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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

REACTOR FUELS SUBCOMMITTEE

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MONDAY,

APRIL 21, 2003

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 10:00 a.m., Dr. Dana A. Powers, Chairman, presiding.

COMMITTEE MEMBERS:

DANA A. POWERS	Chairman
F . PETER FORD	Member
THOMAS S. KRESS	Member
STEPHEN L. ROSEN	Member
WILLIAM J. SHACK	Member
JOHN D. SIEBER	Member

ALSO PRESENT:

MILTON LEVENSON Member, ACNW

MICHAEL T. RYAN Member, ACNW

ACRS STAFF PRESENT:

MAGGALEAN W. WESTON

OTHER NRC STAFF PRESENT:

TIM JOHNSON, SR.

ANDREW PERSINKO

SHARON STEELE

CHRISTOPHER S. TRIPP

WILLIAM TROSKOSKI

RUSS WESCOTT

A-G-E-N-D-A

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

10:00 a.m.

CHAIRMAN POWERS: The meeting will now to order.

This is a meeting of the ACRS Subcommittee on Reactor Fuels. Those of you here for something else, should probably leave.

I'm Dana Powers, Chairman of the Subcommittee. ACRS members in attendance are Peter Ford, Thomas Kress, Steve Rosen, Jack Sieber, Bill Shack.

We also have the benefit of the presence of two members of the Advisory Committee on Nuclear Waste, Milt Levenson and Mike Ryan. Welcome, gentlemen. And we encourage you to participate fully and give the benefit of your perspective on this problem, which is undoubtedly going to be at least different.

The purpose of the meeting is to discuss the Mixed Oxide Fuel Fabrication Facility construction authorization application.

The Subcommittee will gather information, analyze those are in the issues and facts, and formulate proposed positions and actions as appropriate for the deliberation by the full

Committee. In fact, we are scheduled to provide a Subcommittee report to the full Committee in May. And at the conclusion of this meeting, I will be polling the members for suggestions on input to that. I am going to be looking for fairly definitive input to that, so you might want to bear in mind as we go through these things, the points that we should be raising to the full Committee.

I don't believe we're going to be asked to produce anything from the full Committee. So we're going to be looking to educate the full Committee in this area. In that regard, as members have undoubtedly understood and they're looking at the written material, this is a rather different world than the reactor safety world. And there's a different set of vocabulary used here. So we're going to have to work on that.

I encourage everyone to re-familiarize yourself with 10 CFR 70.61 A through F, 70.64 A and B, 7065, 10 CFR 50.2 to understand the definitions, the baseline design criteria, integrated safety analysis, items relied upon for safety. Because I don't intend to ask any of the speakers to go into those particular definitions except as they plan to in their presentation.

I will be asking the speakers to explain to me, at least, the meanings of words like "unlikely, highly unlikely, credible and incredible," recognizing I'm a particularly credulous person.

Mag Weston is the cognizant ACRS staff engineer for this meeting. Mag. And she does an excellent job keeping me straight.

The rules for participation in today's meeting have been announced as part of a notice of this meeting, previously published in the Federal Register on April 4, 2003.

A transcript of the meeting is being kept, and it will be made available as stated in the Federal Register notice.

It is requested that speakers first identify themselves and speak with sufficient clarity and volume that they may be readily heard.

This is a Subcommittee meeting and I do encourage discussion and debate, and a relaxation of the formality that we might have at full Committee meetings. And so as the presentations go along, people who are not presenting, are encouraged to ask questions both from the public and any other group that wants to go on.

I will worry about the schedule, the

speakers do not need to. The idea is to get as much information as we can in these discussions, rather than complying with a time schedule. In that regard, we are going to change some of the published scheduling here to make the presentation what we think, a little more logical.

We've received no written comments from the members of the public regarding today's meeting.

The scheduling changes that I mentioned is we're going to move Confinement Ventilation to follow Fire Protection. And we're going to switch around some of the ordering of the presentations at the beginning so that DCS will talk before the staff does on the introductory comments.

