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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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598TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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OPEN SESSION

+ + + + +

THURSDAY

OCTOBER 4, 2012

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., J. Sam Armijo, Chairman, presiding.

COMMITTEE MEMBERS:

J. SAM ARMIJO, Chairman

JOHN W. STETKAR, Vice Chairman

HAROLD B. RAY, Member-at-Large

SANJOY BANERJEE, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

JOY REMPE, Member

MICHAEL T. RYAN, Member

STEPHEN P. SCHULTZ, Member

WILLIAM J. SHACK, Member

JOHN D. SIEBER, Member

GORDON R. SKILLMAN, Member

NRC STAFF PRESENT:

DEREK WIDMAYER, Designated Federal Official

STEWART BAILEY, NRR

DONALD A. COOL

JOHN FLACK

ERVIN GEIGER, NRR

PAUL KLEIN, NRR

WILLIAM RULAND, NRR

STEPHEN SMITH, NRR

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P R O C E E D I N G S

(8:28 a.m.)

CHAIR ARMIJO: Good morning. The meeting will now come to order. This is the first day of the 598th meeting of the Advisory Committee on Reactor Safeguards.

At today's meeting, the committee will consider the following: first, the proposed revision of 10 CFR Part 20 for conformance with International Commission on Radiological Protection Recommendations; 2) Safety Evaluation Report associated with WCAP-16793-NP, Revision 2, the "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid" and the status of the resolution of Generic Safety Issue 191, "Assessment of Debris Accumulation of PWR Sump Performance"; 3) reactor pressure vessel fabrication and flaw assessment; 4) assessment of the quality of selected NRC research projects; and 5) preparation of ACRS Reports.

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

We have received no written comments or requests to make oral statements from members of the public regarding today's sessions.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed in a listen-in mode during the presentations and committee discussions.

A transcript of portions of the meeting is being kept and it is requested that speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

The first topic we will consider this morning will be led by Subcommittee Chairman, Dr. Michael Ryan. Mike?

MEMBER RYAN: Thank you, Mr. Chairman. I appreciate it very much. Without further ado, I'll introduce Dr. Don Cool, who is providing the subcommittee with a fairly complete briefing. He will give us a summary here this morning. Don?

DR. COOL: Thank you, Dr. Ryan. Good morning, members. I will begin.

Today I am going to try and refresh where we are because we have been doing this for a bit of time now and then talk about several of the issues

that in particular came up and we discussed during the subcommittee meeting, the SECY paper.

I realize that the title slide I put up there was rather cryptic. The staff's recommendations for possible options to proceed. It is possible we can the language with International Commission on Radiological Protection recommendations went to the Commission on April 25th. The Commission has not completed voting on that subject.

The staff met with the Subcommittee on Radiation Protection and Nuclear Materials on April 27th and again on September 18th. We met with you and the full committee here on June 6th and we are back with you today.

One of the topics that was discussed during the subcommittee had the last time the full committee met was the discussion of what the actual radiation risks were. I put this up, not to spend a great deal of time, but just to refresh folks' memory. The underlying risk basis for the existing Part 20 is from 1977 from the one and a quarter times ten to the minus two per sievert. The current level, which has actually been the rough estimated risk since the late 1980s, 1990 or so, is five times ten to the minus two per sievert. So those equations give us ratios of

what the error bands or the uncertainty bands were. I have included those and that is my work on the screen.

I included those on the bottom. This is from EPA's latest publication, which was based on the BEIR VII report. The mortality number, the bottom number, 5.8 times ten to the minus two, notice the error bands is 2.8 times ten to the minus two to one times ten to the minus one. I still didn't manage to get that corrected from last time. That is how those -- you have to always have one.

And for purposes of this discussion, yes, the error bands of the old estimate and the new estimate overlap. However, the central values of those estimates are not within the errors, the other error bands.

MEMBER CORRADINI: So can I, since I am one of the least knowledgeable, just to ensure that it is right. So that means that incidents that the current radiation risk for incidents is a five percent chance -- no, I'm sorry. If I had a sievert of -- yes, sievert. If I had sievert of exposure, I have a five percent chance of incidents.

DR. COOL: It's more or less a ten percent chance of incidents.

CHAIR ARMIJO: A five percent chance of what, Mike?

DR. COOL: A five percent chance of mortality.

MEMBER CORRADINI: Oh, I'm sorry. Excuse me. I'm sorry.

DR. COOL: It is a ten percent chance of incidents --

MEMBER CORRADINI: Okay, I'm sorry.

DR. COOL: -- of some cancer or other effects showing up.

MEMBER CORRADINI: You're right. I said it incorrectly. So a five percent chance of mortality, a ten percent chance of incidents.

DR. COOL: That's correct.

MEMBER CORRADINI: Per sievert of exposure.

DR. COOL: Per sievert of exposure, which is 100 rem for those of us who, at best are bilingual when we work at it.

MEMBER CORRADINI: And -- sorry.

DR. COOL: No, go ahead.

MEMBER CORRADINI: And none of the current scientific studies that I was at another meeting for the Nuclear Radiation Safety Board for the National

Academy and there were a number of studies that were presented to us of current research studies which indicate that dose rate is the key issue here and it is none of these consider what is the new research and low-dose rate effects.

DR. COOL: That is correct. The hot topic of discussion now is the dose and dose rate effectiveness factor, the DDREF acronym, which had been used to, in essence, lower the risk, assuming that there would be a smaller proportion than the ration that was seen at very high doses. Typically, and including ICRP, that number has been taken to be two, a factor of two reduction.

There is now a debate ongoing as to whether or not it is much closer to one, just use if you do that, although these numbers jump by a factor of two again.

MEMBER CORRADINI: Back up?

DR. COOL: Up. Yes, sir.

MEMBER SCHULTZ: Isn't there also positions that would drive it down? In other words the factor of two has also been represented as a lower bound, that the factor of reduction could be as high as four or five?

MEMBER CORRADINI: That is what was -- you

know, again, we are talking about scientific studies going on but that is, at least from NCRP, the head of NCRP when he gave his presentation to the Radiation Safety Board, that was the conclusion, at least at this, where he thinks things are going.

MEMBER SCHULTZ: The range of factors presented, even back in the '80s and '90s and beyond, that range of reduction factors has been in the range of two to five and even up to ten in the literature. It hasn't been accepted by the organizations UNSCR, ICRP, those have not accepted it in putting forward the regulations, proposed regulation and the changes to it.

DR. COOL: That is correct.

MEMBER SCHULTZ: So really, I haven't seen that the approach of these organizations has changed over 25 years.

MEMBER RYAN: Or more.

MEMBER SCHULTZ: Or longer.

MEMBER CORRADINI: I just wanted to make sure because my impression, not doing anything in this area except just listening to talks is there is a wide band. And so I guess I was thinking one to five but I don't know enough about the background.

DR. COOL: Depending on the type of

radiation being used in study, depending on the cellular system and otherwise you can get lots of different end points. Biology is wonderfully variable, depending on exactly what you are looking at and the circumstances.

MEMBER RYAN: It is not unreasonable to expect these values to be within a factor of ten, up or down, and we have good justification for anything in that range, for the experiments that are considered in a particular study.

DR. COOL: For complete openness --

CHAIR ARMIJO: I'm certainly not a -- this is not my field but I was taken by a recent MIT study at the DNA level to the effect of low dose of radiation which we received. Their study they did really what seems to be very elegant experiments in vivo in mice studying DNA damage from low doses of radiation and repair of mechanisms of the DNA and they found no detectable damage even at something like 400 times low background level. And that set is kind of consistent with at least a belief of some people that here are limits below which low doses of radiation are not harmful at all.

And so that is something in the back of my mind in saying if we are going to regulate, there must

be some level of radiation that even the ICRP might consider as safe.

So you know, the issue I have is what is that and what is the upside and the downside and continuing to push the dose limits to lower and lower values. That is really kind of a capsule of my concern.

DR. COOL: I will just make a quick observation that, as I said, biology is wonderfully diverse. We are talking about an area where you have greatly different results, depending on the kinds of systems and the level that you are looking at.

From my personal view, if I took off my NRC hat and you just got the Donald Cool view, I don't know of anything in biology that is linear. So why should I expect radiation to be any different from the chemical in all the other ones?

On the other hand, I don't know regulatory systems that work very well that aren't either linear or a switch. And I would note that ICRP and NCRP have been very careful to make a distinction between risk assessment, which is what you would build into trying to figure out what my risk is, Donald Cool who weighs about 160 pounds and is five-foot-seven, and all the things that go into that, versus risk management and

an approach to try and establish a reasonable, consistent, proactive program for protecting people before they ever get an exposure. And their recommendations have been to use linear approach for purposes of risk management or regulation, recognizing that that is probably not the exact model in the actual biology but believing that it continues to be a conservative view and provide protection.

The selection of the limits, and here I am talking about occupational exposure, 1977 the general view that industry's safe working environment roughly one times ten to the minus four death. The five rem value that was recommended at that time was actually not numerically equivalent to that one times ten to the minus four, but rather an assumption that a limit there and the application of what we know as ALARA would result in most people not being likely to exceed one rem, which was the actual numeric equivalent to the one times ten to the minus four death.

In 1990, the took a significant and more I wouldn't necessarily call it elegant approach, but a multi-attribute approach to looking at a variety of things. Their underlying objective conclusion, after looking at a variety of points was that the limits should try to prevent the cumulative exposure to below

one sievert total over a lifetime and, therefore, they recommended an average and a maximum value, recognizing that there was some flexibility.

The NCRP took a slightly different approach to that same sort of approach of what you might actually recommend for limits, but their underlying basis was the same, to try and prevent exposures to an individual that would exceed one sievert or 100 rem.

So during the subcommittee meeting we spent a great deal of time going over a lot of the data that we had available and correspondingly pointing out that there are lots of place where we do not have the data that we might wish we have on occupational exposure in various categories and groups.

This slide is a medical exposure. It is from the NCRP Report 160. So the latest year that was recorded in that was 2006; that is the yellow bars on the graph and the yellow lines on that table.

For medical exposures in that year, 99.57 -- I know way too many significant figures -- of the individuals had exposures that were less than the 20 millisieverts, two rem recommended average level.

If I were to have put up the pictures for

nuclear power, it would be better than this. If I were to put it up for industrial medical applications, it would have been a little bit worse than this. So you get a variety of things.

You will note that there are numbers in the greater than 50 millisievert category. I would point out that we do not know the extent to which those might represent actual overexposures versus the limits because the NCRP was working with the dosimetry processors and using the basic dosimetry data. So this does not necessarily account for places where there might have been a calculation of protective dose for multiple batches.

Moving very briefly to the information that we have in our REIRS database, this is from the latest report that came out last year, dealing with 2010 data and shows you the trends over time for the individuals that were greater than the two rem number.

If you calculate out that percentage, you get to a very small percent. You would see that the number of individuals that were less than two rem was about 99.87 percent, smaller than what you have in the NCRP report.

I will also remind you that this data is that which is reported to be NRC. It is almost

entirely the reactor, power reactor data. There are some small numbers of industrial radiographers, nuclear pharmacies and things, but something like 80 percent, which is a rounded number, of the occupational exposure that is out there in the United States is not reported. We do not have that data available to us.

MEMBER BLEY: Is it reported to anyone?

DR. COOL: Much of it -- let me phrase it slightly differently.

The requirements for compatibility for reporting are with the states, alright, but they do not have to adopt them. So there are some states that get some of the data. Many of the states just choose to inspect it, rather than have it reported to them. Those are for the categories of exposure they have to report.

Medical licensees, all of the doctors, do not have to report to anyone under this system. Likewise, since we are talking about regulations which deal with radioactive materials, this does not touch at all all of the occupational exposure from the machine-produced site. All of the x-ray, fluoroscopy, interventional radiology, cardiology, CT, all of that sort of stuff is not reported at all. It isn't under

our jurisdiction.

MEMBER RAY: Well returning, though, to this data set, you will permit me, I hope, to just reiterate my concern that yes, it is a small fraction but it may be a very important fraction from a safety standpoint.

DR. COOL: That is correct, sir.

MEMBER RAY: All right. I've ridden that hobbyhorse a lot so I will just leave it there.

DR. COOL: That was almost a perfect segue to my next slide, but I will go to Dr. Skillman.

MEMBER SKILLMAN: So the Y axis is basically badged workers in the nuclear -- the commercial nuclear industry?

DR. COOL: This is number of individuals on that axis. So yes, they are badged. They are the individuals who have gotten a greater than --

MEMBER SKILLMAN: Exposed.

DR. COOL: -- two rem in this particular chart.

MEMBER SKILLMAN: Okay. Now, by how much greater than two rem? Are we looking at threshold right at two or are some of these individuals ten, 15, 20 rem?

DR. COOL: Anything from 2.00000 up to and

in a few cases greater than five rem due to events or otherwise. In the nuclear power industry, there are none that are over five. None over the last couple of years that have even been over four.

MEMBER SKILLMAN: Thank you, Don.

MEMBER BANERJEE: Can you tell us about the medical industry? Any idea?

DR. COOL: I can tell you what we have been told, which is that they do try to practice ALARA. Radiation safety officers in the university medical hospitals and otherwise are always looking over the data and always cajoling their doctors and otherwise.

We have a constant stream of statements which border on allegations, which is when their dose gets up too high, the badge just stays back on the desk when they go to the interventional suite or otherwise.

We also know there is a considerable variability in the way in which the actual occupational dose is counted, as in several of the states still require it to be the deep dose equivalent on the color, notwithstanding the fact that an interventionalist probably does have the lead apron and things which shields most of the body and so the

effective dose would be much less. So that pushes the numbers up against the limiting value in some of those circumstances.

So you have a lot of variability out there. I think and I know I am putting words in their mouth. Their statement would be they took an oath when they took their degree to deliver medical service for the best treatment of their patients and they will let very little stand in their way of trying to do the best for the patient.

MEMBER BANERJEE: Does that mean that a large number of them go over these limits of five rem?

DR. COOL: We don't know.

MEMBER BANERJEE: But based on their badges, let's say.

DR. COOL: Based on their badges, you don't see very many that are over. But we have both the statements in the meetings and the dosimetry processors who tell us, you know, zero does not correlate with them doing work.

So when a badge comes back and it has no radiation dose on it at all, and you know the physician was working that month, you don't have that set of information. That is an issue. I know that there are follow-ups and otherwise. And as I said,

although there are these generalized statements made both here and abroad, I would note, this is seemingly a worldwide issue of approach and thinking. But we in fact do not know with any good understanding what the actual distribution of occupational doses might be.

MEMBER BANERJEE: But based on the information you have, moving aside that they may leave their badges on their desks when they do a CAT scan or something or a cardio cath, what you understand is they come within these limits and going down to two rem would not cause a hardship for them?

DR. COOL: My understanding at this point is two-fold. There are a number of them that are pushing the current five rem occupation dose value. They would exceed a two rem or a two rem average consideration. Exactly how many of those, I don't know.

The second part of my understanding is for the couple of groups that are what we believe the highest, interventional radiology and cardiology, which are in fact not NRC-regulated activities but clearly would be directly influenced by our studies. If there was a consistent calculation of effective dose for those individuals, they would probably be within the two rem.

MEMBER BANERJEE: So in Europe, this has already become a rule, right, the two rem?

DR. COOL: Yes, it has.

MEMBER BANERJEE: So the cardiologist, the interventional cardiologists in France has to be subjected to this two rem.

DR. COOL: That is correct.

MEMBER BANERJEE: You don't want to get your CAT work done in France.

MEMBER CORRADINI: No, I don't.

MEMBER REMPE: I don't understand.

MEMBER CORRADINI: But I think the one thing, since I happen to have a relative that does this in France, everything about what is done off the books that he is talking about here is as bad or worse, as I hear it, in Europe.

MEMBER REMPE: Of the facilities you do regulate, if there is some suspicion that people are leaving the dosimeter on the desk, how come there aren't inspectors from NRC going in and regularly inspecting them and reporting?

MEMBER RYAN: NRC is not authorized to regulate that part of the industry.

MEMBER REMPE: There is none -- I thought there were some areas that they could regulate.

MEMBER RYAN: No.

MEMBER REMPE: What about universities, too? You regulate them.

DR. COOL: So, the NRC's jurisdiction or correspondingly the Agreement States, is the radioactive materials. So all of the nuclear medicine, now all of the PET isotope tests and otherwise, would be under our jurisdiction. Those are inspected. We look at them. We follow up and we would certainly follow up on any allegations. Those tend not to be the areas where these high doses are seen for several reasons.

