tell the licensees how to do those calculations. We can't anticipate what the next mode of degradation is that people are going to want to address. So there's going to be new calculational models developed.

And a circ. crack is different than an axial crack. The models are going to look different. The guidance in the reg. guide says if you do it in accordance with this guidance, we should have reasonable confidence in it. In fact, it specifies if you're going to do a

statistical evaluation, what sort of confidence levels you need to end up with.

All right, and I guess I'm repeating myself. But the intent was, say, if you develop within these guidelines, it should be acceptable. The viewgraph that Mr. Tuckman put up which showed those lower tier documents which were repair criteria for different types of degradation, the assumption here is that they would all be developed and satisfied within that regulatory guide.

And it's not only the calculational methods. It involves the inspection method that you're using. Everything has to be looked at in an integrated way. But assuming that each of those lower tier documents satisfy what's in the reg. guide, you wouldn't need to look at them. But that is a question, as I said, that Brian pointed out.

MEMBER APOSTOLAKIS: I don't understand that. I mean, what I saw in the guide is advice of this type: when you do this calculation, make sure you include this and this and that.

MR. STROSNIDER: Right.

MEMBER APOSTOLAKIS: But that doesn't come close to the actual calculation. So you're saying as long as these documents contain these things, fine? No, because you have to look at how these uncertainties are

quantified and accounted for, right? I mean, just to say that I have accounted for the uncertainty in burst pressure data scatter and so on, that doesn't mean much.

MR. STROSNIDER: But it says more than that. It says you need to account for those; and for condition monitoring, you need to end up with a 95% probability and 50% confidence. That tells you how you need to integrate all your parameters and assess it.

MEMBER APOSTOLAKIS: That's --

MR. STROSNIDER: Whether it says enough or not, --

MEMBER APOSTOLAKIS: That's another problem I have with that. At some point, we have to discuss that too, because I don't know what that means.

MR. SHERON: Just as one example is that they first -- the industry first started going down the road of trying to size circumferential cracks. What they learned is that they couldn't correlate what they were seeing. And so now they're moving towards a voltage based approach which doesn't really look to an actual depth size, okay.

Again, you know, this guide is basically saying regardless of what approach you use, okay, these are the kind of things you need to consider when you use whatever methodology you decide to go with. So in other words, a prescriptive guide would say you must develop

something that measures depth period.

Okay, we're not doing that. All we're saying is that, you know, whatever method you use to reach your end state which is to show structural integrity, you know, follow these approaches for developing correlations, etc. But we don't tell them how to do it. I don't say use --

MEMBER APOSTOLAKIS: I understand that. But after a correlation is developed, then you will review it, right?

MR. SHERON: No.

MEMBER APOSTOLAKIS: You will not review it? If it is used --

MR. SHERON: They do it through the inspection process just to convince ourselves, okay; but there is no requirement that the staff will have to review that correlation. What we're saying is that if they develop the correlation in accordance with the guidance in the reg. guide, okay, we are basically saying we would find that acceptable.

MEMBER APOSTOLAKIS: So the results then of the correlation will be accepted?

MR. SHERON: Yes; we believe that if they follow that approach in there, we would find it acceptable, and we would have no need to review it and approve it.

MR. STROSNIDER: The results of the correlation have to be compared to the performance criteria. All right, and then they dictate where -- at what level you repair to that you plug them so that you stay within the performance criteria.

MEMBER APOSTOLAKIS: This is very different from what I thought risk informed performance based regulation was, but maybe this will broaden my horizons.

MEMBER POWERS: George, I don't recall a stipulation that there be pre-approved methods.

MEMBER APOSTOLAKIS: That's the general understanding that in a performance based --

MEMBER POWERS: Can't be too general; I didn't understand it.

MEMBER APOSTOLAKIS: No, the staff has not stated it in their list. But if you look at papers and documents in the literature, when they talk about performance based regulation, they say, you know, you establish performance criteria, then there is a set of approaches that are accepted by the regulator and the regulated; and then the licensee can use any method or any combination of these approaches to make its point.

MEMBER POWERS: That's the step that I've never -- I'm unfamiliar with that ever being articulated.

MEMBER APOSTOLAKIS: Not in our context here,

no. But for example, if you look at the papers from the fire or protection business -- I mean, that's always a bullet there that the methods have to be approved in advance. Now, maybe they have different problems than we do, but you will have to look at the methods at some point any way.

I mean, I can't imagine that somebody will tell you this is how I do it. And you say oh, did you include these uncertainties? Yes, thank you very much. Well, I mean, you're going to look, right? So maybe there is some reason to approving things in advance, or at least to some degree so you don't have --

MEMBER SHACK: We now know where you'd draw the arrow for NRC referral, George.

CHAIRMAN SEALE: Let's find out where the NRC's drawing it.

MR. STROSNIDER: Okay, so just to go through briefly on structural integrity criteria, there's deterministic criteria which is consistent with ASME code; consistent with what we require for the rest of the reactor coolant pressure boundary; and a probablistic criteria consistent with risk assessment, GDC, balanced approach -- say just a little bit about this.

We have performed in the past and more recently some risk assessments which indicate that the

numbers that you'll hear later are acceptable within the risk area. I point out again compliance with the GDC and a balanced approach to managing degradation. There's some arguments that if you can show, for example, that the initiating frequencies of design basis accidents are low enough, that the conditional probability of tube failure could go up to one in ten or higher.

Okay, but we don't think that's a balanced approach, and we don't think that it satisfies the GDC. So, we've done some risk assessment to confirm that the numbers we have provide an acceptable level of risk. But in addition, we've looked at them in terms of the GDC and others areas and said we think that this provides a balanced approach.

You don't want to put all your eggs in one basket; that's all we're saying.

CHAIRMAN FONTANA: With respect to that, the first part of the rule that says use ASME Boiler & Pressure Vessel Code and so on, that's for a design basis accident of some kind, correct?

MR. STROSNIDER: Actually, the ASME code specifies factors for normal operating conditions and for design basis. And depending upon the design of the plant, one or the other would govern.

CHAIRMAN FONTANA: For example, what would be

a design basis accident by which you'd design the tubes according to the Boiler Pressure Vessel Code?

MR. STROSNIDER: Oh, this would be -- the main steam line break will govern.

CHAIRMAN FONTANA: Okay. Now with respect to the probablistic criteria, it doesn't -- the difference, as I understand it, between designing to a design basis accident -- you have to design to the code. You have codes and standards, inspection, qualification, and so on.

Whereas, a probablistic assessment could go to loads that are beyond that, but also could take into consideration the capability of the system or the tubes to withstand loads and go beyond design bases.

MR. STROSNIDER: Okay.

CHAIRMAN FONTANA: In other words, --

MR. STROSNIDER: We're getting into some of the discussion I think you're going to hear later. But actually, the probablistic criteria are established for the design basis events. Okay, there's a conditional probability under main steam line break.

CHAIRMAN FONTANA: Okay, it's still design basis events. You haven't gone to -- beyond design basis events.

MR. STROSNIDER: And then there's other areas where we covered the beyond design basis.

CHAIRMAN FONTANA: There are? Okay.

MR. STROSNIDER: Operational leakage criteria -- this is basically similar to what's in the current technical specifications. I'd just point out that monitoring primary to secondary leakage is a very effective way of minimizing tube ruptures. It's been proven in the past.

And if you look at some of the events with hindsight -- that if you had good procedures here, you might head off some ruptures. So this is consistent with what's currently being done. Now we have consideration of accident leakage. All right, this is leakage that would occur under postulated main steam line break, design basis accident.

Okay, the beyond design basis is covered in other areas. It's limited here both to -- based on dose considerations and also based on make up capacity of the plant. Dose considerations, I think, are fairly obvious. This criteria on make up capacity is basically to avoid operator challenges and taking the operators into potential events beyond what you'd really like to see them challenged by.

One other comment that I'd make here is that the doses are conservatively calculated. And I think that's an important point because I mentioned earlier that

there has to be margin in your performance criteria. When you say that, you can put the margin either in the way you do the calculation or else in the acceptance criteria.

All right, and here, some of that -- at least a fairly significant portion -- is in the way the calculations are done. But you'll hear more about that later.

CHAIRMAN FONTANA: It's interesting that some small fraction of Part 100 guidelines -- I'm not quite sure what that means. Four lines from the bottom there.

MR. STROSNIDER: Okay, I'd like to leave that for the discussion of the regulatory guide where different types of accidents and spiking and etc. dictate whether you use 10% or whether you use the full Part 100 on this. But I think that can be described better by the staff in that area.

MEMBER APOSTOLAKIS: Now, the -- why aren't these accident leakage criteria probablistic? I mean, why don't you say the probability of exceeding the total charging pump capacity should not be greater than such and such? And -- because you say calculated potential primary to secondary leak rate should not exceed, so -- and that's only five lines below the probablistic criteria for structural performance.

MR. STROSNIDER: That's a good point. We

didn't include that sort of language in here. If you look at the regulatory guide, it talks about actually doing these calculations to certain confidence levels -- you know, giving you certain probabilities and confidence. So it's -- it's in the regulatory guide, but it's not specifically stated that way here.

MEMBER APOSTOLAKIS: Could have been probablistic?

MR. STROSNIDER: Well, --

MEMBER APOSTOLAKIS: I mean, I suppose there are rules that you show what potential primary to secondary leak rate is and -- so it's engineering approach or the deterministic approach, right?

MR. STROSNIDER: Well, again, there's -- and I look at one we're already looked at, Generic 95-05. There's a model put together which includes the probability of leakage of given indications, and that's integrated into an overall assessment which says, you know, you have certain probability of this amount of leakage and a certain confidence level.

And that's the way the regulatory guide indicates these analyses should be done.

MEMBER APOSTOLAKIS: This is the regulatory guide, right?

MR. STROSNIDER: Right.

MEMBER APOSTOLAKIS: Yes, but that's not probablistic. It says shall --

MR. STROSNIDER: No; it's a statistical analysis, but it's not --

MEMBER APOSTOLAKIS: No. It says calculated potential primary to secondary leak rate during limiting postulated events should not exceed the total charging pump capacity, period.

MR. STROSNIDER: Yes; but if you go back into one of the detailed sections in the back, it talks about how those calculations are performed. And there is probablistic and statistical considerations in the way you do these analyses. Just a point here: the first part of that regulatory guide provides some general statements; but then, in the back of it, there are more detailed guidance.

It's a good question. We'll have to consider that.

MEMBER APOSTOLAKIS: The second question on the same subject. Are the structural performance criteria and the accident leakage criteria consistent with each other? I mean, if I -- let me put it differently. If I make sure and I demonstrate to you that the probability of one or more cube ruptures is 5×10^{-2} and the other criteria that you give me here, then will I have

reasonable assurance that the probability of the primary to secondary leak rate will be less than the total charging pump capacity rate?

I mean, these things cannot be independent of each other.

MR. STROSNIDER: You have to do both analyses. And --

MEMBER APOSTOLAKIS: But they do overlap just to gain additional assurance or --

MR. STROSNIDER: If you have lots of small leaks, --

MEMBER APOSTOLAKIS: Yes.

MR. STROSNIDER: -- you know, I mean, you do have, you know, thousands of tubes; and if you have small leaks from each of them, you know, it adds up to something equivalent to a tube rupture eventually. But they're different.

MEMBER APOSTOLAKIS: They are --

MR. STROSNIDER: Yes.

MEMBER APOSTOLAKIS: -- sufficiently different to justify --

MR. STROSNIDER: In Generic Letter 95-05 on the voltage based criteria, --

MEMBER APOSTOLAKIS: Okay.

MR. STROSNIDER: -- you have to calculate both

probability rupture, and you have to calculate leakage. And you'll find the different situations that the operating cycle is governed by, you know, one or the other. It depends on the number of indications --

MEMBER APOSTOLAKIS: Okay, fine. I'm ready for a cup of coffee.

CHAIRMAN SEALE: Perhaps we ought to take a short break, if that's all right with you. All right, let's be back at quarter of 11:00.

(Whereupon, the foregoing matter went off the record at 10:31 a.m. and went back on the record at 10:53 a.m.)

CHAIRMAN SEALE: Okay, we're back in session. Yeah, but we've got a quorum, so let's go ahead.

MR. STROSNIDER: Do you want me to begin?

CHAIRMAN SEALE: Yes, sir.

MR. STROSNIDER: Okay, we had just completed some discussion about performance criteria. And moving into the next section of the rule, this gets into some programmatic elements. And quite frankly, there's been some debate about whether programmatic elements have a place in a performance based rule.

I want to talk a little bit about what they are, some of the rationale. To ensure that the performance criteria met, each licensee shall manage the

types of degradation, etc., through a combination of -- and there's a list of things here. Preventive measures, in service inspection, repair of tubing, primary to secondary leakage monitoring, condition monitoring, and this goes on -- the next page to operational assessment and some other areas.

I think some of the key here is combination. One of the things we were striving for here is to assure a balanced approach. Experience tell us that we can't manage steam generator tube degradation through inspection alone. We also need some primary to secondary leakage monitoring to go along with it.

We can't manage it strictly by improving the design necessarily. All right, you need all of these different things, we believe, in order to have an effective program. It assures a balanced approach. It also provides defense in depth. The last time we were down here talking to the committee on this issue that the subject came up on defense in depth and how it would be assured.

Typically, we think in defense in depth in terms of fuel cladding, reactor coolant pressure boundary, and containment. Well, as I mentioned earlier, we've already got reactor coolant pressure boundary and containment tied up in one component here, so we've got

two strikes against us in a sense.

But we're looking at defense in depth perhaps in a broader context. In the sense of the program that you use to maintain integrity of these tubes, that you should be looking at a number of different areas which have been proven to be effective in managing tube degradation.

Most of these areas, I believe, are areas that licensees with good programs are currently doing.

CHAIRMAN FONTANA: Now defense in depth, could that lead you to put on isolation valves?

MR. STROSNIDER: Well, depending upon the level of cost, etc., you get into back fits and -- if it survived the back fit analysis, yes. On the flip side, if somebody decides that that's an effective way to do this, it could be part of it. But then you get into issues about the reliability of the isolation valves, etc.

So, I want to point out that in all these areas -- and if you go into the regulatory guide too, we've gone -- we've made a conscious attempt not to make any of these things prescriptive. Now, I'll tell you, if you go look at the inspection section in the reg. guide, there's some stuff in there about initial sample sizes and that sort of thing.

It's hard to avoid some degree of specicivity

(sic). It's hard not to be specific in some areas. And where we've done that -- the other thing I'd point out is that we've tried to reference industry guidance in documents where we can. And to the extent that those perhaps might be modified, Mr. Tuckman indicated some things this morning that they were doing to change some of the guidelines.

We could reference those directly from the reg. guide. Finally, I want to point out that this provides some enforceability. And this was a significant driving force. After we constructed -- drafted the rule in the regulatory guide and we looked at what things really needed to be enforceable.

If a licensee fails a performance criteria, we'd like to be able to go in and determine why that happened. And these are the areas that we'd look at. And in terms of enforcement, if you can tie the failure to meet the performance criteria to one of these areas, there's a very clear nexus, we think, and a good basis for enforcement.

It also provides the licensees with some guidance on the areas that we think are important. And going on to the next section -- okay, let's see. There's a number of -- yes, here you can almost look at these as performance criteria in each of those areas that were

described above.

At least some general guidance. Utilize in service inspection systems which have been demonstrated to be reliable for flaw mechanisms affecting the tubing such that repairs may be implemented before the performance criteria exceeded. What this gets down to is understanding the NDE technology that you're using, being able to quantify its reliability, and accounting for that to make sure that you're repairing tubes in an appropriate time.

For condition monitoring, you need to provide a high confidence in the assessment of the condition of the tubing. This is something we discussed earlier about in performance based regulation, it doesn't mean a lot to say you've established performance criteria is you can't measure them reliably.

All right, so that's the point we're getting to here. And number four gets into utilizing analysis methods. As we pointed out, this is not something that you just measure with a ruler. There's very often calculations involved either in the structural integrity assessment or in the leakage.

So, you have to have some high confidence in the evaluation of the condition of the tubing. Now, these are somewhat general words we feel that are appropriate in

the rule. In the regulatory guide, we get into some more definition of what we mean by high confidence -- something that's acceptable to the staff.

That is, what confidence levels we think are acceptable. So, this portion of the rule establishes expected performance. Again, some of the same things. It's non-prescriptive in terms of we're not telling people how to do these things, but they are goals that need to be accomplished.

Again, it enhances enforceability. Items (ii), (iv), and (v) and five are critical to assuring performance criteria are calculatable. And, you know, I just mentioned -- touched on those. And as Brian Sheron pointed out this morning, there's an issue we think that needs to be determined regarding the need for review and approval of those methods.

As this is currently proposed, the staff would not review and approve.

CHAIRMAN FONTANA: Am I missing something? Which roman numeral (v)?

MR. STROSNIDER: Did we lose one? I'm sorry. The numbering changed from when we first put this together. It should be (ii), (iii), and (iv); which (ii) is utilizing -- deals with the in service inspection systems; (iii) with the inspection or test methods for

assessing -- or doing the condition monitoring.

They have to have high confidence. And (iv) deals with the analysis methods -- calculations. Is that correct in the copy of the rule that they have? I think if you look at the copy of the rule that was distributed, you'll see those numbers.

Okay, the next section talks about mitigating measures. Again, this is part of defense in depth. And what we're referring to here is licensee operator training, emergency operating procedures, and all the things that go into coping with a tube rupture in the event that one should occur.

It's primarily defense in depth. Licensee shall take reasonable, achievable measures necessary to preserve the steam generator tube function as appearing against uncontrolled release of fission products. This is intended to address a severe accident case. Some bullets down here with regard to the bases for that.

You're going to hear more about this from the systems and the risk staff who have been doing work in this area. I think what I'd point out at this time is that there's been a lot of work done that remains to be documented in the NUREG report that you're going to see.

It also has to be put through the reg. impact analysis to determine exactly how it's implemented. And I

think the important thing for today is that you hear the sort of calculations that have been done and the results. And I'd really like to defer them to the proper technical staff to get into more detail on that.

MEMBER SHACK: Jack, when is the reg. impact analysis going to be done?

MR. STROSNIDER: I guess it's going to be done mid December now, is that -- yeah, mid December. Our goal is to have the entire package for this rule and regulatory guide -- and by package, I mean the reg. impact analysis, statements of consideration, and all the technical back up work -- put together in December, sent out for office concurrence; and of course, the committee would get a copy too.

But I think that's mid to late December at this point.

MEMBER APOSTOLAKIS: So when are we supposed to write a letter? When do you expect us --

MR. STROSNIDER: Well, let me talk to my project manager. I guess one comment I would make is that I think a letter with any feedback that you can give based on some of the discussions today, including some of these policy issues, would be very useful to us in completing the final package.

Final endorsement would be after you've had a

chance to look at the package in the December time frame.

MR. REED: Yes, I think that's -- this is Tim Reed from NRR. Yeah, what we want right now -- obviously, if we could get it, it would be a technical endorsement from your committee to go forth with the draft rule package for public comment. That package will go through the chain starting in December.

And at that time, I'll give you a -- you know, a copy of this foot thick package -- it's going to be about a foot thick -- for comments. But generally we do better on the endorsement. No, I mean --

MR. STROSNIDER: But the schedule is to have the package to the Commission in February.

MR. REED: Yes, that's --

MR. STROSNIDER: And out for public comment in March.

MR. REED: It's an extremely aggressive schedule.

MR. STROSNIDER: Yes, this is an ambitious schedule. But one of the reasons we wanted to get here earlv was to get any feedback that you might have as soon as possible.

CHAIRMAN SEALE: That's opposed to offensive.

MEMBER APOSTOLAKIS: So when the package goes to the Commission, there should be an ACRS letter.

CHAIRMAN SEALE: Yes.

MR. STROSNIDER: The paragraph on implementation -- currently thinking that it's probably appropriate for about a year or so to implement this program. Technical specification requirements are changes would be required if nothing else to take out some of the tech spec requirements that are currently in there.

We're going through discussions right now on how to implement this rule. And I just -- for thought, if you look -- what you might consider pure performance based approach, you could say here's the rule, and there's a regulatory guide which is acceptable guidance; but that's one way to implement it. That might be all you need.

I mentioned earlier some of the concern about having a box in which licensees would be able to operate. What we're considering right now is the possibility that you need something in the technical specifications to basically make that enforceable.

And so, we -- it's not been through senior management review, but we have some draft tech specs which would reference the reg. guide or other approved industry document at such time as such a document were completed.

So -- and as I indicated, that's -- a year seems reasonable to develop the program. There will have to be a large number of tech spec changes processed by the

staff. Because recognize, there are requirements in the tech specs now where you can't go to this performance based approach unless you take them out of the tech specs because you're required by your license to file them.

This paragraph in here talking about the relationship to the maintenance rule and then basically trying to provide some unambiguous definition that this rule covers steam generator tubes, OGC recently informed us that we felt we need to add something with regard to license renewal, and that satisfaction of this rule would satisfy license renewal requirements.

But that's some recent comments we got back. We haven't incorporated that yet. So, basically, it takes us through the text. As I said in other presentations, this is the viewgraph that makes it all clear. I'm not going to go through this in detail.

Emmett Murphy is going to talk a little bit more from this, I think. But I wanted to point out that basically when implemented, the way we would see this as working. And I'd suggest first ignore all these boxes on the left-hand side. The requirements in the rule are pretty much covered by this flow chart on the right, along with the NRC accepted performance criteria.

Basically the plant shuts down and does a tube inspection. They then perform a condition monitoring

assessment. That is, they assess the as found condition of the tubes relative to the performance criteria. If the performance criteria aren't satisfied, they inform the NRC to determine what appropriate corrective actions need to be taken and come in and perform this operational assessment which is the forward look to provide some confidence that your next operating cycle is an appropriate length.

This can be adjusted either based on the length of the cycle or perhaps by changing the tube repair criteria. It doesn't require a tech spec amendment for this framework to change that repair criteria. So, you might repair the tube at smaller defect size or larger, depending upon what you found at the end of the cycle.

Performance criteria satisfied, you fall into that same box. After you've done your operational assessment and you have confidence that you'll meet the performance criteria through the operating cycle, you perform repairs, implement the preventive measures.

These could be things relative to water chemistry or temperature -- you know, operating temperature to keep the corrosion rate down. Risk assessment -- that needs to be taken into consideration. And we talked about having EOP's in training. Some of these things happen not necessarily chronologically here,

but there's something that's in the program.

Plant re-start -- the NRC gets a report on what was found during the outage. And while operating, monitor the operational leakage. And that's the cycle. All these boxes over here are areas in which the regulatory guide provides additional guidance on acceptable ways to accomplish these things.

And Emmett Murphy's going to talk about the regulatory guide in a little more detail, so I'm not going to go into those. But I just wanted to show sort of the big picture of how this -- how we visualize this working when it's implemented.

That covers what I wanted to present. I guess I'd just ask if there's any questions.

CHAIRMAN SEALE: Any further questions for Strosnider?

MEMBER SHACK: Jack, if the NRC decided to review that lower tier of documents that we talked about, is that basically equivalent to what you've done now with 95-05 in the generic letter? I mean, would you need this rule if you were going to review those documents anyway?

MR. STROSNIDER: Well, I think -- first of all, if the NRC reviewed the methodology that's used for comparing tube condition to the performance criteria, you'd probably catch 90% or so of the sort of reviews that

we did on Generic Letter 95-05.

I mean, the only thing that's absent in the repair criteria. Because what you're really looking at is here's how at the end of the cycle I take my final distribution and compare it with the performance criteria. In the next step, you'd have to go back and say well, what should my repair criteria have been considering growth rate and that sort of thing.

And, there's maybe a subtle distinction there, but I think if you review the methodology for condition monitoring, you're capturing a large part of the overall assessment. In terms of -- I guess your second part of your question was would you need this rule if you reviewed all of it?

Well, there's a couple of parts to that. I think the rule would be appropriate in terms of improving the NDE qualification and the technology there and some of those other areas that we looked at. In terms of implementing alternate repair criteria, it probably wouldn't be a whole lot different than reviewing topical reports and processing tech spec amendments under the current framework.

You would lose a great -- the industry would lose a great deal of flexibility if we got into reviewing and approving all of those condition monitoring

methodologies.

Does that answer your question?

CHAIRMAN SEALE: Any other questions?

MR. STROSNIDER: Okay, I guess Emmett Murphy's up next then to talk about the regulatory guide. Thank you.

CHAIRMAN SEALE: Very good. The committee is going to have to break at 12:00 because of other commitments, so you might keep that in mind.

MR. MURPHY: Okay, Jack presented a more complicated version of this particular flow chart which basically outlines the strategy taken in the regulatory guide for complying with the propose rule. And I think Jack did a very good job of discussing how this strategy works.

Just a couple of points I might add. First, the last question that was asked having to do with whether or not the rule would be needed given the presence of evaluation methodologies developed by the industry for the different degradation mechanisms if we were looking -- review and approve those, perhaps we don't need this structure.

I think realistically we have to recognize now that we only have -- there are many different mechanisms that occur in the field affecting the tubing. Various

types of stress corrosion cracking -- they occur at different locations, different orientations. To develop methodologies that address each of these different problems is going to be many, many years off.

I think the industry's focus will be to develop detailed methodologies for those mechanisms that are causing a lot of tube plugging activity in an effort to try to save as many tubes as possible. And what we're trying to do here with the rule then is to provide a framework that addresses not just degradation mechanisms for which there is this detailed methodology for ensuring that the performance criteria are met, but to ensure that all active degradation mechanisms which the plant is encountering -- that he has fully evaluated all of those mechanisms relative to the performance criteria.

So, for completeness -- the rule will help ensure the completeness of the evaluation relative to the performance criteria. The second point to make, I think -- I'd like to make here is that this strategy is basically consistent with the strategy that's being implemented today by the staff on an ad hoc basis.

That is, the current regulatory structure is embodied in the code and the tech specs concerning how you do inspections and so forth. That approach, of course, is prescriptive; and implementing these prescriptive steps

point by point doesn't necessarily ensure tube integrity for all situations.

Licensees are, of course, obliged under Appendix B of the regulations to do what's necessary to ensure tube integrity. But very frequently, their focus isn't on that. So, in our interactions with utilities on a daily basis or for those utilities that have encountered significant problems, the strategy that is generally -- that generally evolves from these interactions is the strategy that's outlined here.

Okay, these first two or three viewgraphs cover some material that I think, with all the give and take during Jack's discussion, has been covered already, and I won't belabor the points. The first topic I'm covering here are the performance criteria. And Jack has discussed the attributes that we're looking for the performance criteria.

The first of these criteria has to do with the structural integrity of the tubing. This means ensuring against burst. This will initially ensure that the tube will be leak free. The tube can leak and still have adequate structural integrity against burst.

So these requirements are intended to address the potential for burst. I'm going to explain why in a moment we've allowed for a probablistic criteria in lieu

of a deterministic criteria, but the traditional way of doing business has been to have -- we've traditionally relied on deterministic factors of safety for purposes of assessing where we are structurally in terms of tube integrity.

The deterministic criteria that we've described in the rule and maybe explained a bit more about in the regulatory guide is -- we've taken the traditional approach that the structural criteria should retain margins of safety against burst consistent with the stress limits in Section III of the ASME code.

Existing regulatory guidance concerning the structural margins we're trying to maintain in the tubing are presently given in Reg. Guide 1121. That reg. guide would be superseded by the regulatory guide that we're developing in support of this proposed rule. But basically the philosophy behind the criteria in that reg. guide -- in the current reg. guide is to maintain the Section III factors of safety.

Similarly, in Section XI requirements for flaw evaluations for piping components, for example, when these flaw evaluation procedures are developed, they're generally developed again with the philosophy of trying to maintain the factors of safety implicit in Section III of the code.

But simply saying this doesn't -- there is room for interpretation as to what that may mean in terms of a specific factor of safety that has to be maintained. For example, an issue that we've already been discussing with the industry and I think they still have comments on has to do with in fact whether we -- whether being consistent with Section III of the code means providing for a factor of safety of three against burst during normal operating conditions.

This traditionally has been the most limiting structural criterion that we have for tubing; more limiting than the criterion that exists for evaluating integrity under postulated accidents. We have -- the regulatory guide makes than an interpretation of the -- what we're saying in the rule.

The regulatory guide clarifies that our interpretation of this requirement is that we're looking for a margin of three with respect to burst.

The rule and the reg. guide allow for use of an alternative way of looking at structural margins, namely a probablistic approach. In recent years, we've run into situations where we're dealing with literally thousands of tubes containing identified flaws -- for example, outer diameter stress corrosion cracking.

The traditional way of looking at things is

that -- is one has an expectation that everyone of those thousands of flaws should maintain the margin of three against burst. We're dealing with -- the real life situation is that the bulk of the indications that you're finding -- the thousands of indications that you're finding tends to fall within a range of voltages or a range of depths and so forth.

But you have a tail of the distribution that frequently challenges the factor of safety margin that you're trying to meet. And your whole strategy then for how to schedule your inspection outages becomes dominated by a concern over one or two or three or four indications that you're expecting during the course of the cycle out of the thousands of indications are likely to occur.

And a roughly small number of indications that may not have a full margin or a factor of safety of three may not have -- may not contribute significantly to the overall frequency of rupture or condition of probability of rupture during postulated events. And so, by allowing for the consideration of probablistic criteria instead of the traditional deterministic criteria, we're providing a -- I think a reasonable way for dealing with these kinds of situations that we are starting to encounter more and more in the field.

CHAIRMAN FONTANA: Let's see, I think if I

understand this, you can do measurements of tube condition. And on a basis of these measurements and on a basis of postulated accidents, you can develop a probability curve, for example, of the number of failures expected, is that correct?

MR. MURPHY: That's right, yes. And the -- there is one mechanism for which such a methodology has been developed, as Jack explained earlier, and that's for this outer diameter stress corrosion cracking at support plates where there is considerable date accumulated now relating burst pressure to the voltage response associated with the indication.

There's considerable scatter in that data around the mean regression line of that data. That scatter has been modeled statistically. Furthermore, the variability of the voltage measurements relative to the nominal value has been quantified statistically. The growth rate probability -- distribution of growth rates among the population of ODSCC flaws has been quantified.

So you can use various statistical methods then for evaluating, you know, where you're going to be at the end of the next cycle in terms of voltage distribution of flaws and what that would mean in terms of the overall probability of failing a tube at that time.

CHAIRMAN FONTANA: Now, the actual

determination of the failures, is that done in experiments outside of the ex reactor experiments?

MR. MURPHY: Yes.

CHAIRMAN FONTANA: And if that's the case, --

MR. MURPHY: Well, --

CHAIRMAN FONTANA: -- are the tube failures simulated or are they really --

MR. MURPHY: The one, you know, for the ODSCC, what we have there is both -- the data upon which the burst correlation is based is half the data comes from tubes that have been removed from steam generators and burst tested in the lab. Some of the samples that go into the correlation were -- involved laboratory induced cracks in the tubes.

But it's possible that one could also gather useful information concerning the burst and leakage properties of tubing based on pressure tests that could be done -- performed in situ. Such tests are being performed quite commonly in the industry today.

Okay, briefly then, we're talking about under probablistic two sets of criteria. The first set is a single criterion regarding the frequency of the steam generator tube ruptures occurring as initiating events. And the criterion is basically a number that is consistent with experience to date.

This is, at present time, the frequency of tube ruptures averaged over all plants over -- since the beginning of time.

MEMBER APOSTOLAKIS: Now, the guide has 10^{-2}. Did you --

MR. MURPHY: We fixed that, and the master copy -- yes, that is incorrect.

MEMBER APOSTOLAKIS: And this is supposed to be a mean frequency?

MR. MURPHY: This is -- I mean, I'm not sure I understand. It should be a plant specific number. This is a number that you would calculate for the specific unit for the specific situation that you have.

MEMBER APOSTOLAKIS: But, I mean, is there some uncertainty about this frequency even for a given plant, or is it the uncertainty is very, very small, so one number is good enough? Do they have sufficient statistical evidence at a given plant to be able to say yes, the frequency is 5×10^{-3} or whatever?

If I calculate -- is this a number that's based on data, or is it a number that requires some analysis?

MR. MURPHY: It's a number that requires some analysis.

MEMBER APOSTOLAKIS: And there are no

uncertainties in that analysis?

MR. MURPHY: Yes; but the regulatory guidance requires that you account statistically for these uncertainties such as to generate a realistic estimate of what that frequency is.

MEMBER APOSTOLAKIS: So this should be then the mean value --

MR. MURPHY: Yes.

MEMBER APOSTOLAKIS: -- of those uncertainties.

MEMBER KRESS: Is that number how many -- relationship to how often you shut down and inspect a steam generator tube?

MR. MURPHY: Yes, it should have a -- it should have -- that is an important variable affecting the number.

MEMBER KRESS: How can you put a number in then if -- is there a variable of frequency for inspection depending on the plants?

MR. MURPHY: Well, I was going to get into the guidance that we had developed regarding the frequency of inspection. But basically, the strategy in the reg. guide is when you do your forward look, your operational assessment, you need to inspect at such a frequency as to ensure that you will meet the performance criteria at the

time you are scheduled to meet inspection.

Or if you don't, then you need to reschedule the inspection in such a way as to ensure that the performance criteria will be met. So the frequency of inspection is as necessary to meet the performance criteria rather than saying every 18 months or 24 months or what have you.

It's as necessary to meet the performance criteria. Currently, right now, I think the requirement is inspect every 24 calendar months if you've had past problems. If you haven't had problems and if you've been a good unit behaving well, the frequency of inspection can be stretch out to 40 months, I believe, as I recall.

So those prescriptive requirements would be replaced with the general criterion that you inspect frequently enough to ensure that you meet the performance criteria.

MEMBER SHACK: And as I recall, the spontaneous rupture frequency assumed in 1150 and 0844 was .05. Now, this is much smaller.

MR. MURPHY: Yes; the frequency of ruptures has been trending down.

MEMBER SHACK: But if that was acceptable from a risk point of view then, you know, is this now defense in depth?

MR. MURPHY: No, this is not -- this number is not driven or controlled by risk. I mean, it's consistent with maintaining a low level of risk. This is a performance -- it meets the tolerable attribute that we're looking for in a performance criteria. Exceeding that performance criteria doesn't necessarily mean we have an unacceptable situation, but it means we -- that we want to see why the number is as high as it is.

We want to investigate the causal factors and see that those factors are addressed. We do think as a goal that people should be striving not to have the frequency of ruptures, start going back the other way. They've been trending down through the years. We don't want -- I don't think that we want to have a criteria that will allow for us to start trending back the other way in terms of increasing the frequency of ruptures.

MEMBER APOSTOLAKIS: Now if the objective is to use this as a red flag that something is going on and you want to look, I wonder whether the frequency is really the right criteria. 5×10^{-3} -- how long will it take for you to realize that this frequency has changed?

MR. MURPHY: Well, this -- when one does the evaluation relative to this criteria, one is not counting his tube ruptures that he's actually experienced through the years. I mean, I guess the typical plant probably

won't get a tube rupture over its 40 year life time. Rather, this should be a calculated number.

To compare yourself to this probablistic criterion requires that you must have a lot of information. If you don't have information concerning the burst pressure uncertainty, the growth rate variability, the under current measurement error -- if you don't have this information, then you have to go to deterministic space.

You have to demonstrate that you have margins of three, for example, against failure during normal operation. And all tubes have to meet this criterion. Because frequently, we don't have enough -- as a matter of fact, it's -- more typically, we don't have sufficient information for a degradation mechanism to calculate where we are relative to these criteria.

That's the typical situation. We have one mechanism for which we do have the tools, and that's ODSCC at the tube support plates. If they use the right techniques and they do the evaluation in the prescribed way, then we have the tools for evaluating against these criteria.