Do any members of the Committee have comments they want to make before we get started? Jack?

MR. SIEBER: A couple of questions. I would appreciate it if you would repeat the citations to Title 10 so I can write them down.

CHAIRMAN POWERS: I will send you a note around with those on it.

MR. SIEBER: All right.

CHAIRMAN POWERS: Because I do think it's worthwhile to reexamine those sections. Because the ones that we don't ordinarily deal with in our work with reactors. And life is different in the facility world.

MR. ROSEN: And I'd send them to everybody, Dana.

CHAIRMAN POWERS: We will do so.

And in particular, we'll try to understand a lot about what is meant by the words "defense-in-depth" in the context of facilities.

Jack, go ahead.

MR. SIEBER: Yes, I have another question. In the SER for this project, which is a huge work of art, there is a section that is open items.

CHAIRMAN POWERS: Yes.

MR. SIEBER: And in the open items section, there's a lot of open items in seems to me.

CHAIRMAN POWERS: Yes.

MR. SIEBER: RAIs. If speakers could mention the more important ones.

CHAIRMAN POWERS: Well, I suspect they would.

MR. SIEBER: I appreciate that also.

CHAIRMAN POWERS: I suspect the presentations are directed in those directions. And I know the concluding comments will discuss the inventory of open items that we had.

MR. SIEBER: Okay. Thank you.

CHAIRMAN POWERS: Are there any other comments members want to make before we get into -- if there are none, I will proceed with the meeting. And I believe Ken Ashe of Duke Cogema Stone & Webster is to start us out.

MR. ASHE: Good morning. My name is Ken Ashe, and I'm the license application manager for Duke Cogema Stone & Webster.

And I'd like to thank you for asking us to come and talk about some of the topics of interest today, specifically the topics that we'll talk about today are associated with the open items.

One of the first things I want to do is, is to sort of give you a little bit of a background.

The construction authorization request was originally submitted in February of 2001, and we got a draft Safety Evaluation Report, which you mentioned. And then we updated the construction authorization in October of 2002. And we hope to get a draft Safety Evaluation Report at the end of this month with a much shorter list of open items.

In the change between the first CAR and the second CAR, there was a program. And that was associated with the Department of Energy making the decision to not have a mobilization. And with that there were changes to our Construction Authorization Request that really were not that significant. There were some design changes, there were some new feed stock, etcetera. But it wasn't a real significant change. And that's why you'll see that the draft Safety Evaluation Report that we get this time came much quicker than the last one. Because the changes were really --

CHAIRMAN POWERS: I agree with you that the process change for most of it, it's pretty -- I mean it's virtually no change at all.

MR. ASHE: Right.

CHAIRMAN POWERS: The front end has a little bit a change. It seems to me that if I were planning to operate at this facility and suddenly I'm dealing with not one but four feeds, that's a real headache for me.

MR. ASHE: There were some changes associated with receiving the fuel in or the feed stock, if you will. And we did accommodate those. And there were some changes associated with the aqueous polishing. And with that, we had to take and increase some of the flow pass, if you will, by adding a lot of the same type of equipment. So there really wasn't anything that was created that provided us with a big challenge with respect with that, other than just working through the design and getting it done.

As you did mention, there were quite a few RAIs. There were 239 of them. We have provided a lot of correspondence back and forth. We've had several meetings with the staff to talk about those responses. There were letters of clarifications that have gone back and forth, such that we believe that we now have provided a good set of information for the staff to continue to review.

We understand in their draft SER there will still be some open items, some where we still owe them some information, and some where we understand that they are reviewing the information that we provided them and, hopefully, we'll get those to closure also.

Let's see. These things that we're going to talk about today, as you mentioned, there's two topics on chemical safety. The TPB red oil and HAN. We'll also talk on the confinement ventilation and with that we'll have a discussion on HEPA filters where we do have other than presenters, we do have a few other people in the audience to answer some of the technical questions. For HEPA filters, we do have Dr. Bergman who will be here to answer any detailed questions you have on that. And then if there's questions on our safety analysis, safety assessment, etcetera, then Gary Kaplan will also be here to answer those questions.