MEMBER REMPE: But if there are some areas with --

DR. COOL: But one we are looking at -- we are putting out loud what Dr. Shack is saying there. But also noting that for a lot of these because you have material in a vial, you can keep it shielded and otherwise the longer periods of exposure for the individual workers is not nearly the same as someone who would be doing interventional cardiology, working with the beam on the pedal, trying to get the stent up to open the blockage before the individual dies of the heart attack there on the table. It would be very rapid.

MEMBER RYAN: Radioactive material is something the NRC regulates and authorizes Agreement States to regulate. So the radioactive material stuff is under the purview of the NRC in the Agreement States.

MEMBER REMPE: But not the personnel.

MEMBER RYAN: Electronic know who the personnel in that case is. Electronic product radiation made by a machine is not regulated by the NRC or Agreement States.

MEMBER REMPE: Okay, I understand there are certain areas you can't control but the areas you can control, what I am hearing is there may be some people still leaving their dosimeter in their desk.

MEMBER RYAN: Yes.

MEMBER REMPE: And why aren't you inspecting those that you can regulate is what I am asking, and do a lot of findings or whatever?

DR. COOL: They are inspected and there are follow-ups. I think the percentage of that happening on our side is lower but I don't have any data.

I do know from having been the director of the program for a number of years, that we send our inspectors out. They are very good. If they sense

something is not quite right, they dig down into it and they do find things and we do bring them up.

MEMBER REMPE: Okay.

MEMBER BANERJEE: So it's really the problem. The area that you can regulate is not where the problem is.

MEMBER SIEBER: Right.

DR. COOL: That is correct. The areas that are known to have the issues are not areas in our current jurisdiction and they are not areas that require reporting. And while this is a correlated fact, something that I can represent to you as causative, it is quite interesting, the groups that are required to report, that show up in our database, are the groups that don't have any numbers over five rem, except for radiography event and accidental overexposure. But the groups that do not have the reporting or have no requirement for reporting at all where this data appears to show up when, as NCRP did, you go and mine the larger set of dosimetry data because certainly there are requirements to monitor it and there are requirements for them to keep records.

It would be possible to go get this data if we wanted to expend the manpower and time and money to go do the inspections, pull records that some

representative sample of facilities and a lot of that effort. It is just not that it is available to us in typical ways. And I suspect that getting OMB clearance in this environment be interesting.

MEMBER BANERJEE: Thank you.

MEMBER REMPE: At the universities, are there any monitoring issues at all? Because they are probably generous as well with their values.

DR. COOL: The universities have their licenses. They do their monitoring. And generally speaking, there are not issues.

MEMBER REMPE: Okay.

CHAIR ARMIJO: Don, how does lowering a limit from five to two solve that problem of non-reporting or not wearing dosimeters in that population that you are concerned about?

DR. COOL: It doesn't. That is a separate issue. That is why in the staff paper you have staff recommendations that we examine the implications not only of possible changes to the limit value but possible changes and additions to the reporting of dose and other things.

They are certainly correlated issues but they are not the same issue. You have to attack them differently.

CHAIR ARMIJO: But are you contemplating an approach that targets the problem area?

DR. COOL: We, if the Commission agrees to us moving forward, would explore that with those groups that we would need to be partnered with in order to get that done. I can't tell you today that we would do this or that on any of these topics yet. And I would fully expect there to be a lot of push back from some of those organizations.

CHAIR ARMIJO: Well, sure. I wouldn't be surprised about that. But addressing the problem should be the objective, right?

DR. COOL: Yes. Yes, and I will tell you that in discussions we have had with some of the representative Agreement States, we didn't have all 37 of them on the phone when we were talking about this paper before it ever went up, and we talked to them about the different approaches, jumping ahead a little bit to something that is on one of the later slides, they were supportive of the approach that the staff was recommending because their preferred approach is to try and have a simple, straight-forward line and to work with licensees who need special considerations or work to try and address the problems, in order to improve safety.

MEMBER SKILLMAN: Don, what is the population within the REIRS database here?

DR. COOL: The 2010 data had 142,513 people in it in 2010.

MEMBER SKILLMAN: Thank you.

DR. COOL: So I think we have touched a lot of this already. Most all of the exposures are below the dose limits. There are a few things that exceed today's dose limits due to accidents and events. You get a radiography source that gets disconnected out there and they fail to survey and otherwise they get themselves over five rem rather promptly.

There are exposures that are occurring every year in excess of the ICRP's recommended average of two rem. The number of individuals that are doing that is small. But we have folks that are out there every year. The statements made by licensees are that they do that every year.

We have a small number of individuals in our database, which are at or above 100 rem for their cumulative exposure, keeping in mind again that our database doesn't include most any of or all of the radiographers and none of the medicals and others who would be more likely to be up on that range.

When you look at this in the typical cost-benefit reg analysis sort of things of dollars per person rem, this doesn't get you there for this group because the number of individuals are small, even though their doses are higher. So this is not an area that you do the typical justification by reduction in dollars per person-rem because even if you wipe out this entire small group, it is not that many individuals.

So the challenge, as we were talking with stakeholders the past three years, what would be the most efficient and effective method to ensure that each individual is adequately protected? Knowing that is to be clear, predictable, reliable. You have got to understand what it is. There has got to be consistent interpretation across all different kinds of uses, across NRC 37 Agreement States. And you can translate onto that all 50 states and the territories for their machine-produced side of the house. So it has got to cover everybody.

What are we considering? We specifically talked about several different things. First of course we asked the question do you think that those limits should be reduced and everyone said, of course, no. That's not surprising. So we dig a little bit

deeper on that.

We talked about how would we -- might an approach be to strengthen ALARA? And quite frankly, the staff as it went into it was thinking that a strengthening and focus on ALARA might be the solution to this issue by adding strength to the ALARA program.

There was a lot of push back on that from several points. One, they said, and as you listen to it you will sort of have to agree, if you established a numeric value that the licensees either had to use or establish on their own, and if you required them to take a set of actions to be turned to compliance or some similar work with that number if they were exceeded, then it is a limit. You have just called it a different name.

MEMBER RYAN: I think that is being a little harsh. ALARA is not a limit. It never has been. You know I have run ALARA programs in several different venues and it is a strategy. It is not a limit.

And I think the point that ALARA is the right way to do it is because it is a planning process that optimizes the work and minimizes the regulation. I think anybody that has been in the power plant knows that at this table, I am sure, others who have been in

other settings would agree. But I think that for those who perhaps have not participated much in ALARA, it seems like a big deal. It is really not. It is really nothing more than a really effective work planning process and the one aspect in addition to getting the work done is the addition of a safety consideration of the occupational regulation exposure involved there.

DR. COOL: I would agree with you but I would like to make one further point.

MEMBER RYAN: Okay.

DR. COOL: The outcome of ALARA via the planning process will be different for each thing that you planned for because each of your activities are different your circumstances are different. Otherwise, it has to be a planning process. That is why it works and you are exactly right.

The discussions with the stakeholders on issues was the question of whether the range in which you could plant would have a harder boundary around it in order to avoid individuals being at the upper end of those distributions.

MEMBER RYAN: But see that is the mistake.

DR. COOL: That is what the stakeholders both here and internationally have been concerned

about. The constraints were just another form of limits.

MEMBER RYAN: But that is an education program. That is not a fact of ALARA. You know if you have a good ALARA program and you decide somebody is going to get 3.5 rem because it is a particular activity that has to be done to save a calamity of some sort, you do it. I mean just because you are making a decision and the dose is going to be higher, it doesn't mean it is a bad decision but if a higher does is justified, I'm going to take it into practice.

It is not a way to say we are going to be under two. It is a way to say this work activity is going to be optimized so the radiation protection, the radiation dosage received by workers is not any more than it has to be to get the job done. And if it is going to be 17 rem, well then we are going to have to figure out a different way to do the job. Maybe it is now remote tools or robotics or whatever all else you might want to do.

So as the challenges gets higher and higher -- I think I am preaching to the choir here a little bit. As the challenge gets higher and higher, the work gets a little bit more complicated to accomplish. Okay, well that is the nature of the

beast. I don't see why that is a problem. So strengthening ALARA and training people to use ALARA properly is probably the number one priority to make radiation exposures lower, if you want to do that. So not by changing the limit.

It doesn't change the risk. If you have a limit of two and you have to hire two people to do the job that one could have done with a limit of five, well, are you going to spread it out a little bit. You have to give two people part of the risk instead of one. So what have we accomplished there? Nothing.

MEMBER SCHULTZ: I have the same type of view.

MEMBER SIEBER: When you do it that way, when you use two people instead of one, the summary dose of both of those people is greater and sometimes substantially than one individual would have achieved --

MEMBER RYAN: Getting the smaller increment. You're right.

MEMBER SIEBER: -- because there is inadvertent exposures while you are trying to get to the work.

MEMBER RAY: Well not only that but the person -- there may be one person who is best able to

do the job quickly and efficiently because they have been there, done that. They know exactly what they are doing. You have to have other people do it. They aren't as able to do it efficiently as perhaps in a particular case an individual who has been responsible for a particular piece of equipment or whatnot could do it.

MEMBER SCHULTZ: It seems as if those reasons the stakeholders have provided as to why strengthening the ALARA program is not effective for them would suggest to me that they don't really understand the principles of ALARA, either in terms of the flexibility that ALARA should provide or the principles associated with the reason ALARA is there to protect the population and protect the individuals.

There are very clear and distinct principles within ALARA, that guideline process, that have been very effective and appropriately effective to accomplish a very good benefit for the doses received for groups that apply ALARA well.

And those that say I would rather have a lower limit instead of ALARA are missing out on very important principles that would provide the maximum benefit for the lowest dose.

DR. COOL: I would make two observations.

One, we very much agree with you. And if we were dealing with a licensee set which had the resources, protection culture, and approaches that you are very used to in the nuclear power plant industry, we wouldn't be having this discussion.

I, on the other hand, when I go back upstairs have to deal with 22,000 licensees for whom that set of statements does not apply. I am not about to tell you that they don't do ALARA. They work very hard at doing things but their planning base is to stay inside the limit, period, end of discussion. It is not the same sort of driver. I would note to you that there are a number of drivers in the nuclear power industry which all hope to support driving the doses down. They are ranking the quartiles of the goals, the best practices, a whole series of things which are not embodied directly in our regulations but they all contribute to very good practice and continuing improvements in that practice over time. None of those things exists in the world in which I have to work each day on the materials side of the proposal. They do the best that they can but if they are under five, they are happy.

The RSOs would be bristling in the back corner if they were reading this transcript now

because they do what they can do to improve the doses but it is a very different environment. There are none of the other forcing factors.

So we are in a position here where we are looking at both very much agreeing that ALARA is the way to improve protection but at the same time figuring out or making a determination of whether something needs to change in the regulation itself so that the outer boundary of that planning guide for some small number of licensees, and no it is not going to pass cost-benefit, have a reasonable assurance that they wouldn't exceed one sievert over their working lifetime.

And what I can reflect to you now is of course only the discussions that we have had with the stakeholders to date. If the commission agrees that we should continue to have this discussion, I am sure we will have additional debate. And the great thing about moving to more detailed discussions of different actual proposals is that the devil is in the detail. And when you get to the detail, then some of the reasons will start to show up with what will work and not work and what sorts of flexibilities are not available.

Do I think that health and safety requires

a strict two rem, period, end of -- no discussion? No, sir, I do not. The question is what is the right way across the entire segment of all of the different kinds of licensees and uses which this commission has to apply its regulations to is the most appropriate way to make sure that each individual has adequate protection.

MEMBER RAY: Well Don, you know that seems very profound and persuasive and so on and so forth but it never addresses the question of, it seems to me, what is the unintended negative consequence here? How might this adversely affect safety, which the people upstairs also need to be concerned about? It is as if it can't, it won't and we won't think about it or discuss it.

I mean we can all envision and we have talked about the medical field and how that operates and the tradeoffs that are involved there but there doesn't ever seem to be any discussion of the tradeoffs that I have been talking about. And in trying to pursue that with some of my friends, I think I understand why. It is just not a discussion that is easily had. But there is reality there, nevertheless.

And so I guess if we are the only ones that can raise this issue, I, for one at least, think

it is worth raising. But in your summary of the, like I say, the reflections that people have upstairs, they never seem to bring this issue up. I mean, is there some potential that we would inhibit, discourage, or even subconsciously cause people to not do something that they would otherwise do that would have to do with reactor safety?

DR. COOL: Dr. Ray, I think you have a very important point and I am very much in hopes as we dig into the details of the proposal that that will be a key part of the discussion.

MEMBER RAY: Okay.

DR. COOL: I will reflect that I don't think that is quite as bleak as you would portray it because in the medical side of the house, it comes up immediately as so what are the implications for the number of procedures? Can we actually provide medical care that is necessary otherwise? That is another component of safety. Different factors play in different groups. That will need to be part of the discussion, I firmly believe, personally.

I would hope that that would be part of the discussion that we would engage in if we move forward to try and find specifics of a proposal with this rationale.

MEMBER REMPE: I was looking at the documentation to support this. They talked about exemptions if you went to a lower limit, that you might have certain cases that you would say okay, there will be certain circumstances you go to a higher limit. And I am wondering okay, if you go to this lower limit and you have the exceptions, are you going to end up with a system that is much different than the current system that is at five, where have ALARA and most people are below two --

MEMBER RYAN: You've hit the nail right on the head, Joy.

MEMBER REMPE: So is this just a paperwork exercise when it is all said and done in a lot of work? I am wondering if that is what is going to happen.

MEMBER RYAN: I'm with Joy in that view.

MEMBER REMPE: I don't know but it is just what I am wondering.

MEMBER BROWN: But how can you give an exemption to one and not others? It's going to be a big battle between who gets exemptions.

MEMBER RYAN: I guess I will go back to my experience with ALARA. ALARA programs do exactly that in a systematic way. It can be laid out for a

regulator in an inspection or a management committee that wants to review it or whatever it might be.

And at the end of the day, I don't think the system is broken. We are trying to fix something that is not broken.

CHAIR ARMIJO: Well there is a problem population that Don talked about.

MEMBER RYAN: Which is not regulated by this Agency.

CHAIR ARMIJO: Right and that is what troubles me, to address this problem population, we are going to apply new limits to a population that is doing an exemplary job.

MEMBER RYAN: Sam, I agree with but let me say it again. The problem population is in no way, shape, or form, regulated by the U.S Nuclear Regulatory Commission.

CHAIR ARMIJO: Then why are we here?

MEMBER RYAN: That's a fact. I mean that has got to sink in. Where the real problems are suddenly non-material regulated areas. Electronic product radiation, which I mentioned earlier, is not regulated at all by this Agency.

Now very often in a state regulatory office the person who is inspecting the nuclear

materials activities for nuclear medicine studies also is the same guy that is going to make sure the x-ray machine is pointed in the right direction and working properly. But that is the state's decision that is not what this Agency has oversight on.

I share the concern that you raised. I don't discount it at all but I am saying we can't write a letter about --

CHAIR ARMIJO: Something we don't regulate.

MEMBER RYAN: -- something we don't regulate. So we are kind of strictly focused on the NRC authority here.

CHAIR ARMIJO: I would point out to you that we know we have similar issues in industrial radiography and a few other types of uses that are NRC-regulated and where again, because the states do not require reporting, I only have a very small sample of the data available. So this does not apply. The issue is not only outside of NRC jurisdiction but it is a small a number of individuals and that is the question.

Just to quickly finish off so we can continue the discussion, we looked at an average and maximum value to date. And I keep wanting to

emphasize this because we can only report to you the discussions and the conclusions that we can reach from the discussions with the stakeholders thus far. There was a very strong few that they did not want to have the additional burden applied across the board of having to keep track of multiple years of exposure or otherwise in order to demonstrate compliance.

We talked about a single lower value. The states, at least, preferred that approach. And then going in and working, being an exception or otherwise, over some period of time unknown, you are quite right, Mr. Ryan. We don't know how long that might be.

Part of the discussion would have to be what sorts of criteria and bounds do you place on it. And the question is always going to be so is there a consistency across all of the different organization units otherwise that would be applied. So there are a lot of things that if the Commission says we should be moving forward on this will require continued detailed discussion to try and figure out where the place might be.