If we don't have the tools -- and we typically, for most mechanisms right now, don't have the tools -- you have to do it deterministically.

MEMBER APOSTOLAKIS: So in a deterministic space, you don't need any tools?

MR. MURPHY: In deterministic space, we can leave more -- we're frequently doing bounding calculations. We may not know the -- we may not calculate them explicitly, so we try to bound them.

MEMBER SHACK: It's plug on detection is what --

MR. MURPHY: Well, no; that's a different issue, but it may be somewhat related. But I'm coming to plug on detection in a minute.

MEMBER SHACK: But if I have a mechanism for which I don't have all -- as soon as -- you know, if I don't understand everything as soon as I find a defect, how can I assure myself I'm ever going to meet this thing unless I don't plug the sucker on detection?

MR. MURPHY: Well, in general, one need not plug on detection when he knows how well his eddy current system is performing. How well does it size -- what is the accuracy of the sizing measurements that he's making. And when he's able to see -- when he's able to demonstrate with reasonable confidence that that flaw meets the performance criteria, then he can keep that flaw in service.

If he doesn't have sufficient information to

evaluate the condition of the flaw versus the performance criteria, then yes, it's plug on detection. That's basically what it boils down to. Then it's consistent with the status quo. It's consistent with the way business is being done today.

For most -- except where the voltage based approach is being implemented for ODSCC, in general, we don't have the capacity today to size flaws -- cracks within a known set of error bounds. Therefore, we don't know where the flaw truly sits relative to the 40% plugging limit that's out there today; and also, we don't know real clearly whether we'd meet the performance criteria that existed at the end of the next cycle.

So the only reasonable course to take is to plug that tube, and that's the way business is conducted today.

MEMBER SHACK: Well, suppose I do something where I know how to calculations. I'm in 95-05 space with ODSCC. If I did the calculations for the .05 on 10^{-2}, does that basically assure I'm going to meet the -- you know, the 5 x 10^{-3}? This spontaneous frequency then would be basically ruptured during normal operation.

MR. MURPHY: Yes. Well, it may well be, it may well be. In fact, this is not something that can be wrote into -- this particular item here is not written

into Generic Letter 95-05. We included it here because -- for purposes of completeness. If you look at the code, for example, you have different factors of safety you try to maintain for a normal operation for accidents and all the rest.

We thought that for completeness, that the probablistic criteria should address both normal operating conditions. And for accidents, it may well be that these conditional probability criteria will almost always control the outcome of the evaluation. This may never be a limiting situation. But for purposes of completeness, we've included it among the set of criteria.

CHAIRMAN FONTANA: On the spontaneous rupture, is that consistent with historical experience?

MR. MURPHY: Yes.

CHAIRMAN FONTANA: Because we've had, you know, between one and two thousand reactor years of experience.

MR. MURPHY: That's right. And --

CHAIRMAN FONTANA: Does that mean we've seen between five and ten of them?

MR. MURPHY: Domestic PWR's, we've seen seven tube ruptures. There have been nine worldwide. And I think on the order of 1,500 reactor years I think is what's --

MEMBER SHACK: What you're basically saying here is that you don't want to allow any new regulation scheme to allow the frequency of tube ruptures to go higher than it has been.

MR. MURPHY: That's right, that's right.

MEMBER APOSTOLAKIS: Now when you have these spontaneous ruptures, is it typically one cube that ruptures?

MR. MURPHY: Yes. Where pressure is constant, where a plant is in normal, steady state operation, it's not -- doesn't seem to us credible that we could have two tubes simultaneously have their pressure retaining capacity drop to 1,400 psi at the same moment in time. And once you have one tube rupture, I mean, the pressure drops.

And if you have another tube that's right on the hairy edge of failing, well the pressure has dropped, so, you know, it's probably going to be all right until you shut down the unit. So the real potential for more than two ruptures -- I mean, to the extent that it exists, would be where you increase the loading on the tube.

That's the credible -- only credible scenario for inducing tube ıuptures.

MEMBER APOSTOLAKIS: Now so we've gotten the condition of probability. I want to understand it better.

You describe in the guide three sources of uncertainty. Okay, you talk about NDE flaw size measurements, material properties, and the burst pressure failure model used.

MR. MURPHY: Yes.

MEMBER APOSTOLAKIS: If I have -- let's pick one postulated accident, okay; and I have, say, 100 of those.

MR. MURPHY: 100 what, tube ruptures?

MEMBER APOSTOLAKIS: No, 100 accidents.

MR. MURPHY: Okay.

CHAIRMAN SEALE: What is it that's random about the failure of the steam generator tube? I mean, I'm going to see a number of tube ruptures, right, in one plant. Now, am I going to see the same number in all 100 of them?

MR. MURPHY: No.

MEMBER APOSTOLAKIS: Or will there be some random variability?

MR. MURPHY: If we have 100 steam line breaks, --

MEMBER APOSTOLAKIS: Yeah, okay.

MR. MURPHY: -- I think our expectation should be that no more than five of those 100 steam line breaks should involve rupture of any tubes.

MEMBER APOSTOLAKIS: Right. Now, so there is

some element of randomness there, that's why you're saying no more than five. In other words, some fail and some don't.

MR. MURPHY: Failures may occur sometimes when we have steam line breaks.

MEMBER APOSTOLAKIS: Yeah, sometimes; and not --

MR. MURPHY: But it should be a roughly -- it should not be -- the design basis for steam line break includes no tube ruptures -- to assume the tubes will remain intact. So we think that anything more than one chance in 20 that you might fail a tube would kind of --

MEMBER APOSTOLAKIS: What is it that causes this randomness? I mean, why do some fail and some don't?

MR. MURPHY: The condition of the tubing varies widely from plant to plant. The inspection methods that have been employed through the years have encountered all kinds of difficulties in terms of their ability to see the flaws or to measure them as they see them. Sometimes the personnel doing the inspections are not adequately trained or qualified.

Sometimes corrosion rates or crack growth rates can be much higher than you anticipated, so the situation's changing more rapidly than you anticipated. There are many reasons why you -- why there's this

randomness.

MEMBER APOSTOLAKIS: But this is plant to plant randomness?

MR. MURPHY: Yes.

MEMBER APOSTOLAKIS: How about the same plant? Let's say if it's a third experiment, and for the given plant, I consider 100 of these steam line breaks. Is there still going to be randomness? Or if, in one five fail, and in all trials, five will fail.

MR. MURPHY: I think at a specific plant -- I mean, I guess maybe I don't fully understand the --

MR. STROSNIDER: Let me take a shot at this. This is Jack Strosnider of the staff. I think a good example is Generic Letter 95-05. If you look at the methodology that's in there, there's at least three random variables in the model: crack growth rate you sample from -- and this is a Monte Carlo analysis. Okay, so you've got crack growth rate, you've got NDE uncertainty, and you've got material properties which affect the burst strength.

So, if you start off with the beginning of cycle distribution of voltage indications; and for each one of those, you sample a growth rate, an NDE uncertainty, and a material property, you come up with some condition of that indication at the end of the cycle.

And when you do that for all the indications, you come up with one distribution at the end of the cycle.

MEMBER APOSTOLAKIS: Now when you say you sample, you sample one value and that applies not to all cubes?

MR. STROSNIDER: No. You do it indication by indication. You take an indication and you sample from the crack growth rate distribution of growth rate; you sample an NDE uncertainty size; and you sample material property. Assume that they're independent, okay.

MEMBER KRESS: Getting a probability that that indication will result in the rupture.

MR. STROSNIDER: Right, and that gives you -- if you do that for all the indications, okay, and you go through one Monte Carlo sampling routine, it's a voltage measurement in a tube. So at the end -- so you end up at the end of the cycle with a particular distribution which you subject to the pressure of a main steam line break and you see how many tubes fail.

Then you go back and you do that all over again. All right, you take another sample and you do that Monte Carlo process 100 times, each time sampling from the three random variables. And you have to demonstrate you meet this criteria. So the point is, in terms of analysis base at least, you don't know which indications are going

to grow the fastest, where the operator may have had the NDE uncertainty, etc.

So you treat all those random variables. You go through this process 100 times. And it should show that less than five --

CHAIRMAN SEALE: If you go back to even a more fundamental thing, if you do a steam generator tube inspection, and you look at the voltage indications you get, you get a distribution of voltage indications from tube to tube and from one foot of tubing to the next foot of tubing in the same tube. And so, there's even a distribution at that very fundamental and observable level.

And that distribution then propagates throughout the steam generator in a given plant.

MR. STROSNIDER: And these are real variabilities. If you take a number of NDE analysts out and you ask them to measure voltage on an indication, you'll get a distribution. Just like asking somebody to measure a height or a length or whatever. If you look at material properties, there's dozens or more heats of material that go into a generator.

So, there could be a lot of different material properties in terms of flow stress or whatever value you're looking at.

MEMBER APOSTOLAKIS: What do you mean by burst pressure failure model? What uncertainties do you have there?

MR. MURPHY: The -- for example, several tubes have been removed from the field containing cracks, producing a three volt signal. In other words, these cracks appear to be identical to your NDE. But you subject each of these, say ten tubes, to a burst test. The burst pressures that you measure for these apparently identical tubing -- but they're not.

But as far as the NDE knows, they're identical. But the range of burst pressures may vary, say, from 4,000 psi to 10,000 psi. So there's some sort of distribution. You know, so we have this -- in the case of ODSCC, we had this tremendous amount of scatter in the burst data.

CHAIRMAN SEALE: Typically how long is the segment you do the burst test on? The point being, you can do a burst test on different segments from the same tube and get a distribution.

MEMBER SHACK: But he needs it with a flaw in it.

CHAIRMAN SEALE: Yeah, right; but --

MR. STROSNIDER: This is Jack Strosnider again. Typically, the tube is removed from the generator

for testing. It will have at least one indication in it. And while the licensee is pulling the tube, which is an expensive process, if they can get more data, they'll pull one with more indications.

But then you test the section with the indication and each one separately.

MEMBER APOSTOLAKIS: So this model then would seem to predict what to give a distribution for the number of cubes that will rupture from the population of cubes, correct? That's what -- yes. So the frequency then of one or more tubes and so on should be a fixed number. Because the random variable is the numbers of tubes that failed.

But if I take that and divide it, I get a frequency.

MR. STROSNIDER: This is Jack Strosnider. I think the -- when you go through this calculation, you -- the simulation analysis I was talking about, you get a conditional probability of failure. All right, what really drives the frequency then is you multiply that probability times the frequency of the event.

MEMBER APOSTOLAKIS: I'm talking about the condition of the -- now the event has occurred. The initiating event, you mean?

MR. STROSNIDER: Right.

MEMBER APOSTOLAKIS: Yes, that has occurred.

MR. STROSNIDER: And these are probabilities in the second criteria.

MEMBER APOSTOLAKIS: Yes.

MR. STROSNIDER: Conditional probabilities.

MR. MURPHY: But these methodologies, these simulations of Jack's I'm talking about, they'll lead to a unique -- you know, a unique value of one or more -- one tube rupture, unique value of two tube ruptures.

MEMBER APOSTOLAKIS: But it says here that the condition of probability estimates should be an expected value, and I don't understand why it is expected. I mean, if it's one number, it's not expected, right? You just said that --

MR. MURPHY: I mean a 50% confidence level estimate of probability.

MEMBER APOSTOLAKIS: It doesn't say that here. It says the conditional probability estimates should be an expected (mean value). And I'm trying to understand it's a mean over what? Because it seems that the number of tubes is a variable, and then you just said that these numbers then, the conditional probabilities are single numbers.

But then how can they be average values?

MR. MURPHY: Well, you could calculate the

probability of failure if you want to have a conservative estimate of the probability of failure relative to the two probabilities. I mean, you can specific -- that that estimate be performed at different conference levels.

You want so much confidence that the -- you want to assign a confidence level to the probability estimate. In this case, for condition monitoring, we felt that the mean value estimate was appropriate.

MEMBER APOSTOLAKIS: Is that generic letter available when you say that's where the analysis is?

MR. STROSNIDER: Yes, Generic Letter 95-05 was published in '95. So, yes; we can get you a copy.

MEMBER APOSTOLAKIS: So that's where all this is described?

MR. STROSNIDER: For that one degradation. But it's a good example. You can look at that and get some good examples. In fact, we should get you a copy of this supporting package that was with it where we walked you through this methodology.

MEMBER SHACK: But basically what we're talking about here is just how Monte Carlo trials they have to run to establish this probability, right?

MEMBER APOSTOLAKIS: Yeah, that's all we --

MEMBER SHACK: If you want two trials, you know -- one thousand, five thousand.

MEMBER APOSTOLAKIS: So that's what this means by mean value?

MR. MURPHY: No, that wouldn't drive the number of simulations.

MR. STROSNIDER: This is Jack Strosnider. When you come up with the probability distribution at the end of this, you can estimate a mean or a certain level of confidence, or you can estimate, you know, some 90% tolerance interval with some confidence.

All right, and then the idea here is that you'll take the best estimate mean value, run through the calculations and see what comes out. As opposed to putting additional conservatism in your probablistic assessment.

MEMBER APOSTOLAKIS: No, but you come up with a probability distribution of the number of cubes that rupture as you described it. So, then I could have a probability that ne or more cubes rupture and that is a single number. Why is there uncertainty about that number?

MR. MURPHY: There's uncertainty about the number because you have a finite number of data points defining, for example, the burst correlation as a function of voltage.

MEMBER APOSTOLAKIS: So there is some model

uncertainty you're saying that's on top of the other uncertainty?

MR. STROSNIDER: This is Jack Strosnider. Let me try one more time. When you come through with the end of the Monte Carlo simulation, you have a number -- a probability of failures, you're right. And the point we're making here is that we're not trying to apply any confidence interval to that estimate of the mean.

MEMBER APOSTOLAKIS: But why --

MR. STROSNIDER: If you go through that calculation -- if I said calculate it with a 95% confidence interval, you'd have to take a higher probability depending upon how many simulations you run, which is what Dr. Shack was pointing out.

MEMBER APOSTOLAKIS: No, but I guess my question is, what is it that would cause a variability in the probability -- condition of probability of one or more tubes rupturing that would then lead me to take the mean value? And from what I heard, there is no such variability. The variability is in the number of tubes. But after I do the calculations, I will have a single number for the probability of one or more tubes rupturing.

Now, maybe I should read the generic letter to understand that.

CHAIRMAN SEALE: I suggest that you do. We're

going to have to break here in about five minutes, so let's --

MR. MURPHY: Okay, well let me -- there is one additional point I'd like to make about these probablistic criteria. These criteria are intended to address all mechanisms taking place in a given generator. This should -- the total probability of failure should not exceed these numbers. However, you may only have performed the calculation, the probablistic calculation, for one mechanism.

There may be ten mechanisms that are active in the generator, and you may have taken a deterministic approach to the other nine mechanisms. So, we can't allow consideration of one mechanism to eat up the entire criteria here because even though we haven't calculated probabilities for some of these other mechanisms, they also make a contribution to the probability of failure.

So we've specified then that no individual mechanism where you're comparing yourself to the probablistic criteria -- no individual mechanism should contribute more than 20% toward that -- the performance criteria.

MEMBER APOSTOLAKIS: Just a note to the members. This is similar to one of the -- actually, it's the same idea that is applied to -- at higher levels, core

damage frequency. Remember that no single scenario should --

MEMBER KRESS: Risk apportioning --

MEMBER APOSTOLAKIS: -- contribute more than 1/10th and that kind of thing.

MEMBER KRESS: This is not exactly the same.

MEMBER APOSTOLAKIS: It's close.

MEMBER KRESS: This puts the apportioning among the degradation level.

MEMBER APOSTOLAKIS: Yes, which are scenarios. Well, each mechanism is a scenario for --

CHAIRMAN SEALE: It's the same idea though.

MEMBER APOSTOLAKIS: It's the same idea. For the cube, it's a scenario failure. Right? Close.

MR. MURPHY: Okay, just to finish up here --

MEMBER SHACK: Just coming back to this -- I mean, that would make sense if I was actually doing analyses of the different mechanisms. But if I'm only analyzing one mechanism and I'm plugging on detection for every other mechanism, you know, why can't I use up more for this mechanism?

MR. MURPHY: Because even if you're plugging everything you can find for the other mechanisms, you'd be initiating new flaws and there's always potential they could be challenging the performance criteria. So just

because we're plugging on detection which is the usual mode we're in for cracking problems -- I mean, the threshold detection is very high. Sometimes it's 40-50% through the wall.

And these flaws may be 6, 70, 80% through the wall at the end of the next cycle. So they're making -- these other mechanisms are making a contribution to the probability of failure. We may not be calculating these contributions because we don't have sufficient information, but we have to allow for the fact that they are contributing.

And that's why where you are able to do the calculations, you shouldn't be exceeding more than 20% of those values -- performance values for that mechanism. The other two performance criteria I think have already been discussed I think in sufficient detail, the operational leakage criteria. I'm not going to add anything beyond what Jack has discussed.

Certainly I think there's been adequate discussion at this point of the accident induced leakage criteria. Unless there are any further questions, then I'll move on. Actually -- I don't know, maybe this might be a good place to stop. Your call.

CHAIRMAN SEALE: Okay. Well, I hope all of the members are making copious notes so we can resurrect

our uncertainties and problems here as we try to go back over this. On that optimistic note, I'll --

MEMBER APOSTOLAKIS: When do we reconvene?

CHAIRMAN SEALE: 1:30.

MEMBER APOSTOLAKIS: 1:30.

(Whereupon, the foregoing matter recessed for lunch at 12:00 p.m.)

A-F-T-E-R-N-O-O-N P-R-O-C-E-E-D-I-N-G-S

(1:35 p.m.)

CHAIRMAN SEALE: Mr. Murphy, I guess we'll give you the floor back and see what you can do with it here.

MR. MURPHY: Okay. We're back to business.

First, I'd like just to clarify a point that we were discussing near the end before lunch, in response to Mr. Apostolakis's question concerning the meaning of a mean value of conditional probability of failure. I didn't fully understand the question before lunch.

But basically, in the space of condition -- when doing a condition monitoring system, which I believe is what you were talking about, we were talking about doing that assessment at a 50 percent confidence, in the operational assessment when we calculate the probability at, as I recall, a 95 percent confidence level. And what this refers to is the fact that we're running a finite number of simulations, in general, to calculate the conditional probability of failure.

So if we calculate the conditional probability of failure on the basis of 1,000 simulations of a given distribution of indications, we'll get an answer, we'll get a probability number. If we do the calculation again with 1,000 simulations of the same distribution, we're

going to get a different answer, and those answers each time we do the simulation will fall within a distribution from which we can assess or assign a confidence level to the answer.

Okay. In-service inspection. Traditionally, the function or the objective of in-service inspection was to identify defective tubes. Defective tubes are tubes containing identified flaws exceeding the specified repair criteria, sometimes called the plugging limit. That objective continues to be an objective of in-service inspection under the new regulatory framework we are proposing.

However, we have added a new objective that we'd like to achieve with in-service inspection, which is to support the condition monitoring and operational assessments. It is desirable to be able to use the in-service inspection results to characterize the condition of the tubing relative to the performance criteria and for purposes of projecting where we're going to be at the end of the next cycle relative to the performance criteria.

So this is a new objective for the in-service inspection, and the capabilities of an inspection technique to support meeting each of these objectives is somewhat different, as I'll get to in a moment.

In-service inspection involves a number of

different topics. We need to talk about data acquisition analysis. We need to talk about frequency of inspection. We need to talk about sampling levels, how many tubes we're going to inspect.

With respect to data acquisition analysis, Jack described what the proposed rule requirement is, and basically what it calls for is the use of inspection techniques which are reliable such that there is reasonable assurance that tubes will be identified -- the defective tubes will be -- tubes will be identified before they exceed the performance criteria. And that particular objective is necessary to satisfy this objective.

What we are requiring in the regulatory guide is validated techniques in personnel, which is applicable to the specific plant. Those techniques in personnel should be used when available for each potential degradation mechanism. Validated techniques are techniques that are: 1) qualified per guidelines developed by EPRI; 2) that these techniques have undergone supplemental performance demonstration to determine the detection and sizing performance of the technique in personnel.

Current Appendix B of 10 CFR 50 requires that basically NDE techniques that you use on Class 1 components, like the tubing, be qualified in accordance

with applicable standards. With respect to the techniques, the applicable standards basically for qualification involve the calibration of the eddy current instrument on a reference tube standard containing holes and EDM notches, representing flaws.

And this has proved -- this has not proved to be an effective method for demonstrating that techniques are capable of finding the kinds of flaws which occur in the field.

Qualification requirements for personnel in the code have also not proven sufficient to ensure that personnel are performing exceptionally well in the field either. And the industry has long recognized the limitations in this regard, from a matter of qualification of the eddy current system, and has developed guidance for the qualification of eddy current techniques and eddy current personnel.

And these have clearly represented a substantial improvement over what has existed prior to this time. These EPRI guidelines for qualification have gained wide acceptance among the utility industry. All personnel engaged in eddy current work in this country in the field have been qualified per the EPRI guidelines. Techniques are available for most of the degradation mechanisms taking place in the field today that have been

qualified in accordance with these guidelines, at least for purposes of detection.

There are still many degradation mechanisms, particularly cracking mechanisms, for which there is no EPRI qualified technique for sizing, although EPRI does have a protocol for what would constitute qualification for sizing, for a particular degradation mechanism.

The staff has concluded that this qualification process, the EPRI qualification process, is sufficient to identify the defective tubes reliably as would be required by the rule. When the rule says, "Reliable such as to ensure that tubes are identified and removed from service before the performance criteria are exceeded," in that context the EPRI guidelines seem to, we conclude, accomplish that goal.

However, these guidelines do not provide an adequate basis to support what we have in mind for condition monitoring and operational assessments. And the issue primarily involves qualification for sizing, flaw sizing.

The fundamental difficulties with the EPRI qualification process are: 1) the implementation of the EPRI protocol has evolved such that people are using EDM notches basically to represent real cracks. Qualification on EDM notches has been the basis for concluding that a

number of techniques are qualified for a specific application.

We believe that to really -- to be in a position to estimate the protection in sizing performance to be expected in the field from an NDE technique or eddy current, we must be working with tube specimens which contain flaws that are realistic representations of what are in the field, in such ways as, for example, the signal amplitude coming from the flaw, signal to noise ratio. If these kinds of parameters are not well represented on your qualification set, you're not going to get a realistic estimate of what your performance is likely to be in the field.

Another fundamental difficulty that we have with the EPRI guidelines has to do with the basis for the qualification of personnel. The personnel are basically qualified to standards which are subjective rather than objective. That is, the personnel performance is -- whether a flaw exists or doesn't exist, what's the size of the flaw -- the personnel performance in this area is evaluated against expert opinion and not ground truth.

So, again, we see this as a second fundamental limitation of the EPRI approach.

So for purposes of supporting, then, this second objective, we would expect that eddy current

techniques should undergo supplemental performance demonstration which would basically, in a nutshell, address the fundamental limitations of the EPRI protocol. That is, it would be performed on a statistically valid set of realistic flaws, and personnel performance, in addition, would be evaluated against ground truth.

CHAIRMAN SEALE: Mr. Murphy, through no fault of your own, because we have certainly been adding considerable to the effort, you've got about 40 slides to go and about another hour, and there are a bunch of industry people here who have made the trip and who deserve the opportunity to talk, and perhaps may even have some flights out later at the end of the day. So at some point, I'm going to have to cut you off and let them talk.

But I would suggest that you allow us to read the slides, where that's appropriate, and give us comments as are necessary to elaborate.

MR. MURPHY: I understand. And let me just say that this matter of data acquisition analysis, the qualification process, is a point of major interest to the --

CHAIRMAN SEALE: I understand that. I appreciate your concern.

MR. MURPHY: But I will attempt to expedite this here.

CHAIRMAN SEALE: Very good.

MR. MURPHY: The regulatory guide specifies, however, that where validated techniques are not available, such as for sizing, one may use non-validated techniques, provided the technique has been demonstrated by assessment to be the best available, and 2) that the techniques and personnel are qualified for detection per the EPRI guidelines. You know, that ensures that the techniques in personnel are capable of being the initial objective, the traditional objective of in-service inspection.

And finally, another important point is that where validated techniques are not available -- in other words, you don't know the performance -- expected performance of the test -- you need to plug on detection, which is, again -- which is consistent with current practices.

MEMBER POWERS: When you say "best available," in what sense? Easiest to use?

MR. MURPHY: No. Detection.

MEMBER POWERS: Detectability.

MR. MURPHY: Best available detection performance, yes.

MEMBER POWERS: Detectability, then, is what "best" is.

MR. MURPHY: In that context, yes.

I think I have already talked about frequency of inspection. Basically, the frequency of inspection is as necessary such that you can demonstrate by operational assessment that you'll meet the performance goals.

Initial inspection sample. The only initial inspection sample that is fully consistent 100 percent with the performance goals that we've talked about is 100 percent initial sample. We don't think that's necessary. The main objective of an initial sample is to identify the active degradation mechanisms.

Once one has identified the active degradation mechanisms, one performs an expanded sample to address the portions of the generator affected by those active degradation mechanisms, and that expanded sample should be done consistent with meeting the performance criteria. But for purposes of doing the initial inspection sample to identify the active degradation mechanisms, we believe the EPRI recommendations in this area should be followed. EPRI has recommended a 20 percent sample, initial sample of tubing, and we concur with that recommendation.

MEMBER SHACK: What's the current tech. spec.?

MR. MURPHY: Three percent.

MEMBER SHACK: Three percent.

MR. MURPHY: Which does not really --

experience has shown it does not really provide you a very timely indication of the onset of an active degradation mechanism.

I've covered this slide. Let me just go on.

All right. I think Jack and some of my earlier discussion pretty much has explained what we expect to get out of condition monitoring -- the backward look -- and I don't want to repeat a lot of that discussion.

I do want to make one point, however. In the case where we don't have validated techniques for sizing flaws such as cracks, the question arises as to how we're going to assess the condition of the tubing relative to the performance criteria. There are alternative means available for evaluating the condition of the tubing -- alternatives to eddy current testing.

One of these alternatives is coming into increasing use within the industry for this purpose -- condition monitoring. That's the in situ pressure test, where basically you're pressurizing individual tubes in place, and demonstrating that they can hold, for example, three times normal operating pressure.

These tubes -- the current practice is after you do this test the tube is removed from service. You wouldn't be leaving this tube in service.

And that's all I'm going to say at this point about condition monitoring.

MEMBER SHACK: And the question always come up about this point as to how you get out of the catch 22 here. That, you know, you plug on detection everything that you don't understand. But how are you ever going to be able to forward project something that -- you know, if you're plugging every flaw on detection, how are you ever going to be able to get confidence that you can, in fact, do a forward look?

MR. MURPHY: Well, I think, you know, when you have a real absence of information you have to take a somewhat conservative outlook on things. But you can't -- you can gain various insights. For example, where you do the in situ pressure test and the -- all of the tubes were able to take 5- or 6,000 psi, no matter what the eddy current said, or where you've taken steps to ensure that the corrosion rates shouldn't be expected to be any worse the next time around, and you've operated successfully for the last 12 months and still the in situ pressure test indicated you had all of this capability, you should be able -- you might be able to build a story that says, "I'm good for another 12 months, barring anything totally unexpected."

But this often will mean a very conservative

approach. It often means -- I mean, if a tube fails during in situ pressure test at 4- or 5,000 psi, you're going to have to make some conservative assessments as to how much of that pressure capacity reduction took place during the last cycle, what is expected, you know, based on that, what is a conservative projection of how quickly these tubes are degrading, and set your operating interval length accordingly. But basically, one will be compensating for lack of information with bounding assumptions.

MEMBER SHACK: Well, when am I going to get to leave a flaw in service?

MR. MURPHY: You'll be able to -- you'll be in the position to leave a flaw in service when you have a technique -- an eddy current technique available where you have quantified its performance, its sizing performance. You know that it gives you depth and/or length within -- you know, within plus or minus 25 percent with, you know, a probability value of, you know, 95. And you can then take into account that uncertainty when you're doing the condition monitoring or the operational assessment relative to the performance criteria and showing that you meet these performance criteria with a likelihood of X -- confidence level of X.

MEMBER SHACK: But how am I going to get a

growth rate for this thing, a progression rate?

MR. MURPHY: You may not be able to directly get a progression rate. But, you know, there are various things you can do. I mean, for example, if a tube fails during the in situ pressure test at 6,000 psi, one can infer from that, say, that maybe he has got -- if it came from a one-inch long flaw that the depth must have been, you know, 90 percent, and that since the flaw wasn't seen last time it must have been 40 or 50 percent deep last year and infer something about the corrosion rate that way. There are many different ways, you know, that one might approach this. That's just one way.

This has already been discussed, but I think it is particularly noteworthy. If condition monitoring fails to show that the performance criteria are met, we expect prompt notification of the NRC. We expect corrective actions to be implemented prior to restart. And, of course, at that point there would be -- we would expect that there would be interaction between NRC and the licensee as to what the cause of this occurrence was, whether there are programmatic deficiencies on the part of the utility, and provide a basis for enforcement action, if necessary.

Operational assessment we have also discussed sufficiently at this point. However, I do want to

highlight an important objective of the operational assessment. That is, the operational assessment will yield -- is intended to yield an acceptable length of time over which you can operate prior to your next inspection. That should come out of the operational assessment.

Also, where people are implementing alternatives to the 40 percent plugging criteria, this assessment will identify the appropriate value of that plugging criteria. As a matter of fact, there may be situations where the 40 percent plugging criteria itself may be inadequate, and the operational assessment should ensure that that 40 percent plugging criteria that you're implementing is sufficient to carry you through to the next scheduled inspection.

I'm going to suggest that perhaps this next slide here be my final slide for this presentation. I think I will have covered all of the main points at that point.

Two prepare criteria -- we would continue in the reg. guide to identify the traditional 40 percent depth-based criterion. That is, where one is not -- for a degradation mechanism, where one has not developed an alternative plugging criteria, he could use 40 percent but he would have to demonstrate by operational assessment that he is meeting the performance criterias I just

mentioned.

Alternative repair criteria to the 40 percent may be implemented as part of an integrated strategy that has been historically called SGDSM and which has been the subject of earlier meetings with this subcommittee -- steam generator defect specific management. But basically, we're talking about a strategy involving in-service inspection, methodology for operational assessment, and setting the value of the repair criteria, such as to ensure that the performance criteria will be met for that plugging criteria, for that specific degradation mechanism.

So plugging criteria for these alternate repair criteria may not be a fixed value, may not simply be three volts or what have you. They are basically a methodology that are a function, among other things, for example, the crack growth rates. And depending upon the crack growth rates that you're observing during a particular inspection, you would adjust -- you could adjust, then, the specific value of the repair criteria that you're implementing to reflect that growth rate without interacting with the NRC in the process.

Okay. That's all. I think I can stop this here.

CHAIRMAN SEALE: All right. Any questions for

Mr. Murphy?

Thank you very much.

Who's next?

We know it's not your fault, but any help you can give us.

MR. DONOGHUE: Timewise.

CHAIRMAN SEALE: Yes, sir.

MEMBER SHACK: Any other help, too.

(Laughter.)

CHAIRMAN SEALE: Any other help, too.

MR. DONOGHUE: I'll see about that. I don't know.

That's who I am. That's what we're going to talk about.

CHAIRMAN SEALE: Okay, Joe.

MR. DONOGHUE: That's pretty quick. I'm Joe Donoghue from Reactor Systems, and I have just a couple of pages on some parts of the reg. guide, the first being leakage monitoring.

What we want to do here is augment somewhat what is already in the tech. specs. for primary-to-secondary leakage monitoring and the limits. And I'll skip some of the motherhood statements about what the objectives are, but we do spell them out in the reg. guide.

What we try to do without giving them any -- industry any requirements in the way of what kind of monitoring they should use, just recommend some things, especially N-16s. We've seen those have had a lot of benefit to operators during leakage events. And one thing that we mentioned that's not in the EPRI guidance, which I'll talk about briefly, is low power monitoring.

There's a lot of reservations about using N-16s because they don't give you accurate or any indication when you're at low power or, of course, in shutdown. And what we want to do is make sure that after an outage where people have done something to the tube bundle that there is monitoring in place being used when you're coming up from a -- coming up to power. And it's not -- again, these aren't requirements. This is the recommendation in the reg. guide that people should pay attention to this kind of thing.

Now, the other parts of the reg. guide get into the limits that are going to be in the tech. specs. Some of this comes from the EPRI guidance, the document that was published last year. It looks like that. And we liked a lot of the guidance in here because it was based on operational data. Actually, we went back and looked at leakage events and were able to understand things that were going on with leak rate and the change in leak rate.

And you will actually see in the tech. specs. that we're recommending 150 gallons per day leak rate, which is being used now under the Generic Letter 95-05, or IPC, and a relatively new approach, which again this is being used -- I'm not sure if it's 60 gallons per day per hour, the rate of change of the leak rate is actually being implemented, but some form of that is being used so that it alerts the operator that something is going on.

There's a fast-developing situation. And when it's that high a change, rate of change, it looks like there's going to be a tube leak. So these things, again, are actually in the tech. specs. They're based on recommendations that the industry is making, but that's nice to be in agreement on something. And the other parts of the guidance are, again, recommended in the reg. guides.

CHAIRMAN SEALE: I compliment you on the versatility of your units.

CHAIRMAN FONTANA: Gallons per day per hour.

CHAIRMAN SEALE: Well, go ahead. I -- don't --

(Laughter.)

MR. DONOGHUE: I didn't know how to do it without --

(Laughter.)

-- half the slides.

MEMBER SHACK: I did have one question.

MR. DONOGHUE: Yes.

MEMBER SHACK: Page 41 here. It says that 150 gallons a day is not acceptable. It should be some appropriate value less than 150 gallons per day. Then it tells you to go back to c.22.2, and it tells me the operational leak limit should be the one discussed in c.8.2. Somehow it seemed to be in a circle.

MR. DONOGHUE: From a risk point of view, there has been discussion in the staff on whether or not the units should be shut down before or at 150 gallons per day. I guess we haven't resolved that since it's still in the reg. guide in a confusing manner.

Let me say my piece on it. The guidelines recommend shutting down at 150 gallons per day. From a risk point of view, I don't see a big difference in the risk that the plant is giving us if it's shut down at 150 gallons per day or something just below that. In practice, plants have shut down before they reach their tech. specs. One would expect that to happen, even at a lower tech. spec. But I think the staff is splitting hairs when it is trying to argue one way or the other on this. We have to just resolve it.

CHAIRMAN FONTANA: Well, how big a crack are

we talking about at 150 gallons per day, roughly?

MR. DONOGHUE: This was based on some analysis I think that Westinghouse had done back when the IPC Generic Letter was being put together.

And correct me if I'm wrong, Emmett, the 150 gallons per day was based on a critical crack leaking at main steam line break? A main steam line break critical crack would be leaking at a normal operating pressure.

MR. MURPHY: Its expected leakage, accounting for some uncertainties from a crack whose length is the critical crack length on your main steam line break conditions.

MR. DONOGHUE: Thank you. He said it much more clearly than I did.

Any other questions about that?

MEMBER SHACK: 150 gallons per day?

MR. MURPHY: Yes.

MEMBER SHACK: Oh, at the operating pressure --

MR. DONOGHUE: Operating pressure.

And, you know, contrasted with what's in the tech. specs., it's more than half what's in there now for a steam generator, half below.

MR. MURPHY: Joe, this is Emmett Murphy. I'd like to clarify one point. You've been talking about a

tech. spec. limit, which would have a certain value, say 150 gallons per day. We have a proposed performance criteria which in the reg. guide we are recommending the performance criteria be set at the tech. spec. value.