And then we will also have a presentation on fire protection.

And when you look at the items that we believe are still open as of the latest monthly report published by the staff, those four areas cover a good portion of those open items. So we believe that you'll get a good flavor of those things that are still outstanding.

CHAIRMAN POWERS: Let me ask you a couple of questions. You're giving us an overview of what you have available here. You going to have somebody that's going to be able to discuss your view of defense-in-depth, especially with respect to fire safety?

MR. ASHE: We'll have some discussions with respect to defense-in-depth and how our system is laid out, and how it provides for defense-in-depth. The detailed questions we will field the ones that we can, absolutely.

CHAIRMAN POWERS: The issue comes up because when I look at your definition of defense-in-depth and I look at the definition of defense-in-depth that's in Appendix R Part 50 I see a different. And I want to understand that difference.

MR. ASHE: Okay.

CHAIRMAN POWERS: Because I think it has an impact on your overall safety. And whereas you do look at the single failure in your definition to defense-in-depth on fire safety, your third element idea is distinguish the fire rather than protect equipment from damage from by the fire.

MR. ASHE: Right.

CHAIRMAN POWERS: And that's the difference I want to understand.

MR. ASHE: Okay. Okay. Well, that was pretty much my introductory remarks. Again, thank you for the opportunity for us to be here and provide you with some information about our program.

CHAIRMAN POWERS: And the other question that I'll alert you to is, especially my colleague Dr. Kress will be quite interested in your categorization of items with respect to the various criteria, and in particular how you came about your consequences for some of these scenarios that you've looked into to.

You going to be able to discuss that?

MR. ASHE: I'm trying to think with respect to the topics that were on the agenda today, do you have some examples that you were thinking of?

CHAIRMAN POWERS: I think it's going to be pervasive on every single one of them. But particularly in the area of fire. Issues kind of come about of how do you know what the magnitude of the release, the transport efficiency are for the materials at risk in the event of the fire?

MR. ASHE: We can talk some about that. We may not be prepared to answer all of your questions.

CHAIRMAN POWERS: That's fine. That's fine.

MR. ASHE: Okay.

CHAIRMAN POWERS: Okay. If we run into roadblocks, you can -- you can point either to the particular section in the CAR that we want, or we may chase around and find some other information.

MR. ASHE: Okay.

CHAIRMAN POWERS: The extent to which you've used the Machima database will be of interest I know to Dr. Kress.

MR. ASHE: Okay.

CHAIRMAN POWERS: Drew? I guess I ought to be a little more formal. This is Andrew Persinko that's going to give the staff overview on this.

And, Drew, I'll just say that I have admired the comprehensiveness of the draft SER. We'll discuss some of the specifics as we go along, but the comprehensiveness has been impressive.

MR. PERSINKO: Thank you.

CHAIRMAN POWERS: That goes as well for the CAR as well. That's quite a comprehensive thing, too.

You've certainly occupied my evenings and weekends. You know, it's been delightful not to have to think about cruising out to the bars or things like that.

MR. PERSINKO: Sorry about that.

CHAIRMAN POWERS: Knowing that I have something to be occupied with.

MR. PERSINKO: Okay. My name is Andrew Persinko. I'm the MOX project manager at NRC.

We last spoke to the Subcommittee in April of last year, April 10th to be exact. Since then, we the staff, have issued the draft Safety Evaluation Report. We've received a revised Environmental report. We've received a revised Construction Authorization

Request. And we've issued our draft Environmental Impact Statement, which is currently out for public comments. And our plan is to issue the revised draft Safety Evaluation Report the end of April.

I thought before we get into the real meat of the discussion today, very briefly it would be good to refresh the Subcommittee's memory on a few overarching items.

CHAIRMAN POWERS: We're old and we forget quickly.

MR. PERSINKO: I'm with you.