At this point, based on the information we have, and our interactions with our stakeholders and our co-regulators the states who have 18 plus thousands of these licensees and their corresponding

side, the view with the information that we had was that looking at a single lower value and finding a mechanism for flexibility, what we suggested from the paper was the same approach that is in the regulations and a couple other places. So there is a clear legal track record on those. That doesn't mean that we are, in any stretch, pardon the pun, limited to that but a mechanism to examine how to provide the right kind of flexibility.

This will require both regulatory analysis and backfit because this applies to all licensees. The industrial radiographers and the medical folks don't have backfit, but that doesn't get me off the hook from having to look at it across the board.

MEMBER RYAN: One comment on that point. You have actually laid out two approaches here. One is lower the limit and then fight to get above it or have the current limit and then demonstrate performance to lower below that limit.

So going over a limit has a lot of implications that need to be carefully thought about before you propose that. And to me, going over the limit has legal implications. You overexposed me. Here is the legal limit. I am sick. I am going to sue you.

MEMBER SCHULTZ: I didn't understand the first bullet on the conclusion. Is that the performance-based part? I didn't understand what that meant. A change to limits is a more straightforward performance-based --

MEMBER RYAN: Yes, and the change would be to lower the limit two rem.

MEMBER SCHULTZ: Why is that performance-based? What is performance-based about that?

DR. COOL: You have set the standard and you have not dictated to the licensee how they go about meeting that. Much of what was discussed in terms of how you would strengthen ALARA, the procedures, the review boards, the additional approvals and things end up being a very prescriptive list of things to do, hurdles to jump, to get to some endpoint. Simply saying here is the number, you figure it out, is a more performance-based approach than that part of the discussion. And that is what these words are referring to.

MEMBER RYAN: And again, I am drawing on my own experience. For a licensee that has a licensed activity and has some kind of a safety oversight function for industrial safety, radiation safety, all the rest of it, these things don't become necessarily

routine but they become systematically ingrained in the culture of getting the work done. People just don't go, you know, using a shipping cask and start unbolting the lid with their bare hands. You know, there has got to be a lot of stuff that happens on a systematic way to do it and a systematic way to get it done, which results in higher doses.

So what we are kind of, what the suggestion to me is that you are just taking all of the cultural trappings of an ALARA program and an ALARA process that works and throwing them out the window. I think that is really dead wrong.

CHAIR ARMIJO: I would like to see a safety-based approach and I haven't seen any data that shows a quantifiable safety benefit from making these changes. And this is all nice at a high philosophical level but there are specific recommendations on the worker limit. There are specific recommendations on exposure to the lens of the eye, a number of things that are -- and we haven't talked about them yet. And we have been focused on this philosophical thing in some problem populations and I am still hung up on the fact that have good, safe limits now that people are not only complying with but exceeding. And I think the pot is right, at least for the vast majority of

the people that we deal with, the nuclear industry people and the facility people.

So just if they are doing well, lower the limit because it would be in conformance with some other groups that seem to feel that that is what they want to do. I haven't seen the justification for that. So I just don't know how you -- you have to first make the safety case before you can change the limit, I would think. And I haven't seen it done.

DR. COOL: I understand, sir. I just would reflect that if you are looking for a safety case in dollars per person-rem, you will never get there because we are not --

CHAIR ARMIJO: I'm just looking for --

MEMBER SHACK: This is an individual risk problem.

DR. COOL: This is an individual risk problem that is over time.

CHAIR ARMIJO: It is alleged to be on an individual risk problem over time. I have yet to somebody that says hey, show me some data.

MEMBER SHACK: Well, the incidence went up by a factor of three from 1.25 to five. That is the data you work with. Those are your experts. They are the ones that are telling you that the risk has

increased.

CHAIR ARMIJO: Well there are other experts that say this --

MEMBER SHACK: No, the consensus -- but let me ask another question. It seems to me that the ICRP, NCRP all have the flexibility, you know, they have the five rem limit with the cumulative limit. The scientific basis seems to indicate that everybody is willing to live with the five rem limit over a year. It is the cumulative thing that you worry about. I don't see that it is more straightforward to bring in an exemption process than it is to have the five rem plus a cumulative dose, which again is consistent with all the recommendations of all the scientific side.

I mean, I'm not a health physicist, a microbiologist, an epidemiologist, but they are all willing to live with five rem per year but they want a cumulative limit and I don't see why --

MEMBER RYAN: Even within those specialty groups, it is not all.

MEMBER SHACK: Well, not all.

MEMBER RYAN: Not a majority.

MEMBER SHACK: Well, I'm not even sure of that. But at any rate, it just seems to me that I

don't think -- I can't believe that you can come up with an exception process that is simpler than tracking a cumulative limit.

MEMBER BROWN: There is no cumulative right now.

MEMBER SHACK: Well they are going to change it by making the --

MEMBER BROWN: No, I understand the 100.

DR. COOL: At the present time, there is no cumulative requirement in the regulations.

MEMBER BROWN: So somebody could literally get five a year for 40 years, a couple hundred rem.

DR. COOL: However long they want to work. That is correct, sir. That is the legal basis, correct, right now.

MEMBER BROWN: I just am not saying that is bad. It is just that that is the way --

DR. COOL: Theoretically you could accumulate that.

MEMBER BROWN: Yes, okay.

MEMBER REMPE: What are you going to do with the employees that max out?

MEMBER BROWN: There is a lot of action on the side, too.

MEMBER REMPE: What do you do you with the

employees that max out?

MEMBER BROWN: Fire them. I'm just kidding.

MEMBER STETKAR: Put them in non-radiological work areas. People do that. I mean, people do that --

MEMBER BROWN: It's happened for years.

MEMBER STETKAR: When people exceed their annual dose limit, the get moved out of radiological work. We used to do it in the power plan 30 years ago, for crying out loud.

MEMBER BROWN: We had to do that in the shipyard with guys on an annual basis. It wasn't done --

MEMBER SHACK: I mean that is true whether you have a single limit, a max limit.

MEMBER BLEY: Don, this is kind of close to something that you suggested. What you said is flexibility. Have you guys done all you think you can do on considering the idea of flexibility? I mean, exemptions is one approach to flexibility. Are there others?

DR. COOL: I think there probably are.

MEMBER BLEY: I mean we have got a big hunk, a major part of the industry that has really

done a bang up job in this area. We have got another big piece that has done pretty well with some exceptions. It just feels like there ought to be some way to deal with the outliers rather than jumping in and changing a limit that, we haven't talked about it today, that may have some negative repercussions for other aspects of safety. Because now suddenly in an industry where you have been close to two rem but below it, all of a sudden they are going to need more headroom to cover other kind of work. We haven't talked about that today, at least in the subcommittee meeting.

So some approaches to flexibility just seem like they are begged for in this area, either flexibility or dealing with the outliers, rather than hitting a broad brush with everything.

MEMBER BROWN: yes, but flexibility is good in the eyes of some beholders. How do you define useful flexibility?

MEMBER BLEY: Well that is the job for staff. That is why I am asking the staff what they thought about flexibility.

MEMBER BROWN: Yes, but you grant some to one and none to the other. That is almost like an exemption-type process if you are going to --

flexibility is being able to --

MEMBER RYAN: Well it needs to be a very standardized flexibility. For example, the average dose of some number of years can't exceed X but you can have variations within the five-year period. There is all sorts of ways to do it. It is not hard to do it.

MEMBER BROWN: Yes, well that isn't what they said. I didn't see it was that hard to --

CHAIR ARMIJO: That is what exists in the current ALARA program and the limit is fine.

MEMBER BROWN: It seems to work.

CHAIR ARMIJO: And most people are running at two or less in the nuclear industry but when they need to have exposures above that, it is built into their planning and they can do it. They won't get fined. They won't get -- but you bring that down to two now that is going to cut down on their flexibility. And the proposal appears to be you come back to the NRC and ask us for permission or a waiver so that you can go above two for this particular individual.

It seems to me just an incredible amount of bureaucracy for no benefit.

MEMBER RYAN: I think it is a very unfair

thing for us to ask the staff to make those kind of ALARA decisions when they don't have the direct hands-on experience or insights that plant operators have.

I mean the radiation protection program folks at nuclear power plants know how to do this and they have done it very well.

MEMBER RAY: Well the kind of things that I am concerned about, believe me, occur in the middle of the night. When you are ready to take the plant back online, somebody says what about this or that. You know, you only have so many on shift who could go take a look at it and you just, you know, with these lower limits, you are going to say no more often than you used to. And it is that kind of stuff that bothers me. I mean, the idea of going and seeking a waiver or something like that, it is just going to discourage things from happening that I think will, long-term, have a negative safety effect.

MEMBER RYAN: But I think the negative influence also includes that people will skip through it and just do it because they have got to get it done. I mean, it has the potential to stimulate bad behavior.

MEMBER SCHULTZ: The ALARA principles were established to provide this flexibility that we are

talking about.

MEMBER RYAN: Exactly so.

MEMBER SCHULTZ: I just think if stakeholders are saying that is just too complicated, then they don't -- well they are not doing the work that they ought to do in order to establish the ALARA program for the work that they are doing with radiation.

MEMBER RYAN: Well said.

MEMBER SHACK: Well never having managed an ALARA program, I am willing to bet that you don't truly optimize or minimize things. If you do optimize or minimize subject to constraints of costs and maybe a target that you are trying to hit like five rem. And I don't think that changing limits has no effect on ALARA programs.

MEMBER RAY: You ought to sit through an INPO exit interview.

MEMBER SHACK: That's because it is not truly optimizing or minimizing. It is optimizing or minimizing subject to a set of constraints like --

MEMBER REMPE: Administrative limits like in the DOE.

MEMBER SHACK: Well limits in costs.

MEMBER POWERS: In my experience in ALARA reviews of work is that the limit doesn't come up because you have already established when you sent the work package down, that nobody is going to go over a dose limit which is usually not five, it is usually half a rem. That comes in. Then you do the ALARA review. And I don't recall the limit ever coming up.

MEMBER SHACK: But you would have a different answer, I think, if they sent you down with a number that said five instead of half, and then started the ALARA process.

MEMBER RYAN: I mean, five is the annual limit for work. And if he is going to do one job in a year, he doesn't have to worry about anything but five. But that is not the way it works.

MEMBER POWERS: Typically when a work package comes to you, a health physicist has looked at it and said this work package should result in anybody getting over 0.5 rem.

MEMBER RYAN: And that is by detailed analysis and calculation and the whole thing.

MEMBER POWERS: Yes, it is an engineered package. Then you do the ALARA review. I don't think I can recall anyone ever mentioning a limit. Then what you are asking is we have done -- somebody wrote

up this package who doesn't have to do the work.

Now you people who have to do the work, is there a better way to do it, to cut down? I mean the beauty of the system is it is wonderfully linear and that people use skill and craft and typically you will drive those doses way the hell down in a very brief review. I mean, really down. They are breathtaking how clever people are when you tell them time and distance are the two factors you have to worry. How can you reduce your time and keep your distances?

MEMBER RYAN: And shielding.

MEMBER POWERS: And shielding, yes.

MEMBER SCHULTZ: And appropriate protective clothing.

MEMBER RYAN: All of that.

MEMBER POWERS: At least the ALARA reviews we gave no credit for clothing. It was just assumed. It got no credit, the ones I participated in.

MEMBER SCHULTZ: That's right. I was thinking of the programs associated with assuring that respirators, for example, were used in an appropriate way, not increasing those, rather than --

MEMBER POWERS: It is usually specified in the package. That is kind of a given and you don't -- you give that real credit. Everything is based on

time and distance and shielding, but the shielding is again clothing.

MEMBER RYAN: But the effects that are ad hoc are hand, you know you can wear certain things on your hands like gloves, you know whatever it might be. There is all kinds of different ways to skin the cat, based on what the job is and what materials are involved.

I mean my own view is that a limit that I now have to go in and have a "mea culpa" "may I" exceed the limit is the wrong tact to take. ALARA programs are inspectable under a license and their records are inspectable under a license. And I guarantee you that I was inspected all the time about ALARA by customers, by regulators, by both federal and state regulators. And it is a system that works. I just don't see the advantage of saying okay, we are going to break the rules. We are going to have a two rem limit. If you want to exceed it, you have got to come and beg for it. I just think that is the wrong way to go. It is going to take away the way ALARA works now from the system. I just think that is a bad mistake. I think the number is fine the way it is. If you want to increase anything, increase the oversight of the ALARA programs that licensees used to

do.

MEMBER RAY: Well again, agreeing with all of that, I think also we want to encourage people, not discourage them, from taking actions that assure the safety of the people.

MEMBER RYAN: You are absolutely right. Or the facility, if it is a plant or anything. I couldn't agree with you more.

MEMBER RAY: I am talking about, you know, like I say, I have got a limited number of people and I have got so many different skill sets, I have got to run the plant. I don't want this to be a discouragement of doing the things that you need to do to make sure the plant is safe.

MEMBER RYAN: And to put it crudely, you can't afford having everybody on the bench to work a two rem per year, and you sit there paying to hang out until they are needed later in the year. It is just not going to work.

CHAIR ARMIJO: Well if there was a real safety risk, I would do it.

MEMBER RAY: You mean to the individual.

CHAIR ARMIJO: You know, if there was a real safety risk, I would say, we will have these guys sitting on a bench but I just don't see the --

MEMBER RYAN: But then you know costs go up and that has negative impacts. It could be a very negative thing.

CHAIR ARMIJO: Mike, there are a number of very specific things like cataracts and other things in these recommendations. We didn't discuss those at all. It is really Don's presentation but --

MEMBER RYAN: Why don't we let Don finish?

MEMBER STETKAR: Let me just throw one thing out there because this is certainly not an area I know anything at all about, technically. On the other hand, the Nuclear Regulatory Commission has adopted what we like to call a risk-informed, performance-based regulatory framework.

The first bullet there strikes me as setting a speed limit of 14.367 miles per hour applicable to everyone everywhere is not a risk-informed performance-based regulatory framework. So you are fully cognizant that that first bullet has a dichotomy in it. It is not a performance-based regulatory framework. It is a strict law. So don't call it performance-based. It is not performance-based.

A risk-informed performance-based regulatory framework as embodied, for example, in the

reactor safety end of the business, looks like Reg Guide 1.174. If you are a bad performer, you don't have very much margin allowable. If you are a good performer, you have got a lot more margin allowable. How good a performer are you? You do a risk assessment or you do some other performance assessment to say where are you on that scale. If you are a bad performer, maybe you have got to crank down the thumbscrews. If you are a good performer, you have more margin. That is risk-informed performance-based. That first bullet is not performance-based. So don't, please don't advertise it as such.

DR. COOL: But the ALARA program --

MEMBER STETKAR: It is -- the ALARA program --

DR. COOL: -- principles are performance-based.

MEMBER STETKAR: -- is -- are performance based. The ALARA principles are. But simply setting a lower limit is not a performance-based regulatory guideline. It is saying your core damage frequency shall be ten to the minus seven and do whatever you can do to get under ten to the minus seven.

MEMBER SIEBER: I think one of the issues that sort of lies in the background is I don't think

there is sufficient data to establish that there is a measurable improvement in health benefit when you go down to two because they are small doses, without a doubt. And when you consider that the cosmic background dose, industrial background dose is 300 millirems, you get an additional 200 to 600 millirems just by going to those -- I just don't see that body of evidence that says if we don't go down to two, then the mortality will increase by ten percent.

CHAIR ARMIJO: Or latent cancer.

MEMBER SIEBER: Or by one percent or zero. It is just not there.

MEMBER STETKAR: I know we're getting tight on time, Don. One thing you did say, you said many of the stakeholders balk at -- they feel the two rem per year limit is easier for them because they don't want to keep lifetime dose records. It is simply a record keeping issue?

DR. COOL: For many of the licensees in the discussions to date, it was a record keeping and other burden, getting the information available to know what the individuals received over multiple years. Many of them remember the days prior to 1991 where it was a 5N minus 18. You had to have multiple years of exposure. You had to try and go back and do

your best efforts to gain the data of their previous exposure. If not, there were certain, much more stringent assumptions about what you could do or not do. And the view with the information they had, is they would prefer not to go back there.