This means that, you know, exceeding the performance criteria on operational leakage would not be a tech. spec. violation. The tech. spec. says that when you exceed the limit you shut down within a prescribed period of time. But we feel that when the leakage limit is exceeded, while not a tech. spec. violation, it should at least be a flag for going back and seeing how the situation developed, whether there may be a problem with how the leakage is being monitored, or whether there is an inspection problem, or whether the crack growth rates are much higher than projected.

So the performance criteria is intended to accomplish a little different thing than the tech. spec. limit even though they have the same value.

CHAIRMAN SEALE: Proceed.

MR. DONOGHUE: Any further questions?

Okay. Now, just change gears, the other part of the reg. guide I was going to discuss was the guidance we've put in there to assess severe accident risk. And what we've done is based on the rules you saw earlier in the rule that require some assessment of the severe

accident risk, we started by mentioning that it should be addressed consistent with the Commission's safety goal policy. And specifically, what we talk about are the subsidiary safety objectives, the value for a containment bypass.

The first step that we're recommending is that the licensee use guidance that we want to be consistent with the PRA implementation guidelines, and those are still being formed, so that's not in stone yet, by any means. But when it is, we want to make sure we're consistent with those guidelines.

We do a PRA to show that the initiating frequency for the type of events that are going to challenge the tubes thermally will be no more than 10^{-6} per reactor year.

MEMBER POWERS: But that's a number you will change once those guidelines are finished for the PRA?

MR. DONOGHUE: Well, I'm not sure -- well, this is based on trying to be -- that number is based on trying to be consistent with the Commission's safety objectives. And the PRA implementation guidelines reference is to ensure that the methods and the pedigree of the PRA are going to be done on a consistent basis that we can accept.

Now, I understand there's a discussion going

on in the staff about what is acceptable for a large early release frequency. That might be different than this.

MEMBER POWERS: What I'm trying to understand is where the 10^{-6} came from.

MR. DONOGHUE: From the surrogate -- from the subsidiary safety objectives.

MEMBER POWERS: That's the large release objective?

MR. DONOGHUE: Yes. 10^{-6} per reactor year.

MEMBER POWERS: But it seems to me they've kind of abandoned that large release objective, that they've gone to a probability of containment failure. It's a large early release, but it's definitely not 10^{-6}. And it seems not to have that large early release component of the past. It's just different --

MR. DONOGHUE: Do you mean when we discussed this in the past, the containment bypass frequency number that we --

MEMBER POWERS: When we discussed it recently, the LERF probability is different from the 10^{-6}.

MR. DONOGHUE: Well, I understand there is discussions going on about that. But as I say, the staff I don't think has concluded that there was consideration. So right now we have left that -- so I guess the answer to your original question is: yes, this could change, but to

be consistent with whatever the PRA implementation guidelines are.

But I see that less of a -- I see less of a chance of that changing than whatever the -- if somebody sat down and read the draft guidelines right now, as far as the methods of -- methods to use to do the PRA, that might change to some extent.

Now, if a plant or a licensee cannot pass that hurdle for the initiation frequency, the next step is to go into a calculation which tomorrow I'll try to outline the steps that we've taken to try to do this kind of calculation, but to determine the tube failure probability.

And when we say "low" there, that has got to be connected with understanding of the initiating frequency. If a plant is -- say they can't get a PRA to conclude that they are below 10^{-6}, but they are below 10^{-5}, well, a tube failure probability on the order of 10 percent would be keeping us consistent with the safety objectives.

Now, there is a lot that goes into this, as I'm sure you heard us discuss at some length before, and we're going to hear some more tomorrow. This is going to be a tough order to fill right now, but we want to leave the option.

If a plant is unable to show their low risk system with the safety objectives, this is where we're talking about plant and procedural modifications may be necessary to change one or the other, or both, of these values to get what we can an acceptable risk. And there's a number of different things that we can discuss, but I don't want to take up the time right now.

But what we have written in the reg. guide right now is that once the modification is made, these or one of these have to be -- one of these assessments has to be performed again to demonstrate the low risk.

Any questions on that? That's all the discussion I was going to have today.

CHAIRMAN SEALE: Thank you very much.

MR. HAYES: My name is Jack Hayes, and I am in the Radiation Protection Branch and I will be discussing the radiological dose aspects of the implementation of the steam generator rule and the reg. guide.

Prior to us getting into this discussion of the steam generator rule, and the implementation of the dose calculational aspects of the reg. guide, I think it's important to provide to you some understanding of the dose calculations which are performed presently and under the proposed rule. I think it's important so that you recognize what took place prior to the implementation of

Generic Letter 95-05, the state we're in right now with the Generic Letter 95-09, and then what the rule is going to bring forth.

In that vein, I think it's also important that you understand the design basis accidents and how those are reflected in the present technical specifications. So with that introduction, I'm going to briefly go through the technical specification aspects as they existed prior to the implementation of Generic Letter 95-05 and as they exist now.

The technical specifications for design basis accidents of steam generator involved activities are reflected, in essence, in three particular technical specifications -- one involving a 48-hour dose equivalent iodine-131 tech. spec., another being the maximum instantaneous value, and finally, in the normal operating primary-to-secondary leakage.

In using the Westinghouse technical specifications as an example, these are the improved standard technical specification and they require that the specific activity of reactor coolant be within the limits. And those limits are as follows: first, there is a value which I refer to as the 48-hour value, and this is the one microcurie per gram. And licensees are allowed to exceed that value for up to 48 hours, provided they are in an

acceptable range of this Figure 3.4.16-1, and this is that figure.

What this figure shows is this is the acceptable region, and this is what we refer to as the maximum instantaneous value that one can be allowed to operate under. And this value is typically 60 microcuries per gram at a power level of 80 percent or greater.

This particular value of 60 is used in our dose assessments for an accident referred to as the accident involving a pre-existing spike. The value of the one microcurie per gram is utilized in an accident referred to as the accident-initiated or accident-induced spike.

With respect to these evaluations that we do for a design basis case, for the pre-existing spike we usually take the maximum instantaneous value of dose equivalent iodine-131, which is typically the value of 60 microcuries per gram. We had then assumed the normal operating primary-to-secondary leakage, and this value will fluctuate between plant to plant. But typically, it is either a one gallon per minute total or 150 gallons per day per steam generator. That is usually the typical values. There are some variances.

We then calculate the doses for two accidents -- a main steam line break and a steam generator tube

rupture. The acceptance criteria for this particular accident is the full Part 100 value of 300 rem thyroid, 25 rem whole body. There is also a requirement that the control room habitability doses be met, and the control room habitability doses are associated with General Design Criteria 19 of Appendix A.

In terms of the accident-initiated spike, again that is a 48-hour value of dose equivalent iodine-131. Again, the typical value is one microcurie per gram.

We assume the tech. spec. value for normal operating primary-to-secondary leak rate and calculate the doses. And here the acceptance criteria, as it presently is, is a small fraction, or a small fraction is defined as 10 percent of Part 100. So it's 30 rem thyroid and 2.5 rem whole body.

Again, for the accident-initiated, you must also meet GDC-19 doses for the control room operators. So if you will, this was all prior to the implementation of Generic Letter 95-05.

Now, with the implementation of Generic Letter 95-05, it presented a new situation for the staff, because it allowed tubes to remain in service which previously had been plugged or sleeved. Consequently, we had to introduce a new term into our accident evaluation. And this is for the main steam line break, and we had to

introduce a term which we referred to as the event-induced leakage, and that particular term results because of the large differential pressure associated with the main steam line break.

But it's postulated that if you would have a main steam line break, those tubes which you would have left in service, and not plugged or sleeved, would have a tendency to open up further, and in terms of the large differential pressure. So, consequently, you would have some additional leakage above the normal operating leakage.

Utilization of the interim plugging criteria requires that you project the degradation or rates that you anticipate in each steam generator for each operating cycle. Once you have that information, then you're required to do a new main steam line break assessment to ensure that over the next operating cycle you don't have the potential for exceeding either Part 100 or GDC-19.

It is not unusual for such an evaluation to require licensees to come in with an amendment request to lower the values for the dose equivalent iodine-131, be it either the 48-hour value or the maximum instantaneous value.

I now want to talk about the dose aspects of the steam generator rule. Our intent was rather simple.

It was intended to maintain the status quo for those licensees who decided to maintain their status quo, and yet to provide an option for those licensees who are seeking a potentially alternative approach.

The question you're probably asking, "Well, why would anyone want to remain with the status quo?" Well, we do have quite a few plants which have replaced their steam generators. And so, consequently, right now they may not be having any problems associated with their generators.

In addition, you may even have some plants which, although they're applying the interim plugging criteria and are going through this cycle per cycle assessment, they may choose to do so rather than take an alternative approach. So we left that particular opportunity open to our licensees.

It's important to understand that for those plants who wish to maintain the status quo, that nothing is going to change for them. In other words, they are still going to have the opportunity for the full Part 100 doses for the pre-existing spike case. For the accident-initiated spike case, they will still be limited to a small fraction, and for GDC-19 will be applicable in all cases.

Now, for plants which have the steam generator

tube degradation mechanisms, they will still be required to perform reassessments every refueling outage, and, you know, depending upon those assessments, they may or may not be required to amend their existing technical specifications.

The alternative program that we're offering we believe is a program which will efficiently handle reviews such as those associated with the interim plugging criteria. It should be pointed out, though, that the criteria, while in essence it remains the same, it is going to become accident specific. And we're going to -- if you choose the flex program, you're going to be choosing tech. specs. which will account for your event-induced leakage.

I'd like to discuss now what we perceive to be some of the benefits associated with the flex program. We believe that with the flex program you have quite a bit of flexibility of operation, and we think that that will be a benefit to the industry. It is a part of the technical specifications. I think it benefits both the NRC and industry by being part of the technical specifications, because it should be clearer in terms of what your requirements are. From an enforceability aspect, I know that it should be much clearer.

Earlier today you heard Jack Strosnider talk

about this box which we wish to draw around some of the licensees' modes of performing some of their assessments. Because this involves a technical specification, it will require initial NRC review.

As I go through and show you what this involves, you will see that it involves an assessment of their dose calculations, and the manner in which they arrive at particular values for reactor coolant activity levels. With that, the NRC will be able to review that, and there will be less question in terms of the dose calculational methodologies utilized by the licensee.

One thing that we think is a benefit -- its independent or degradation mechanism. We don't care what the mechanism is from a dose calculational standpoint. We're only interested in the net leakage. It will reduce the number of amendment requests, and we think that's a positive use of resources, both on the part of industry and on the part of the staff.

It will eliminate the need for a dose assessment each cycle. You know, you don't need to find out where you exist on this particular path because the tech. specs. will already show that for you.

And finally, the focus becomes a determination of the tube degradation mechanisms and flaw indications. We don't get into an argument about how the calculations

are performed.

I'd like to run through an example of how this methodology will be applied. First, we'll take the case of the pre-existing spoke, which again is the instantaneous maximum tech. spec. value for dose equivalent iodine-131. First of all, you assume a reactor coolant activity level. Typically, you would start out with a value of 60 and proceed down to a value just slightly greater than one microcurie per gram.

You assume a primary-to-secondary leak rate, and you calculate the doses, and the doses are calculated using the methodology of the existing standard review plan.

Okay. Now, the allowable leakage is determined based upon the assumed leakage multiplied by the ratio of the allowable dose to the calculated dose. In other words, the way this is applied, you go right up to the limit. For GDC-19, it's 30 rem thyroid, and for Part 100 it's 300 rem thyroid. Okay?

So that establishes the allowable leakage for a particular accident for a particular reactor coolant activity level. Okay?

And then you assume a new value for reactor coolant activity level. You step down from a value of 60. Say, you might go to 20. Okay. You perform the

calculation again, and you continue these iterations until a value of one microcurie per gram is reached, or until the allowable leakage is greater than the charging pump capacity.

Okay. The allowable reactor coolant activity level will be based upon the projected leak rate in the event of a main steam line break during the next operating cycle. And let me give you an example that shows this.

This is for an actual plant which came in for an interim plugging criteria. We assumed a value of 3.7 gallons per minute leak rate. This is event-induced leak rate. And the values which were assumed were 12, 6, and 1.2, and we calculated the doses at the exclusion area boundary, the low population zone, and the control room. Okay? The limit is 300 for the EAB, LPZ, and 30 for the control room.

Now, to exhibit how this would be done, let's take this location where we have the value of 12. Okay? Okay. The factor to reach 300 rem at the exclusion area boundary -- and you choose the exclusion area boundary, obviously, because it's larger than the LPZ. It's equal to 9.6 rems. Okay. That's the location. Okay. The factor you want is 300, divided by 9.6, or a factor of 31.25. Therefore, your allowable leakage is 3.7 times 31.25 or roughly around 116 gallons per minute.

Now, at that same location, the control room dose was .83 rem. The allowable limit is 30. Dividing it by .83, the factor is 36, so the allowable leakage for the control room evaluation would be 118. Based upon the comparison of these two locations, the limiting is the exclusion area boundary. So when you plot your reactor coolant activity level, and you plot your leakage, your allowable leakage would be 116 for this particular location.

Now, a similar type of calculation is performed for the accident-initiated spike. Again, that's a 48-hour tech. spec. value for dose equivalent iodine-131. But here we start out with one microcurie per gram, and we end up with a lower limit of .1. Same thing -- primary-to-secondary leak rate assumed, doses are calculated based upon the standard review plan guidance, and we determined the allowable leakage in a similar manner.

A new value for the reactor coolant activity level is assumed, and we continue these iterations until we reach either .1 microcurie per gram or the allowable leakage is greater than the charging pump capacity.

Again, from that same plant, here is a utilization of the methodology. Again, taking the initial case, which was the one microcurie per gram, the limiting

dose between the EAB and LPZ is the EAB of 27.1. Control room dose is 6.7.

The factor associated with the exclusionary boundary dose is 11.1. Multiplying that by the allowable leakage comes up with an allowable leakage of 41.1 gallon per minute. Taking the control room dose, the limit being 30 rem, dividing the 30 by the 6.7, the factor is 4.48. So, therefore, the allowable leakage is roughly about 14 gallons. I guess we ran off on the slide, but it's around 14 gallons. Okay?

So in this particular reactor coolant activity level, the limiting leakage would be that associated with the control room.

Now, this particular plot is just a plot of -- let's see, I'm one too far. If we just look strictly at allowable leakage for Part 100, and looked at what we would be permitted, from purely a dose standpoint, okay, this portion of the plot here corresponds to the maximum instantaneous value. This corresponds to the 48-hour value. So this corresponds to the calculations performed with the pre-existing spike. This is with the 48-hour value or accident-initiated spike.

Do you see this dashed line across here? That's charging pump capacity. That illustrates to you the location at which the allowable dose, okay, is met,

and you can leak anything above that and you would still meet the dose criteria, but you would have a different problem because, in essence, you would have a loss of coolant accident because you wouldn't have sufficient makeup.

Okay. Taking the exhibit here, at the 12 you can see that you're roughly approximately -- this is -- the charging pump capacity corresponds to about 150 gallons per minute here. That corresponds to a value of around 116, I think we discussed. At the values here, we're talking about event-induced leakage ranging from a value of approximately 17 or 18 over to above charging pump capacity. I think that the value we're charging pump capacity is reached is .12 here, and over at this location is around 9.

Now, let me show you how this is applied to technical specifications. Okay. Let's say you go into an outage and you determine that based upon the degradation in your worst steam generator you would project that the event-induced leakage would be 20 gallons per minute. Okay?

Based upon the projection of 20 gallons per minute, the maximum 48-hour value that you would be able to have would correspond to this location right here, which is approximately -- I think it's about .085 -- or,

excuse, .85 microcuries per gram. So that would be -- it would be in this particular area, which would be the operating range.

Okay. For the maximum instantaneous value, the value would then be -- at 20 would be approximately 60. Okay? Okay. So you would still be -- and that's the existing maximum allowable value in the present tech. spec.

Now, as you saw in the previous figure, when we reach nine microcuries per gram, we reach charging pump capacity here. And the same thing as at the 48-hour value -- when you reach approximately .12, and if you extended this out, you would be at maximum charging pump capacity at those particular locations. Now, this is just one example for plant A.

This is plant B. You can see that, if you will, the plant A was a little bit further down here, and it has been pushed up even more because here roughly at 18 you're at charging pump capacity, and at this particular location it's like roughly approximately .25.

So your technical specifications would look like this. They would start out -- there's a 60, proceed up to the value of charging pump capacity at roughly 10, and proceed over to 1. For the 48-hour value, you would start at 1 and go up to approximately .25 before they hit

charging pump capacity.

Now, these plots are very plant specific, because I'm going to show you this last plant, where if you see that on all conditions, no matter what the reactor coolant activity level in terms of the normal technical specifications, the allowable leakage would be above charging pump capacity.

So, in essence, the technical specification could be either a straight line like this, going all the way across, or you could just have a sentence in the technical specifications indicating that the charging pump -- that event-induced leakage is limited to 150 gallons per minute.

It's important to emphasize to you that in development of these revised dose guidelines, that the criteria we have established is now dependent upon the accident. Okay. Previously, if you looked at the standard review plan and looked at the main steam line break and steam generator tube rupture, the criteria was based upon whether you had an accident-initiated spike or a pre-existing spike.

The criteria as it exists in the standard review plan, anything with a pre-existing spike is 300, and anything with an accident-initiated spike is 30.

Now, with the implementation of Generic Letter

95-05, for interim plugging criteria applications, for the main steam line break for both cases, whether it be a pre-existing spike or an accident-initiated spike, the limit that has been applied has been 30. And that -- we're not exactly sure how that limit was generated, because all of the licensees seem to apply that as being a limited -- there is nothing in text that we can determine as exactly why, but that's what has been applied.

What we are proposing for the implementation of the rule is that the full Part 100 limits for the main steam line break -- and the basis being that we consider it to be a remote accident, you know, compared to steam generator tube rupture.

I think Emmett Murphy told you that there has been seven steam generator tube rupture events in the U.S., two foreign. So you can see that this is a much more probable event.

We are proposing a reduction in the limit for the pre-existing spike case, and that would be the value of 30.

CHAIRMAN FONTANA: Are you saying a main steam line break is a more probable event than a spontaneous steam generator rupture?

MR. HAYES: No. No.

CHAIRMAN FONTANA: That's not what you said.

It sounded like it.

MR. HAYES: If I said that, then I --

CHAIRMAN FONTANA: No, no. You didn't say that, but --

MR. HAYES: I said that the main steam line break is a more remote event, as compared to steam generator tube rupture. We think it's a very low probable event.

CHAIRMAN FONTANA: Okay. Of course, yes.

MEMBER POWERS: Jack, you've gone through this thing for a thyroid dose from iodine. Is there a reason you're not using total dose effective?

MR. HAYES: We considered whether to utilize total dose effective, and we didn't think that it was -- that the steam generator rule was the point to bring TEDE into our evaluations. I think that should be tied to changes to GDC-16 and Part 100.

So knowing the difficulty in making some of the changes associated with Part 20, we thought we didn't want to put any more value --

MEMBER POWERS: And it probably wouldn't make that much difference anyway.

CHAIRMAN SEALE: Okay. Very good.

Any other questions?

Are you through?

MR. STROSNIDER: I believe that completes the presentations that were planned by the staff.

CHAIRMAN SEALE: Very good. Thank you very much. I stand corrected, or maybe vindicated, one or the other.

Let's see, next we go to the industry. Who will be starting off?

MR. PEARSON: I'm Richard Pearson from Northern States Power, a steam generator engineer at the Perry Island Nuclear Plant and I'm representing today the EPRI rule issue resolution group and the NEI steam generator working group and task force of which I'm a member.

My goal here is to go a little bit on the industry perspective, talk about our industry document and introduce some other speakers that will follow after me and there is a handout being passed around.

The topics we want to discuss today were an overview on the industry document, discussion on deterministic structural performance criteria/safety factors which will be given by Tom Pitterle of Westinghouse, an area that we've identified as a difference between us and the NRC; a discussion on another way to look at the probabilistic performance criteria dealing with this minimum of 20 percent for one mechanism.

David Steininger from EPRI will present that. And then John Smith from Rochester Gas & Electric will give a presentation on the PWR steam generator examination guidelines.

A few more comments, I guess, on the industry perspective of the rule. We are in general agreement with the concept of performance-based steam generator degradation specific management to insure that the two will fulfill their intended safety function.

We, in general, agree with the performance criteria and I'll talk about a couple of differences we have as I go along and we agree with the need for steam generator programs and steam generator integrity assessments. I guess you might say we disagree right now with the amount of detail in the draft regulatory guide and so there's perhaps some disappointing things there from the perspective of the industry.

MEMBER APOSTOLAKIS: So you agree with all the performance criteria they have?

MR. PEARSON: With some exceptions and I'll talk about that here in a little bit more detail, but basically, the concepts that we agree with.

Some of the issues we do have that perhaps will have a major impact on us. The assessment of potential lifetime degradation mechanisms and the

resultant inspection requirements, right now it looks somewhat inflexible. It looks like you'll have to decide how the steam generator is going to degrade over the next 20 or 40 years. And you'll have to inspect for all the degradation mechanisms, whether they have been shown by experience to exist yet or not. Right now, there doesn't seem to be allowance for the fact that some of these are very temperature dependent and exist. We've seem them primarily on the hot leg and not on the cold leg. So we have some disagreement there. We don't disagree with the need to assess how you should do the inspection.

There's some signific nt heartache with the supplemental performance demonstration. I understand it's a matter of interpretation, but if you look at it and try to rigorously apply what's been written in the extreme case, it means lots of tube pulls and becomes very expensive and site specific basis and we'll talk -- John Smith will talk about that a little bit more. We're trying to find some middle ground there, along with the validation process that's part of that supplemental performance demonstration and the buffer zones.

We don't disagree that there's perhaps, that there is a need that the -- that we insure that the site specific inspection is done well and can be tracked back that the way you do it in the field does, in fact, reflect

how the techniques were qualified originally.

I already mentioned the deterministic structural integrity safety factors and the discussion on that -- there won't be discussion today, but the treatment of deterministic uncertainties is an issue as to how we will actually implement that from a calculation standpoint. I mention the 20 percent limit on probability versus one mechanism and then we have an issue with the way the 150 gallon per day leakage limit looks like an enforcement trip point to us.

There is an industry document that was drafted and given to the NRC last winter, January-February time frame after some industry review. The document was drafted by a consortium of people involving EPRI, utilities, some of the NSSS vendor and contractors and NEI personnel. That document has undergone some significant changes since the NRC saw it. It's been reformatted to parallel the regulatory guide in many respects and not necessarily the same outline, at least to have the same requirements there.

It's been somewhat of an iterative process because we gave them an industry document. We saw their Reg. Guide. We're trying as an industry to come to terms and agreements on some of the issues when we're not presenting our side.

At one time, we tried to differentiate performance measures or objectives from the performance criteria and we now are agreeing on calling them performance criteria with those specific values. We have a lot of details in the industry document on ISI on the in-service inspection. We took those out and have -- and they'll be talked about a little bit more. We're putting into there, basically referencing the EPRI guidelines.

We added a section on in situ pressure testing that has become a valuable tool for doing condition monitoring. And agreed with the reporting, but that keeps changing with these draft Reg. Guides so we'll keep changing too, I guess or present our positions.

There was an issue associated with 40 percent plugging criteria where we wanted to consider that an average depth when they changed the wording to maximum measure depth. That seemed to be acceptable to our people.

We've added a section on how you develop an alternate repair criteria and have really adopted lots of the Reg. Guide wording where it seemed to say same things that we wanted to say.

We are, in fact, going parallel past with an industry document and a Reg. Guide. It's our understanding the NRC is, in fact, putting everything they

think is important in the Reg. Guide. It's our understanding that we're going to try to put everything we think is important in the industry document with the hope that when the final analysis comes out, the Reg. Guide will get smashed down to something small and reference our industry document. That's our hope in this whole process and I guess we say that because we think it's slightly easier to make a change to NEI document than it would be to the Regulatory Guide.

The industry document is broken down into five major sections. One, an introduction. A second one dealing with performance criteria. A third section deals with the evaluation of the tube structural and accident leakage integrity, will end up in that section also for us.

We have a section on developing steam generator degradation specific repair criteria, a section on the steam generator program elements and as I say we've been rewriting ours as well as the NRC has been doing likewise.

The introduction for the document basically establishes the purposes for the document and the first, of course, the first one is that the tube shall remain capable of providing their intended safety function. And we itemized those.

And then this document would provide utility assistance in implementing the rule. We would hope that it would be a correct interpretation of what the NRC wants to accomplish with the rule. It does, in fact, incorporate the areas of inspection of assessment, of repair of preventative things that we have to do and leakage monitoring. We want it to be able to accommodate implementation of the steam generator degradation specific management strategies. We want it to be able to accommodate new technology and I think those are in agreement with what the NRC wants to accomplish also.

A little bit about the performance criteria. We have a section in front that gives them from an objective standpoint in that the first one is, of course, is that you maintain adequate tube integrity during the planned operating cycle. In other words, we don't want steam generator tube ruptures. The accident leakage criteria is that you don't exceed the consequences of the limits of the 10 CFR Part 100 guidelines, the general design criteria or the normal make up capacity. And then operating and leakage, consider that to be a defense-in-depth that insures that if you are going to exceed the established operational leakage limit, that the unit is shut down in a timely manner to reduce the likelihood of failure.

Now I'll get into the details a little bit of perhaps where we've got some a little bit of disagreement on the performance criteria. We look at the structural integrity performance criteria. We've been working on this three times normal -- we've had some discussion earlier with the NRC on the three times normal operating pressure safety factor and we think we have a different interpretation of what that means and Tom Pitterle is going to present that in detail.

We also have a document written up that gives that a lot more basis on it that would be sent to the NRC within the next week or two. But the proposal is that we do not exceed the larger of 3600 psi as a limiting factor instead of 3 delta P or 1.43 times the accident delta P. We feel in that presentation that we will be meeting code safety requirements.

Then for the accident conditions, it's the same as the NRC and in the probabilistic performance criteria we've accepted the numbers that are there, except we have some discussion presented this afternoon on why we think applying 20 percent to one mechanism may not be the proper route and we will give some basis for our suggestions and right now, at this point in time, we don't include the spontaneous normal operating condition probability of burst.

I'm not sure how that applies even after listening this morning to a site specific because if you have one tube rupture, you've exceeded that and none of us want to have tube ruptures and we all will acknowledge that if you have a tube rupture, we've got some significant problem somewhere and it does, in fact, warrant additional investigation and perhaps oversight.

We've left that one out of our criteria for right now. Accident leakage, we agree with that. We also put a definition in there for normal makeup. In other words, the makeup that doesn't require safeguards initiation. It would look to us from what we saw today, the total charging pump capacity that that would be acceptable. There might -- we probably still would leave our definition in there the way we see that and how that would be exactly defined.

In the operating leakage performance criteria, we acknowledge there has to be one. We agree with 150 gallons per day, primary to secondary leak rate and in our document we would also invoke the 60 gallons per day per hour change in leakage which comes into effect, if you're graded on 30 gallons per day.

Implementing that at my plant, the operators are not necessarily readily fond of all those criteria. There are ways to help them along from the computer

standpoint, but those are the criteria that we've agreed to from an industry standpoint.

There has been some discussion about how that limit should actually be treated. We are of the opinion that should be treated, I like a technical specification limiting condition for operation and that because you reach the 150 gallons per day, doesn't mean you have a failure of the steam generator program and doesn't automatically get you into a violation space or enforcement space or augmented inspection team space. Perhaps that's what our concern is and so we put that one out on the table that we think it should be treated like a technical spec limiting condition for operation.

We think any leak outage, particularly from a utility perspective, if you have to bring the unit down because of a steam generator tube leakage, whether you go over that tech spec limit or not, it's a major issue for you as an outage, for you as a utility.

In our evaluation section, we considered the same evaluations that the NRC is proposing. I guess I'll point out from the industry perspective, a lot of the stuff that is in this draft Reg. Guide is very realistic day-to-day expectations that the NRC is placing upon us. And most utilities are trying to look at that draft Reg. Guide and when they're looking into outage assessments, I

suppose particularly within the last year and in the future, trying to meet some of those requirements, but what's in that draft Reg. Guide, to a large extent, is what we're dealing with on a utility-specific issue today.

And so sometimes we call the draft Reg. Guide a codification of the expectations that we are presently under. And we acknowledge that they can be done deterministically and probabilistically and we will ut a section in there of dose assessments, our dose assessment section has been written a couple of times and we just saw today for the first time the official NRC position on that, so we have to evaluate that.

From the condition of monitoring and operational assessment perspective, we have adopted most of the wording in our industry document. I mentioned before the non-destructive examination validation concept, we have a lot of concern with how that is. We don't necessarily disagree with the purpose. The way it's written up, we're concerned about an inspector coming in and saying you don't meet this, you don't meet that and the way it's written, if you want it to meet the standard of excellence versus a minimum regulatory requirements it may not in fact, be possible from an economic standpoint.

And so we have a lot of concern there and we're searching, looking for some middle ground and for

some alternate proposals. That will be discussed more.

I mentioned we have some interpretation issues on a structural limit safety factors and then on the acceptable uncertainty levels and it's my understanding that those requirements that are in condition monitoring about uncertainty levels and for example, this one that says probability of burst be less than 10 to the minus 4 for the limiting postulating accident for the tube structural limit are an attempt to write a higher level requirement for how to deal with all of the uncertainties. We talked this morning a little bit about we think there's huge uncertainties and I'm not able to explain that much better than it was explained this morning, although we're taking a look at that for one particular degradation mechanism, one of the simple ones in the next couple of months at our plant.

I guess the comment about deterministic and risk and probability is that sometimes I look at that document and it looks to me like it's risk saturated and not risk informed. And I know risk usually refers to severe accidents, but the concept of probability is also risk and we are being asked to assign probability and confidence levels to lots of things we're doing in the steam generator world that weren't required specifically under the normal default tech. spec.

We have a section on the development of a steam generator degradation specific repair criteria and it kind of follows the format of the generic letter 95-05, but also from a common a sense approach and that is, you have to know what the degradation morphology is. You have to know what the degradation mechanism is that you're going to apply to the specific repair criteria to and the way you find that out is via tube pulls.

And of course, there is a benefit to the utilities, if you do know specific what the degradation mechanism is, you may be able to justify not plugging on detection. And that can be a substantial savings for the utility.

Once you fold the tube and know what the morphology is using ·ifferent techniques you would determine what the tube structure limits are empirically or by analysis and you'll have to define some sort of NDE correlation that will correlate those structural limits back to the test based and analytical based techniques.

Once you have that NDE correlation, of course, you want to assure yourself that the inspection technique is properly qualified in order to give yourself certainty or assurance that what you think you have in your steam generators is really what you have there.

Along with the qualification, you identify the

inspection uncertainties. then once you've done the inspection, you can hopefully determine a flaw growth rate which is difficult when you're plugging on detection and we haven't quite gotten around that issue of how to determine flaw growth rates when you can't leave the flaw in service.

Then the tube repair limit becomes based on the projected and the cycled conditions either with the deterministic determination or the probabilistic one and the deterministic is the standard, your repair limit is based on some structural limit minus some NDE errors and uncertainties and minus the growth you expect during the coming cycle.

Or if you want to do it from a probabilistic standpoint, you can determine what the probability of burst is and what the accident leakage would be at the end of the cycle.

So we've proposed in our industry document that type of scenario for developing an alternate repair criteria. In the steam generator program elements, we've covered the same items that the NRC has. I've bolded some of these things here because these are the ones that to some extent, well, our in fact, large impact for utilities and it's going to depend on utility-specific situations, but let me use for example assessment of potential

degradation mechanisms. Most of us do that and most of us say we're going to follow the EPRI guidelines and most of us have it written down, perhaps somewhere under the rules based. that needs to be written down. In our case, it's going to be written down in a procedure. In fact, we've started writing one for our site and then once you get that assessment done, you have to do the selection of inspection techniques and the selection of the inspection techniques need to be appropriate and we have to use qualified methods for each one of those potential degradation mechanisms. It is going to be pretty site specific, depending on how many degradation mechanisms you have. If you've got older steam generators, it's a little more detailed than somebody with a brand new replacement steam generator.

In the tube plugging repair, again the condition monitoring assessment. Let's take a look at did you meet the requirements when you shut down? And as we're finding out and I truly believe the expectations are greater than they were, the things the utilities are doing this year are much more extensive than they were done last year. It's not necessarily bad, but it is involving time and money. But to establish the fact that a particular tube you found did, in fact, meet the requirements when you shut down.

And then repair criteria, under the rule would be somewhat more flexible than they are right now and I guess that's one of the advantages we've like to see out of the rule, but you would take and do your repair criteria and then whatever you've got left of the steam generator make the operational assessment on and for a lot of utilities, this is not something that's easily done in-house. Typically, utilities do have to go outside, either to NSSS vendors or others who have skills in this area.

There's a certain amount of statistical skill involved in statistical procedures, predictions involved and in essence, there's more work to be done than there was in the past. It should have been done in the past, to some extent, yes. But in the environment, and I work at the plant, the requirement remains that you justify a lot more than we ever did in the past. You write down a lot more and you do a lot more calculations and all this fits into that pattern that there's more to be done to get out of a steam generator inspection.

The preventive measures, the corrective actions and the reporting requirements, we are pretty much in agreement with what the NRC has written down there.

From the perspective of the utility, and the industry, there are certain responsibilities that we see that we have taken seriously in the past that become

probably more regulatory, tied to regulation now than perhaps in the past and that's with the various EPRI reports that we proposed to meet the requirements of the draft Reg. guide and the rule.

And those reports most of which exist right now, are the primary, the PWR steam generator examination guidelines, being revised, that we talked about and need some guidelines written for how we do the site specific implementation to assure yourselves that you can meet the intent of the validation and supplemental performance demonstration issue. There are secondary water chemistry guidelines that have been out for 15 years and they get periodically reviewed. Primary to secondary leak guidelines recently issued and probably need revision here in the near future. Some in situ pressure testing guidelines which -- we've got some guidelines out there we want to get them issued as an EPRI report. We've also got some laboratory leak and burst testing standards and there's an EPRI steam generator degradation specific management data base and I guess the steam generator arena has had to sort of plow new ground in some of these standards and this is one way of getting them out from an industry-wide perspective, accepted by the industry.

We have one called the sleeving assessment document that the NRC has also mentioned.

Looking on to some other issues, the maintenance of the EPRI ISI technique qualification program is no small task to take into account tube pull data and reflect that back into what the qualification process was in the past and that's being worked on. One of the things utilities are looking at is how do we get all these evaluations done that maybe haven't been done in the past and one concept is looking at handbooks done for a specific degradation mechanism to cover those requirements to the structural limits, the condition monitoring, the operational assessments, correlations and NDE techniques and growth predictions, etc. And one concept we're looking at is developing one of those for each one of the degradation mechanism that are out there.

Of course, then we have the task of trying to get the industry to untie to do that because each individual utility is in essence doing some of that on an individual basis as we go through each outage and so the utilities can't always wait for the industry to provide those sorts of tools.

Another requirement that the utility consider all the industry experience in assessing the potential degradation mechanisms and how do we insure that there's an experienced data base out there that's widely available to all the utilities and we do have some new guidance. we

think they will be necessary and the severe accident assessments which we know that NSC has bene working on and just today we've seen the same things that you have, so we aren't really in a position to comment on those.

Let's see, we'll skip over slides 18, 19 and 20 for now. And come to -- some conclusions here.

Going back to 1993, industry felt a vehicle was needed to implement degradation specific management in a timely manner, getting the ultimate voltage criteria reviewed and approved a pretty slow and painful process. We also acknowledged that it was a new ground for the NRC to basically allow cracks in the primary system pressure boundary to be in service.

But one of the hopes we have for the rule is that this implementation of degradation specific management may occur in a more timely manner.