First of all, this is a picture overview of the mixed oxide fuel project. It's meant to show the jurisdictional and geographical boundaries, to show that should the mixed oxide fabrication facility be approved and constructed, it would be constructed at the Savannah River site along with the pit disassembly and conversion facility.

The pit disassembly and conversion facility will be under the auspices, jurisdictional regulation of Department of Energy. NRC would become involved with regulation of the fuel facility as well as the reactors.

This is a high level view of the process itself.

CHAIRMAN POWERS: Drew, just to interrupt. Maybe you're going to get into it. I haven't looked ahead in your slides.

There are various boundaries. This is located on a government reservation. There are various boundaries that come up. I wonder if you could just walk through that various boundaries just to remind us which ones are which?

MR. PERSINKO: I could. I don't have a slide with me for that, but we can walk through.

CHAIRMAN POWERS: Just a thumbnail sketch on that.

MR. PERSINKO: Okay. Well, maybe we could try that right now.

The MOX facility itself is planned to be constructed in the F area of Savannah River site. Close proximity to the pit disassembly facility and conversion facility.

The applicant has chosen the control of area boundary as defined in the Part 70 regulation to be largely coincident with the Savannah River site boundary. And there are provisions within Part 70 which talk about whose a member of the public and who is the worker.

You're familiar with the term facility

worker, if you've read it. Facility worker is meant, is referring to the MOX facility worker within the restricted area right in close proximity to the facility.

CHAIRMAN POWERS: Those are the distinctions that I'm interested in here. Because it's important to understand the differences between facility worker and co-located worker.

MR. PERSINKO: The term is used by the applicant as site worker, and that is referring to the Savannah River site workers. And then it's referring to then the public, the term public is used by the applicant as people beyond the site boundary, the controlled area boundary, meaning off the Savannah River site.

It gets a little confusing in that the Part 70 regulation allows for persons whose ongoing duties are requiring them to be within the controlled area boundary but yet by definition they're still members of the public. Part 70 allows these people to be considered as workers if certain provisions are met, such as the training requirements that are shown in 70.61. So for the purposes of meeting the performance requirements, these people can be considered as workers if they meet certain training requirements.

It gets a little confusing in that Part 20 also applies to the facility.

CHAIRMAN POWERS: Yes.

MR. PERSINKO: And Part 70 is a little -- NRC and DOE have a difference in the term of "worker" when it comes to Part 20.

Part 20 -- let me see if I can remember this correctly now. You are a member of the public if your duties do not involve occupational exposure in your normal duties. So it gets slightly confusing if you're going to talk worker, are you talking worker with respect to Part 20 or worker with respect to Part 70.

Most of the discussion today will focus with respect to the performance requirements, and there are some people on the site who NRC would consider as workers unless the training is provided, in which case for the purpose of meeting the 70.61 performance requirements, they can be considered -- they have the training, those people can be considered as site workers.

CHAIRMAN POWERS: I know that in your draft of this you made some effort to try to articulate this thing. I'd encourage you to go back and reexamine that to make sure you've made it crystal clear to the unexpert.

MR. PERSINKO: I think you'll see in this revision, I think we've gone from a couple of paragraphs to maybe a couple of pages.

CHAIRMAN POWERS: You have, and I enjoyed it. I mean, it was useful. There are still parts of it that are challenging to the nonspecialist here.

The other question that comes up is training that allows you to treat what I will call, perhaps incorrectly, co-located workers as radiation workers. Is that something we should look into it? Have you looked into it?

MR. PERSINKO: Yes. Oh, yes. It was looked into during the Part 70 rulemaking that was several years ago. And the training is described in the -- I believe it's 10 CFR Part 19.

CHAIRMAN POWERS: Right.

MR. PERSINKO: So that is the training requirements. But it's basically to inform the worker of the risks associated with the facility so that the people are aware of what goes at the facility and what to do in case of an accident. And basically so that they know and understand the risks that the facility can present.

Any other questions?

I just wanted to present a high level overview of the process at this point. We'll be getting to some of the more specific areas when we talk later, especially with respect to chemistry.