MEMBER STETKAR: These people don't have computers? I mean keeping records these days is a lot different than it was 30 years ago. I mean, I just don't understand that argument. This goes more to --

MEMBER RYAN: Again, I'll speak to my own experiences at RSO. If we had a worker that came in and there were holes in his record, we filled them because we wanted a complete record. Employers who are working, I think, appropriately, will want to have a complete occupational exposure history but it is a lifetime record. So I mean, I don't think that is a -- I mean maybe some folks have problems keeping their records but I never ran into it in a really obstructive sort of way. It really is something that can be managed. I see that more as an excuse than as a problem. It's just me.

DR. COOL: I am not going to sit here and try to put words into the mouths of people --

MEMBER RYAN: No, no, I appreciate that.

DR. COOL: -- that have talked to us.

MEMBER RYAN: My experience is --

DR. COOL: The staff's job in this particular activity was to ask the questions and provide the information.

To go back to Dr. Bley's question of a while ago, are there other ways for flexibility? I am sure there are. We have put forward one possibility because it had a clear legal precedent already within the regulations and which the states were quite comfortable with as a way of moving forward. I am sure there are others. I would fully expect that there would be ways to write it explicitly into the regulation such that there was not a necessity to apply for it otherwise. We would need to look at some of those details.

Where we were was a quick little process where we had engaged the stakeholders on a wide variety of issues. It was time to assess where we were. And did the Commission wish for the staff to continue to expend the resources over the next couple of years, as the scientific information for dose coefficients for the internal exposure otherwise continues to be developed to try and work on a specific path or not. That is what we have asked the Commission to do, to explore the implications of and,

therefore, by analogy the implications and options for other things with the stakeholders on a specific proposal can move forward, recognizing the wide variety of licensees that we have to deal with.

Dr. Shack, you have never done a radiation protection program but you are actually quite close. There are always a series of constraints. That is in fact the ICRP's worth, a series of constraints and boundary conditions of what will be accepted within that particular ALARA plan.

And I would simply reflect again, that works very nicely in the large programs where you do specific planning around a certain job. That does not translate nearly so well to most of the other environments that radioactive materials are used in in industry and in medical and otherwise.

MEMBER RYAN: Like what? Help me to understand what is on that list. I want to make sure we are on the same list.

DR. COOL: Okay. Let's start with industrial radiography. Certainly there is some planning. An industrial radiographer has to go and do a survey of where their two mR per hour boundary is. That make extend over several floors if they are doing radiography up in the scaffolds or, as cases in times

past where we were doing checks of the concrete in our parking garage levels here, we discovered once that they hadn't put a boundary on the floor up above.

So you can do some degree of planning around that. Most of that planning is simply a go measure where the boundary is. Try to keep it under surveillance. And crank out the source, do your shot, get it, crank it back in. For those particular licensees, we have in fact gotten quite prescriptive about the things that they have to do because they have proven to us that without the detailed prescription -- you will have two dosimetries, you are to do the following survey, and otherwise -- they manage to screw it up. And they manage to screw it up anyway, thank you very much.

So the detailed planning of I am going to go in and do this, does the radiographer go in and do that when he goes into a new facility? No. He is going to go in. He knows, generally speaking, what his dose limit it. He is going to string a tape around that general area and he is going to go at it.

So that planning and the review and oversight and somebody looking over his should simply doesn't exist.

In the medical area, in a nuclear

pharmacy, it probably exists a little bit more. That is a production operation. You can look at your hot cells and you can have a pretty good control. For the most part, they don't have many issues.

The folks who are pulling PET targets, a very short half-life, trying to draw it off, it has got to be medical grade, it has got to be very -- it has got to meet all the conditions for injection into the human body and get it upstairs before the five minute half-life or whatever it is goes, they are getting more. That is one of the groups that we believe may be closer to the current dose limit because those are high-energy photon types of isotopes. So the lead aprons and things don't really work. But yes, they are structure and things that you can put around those and there is some planning for the nominal activity.

The actual interventional hospital suite, certainly there is standard planning. There is shielding that is put in there. My understanding from folks is that much of the setup of those suites hasn't changed a lot over the last 30 years, although the equipment in there has changed multiple times and gotten considerably fancier and otherwise. That is one of the things that I have heard some of the

interventional groups, some of the physicians in there who are radiation protection lament about the fact that there haven't been updates to ways to provide protection. Is there an opportunity there? I expect so.

MEMBER SHACK: Just to come back to your SECY. Until this is resolved, we are not going to move forward on modernizing any other part of the regulation either, as far as the way we calculate doses and such. So this is a package that is going together.

DR. COOL: The staff has put this forward as a package. The Commission could, of course, and there was a range of options to only do certain components of it.

MEMBER SHACK: But in our letter, we can address the elements of the package. There may be some elements we are fully in agreement with and some that we disagree with. And that is why I was hoping that there would be some time allocated to talking about the specifics. You know, who can argue with SI units? I think you can learn how to use them. Painful, but we will learn.

DR. COOL: Dr. Ryan, my presentation is done. We can explore these other issues in the last

two minutes as you would like.

I would like to respond, Mr. Chairman, with a simple note that a number of the things that I think the Committee is probably very much in agreement with in terms of yes, more people should report, yes we should move to SI, have enormous cost implications when you do a reg analysis. And I can't show you one whit of a direct radiological benefit associated with it.

MEMBER RYAN: I'm bilingual. I don't care what units we use.

CHAIR ARMIJO: Yes, I know you're good at this.

MEMBER SHACK: No but I mean calculating a dose correctly in our best understanding is just the right thing to do.

DR. COOL: The right thing to do. And that is why in the paper you received, what the staff has said on the back, that in regulatory analysis this would, as last time, have to be justified on both quantitative and qualitative. Those sorts of things, graphs.

CHAIR ARMIJO: Correct calculational method, I don't think it is a cost justifiable thing. It is either right or it is wrong.

MEMBER RYAN: You know, the examples of radiographers and other sealed-source users under one scheme or another always come up as the examples of something that needs to be fixed. They have been coming up since I have been in this business, which is quite a while now.

And I think that licensees, whether they are Agreement State licensees or nuclear power plant licensees or other material licensees in the system somewhere, the level of quality is much higher. And I think that this change, a proposed change really doesn't add any value to the current practice of ALARA. And the idea that going from five to two the population that is in the two to five range, is so small, I don't know what that benefit would be enough.

And you know, I mean, there have been abuses in the past. I mean a guy shows up as John Smith one day and he is Fred Johnson the next day and he is working under a different badge. I mean those things have happened. Luckily now they don't happen so often because there is a little bit more attention taken to those details. I just wonder if we are opening the door to back practice creeping back in.

And you know, my colleagues at the NCRP and the ICRP one thing they never seem to really want

to emphasize is what the uncertainty is on the estimates of risk. They do have some after that analogy. I just don't know that the range in risk is not reasonable, based on with the current limit of five, what the range of uncertainty and what the risks might be.

What is the average person's medical exposure for a lifetime if you could make a guess? Just in the normal care that you get from our physician? It far outweighs for occupational risk in terms of radiation exposure. And that is not even accounted for in your dose records

So while there are just practical factors that we have to take into account to think about does this make any sense. I come down and the answer is no, it doesn't.

CHAIR ARMIJO: Mike are you talking medical risk for people who have to take these enormous doses?

MEMBER RYAN: I'm talking about people that go to their doctor, who get routine exams, and whatever other exams the doctor decided are needed, whether it is a colonoscopy with CT scan or whatever it is. You are going to get routine medical exposure and it is not trivial, per exam.

DR. COOL: Mr. Chairman, for example, yesterday I had two chest x-rays taken because I am now in week five of continuing considerable coughing and lung irritation and it was necessary to determine whether I have pneumonia or some other structural issue that has to be addressed. Yes, that is more dose than I got, probably, in a year of working in my laboratory when I was doing graduate work. Those factors are certainly--

MEMBER RYAN: Well in terms of the risk to the workers, we are not even including the entire scheme of radiation exposure that they get in routine medical care.

DR. COOL: Dr. Ryan, I would also like to --

MEMBER RYAN: Yes, please.

DR. COOL: -- do the same thing that I do in most of the public meetings, which is I very much agree with most everything that you have said. And I would really love to have a way in which an ALARA program could be systematically strengthened such that it would be effective across a wide range. And I would love for someone to give me a proposal that would allow me to do that. To date, I have not gotten one that would work. Have at it my friend.

MEMBER RYAN: Okay. Well who knows? We may get lucky, Don.

MEMBER STETKAR: Have you thought about -- I keep coming back -- and again I apologize because I don't know about the technology but I see what we are doing in the reactor oversight licensing process in terms of safety. In that process, we have basically two options. Licensee can opt to adopt something for a particular issue, I don't want to get into specifics, a risk-informed performance-based approach, which entails a certain amount of rigor record keeping analysis and so forth. It gives them a lot more flexibility in many cases, as constraints about an analytical processes to evaluate risk or something like that.

Or a licensee can opt to adopt a deterministic licensing basis which has fixed, very specific black and white rules. It is up to the licensee. You make one decision. You make another decision and you live by your choice. Could a similar type of framework operate here? If you are a certain type of licensee, a radiographer, yea, verily, I am going to live by two rem per year limits because that is the way I want to live my life. Fine. You want to live your life with doing analyses, let's call it

ALARA, and keeping records about cumulative life exposure, fine. You get more flexibility then. Have you thought about that? That is this notion I think, Dennis --

MEMBER BLEY: I was wondering if you had read the transcript of the subcommittee meeting.

(Laughter.)

MEMBER STETKAR: No, sorry. Never mind.

DR. COOL: That was in fact some of the discussions.

MEMBER STETKAR: Okay.

DR. COOL: And certainly there are possibilities. The question becomes what do you put in the regulations and what is in the licensee's license condition with guidance and otherwise.

All that happens in the reactor radiation protection programs, all of the detail that you are describing, all of the things that are reviewed under the reactor oversight program are part of the licensee's procedures and conditions and otherwise. Those reviews are not being done to see whether or not they are in compliance with 10 CFR Part 20 1101(c). All of those procedures are carefully designed to ensure that compliance and then some and the inspections and the findings are made against those

procedures, not against the regulation.

Part of what we, unfortunately, have to deal with is the situation where to translate it into other groups you do not have those sorts of licensing basis activities, reviews, things in other activities. The question becomes what do you actually put in the regulation because that will be all that there is.

MEMBER RYAN: Well that is not exactly right. Let me tell you why. I worked for a company that provided services to nuclear power plants, we had to meet their requirements walking in the door. Part of their requirements were that we have a safety review board and all the things John mentioned for the workers, for the work activities, and for the equipment. You know it all had to be pedigreed and signed off by us and then that package is reviewed by the customer, and they decided whether we can do the work or not. It can get -- it has been getting done. It just wasn't required by a specific regulation.

DR. COOL: It was not required by regulation and --

MEMBER RYAN: By a specific regulation.

DR. COOL: I'm sorry. I have to also reflect that once again it is because you were going to the power plant.

MEMBER RYAN: But it was also non-power plant customers had the same desire. And we did it in non-power plant places as well because that is the way we have made a commitment to our license holder for the facility that we would do it that way. So we chose John's option B or two.

MEMBER SHACK: I'm still -- I disagree with John. I think that it changed the limits, the ICRP limits is performance-based in your state. Those limits are picked on looking at limiting the individual risk to an acceptable level so you can introduce your risk. It is performance-based. You have set a performance criteria that assures that you meet those risk levels. And the guy is up to his own on how he does it.

MEMBER RYAN: How can you set up a performance criteria? Performance criteria -

MEMBER SHACK: It is just because again to bring individual risk to a desirable level, I have to go to my health physicist, molecular biologist, epidemiologist, and he tells me I can give him five rem per year with an average of two year and that is my now my performance limit. It assures that I have an acceptable individual risk. After that, it is up to me how I meet that. So to me, that is performance

-- risk-informed performance based.

MEMBER BLEY: I don't think -- you don't completely -- what you have said doesn't completely conflict with what John said. I think that can live within the other framework.

MEMBER SHACK: Don just said that that is absolutely positively not risk-informed performance-based.

MEMBER BLEY: Oh that part. Okay, never mind.

(Laughter.)

MEMBER SHACK: That part.

CHAIR ARMIJO: Okay, well Don, thank you very much for your patience and for your presentation. What we are going to do now is take a 15-minute break.

MEMBER RYAN: Mr. Chairman, before you break, I want to thank Don as well. Don is encyclopedic in his knowledge of this area. He has been in the Agency doing this for a long time and is always very gracious and patient with our roundtable discussions. Thanks very much, Don. It is very helpful to have the interaction. Thank you.

CHAIR ARMIJO: All right. We are going to reconvene at 10:15.

(Whereupon, the foregoing proceeding went

off the record at 9:58 a.m. and went back on the record at 10:13 a.m.)

CHAIR ARMIJO: Okay, our next topic is WCAP-16793-NP Rev. 2 and Dr. Banerjee will lead us through this discussion.

MEMBER BANERJEE: Thank you. This will be a presentation by the staff on the safety evaluation of WCAP-16793-NP Rev. 2. Even though the title is rather general of this WCAP, which says "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," it is really focused on in-vessel effects and what happens in terms of blockage.

So we had a subcommittee meeting. This has a long history with the staff to go through but we had a subcommittee meeting on the eighth and ninth of May. And the PWR Owners Group presented on the eighth. The staff presented their draft Safety Evaluation on the ninth and really we are going to deal with the draft Safety Evaluation today.

So without too much more, I think we will turn this over to the staff. I don't know, Bill do you want to make some remarks to start with?

MR. RULAND: Yes, thank you. Thank you Sanjoy and Mr. Chairman. Good morning to everyone.

Normally I like to keep my opening remarks about two minutes but they are a little longer today because of what I see as the unique nature of what we are doing today and the long history of this particular topic report.

As Dr. Banerjee has suggested, this is the staff's review. We are here to present the staff's review of Revision 2 of this topical report on in-vessel effects. The Safety Evaluation has been several years in the making. There have been two revisions and years of testing. And I might add that the testing, this whole testing regime, was performed in response to ACRS challenges of the analysis-only approach that was in the original topic report.

Par for the course, through GSI-191 the testing showed unexpected results. Despite repeated attempts, the owners group could not demonstrate that the core can tolerate more than a very small amount of debris.

Staff presented the draft SE to the Thermal Hydraulics Subcommittee in May. The subcommittee had several questions at that meeting and the overall opinion from the subcommittee that we gleaned from it was that there was insufficient testing to support the limit of 16 grams of fiber per

fuel assembly. The WCAP is only two tests with this fiber amount.

Note that the PWR Owners Group does not consider the 15 grams limit to be realistic. They believe that the actual limit is much higher. This is one reason that most of the PWR Owners Group testing was done at higher fiber amounts.

The Owners Group has evidently considered the ACRS questions from May as well as the staff feedback. They elected not to run additional testing at 15 grams, but rather to develop a new program of analysis and testing that would answer not only the debris question but also answer questions on boric acid precipitation as well.

The results of that program are scheduled to be submitted in the summer of 2014. The PWR Owners Group sent the ACRS a letter on this subject on September 20th. As such, the PWR Owners Group is not actively supporting the topical report in its current form but they have not withdrawn it.

The staff, on the other hand, still holds to the position that the analysis and testing that support the WCAP in its present form provide reasonable assurance that 15 grams is an acceptable debris amount to the operating fleet of reactors.

While the PWR Owners Group only ran two tests at 15 grams, over 60 tests were performed in all. Testing from other sources also boasts the position that 15 grams is acceptable.

I will ask you to consider the staff's presentation of the relevant data and also to consider the broader context of this WCAP. If the analyses for GSI-191 have several conservatisms, the amount of debris generated an event, the amount that transports to the strainer, the timing of the events, and all of the simplifications that went into the analysis and testing in the WCAP, in that context, the WCAP provides an acceptable method for licensees to close GSI-191. Roughly half of the plans are expected to meet this limit. The rest need a basis for any future modifications. More refined guidance from future Owners Group testing will not be available for at least another three years.

The staff is asking the ACRS, hopefully if we have supported it, for a positive letter on this topical report. The staff would also appreciate any additional thoughts on the future testing program, if warranted, if you have had a chance to look at their letter.

A portion of the presentation will be

closed to the public as the staff discusses proprietary information from several sources.

With those remarks, --

MEMBER SHACK: Quick question.

MR. RULAND: Yes. Yes, sir.

MEMBER SHACK: The whole package as you put together corresponds to your option one for resolving GSI-191. Now there is your option three where they come in and perhaps do some -- not a fully risk-informed but they do some other things.

MR. RULAND: Right.