I will acknowledge on this performance-based issue that utilities are at risk too when it comes to whether we want pre-approved documents or not. Having gone through sleeving issues, while the plants are running, I personally would much rather have things approved before I start up and so there is a risk to utilities that they implement a new alternate repair criteria for example and the inspector comes along in the audit and halfway through the outage or through the cycle

and says well, you forgot to do this or we don't agree with what you did here and now what are you going to do. There is along with that responsibility becomes a greater risk on the part of the utilities of being might I say second guessed while the unit is running or brought up some shortness or weakness.

So that's an issue from our perspective also. We'd like to realize some benefits from improved NDE techniques, we're finding indications that is often general consensus that they're not concerned, but because we can't size them very well, we have to plug them and so we keep finding smaller and smaller defects and we don't have the engineering or the regulation that's caught up to say well, I guess you've found us small enough and it doesn't matter. We're not at that place yet.

We do see a significant impact in the utilities from the requirements of the rule from inspection time, from an engineering analysis perspective and from tool pool costs. But I want to acknowledge that there are many areas of agreement and it's based on previous meetings that have taken place between us and the NRC and to some extent this may facilitate trying to get the industry to standardize more. Some people just came back from France recently and were amazed at the standardization that the PWRs have over there that we

don't have here and that's partly because it's America maybe and partly because we've had several vendors involved.

So we're in agreement with the NRC in lots of things, but we are concerned that there is a large impact with the requirements being placed upon us by the rule and we are trying to prepare ourselves for that and in fact, a lot of the utilities are trying to meet the intent of some of the stuff already put out by the NRC based on the draft Reg. Guide.

That's all I have to present at this point.

CHAIRMAN SEALE: Okay, any questions for Mr. Pearson?

MEMBER SHACK: I guess you've already agreed you're not going to comment on the severe accident.

MR. PEARSON: My comment is that we thought it would stay on a steam generator rule arena. We thought it belonged to the severe accident arena and we're disappointed, but that's all we can comment on because we haven't had time to evaluate it and discuss it.

CHAIRMAN SEALE: Any other comments? I would certainly encourage you to, the industry that is, to develop the handbooks or whatever, because it seems to me that it provides a lot, a vehicle by which you can get some standardization, if you will, and get the NRC's

concurrence a lot quicker than if you spread it around and spread them around in the process.

MR. PEARSON: Yes, we agree with you. In fact, a couple of weeks we got another meeting with the industry to try to establish our funding for next year.

CHAIRMAN SEALE: Okay. I think before we go any further, we're going to take about a 15 minute break here and let everybody pump their blood around a little bit more than they have right now.

(Off the record.)

CHAIRMAN SEALE: We're going to hear about deterministic safe performance criteria and safety factors. Is that right?

MR. PITTERLE: Should we proceed?

CHAIRMAN SEALE: Yes sire. You've got a quorum here.

MR. PITTERLE: All right. I'm Tom Pitterle from Westinghouse and representing the EPRI ad hoc ARC Committee, relative to this topic. We're kind of shifting gears from talking about whole documents to basically focusing on about two lines of the draft Reg. Guide for this discussion.

I'd like to first go over some of the differences between the draft Reg. Guide and the industry proposal and again the main issue here is the structural

requirement at normal operating conditions. And we'll look at it through the proposed, that's the industry proposal and what's the basis behind the industry proposal with regard to ASME safety factors, qualitative arguments for the change and some demonstrations off of burst probability that the proposed criteria is adequately conservative.

As noted by Emmett earlier, the NRC Reg. Guide requires that the tubes maintain margins of safety against rupture consistent with ASME Section III and that we have no basic difference with. It's the additional statement in the Reg. Guide that the ASME criteria include a margin of not less than three against burst under normal operating conditions.

This issue, this is the source of the difference from the industry position and that a factor of 3 on a burst test as we proposed by industry is not consistent with the ASME factor of 3 on an elastic analysis. The fact is we'll show in the presentation that the safety factor of 3 on burst applied by the Reg. Guide would result on a safety factor in the code, an elastic analysis of about 3.4.

So the Reg. Guide is being in this area more conservative than the code. As noted by Rich, the industry proposal and this is a little different than

we've discussed with the NRC in the past. We have modified it to some extent to try to reconcile differences with the NRC, but we still differ in particular on whether or not the factor of 3 applies to burst.

So the industry proposal is that there shall be a normal operation, same safety factor as applied for accident conditions, 1.4 times the accident condition pressure differential or a minimum pressure differential of 3600 psi when a burst correlation is applied.

When the analysis is being done by elastic analysis the code would apply, but in the specific case, where we use a burst correlation is when the proposal differs from the draft Reg. Guide.

The minimum of the 3600 psi is incorporated to maintain and assure that we always have a factor of safety of 2.4 to 2.9 relative to normal operating pressure where the variation is due to specific steam generator pressure. What we'll show is the safety factor on burst that is consistent with the factor of safety of 3 in the code for elastic analysis is about 2.6.

So we're proposing to maintain that and basically within a range of 2.4 to 2.9 depending on specific steam generator to show that the proposed criteria results in very little burst probabilities at normal operation of less than 10 to the minus 5 for

indication to a negligibly small number calculationally on the order of 10 to the minus 10 depending on the burst correlation that's being applied, like the voltage correlation or correlations for axial crack burst.

So the proposed criteria have a negligible effect on the potential for rupture at normal operation ad the other thing that we're proposing that is different is to try to avoid the use of the normal operating pressure differential in the criteria because of the difficulties in actually projecting steam pressure over the next operating cycle.

It varies over the operating cycle, varies between steam generators and therefore makes at least in principle the criteria could be as much as steam generator dependent per cycle.

Code requirements, particularly focusing again our differences is strictly under normal operation. Code requirement being the primary membrane and what tends to e limiting is SU over 3 and the terminology that will be used in the primary pressure differential of less than SU over 3 with an elastic analysis and what we typically call the structural limit and the terminology, basically saying that the structural limit is to have a burst capability greater than 3 delta P normal operation. But it is important to recognize that the code is based, this safety

factor is based on the linear elastic analysis methodology requiring a factor of 3. The rest of it is we're common with the Reg. Guide as far as accident conditions. I don't think we need to address that.

The industry proposal again if we're doing an analytical analysis would use the ASME code directly with the factor of 3 on the analytical burst, exceeding the ultimate capability, ultimate strength. When there's burst test based correlation, which is most common to the industry's development of alternate plugging criteria, we develop a burst correlation off of extensive data bases, the pulled tubes or simulations. To develop the burst capability and are actually used in the correlation of the burst pressure. In that case we would maintain the condition that the 1.4 steam line break or the minimum of the 3600 and again the 3600 to assure consistency with the code.

The way we propose it, there are two lines of the requirements, evaluation based on analysis totally consistent with the code and the Reg. Guide and the major exception is strictly in this normal operation category for infrastructural limit. Realistically, that is the one that tends to be most limiting on steam generator tubing so it's -- in most cases the alternate repair criteria being built off of burst correlations. So it's the most

influential on the industry direction in terms of the structural criteria.

I'd like to look at here the equivalence of safety factors with the code and trying to show that the normal operation factor of 3 of the code on elastic analysis is consistent with the safety factor of 2.4 to 2.7 on an experimental burst pressure. So if you look at the code requirement with the factor of 3 requiring that the delta P normal operation for elastic analysis satisfy this equation with the factor of safety of 3 which is this factor of safety of 3 alluded in the Reg. Guide, but referred to as a margin on burst.

Look at what the burst relationship looks like in terms of the tensile properties utilized in the EPRI burst correlation for through wall axial cracks, but at the nondegraded level of the tubing. We obtain a burst pressure which is a function of the yield and the ultimate strength as shown and if we plug in the actual values of the burst pressure and then compare it to the -- to just the tensile analysis, sigma ut over rm, and find that the burst pressure -- the ratio of the burst pressure to the ultimate stress term without getting into a factor of 3 is .87. That says basically a tube that might be designed to the code and just to meet the code might actually not be able to operate because it would be, the burst pressure

would be below the code requirement if we have to maintain the same factor of safety on burst.

That 8.7 can be used to look at the safety factors, depending on how they are to be defined, either up or down. So if we look at the ratio of the code analysis to the proposed Reg. Guide where the factor of safety is 3 on burst, then basically that ends up to be the 3 divided by that .87 factor and that implies a factor, a safety factor of 3.4. What we're saying is that the Reg. Guide is more conservative than the code for an equivalent basis, when we apply a safety factor of 3.4.

Look at it the other way and say all right, what should be the safety factor on a burst correlation that gives us equivalence with the code and we're just looking at the ratio basically in reverse, looking at the ratio of the burst pressure to the code requirements and then basically it's that .87 factor times 3 and it results it in 2.6.

So the requirement of the safety factor of 2.6 on burst is equivalent with the safety factor of 3 of the ASME code for elastic analysis. It's this range that we're proposing for the industry requirement to -- rather than the factor of 3 on burst of the draft Reg. Guide.

CHAIRMAN SEALE: Excuse me, I have a nagging question that's bugging me a little bit. Could you tell

me what the properties or the difference in properties are between the 650 that you have there and the temperature in which the test is actually performed?

MR. PITTERLE: From normal operation to 650, the tensile properties have about an 8 percent reduction.

CHAIRMAN SEALE: I'm talking about the temperature at which the burst test is performed.

MR. PITTERLE: The burst test, typically, if we're testing it in the lab would be done at room temperature.

CHAIRMAN SEALE: Yes, that's my --

MR. PITTERLE: So there's about an 8 percent reduction in --

CHAIRMAN SEALE: Eight percent.

MR. PITTERLE: In going to 650 degrees.

CHAIRMAN SEALE: Okay, and is that in -- and that's in the -- well, no.

MR. PITTERLE: It doesn't affect the ratio very much.

CHAIRMAN SEALE: Okay.

MR. PITTERLE: But it's done at room temperature and will yield maybe a percentage or so.

CHAIRMAN SEALE: Okay.

MR. PITTERLE: They're both tending to change at about the same rate.

CHAIRMAN SEALE: Okay.

MEMBER SHACK: Why is this of such great interest? I mean it would seem to me the number of acceptable flaws that are acceptable under one factor are not, can't be all that much different under the other factor.

MR. PITTERLE: We look at it in terms of a burst probability, it probably could be as much as a factor of 100 between these two because you're looking at the tails of the distributions in these areas. And the other part of the issue is we'll get into is some of the difficulties in defining the normal operating pressure -- steam pressure basically over the projected cycle. It can vary by 20 psi over an operating cycle. It's different between steam generators, different between plants. You end up basically having a very specific plant specific structural limit.

But the industry proposal and moving away from using normal operation or steam pressure through the normal operation differential, you now have basically a structural limit that's common to a whole class of plants because we're using the safety valve set points which is basically common at least to all Westinghouse plants. All plants have the same tubing size and end up with the same structural limit. Some of the other fringe benefits, but

that does make -- and now when we're at the next step that we are not prepared to discuss yet, but it is to put the confidence levels that all of these have to be satisfied. If we're saying as some of the current draft Reg. Guides says that if I'm going to use 3 delta P and I Have to satisfy that with a high degree of confidence, burst probability is a normal operation at a less than 10 to the minus 10 by calculation, basically zero.

It's just too severe and it does show up time and time again because you can get in that range of a difference between the 2.6. It's basically 3650 burst capability versus 4350 for some of the plants. It's quite a spread.

All right, so this was a factor of 2.6 is based on the mean of the correlation. If we look at it and we plotted up all of the measured burst pressures from a lot of the pulled tubes from the support plate and you end up with a range relative to the code requirement on ultimate, but again the mean of that as consistent with the correlation is in the range of about 2 point -- 50 percent cumulative probability coming into about 2.6 and this includes, of course, measurement errors and burst pressure, etc. given the spread basically between -- well, through the tails 2.5 to about 3. So the burst data directly supports the mid-range or mean correlation factor

of about 2.6.

Another simplistic way that basically also comes up with the 2.6 is to look at at the time of burst, the plastic hoop strain in the tube is about 15 percent. You've increased the idea of the tube at about 15 percent as compared to the small strain assumption of the code analysis. So basically you've increased the radius of the tube by that strain, plastic strain and then this gives you about 2.6 as well.

So that, I think, supports the equivalency of the 2.6 factor on burst, the appropriate safety factor for consistency with the code.

Our conclusions, basically from looking at it from equivalent safety factors is a test derived structural limit at normal operation that results in a safety factor in this range is consistent with section 3 of the code.

Let me just try to give you an example of showing some of the safety factors that would result using Westinghouse steam generators and some typical operating pressures. For the accident condition pressure differential, it's basically the safety valve set point with a 3 percent uncertainty is 2560 psi. You apply the safety factor 1.4 times that we end up with the 3657 requirement.

Look at that and some of the ranges of operating pressures and in three quarter inch Westinghouse units which have been later designed for higher steam pressures, pressure differentials of 1250 to 1350. The safety factor, equivalent to normal operation. The ratio to normal operation would be 2.7 to 2.9.

Look at plants with 7/8ths inch tubing somewhat older in design, designed for lower steam pressures and that ratio falls into the range of 2.4 to 2.6. We are in that proposed range of equivalency with the code of the 2.4 to 2.9 with the proposed criteria. As I'll address in the next vu-graph, really if you use the normal operating pressure, we end up with a penalty by tube size effectively because of the difference in steam pressure, even though when you put them at a common criteria the burst probabilities, for example, of the 7/8ths inch tubing would be lower than the three quarters. If you have to use normal operation because of the steam pressure differentials, the structural limit for 7/8ths inch tubing must be higher.

Let me just go through some of the qualitative support for wanting to make this change. The tube size consideration that I was just alluding to, where really it's a penalty on tubing size to use normal operating pressure because they operate at a lower steam pressure

it's driving the requirement up considerably higher in order of 500 or 600 psi higher from a structural limit in 7/8ths inch tubing than the 3/4 inch tubing. As proposed by eliminating dependence on steam pressure, that's eliminated.

Another factor that is commonly being done is plants are reducing T-hot to reduce corrosion. When you reduce T-hot you reduce the steam pressure. Here's the case of a step designed to reduce and basically increase safety by reducing the potential for corrosion that ends up forcing a higher structural limit because it drops steam pressure when the 3 delta P criteria has to be applied. The penalty for doing the right thing in this case because of that dependence on normal operating pressure which again would be eliminated with the proposed criterion.

The proposed criterion would really have no effect on normal operation rupture probability. If we looked at the history of those ruptures that have occurred, none have occurred due to cases that have been evaluated against the structural limit. There have been cases of loose parts, new degradation mechanisms were not predicted, not expected, therefore not having really established against a structural limit. We do not believe just based on historical ruptures and I'll show later that

the burst probabilities remain extremely low at normal operations, but just on the historical basis of ruptures the proposed criteria would not affect the likelihood of a rupture at normal operations.

The uncertainty in predicting the delta P, again I'll show this as an example of variations in steam pressure and now if we are moving much more into the rigorous realm of being checked and checked, one could easily have mispredicted the steam pressure next cycle and find you're out of compliance so it's really something that probably has nothing to do with steam pressure, but because it happens to fall out a little bit lower than predicted might result in a noncompliance.

The point is that steam pressure is steam generated dependent between steam generators of the same plant. It can vary by 10 psi over the operating cycle. There are plants that vary from 10 to 20 psi. It makes a very cycle-dependent and then generally done by trying to predict the lowest steam generator of the group in applying the criteria which adds more margin than just the difference in steam pressure because of trying to lower bound the estimate for the next cycle.

We're trying to move to and industry is to a much more common set of criteria. If we can move away from the dependence on steam pressure, we end up with a

common structural criteria across all plants that are basically the same vendor and tube size and much more uniform it would be to the criteria, the methods and become inherently in somewhat more consistently applied on the structural limit which guides most of this effort is the same.

This is an example of variations of steam pressures over operating cycle with a shutdown. There's a strong tendency for steam pressure to drop them up over the operating cycle. These are largely due to some limited understanding of the effects of deposits and that type of a thing, but not unusual to see plants that have this behavior of the steam pressure dropping after the scram or an outage than increase over the operating cycle.

Also it can change, of course, by tube plugging in one generator, the difference between which loop is the lowest pressure drop can cause also differences between loops.

The point is that one can readily see that unless you really have to low bound the steam pressure for the next operating cycle, you have to pay more than just the 3 delta P penalty. You have to try to lower bound it to avoid not being in compliance when steam pressure is used as the structural criteria.

Just a further look at this. We looked at it

in a more quantitative basis by calculating the burst probability at normal operation for the proposed criteria. We're trying to basically show as our proposed criteria results in negligibly small burst probabilities at normal operating conditions. Looked at it through the EPRI through wall axial burst length correlation in the next vu-graph, the voltage correlation that's used for the support plant. So if we look at the criteria as proposed, the critical crack length just to satisfy that criteria for 3/4 inch tubing would be .51 inches or .57 inches for 7/8ths inch tubing at the structural limit and this includes lower material properties which are typical of the application of these types of limit.

Look at the equivalent crack lengths at normal operating conditions and then taking the ratio of the cracked length that would rupture and just match normal operating conditions that leaves us with a link ratio of abut 2.5 to 3. We have a lot of margin on length which is really what reality is to driving. The issue is how close are we on length to a rupture and that leaves us with a pretty significant margin.

The limit on margin on length to burst is a steam line break given this criteria would be about 1.5. In terms of burst probabilities at the normal operating pressure differentials which are typically again 1250 for

three quarter inch tubing and 1450 for 7/8ths. With this correlation the burst probabilities are totally insignificant. We calculate, but there's no credibility to the number that's the order of the calculation which is on the order of 10 to the minus 12 where burst probability at normal operating conditions.

So it's clear that the proposed criteria results at least for this correlation and totally negligible burst probabilities and there would be no need to add more conservatism to increase the normal operation criteria to the 3 delta P.

Looking at it from the bobbin voltage correlation, because it's an indirect parameter, there's much more spread in the correlation parameters. Again, in terms of a voltage the criterion leads to the order of about 4.7 to 9. This is done to the correlation as of about six months ago and it changes a couple tenths of a volt, but nothing has changed in these numbers in any significant manner in over -- almost four years now. But the margin on volts between the criteria and normal operation, I look at the normal operation voltage or burst, pressure differential, what voltage would result and that pressure and that's about a ratio about 7 to 10 relative to what the criteria -- but basically says that the range of 36 to 91 volts indication could be required

to burst at normal operating conditions.

Again, an extremely high margin and if I look at voltage as something like equivalent to length and measure parameter anyhow, because of the spread of the correlation, burst probability is not quite as low as it is predicted to be with the axial but still remains to be less than 10 to the minus 5 for an indication at the structural limit bursting at normal operating conditions, again, a very negligible number in response to one question raised earlier with this criteria would it maintain more than that decade of burst probability between normal operation and steam line break and the answer is definitely yes.

This criteria will typically be about a factor of 100 difference in burst probability between normal operation and steam line break.

So again diverse probability for normal operation is negligible and no real need to again increase the margins by the factor of 3 on burst.

Just to wrap this up with a summary of the overall conclusions, the proposed criteria is consistent with the ASME section 3 criteria. End up with the equivalent safety factors and therefore consistency with Section 3 of the code. Burst probabilities at the normal operating conditions are negligible for the proposed

criteria. You're not introducing anything that is going to increase in any significant manner the likelihood of a rupture at normal operating conditions.

No effect really on the normal operation of spontaneous rupture probabilities if the point be called. The other key element that we struggle to get to more uniform consistency in the criteria is to be able to get to that uniform structural limit across plants of the same type and we avoid the issues with this criteria in defining and projecting what the steam pressure will be for the next operating cycle.

Thank you. That concludes this presentation as we move from rather generalities down to two lines of the Reg. Guide, but two lines that are very important to us relative to the implications in applying these criteria for the operational assessments, condition monitoring and development of the plugging criteria.

CHAIRMAN SEALE: Any questions? I have one. Would you put the graph of frequency versus safety factor back up there?

MR. PITTERLE: This one?

CHAIRMAN SEALE: Yes sir. This graph is for all of the tubes that were tested that had flaws in them or is it for all of the tubes?

MR. PITTERLE: This is for -- Bob, correct me

-- is for pulled tubes and laboratory -- pulled tubes have no degradation. Pulled tubes basically that had no degradation, pulled them and would take a section of the tube away from say the support plank, so it's a free span undergraded section of the tubing. Taking that burst pressure and ratio of the tube, the elastic analysis of that limit. That's equivalent to the safety factor as implied from burst to elastic analysis.

CHAIRMAN SEALE: Well, am I drawing the proper conclusion then when I say that if you had a safety factor of 3, you would burst 98 percent of all the tubes you've tested?

MR. PITTERLE: Safety factor of 3 would envelope that burst pressure of that tube relative to the stress analysis, 98 percent of them would have a factor lower than 3, a margin, a burst margin. This is a safety factor. The actual burst pressure compared to that predicted from the basically sigma u over 3, sigma u without the factor of 3. It is the margin factor of the burst pressure to the elastic analysis.

What we're saying is that it clearly demonstrates from a peak that in the burst, yes, I can sometimes get some that demonstrate a factor of 3 in safety. The more common factor of safety, the mean, as we would get from that correlation that we presented that

derived the 2.6, the mean of that population is about 2.6. No tubes compared to the code that were burst undegraded tubes had less than the 2.5 margin compared to the linear elastic analysis.

CHAIRMAN SEALE: Okay. Any other questions?

CHAIRMAN FONTANA: I'm just curious how do you get 10 to the minus 12.

MR. PITTERLE: Well, we plug in the numbers into a burst probability calculation and it falls out. I mean --

CHAIRMAN FONTANA: I mean what goes into it? A probability of flaw, undetected flaws?

MR. PITTERLE: Basically it's the distribution of the burst pressures basically and the distribution of the pressures about the mean plus the material properties and likelihood of material property being low enough that that combination of the burst pressure at that distribution, at that structural limit.

CHAIRMAN FONTANA: So it doesn't take into consideration of possibility that the inspection has missed flaws?

MR. PITTERLE: No, this does not involve the inspection.

CHAIRMAN FONTANA: I've got you.

MR. PITTERLE: That is treated separately

through NDE uncertainties in the methodology and PODs. This is strictly intended to be structural.

MEMBER POWERS: Bob, this looks like a fairy explicit question. Should we ask the staff if they have any response to this?

CHAIRMAN SEALE: Good point.

MR. STROSNIDER: This is Jack Strosnider from the staff. We've had a number of discussions on this issue. My understanding is that we're going to receive the document from the industry which presents this -- the analysis that you just heard.

So we're going to take a look at that. WE haven't reached a final conclusion on that. I guess one thing it does point out is that something which sounds like a very simple statement may not be all that simple and in fact, there are probably, there are certainly other interpretations of section 3 and what it means and how it's been applied in other applications and the precedents that have been set. So we're going to take all of that into consideration, but we are expecting that this will be submitted to us for us to take a look at.

CHAIRMAN SEALE: It does sound like these two lines echo rather resoundingly when you start listening to what the implications are.

MR. STROSNIDER: It does and I think there's

an interesting point with regard to the incentive, with regard to reducing operating temperature.

CHAIRMAN SEALE: Yes.

MR. STROSNIDER: And the penalty that's paid there. So we need to take a look at this when it comes in.

CHAIRMAN SEALE: Any other questions or comments? Thank you, sir.

Okay, next.

MR. STEININGER: Hello. My name is David Steininger. I am program manager in the Steam Generator Management Program at EPRI.

What I will talk to you about today is a subject that is mentioned quite a bit within the rule and the regulatory guide called the "Conditional Probability of Tube Burst." There was much discussion this morning on this particular parameter. I'm sure that this will elicit quite a bit of discussion in the afternoon. Unfortunately, the gentleman that had many questions on this particular parameter is not here.

CHAIRMAN SEALE: He had to go teach school tomorrow.

MR. STEININGER: Okay. It's interesting to note that I actually stood in front of this committee in 1992 presenting the industry initiative called steam

generator degradation specific management, which has been mentioned by the staff.

Let me say that back in 1992, I did not in my wildest dreams think that that presentation would eventually result in the promulgation of a steam generator rule, much less one that was supposedly risk informed with severe accidents being addressed. So a lot has happened since I made that original presentation to this committee back in 1992. Fortunately, I guess a number of faces have changed since then on this committee.

Well, I won't bore you. I think you already know what this parameter is. It's conditional probability of tube burst. It's a rules performance criteria. It's a conditional probability based on the limiting initiating accident. Usually the limiting initiating accident is one that produces the highest differential pressure across the steam generator tube, causing it to burst, or may cause it to burst. Usually it's a main steam line or feedwater line guillotine break being the initiating accident.

Well, my objective, or industry's objective in this presentation is simply to get the following points across, that we believe that the conditional probability should be risk based.

Now let me stand here right now and simply apologize to all of you, but I am having a great

difficulty in understanding the difference between risk based and risk informed.

MEMBER KRESS: Join the club.

MR. STEININGER: Okay. Very good. In fact, I will probably use both terms interchangeably during the course of the presentation. Again, I apologize. I am at fault. I simply don't understand the distinction.

We believe that acceptable risk must be appropriately defined and not arbitrary. To be more specific, we believe that risk should be defined in terms of the NRC's safety goals.

Finally, the staff and the industry believe that the defense-in-depth should be maintained. That can be done in many ways. I will get to those ways later on in the presentation.

Just to briefly review for you the parameter which caused all the discussion this morning. In the regulatory guide, supporting the role the conditional probability is given as these particular values. For example, five percent for one or more tube ruptures. But then the regulatory guide goes a little bit further than this and says that the conditional probability of burst is applicable to any one degradation mechanism in the faulted steam generator, and should not exceed 20 percent of the above noted values.

Now what we would like to do is give you at least our interpretation of where these numbers come from. For example, the five percent for the one or greater -- greater than one tube ruptures.

We believe that the conditional probability of burst as stated in the regulatory guide is an arbitrary modification of a value based on historical events as described in NUREG-0844, the title of which is "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 regarding Steam Generator Tube Integrity," which was published in September of 1988.

Now in that NUREG, the following is done. The NUREG evaluated circumstances leading to four steam generator tube rupture events that had occurred up to that period of time, at which the NUREG was published, which was 1988.

The analysis effectively identified periods of vulnerability of tube rupture under main steam line break conditions for those tubes that ruptured during normal operation, and came up with a period of vulnerability of approximately 1.2 years, which translated at that time into a conditional probability of burst of .027 or 2.7 percent.

The NUREG then takes this historical value of .027 and it arbitrarily increases that value to five

percent. The reason the NUREG did this was to -- is that my watch? Is that mine or somebody else's? Okay. I thought it was mine. Now that I inappropriately took my watch off.

The NUREG arbitrarily increased the 2.7 percent to five percent in order to account for periods of vulnerability of tube rupture under main steam line break conditions, but were terminated as a result of either in-service inspection, that is, a tube was found to be degraded and therefore taken out of service, so it did not result in a tube rupture at normal operating conditions. Or the tube produced primary to secondary leakage and therefore, the tube was taken out of service.

So the arbitrary increase from 2.7 percent to five percent was to account for those cases where the tube was in fact vulnerable to rupture under main steam line break conditions, but was eventually taken out of service.

In fact, the NUREG states the following. "It is implicit in the five percent conditional probability assumption that periods of vulnerability to rupture during postulated accidents are almost 20 times more likely to be terminated as a result of in-service eddy-current inspection or small leakage events than as a result of a steam generated tube rupture event at normal operation."

So the NUREG itself is saying that this was a

very conservatively derived value. It indicated that in fact, in-service inspection will take the tubes out of service or they will produce a leakage and subsequently be taken out of service such that they will not be available for rupture under a main steam line break condition.

Then unfortunately, the regulatory guide supporting the rule takes 20 percent of this value and we believe that the 20 percent of the five percent is done in order to address unknown factors that may result in tube rupture. That is, unknown factors that you are not tracking, for example, under the rule, that may result in a tube rupture. For example, loose parts.

Now in all fairness to Emmet this morning, he gave a different interpretation of the rationale for the 20 percent of the .05, and that's the first time that I heard that interpretation.

The interpretation that he provided this morning was that under the rule, if you have an alternate repair criteria, you will be monitoring that specific degradation, and you will be handling it probabilistically. With all of the other degradation, you will be handling deterministically under the rule. Therefore, since you are not handling it probabilistically, you have to be more conservative. That's why he took the 20 percent. I believe that's what

Emmet said this morning. I will address that particular rationale later on in the presentation. Obviously, I am not going to agree with it.

Okay. What is industry's proposal? Well, we believe that the NUREG analysis of historical events with an arbitrary assumption getting to the .05, is not appropriate for establishing a performance criterion used in the regulation.

As you can see, even though it says measure on changing to the terminology which is now politically correct under the rule, which is a performance criterion rather than a performance measure. Unfortunately, I didn't update my viewgraph.

Performance criteria should be based on acceptable risk. The reason we say that is because the rule is supposed to be risk informed or risk-based, as I would classify it. Therefore, the conditional probability of burst should be established considering the probability of the initiating event leading the tube rupture. For example, main steam line break or a feedwater line break and the acceptable level of risk. We would classify what is risk in this particular risk, it's the safety goal or a safety goal. In this particular case, we would say core damage frequency.

CHAIRMAN FONTANA: There's not really I think,

unless I'm wrong, if the tube rupture leads to core damage, and you are using 10 to the minus four, that core damage now has a pass to the environment. So it really ought to be 10 to the minus six.

MR. STEININGER: Yes. If you go all the way to the end?

CHAIRMAN FONTANA: Yes.

MR. STEININGER: Right.

CHAIRMAN FONTANA: Yes, okay. Anyway, minor point.

MR. STEININGER: Yes, I understand. How would it utilize this particular -- how do we come up with this particular performance criteria as suggested by the industry using risk? Well, we would simply for example, use a simple risk relationship as presented here. These terms I think are probably familiar to everybody in the audience.

The first probability is just the probability of the initiating event. This probability here P(D) is the probability of failure to mitigate the consequences of the event and prevent core damage.

Now, within the bracket we have here, which is the conditional probability associated with the degradation mechanism that you are following under the rule, degradation being J, you would sum over all

degradation mechanisms that you are presently following or monitoring under the rule.

This term here is simply a conservatism that is added to take into account the conditional probability associated with all of the unknown mechanisms, for example, loose parts, something that you are not following under the rule, that may in fact lead to a steam generator tube rupture event.

Finally, A then is the value that would indicate an acceptable level of risk and would be in terms of a frequency. For example, core damage frequency.

Okay. Let's simply go and use that equation. For the probability of the initiating event, I have taken a value of 8.2 times 10 to the negative four per year. I have taken this value from an NRC staff presentation that was made in 1994 to the ACRS. It's for the sum of the main steam line break and feedwater line break frequencies.

The conditional probability for the unknown or unanticipated causes of something degrading the tube which could cause a steam generator tube rupture event during a faulted accident, I have arbitrarily set at 10 percent, a very high value, quite high, 10 percent.

The conditional probability at the plant simply doesn't handle the event very well, that the

operators don't handle the event in an acceptable manner, I have used 10 to the negative three. This is a typical value published, published value used by the NRC staff in evaluations of this type. I went to NUREG 1477 to get this particular value. It's a NUREG that was published by the staff in the early days of interim repair criteria.

Finally, the conditional probability -- now this is an important point. The conditional probability for all damage mechanisms that you are tracking I'm giving the value of five percent. Not every one, but the sum total.

Well, if you take those values and you plug it into that relationship, you get the lefthand side of the relationship provides a value of 1.23 times 10 to the negative seven per year. Now the range of the NRC safety goals in the published literature and in presentations is usually .5 to .1 times 10 to the negative six. So our conclusion therefore is that the .45 or the five percent that was allocated for all degradation being monitored under the rule with a very conservative factor of 10 percent added in for all the other unknown causes, is quite acceptable in terms of the NRC's safety goals.

Okay, what are at least our conclusions. The risk analysis shows that the five percent should be the conditional probability criterion for all monitored forms

of tube degradation, and should not arbitrarily be set at 20 percent of this value for each degradation form being monitored. For example, under what's written in the regulatory guide, it's 20 percent of the five percent. For each degradation, if you have five degradation mechanisms that you are tracking, then you can take full credit for the five percent.

Well, we think you should not even have 20 percent. We believe that risk analysis shows that the 20 percent is not needed.

As I indicated earlier in the presentation, I would address Emmet's, what I think is a new interpretation of why the 20 percent is there. He indicated that it's there because for all other forms of degradation, you are applying deterministic analysis.

Well, my interpretation of deterministic versus probabilistic analysis, probabilistic analysis means that you have a sharper pencil. You can get rid of conservatism. That's why you can use probabilistic analysis.

If you go to deterministic analysis, you have a lot of conservatism. At a minimum, the deterministic analysis should give you identically what the probabilistic analysis gives as a minimum. What it should give you is something even much higher than probablistic

analysis. There should be a lot of conservatism involved.

So therefore, I guess I don't accept Emmet's evaluation that if you are following a degradation mechanism probabilistically, you can use as probablistic conditional probability of burst, but if you are following something that under the rule which is deterministically evaluated, that is why you have to arbitrarily reduce the conditional probability of burst by 20 percent. The conservatism is already part of the equation when you do the deterministic analysis. Therefore, you shouldn't modify the conditional probability of burst.

CHAIRMAN FONTANA: I would guess that if you had a good probabilistic assessment and you knew the distributions, then that would let you know just how much margin you have if you did it deterministically, and doesn't even mean it would be less or more whatever, but it would tell you what it is.

MR. STEININGER: Exactly. That's another way of saying it. If you are going to say if you are going to have options, deterministic and probabilistic, as a minimum they should be equal at some point as a minimum.

Usually what happens is that you throw so much conservatism in the deterministic analysis because you say there is something unknown, that it's very conservative relative to the probabilistic analysis where you have

actually sharpened your pencil. That's another way of interpreting.

MEMBER POWERS: Would your conclusions change if you considered initiators different from a main steam line break or feedwater line break?

MR. STEININGER: No. I don't think so. Those are usually the two that give you the highest differential pressure. There are transients that produce lower differential pressures across the tube wall, and in fact, those transients happen obviously more often. But if you go through the risk analysis, if you go through the PRA analysis, you will see that the limiting accident events that drive the risk are the main steam line break.

MEMBER POWERS: But you start summing, and though one accident may be dominant, by the time you sum, it's not evident that it won't change the risk. In fact, if I take a one times 10 to the minus four core degradation event, and multiply it by .05, I suddenly get more than the safety goal for a large release.

MR. STEININGER: But if you add in all the other transients?

MEMBER POWERS: Well, it's just adding it all in with the core damage frequency goal of one times 10 to the minus four.

MR. STEININGER: That may in fact be the case.

All I am suggesting here is a methodology to arrive at what the value should be. That's what I am trying to get across to you. That if it's truly a risk-informed rule, and reg guide, then you should use risk to help you determine what these values should be.

They should not be arbitrary values taken out of historical analysis. That's my point. So obviously, I would say you would have to take a look at exactly what you have suggested.

But in any event, that is the way you would do it. You would come up with this value.

MEMBER POWERS: But even if I do it that way, it's not evident that I come to the conclusion that I don't want to restrict each mechanism to 20 percent.

MR. STEININGER: If that's what the analysis shows you should do, then you're right. I agree. I don't believe it will.

Evaluation of risk has accounted for what I believe to be both the known and the unknown mechanism that may increase the vulnerability of tube rupture during a faulted event. I indicated in that very simple risk equation, that I took what I thought was an extremely conservative value for the conditional probability associated with the unknown causes or the unknown mechanism that may in fact result in a steam generator

tube rupture under main steam line break conditions.

I indicated that there is still defense-in-depth in this overall approach. It's apparent. It's quite robust.

What we are doing is increased tube inspection under the rule, we believe will lower the vulnerability of tube rupture from known and unknown causes. The NUREG said that itself, NUREG-0844.