The top row in this diagram represents the aqueous polishing part of the process. This part of the process is modeled after the La Hague facility in France. It consists of the three steps as shown. The impurities that are removed as such things as callium and americium.

The lower set of three boxes is what we call the MOX fuel fabrication process. This is modeled after the MELOX facility in Marcoule, France. And I understand a number of the Subcommittee members visited that facility since we last spoke.

CHAIRMAN POWERS: And they all came back starry eyed and totally impressed.

MR. PERSINKO: But the three major areas there are the blending of the uranium and the oxide powders, fabrication of pellets, the assemblies of rods and fuel assemblies.

At this stage of the facility, which is the construction that we're talking about, I would just like to point out a few things.

Part 70 allows for a two step approval process. One for construction and one for possession and use, i.e., operation.

We are currently at the construction step only.

The approvals with respect to construction in Part 70 consists of staff review and approval of the design bases of the principle structures, systems and components, which we often refer today as PSSCs. It also requires that the staff approve the quality assurance program, which the staff has done separately in a separate Safety Evaluation Report already.

It's important to point out, I think, that the Part 70 regulation specifies that an Appendix B quality assurance program be adopted, and it is.

It also requires that the staff issue a decision with respect to the environment, i.e., the Environmental Impact Statement.

I'd also like to point out that there's a provision in 70.64 with respect to defense-in-depth. That, too, has to be applied at this stage, but it will also be applied at the operational stage as well when the PSSCs are described in more detail. At the stage the PSSCs are described primarily on a systems level. We expect, based on our discussions with the applicant, that assuming approval at this stage, that the possession and use stage these PSSCs would be described more on a component level.

And what I just want to point out in the last bullet is the distinction between PSSCs and IROFS. You'll see principle structure systems and components, that's associated also with the term safety analysis, which is used at the construction stage. You will hear today also the term items relied on for safety, i.e., you will hear IROFS. And that's associated with something we know as the integrated safety analysis. That part of it is respect to the possessio of use license. Sometimes we forget ourselves and use the terms interchangeably, but I want to point out that that one is for construction and one is for possession and use.

DR. FORD: Is there much lessons learned from the French on the slicing topic? Do you take into account their licensing process and whether we should modify it?

MR. PERSINKO: We did not take into account their licensing process. We are licensing it according to the NRC regulations. We discussed operational history and experience with the applicant rom the French facilities, and those are being incorporated into the design of this facility. But as far as the licensing process itself, no, we're using Part 70.

DR. FORD: Okay.

MR. PERSINKO: I just want to point the definition of design bases that we're using is the one at 50.2. I'm not going to read it, but I just want to point out what we're using.

In a nutshell, this is a nutshell of Part 70 performance requirements. It basically is a risk-informed regulation which consists of consequences on one axis, likelihood on the other.

Consequences are described in the regulations to the depth you see in the left hand column. The likelihood terms are not defined in the regulation. They are described in our standard review plan, but not in the regulation itself. So they're not requirements. And during the Part 70 rulemaking process it was clear that the terms, like likelihood terms could be qualitative likelihood terms.

But I wanted to show that it's basically a likelihood consequence matrix with the upper right hand corner being an area that the applicant is not allowed to be in. So if there is an accident sequence which brings into one of those upper right hand boxes, the applicant must apply either at a mitigative or preventive feature to lower the likelihood or mitigate the consequences to remove themselves from the boxes.

I didn't want to get into a lot of detail on this, because I didn't want to turn in into a Part 70 risk meeting, but --

CHAIRMAN POWERS: This group you can't avoid the subject of risk.

DR. LEVENSON: I have a question. Why are environmental releases listed only for the medium consequences, not for high and not for low?

CHAIRMAN POWERS: Because that's the way the regulations read.

MR. PERSINKO: It was per the regulation, of course. I think it was felt that the high consequences were more with respect to human exposures.

DR. KRESS: The picking sequences that go into likely, highly unlikely, etcetera, is that done in the ISA from expert opinion process?