MEMBER SHACK: You wouldn't have all the conservatisms that we have built into all the parts of option one. Is this still the operative thing when they finally get to the end of option three or is that something to be determined yet?

MR. RULAND: Something to be determined.

Yes, sir?

MEMBER CORRADINI: For those that forgot, I am actually asking Dr. Shack and Bill can help.

MEMBER SHACK: Ask him, not me.

MEMBER CORRADINI: I didn't understand. I don't appreciate your question. That is what I wanted you to kind of expand on the question.

MEMBER SHACK: Option one, we have been

through this whole discussion of generation, zones of influence, and I think it is true that we all believe that those are very conservative, that they have conservative amounts. They have handled everything conservatively at this point. Now they are down to this last step. So they want us to look at this thing as a Gestalt, the whole thing. And that is one Gestalt.

MEMBER BANERJEE: Can you translate that into English, please?

MEMBER CORRADINI: It's kind of like the dice but not split.

MEMBER SHACK: Option two is the risk-informed thing that we saw from South Texas, so that is off somewhere else.

MR. RULAND: Right.

MEMBER SHACK: Option three is something yet to be determined, where you come back and do some arguments that maybe you don't really have. The breaks aren't as big as you thought they were. And the likelihood of generating this huge amount of stuff is less than you think it is but then that would have be coupled with a subsequent analysis.

And I was asking if you bless this for option one, does that somehow implicitly bless it for

option three.

MR. RULAND: Which Option three is kind of like risk-informed light.

MEMBER SHACK: Risk-informed light.

MR. RULAND: So really the question, I think the question centers around the topical report. Do we need to relook at this topical report in light of any maybe refinements that are done for option three.

MEMBER SHACK: And your answer is?

MR. RULAND: And the answer is we will need to look at that. Now, it may be in fact that we decide that yes, 15 grams is still okay. But that is a future decision that we would have to make.

MEMBER SHACK: Okay, thank you.

MEMBER BANERJEE: Bill, can I ask one question? You wanted some comment in our letter on the proposed plan for future testing. If we haven't discussed that at a subcommittee meeting and we -- I just have seen a September 6th letter to the Commission from NEI. If we have received a September 20th letter from NEI, the ACRS, I haven't seen it and I don't think the committee has seen it.

MR. RULAND: Okay.

MEMBER BANERJEE: You know so it may be

difficult for us to comment. That's all I am saying.

MR. RULAND: Yes, sir.

MR. BAILEY: Yes, fair enough. That was just -- this is Stewart Bailey. I am the Branch Chief for GSI-191-related issues.

And really the thought behind that is if something jumped out at you about the new testing if anything were to come up here, then we would appreciate that sort of feedback.

MEMBER BANERJEE: Okay.

MR. RULAND: The NEI letter that we sent directly to the Commission, not to the committee --

MEMBER BANERJEE: Was September 6th.

MR. RULAND: -- was September 6th. And actually I signed out the response to say that is part of what the Commission will consider when they vote on the paper.

MEMBER BANERJEE: Okay.

MR. RULAND: So Steve or Paul?

MEMBER BANERJEE: Now we may need to close the meeting, Mr. Chairman, at a certain point. And in that case, we will have to clean everybody other than staff out of the room. All industry people will have to go.

CHAIR ARMIJO: All right. And the bridge

line. Is it open?

MEMBER BANERJEE: No, no. It will be only staff will be --

MEMBER BROWN: No, but is the bridge line open.

CHAIR ARMIJO: Is the bridge line open at this time?

MEMBER BANERJEE: That I don't know.

MR. FLACK: Yes, it is. So we will get to a point -- this is John Flack. We will get to a point where we will close the meeting. It is coming up. You will see the slide.

CHAIR ARMIJO: Go ahead.

MR. KLEIN: Good morning, ACRS. I am Paul Klein. Seated off to my left is Steve Smith. And we are both from the Office of Nuclear Reactor Regulation. I would also like to acknowledge contributions of Ervin Geiger to the Safety Evaluation in this presentation.

As we just discussed, this presentation does have some proprietary information. So our intent would be to close the meeting once we reach slide 12 in the presentation. At that point I would ask that only ACRS and NRC staff remain in the room. And after we proceed through our slide 20 would be at a point

where we could reopen the meeting for the remainder of the audience. Next slide please, Steve.

This slide shows an outline of our intended presentation today. We recognize that your highest interests are in the technical evaluation area and in particular in any additional information we might be able to present since the May 2012 subcommittee meeting.

So our plan is to try to get through the initial slides at a relatively quick pace and then we will anticipate you will have more questions as we get into the more technical detail. Next slide.

By way of introduction, it is probably worth noting that this piece, the in-vessel WCAP, if you will, is really the last key technical area associated with GSI-191. When the Generic Letter was first issued in 2004, the focus at that time was predominantly on the sump straining, sump straining clogging and for the plants a lot of their initial efforts went into installing larger strainers in the plants.

Once we got into the more mature part of the strainer testing, the Owners Group developed WCAP-16793 and it was intended to be a tool that would evaluate the impact of debris that might pass through

the stump strainer and arrive at the reactor vessel to see how that might affect the fuel with respect to blockage or willful heat-up under deposits.

We presented the safety evaluation for the WCAP Revision 2 in May and that draft SE was based on approving a 15 gram per fuel assembly fiber limit.

MEMBER SKILLMAN: Paul, are there any PWR owners that are not part of the PWR Owners Group?

MR. KLEIN: There is some members in the audience can correct me if I am wrong but I believe that they are all members of this particular effort.

MEMBER SKILLMAN: Thank you, Paul.

MR. KLEIN: This slide pictorially shows a timeline of the WCAP history. And probably the first thing you will notice is the overall length of the evolution. And it speaks to the complexity of the technical review associated with this topic.

The color coding shows ACRS meetings in red, key testing milestones in blue, and the black items are associated with documents either from the staff or from industry into the NRC.

As you can see, we first came before the committee in March 2008, which is quite some time ago. You gave us a number of things to consider. Coming out of that meeting, we issued an additional RAI and

that caused the industry to begin a series of tests that went on for a period of years and went through several revisions to the WCAP.

We hit a point near the end of 2010 where we saw under one set of conditions, which was a low particulate to fiber ratio in hot-leg test flows. We saw an order of magnitude difference in the amount of fiber that could be tolerated by the two different fuel designs. So at that point, we were trying to sort out whether it was a design thing or a test facility thing or some combination of the two. And so the staff requested that the owners group do some cross tests at that point. And they did several cross tests. And as I think Bill alluded to earlier in his comments, there were some surprises that came out of the cross tests. So testing continued all through 2011 and we came back in here in May 2012 with our draft SE.

And we anticipate that coming out of this meeting, this topic will probably continue because the industry has already expressed interest in a new test program that is intended to start soon.

I should mention one other thing before we move off that slide, too. Over time, the staff's strategy for drafting an SE has changed as well as we

have gained a greater knowledge base of test data it became increasingly hard to understand some of the drivers of what was causing head loss in the data.

Our strategy for drafting the SE became limiting the acceptable fiber amount to a level that we thought just wouldn't build a filtering bed that was capable of sustaining high DPs and causing flow blockage. Next slide.

So very briefly an overview of the WCAP. The WCAP is a method licensees can use to address the impact on cooling from debris that passes through the strainer and is really a two-pronged approach. There is an analytical part that looks at demonstrating that local blockages within the grid spacers are underneath deposits and not cause unacceptably high temperatures. And then there is the testing part which is the fuel assembly tests that Steve will be talking about in a minute. And those were intended to demonstrate that you won't get blockage at the core inlet such that you couldn't get coolant into the fuel.

MEMBER BANERJEE: Paul, perhaps you could expand slightly on what the fuel clad temperature limit based on autoclave tests came to be.

MR. KLEIN: Yes, the limit that we agreed to with the industry for the test or the analytical

piece was an 800 degree limit. As you mentioned, it was based on having longer-term autoclave data that demonstrated that would be an acceptable temperature. So it is possible you could go above that temperature for a longer term without detrimental effects but we just didn't have the data to support it. So therefore, we agreed on the 800 degrees and based on the LOCA DM analyses that we have seen so far, that really isn't the challenging part of this particular WCAP.

MEMBER BANERJEE: And the second limit you came to was a 50-mil deposit thickness. Correct?

MR. KLEIN: That is correct. And the thought there was that the deposit would be limited such that you could not bridge the deposits from two adjacent fuel pins such that you would restrict flow over a longer range. So 100 mils was the minimum gap in existing fuel. And the thought was as long as you had flow between the fuel pins, you could show analytically that that would not cause unacceptable temperatures.

MEMBER CORRADINI: Can we go over those two things again? Can I say something back, just so I make sure I get it right?

So what you are saying about the first one

that was, you could have picked 800. You could have picked 700. You could have picked 900. You could have picked 1000. It is a cliff. I either keep way below 800 or if I start starving the channel, it is going to pop way up. So the 800 was just a convenient number.

MEMBER BANERJEE: No, it is based on 30-day exposures and autoclave tests.

MEMBER CORRADINI: But what I am saying, though, sure, that is on how I get damage. But and what I thought I heard from the -- maybe I misinterpreted it, is that it is going to be a pretty big jump in terms of either I am going to stay way below that limit and stay cool, or I am going to jump beyond it, in terms of how the fuel would perform if I start starving the assembly.

MR. SMITH: If you don't have coolant, yes you are going to go beyond the limit by --

MEMBER CORRADINI: Right. I mean you guys have a justification for why it is 800 but my point is either I am going to stay way below it at boiling conditions or I am going to starve the assembly and it is going to whiz right past 800 just because of how nature takes its course.

MEMBER BANERJEE: Well you get some steam

cooling, even if the level crops.

MEMBER CORRADINI: Right. But in all the calculations we have seen, maybe if we are not allowed to say it at this point, in all the calculations we have seen, it is either way down here or it is way up there.

MR. BAILEY: I think what you are -- this is Stewart Bailey again. What you are looking at at the 800 degrees is that is where they did the autoclave testing. This if for a fuel that has already been through a transient up to 2200 degrees and back down again. Then it can return to 800 degrees on a long-term basis.

And what you are looking at here, it is a two-pronged approach. You are looking at one, making sure that you don't dry up the core. That is where the fuel, the fiber limits come from.

If you do not dry up the fuel, the second question was what happens to the local temperatures if you have local blockages at grid spacers or you have local deposits on the fuel due to chemical effects or other issues. And there, if you keep the core wetted, even through the deposits, the analysis show that the cladding will stay below 800 degrees.

MEMBER CORRADINI: Okay. So all right, I

am with you on what the -- how you get to the limit. All I am saying is in terms of analysis I remember seeing, maybe I have missed some subcommittee meetings, it is relatively one parameter analysis that shows either I am at boiling or if I starve it is going to go right past 800 from a one parameter analysis.

I have never seen an analysis that is three-dimensional in local that I see somebody predicting a local temperature I believe.

MEMBER BANERJEE: Well I think, you know Mike, you may be recalling the AP1000. So we may not be able to talk about it in open session.

But there is another limit. I don't want to muddy the waters here, which is related to boron deposition as well.

MEMBER CORRADINI: Right but were we presented analyses that there are local measurements and local data?

MEMBER BANERJEE: There was not local data but there was local analysis done.

MEMBER CORRADINI: Okay, which is a boron buildup, which I remember.

MEMBER BANERJEE: Yes. So I think let's move on.

MEMBER CORRADINI: Okay, so I understand. And then the second part you said it and I was trying to write it down. The 50 mils is based on what again?

MR. KLEIN: The 50 mils was based on ensuring that deposits growing from adjacent fuel pins would not bridge and cause a complete blockage of a channel between adjacent pins.

MEMBER CORRADINI: So you have an L over D of a bridge of one to two. You said it is 100 mils across the span and you want to keep the span thickness a half as big as the bridge. And that is based on what analysis?

MR. KLEIN: That is based on their analysis that shows if you have flow between the pins even underneath the deposit, if it is less than 50 mils, you won't exceed the excessive limit on temperature.

MEMBER BANERJEE: Both sides, 50 mils each. So you close the gap at 50 mils.

MEMBER CORRADINI: Okay but you are spanning -- I'm sorry to dwell on this but you are saying that the pin spacing is like 100 mils and you want the thickness to be about half of that. And you feel confident that it is no thicker than that, it won't bridge across and block.

MR. BAILEY: And if I can clarify again. I think the gap is actually larger than 100 mils, although that was the assumption that was made. The analysis actually were backwards and what they are doing essentially is they have a heat transfer analysis looking at essentially the heat-up across -- as you transfer heat across the deposits. And the deposits are assumed to be 50 mils thick and they take a conservative heat transfer coefficient conduction factor, essentially, across those deposits.

And so that sets an upper bound for the amount of deposits that you can get --

MEMBER CORRADINI: And the 50mils translates to the 15 grams?

MR. BAILEY: No, they do not. The 50 mils translates into keeping the perimeter of that fuel pin wetted and keeping the clad at less than 800 degree F.

MEMBER CORRADINI: Okay, thank you.

MR. BAILEY: And then the other half is for keeping it wetted.

MEMBER CORRADINI: Okay, thank you.

MR. KLEIN: And we'll move on to the next slide.

Okay so the tool that the WCAP uses to determine the deposit thickness and clad temperatures

is termed LOCADM. And initially the WCAP was intended to bound all PWRs. And since the current fiber limits that area acceptable to the staff no longer bound the all plants, they cover approximately half of them, the Owners Group is considering additional testing analysis to try and get higher limits.

MEMBER SHACK: I think I saw some letter from NEI that claimed it was a much smaller number than half.

MR. KLEIN: I have seen an NEI letter that suggested half. We have heard from the industry that the people that can meet the fiber limit of 15 grams, some of them might not be interested in pursuing that path. They still may want to pursue a risk option path.

MR. RULAND: And of course the reason the licensee is interested in doing that is because the 15 grams is so restrictive, an outage happens, the resident inspector goes into the containment and finds a pair of anti-Cs and the licensee has to defend that they were not inoperable during the fuel cycle.

MEMBER BANERJEE: They say 34 plants can meet the -- demonstrate compliance. That is the --

MEMBER CORRADINI: And I'm sorry just I am writing little notes to myself so I can remember. So

the 15 grams, if I compute it right, is up to like a couple of liters of volume, like two quarts.

MEMBER SHACK: Yes, if it is as manufactured density.

MEMBER CORRADINI: Right. I mean we have been using this in some other venues and at about that density is a couple liters.

MEMBER BANERJEE: Well it is perhaps a cubic foot of fiber.

MEMBER CORRADINI: Okay, I just wanted to make sure, come to some sort of correct -- that's fine. Thank you.

MEMBER BANERJEE: I won't stand behind the cubic foot.

MEMBER SHACK: Well 2.4 pounds is a cubic foot. Right? So --

MR. KLEIN: This slide, after the subcommittee meeting in May the staff went back and we compared our notes and reviewed the meeting transcripts and we compiled this list of what we thought was some of the key feedback that you provided to us coming out of that meeting. And I was going to briefly touch on each of these and then Steve, of course, in much more detail, will cover these later.

One of the main concerns was the limited

number of tests that had 15 grams and uncertainty in the margin at that limit, since there appeared to be a transition at fiber limits that were not much higher than 15 grams.

You also questioned us on the use of silicon carbide as a surrogate particulate and the size and distribution of the particulate size and also the fiber size for testing. You had asked about the radiological effects on chemical deposits.

We received a lot of question son the 45-gallon per minute flow rate for hot-legs and whether that was really necessary. We received questions on debris additions and whether sequencing the particulate fiber and chemicals in a different manner or changing the timing of the additions might affect the overall results.

We discussed particulate to fiber ratios and which ones appear to be limiting and mentioned that the hot-leg particulate to fiber ratio was limiting and was different than the cold-leg flow rate.

And of course there is questions on repeatability of the data.

Of those seven items, I believe that we will be talking about five of them in more detail in

the upcoming section. We have no new information on the radiological effects or the debris mixture ratios. So our intent is not to discuss those further, unless you have questions.

MEMBER BANERJEE: Paul, there was an issue related to temperature which I don't know if it got -- but I am trying to recall it. These transients often start at pretty high temperature before they get down to 130 or whatever. And there was a question as to whether this would lead to formation of something like felt over the fiber. Because you know if you go through this trajectory of very high temperatures, could it lead to a more compact fiber? Is there any evidence in that direction?