Restrictions on operational leakage under the rule we believe lowers the vulnerability to rupture from, this should read from both known and unknown causes. Again, NUREG-0844 said exactly that.

You should also realize that the plant design basis is in fact the single double ended guillotine break of a tube. Additionally, analysis shows that the plant can easily handle multiple tube rupture events in combination with a full main steam or feedwater line break.

CHAIRMAN FONTANA: But not with fuel failure, is that correct?

MR. STEININGER: I don't remember the analysis, but I believe you can take multiple tube rupture events without even failing any fuel.

CHAIRMAN FONTANA: Oh. But you are doing a dose calculation on the basis of --

MR. STEININGER: Correct, without fuel.

CHAIRMAN FONTANA: Of a coolant activity.

MR. STEININGER: Yes. Yes.

CHAIRMAN FONTANA: Not anything coming out.

MR. STEININGER: Correct. Correct.

Just on that particular point, we recently took a complete operator crew through the Commanche Peak simulator. We didn't tell them what event they were going to be faced with. It was a 20 tube rupture event, 22 guillotine break event that these operators were faced with. They had no idea what they were going to be faced with. They were not told that it was an accident event. They were not told that it was an event that they had never seen before. They handled the event quite well. I believe they were able to get into RHR recirc mode within 2.5 hours. The IRWST was only depleted to about 40 percent.

We actually did that with two crews. Both crews reacted quite similarly. There wasn't a problem.

CHAIRMAN FONTANA: Did they need to figure out what it was in order to --

MR. STEININGER: They figured it out right away. They figured it out.

CHAIRMAN FONTANA: Was it necessary that they figure it out? Could they use symptom based procedures?

MR. STEININGER: Well, what we told them to do, all they had available was the EOPs. We told them simply to follow the EOPs, and we wanted to see what would happen. That was the outcome.

CHAIRMAN SEALE: And they are symptom based?

MP. STEININGER: Yes. Yes, they are.

Finally, all plants can experience significant leakage with main steam line break or feedwater line break and meet 10 CFR 100 or GDC dose requirements.

If you actually did a complete uncertainty analysis, a probabilistic analysis when you do your dose, for example, like you do for normal radiation releases, the amount of leakage that you can tolerate is quite substantial. So that's defense-in-depth as far as we are concerned.

Again, the bottom line just arbitrarily taking the conditional, the allowable conditional probability of burst, the five percent, which is based on historical events, an arbitrary modification of historical events, it's inappropriate and then simply taking 20 percent of that value may or may not be inappropriate.

We feel that you have to do the risk analysis to become informed to tell you exactly what that number should be. That's all I have.

CHAIRMAN SEALE: Questions? Comments?

MEMBER KRESS: Given that the real risk goals that are in the safety goal policy statement or --

MR. STEININGER: 10 CFR 50?

MEMBER KRESS: Are quantitative health objectives, and they depend on site specific properties, that's population, weather and so forth, and if we back off on those and say instead we want some subsidiary goals that we can really deal with, like core melt frequency and conditional containment failure probability or a combination of the two, 20 percent reduction in the acceptance criteria doesn't look like it's overly conservative to me.

Would you like to comment on that?

MR. STEININGER: Like again, I have proposed a methodology I think that a rationale that you have to go through, or you should go through to establish that number.

If you accept the contention that you should be risk-informed, that CDF is a good number to deal with, then you should go through this rationale and come up with the correct number. Maybe you are absolutely right, but at least you should have a rationale. It should be risk informed. But I'll take whatever you give me that comes out of the analysis. That's my point.

MEMBER KRESS: Okay. But you wouldn't --

MR. STEININGER: I am not going to argue against my own proposal.

CHAIRMAN SEALE: Any other questions by members of the committee?

Jack Strosnider, would you like to comment?

MR. STROSNIDER: Jack Strosnider of the staff. We have had discussions along this line. This is a little bit different but I think fairly similar to discussions we have had in various meetings. I think actually the staff does have a problem in this area.

I think it gets back to a basic question that Mr. Steininger asked when he got up there, the difference between risk based and risk informed. I think if you carry this logic that was laid out to its extreme, you can look at the initiating frequency, and you can look at the probability or the frequency of failure to mitigate the event, and you can conclude that you meet the objectives without doing any in-service inspection at all.

But I don't think that that's balanced. I don't think that it represents defense-in-depth. I am not suggesting that's what you have proposed either.

MR. STEININGER: I didn't suggest that.

MR. STROSNIDER: But the point is, if you take this logic to the extreme, you can get to that conclusion.

Now, with regard to the .05, I am going to let

Steve Long address some work that we have done in that area, some of the recent risk assessment which the industry has not seen yet, to address that issue.

With regard to the reduction in it, 20 percent, and I'm not sure that I completely understood the proposal here, but the idea was that you should not have one degradation mechanism taking you right up to performance criteria. You recognize certainly that you could be tracking more than one. In fact, there may be some you don't know about.

The reduction of 20 percent, I will admit is somewhat arbitrary. There was some judgement on the staff's part of how many degradation mechanisms might you be tracking, what other things might influence this. So yes, there is some regulatory judgement there. But it would appear that that needs to be addressed in some way. That is, the fact that you could have more than one degradation mechanism. You could have other areas contributing to this risk. So I don't think you can ignore it. I don't think you can take each mechanism right up to the goal and basically conclude that you are satisfying your overall objective.

MEMBER KRESS: But he is saying he would let the summation of the things go up to there. All he is saying is he doesn't think that each one of them needs to

necessarily be 20 percent.

MR. STEININGER: I would like to be able to trade off.

MEMBER KRESS: It's a trade off.

Jack, on your comment on the performance criteria and what that implies in terms of taking it to its extreme, it seems to me like if you have a risk informed performance based system, that when you come up with performance criteria, they could be arbitrarily selected or selected in a bounding sense. Or if possible, one could derive them from risk acceptance criteria just as he said.

It seems to me like the reason we go to performance based is -- well, there's lots of reasons. But one of the reasons is you can't always make that derivation. There are lots of things that you can't derive the performance criteria directly from risk acceptance criteria. But when you can, and like in this case, it seems to me like that would be a reasonable approach. If you can do it, do it. If you can't, then go some other route.

MR. STROSNIDER: With the caution that you have to still maintain balance in your approach in defense-in-depth.

MEMBER KRESS: Yes. I'm saying keep defense-

in-depth as a definition, and these other things are the balance that gives you the defense in depth.

MR. STROSNIDER: I would like to let Steve Long from the Risk Assessment Branch perhaps address that in a little more detail.

I guess the final comment is with regard to the reduction, there was an earlier proposal from the industry in one of our meetings which suggested that the sum of all the degradation mechanisms we were tracking would add up to something less than 10 to the five times 10 to the minus second, to account for the unknowns. I think that made more sense than letting everything that's known take you right up.

MEMBER KRESS: Yes. There may be a lot of value to that.

MR. STROSNIDER: So there's a number of different ways of approaching it. What the staff has proposed at this time is that we're considering, for example, five different degradation mechanisms. Maybe you are tracking two or three. There are some other ones that could contribute. There's some judgement involved though, certainly.

MEMBER KRESS: It looked like if you throw out his probability of the unknowns, and then put the 20 percent out, you come out actually worse than he had

actually. He was putting more of a factor in that one than you would have with the 20 percent.

MR. STROSNIDER: Understand, yes.

MEMBER KRESS: But either way would look like a way to deal with this.

MR. STROSNIDER: Exactly. I'm just saying that --

MEMBER KRESS: I like his way up front because it makes it explicit rather than hiding it in that number.

MR. STROSNIDER: I would like to let Steve Long make some comments on some of the work that has been done recently with regard to the .05.

MR. LONG: I'm Steve Long with the Risk Assessment Branch in NRR. We have really tried to do what I think they have suggested, of taking a fresh look at the risk from the secondary side depressurizations. We typically refer to those as steam line break because that's the design basis event in the chapter 15 analysis of the FSAR. But frankly, it is dominated by other depressurization mechanisms like stuck valves.

The way that the 0844, NUREG-0844 input was described, we've got some minor differences with it, but basically, that was a description of how in the late 1980s reviewed steam generator degradation and the risk from it. We came up with a risk estimate that was in the low 10 to

the minus six per reactor year for core damage with bypass of the containment. That involved that number of .05 as a conditional probability for rupturing steam generator tubes.

So that looked, when we started developing the rule, like a reasonable place to put a performance criterion so that that analysis wouldn't become invalid by changing that particular number. However, we did go back, and this is what the industry hasn't seen the results of yet, and do a fresh assessment of the risk, where we assumed that that number was the performance goal and that a plant would actually go up to that number and ask what risk would result if we did a more moderate assessment PRA.

For the secondary depressurization events, it then would induce core damage, will induce a tube rupture that then would have a failure to mitigate that would lead to core damage and because the secondary and primary are now breached, it would be a large release or at least a bypass release.

The number he noted interestingly enough, about the same place as NUREG-0844's conclusions, but with different things contributing to it. NUREG-0844 had a lot of contribution from multiple tube ruptures that were sort of non-mechanistically assumed to occur. We weren't sure

whether they could or could not be induced by different physical phenomena. We revisited some of those. We think that the probability of inducing a large number of tube ruptures is pretty small.

On the other hand, the failure to mitigate one tube rupture was put in the one times 10 to the minus three range. The failure to mitigate two or more tube ruptures was put in the one times 10 to the minus two range.

In NUREG-0844, we tried to reproduce the one times 10 to the minus three number for a failure of one to three tubes, which looked like they behaved thermodynamically similarly.

Our consultants came back with the human error probability of one times 10 to the minus two. So what we really have is something that's dominated in either case by an estimate of the human error probability. We know we're not very accurate at those.

So we think we're somewhere in the vicinity at the low 10 to the minus six per year for damage with containment bypass frequency range. We know it's based on some of the things we have the hardest time estimating.

I should add that this is about a third of the work we've done in the estimation, the risk estimation process. We also consider spontaneous rupture, to

mitigate that. We also will talk to you in a lot of detail tomorrow about considering sequences that get to core damage before the secondary boundary -- before the primary and secondary boundary is breached. The core damage progression itself is the tube ruptures. We did a lot of technical work on that as well. That's what we will describe tomorrow.

We tried to do the complete risk assessment with all three of those components, and ask the question, do we believe that the rule as we have written it, would result in a satisfactory level of risk if the rule is complied with.

CHAIRMAN SEALE: Okay. We'll look forward to hearing from you tomorrow then.

Any other questions or comments? Are we ready for the next presentation on the EPRI PWR examination guidelines? It looks like we are.

MR. SMITH: Okay. Good afternoon. This is the final presentation of the day. I know people are getting tired at this point. I'll try to be brief and go through this as quickly as possible.

MEMBER KRESS: Is that your real name?

MR. SMITH: My name is John Smith. Yes, it is my real name. I am from Rochester Gas and Electric. I usually use the F. because when I get to the hotel room,

otherwise it's not --

MEMBER POWERS: They look around and see who you are with. They wonder.

MR. SMITH: I do work for Rochester Gas and Electric. I am currently the maintenance superintendent at Ginna Station. I am also the technical lead for the steam generator management project issue resolution group dealing with ISI.

CHAIRMAN FONTANA: You had one of the first ones, didn't you?

MR. SMITH: Pardon me?

CHAIRMAN FONTANA: You had one of the first ones, didn't you? One of the --

MR. SMITH: First tube ruptures?

CHAIRMAN FONTANA: Yes. Well, steam generator problem. About 10 years ago?

MR. SMITH: Yes to both, I guess.

CHAIRMAN FONTANA: Okay. Keep going.

MR. SMITH: By way of the presentation outline, I will give a brief introduction, talk a little bit about the industry perspective on steam generator rule making, utility implementation of steam generator ISI, basically how utilities would implement the ISI program.

We'll talk about the steam generator examination guidelines, rev. 4, basically outline what's

in the rev. 4 guidelines. I am not sure how familiar most people are with those. Talk about some of the more specific issues addressed by Rev. 4, a little bit about Rev. 5, which we have already started to work on to address some of the concerns that you have heard today. Finally, some conclusions.

By way of introduction, I will start off by saying that there is significant agreement between the draft reg. guide and rev. 4 of the industry examination guidelines. There are a lot of things that we have heard today from both the staff and from the industry that are in agreement with each other.

We do believe that there are some parts of the reg guide that need clarification. I have listed three of those here, probably three of the more substantial ones in our opinion, validation, supplemental performance demonstration, and the basis for the buffer zone.

We have, incidently, met with the staff on at least a couple of different occasions to talk about the reg guide and specifically, the NDE portion of that. I think we are trying to set up another meeting in the near future here to address some of these concerns, to come to some agreement on those.

I guess to talk just a little bit more about validation and supplemental performance demonstration,

throughout the guidelines or throughout the draft regulatory document, you will see a mention of the ISI guidelines, things like appendix G and appendix H. So if you were to take the validation to the limit based on the comparisons to appendix G and appendix H, that could mean that in order to validate a particular technique, that each utility for each plant could end up pulling 16 tubes for each defect mechanism.

I am not sure that that's in fact what the Commission is advocating, but taking it to the limit, that certainly is a possibility. We don't believe that that's really feasible or that that's really the thing that we should be doing.

I mentioned earlier that rev. 5 of the industry examination guidelines are being prepared. We're trying to make some clarifications in rev. 5 and to enhance some of the requirements.

The current guidelines contain methodologies for the qualification of probes and techniques. That's appendix H to the guidelines. Qualification of analysts, that's appendix G to the guidelines. We already have in there a section dealing with site specific training requirements. That's contained in the body of the guideline.

Qualification and training are updated as new

data becomes available. So that we learn something from tube pulls. We incorporate that back into the guideline.

I think over the years that we have learned a lot about steam generator ISI. In particular, over the last several years there have been significant advances in steam generator NDE. Recognizing that there are still issues that remain. There are some significant issues that remain.

I guess one of the major issues remaining, I know it's been touched on a couple of times today already, is how you deal with small volume flaws, the things that are less than 40 percent through wall. In many cases, utilities are penalized for using the most up to date probes and techniques. They find things that can be detected but not sized and then are into a plug on detection. So we think that there is some penalty to utilities that use the most current technology available.

The industry has spent significant resources over the last five years on improving steam generator NDE. I put some numbers down here. The EPRI guidelines that I am talking about right now, we spent over 500,000 dollars on those.

The QDA or quality -- QDA program, qualified data analyst program and maintenance of that, 2.5 million dollars. I have said conservatively that utilities have

spent upwards of 15 million dollars. I say that's a conservative number because in coming up with that, I said that 30 utilities have spent 100,000 dollars a year for five years. This does not involve qualification of new probes or development of new probes, but it's really things like the guidelines, coming to meetings like this, doing site specific performance demonstrations on their own sites. The industry has spent a lot of money to work on this problem.

I don't know whether I should put up this slide. When Mike Tuckman put this up this morning, he got a lot of reaction, but I will put it up in any case.

This box right here I think has been changed in the handout, but here it says regulatory document. NEI doesn't really do that. It's really the NEI industry document. The reason I put this up is that there is a specific section of the NEI industry document that deals with NDE issues. I will talk about that in the next slide. But this right here, the EPRI inspection guidelines are really the gist of this presentation, so I won't dwell on this slide any more. I think we've talked about that enough.

But if the industry perspective on how the regulatory guide and the regulation works, if that in fact does happen, things that would go in the NEI industry

document really become requirements that would be reviewed and approved by the NRC. By doing this then, those are things that every utility in fact has to abide by.

I will go over these because I think these are important. They are also, these are all included in -- the details of these are in the EPRI guidelines.

Inspections shall be done with qualified techniques. That's an appendix H requirement of the guidelines. Analysis shall be performed by qualified data analysts. That's appendix G of the guidelines. Minimum sample size of 20 percent, which we have already talked about earlier today. I think there's agreement on that.

Sample expansion as required by the ISI guidelines. So if you start finding things and expand, there are details of that. Independent data analysis review teams, one of the things we have never taken any credit for or been able to take any credit for is the fact that there are in fact two teams of analysts. Discrepancies between the two are resolved.

No steam generator shall go uninspected for more than two cycles. Preservice examinations shall be performed prior to startups. This is for new steam generators. A hundred percent ISI at the first refueling outage, using qualified techniques.

Management involvement in the steam generator

program. We think that's a very important part. There's a whole chapter in the guideline that deals with that.

Utility self-assessments to monitor guidelines compliance. The way we have handled this, and I think this was mentioned earlier, is that we have had info. coming in and auditing utilities starting this year. I think they have done eight or nine of those. I think that's important.

Quality assurance verification of compliance. This really deals with things like are you using the right sized cable lengths that your procedure says you should be using. Are you using the right sized probes, those types of things.

Site-specific performance demonstration and data analysis guidelines. Finally, leakage-forced outage responses, there's an appendix that deals with how you respond to those.

Again, not knowing how familiar some of you are with how utilities do ISI or steam generator ISI, I thought it would be worthwhile just to go through this slide. Typically, a utility inspection scope would be defined by their ISI program. Taking that program then, the utility would put out a bid specification to one or more vendors requesting eddy current services during the outage. Typically, that specification would require a

qualified data analyst to appendix G of the guidelines.

The vendor would deploy to site either just prior to the outage or at the very beginning of the outage, and then go through a site specific performance demonstration required by the ISI guidelines.

The data analysis or acquisition and analysis would then take place with appendix H techniques. The evaluations and repairs would be done as necessary. Then finally, return to service.

You can see how the guidelines fit into the inspection program of the utilities.

CHAIRMAN FONTANA: How long does it take to do an inspection of a steam generator?

MR. SMITH: Well, of course it depends on the number of steam generators and the numbers of tubes. But a week is probably a good number for 100 percent.

I just put these up again, because I am not sure how familiar you are with the background. But these are all the sections that are included in rev. 4 of the guidelines. There's an introduction and a background section. A section that deals with compliance responsibilities. That's the management section. Tube selection procedures, data acquisition, and analysis procedures. Qualification of data analysts and finally, qualification of examination techniques. So those are the

main sections.

Then there are several appendices to the guidelines. First, dealing with steam generator operating experience. That deals with Westinghouse, B&W and CE steam generators. The basis for the recommended examination program, steam generator, NDE experience, site specific data analysis guidelines, the typical steam generator bid specification, definitions.

Appendix G, which we have talked about quite a bit, qualification of NDE personnel for analysis of eddy current data. Appendix H is technique qualification for eddy current of steam generator tubing. There is no appendix I right now.

Appendix J is a technique qualification for UT of steam generator tubing. Finally, appendix K, inspection requirements for forced outages.

We'll talk some more about appendix G and appendix H. Those are very important parts of the guidelines.

Specific issues addressed by rev. 4. Some of these are some of the more important parts of rev 4 of the guidelines. Preservice inspection requirements, in-service inspection requirements, performance demonstration, qualifications of NDE techniques and personnel. This is appendix G and H again. And site

specific performance demonstration.

Now I will talk about each one of those in a little bit more detail. The preservice inspection requirements basically require 100 percent of the tubing to be inspected at the preservice inspection using a general purpose or volumetric probe, a bobbin coil probe.

After hot functional testing for new plants, and after installation for replacement steam generators. As I mentioned earlier, the 100 percent inspection at the completion of the first operating cycle. So that's the preservice inspection requirements.

These are the direction graphically, the inservice inspection requirements. This really starts off with an active damage mechanism identified either yes or no. If it's no, you go down the righthand side. At each refueling outage, you may inspect 40 percent sample of tubes at each steam generator, in each of half of the steam generators.

In the case of gannet, where there are two steam generators, what that means is that at each refueling outage, you could do 40 percent of one steam generator and nothing in the other steam generator. Or at every other refueling outage, you could do 40 percent of both steam generators.

If there is an active damage mechanism, you

must inspect the 20 percent sample of all the tubes in all the steam generators. That also includes plugs and sleeves.

When you get down to the bottom, there are some additional requirements, that you must inspect 100 percent of all tubes in all steam generators within 60 effective full power months. Again, the last bullet there, no steam generator can operate more than two cycles without an inspection.

MEMBER KRESS: How many years is a cycle?

MR. SMITH: Well, it depends. The longest cycle I am aware of right now is 24 months. I think the majority of the people right now are probably 18 months.

MEMBER SHACK: Would the no apply to a replacement steam generator?

MR. SMITH: Yes. In fact, that's actually part of the reason that that's in there now, is to really address the new steam generators with no active damage mechanism. So in fact for gannet, I would start right down that line. So that's the inservice inspection portion.

Important features of the industry performance demonstration program. This is designed with implementation capabilities in mind, both current and future capabilities. An important point is the second one

there, that this program really has been in existence since 1992. So it has served the test of time. We think it has served it pretty well.

We have put more than 200 data analysts through the program. They have become qualified data analysts. Many of those now have gone through that program a second time to become qualified, requalified after the three year interval.

The program addresses both industry generic and plant specific qualifications.

CHAIRMAN FONTANA: How many qualified inspection members are there?

MR. SMITH: I'm not sure. Half a dozen, 10 maybe. I'm not sure if that meant 10 or I don't know. But it's probably in that range. It's probably a half a dozen major vendors.

Elements of the industry performance demonstration program. Appendix H on technique qualifications and appendix G on personnel qualifications really are the keys of this thing. We'll be spending a lot of time on those two appendices when we go through revision 5. They have worked well up to this point, but obviously the more we get into this, the more things we see that we would like to enhance. So we will be doing some of that.

The site specific performance demons ration is really to address plant specific issues, to cover issues that may not have been covered under the industry generic program.

Again, when a vendor comes in to a specific plant, he would be tested on those specific things applicable to that plant.

There is a built-in feedback loop to disseminate industry experience to plants and vice versa. I'll put this slide up. It shows kind of schematically how the performance demonstration program works.

The first box up there on the left, I think this morning when Emmet Murphy was making his presentation, mentioned that appendix H techniques are qualified with saw cuts. Well, that's not exactly true. The majority of the samples that we use are either pulled tube data or laboratory grown samples. There are very few saw cuts in the appendix H techniques. By saw cuts, I mean EDM notches.

On the other hand, appendix G does deal with expert opinion. So the main difference between appendix H is that that's a pulled tube and laboratory sample. Appendix G deals with expert opinion, if you will.

So having said that, we started off with representative samples of various degradation methods and

locations. Qualified techniques using appendix H. Use those techniques in the field to collect data. Qualified analysts using appendix G, analyze the field data, the production mode. Do tube pulls to verify the practices. Then of course feed that information back into that loop.

So it's a continuously updated loop. In fact, we have gone through almost, in fact I think all of the techniques that have been qualified, and updated all of those just over the last several weeks. So we have gone through that loop a number of times. Of course the intent there is to get the most latest and the best information.

Appendix H is technique qualification for detection. It consists of a two-step process. First, to document the capability and known flaws, and then to apply an acceptance criteria.

The technique qualifications are basically as specific in terms of degradation form and location as the available sample set would permit us to be.

This talks a little bit about appendix G. Analysts are tested on field data, as I said earlier, from many different plants and steam generator types. Now there is a reason for this. As I mentioned again, I'll just reinforce that appendix H is pulled tube data. Appendix G is expert opinion. You will see in a slide a little bit later that I think typically when an analyst is

tested, he looks at over 5,000 intersections. That test will take a week to complete. It's just not feasible to have pulled tube data for all of those intersections and all of that information. That's the reason that we use field data and expert opinion.

We have had experts in to test those questions, if you will, to see if the analyst, if what I'll call good analysts get the right answers and bad analysts don't get the right answers. In fact, those tests have proved that our testing methods are acceptable.

Qualified data analysts, QDAs, must stay in practice or loose their qualifications if they don't do data over a certain period of time, they have to go through and be retrained.

There is a training requalification every three to five years. The three years is for the level 2, and the five years for the level 3. QDAs may be subjected to repeated site specific performance demonstrations. Just about every time an analyst goes to a different site, he is retested on a site specific performance demonstration test. So an analyst working for somebody like Westinghouse may take several of these tests every year.

Analysts are tested for each form of degradation separately. They must have a passing score in

each of those. So that would say that you must pass PWSCC. You must pass thinning, and all the different defect types.

Tubes are analyzed in the blind and are examined from tube end to tube end, not knowing what may be in them, if anything that should be. I think that's correct on your handout, but not on this slide. So there may not be anything in a particular tube. In fact, a lot of tubes do have nothing in them.

A typical test, as I said last week, it involves some 5,000 intersections. So it's a difficult test.

I mentioned just a little bit about the site specific performance demonstration program. It tests an industry qualified QDA on plant-specific issues, as I said earlier. So the person is a QDA before he ever gets to the plant.

It's in addition to the annual training required and periodic requalification that each QDA must undergo. As I said, there's no limit on how extensive or frequently the site specific performance demonstration may be applied.

Now I will talk briefly about Rev. 5, and some of the things that we will do in Rev. 5. Basically some rearranging of volumes I and II of the guidelines, are in

two volumes right now, with basically volume I being requirements, and volume II being the details or backup information for those things.

We do anticipate having a draft of Rev. 5 out in the spring, probably about the same time that the reg guide is issued in the spring or at least out for comment I think.

Appendix G and H I mentioned that we'll be updating those in Rev. 5. The expansion criteria will also be updated in Rev. 5, as well as operating experience updates, and incorporation of some of the items from the draft reg guide. Many of those things we have incorporated into Rev. 4 already, based on discussions that we have had with the staff, but we'll also incorporate areas of agreement with Rev. 5. I think it's essential that we continue to meet with the staff to discuss those things so that we can come to as much agreement as possible.

Finally, a few conclusions. We do believe that ISI is the cornerstone of the industry's steam generator program. I think there's a lot of data that indicates that ISI has reduced the number of forced outages, and has reduced the amount of lost capacity in the industry. We believe the performance has improved significantly over the last several years, but we're still

not there. There's still a lot of room for improvement.

We do have a lot of agreement on the draft regulatory guide. However, there are some significant issues that remain. I have listed these three again, the supplemental performance demonstration, the concept of validation and a buffer zone. Those really are hard spots that we really need to get some resolution on because we do not believe that those are acceptable the way it's currently written in the regulatory guide.

That's the conclusion of my presentation. I'll be glad to try to answer any questions you may have at this point.

MEMBER SHACK: What do you find unacceptable?

MR. SMITH: I talked about validation in the supplemental performance demonstration could get us into pulling as many as 16 tubes for each damage mechanism. Sixteen tubes is probably upwards of three million dollars for each damage mechanism, for each plant. That's unacceptable as far as I am concerned.

CHAIRMAN SEALE: Any other questions? Any observations? Any other comments?

MR. STROSNIDER: I think it's probably appropriate to make one comment with regard to these inspection qualifications and guidelines. That the staff's observation is that they have resulted in a great

improvement in the inspection technology by the industry. So we really do think these are good guidelines. We endorsed them in the regulatory guide to the extent we can. There are some issues we need to work on. We are going to be scheduling a meeting on that.

CHAIRMAN SEALE: Okay. Could I ask, are any of the industry people going to be here tomorrow?

Okay good. I notice you are not on the scheduled program, but on the other hand, you may have comments to make about the staff's presentation. We certainly would be pleased to hear any comments you may be willing to offer.

MR. STEININGER: I just saw some of this stuff.

CHAIRMAN SEALE: I appreciate it. We ran into the same problem.

I want to thank everyone whose presentations obviously had a lot of thought put in them, and it's clear that this is an issue that's been around a long time and people have thought about it very hard.

We will take up again tomorrow morning at 8:30, at which time we will hear from the staff on a variety of issues having to do with the risk analysis that they have performed.

I would ask members of the committee to please

put together any comments, any notes, that might be helpful to us in preparing the agenda for a presentation to the full committee. We will be discussing that particular aspect of the timing and the subjects tomorrow at the end of our session. We do plan to finish this subcommittee meeting by noon. There is another subcommittee meeting for a half a day that will take place tomorrow afternoon.

If there are no other comments -- yes, sir.

MEMBER SHACK: Bob, one issue that seems to keep coming up is the risk analysis. Tomorrow we are going to hear everything on the severe accident part. Is there any way we could get a heads up on the rest of the risk analysis beyond what Steve Long gave us today? I mean I think that issue will come up again at the full committee meeting.

MR. STROSNIDER: Steve and his management are not here to speak for him, but I guess what I would suggest is first of all, that there be the opportunity for questioning tomorrow in those areas that aren't covered obviously, to try to address it to the extent that you have specific questions.

The NUREG report that we talked about is intended to document all of these analyses, and that that will be provided to the committee as soon as it's

complete. We just haven't gotten it done yet.

CHAIRMAN SEALE: Any other comments? With that, I want to thank everyone. I will close the meeting or recess the meeting until tomorrow morning at 8:30. Thank you.

(Whereupon, at 5:16 p.m. the proceedings were concluded.)

C E R T I F I C A T E

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

Name of Proceeding: ACRS JOINT MEETING: MATERIALS AND METALLURGY AND SEVERE ACCIDENT SUBCOMMITTEES

Docket Number: N/A

Place of Proceeding: ROCKVILLE, MARYLAND

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

Corbett Riner

CORBETT RINER
Official Reporter
Neal R. Gross and Co., Inc.

.2

INTRODUCTORY STATEMENT BY THE CHAIRMAN OF THE
MATERIALS & METALLURGY AND SEVERE ACCIDENTS JOINT SUBCOMMITTEE
11545 ROCKVILLE PIKE, ROOM T-2B3
ROCKVILLE, MARYLAND
NOVEMBER 5-6, 1996

The meeting will now come to order. This is a meeting of the ACRS Joint Subcommittee on Materials & Metallurgy and Severe Accidents.

I am Robert Seale, Chairman of the Subcommittee.

The ACRS Members in attendance are:

Mario Fontana, George Apostolakis, Thomas Kress, Dana Powers, and William Shack.

The purpose of this meeting is to hold discussions with representatives of the NRC staff, the Nuclear Energy Institute (NEI), and the Electric Power Research Institute (EPRI) to gather information concerning the technical approach used in developing the proposed risk-informed, performance-based rule and regulatory guide associated with steam generator tube integrity. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate, for deliberation by the full Committee.

Noel Dudley is the Cognizant ACRS Staff Engineer for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on October 21, 1996.

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

We have received no written comments or requests for time to make oral statements from members of the public.

(Chairman's Comments follow:)

The staff briefed this Subcommittee on the status of the activities associated with the development of the proposed rule and regulatory guided concerning steam generator tube integrity during a June 3-4, 1996 meeting. Representatives of the Electric Power Research Institute (EPRI) presented the results of related MAAP code calculations at the same meeting. The minutes of the June 3-4, 1996 Subcommittee meeting are in the notebook.

During the June 12-14, 1996 ACRS meeting, the Committee heard presentations by representatives of the staff and the Nuclear Energy Institute (NEI) on this matter. Today the Subcommittee will hear from representatives of the staff, NEI, and industry concerning the latest draft of the proposed rule, regulatory guide, and industry implementing documents. Tomorrow the Subcommittee will hear from the staff concerning the technical basis for the proposed rule.

We will proceed with the meeting and I call upon Brian Sheron, Director, Division of Engineering, NRR, to begin.

Steam Generator Proposed Rulemaking

ACRS Materials and Metallurgy Subcommittee
and Severe Accidents Subcommittee

November 5, 6, 1996

Brian W. Sheron, Acting Associate Director
for Technical Review
Office of Nuclear Reactor Regulation
(301) 415-1274

AGENDA FOR DISCUSSIONS

- Introduction -- Brian Sheron
- Draft SG rule -- Jack Strosnider
- Draft SG regulatory guide:
    - Tube integrity -- Emmett Murphy
    - Leakage Monitoring -- Joe Donoghue
    - Risk guidance -- Joe Donoghue
    - Dose Assessment -- Jack Hayes
- Safety analysis supporting draft SG rule -- Joe Donoghue, et al.

MEETING OBJECTIVE

- Provide ACRS with the technical basis for the proposed rule, proposed regulatory guide, and supporting risk technical work

- Achieve ACRS endorsement on the technical basis for the draft rule for the staff to proceed with issuance of the proposed rule for public comment

INTRODUCTION

- Previously briefed ACRS regarding the SG rule and supporting technical work on:

- June 3 and 4, 1996--provided an information/status brief on technical work supporting the SG rule

  -- Discussed draft rule, draft RG, and technical approach to assess risk (not details or results)

- September 12, 1996--RES discussed the T/H codes used to calculate T/H conditions during a severe accident

- Staff plans to send the draft rule package to ACRS (at the same time it goes out for office concurrence) to get ACRS comments on the draft rule package

SCHEDULE FOR ISSUANCE OF DRAFT SG RULE

- Staff schedule for SG rulemaking:

- Proposed rule package to the chairman: Feb 1997

  -- Meet with ACRS on November 5 and 6, 1996 (today)
  -- Office Concurrence -Dec 1996
  -- CRGR meeting -- Jan 1997

- Issue proposed rule/regulatory guide: approx. 3/97

- Issue final rule/regulatory guide: approx. 3/98

INTERACTIONS WITH NEI AND INDUSTRY ON SG RULE

- Staff and industry have met periodically at both the technical and management level and discussed progress on the rule and technical issues and differences between the draft RG and NEI implementing document

  - Technical meetings on structural integrity issues, radiological protection issues, systems issues, severe accident/risk issues

  - Goal was to resolve as many technical issues and differences as possible within the time constraints of the draft SG rule schedule

  - Technical issues and differences remain between industry and the staff regarding the proposed SG rule, associated regulatory guidance, and risk work

  - Believe that can issue proposed rule for public comment and continue to address remaining issues/differences in the interim and as part of the public comments

POLICY CONSIDERATIONS

- o Two significant policy considerations are involved with development and issuance of the proposed rule :

- Severe accident risk within rule framework: How to address severe accident risk within the regulatory framework --including within the rule, RG, and the 50.109 backfit analysis

- Performance-based approach to tube integrity: How much flexibility (i.e. how "performance-based") should NRC afford to the industry given safety significance of tube integrity

Proposed Steam Generator Rule

ACRS Materials and Metallurgy Subcommittee and Severe Accidents Subcommittee

November 5, 6, 1996

Jack Strosnider, Acting Deputy Director
Division of Engineering
Office of Nuclear Reactor Regulation
(301) 415-3298

STEAM GENERATOR RULE ATTRIBUTES

- Performance-based:
  - Tube condition monitored against staff approved performance criteria
  - Not prescriptive

- Risk-informed:
  - Considers safety functions under design basis and severe accident conditions
  - Based on PRA insights

STEAM GENERATOR RULE ATTRIBUTES CONT'

- Adaptable:
  - To new forms of degradation
  - To new inspection technologies

- Provide incentive:
  - To apply best inspection technology

STEAM GENERATOR RULE ATTRIBUTES CONT'

- Enforceable

- Key to effective performance based regulation

- Includes elements to assure enforceability

TEXT OF SG RULE

¶ (a) *Applicability*. "The requirements of this section apply to all applicants for and holders of construction permits and operating licenses for commercial pressurized water nuclear power plants."

- Rule applies to all PWRs

- Requirements need to be updated for all plants

- Rule allows flexibility to address old and new vintage steam generators

TEXT OF SG RULE CONT'

¶ (b)(1) *Requirements*. "Each licensee subject to the requirements of this section shall monitor and maintain the condition of the steam generator tubes consistent with the performance criteria in paragraph (b)(3) to provide reasonable assurance that the steam generator tubes remain capable of fulfilling their intended safety functions. The steam generator tubes are relied upon to function as part of the reactor coolant pressure boundary, to isolate radioactive fission products in the primary coolant from the secondary system and the environment, to function as a heat transfer surface for removing residual heat to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition, and to prevent or mitigate the consequences of design basis accidents. In addition, the tubes are relied upon to maintain their integrity consistent with containment objectives of preventing uncontrolled fission product release under conditions resulting from core damage severe accidents."