MR. KLEIN: I know one of the test vendors in particular boils their fiber before they add it to the test. And we haven't notice substantially different results from their test compared to others that don't go through that process. So it is the feeling of the staff is that we don't think that would make a significant difference.

MEMBER CORRADINI: Wasn't there a time, maybe it is going to -- maybe we can bring it up. I thought there was another temperature comment on the other side, which is temperature tends to essentially

change the fluidity of the mixture.

MEMBER BANERJEE: Yes, you will see later, which we cannot talk about here --

MEMBER CORRADINI: Sure, that's fine. Let's just wait.

MEMBER BANERJEE: Yes, there will be an effect.

MEMBER CORRADINI: Because I remember I was on the phone when a lot of this was discussed last time.

MR. KLEIN: At this point, I would like to turn the presentation over to Steve Smith and I appreciate you saving all the hard questions for him.

MR. SMITH: Thanks, Paul. Good morning.

I know a lot of you have heard a lot about the tests that were run before so I am not going to go through all these. I am just going to say a few things. And if anyone has any questions, I will leave them up here for a minute so you can look at them. And if you have any questions, let me know.

But basically, the fuel assembly that was tested was not full height. It was a partial height. It was basically a prototypical cross-section fuel assembly. And then there was a volume below the test rig and I will show a picture in the next slide. I

don't think it is going to show the whole volume but it will show some of the test rig. And there was a volume below that was meant to model the lower plenum, not really model it but it provided a space like the lower plenum volume.

It wasn't modeled to ensure transport or anything like that but we did observe that all the debris transported up into the test rig.

MEMBER SHACK: Steve, just I know they did some tests to characterize the fiber links. Did they do that for each test or did they have a process they characterized once and assumed that process generated the same distribution every time?

MR. SMITH: I believe they had a process that they went through with a certain blender and you know, length of time they blended it. And they characterized it a couple of times and after that they just used the procedure. They were satisfied that --

MEMBER SHACK: It was reproducible.

MR. SMITH: Yes.

MEMBER BANERJEE: I think Bill had a question at the last meeting as to what the distribution and the sizes were like. I don't know if you need to say that in closed meeting or open.

MR. SMITH: The distribution that was used

during the testing was based on actual data from fiber that bypassed during strainer testing. So that debris was collected. They took results from several plants and came up with a distribution.

And we will talk about it later but I will say it now since you brought up the questions. We did add a condition in limitation to the SE that requires the plants to validate that the fiber size used during testing is applicable for their plant.

MEMBER SCHULTZ: What is the rationale for the debris addition order?

MR. SMITH: The debris addition order that was used was based on what was basically approved for strainer testing. So the strainer testing, what we found was that if you add the particulate first you would come up with a more conservative head loss. And Dr. Wallis did talk about that was mostly from PN&L but we have seen similar results, although not as -- he said orders magnitude when you put the particulate in first. We see slight differences but it usually is greater when you put the particulate in first or in head loss test.

MEMBER BANERJEE: Now there were tests done for the AP1000, which I think we can elude to where it was mixed homogeneously.

MR. SMITH: We can talk about those. We have something to talk about that a little bit later on.

MEMBER BANERJEE: Okay.

MR. SMITH: All right, this is just a picture of the test rig. So I glad it shows up a little bit better than it did in the slide because the slide is a little bit smaller.

MEMBER STETKAR: Steve?

MR. SMITH: But this is Plexiglas column.

MEMBER STETKAR: Steve, just make sure you close to the microphone so we can pick you up.

MR. SMITH: Okay. All right, I can use the mouse. That's good.

So it is a Plexiglas column. Over here is a large mixing tank. It will hold a couple hundred gallons. And they have a system that keeps this agitated. The fuel assembly is inside the Plexiglas column. And you can see that there are spacer grids here. Some of them are here to see because they are behind the supports for the system but there is a spacer grid here, here, and then down at the bottom. You can't see the bottom, unfortunately.

And generally the flow is from the bottom up but they do have the ability to reverse the flow

for upper plum injection plant type or if you have a hot-leg injection. So they could also simulate that.

And then the little red tubes, you see those are the pressure taps that they used to measure differential pressure across the various spacer grids.

MEMBER CORRADINI: And I remembered there was a question just to remind myself. So what is happening between the Plexiglas and the assembly.

MR. SMITH: Between the Plexiglas and the assembly, that distance between where the gap is simulates one-half of the gap between two fuel assemblies.

MEMBER CORRADINI: I knew it was something. I just couldn't remember what it was. Okay, great.

MR. SMITH: So it should be 20 runs.

MEMBER BANERJEE: There were some runs done, if I recall, as well, with sort of a star-shaped full gap. Right?

MR. SMITH: In one test they actually took four quarters of a fuel assembly and put it in here and totally sealed the edge and had a full gap between. So instead of 20 mils on the outside they had --

MEMBER CORRADINI: We'll see that test

result in here.

MEMBER BANERJEE: It is there. I have it if you --

MR. SMITH: I don't think I have it.

MEMBER CORRADINI: That's fine.

MR. SMITH: There was basically no difference in head loss.

MEMBER BANERJEE: Yes, it didn't make any difference but I have the results.

MEMBER CORRADINI: No difference either way.

MR. SMITH: Right.

MEMBER CORRADINI: Okay.

MR. SMITH: Both had the same head loss with this under similar conditions.

Okay, this is just a schematic of the test facility so you can see how it is set up. This is similar to the CDI test facility. One thing that is different between the two facilities is this area down here they have a different shape. In Westinghouse they use a diamond-shaped diverter to make sure the flow just doesn't flow straight up into the bottom of the assembly. And they had an inverted cone at CDI. That was one difference between the assemblies.

And then the other difference, major

difference between the test facilities was they used a stirring pump at Westinghouse and at CDI they used an actual propeller in the tank to keep everything agitated so that it would all transport to the fuel assembly.

MEMBER CORRADINI: So can I ask a question here? I don't think it is closed.

So since we recently had a meeting on another sort of plant about test protocol --

MEMBER BANERJEE: Maybe you can bring that up in the closed session.

MEMBER CORRADINI: Are we going to talk about test protocol later?

MEMBER BANERJEE: You know that will be -- something will be alluded to.

MEMBER CORRADINI: Okay, fine.

MEMBER BANERJEE: Why don't we? Because that has to do with the inlet geometry as well.

MEMBER CORRADINI: Okay, fine. Whatever you say.

MEMBER BANERJEE: It may be better.

MEMBER CORRADINI: Yes, sir.

MR. SMITH: Okay, this is just sort of a -- this is what we based our fiber limits on. We based them on the industry testing that was done at

the limiting facility. It was done at two facilities, CDI and Westinghouse. And CDI was the limiting facility. We only proposed fiber limits because the test programs accounted for variations of the amounts of other types of debris. And we found that if we limited the fiber to an amount that would not sustain a pressure, you know a bed that could cause a high-pressure loss, that it didn't matter what other types of debris you got into as far as the particulate and the chemical got into the fuel assembly.

And our accepted fiber amount is based on the test conditions that resulted in the most conservative fiber limits. So for example, we chose the most conservative particulate to fiber ratio. If you change that, you could put more fiber in it and not get as high of a head loss. That is just an example of one of the conservatisms in the testing.

And I think now is the time that we would want to close the meeting. So we would ask, I guess, everyone who is not an NRC staff member or ACRS member to leave because we have information from several --

MEMBER STETKAR: We need to make sure we get the bridge line closed also.

MEMBER BANERJEE: Yes, we have different vendors, different people.

Mike you will be able to ask all your questions happily now.

MEMBER CORRADINI: I just forget. I mean, it was May. That was five months ago. I can't remember.

MEMBER BANERJEE: No, I am saying regarding this other concept that you are worrying about, where the inlet is completely different for testing.

MEMBER CORRADINI: It is not the inlet. It is the test protocol that Graham brought up, which I assume he keeps on alluding to were these test protocols. I want to understand something.

MEMBER BANERJEE: Well you mean how the particulates are added and --

MEMBER CORRADINI: No. How the delta P and the flow are controlled as the test proceeds.

MEMBER BANERJEE: Oh, okay.

MEMBER CORRADINI: Because Dr. Wallis was fairly precise in what he liked and didn't like. Usually he is kind of -- he was very particular this time.

(Whereupon, the foregoing matter went off the record at 10:51 a.m. for a closed session and went back on the record at

11:50 a.m., continuing the open session.)

CHAIR ARMIJO: Okay.

MEMBER BANERJEE: We can proceed now?

CHAIR ARMIJO: Yes, sir. Go ahead.

MR. SMITH: All right, this slide here, slide 22 we are up to is just talking about talking about surrogate sizes. And one of the questions that the subcommittee had was you know, how varied were the surrogate sizes that were used in the testing?

Basically what happened both AREVA or CDI and Westinghouse bought particulate, commercial grade particulate, which is just bought from a vendor and it was sized at ten plus or minus two microns. And that is what they specified.

We found some information from CDI that is listed under the AREVA particulate, it was used for the AREVA fuel testing and a couple of Westinghouse fuel tests here. It shows that the mean diameter was actually 8.64 and it gives you the minimum and maximum sizes in the standard deviation.

For Westinghouse --

MEMBER STETKAR: But the distribution -- full distribution. I was just being facetious.

MEMBER BANERJEE: Was it log normal?

MR. SMITH: They actually had a graph of

it and I could get you that if you want.

MEMBER POWERS: Do they screen this material or is there is a segmentation or how do they size it?

MR. SMITH: I don't know how they actually sized it. This was just commercial information. They bought it commercially and this is when they looked at it, this is the size distribution that they came up with.

And the Westinghouse we didn't get quite as much, we didn't get a maximum in. I imagine it is slightly larger. So maybe it goes up to maybe 30 microns and down to four or five.

So it wasn't just the ten micron particles, there was actually a range there.

The other thing we wanted to say also was that chemical precipitates also give additional size ranges. I think it is generally on the smaller end of the spectrum.

The next slide, number 23, just talks about some of the conservatisms and the staff thinks that there are conservatisms associated with the way that the testing was done and a lot of the inputs to the testing. The trouble is that the conservatisms haven't been quantified. So basically we don't know

the degree to which head loss would be affected by the -- how much head loss is actually being taken up or being lost to some of these conservatisms. We just don't know.

There is also variations in the test results. And for the reasons just not being able to quantify the conservatisms and also the variability we saw in the test results, we felt that we would use the most limiting tests at the most limiting facility to come up with the limit.

So this is a summary and we have talked about a lot of these. I am not going to go over a lot of it. There is a couple points that I need to make because these address at least one of the things that was at one of the Thermal Hydraulic Subcommittee's issues. The first one just says that you get some additional tests to show that the 15 gram fiber limit provides some margin. We talked about the surrogate sizes.

We did add the C&L which I talked about earlier that the licensees would have to validate with the fiber used in the testing is applicable for their plants.

On the last bullet, you know Paul talked about we didn't have other information on the

radiological effects, which was one of the concerns, the radiological effects on the chemical precipitant but we feel that the chemical precipitant that is used is a conservative one.

MEMBER BANERJEE: There was one other point, Steve, which was whether the absolute amount for a channel was the only important factor compared to the concentration. There was a question related to -- if I recall my memory -- the volume of the system, did it have any effect in terms of the concentration?

MR. SMITH: As far as having a taller fuel assembly?

MEMBER BANERJEE: No, I am talking about let's say the concentration of the fiber in the incoming flow. Is it just the amount of fiber or is it also the concentration that matters? That was the question.

MR. SMITH: You're right. And we only hit the big questions. We didn't try to address every small question because we only had a couple hours here and we probably would have missed some anyway.

MEMBER BANERJEE: But in addition to the radiological effects which was a relatively small question as well, is that --

MR. SMITH: That one came up several times

that when we were going to through the minutes we saw that mentioned.

You're right. That was a question. I don't think there would be -- I think it is just the concentration --

MEMBER BANERJEE: If you have any evidence --

MR. SMITH: -- when it actually collects in the fuel assembly is what matters more than the concentration in the fluid. But there could be an effect there. It doesn't seem like it would be a large one.

MEMBER BANERJEE: Was the volumes of the two systems different, the CDI versus the --

MEMBER SHACK: Relatively close.

MEMBER BANERJEE: Okay.

MEMBER POWERS: I'm wondering a little bit on why you think it is that the radiological effect --

MR. BAILEY: Can I interrupt for a second?

MEMBER POWERS: -- conservatively treated?

MR. SMITH: Well all we are saying is that we think that the surrogate that is being used is conservative compared to one that would actually occur in the plant. Therefore, if there were some radiological -- it is one of these unquantified

things. If there some radiological effects that were to occur in the plant, that we think we have some margin in the way the test was done.

MR. KLEIN: Yes, I don't think that Sam meant to say we are concerned from the radiological standpoint. But we have seen a lot of different chemical tests where they have added this particular aluminum oxyhydroxide surrogate and that has produced the highest head loss compared to other surrogates and compared to tests where they have added, slowly added, dissolved aluminum where they have forced precipitation in situ by adding chemicals. And it seems like when you add it all up, the WCAP aluminum oxyhydroxide is conservative.

MEMBER BANERJEE: Stewart, you had a question?

MR. BAILEY: Yes, if you wanted to go back to the last question. Erv did you want to add some more information?

There were tests where they varied the concentration of the debris that made it to the fuel assembly. So I think that -- we should have gone over that I guess, as we were going over all these other additional testing.

Erv, did you want to give any additional

-- I guess the mike doesn't work?

MEMBER BROWN: No, it is. It's just he sat back down.

MEMBER STETKAR: It's on.

MR. GEIGER: Yes, I had observed a number of tests at CDI that they actually varied because they were trying to determine I guess if they fed it slower, if the fibers were put in slower it would have made an effect. You know they had such a low fiber that a lot of the tests done just to see if they could raise that. And so there were tests where they put in like two grams at a time or five grams at a time and then ten grams at a time and it really did not seem to have an effect on the final battle of the dP at the end.

MR. BAILEY: So I think it is anecdotal that there was testing out there where they did vary the concentrations reaching the core to no discernible effect.

MR. KLEIN: Well I think to add to that Stew, they also ran a test where instead of adding a 20-gallon batch of chemicals they added less than a two-liter addition and had the same effect. So at least from that standpoint, adding smaller amounts didn't seem to have an effect overall.

CHAIR ARMIJO: Yes, the radiation, radiological question, I think you reminded me. I raised at least one of those questions and my concern was all of this testing has been done ex-reactor and the event will happen in a reactor. And all of these chemicals and particles will flow through the core. Some of them will deposit in the lower bridge, in the lower parts of the assembly in an intense radiation field and will that change things? Will it polymerize the aluminum oxyhydroxide in a way it makes it more effective as increasing the pressure drop? Or will the stuff drop out? Will the aluminum oxyhydroxide turn into an oxide where it is harmless?

These are open questions and somewhere along the line it would be good if someone did some limited experiments in cobalt bits or something like that to see what happens with these chemicals.

MEMBER POWERS: I would not expect a very strong radiological effect on aluminum because I am not aware of any strong radiological effect on aluminum.

CHAIR ARMIJO: Dana, let me make sure I understand. You have got this aluminum oxyhydroxide.

MEMBER POWERS: Yes.

CHAIR ARMIJO: Okay, will that be stable

as aluminum oxyhydroxide or in the radiation environment will it decompose into plain old aluminum oxide as particulate, which could be beneficial, rather than as --

MEMBER POWERS: In the heated water, it will tend to evolve toward the aluminum oxyhydroxide, which is lovely gelatinous junk.

The only radiological effect that comes to my mind is that in a -- if you had carbon dioxide in the atmosphere, it will evolve into formaldehyde which, in water, will polymerize into a polyhydroxide.

Now the dose rates in this water are pretty low. And the amount of material that you can possibly have in there relative to the amount of aluminum oxyhydroxide -- aluminum oxyhydroxide is a marvelously ugly stuff as a gelatinous mixture, leads me to suggest that you are probably right. By using the aluminum oxyhydroxide -- the calcium phosphate is another ugly gelatinous thing that is very ugly.

But radiologically I would think the polymer I would worry about would the polymerization of -- formaldehyde turns into dihydroxymethane and that polymerizes up and makes a lovely gelatinous kind of like precipitate.

The chemical evolution of aluminum

oxyhydroxide is probably driven more by temperature. Or speaking of your tap water, how much calcium had dissolved in the water -- calcium or magnesium -- will drastically affect aluminum oxyhydroxide.