TEXT OF SG RULE CONT'

- Objective
  - Provide reasonable assurance SG tubes are able to perform their intended safety functions

- Safety Functions
  - Reactor coolant pressure boundary
  - Containment function
  - Heat removal
  - Design basis accidents
  - Severe accident consideration specifically addressed

TEXT OF SG RULE CONT'

¶ (b)(2) *Requirements*. "The licensee shall notify the Commission within 24 hours and shall take appropriate corrective action if the condition of the steam generator tubes does not meet performance criteria in paragraph (b)(3)."

- Reporting Requirements

  - Prompt notification required if performance criteria are not met
  - Allows NRC to take appropriate actions e.g. enforcement consideration
  - Licensee responsible for corrective actions

TEXT OF SG RULE CONT'

¶ (b)(3) *Requirements*. "To provide reasonable assurance that the tubes remain capable of performing their intended safety functions, NRC approved performance criteria shall be established which are commensurate with adequate tube integrity under the conditions of normal operation, including anticipated operational occurrences, design basis accidents, external events, and natural phenomena for which the tubing must perform the functions identified in paragraph (b)(1). These performance criteria shall include criteria for tube structural integrity, operational leakage integrity, and accident-induced leakage integrity and shall be established consistent with the following:"

○ Performance Criteria:

- Require NRC approval

TEXT OF SG RULE CONT'

- Address structural integrity and leak tightness under normal and postulated accident conditions

- Must be MEASURABLE'(calculable) TOLERABLE

TEXT OF SG RULE CONT'

¶ (b)(3)(i) *Requirements*. "Structural Integrity Criteria: All tubes shall retain margins of safety against rupture consistent with the stress limits of the ASME Boiler and Pressure Vessel Code, Section III, 1989 edition. Alternatively, the probability of tube ruptures as initiating or consequential events shall be limited such as to ensure compliance with 10 CFR 50, Appendix A, General Design Criteria 14 and 31, and low risk."

- Structural Integrity Criteria

  - Deterministic criteria in accordance with ASME Code consistent with the rest of the RCPB

  - Probabilistic criteria consistent with risk assessment, GDC, and balanced approach to managing SG degradation

TEXT OF SG RULE CONT'

¶ (b)(3)(ii) *Requirements*. " Operational Leakage Criteria: Operational primary-to-secondary leakage in each steam generator should not exceed a value consistent with providing reasonable assurance against abnormal leakage or gross rupture of the tubing."

○ Operational Leakage Criteria:

- Monitoring of primary-to-secondary SG leakage similar to current tech spec requirement

TEXT OF SG RULE CONT'

¶ (b)(3)(iii) *Requirements*. "Accident-Induced Leakage Criteria: The potential primary-to-secondary leakage rate associated with the most limiting postulated accident shall not exceed the total charging pump capacity of the primary system and shall be such that the associated offsite dose consequences are in accordance with 10 CFR Part 100 guidelines or some small fraction of Part 100 guidelines, as appropriate to the accident, and the associated radiological consequences to control room personnel are in accordance with 10 CFR 50, Appendix A, General Design Criteria 19."

○ Accident Leakage Criteria:

- Limited to make up capacity to avoid operator challenges

- Doses conservatively calculated

TEXT OF SG RULE CONT'

¶ b.4.(i) a-f. *Requirements* " To ensure the performance criteria are met, each licensee shall:

(i) Manage the types, extent, and severity of degradation that may affect the steam generator tubing through a combination of:

a) preventive measures, as practical, to minimize the potential for tube degradation and to mitigate active mechanisms,
b) inservice inspection of the tubing with respect to acceptance criteria for degraded tubing,
c) plugging and/or repair of tubing which fail to meet the acceptance criteria,
d) monitoring of operational primary to secondary leakage and implementing leakage limits such that the applicable performance criteria is not exceeded,
e) monitoring of the "as-found" condition of the tubing during each inservice inspection with respect to the applicable tube performance criteria (i.e., condition monitoring), and

TEXT OF SG RULE CONT'

f) monitoring of the projected condition of the tubing calculated to exist during future operation with respect to the applicable tube performance criteria (i.e., operational assessment),

such that there is reasonable assurance that the performance criteria are not exceeded"

- Programmatic Requirements:

- Assures a balanced approach
- Along with b.4.(ii) provides enforceability
- Non-prescriptive

TEXT OF SG RULE CONT'

¶ (b)(4)(ii-iv) *Requirements*. "(ii) Utilize inservice inspection systems (i.e., techniques, procedures, and personnel) which have been demonstrated to be reliable for all flaw mechanisms affecting the tubing such that plugging or repairs may be implemented before the performance criteria are exceeded.

(iii) Utilize inspection and/or test methods and analysis methods for condition monitoring such as to provide high confidence in the assessment of the condition of the tubing relative to the performance criteria.

(iv) Utilize analysis methods for operational assessment such as to provide high confidence in the evaluation of the projected condition of the tubing relative to the performance criteria."

○ Programmatic Performance:

- Establish expected performance

TEXT OF SG RULE CONT'

- Non-prescriptive and performance based
- Provide enforceability
- (ii), (iv), and (v) are critical to assuring performance criteria are MEASURABLE (calculable) (Issue exist regarding need for NRC review/approval of these items)

TEXT OF SG RULE CONT'

¶ (b)(5) *Requirements*. "Licensees shall maintain measures for mitigating the consequences of occurrences involving abnormal leakage or gross rupture of the tubing."

- Mitigating Measures:

  - Part of defense-in-depth

  - Operator training, EOPs, etc.

TEXT OF SG RULE CONT'

¶ (b)(6) *Requirements*. " Licensees shall take reasonably achievable measures necessary to preserve the steam generator tube function as a barrier against the uncontrolled release of fission products."

- Intended to Address Severe Accidents:

- Steam Generator tubes contribute to fission product containment

- Reasonableness of measures: judged against perceived risk with respect to subsidiary safety goal objective for large release

- Viewed as a defense-in-depth measure which should enhance plant safety

TEXT OF SG RULE CONT'

¶ (c)(1) *Implementation*. "Each licensee subject to the requirements of this section shall submit a request for revision to the technical specifications to implement the provisions of this section no later than [DATE]. The submittal for technical specification revision must contain justification, including supporting analyses and data, if the licensee chooses to deviate from guidance either approved or endorsed by the Commission."

- Implementation:

  - Technical Specification will require amendment

  - Method of implementation dictates degree of NRC involvement

  - Adoption of NRC approved methodology e.g. draft RG or industry implementing document encouraged

TEXT OF SG RULE CONT'

- One year to develop and submit tech spec change seems reasonable

- Requires staff review and approval of 72 tech spec amendments

TEXT OF SG RULE CONT'

¶ (c)(2) *Implementation*. " The requirements of this section supersede the requirements of §50.65 as it applies to the maintenance of the steam generator tubes."

- Relationship to Maintenance Rule:

- Provides unambiguous definition of relationship to maintenance rule

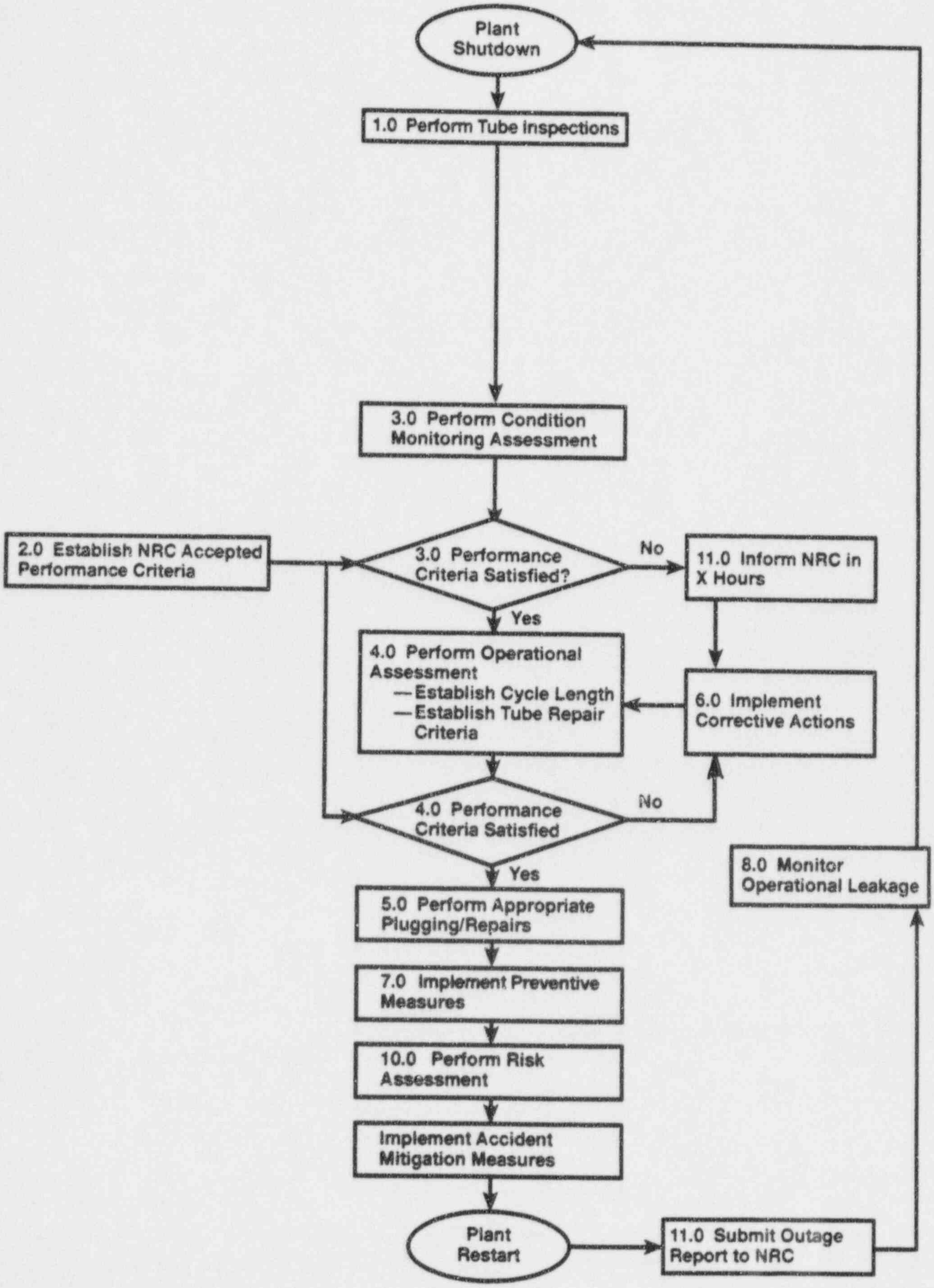
Proposed Steam Generator Regulatory Guide
Tube Integrity

ACRS Materials and Metallurgy Subcommittee
and Severe Accidents Subcommittee

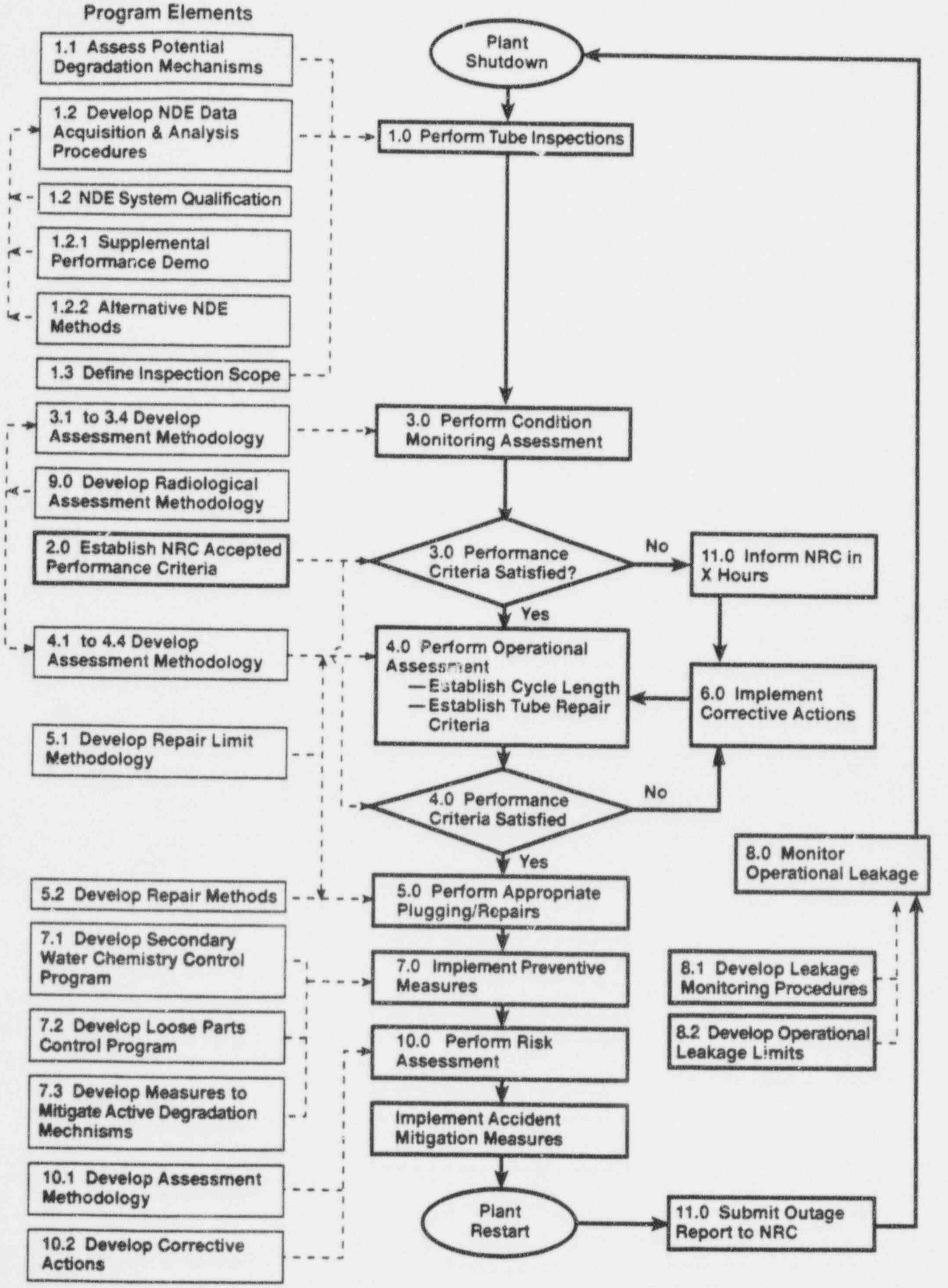
November 5, 6, 1996

Emmett Murphy
Division of Engineering
Office of Nuclear Reactor Regulation
(301) 415-2710

PROGRAM STRATEGY/STEAM GENERATOR TUBE INTEGRITY



PROGRAM STRATEGY/STEAM GENERATOR TUBE INTEGRITY



PERFORMANCE CRITERIA

Reflect following considerations:

- consistent with GDC and low risk
- "measurable" and "tolerable"

Structural Criteria:

- Deterministic:

- all tubes shall retain margins of safety against burst consistent with the stress limit margins in Section III of ASME Code

  -- means margin of 3 against burst under normal operating conditions

PERFORMANCE CRITERIA

Structural Criteria (Cont):

- Probabilistic:

- frequency of SGTRs not to exceed 5X10-3/RY

- conditional probability of ruptures during most limiting postulated accident should not exceed:

  -- 5X10-2 for 1 or more tube ruptures

  -- 2.5X10-2 for 2 or more tube ruptures

  -- 10-3 for 10 or more tube ruptures

PERFORMANCE CRITERIA

Structural Criteria (Cont):

- Probabilistic (Cont):

  - probabilities should not exceed 20% of the above values for given degradation mechanism

Operational Leakage Criteria:

- Operational leakage should not exceed Tech Spec limit

PERFORMANCE CRITERIA

Accident-Induced Leakage Criteria:

- Calculated leakage during limiting postulated events shall:

  - not exceed total makeup capacity of the primary coolant system

  - be such that radiological consequences satisfy 10 CFR Part 100 and GDC-19

INSERVICE INSPECTION

Objectives:

- To identify defective tubes

- To support condition monitoring/operational assessments

Data Acquisition and Analysis:

- "Validated" techniques and personnel, applicable to the specific plant, should be used, when available, for each potential degradation mechanism; i.e.,

- qualified per EPRI guidelines

- supplemental performance demonstration

INSERVICE INSPECTION

Data Acquisition and Analysis (Cont):

- Where validated techniques are not available, may use non-validated techniques provided:

  - technique is best available

  - techniques/personnel are qualified for detection per EPRI guidelines

  - plug on detection

INSERVICE INSPECTION

Frequency of Inspection:

- Scheduled inspections as necessary to satisfy performance criteria
- Unscheduled inspections consistent with current TS requirements

Initial Inspection Sample:

- Random sample per EPRI guidelines

INSERVICE INSPECTION

Expanded Sample:

- Necessary when initial sample identifies active degradation mechanisms

- 100% of affected region of bundle or as necessary to ensure performance criteria are met

Condition Monitoring
(Backward Looking)

- Monitor as-found condition of the tubing viz-a-viz performance criteria during each inservice inspection

- May utilize inservice inspection results provided NDE sizing performance has been "validated"

  - Alternative methods, e.g., in-situ pressure testing, may be utilized

- Must account for significant uncertainties such that there is "high confidence" in the assessment of the tubing condition viz-a-viz the performance criteria

  - Confidence levels to be achieved are specified in RG

CONDITION MONITORING

- If performance criteria are not met:
  - notify NRC within 24 hours
  - implement corrective actions prior to restart

Operational Assessment
(Forward Looking)

- Involves calculation of the projected condition of the tubing immediately prior to the next scheduled inspection viz-a-viz the performance criteria

- Must account for significant uncertainties such that there is "high confidence" in the assessment of the projected tubing condition viz-a-viz the performance criteria

- Confidence levels to be achieved are specified in RG

- Implement tube repair criteria, inspection intervals, and/or other measures or corrective actions as necessary to ensure performance criteria will continue to be met

Tube Repair Criteria

- 40% depth-based criterion

  - subject to demonstrating by operational assessment that the performance criteria are met

- Alternative repair criteria (ARC) may be implemented for specific flaw mechanisms as part of SGDSM strategy

- ARC may not be a fixed value, but a methodology which is implemented as part of operational assessment for determining acceptable ARC value such that performance criteria are met

- SGDSM strategies/technical justification should be documented in technical report reference in plant procedures

Tube Repair Methods

- Tube repairs (e.g., sleeving) may be performed in lieu of plugging
- Tube repair methods are subject to NRC review and approval

Acceptance Criteria

- SGs shall be determined OPERABLE for a period not exceeding 90 days following plant restart from inspection outage after:

  - all tubes with indications exceeding applicable repair criteria have been plugged or repaired

  - preliminary operational assessment and accompanying corrective actions, as necessary, have been completed such as to demonstrate that the performance criteria will be met during the 90 day period

- The OPERABLE status period may be extended to the next scheduled SG inspection upon completion of the final operational assessment, and any additional corrective actions as necessary, demonstrating that the performance criteria will be met throughout the period prior to the next schedule inspection

Reporting Requirements

- A report shall be submitted with 90 days following restart from each inspection outage addressing:

  - description/results of inservice inspection/repairs performed
  - description/results of condition monitoring
  - description/results of operational assessment
  - description of corrective actions, if any

- Submit report with 24 hours, if condition monitoring fails to demonstrate performance criteria are met

Preventive Measures

- Secondary Water Chemistry Program
- Control of Loose Parts/Foreign Objects

Proposed Steam Generator Regulatory Guide
Leakage Monitoring and Risk Guidance

ACRS Materials and Metallurgy Subcommittee
and Severe Accidents Subcommittee

November 5, 6, 1996

Joe Donoghue
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation
(301) 415-1131

LEAKAGE MONITORING

- Objectives: Contribute to prevention of SGTR, and assist in mitigation
- Diversity of methods recommended (N-16 emphasized)
- Recommend low power and hot shutdown monitoring
- EPRI Guidance highlighted:
  "PWR Primary-to-Secondary Leak Guidelines"
- Action Levels recommended: Predefined strategy of escalated monitoring measures as leakage increases
- Limits based on EPRI guidelines: (in Tech Specs)

  - 150 gpd leak rate
  - 60 gpd/hr change in rate

  } Shutdown required

SEVERE ACCIDENT RISK ASSESSMENT

- Recommended licensee alternatives to address severe accident SGTR risk consistent with Commission safety objectives:

  a. Based on PRA implementation guidelines, show low (10^{-6} per reactor year) frequency for events leading to potential tube thermal failure.

  b. Demonstrate low conditional tube failure probability

  - Needed if frequency determined in (a) not acceptable

  - Goal is to show combination of challenge frequency and failure probability consistent with Commission safety objectives.

- **Combination of plant and procedural modifications if unable to demonstrate acceptable level of risk through analysis in steps (a) and/or (b)**

  Risk reduction of modification should be demonstrated.

Proposed Steam Generator Regulatory Guide
Dose Assessment Guidance

ACRS Materials and Metallurgy Subcommittee
and Severe Accidents Subcommittee

November 5, 6, 1996

Jack Hayes
Division of Reactor Program Management
Office of Nuclear Reactor Regulation
(301) 415-3167

DOSE REASSESSMENT ISSUES

- Doses Assessments reflected in TSs values for 48 hour and maximum instantaneous for RCS activity level of dose equivalent ^{131}I and normal operating leakage.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.16.3

A radiochemical analysis for $\bar{E}$ determination is required every 184 days (6 months) with the plant operating in MODE 1 equilibrium conditions. The $\bar{E}$ determination directly relates to the LCO and is required to verify plant operation within the specified gross activity LCO limit. The analysis for $\bar{E}$ is a measurement of the average energies per disintegration for isotopes with half lives longer than 15 minutes, excluding iodines. The Frequency of 184 days recognizes $\bar{E}$ does not change rapidly.

This SR has been modified by a Note that indicates sampling is required to be performed within 31 days after a minimum of 2 effective full power days and 20 days of MODE 1 operation have elapsed since the reactor was last subcritical for at least 48 hours. This ensures that the radioactive materials are at equilibrium so the analysis for $\bar{E}$ is representative and not skewed by a crud burst or other similar abnormal event.

REFERENCES

1. 10 CFR 100.11, 1973.

2. FSAR, Section [15.6.3].

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.16 RCS Specific Activity

LCO 3.4.16 The specific activity of the reactor coolant shall be within limits.

APPLICABILITY: MODES 1 and 2,
MODE 3 with RCS average temperature (T_{avg}) ≥ 500°F.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME

A. DOSE EQUIVALENT I-131 > 1.0 μCi/gm.	------------Note------------ LCO 3.0.4 is not applicable. ---------------------------- A.1 Verify DOSE EQUIVALENT I-131 within the acceptable region of Figure 3.4.16-1. __AND__ A.2 Restore DOSE EQUIVALENT I-131 to within limit.	Once per 4 hours 48 hours
B. Gross specific activity of the reactor coolant not within limit.	B.1 Perform SR 3.4.16.2. __AND__ B.2 Be in MODE 3 with T_{avg} < 500°F.	4 hours 6 hours

(continued)

C. Required Action and associated Completion Time of Condition A not met. __OR__ DOSE EQUIVALENT I-131 in the unacceptable region of Figure 3.4.16-1.	C.1 Be in MODE 3 with T_{avg} < 500°F.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY

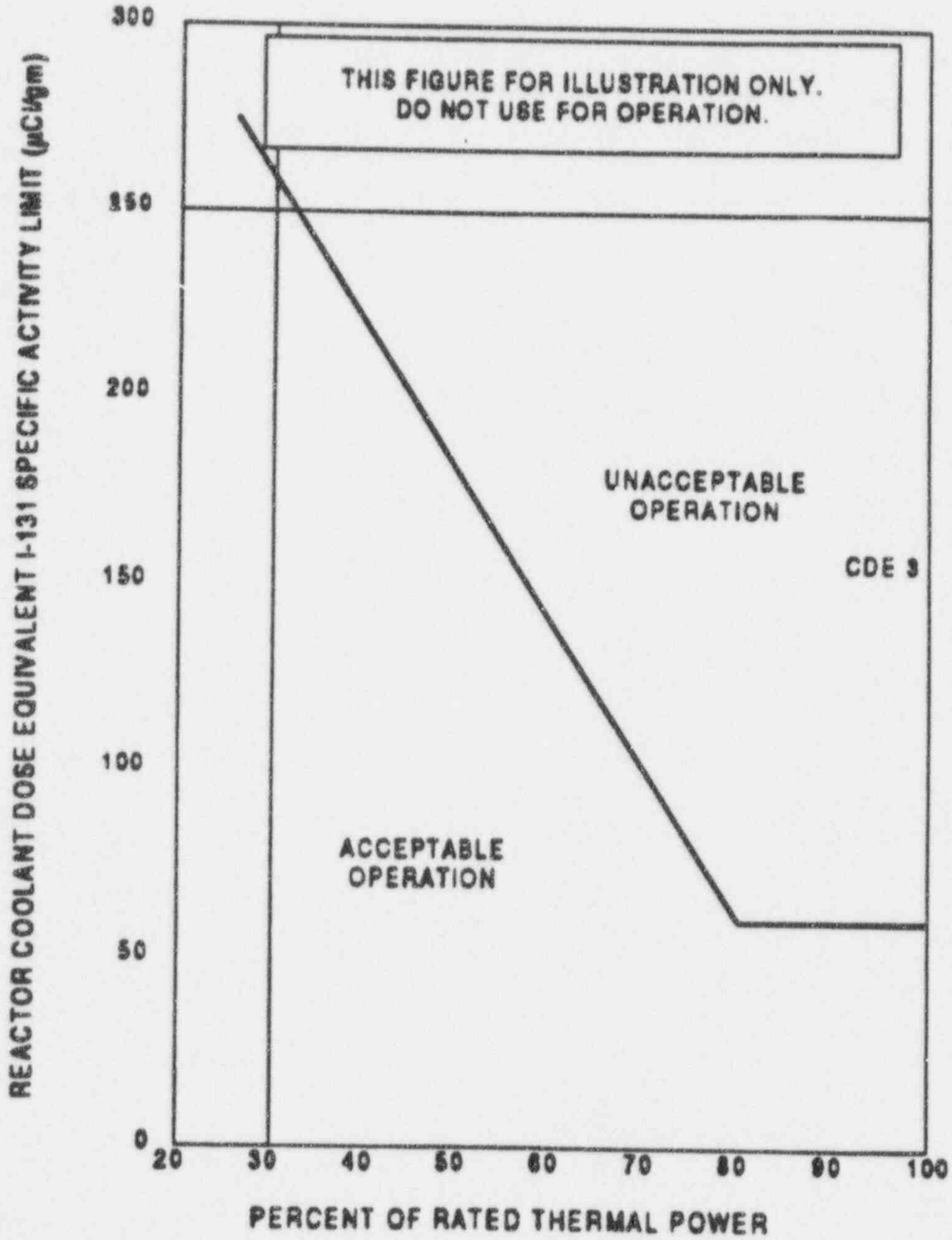


Figure 3.4.16-1 (page 1 of 1)
Reactor Coolant DOSE EQUIVALENT I-131 Specific Activity
Limit Versus Percent of RATED THERMAL POWER

CALCULATION OF SG RELATED DESIGN BASIS ACCIDENTS

- **Pre-existing spike case - Maximum instantaneous value of dose equivalent ^{131}I**
  - **MSLB and SGTR**
  - **Typical value = 60 μCi/gm**
  - **EAB/LPZ acceptance criteria = Full Part 100 (300 rem thyroid, 25 rem whole body)**
  - **TS value for normal operational primary to secondary leakage, typically 1 gpm total or 150 gpd/SG**

- **Accident initiated spike case - 48 hour value of dose equivalent ^{131}I**
  - **MSLB and SGTR**
  - **Typical value = 1 μCi/gm**
  - **EAB/LPZ acceptance criteria = Small fraction of Part 100 (30 rem thyroid, 2.5 rem whole body)**
  - **TS value, operational primary to secondary leakage**

IMPACT OF INTERIM PLUGGING CRITERIA (GL 95-05) ON DOSE ASSESSMENT

- Introduces new term in calculations for a MSLB, event-induced leakage

- Requires projection of degradation rates in the SGs for each operating cycle

- Once utilized, requires a new MSLB assessment for the next operating cycle and probably an amendment request involving the RCS activity levels of dose equivalent ^{131}I.

DOSE ASSESSMENT ASPECTS OF SG RULE

- Intent was to allow licensees to maintain the status quo for those who so chose and to provide an option for those seeking an alternative approach.

STATUS QUO

- Plants without SG Tube Problems

- Plants with SG Tube Degradation Mechanisms

STATUS QUO

- Dose Criteria and TS requirements remain unchanged

  - Part 100 - Pre-existing spike case
  - Small fraction Part 100 - accident initiated spike case
  - GDC 19 for all cases

STATUS QUO

- o Plants with SG Tube Degradation Mechanisms

- Doses Reassessments Required Every Refueling Outage

- Reassessments Frequently Require Revisions to TSs on Normal Operation Primary to Secondary Leakage and RCS Values for Dose Equivalent ^{131}I

DOSE REASSESSMENT CONCLUSIONS

- Mechanism for efficiently handling reviews such as IPC Amendment requests

  - Flex Program

NEW PROGRAM

- Flex Program

- Dose criteria remains the same, Part 100 or a small fraction thereof and GDC 19, but becomes accident specific.
- TSs account for event-induced leakage

FLEX PROGRAM BENEFITS

1. Flexibility of operation
2. Part of TSs
3. Requires initial NRC approval
4. Independent of degradation mechanism
5. Reduces number of amendment requests
6. Eliminates the need for a dose assessment each cycle
7. Focus becomes determination of tube degradation mechanisms and flaw indications

IMPLEMENTATION METHODOLOGY OF FLEX PROGRAM

Pre-existing spike case - Instantaneous TS value for dose equivalent ^{131}I

- RCS activity level is assumed. Start with 60 μCi/gm and end with 1 μCi/gm.
- Primary to secondary leak rate is assumed.
- Doses are calculated.
- Allowable leakage determined based upon assumed leakage multiplied by the ratio of the allowable dose to the calculated dose.
- New value of RCS activity is assumed. Calculation performed as above.
- Iteration continue until value of 1 μCi/gm is reached or allowable leakage is greater than charging pump capacity.
- Allowable RCS activity level is based upon projected leakage rate in the event of a MSLB during the next operating cycle.

PLANT A EVALUATION PRE-EXISTING SPIKE

Assumed Leakage = 3.7 GPM

D. E. ^{131}I	EAB (300)	LPZ (300)	CONTROL ROOM (30)
12	9.6	1.56	0.83
6	4.86	0.787	0.409
1.2	1.08	0.174	0.0897

Factor to Reach 300 REM @EAB = 9.6 REM, [300/9.6] or 31.25; Allowable Leakage = 3.7 X 31.25 or 115.6 GPM

Factor to Reach 30 REM @CONTROL ROOM = 0.83 REM, [30/0.83] or 36; Allowable Leakage = 3.7 X 36 or 118 GPM

ACCIDENT INITIATED SPIKE CASE - 48 HOUR TS VALUE FOR DOSE EQUIVALENT ^{131}I

- RCS activity level is assumed. Start with 1 μCi/gm and end with 0.1 μCi/gm.
- Primary to secondary leak rate is assumed.
- Doses are calculated
- Allowable leakage determined based upon assumed leakage multiplied by the ratio of the allowable dose to the calculated dose.
- New value of RCS activity is assumed. Calculation performed as above.
- Iterations continue until RCS value = 0.1 μCi\gm or allowable leakage is greater than charging pump capacity.
- Allowable RCS activity level is based upon projected leakage rate in the event of a MSLB during the next operating cycle.