MEMBER BANERJEE: One other question which arose, whether it was important or not you will have to tell me, is that for the cold-leg tests, when they added the fiber, most of the tests did not come to a steady state before the chemical addition. Whereas, for the hot-leg test, they ensured that it did. And the cold-leg test was still rising. What effect, if any, do you think that might have?

MR. SMITH: What we concluded from looking at those test results, and we did go back and look at the cold-leg test results and there were some that did level off that got the highest differential pressure when they actually weren't leveled off when they put the chemicals in, it appeared that the chemical addition probably would have come up to about the same amount. It didn't seem like you would get a lot more head loss out of it if you had allowed it to stabilize first. And I think the reason why that happened is the cold-leg flow rate was so slow I think they were waiting for a long time.

MEMBER BANERJEE: They got fed up.

MR. SMITH: They were fed up. So it didn't look like the head loss was increasing very fast because it was only a three gpm. So the turnover was very slow. It has taken a long time to filter the particulate out. So they didn't notice a head loss increasing until they put it on the graph. And I think that is why they probably added the chemical when they did.

MEMBER BANERJEE: But would a cold-leg head loss -- of course you have much less head to work with there.

MR. SMITH: Yes.

MEMBER BANERJEE: It is like three psi or something. So do you think your number is still bounding for that, the 15?

MR. SMITH: The 15 grams will be bounding because for a cold-leg break, even for a plant that has a relatively low injection rate, you are still going to have a lot of the debris going back out the break and being re-filtered by the strainer. So you are not going to get 18 grams was what we found for the cold-leg limit. You are going to have ten or less at the most. And like STP did some evaluations, they are going to end up with five grams or less for a cold-leg break.

MR. BAILEY: Yes, I think to finish that out, if you look in the WCAP, they have looked at the plant flow rates for the fleet. And for the cold-leg breaks, at least half of the debris is postulated to make it back out the break. And that is a believable number. So if we are capping at 15 grams, that is really looking at what makes it through the strainer. For a cold-leg break, you are looking at seven and a half grams. If you take a look at the cold-leg test data down for the early additions of fiber and so you are down in the seven gram limit, there is no discernible buildup of the bed for the cold-legs at that case.

The tests that you are looking at are higher in fiber.

MEMBER BANERJEE: Do you recall what it was because this is just in my memory?

MR. BAILEY: It is indiscernible at that point, when you are down to seven grams.

MEMBER BANERJEE: So 15, though, do you get a discernible pressure loss?

MR. BAILEY: Above ten you start seeing some noticeable pressure difference. Down at around seven you don't really see anything. I realize that the difference there is not that large but it is

dealing with the data that we have available, there is just no discernible trend when they are still down there in the seven grams.

MEMBER BANERJEE: I just brought that question up because I recalled that if it was a question, somebody asked it at the meeting.

MR. BAILEY: Said asked.

MEMBER BANERJEE: Yes, Said asked that question. Okay. All right, let's move on.

MR. SMITH: All right, I think we are down to the conclusion here, our last slide.

Basically RSE concludes that the 15 gram limit per fuel assembly when combined with a successful LOCADM evaluation will provide adequate assurance that you are going to get flow to the core and you are not going to exceed the acceptance limit and this will provide good methodology for plants to close out this portion of Generic Letter 2004.

MEMBER BANERJEE: Now you didn't say much about LOCADM. Can you just summarize how you arrived at LOCADM?

MR. SMITH: I'll let Paul answer but we didn't talk too much about LOCADM because there wasn't many questions. There was no questions, basically, about LOCADM in the subcommittee. So we wanted to

focus on the interesting materials.

MEMBER BANERJEE: Well as long as you know we are going to have to address this briefly in our letter.

MR. SMITH: Okay.

MR. KLEIN: I guess our thoughts on LOCADM was that it provided for a conservative method to evaluate deposits on the fuel. And we thought that way because of the assumed thermal conductivity values that appear to be quite conservative and also the assumption in the larger scale that the entire chemical source term would transport to the fuel and only deposit there. And so that, when you consider that there is no credit given for anything to precipitate out into the sump hole or get trapped on a strainer fiber bed or deposit maybe in a heat exchange or any other surface in containment but on the fuel pins themselves, those were the two primary things that we looked at as far as why we thought that the technique was acceptable.

And there is more. We have a number of backup slides, if you want to go into more discussion on that.

MEMBER BANERJEE: No, I think I was -- the reason we did not address it, I guess there was no

concerns in the subcommittee. Bill would be the person if there was any.

MEMBER SHACK: Yes. No, I mean that was sort of my reaction.

MEMBER BANERJEE: Yes.

MEMBER SHACK: That was not where the focus of the subcommittee was.

MEMBER BANERJEE: Yes, I just wanted to cover all our bases because we are going to have to --

MR. BAILEY: I think you have actually been satisfied with LOCADM since Rev. 0 of this Topical Report.

MEMBER BANERJEE: Right, we didn't have a problem.

MR. BAILEY: We are now several years down the line.

MEMBER BANERJEE: All right.

MEMBER POWERS: We've changed our mind.

MEMBER BANERJEE: I think -- are you done? Are there any other questions from anybody? Okay, if --

CHAIR ARMIJO: On the bridge line, anybody?

MEMBER BANERJEE: Anybody on the bridge line who has any questions?

MEMBER STETKAR: It's not open in this direction so they could be screaming.

MEMBER BANERJEE: Oh, can you open it in this direction? Well they can unmute it, no?

CHAIR ARMIJO: No.

MEMBER BANERJEE: Okay.

MEMBER STETKAR: They can but it has to be -- we have the final check valve.

MEMBER SHACK: Do we know on a plant-by-plant basis what the dissolved chemical levels might be? Is that something -- I mean have they all done that or were they depending on the sort of generic bounding values that --

MR. KLEIN: I think we have a pretty good idea. We may not have it exactly but we have certainly as part of the Generic Letter responses the WCAP assessments and the amount of precipitates that is projected by that technique. That allows us to have a pretty good sense of the relative amounts of different plants.

MEMBER SHACK: I mean it doesn't take very much precipital. If it precipitates, it doesn't take very much. But the amount that is there would have a strong effect on whether it was likely to precipitate or not.

MR. KLEIN: And there is quite a range both in the amount of aluminum, for example, there is at least one plant with aluminum RMI that has the very high aluminum chemical load but there is also plants that use TSP as a buffer and then part of the concern is the potential calcium sources because you might have a whole different precipitate that forms that could form early and cause problems. So it is a combination of both amounts and timing that we look at.

MEMBER BANERJEE: Okay, so there is nobody on the bridge line. So anybody in the audience who would like to make a comment? Please, yes, go ahead.

MR. GEIGER: This is Erv Geiger. I just wanted to make a comment about the chemical piece. The Generic Letter responses do have a number in there for the downstream effects that state how many -- what the deposit thicknesses and the temperature and so on.

And like Paul said before, the temperatures have been typically 400 degrees or so and the deposit thickness is well under the 15 mils. Now it has been several years since I looked at all the data so I don't recall offhand but I know there is usually a lot of margin in what they have.

MR. BAILEY: So I think what you are

saying is we already have the LOCADM evaluation for most plants and it is well below the limit in the WCAP.

MR. GEIGER: Yes, for quite a few plants they did the LOCADM in the initial submittals.

Now since the WCAP is still under review, it has not been finalized but we have a lot of those LOCADM analysis results, yes.

MEMBER BANERJEE: So it remains for me only to thank you. This was an excellent presentation. You addressed really all the issues that we had at the subcommittee meeting. So I think it is a very good basis for us to go forward with the letter. So thank you very much.

And if you have -- we would appreciate it if somebody was here during the letter-writing session so we are factually correct. Thanks very much.

So back to you, Mr. Chairman, on time.

CHAIR ARMIJO: Right on time. Congratulations, Dr. Banerjee.

We are going to reconvene at 1:15.

(Whereupon, at 12:12 p.m., the foregoing open session was concluded.)

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UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

ACRS

SECY-12-0064

Donald A. Cool
U.S. Nuclear Regulatory Commission
October 4, 2012

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Presentation Outline

- **Background**
- **Risk**
- **Occupational Exposure Data**
- **Regulatory Approaches Considered**

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Background

- **SECY-12-0064, April 25, 2012**
- **Staff met with ACRS Subcommittee on Radiation Protection and Nuclear Materials on April 27 and September 18, 2012**
- **Staff met with ACRS on June 6, 2012**

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Regulation Risk Basis

- **10 CFR Part 20 Occupational Dose limits based on assumed risk of 1.25×10^{-2} per Sv cancer mortality and risk of heritable disease**
- **Current radiation risk ≈ 5×10^{-2} per Sv**
  - **Considered mortality, morbidity and hereditary effects**
  - **Comparable results from UNSCEAR, ICRP, BEIR, NCRP**
  - **EPA "Blue Book" values for U.S. Population**

    Incidence: 1.16×10^{-1} (5.6×10^{-2} to 2.1×10^{-1})

    Mortality: 5.8×10^{-2} (2.8×10^{-2} to 1.0×10^{-3})

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Selection of the Limit Value

- **1977 – ICRP 26**
  - **average annual risk of accidental death in industries generally accepted as safe working environment – 1×10^{-4}**
  - **5 rem value based on expectation that most individuals would be unlikely to exceed 1 rem**
- **1990 – ICRP 60**
  - **Multi-attribute approach**
  - **Objective to prevent cumulative exposure to less than 100 rem (1 Sv)**
  - **Average and maximum values to provide flexibility for implementation**

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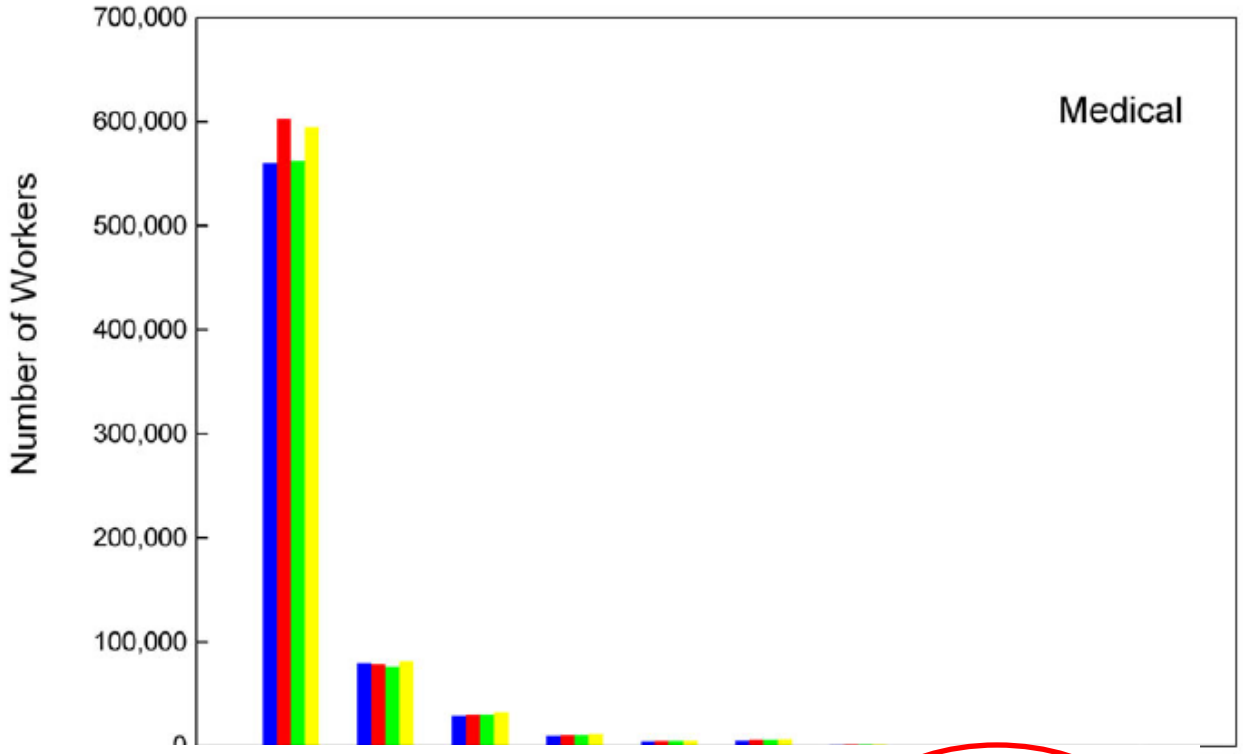

Dose (mSv)	>0 – <1	1 – 2.5	2.5 – 5	5 – 7.5	7.5 – 10	10 – 20	20 – 30	30 – 40	40 – 50	>50
2003	560,203	79,768	28,889	9,764	4,278	5,245	1,343	527	246	398
2004	602,153	78,944	30,076	10,495	4,834	6,032	1,504	612	289	461
2005	562,323	76,247	30,251	10,737	4,970	6,254	1,630	678	320	531
2006	594,394	81,758	32,782	11,536	5,242	6,506	1,691	646	328	524

Fig. 7.5. Dose distribution for workers with recordable dose for the medical category, 2003 to 2006.

< 20 mSv = 99.57%

NCRP Report 160

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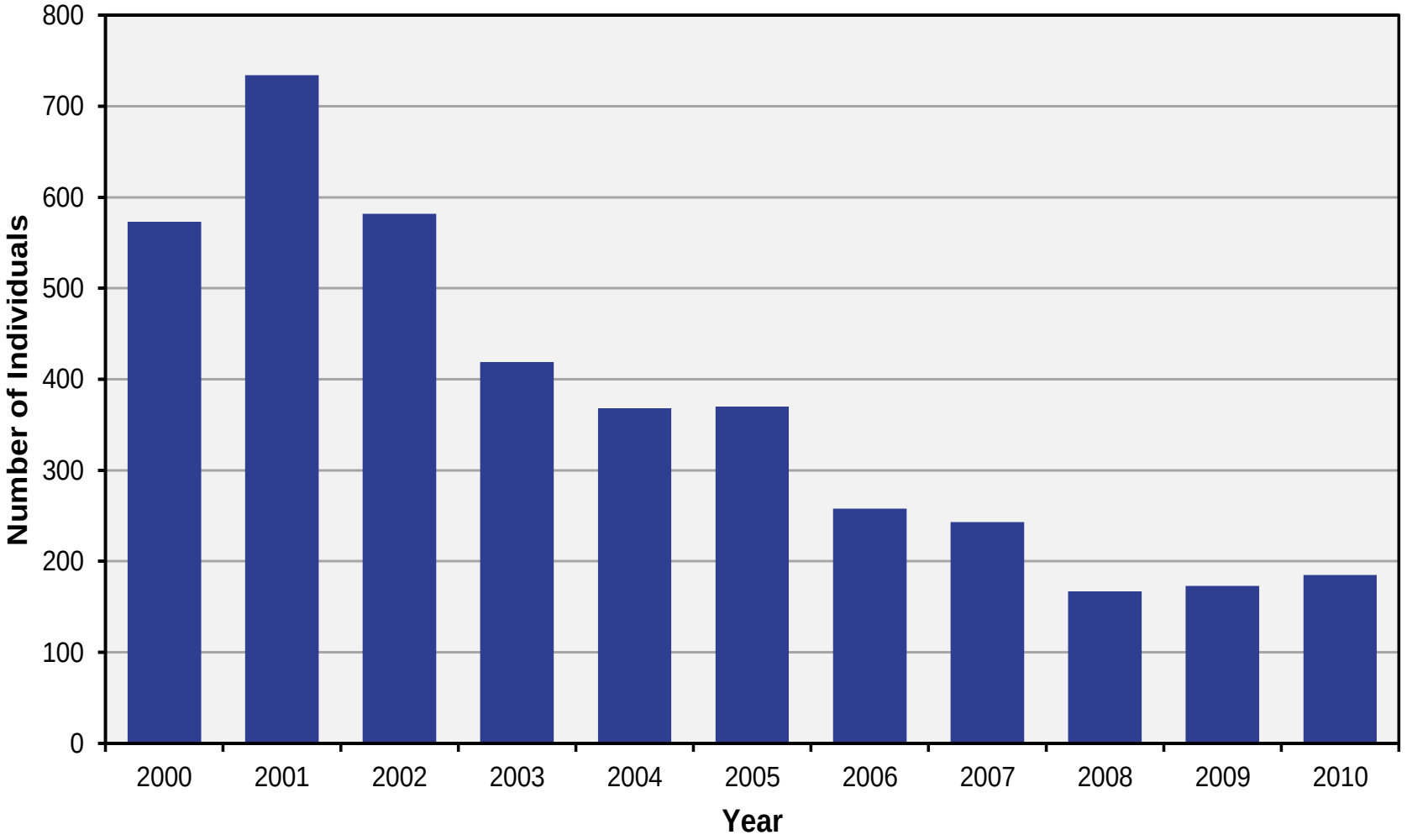
REIRS Data
Individuals with Dose Greater than 2 rem



** Data from NUREG-0713, Vol. 32; www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0713/v32/*

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Findings

- **For reported exposures, almost all exposures are below limits**
- **Individual exposures occur each year in excess of ICRP recommended average**
- **The number of individuals exceeding 2 rem each year is small**

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Findings

- **For the individuals at the high dose end of the distribution, multiple years of exposure can exceed recommended lifetime value**
- **The person-rem total of higher dose individuals is small, because of the small number of individuals**
- **By traditional regulatory analysis, little justification for changes**

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The Challenge

- **What is the most efficient and effective method to ensure that each individual is adequately protected?**
- **Method must be clear, predictable, and reliable**
- **Method must be applicable to all types of occupational exposures, for all types of uses**

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What did Staff Consider?