PLANT A EVALUATION ACCIDENT INITIATED SPI

Assumed Leakage = 3.7 GPM

D. E. ^{131}I	EAB (300)	LPZ (300)	CONTROL ROOM (30)
1	27.1	8.2	6.7
0.5	13.4	4.17	3.01
0.1	3.56	0.944	0.645

Factor to Reach 300 REM @EAB = 27.1 REM, [300/27.1] or 11.1; Allowable Leakage = 3.7 X 11.1 or 41.1 GPM

Factor to Reach 30 REM @CONTROL ROOM = 6.7 REM, [30/6.7] OR 4.48 Allowable Leakage = 3.7 X 4.48 or

Plant A

Plot of Allowable Leakage

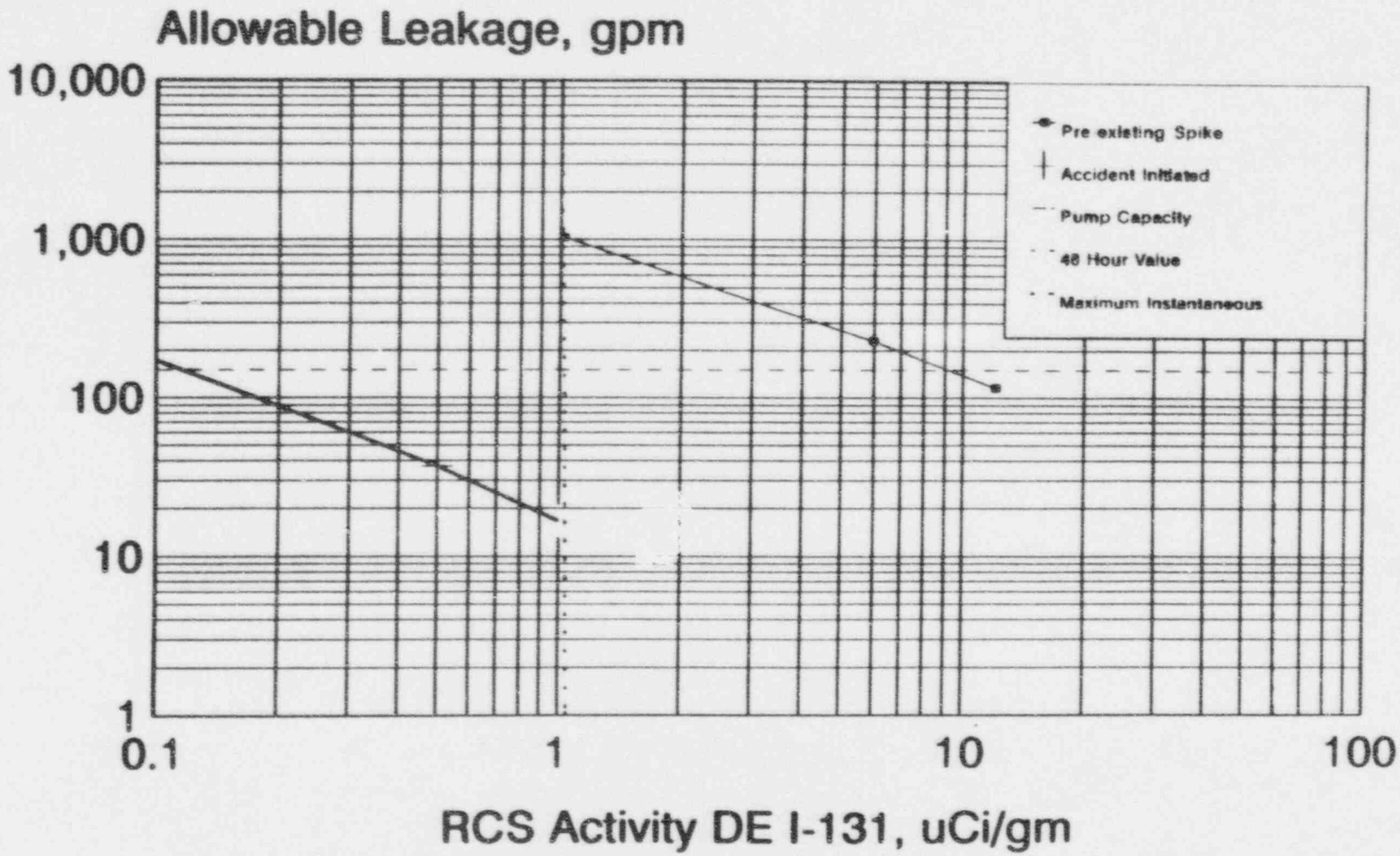


Figure 3.4.16-1A

Plant A

TS Plot of Allowable Leakage

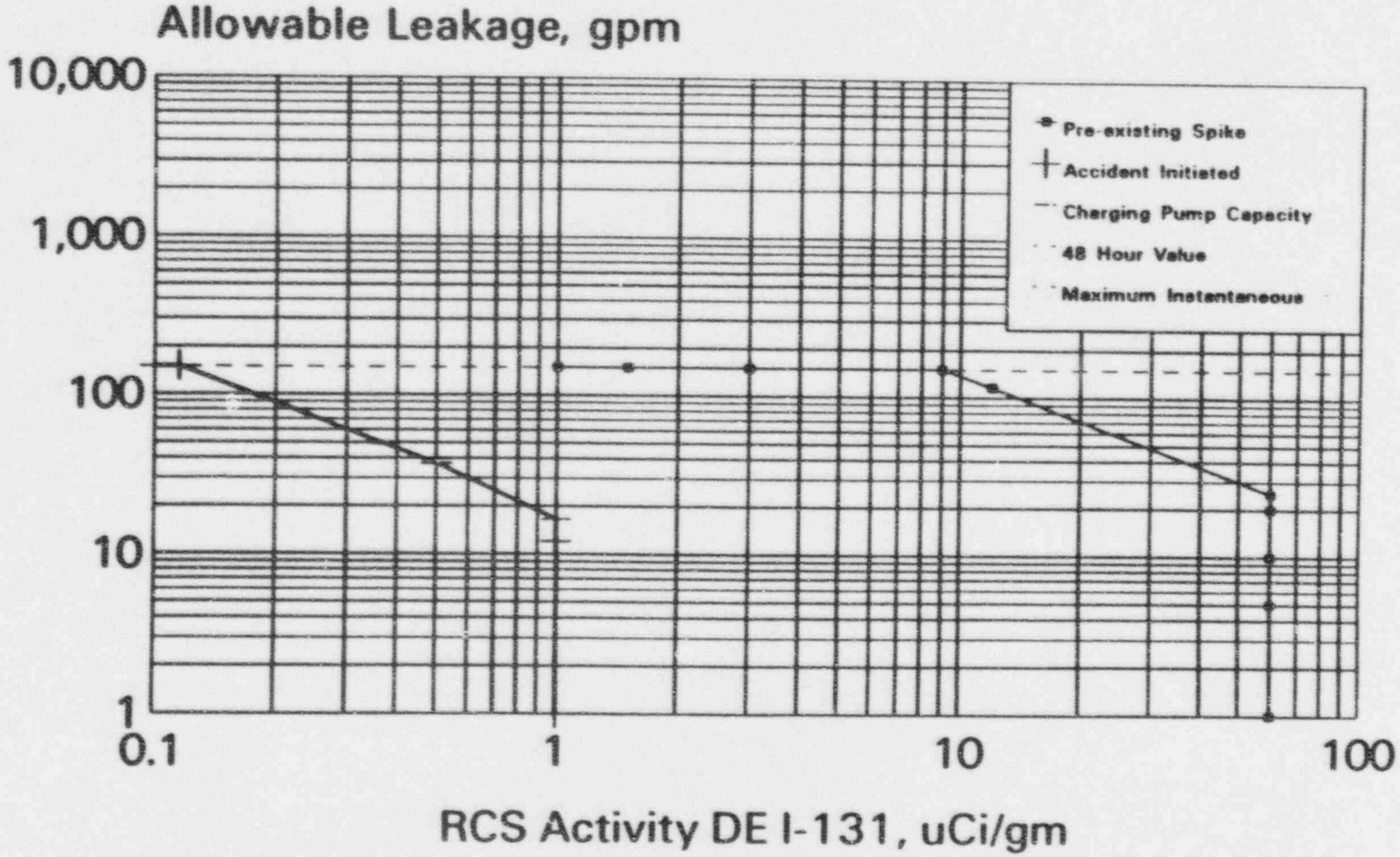


Figure 3.4.16-1A

Plant B

Plot of Allowable Leakage

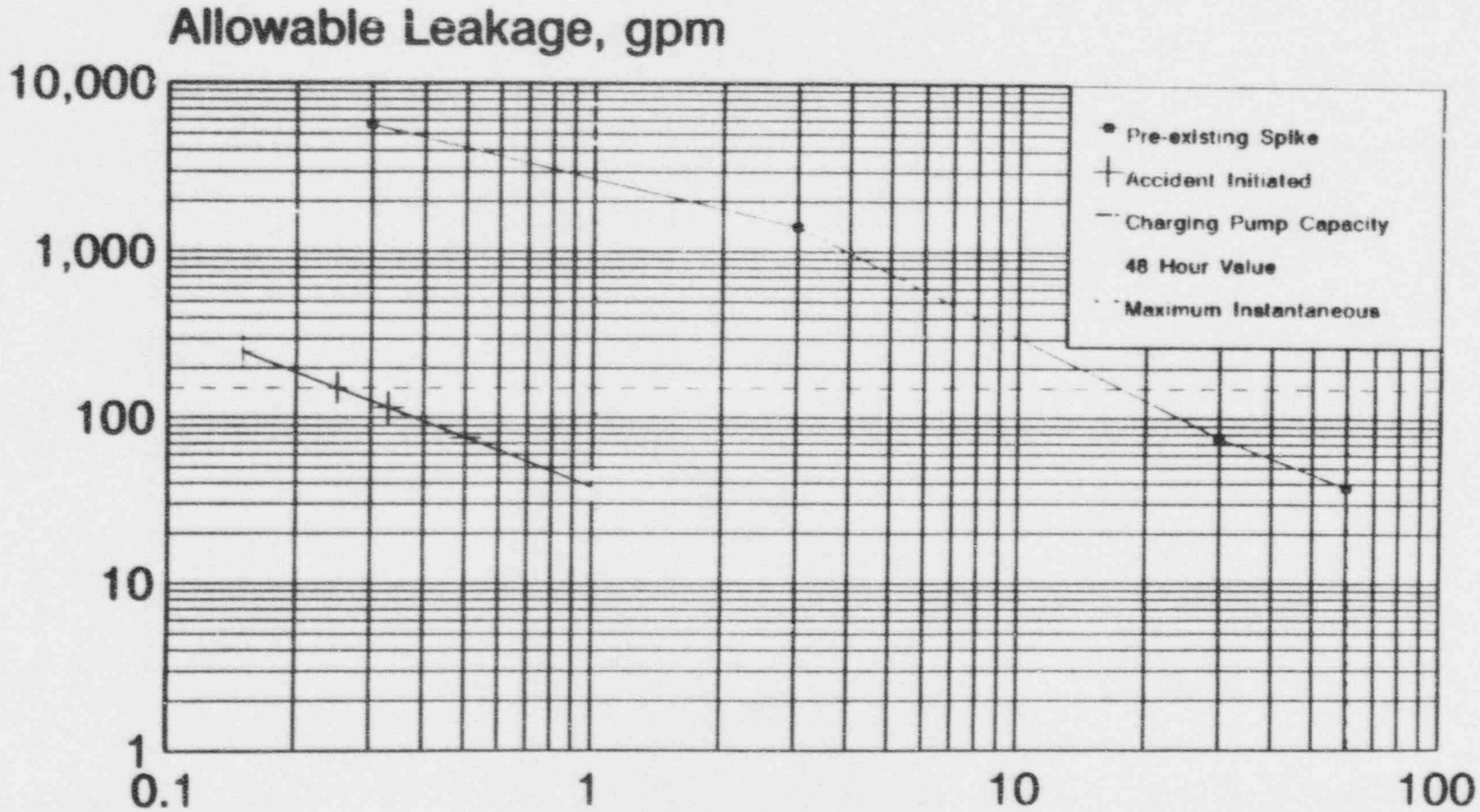


Figure 3.4.16-1B

Plant B

TS Plot of Allowable Leakage

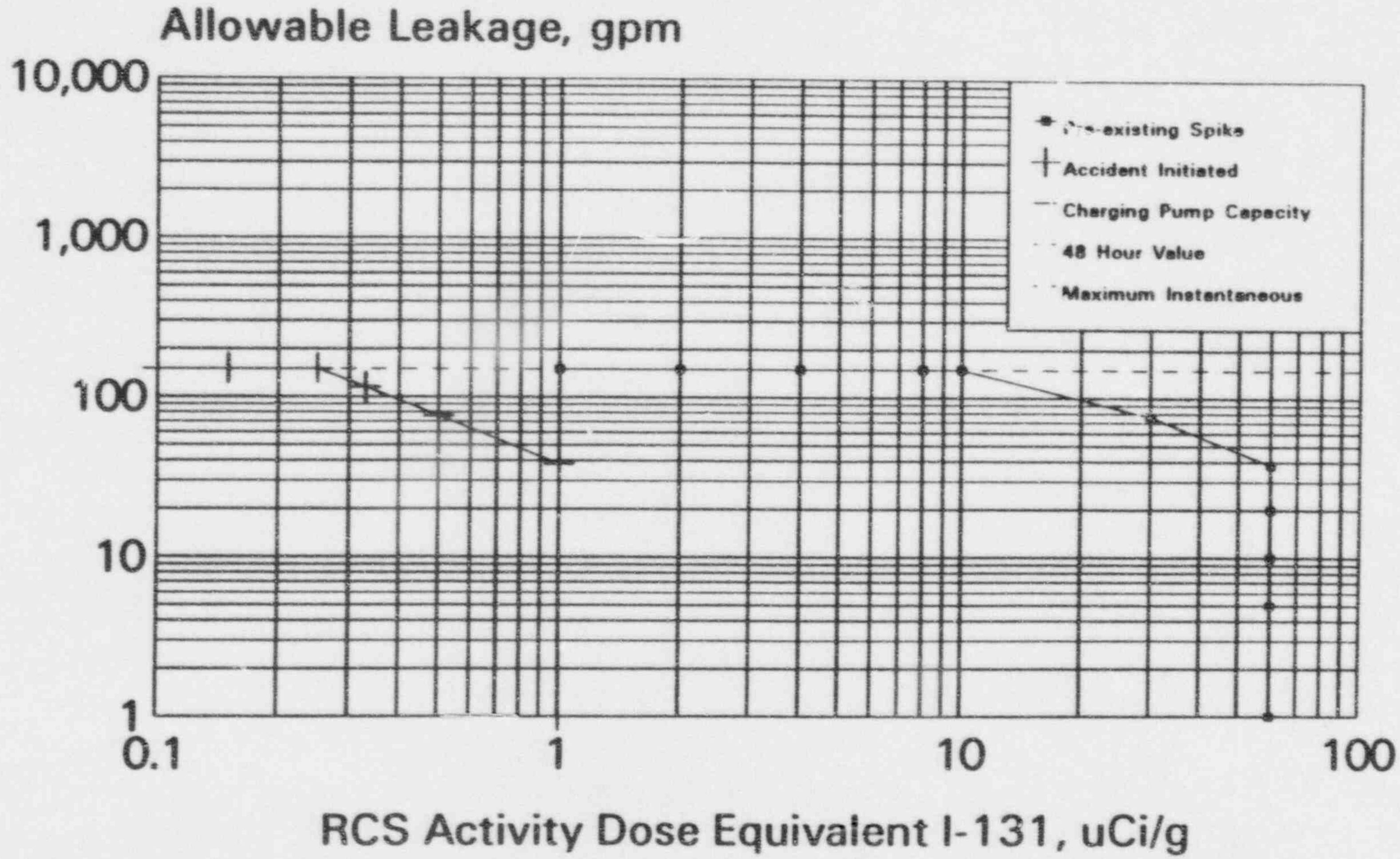


Figure 3.4.16-1B

Plant C

Plot of Allowable Leakage

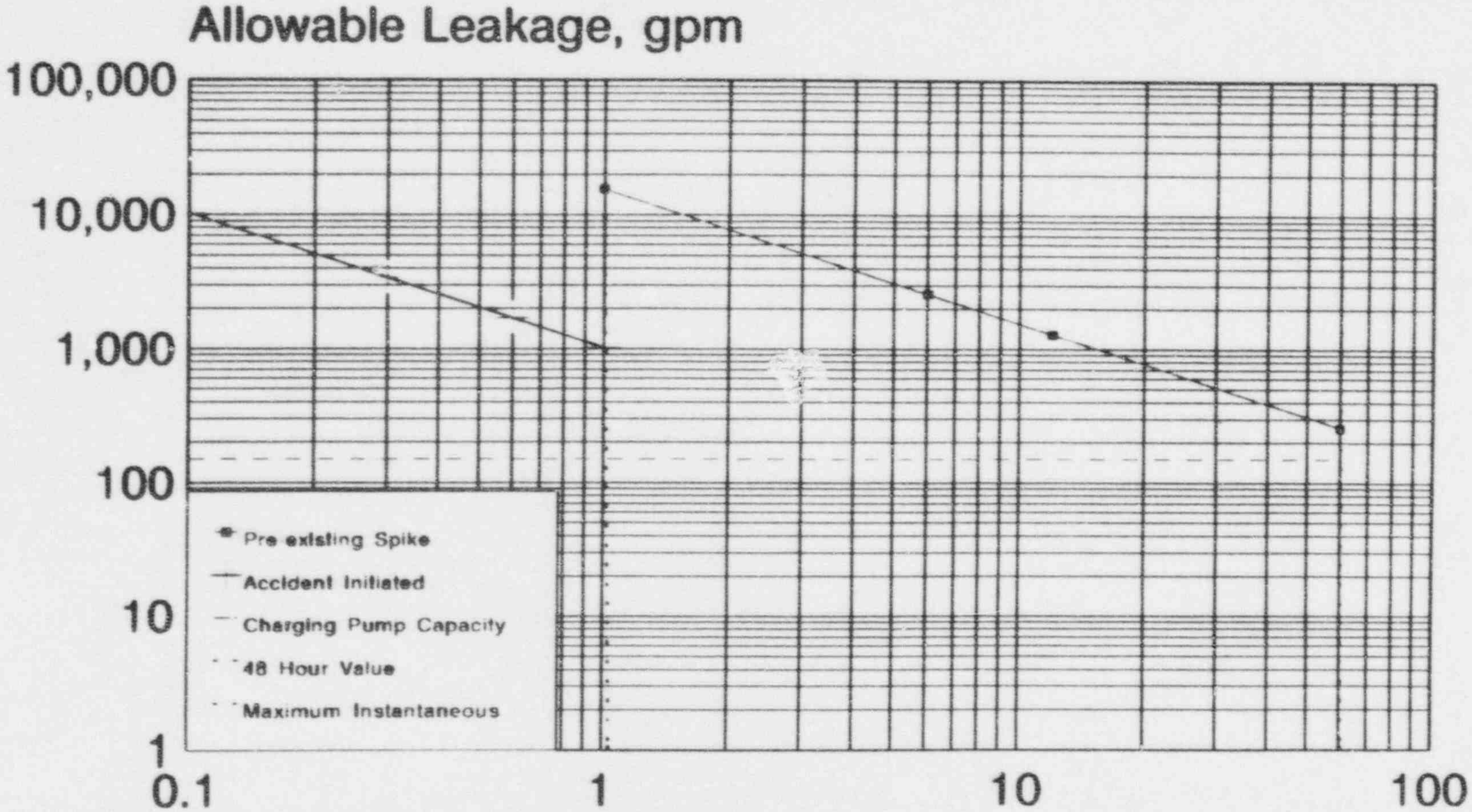


Figure 3.4.16-1C

Plant C

TS Plot of Allowable Leakage

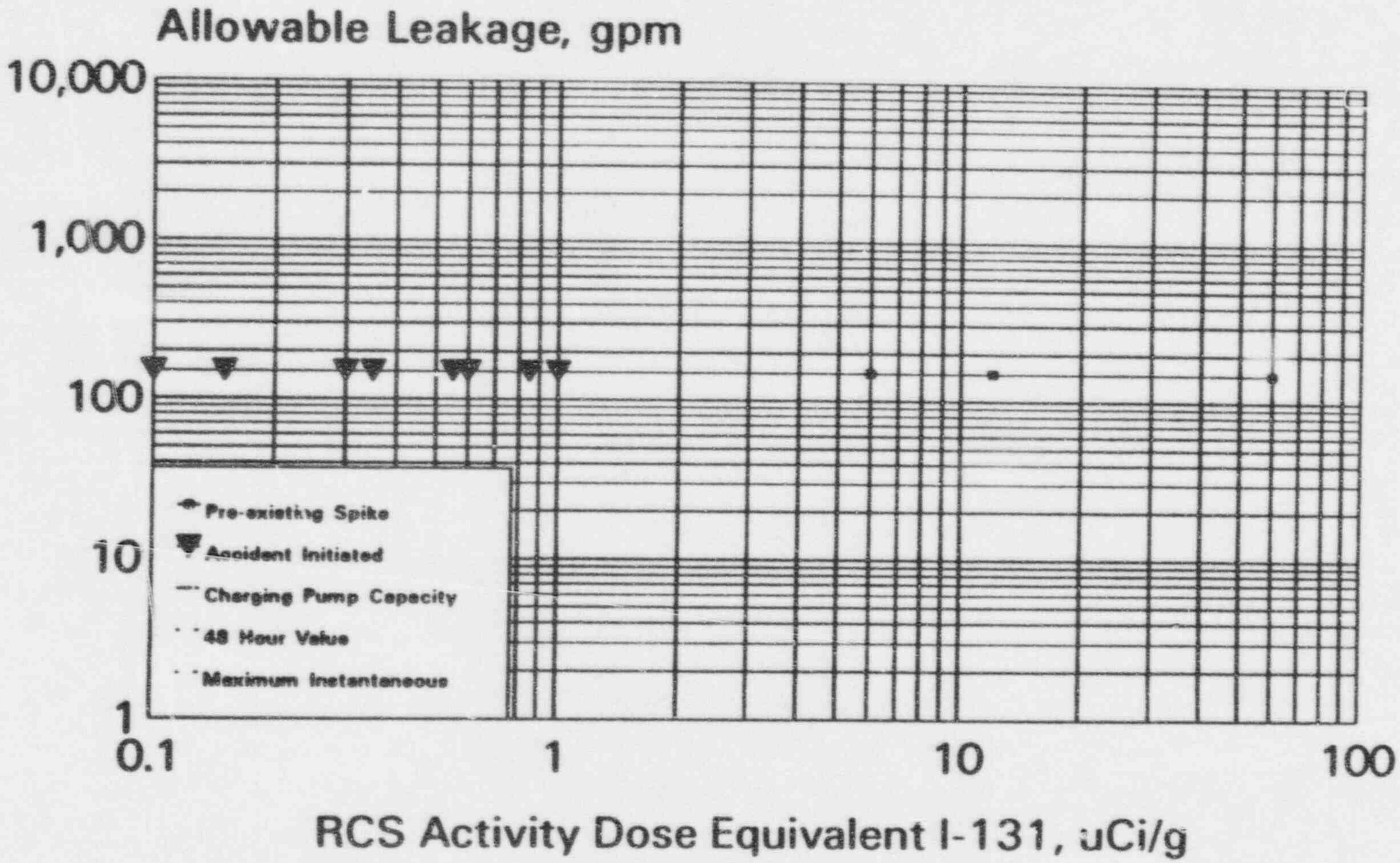


Figure 3.4.16-1C

DOSE REASSESSMENT CONCLUSIONS

- Revisions to dose guideline limits

  - Criteria established based upon the probability of the accident rather than on the probability of an accident initiated spike versus a pre-existing spike.

DOSE REASSESSMENT CONCLUSIONS

- Revisions to thyroid dose guideline limits

CASE	SRP	IPC	SG RULE
MSLB			
Pre-existing spike	300	30	300
Accident initiated spike	30	30	300
SGTR			
Pre-existing spike	300	300	30
Accident initiated spike	30	30	30

7

Steam Generator Rule - Industry

ACRS Materials and Metallurgy/Severe Accident Subcommittees Meeting

November 5-6, 1996

EPRI Rule Issue Resolution Group

NEI Steam Generator Working Group and Task Force

Richard Pearson, EPRI Rule IRG Lead

Northern States Power

1

Industry Topics

- NEI Industry Document Overview - Richard Pearson - Northern States Power
- Deterministic Structural Performance Criteria/Safety Factors -- Tom Pitterle -- Westinghouse
- Probabilistic Performance Criteria -- David Steininger -- EPRI
- EPRI PWR Steam Generator Examination Guidelines -- John Smith -- Rochester Gas & Electric

2

Industry Perspective

- Industry is in general agreement with a performance-based Steam Generator Degradation Specific Management to ensure that tubes fulfill their intended safety function
- Agree with the performance criteria
- Agree with the need for steam generator programs and steam generator integrity assessments
- Disagree with the amount of detail in the draft Regulatory Guide

3

SG Rule Industry Issues

- Assessment of Potential Lifetime Degradation Mechanisms and resultant inspection requirements
- Supplemental Performance Demonstration/ "Validation"/Buffer Zones
- Deterministic Structural Integrity Safety Factors
- Treatment of Deterministic Uncertainties
- 20% Limit on Probability of Burst for one mechanism
- Operational Leakage 150 GPD Enforcement Trip Point

4

Industry Document Changes

- Request NRC to endorse NEI document/simplify Regulatory Guide
- Reformatted to parallel Regulatory Guide requirements
- Performance Measures are now Performance Criteria
- ISI details removed and referenced to EPRI Guidelines
- Added section on *in situ* pressure testing
- Reporting similar to draft Reg Guide
- Changed 40% criteria to maximum measured depth
- Added section on development of an ARC
- Adopted lots of the Reg Guide wording

5

Industry Document Outline

- 1. Introduction
- 2. Performance Criteria
- 3. Evaluation (of tube structural and accident leakage integrity)
- 4. Development of Steam Generator Degradation Specific Repair Criteria
- 5. Steam Generator Program Elements
- Has been rewritten since given to NRC January 1996 -- iterative process

6

Industry Document (ID) - 1. Introduction

- Tubes shall remain capable of performing their intended safety function
- Provide utility assistance in implementing the rule
- Incorporates inspection, assessment, repair, prevention, and leakage monitoring
- Accommodate implementation of SGDSM strategies
- Accommodate new technology

7

ID - 2. Performance Criteria

- Structural -- Maintain adequate tube integrity for the planned operating cycle (no SGTR)
- Accident Leakage -- Consequences do not exceed the lesser of the radiation limits of 10CFR Part 100 guidelines, General Design Criteria (GDC) 19 or normal make-up capacity
- Operating Leakage -- Ensure that if tube leakage exceeds established operational leakage limit, the unit is shut down as a defense-in-depth means for reducing the likelihood of tube failure

8

ID - 2.2 Structural Integrity Performance Criteria

- Deterministic Performance Criterion
  - For normal operation, do not exceed larger of 3600 psi or 1.43 X Accident Delta P
  - For accident conditions, do not exceed 1.43 X Accident Delta P
- Probabilistic Performance Criterion
  - Agree with 5 X 10^{-2}, etc. probabilities of burst, but not with applying 20% to one mechanism
  - Does not include spontaneous normal operating condition probability of burst

9

ID - 2.3 Accident Leakage Performance Criteria

- Defines Normal Makeup
  - Maintain reactor coolant system inventory without the manual or automatic actuation of engineering safeguards features
- Deterministic Performance Criterion
  - Use traditional design basis accident analysis methods with bounding values for input parameters to determine if doses are less than allowable values
- Probabilistic Performance Criterion
  - Use frequency distributions to represent input parameters and calculate the 95% percentile/95% confidence level dose using Monte Carlo methods

10

ID - 2.4 Operating Leakage Performance Criteria

- Initiate plant shutdown in a controlled and timely manner prior to exceeding 150 GPD primary-to-secondary side leakage or if leak rate increase exceeds 60 GPD/HR when leakage is greater than 30 GPD.
- Industry feels this should be treated as a Technical Specification Limiting Condition for Operation and not as a indicator of failure of the steam generator program.

11

ID - 3. Evaluation

- Condition Monitoring -- Structural Integrity
- Condition Monitoring -- Accident Leakage Integrity
- Operational Assessment -- Structural Integrity
- Operational Assessment -- Accident Leakage Integrity
- Each can be done deterministically or probabilistically
- Dose Assessments

12

ID & RG - Condition Monitoring and Operational Assessment

- ID now uses most of the wording of the draft Regulatory Guide for structural and accident leakage integrity with the following exceptions:
  - NDE "validation" -- looking for middle ground
  - Structural limit safety factors interpretation
  - Acceptable uncertainty levels and how to evaluate
    - » Deterministic evaluation conditional probability of burst be less than 10^{-4} for the limiting postulated accident for tube at structural limit

13

ID - 4. Development of SG Degradation Specific Repair Criteria

- Confirm Degradation Morphology
- Determine Tube Structural Limits/NDE C elation
- Qualify NDE inspection technique
- Identify inspection uncertainties
- Determine flaw growth rate
- Tube repair limit based on projected EOC conditions, either deterministic or probabilistic
  - Repair Limit = Struct Lmt -- NDE Errors -- Growth
  - Determine EOC Prob of Burst and Accident Leakage

14

ID - 5. Steam Generator Program Elements

- Inspection
  - **Assessment** of Potential Degradation Mechanisms and **Selection** of Inspection Techniques
- Tube Plugging and Repair
  - **Condition Monitoring Assessment**
  - **Repair Criteria**
  - **Operational Assessment**
- Preventive Measures
- Corrective Actions
- Reporting Requirements

Future Needs of the Industry to Support the ID and the Rule

- Maintenance of EPRI Reports
  - PWR Steam Generator Examination Guidelines
    - » Guidelines for Site Specific Implementation
  - PWR Secondary Water Chemistry Guidelines
  - PWR Primary-to-Secondary Leak Guidelines
  - In-Situ Pressure Testing Guidelines (new)
  - Laboratory Leak and Burst Testing Standards
  - EPRI SGDSM Database
  - PWR Steam Generator Sleeving Assessment Document

Future Needs of the Industry to Support the ID (continued)

- Maintenance of the EPRI ISI Technique Qualification Program
- Handbooks for specific Degradation Mechanisms to cover structural limits, condition monitoring, operational assessments, leakage correlation, NDE techniques, growth predictions, *etc*.
- Industry Experience Database for Assessment of Potential Degradation Mechanisms
- New Guidance on Dose Assessments
- Severe Accident Assessments?

17

ID - 3. Evaluation: Condition Monitoring - Structural Integrity

- Deterministic
  - Need "qualified" NDE technique and personnel to do by analysis (still debating "validated")
  - Assign uncertainty levels to each input parameter
  - May use *in situ* pressure testing when analysis is inadequate
  - NRC suggests overall probability of burst be calculated
- Probabilistic -- we agree with the NRC analytical approach

18

ID - Evaluation: Condition Monitoring - Leakage Integrity

- Deterministic
  - Need an accident leak rate correlation
  - Can be based on *in situ* pressure testing
  - Total leak rate should be bounding estimate with a probability of 0.95 evaluated at the 50% confidence level
- Probabilistic
  - Use Monte Carlo analysis method to determine accident leakage and account for uncertainties

ID - Operational Assessment

- Predictions for end of next cycle conditions.

Conclusion

- Vehicle needed to implement degradation specific management in a timely manner
- Benefits of improved NDE techniques need to be realized
- Significant impacts on utilities - inspection time engineering analysis, tube pull costs
- Many areas of agreement (based on previous meetings)
- Process will facilitate industry standardization

21

8

Technical Bases for SG Tube Deterministic Structural Limits

Presentation to ACRS
November 5, 1996

Prepared By:

EPRI ARC AdHoc Committee

Principal Authors/Presenters:

R. F. Keating
T. A. Pitterle
Westinghouse Electric Corporation

Discussion Topics

Summary of Differences Between Draft Reg. Guide and Industry Proposal

ASME Code Requirements

Proposed Structural Requirements

Bases for Proposed Structural Requirements

- ASME Code Section III Safety Factor Considerations
- Qualitative Support for Structural Limits
- Quantitative Support Applying Burst Probability Analyses

Conclusions

Overall Summary

NRC Draft Reg. Guide(9/96) Normal Operation Structural Margin

- Tubes retain margins of safety against rupture consistent with ASME Code, Section III, for all service level loadings

- Draft Reg. Guide states that ASME "criteria include a margin of not less than 3 against burst under normal operating conditions"
  - Source of difference from industry position that factor of 3 on a burst test result is not consistent with Section III factor on analysis

- The safety factor, SF, implied by the Reg. Guide factor of 3 on burst relative to ASME Code elastic analysis is about 3.4

Industry Proposed Normal Operation Structural Margin

- The structural limit at normal operation shall be $1.43\Delta P_{SLB}$ with a minimum pressure differential of 3600 psi when a burst correlation is applied
  - Minimum 3600 psi pressure differential assures a normal operation safety factor ranging from 2.4 to 2.9 dependent on the specific SG steam pressure

- The appropriate SF on burst for consistency with the ASME Code factor of 3 on elastic analysis is about 2.6

- The proposed criteria result in burst probabilities at normal operation of $< 10^{-5}$ to negligibly small dependent upon the burst correlation
  - Proposed criteria have negligible effect on potential for rupture at normal operation

- Proposed criteria avoid difficulties in projecting ΔP_{NO} for the next operating cycle

Applicable ASME Code, Section III, Subsection NB Requirements

Analysis Requirements

- Typical basis for the NRC Regulatory Guide 1.121 guidelines.
- Applicable to linear elastic stress analysis, i.e., an analytical estimate, and not representative of the results of a test based burst pressure correlation.

Normal and Upset Conditions

- $P_m \leq S_m$ = smaller of $S_y/1.5$ or $S_u/3$
- $\Delta P_{NO} \leq S_u t/(3R_m)$ or $SL \geq 3\Delta P_{NO}$

Emergency and Faulted (Accident) Conditions

- $P_m \leq$ lesser of $0.7\ S_u$ ($\sim S_u/1.43$) or $2.4\ S_m$
- $\Delta P_{ACC} \leq S_u t/(1.43R_m)$ or $SL \geq 1.43\Delta P_{ACC}$

Proposed Structural Requirements

General Considerations

- ASME safety factors are based on the yield or ultimate strength of the material and used with linear elastic structural analyses

- The proposed criteria provide separate safety factors for SG tube evaluations based on analysis and on burst test results
  - Necessary to assure consistency between design to ASME Code Section III and operational analyses utilizing an empirical burst correlation

Proposed Criteria

- ASME Section III used for evaluations based on analytical structural assessments

- Burst test based requirements maintain the accident condition safety factor of $1.43\Delta P_{SLB}$ at normal operating conditions with a minimum pressure differential of 3600 psi
  - Minimum 3600 psi pressure differential assures a normal operation safety factor ranging from 2.4 to 2.9 dependent on the specific SG steam pressure (typical ΔP_{NO} range of 1250 to 1500 psi)
  - Fixed minimum pressure differential assures that this margin range would not be reduced for lower accident condition pressure differentials

Deterministic Structural Limits for SG Tube Integrity		
Plant Condition	**SG Tube Evaluation Based on Analysis**	**SG Tube Evaluation Based on Burst Test Data Correlation[1]**
Normal operation	ASME Code, Section III, Subsection NB requirements for normal and upset conditions. SF typically 3.0: • SL = $3.0\Delta P_{NO}$	All flaws: • SL = Larger of 3600 psi or $1.43\Delta P_{ACC}$ Application of the lower bound 3600 psi structural limit requires $\Delta P_{NO} \leq 1600$ psi Results in $2.4 \leq SF \leq 2.9$ relative to ΔP_{NO} in steam generator operating range of 1250 to 1500 psi.
Accident conditions	ASME Code, Section III, Subsection NB requirements for emergency and faulted conditions. SF typically 1.43: • SL = $1.43\Delta P_{ACC}$	All flaws: SF = 1.43 • SL = $1.43\Delta P_{ACC}$

Notes:

1. For application of a burst correlation, it must be demonstrated that the burst correlation is independent of applied bending stresses or the influence of the bending stresses must be accounted for in the analyses. Mechanical loading conditions should be considered in this assessment.
2. Abbreviations:

SF - safety factor

SL - structural limit

ΔP_{NO} - steam generator tube differential pressure during normal operations

ΔP_{ACC} - steam generator tube differential pressure during accident conditions

ASME Section III Code Safety Factor Considerations

Objective

- Demonstrate that the Code based linear elastic analysis estimate for the stress limit at normal operation with a factor of safety of three on the ultimate tensile strength is consistent with applying a factor of safety of 2.4 to 2.7 on experimental burst pressure

ASME Code Section III Safety Factor Considerations

- Design rules of the ASME Code Section III will result in elastically calculating an allowable limit on the normal operating differential pressure for SG tubes of

$$\Delta P_{NO} \leq \frac{\sigma_u t}{3 R_m} \tag{1}$$

  - The 3 in the denominator is the factor of safety of 3 alluded to in R.G. 1.121 but does not, however, provide for a margin of 3 against burst

- EPRI burst pressure correlation for throughwall axial cracks results in a predicted burst pressure for undegraded tubes of

$$P_B = \frac{0.6(\sigma_y + \sigma_u) t}{R_m} \tag{2}$$

- The ratio of the burst pressure (Eq. 2) to the ultimate stress term of Eq. 1 by elastic analysis is 0.87

ASME Section III Code Safety Factor Considerations

The safety factor, SF, implied by the draft Reg. Guide allowable burst pressure to the Code elastic analysis is,

$$\frac{\sigma_u t/R_m}{P_B/3} = \frac{3}{0.6(1 + \sigma_y/\sigma_u)} = 3.4 \qquad (3)$$

- The yield to ultimate ratio for nominal 7/8" diameter mill annealed tubes is 0.44 at 650°F and for 3/4" tubes the corresponding ratio is 0.47

- The appropriate SF on the burst pressure for consistency with the Code elastic analysis can be obtained from Eqs. 1 and 2 as,

$$SF = \frac{P_B}{P_{NO}} = 1.8\left(1 + \frac{\sigma_y}{\sigma_u}\right) = 2.6 \qquad (4)$$

- The true SF against burst is about 2.6 for Code consistency, and not 3.0 as implied by the draft Reg. Guide

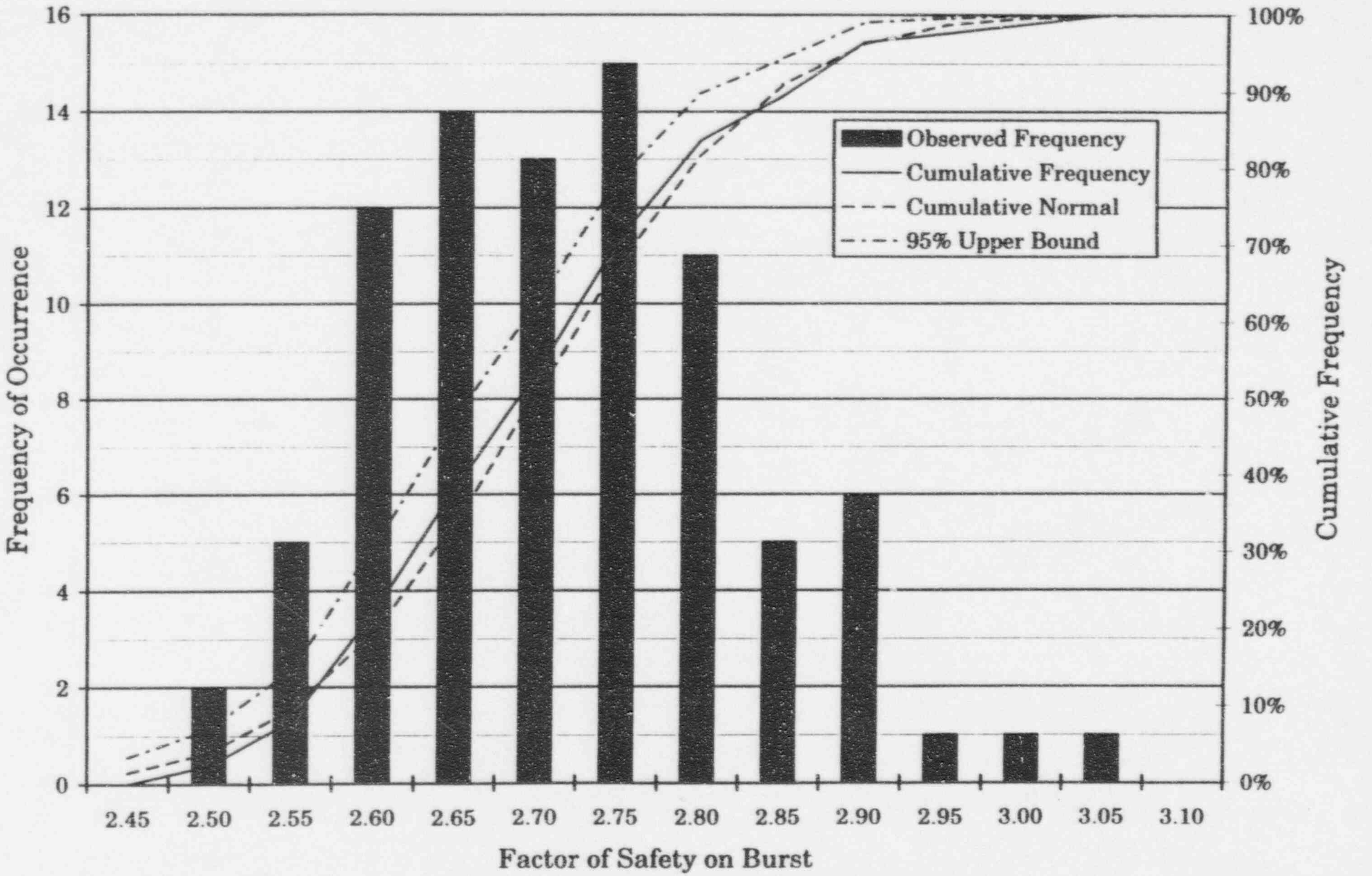
- The SF, obtained using the ratio of measured burst pressures for undegraded tubes to Equation 1, has a range of about 2.5 to 2.9 with a mean also about 2.65

- A similar result is obtained by considering that a uniform plastic hoop strain of about 15% occurs prior to tube rupture rather than the small strain assumption of the Equation 1 elastic analysis. Hence, the expected burst pressure may be estimated as,

$$P_B \approx \frac{\sigma_u t}{1.15 R_m}. \qquad (5)$$

  - Combining this estimate with the allowable pressure of Equation 1 implies a true factor of safety of about 2.6

Figure 2-1: Distribution of Factor of Safety Against Burst
Alloy 600 SG Tubes of Various Sizes



ASME Section III Code Safety Factor Considerations

Conclusions

- The use of a factor of 3.0 on the ultimate tensile stress as in the ASME Code design equation results in an average true SF of about 2.6 to 2.7 on tube burst
  - Confirmed by burst test results

- Proposed criteria for the tube integrity rule is a test derived structural limit at normal operation that results in a safety factor range of 2.4 to 2.9 for SG tubing which is consistent with the elastic analysis factor of 3.0 from Section III of the Code

Example Application

- Limiting accident differential pressure for Westinghouse SGs is 2560 psi for which application of a SF of 1.43 results in a required burst pressure of at least 3657 psi

  - For plants with a normal operation differential pressure of 1250 to 1350 psi (typical of 3/4" tubing), the margin to burst is then 2.93 to 2.71 at normal operating conditions

  - For plants with normal operating differential pressures of 1400 to 1500 psi (typical of 7/8" tubing), the burst margins at normal operation are 2.61 to 2.44

Qualitative Support for Structural Limits

Tube Size Considerations

- The use of $3\Delta P_{NO}$ as a structural limit has a significant effect on Westinghouse SGs with 7/8" diameter tubing but has little effect on SGs with 3/4" tubing since the SGs with 3/4" tubing operate at higher steam pressures

- The net effect of the draft Reg. Guide requirement would be to penalize repair limits by tubing size

- The proposed test based structural criteria do not have a preferential impact on one tube size versus another.

Use of Normal Operating Pressure Penalizes a T_{hot} Reduction

- The use of $3\Delta P_{NO}$ as a structural limit results in a penalty on plants which improve tube integrity by reducing T_{hot}

- The reduction in primary temperature results in a reduction in steam pressure which then leads to an increase in $3\Delta P_{NO}$
  - The temperature reduction reduces potential tube corrosion and the likelihood of a tube rupture but the plant would be required to increase the structural margin

- This penalty is eliminated with the proposed criteria.

Qualitative Support for Structural Limits

Influence of Criteria on Tube Ruptures at Normal Operation

- Tube ruptures that have occurred have been due to new or unexpected causes such as loose parts, new degradation mechanisms, etc.
  - Ruptures have not been a result of inadequate structural margin and would not have been affected by the tube integrity requirements

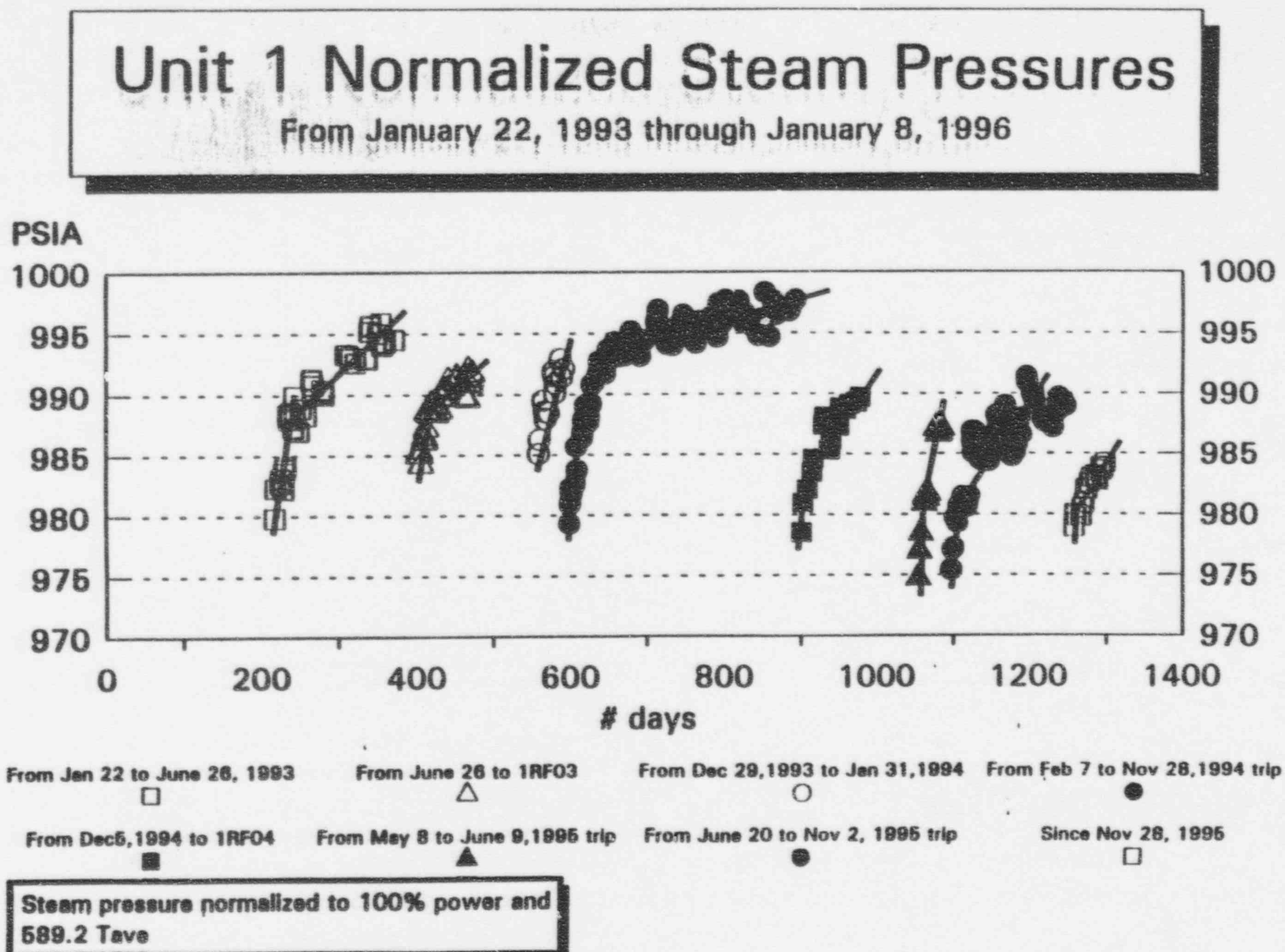
- The proposed normal operation structural limit would not significantly change the likelihood of a rupture at normal operating conditions

Uncertainty in Predicting ΔP_{NO}

- For operating SGs, ΔP_{NO} is not a well defined or a constant value
  - Normal operating pressure differentials can change during one cycle, are different between SGs and also vary from cycle to cycle
    - Since steam pressure can vary by 10 psi and occasionally up to 20 psi in one SG over an operating cycle, the value of ΔP_{NO} for one cycle is not a unique value
    - The differences in steam pressure result from variations in heat transfer coefficients over an operating cycle, differences in T_{hot} between SGs, differences in tube plugging between SGs or between operating cycles and variations in tube deposits between SGs
  - As a result, the tube repair criteria based on ΔP_{NO} varies between SGs and can change during and between cycles

- The use of $1.43\Delta P_{ACC}$ results in uniformity of tube repair criteria between plants of the same generic design and the same or different tube size as well as eliminating cycle dependence for changes in steam pressure

Figure 2


Unit 1 Normalized Steam Pressures
From January 22, 1993 through January 8, 1996
PSIA
1000
995
990
985
980
975
970
0
200
400
600
800
1000
1200
1400
days
From Jan 22 to June 26, 1993
From June 26 to 1RF03
From Dec 29,1993 to Jan 31,1994
From Feb 7 to Nov 28,1994 trip
From Dec5,1994 to 1RF04
From May 8 to June 9,1995 trip
From June 20 to Nov 2, 1995 trip
Since Nov 26, 1995
Steam pressure normalized to 100% power and 589.2 Tave

Quantitative Support Applying Burst Probability Analyses

Assessment of Burst Margins at Normal Operating Conditions

- The margins obtained at normal operating conditions with a $1.43\Delta P_{ACC}$ structural limit can be quantitatively assessed by evaluating the burst probability for an indication at the structural limit
  - Application of the EPRI burst correlations for burst pressure versus bobbin voltage and versus throughwall crack length

Through Wall Axial Length Burst Correlation

- $1.43\Delta P_{ACC}$ structural criteria lead to crack lengths of 0.513" for 3/4" tubing and 0.571" for 7/8" tubing at the structural limit
  - Crack length margins at normal operating conditions (ratio of length at ΔP_{NO} to length at $1.43\Delta P_{ACC}$) of 2.5 to 3.0
  - Structural limit margin on length for burst at SLB conditions is a 1.5 factor.

- Burst probabilities at normal operating pressure differentials (typically about 1250 psi for 3/4" tubing and 1450 psi for 7/8" tubing) are insignificant (on the order of 10^{-12})

- The $1.43\Delta P_{ACC}$ structural limit applied to the axial TW correlation results in an extremely small burst probability at normal operating conditions

- There is no need to add conservatism by increasing the normal operation criterion to a $3\Delta P_{NO}$ structural limit

Quantitative Support Applying Burst Probability Analyses

Bobbin Voltage Correlation for Axial Indications

- The $1.43\Delta P_{ACC}$ criterion leads to structural limits of 4.7 and 9.0 volts for 3/4" and 7/8" diameter tubing
  - Margin on volts between the $1.43\Delta P_{ACC}$ criterion and normal operation is a ratio of 7.7 to 10.2 with 36 to 91 volt indications required for burst at normal operating pressure differential

- The associated burst probability at normal operating conditions is $< 10^{-5}$ for both tubing sizes

- The burst probability for normal operation is negligible
  - Satisfaction of the conditional probability for burst at accident conditions further assures a negligible burst probability for normal operation

Conclusions

- The $1.43\Delta P_{ACC}$ structural limit provides adequate margins at normal operating conditions

- The $1.43\Delta P_{ACC}$ structural limit provides comparable burst probabilities between 3/4" and 7/8" diameter tubing
  - The use of a $3\Delta P_{NO}$ structural limit would result in the 7/8" burst probabilities being reduced well below that for 3/4" tubing since the 3/4" limit is not significantly affected by this criteria

Overall Conclusions

The proposed normal operation structural limit of 3600 psi or $1.43\Delta P_{ACC}$, based on use of a burst correlation, is consistent with the Section III analysis requirements

- The ASME Code, Section III requirement for a factor of safety of 3.0 on ultimate strength corresponds to a safety factor of about 2.6 for tube burst
- Requiring a safety factor of 3 on burst would impose a greater safety factor for degraded tubes than the safety factor inherent in ASME Section III for the design of new tubes
  - An undegraded tube designed to just satisfy the ASME Code would not be acceptable for operation with a required safety factor of 3 on burst

Burst probabilities at normal operating conditions are negligible for the proposed structural criteria

- The use of a structural limit of $1.43\Delta P_{ACC}$ results in tube burst probabilities at normal operation of $< 10^{-5}$ for a voltage correlation and even smaller (about 10^{-12}) for a length correlation

The use of $3\Delta P_{NO}$ versus $1.43\Delta P_{ACC}$ would not significantly change the likelihood of a rupture at normal operating conditions

- Historical tube ruptures at normal operating conditions have been the result of new or unexpected degradation mechanisms and not an effect of inadequate structural margin

The use of structural limits based on accident condition pressure differentials avoids the issues with defining/predicting ΔP_{NO}

- Difficult to uniquely define ΔP_{NO} since steam pressure varies over an operating cycle, between SGs of the same plant and between operating cycles

Conditional Probability of Tube Burst under Risk formed, Performance Based Regulation

David A. Steininger
Program Manager
Steam Generator Management Program
Electric Power Research Institute
ACRS/11/5/96

Conditional Probability of Tube Burst (ConPOB)

- *This probability is a rule's performance criterion*
  - *It's a conditional probability based on limiting initiating accident*
- *Limiting initiating accident is the one that produces the highest differential pressure across the steam generator tube wall*
  - *Usually it's a main steam line or feedwater line guillotine break*

dustry Objective

- ConPOB should be risk based
- Acceptable risk must be appropriately defined and not arbitrary
  - Risk should be defined in terms of NRC's safety goals
  - Defense-in- depth will be addressed in many ways

Rule's Regulatory Guide Present Criteria

- *ConPOB*
  - *5x10E-2 for 1 or more tube ruptures*
  - *2.5x10E-2 for 2 or more tube ruptures*
  - *10E-3 for greater than 10 tubes ruptures*
- *ConPOB applicable to any one degradation mechanism in the faulted steam generator should not exceed 20% of the above noted values.*

Rule's Basis, Industry's Interpretation

ConPOB is an arbitrary modification of a value based on historical events as described in NUREG-0844, "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 regarding Steam Generator Tube Integrity," Sept.1988.

- *NUREG evaluated circumstances leading to 4 steam generator tube rupture events at normal operating pressure resulting in a ConPOB value of 0.027 for these four plants. This results from identifying a period of vulnerability to tube rupture which corresponded to 2.7% of mature reactor years (1.2 yrs) accumulated to date (1988) at the subject 4 plants.*

Rule's Basis, con't

- *Historical value (0.027) is increased in NUREG which* *__assumes__* *ConPOB equal to 0.05 under accident conditions to account for periods of vulnerability which were terminated as a result of tube plugging following inspection and/or primary-to-secondary steam generator leakage. NUREG states:*
  - *"It is implicit in the 0.05 conditional probability assumption, therefore, that periods of vulnerability to rupture during postulated accidents are almost 20 times more likely to be terminated as a result of in-service eddy-current inspection or small leakage event than as a result of an SGTR event".*
- *Final value (20% of 0.05) specified in Rule is believed to address unknown factors (e.g., loose parts) that may lead to additional periods of vulnerability during postulated accident conditions*

dustry's Proposal

NUREG analysis of historical events with an arbitrary assumption is not appropriate for establishing a performance measure used in regulation.

Performance measures should be based on acceptable risk (the rule is risk informed).

- *ConPOB should be established considering the probability of the initiating event leading to tube rupture and the acceptable level of risk (e.g., Core Damage Frequency)*

Industry's Recommendation

- A risk relationship should be used

$$\left\{P(E)\bullet\left(P(R/E)+\sum_{j=1}^{M}P(F/E)_j\right)P(D)\right\}<A$$

where,

P(E) ,	probability of the initiating event,
P(R/E),	conditional probability of tube burst for unknown factors for the initiating event, E,
P(F/E),	conditional probability of tube burst for the degradation mechanism (j) being monitored,
P(D),	probability for failure to mitigate the effects of the events and prevent core damage, and
A,	value that would indicate an acceptable level of risk exists, frequency.

Industry's Recommendation, Con't

The following values are used to show an acceptable level of risk

- P(E) = 8.2E-4/yr.
  - Value taken from 8/3/94 NRC staff presentation to ACRS for the sum of main steam line break and feedwater line break frequencies
- P(R/E) = 0 .1
  - Value is assumed. It accounts for unanticipated causes of tube rupture during the faulted accident evident.
- P(D) = 1E-3
  - This is a typical published value used by the NRC staff for evaluations of this type, e.g., NUREG-1477
- $\sum_{j=1}^{M} P(F/E) = 0.05$
  - This value is the Rule's specification, but without the arbitrary reduction by 20%, and is allocated to all monitored degradation.

Industry's Recommendation, con't

- *Using the above values in the risk relationship results in the left side of the inequality*
  - *1.23E-7/yr.*
- *The range of the NRC's safety goal is 0.5 to 0.1 of 10E-6/yr.*
  - *Therefore, 0.05 appears to be an acceptable ConPOB for all monitored forms of degradation*

Industry's Conclusions

Risk analysis shows that 0.05 should be the ConPOB criteria for all monitored forms of tube degradation and should not be arbitrary set at 20% of this value for each degradation form monitored. Tradeoffs between degradation mechanisms to meet this criteria should be allowed.

Evaluation of risk has accounted for the known and unknown mechanism(s) that may increase the vulnerability to tube rupture during a faulted event.

- Defense-in-Depth:
  - Increased tube inspection under the rule will lower the vulnerability to tube rupture from known and unknown causes.
  - Restrictions on operational leakage under the rule lowers the vulnerability to rupture from unknown causes.
  - Plant design basis is a single double ended guillotine break of a tube
  - Analysis shows that the plant can easily handle multiple tube rupture events in combination with a full main steam or feedwater line break (MSLB/FLB)
  - All plants can experience significant leakage with a MSLB /FLB and meet 10CFR100 and GDC 19 dose limits

Industry Implementation of Steam Generator Examination Guidelines

John F. Smith
Rochester Gas and Electric

Presentation to ACRS

November 5- 6, 1996

Presentation Outline

- Introduction
- Industry Perspective of S/G Rulemaking
- Utility Implementation of S/G ISI
- S/G Examination Guidelines, Rev. 4
- Specific Issues Addressed by Rev. 4
- S/G Examination Guidelines, Rev. 5
- Conclusions

Introduction

- Much Agreement Between Draft Reg. Guide, and Rev. 4 of Industry Examination Guidelines
- Some Parts of the Reg. Guide Need Clarification
  - Validation
  - Supplemental Performance
  - Basis for Buffer Zone

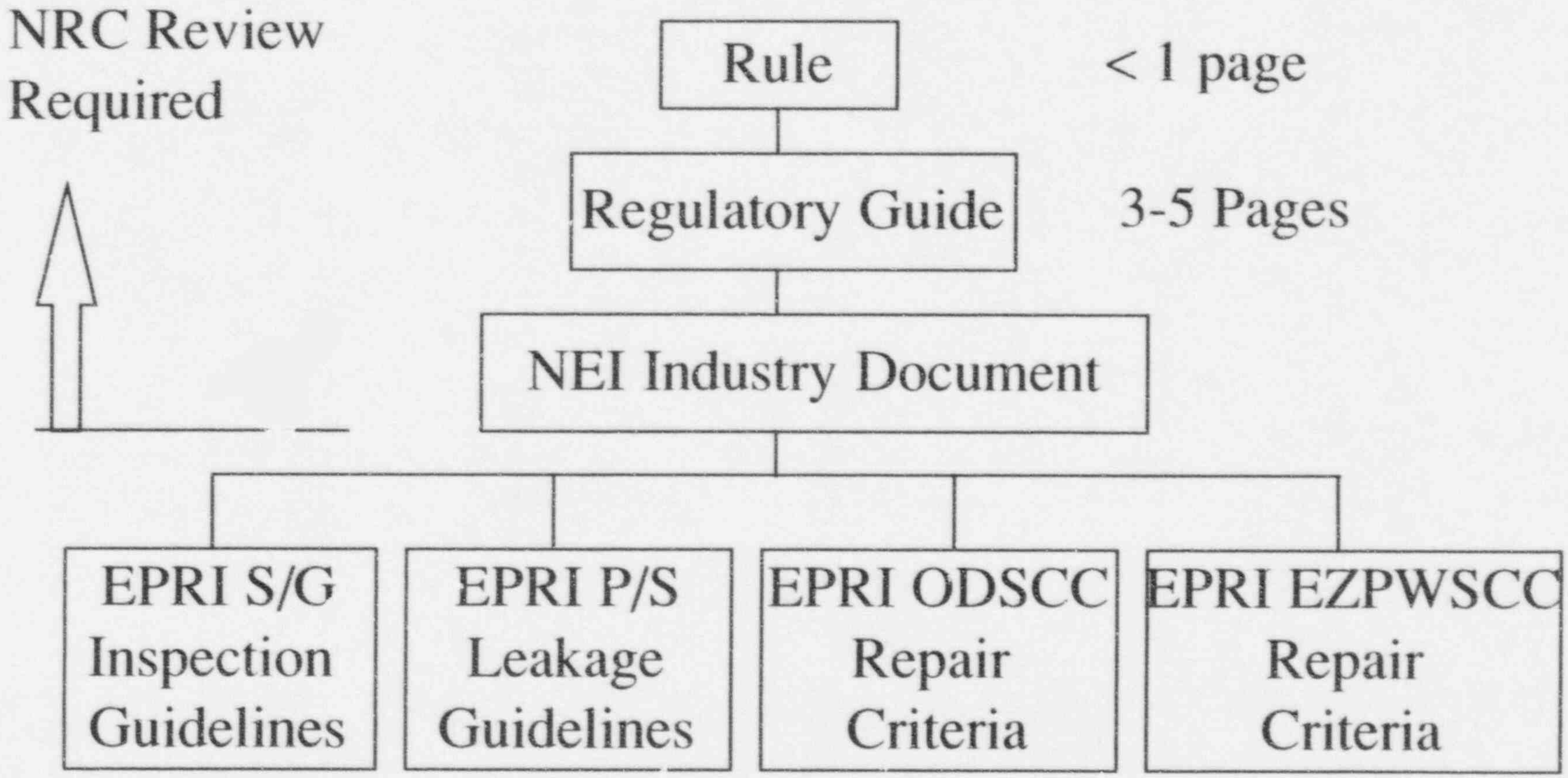
Introduction, Cont'd

- Rev. 5 of Industry Exam. Guidelines Being Prepared to Clarify and Enhance Requirements
- Guidelines Contain Methodologies for:
  - Qualification of Probes and Techniques
  - Qualification of Analysts
  - Site Specific Training
- Qualification and Training Updated as New Data Becomes Available

Introduction, Cont'd

- Industry Has Learned Much About S/G ISI But Issues Still Remain
- Improved Detection Can Penalize Utilities
- Significant Resources Dedicated to Improving S/G NDE during the Last 5 Ys
  - EPRI Guidelines, $500K
  - QDA Program & Maintenance, $2.5M
  - Utilities, $15M

Industry Perspective of S/G Rulemaking



NEI Industry Document

- The following points from the ISI Guidelines are highlighted in the NEI document
  - Inspections shall be done with qualified techniques
  - Analysis shall be performed by qualified data analysts
  - Minimum sample size of 20%
  - Sample expansion as required by the ISI Guidelines
  - Independent data analysis review teams
  - No steam generator shall go uninspected for more than two cycles
  - Preservice examinations shall be performed prior to startups
  - 100% ISI at the first refueling using qualified techniques
  - Management involvement
  - Utility self-assessment to monitor guidelines compliance
  - Quality assurance verification of compliance
  - Site-specific performance demonstration and data analysis guidelines
  - Leakage -forced outage response

Utility Implementation

- Inspection Scope Defined by Utility ISI Program
- Utility Selects EC Vendor or Vendors (Appendix G QDA)
- Vendor Deploys to Site Prior to Shut Down
- Site Specific Performance Demonstration
- Data Acquisition/Analysis (Appendix H)
- Evaluations and Repairs
- Return to Service

Overview of S/G Examination Guidelines, Revision 4

- Section 1: Introduction and Background
- Section 2: Compliance Responsibilities
- Section 3: Tube Selection Procedures
- Section 4: Data Acquisition Procedures
- Section 5: Data Analysis Procedures
- Section 6: Qualification of Data Analysts
- Section 7: Qualification of Examination Techniques

Overview of S/G Exam. Guidelines, Rev. 4, Cont'd

- Appendix A: S/G Operating Experience
- Appendix B: Basis for Recommended S/G Examination Program
- Appendix C: S/G NDE Experience
- Appendix D: Site Specific Data Analysis Guidelines
- Appendix E: Typical S/G NDE Bid Spec.

Overview of S/G Exam. Guidelines, Rev. 4, Cont'd

- Appendix F: Definitions
- Appendix G: Qualification of NDE Personnel for Analysis of EC Data
- Appendix H: Technique Qualification for EC of S/G Tubing.
- Appendix I: Open
- Appendix J: Technique Qualification for UT of S/G Tubing
- Appendix K: Inspection Requirements Due to Leakage Forced Outages

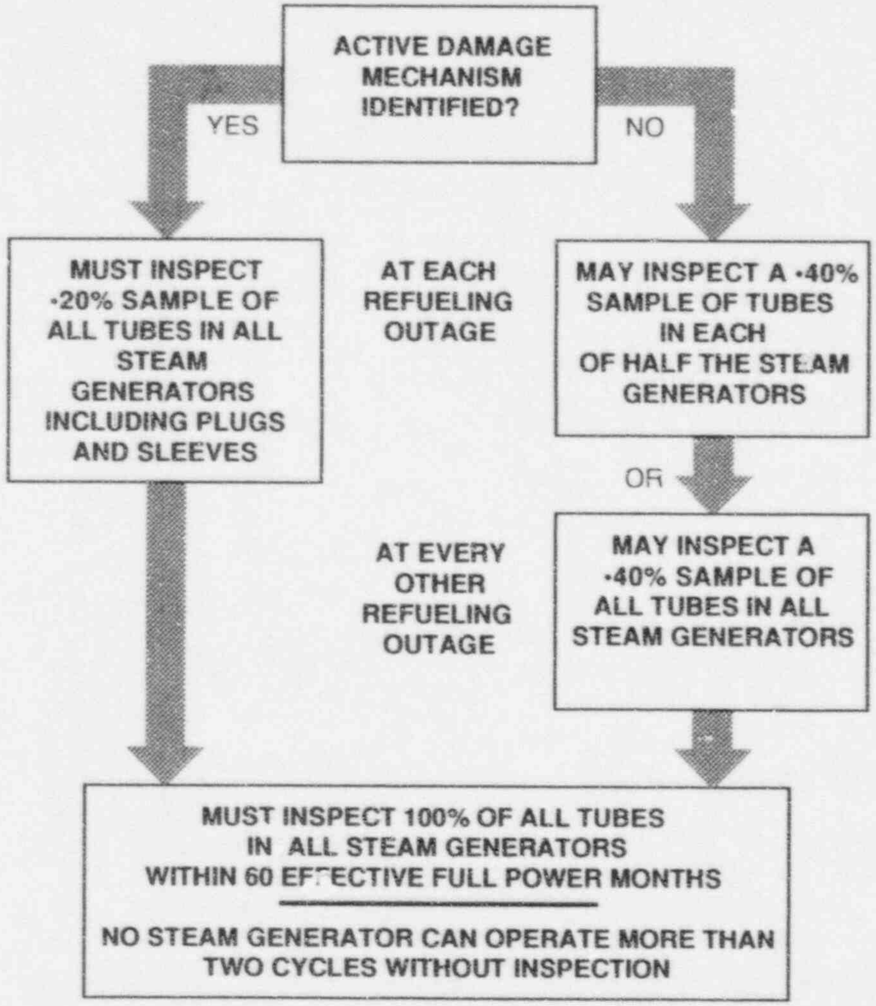
Specific Issues Addressed by Rev. 4

- Preservice Inspection Requirements
- Inservice Inspection Requirements
- Performance Demonstration
- Qualification of NDE Techniques
- Qualification of NDE Personnel
- Site Specific Performance Demonstration

Preservice Inspection Requirements

- PSI of 100% of Tubing
- General Purpose Volumetric (Bobbin Coil) Probes
- After Hot Functional Testing for New Plants
- After Installation for Replacements
- 100% Inspection at Completion of First Operating Cycle

Inservice Inspection Requirements



Steam Generator Selection and Frequency Requirements

Performance Demonstration

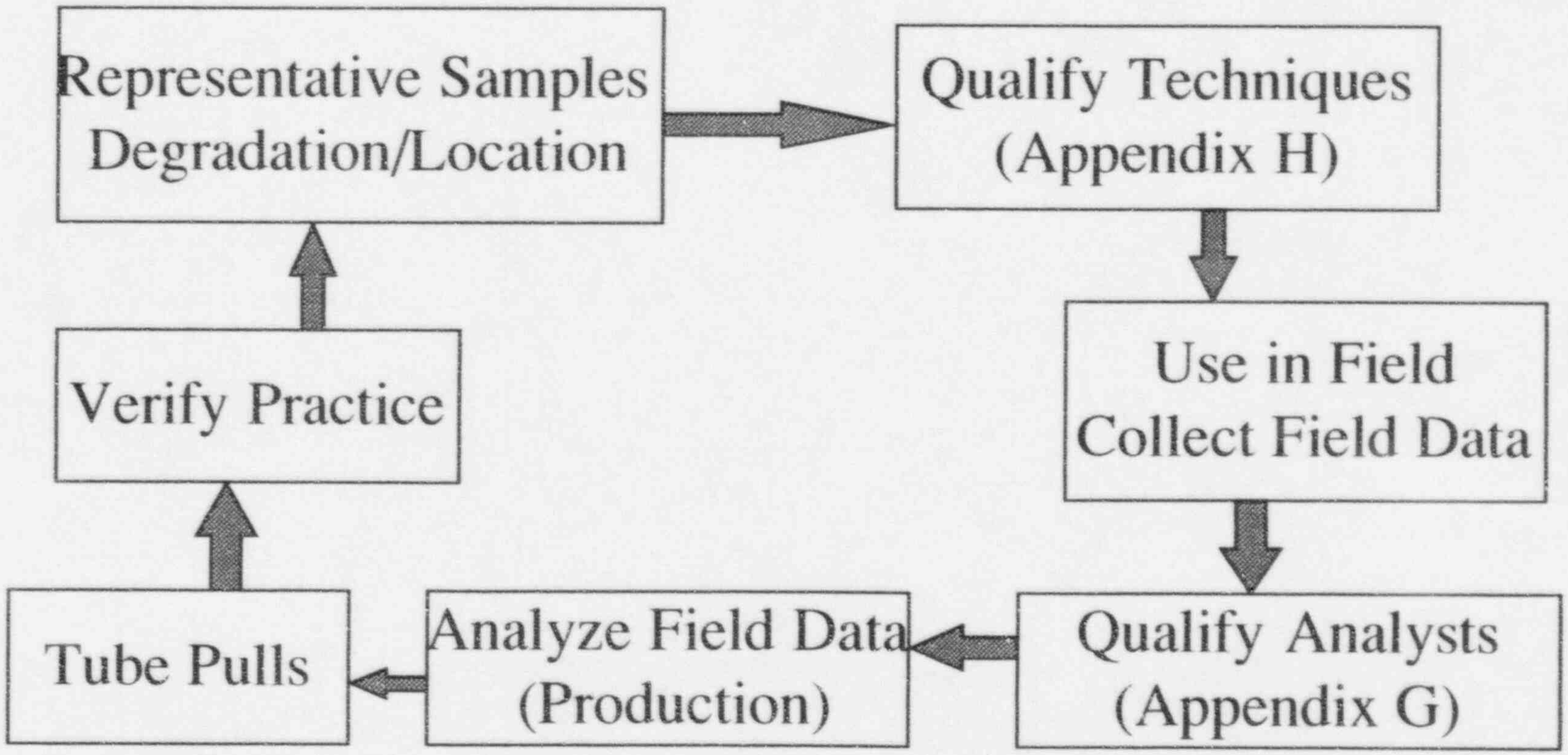
Important Features of Industry Program

- Designed with implementation capabilities in mind -- *both current and future capabilities*
- Time tested -- in existence since 1992
- More than 200 US data analysts have passed the program and many have completed its 3-year requalification tests
- Program addresses *industry-generic* and *plant-specific* qualifications

Elements of Industry Perf. Demo. Program

- Appendix H on Technique Qualifications
- Appendix G on Personnel Qualifications
- Site Specific Performance Demonstration (SSPD) to address plant-specific issues, i.e., to cover issues that may not have been covered under the industry-generic program
- Built-in feedback loop to disseminate industry experience into plants and vice versa

Performance Demonstration



Qualification of NDE Techniques Appendix H

- Technique qualification for detection consists of a two step process
  - Document capability on known flaws
  - Apply acceptance criteria
- Technique qualifications are as specific in terms of degradation form and location as the available sample sets permit

Qualification of NDE Personnel Appendix G

- Analysts are tested on field data from many plants and SG types
- Qualified data analysts (QDA) must stay in practice or lose qualification
- There is annual training and re-qualification every 3-5 years
- QDA's may be subjected to repeated SSPD based on utilities' needs

Qualification of Personnel, Cont'd
Appendix G

- Analysts are tested for each form of known degradation separately and they must have a passing score in each one
- Tubes are analyzed in the blind and are examined from end-to-end, not knowing what may be in them, if anything
- Typical test lasts a week and involves some 5000 intersections

Site Specific Perf. Demo.

- Tests an industry qualified analyst (QDA) on plant-specific issues
- SSPD is in addition to the annual training and periodic requalification (3-5 years) that each QDA must undergo
- There is no limit on how extensive or frequently an SSPD is applied

Rev. 5 of Inspection Guidelines

- Some Rearranging of Vol I & Vol II
- Appendix G&H Updates
- Expansion Criteria
- Operating Experience Updates
- Incorporation of selective items from the Draft Reg. Guide

Conclusions

- **ISI/NDE is the Cornerstone of the Industry's S/G Program**
- **Reduced Forced Outages**
- **Reduced Lost Capacity**
- **Performance has Improved Significantly**
- **Much Agreement on Draft Reg. Guide**
- **Significant Issues Remain**
  - **Supplemental Performance Demonstration**
  - **Validation**
  - **Buffer Zone**