- **Strengthen ALARA**
- **ICRP Recommended Average and Maximum Limit**
- **Single Lower Dose Limit**

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Staff Conclusions

- **A change to limits is a more straight forward, performance based approach than additions to ALARA program requirements**
- **Rulemaking would require designation of adequate protection and/or backfit justification on both quantitative and qualitative grounds**

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Staff Conclusions

- **Additional efforts will be needed to develop regulatory basis for a proposed rule**
  - **Explore possible draft rule text**
  - **Explore possible guidance for implementation**
  - **Dose coefficients needed before Appendix B values can be revised**
  - **Detailed cost-benefit information needed for specific proposals**

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Questions and Discussion

WCAP-16793-NP, Rev. 2
NRC Staff Safety Evaluation

Stephen Smith, Ervin Geiger, Paul Klein
Office of Nuclear Reactor Regulation

Advisory Committee on Reactor Safeguards
October 4, 2012

Contains Proprietary Information

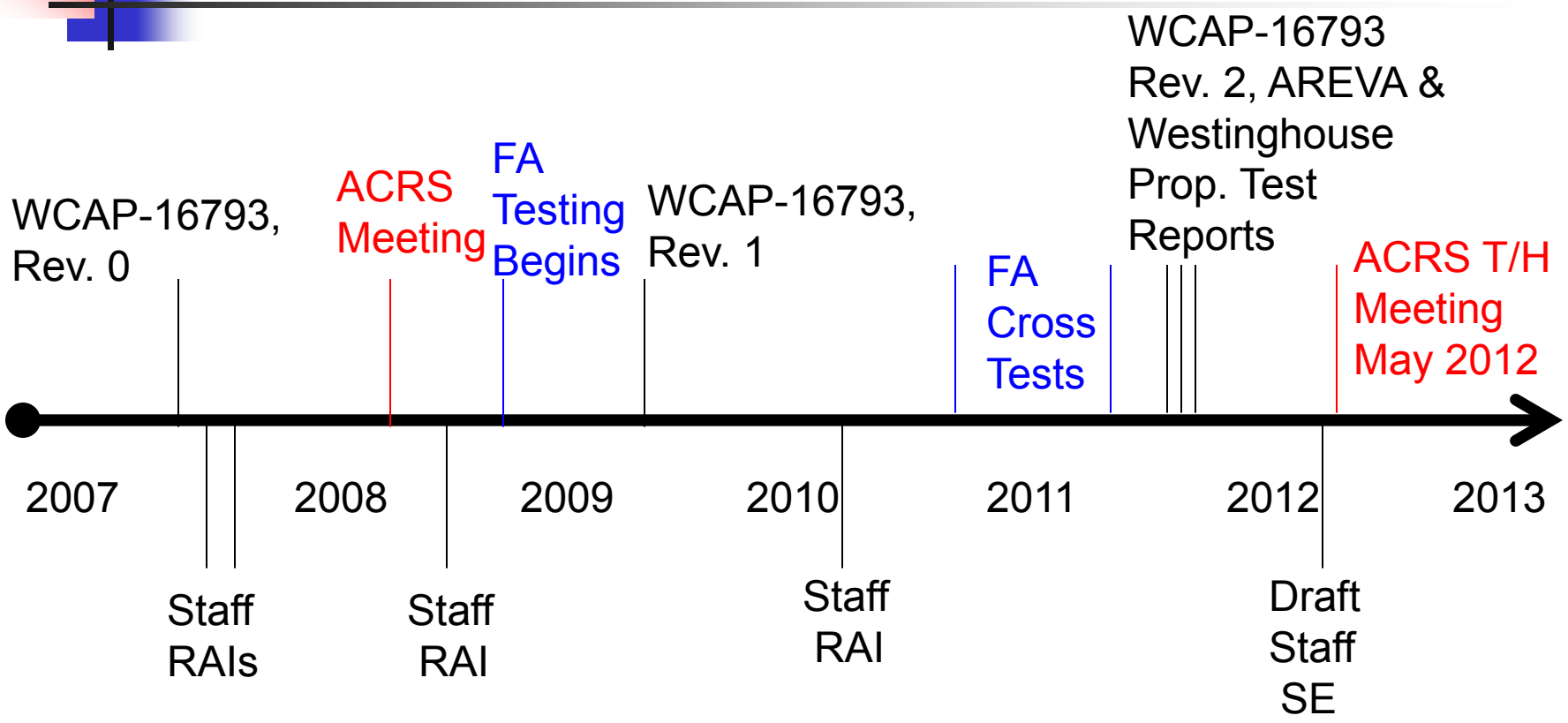
Outline

- Background/History
- Overview
- Technical Evaluation
  - Fuel Assembly Testing
  - *Additional Information since May 2012 Thermal Hydraulic Phenomena Subcommittee*
- Conclusions

Introduction

- Initial response to GSI-191 was focused on the potential for sump strainer clogging
- The Pressurized Water Reactor Owners Group (PWROG) developed WCAP-16793 to provide licensees with a tool to evaluate the ability of the ECCS to cool the reactor fuel considering the potential for particulate, fibrous and chemical debris in the coolant
- Staff presented the draft Safety Evaluation (SE) for WCAP-16793-NP, Revision 2 to the ACRS Thermal Hydraulic Phenomenon Subcommittee in May 2012
- The draft SE is based on approving a 15 gram per fuel assembly fiber limit

WCAP-16793-NP History



WCAP-16793-NP, Rev. 2- Overview

- With respect to GSI-191 and GL 2004-02, the WCAP presents evaluations and a method licensees can use to address the impact on core cooling from debris that passes through the strainer
  - Sets a limit on the maximum temperature of fuel clad based upon a conservative value that prevents fuel damage (in accordance with 10CFR50.46)
  - Establishes an upper limit on the quantity of debris that may be transported to the core inlet
  - Demonstrating that fuel clad temperature will not exceed an acceptable limit when debris is deposited on the fuel rods and spacer grids.

WCAP-16793-NP, Rev. 2-Overview (cont'd)

- Provides a tool (LOCADM) for licensees to perform plant-specific evaluation for deposit thickness and clad temperature
- Suggests options for plant specific testing/analysis to increase the fiber acceptance limit

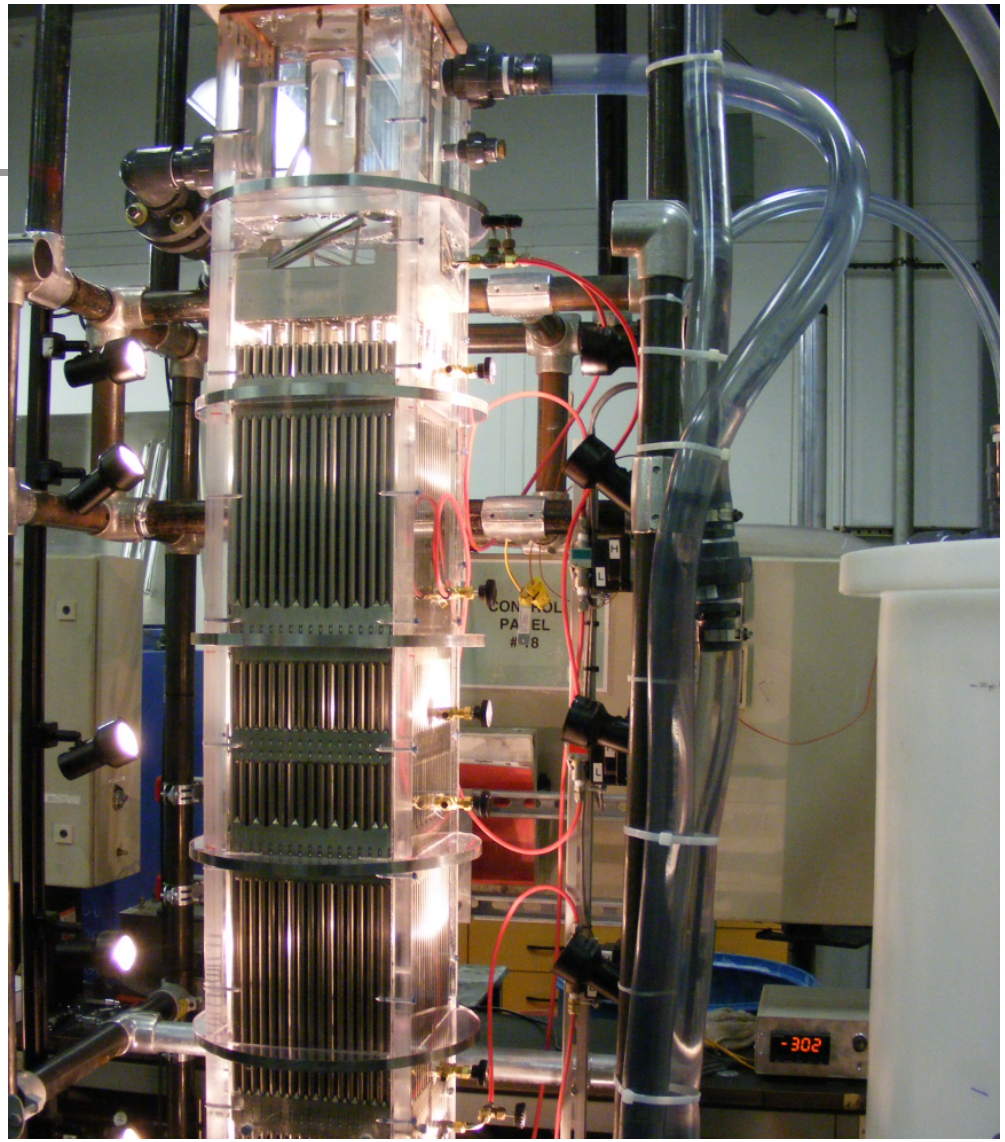
ACRS T/H Phenomena Subcommittee May 2012 Meeting Feedback

- Limited tests and uncertainty in margins at the recommended debris limit
- Particulate and fiber size choices for testing
- Radiological effects on chemical deposits
- Test flow rates
- Debris additions - sequencing and timing
- Debris mixture ratios
- Repeatability

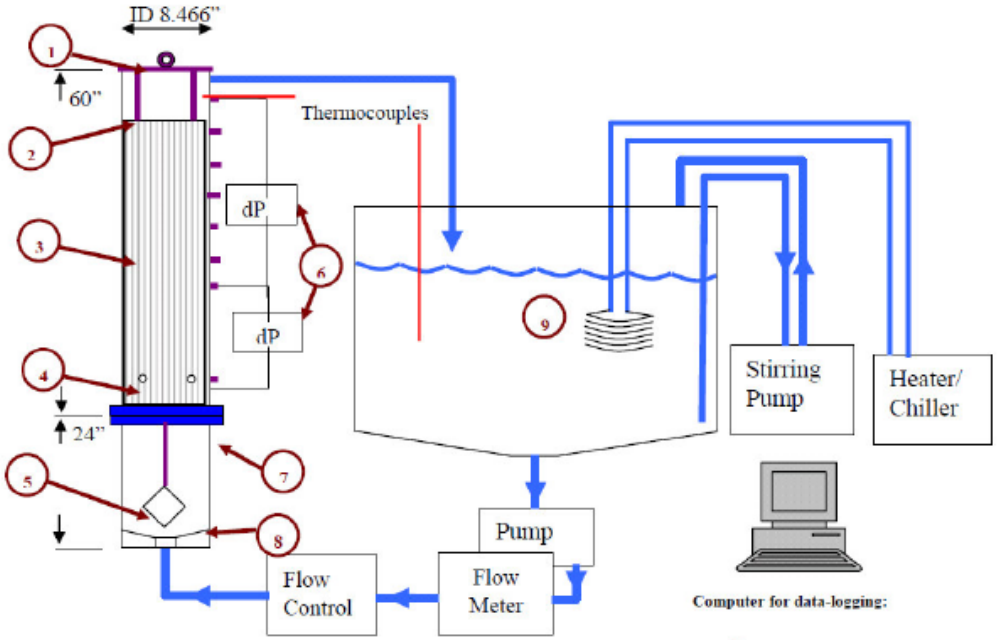
Test Description

- Partial Height (1/3 height), Full Cross Section Fuel Assembly
- Lower plenum and core support plate modeled
- ½ gap between fuel assemblies modeled by test column walls
- Flow rates controlled
- Measured pressure drop across lower grids and full assembly
- Flow rate reduced if head loss approaches test facility limits
- Mixing Tank agitated to suspend debris
- Debris addition order – particulate, fiber, chemical
- Fluid chemistry – potable water
  - Buffered borated test run – no benefit realized
- Temperature - Nominally Room Temp (about 70 ^{o}F)
  - Some tests as high as 130 ^{o}F

Fuel Assembly in Test Rig



Westinghouse Test Facility



Test Results - Fuel Assembly Fiber Limits

- Fiber limits are based on industry testing
- Staff accepted limits are based on testing:
  - At the limiting facility
  - Performed at the limiting particulate-to-fiber ratio
  - Assuming conservative form of chemical precipitate
  - With all debris suspended and recirculated

Close Meeting

- Proprietary Information Follows

Open Meeting

- Do we want to reopen the meeting at this time?

Surrogate Sizes

- The T-H Subcommittee was concerned that use of a single sized particulate surrogate could be non-conservative
- The particulate surrogates used in the Areva and Westinghouse testing consisted of a range of sizes, but were commercially purchased to meet a mean particle size of 10 $\pm$ 2 microns
- Areva particulate
  - Mean diameter 8.64 microns
  - Minimum 3.3 microns
  - Maximum 28.5 microns
  - Standard deviation – 3.4 microns
- Westinghouse particulate
  - 12 micron average
  - Standard deviation – 3.5 microns
- Some testing discussed earlier used a more varied particulate size distribution

Conservatisms – WCAP and Staff Evaluation

- Claimed conservatisms have not all been quantified or demonstrated
- Some conservatisms are apparent
  - p/f ratio will not likely be at the limiting value used in tests
  - No filtering by strainer in fuel tests for debris passing through FA
  - Tests designed to maximize transport
  - Flow rate required for cooling decreases over time
  - Debris will deposit non-uniformly to some extent
    - Only relevant if debris amounts limited
    - Turbulence levels and flow patterns not demonstrated
  - Alternate flow paths exist for some plants
- Variability in fuel assembly test results has been observed

Summary

- The full range of test programs confirm a 15 gram fiber limit provides margin from both a debris limit and head loss perspective to provide reasonable assurance of flow to the core.
- The surrogate sizes used ensure a conservative head loss is identified
- An added C&L requires licensees to validate test fiber sizes apply to their plants
- The head loss margin demonstrated in testing is adequate to assure flow to the core at p/f ratios lower than 1. It is very unlikely for the p/f to be less than 1
- Other test programs suggest that debris sequencing does not have a significant effect on head loss
- Other test programs varied flow rates without significant head loss changes
- Radiological effects on chemicals have not been quantified, but the chemical surrogate used is conservative

Conclusion

- The staff concludes that WCAP-16793-NP, Rev. 2, as qualified by the NRC staff SE, can be used to evaluate the effects of debris in the vessel to support closure of Generic Letter 2004-02
  - 15 gram fiber limit
  - Successful LOCADM evaluation