MR. PERSINKO: It's been done even at this stage for the preliminary hazardous analysis by the applicant, which we have looked at at the applicant's offices. That's largely qualitative by the applicant's decision of where it fits.

For the operational stage, possession and use stage, it also will likely be largely qualitative. It's our understanding that there will be certain systems, certain areas where the applicant will get into more detail in those areas and actually do somewhat like a PRA type analysis.

I would like to also mention, though, that the applicant has stated for site workers and the public, they will be applying the index method as described in the appendix to the standard review plan. But that part of it is not a PRA.

DR. KRESS: One other question on that then. I could see how you might define these terms like in qualitative terms, for example, as not likely to happen in the lifetime of the plant or some such frequency, qualitative frequency. Is that the way they arrive at these?

MR. PERSINKO: Yes.

DR. KRESS: Okay.

CHAIRMAN POWERS: The challenge that you have in nomenclature here, if I look at the regulations I see intermediate consequences. Is that what you mean by your medium consequences?

MR. PERSINKO: Yes. Correct.

CHAIRMAN POWERS: Okay. You might want to bear that in mind, that you're really talking about that.

What I also see in your discussions with the staff that when they say "unlikely," in some cases you've chosen what I would say a very likely probability to correspond to unlikely.

MR. PERSINKO: The staff has?

CHAIRMAN POWERS: Yes.

MR. PERSINKO: Perhaps you could explain?

CHAIRMAN POWERS: Well, there's at least one case where unlikely was taken as once a year. I'd have to dig through to point to the exact -- I mean, you were just discussing things with the staff. I mean with the applicant.

MR. PERSINKO: I don't know where that is off the top of my head. If you could point that out to me.

CHAIRMAN POWERS: It'll be a struggle. Okay.

So what I'm hinting at is you really have to give us some sense, some quantification of this to get some idea of what these things mean. Because aside from the contortion of language associated with not unlikely --

MR. PERSINKO: Let me try to add a little bit there. The applicant has chosen a qualitative definition, the regulations allow for a qualitative definition, and so does the SRP being a guidance document, of course, would allow it as well.

There is an appendix in the Standard Review Plan which talks about a more quantitative approach. It talks about what's known as an index method.

Roughly speaking a highly unlikely event is on the order of approximately ten to the minus fifth; ten to minus 4, ten minus fifth. An unlikely event is somewhere in the order, I think of ten to the minus two; ten to the minus four roughly speaking. And so that's the quantitative aspect of it that's in the Standard Review Plan.

CHAIRMAN POWERS: These are the same criteria that -- I mean, the bins that have been used for decades in the DOE facility regime where the top one is like one to ten to the minus two, the next one's ten to the minus two, ten to the minus four. A highly unlikely is ten to the minus four, ten to the minus six. Below ten to the minus six is deemed incredible.

MR. PERSINKO: Incredible. Correct.

CHAIRMAN POWERS: Unweighted by the

consequences of --

MR. PERSINKO: That's right.

This is largely, like you said, similar to like Department of Energy uses in its standard, I think it's 3009, I believe.

CHAIRMAN POWERS: And sometimes since I've looked at 3009 --

MR. PERSINKO: I mean, this isn't MOX specific. This is from the 10 CFR Part 70 regulation.

Just a little bit about schedule. Said I said, we issued our draft SER. Received a revised environmental report. Received a revised Construction Authorization Request. s I say, we also issued our draft EIS out for public comment. The public comment period closes in May 14th, I believe. And we intend to issue our draft SER construction this April, the end of this month, very shortly. The final EIS in August and the final SER in September.

CHAIRMAN POWERS: The ACRS as a matter of its own operating standards has decided not to look at Environmental Impact Statements. But let me ask you this question, would it benefit us to examine it? Or do we get everything we need to know out of the SER and the CAR?

MR. PERSINKO: I think there's a lot of

good and interesting information in the Environmental Impact Statement. I think it's not -- of course, it has a different purpose which focused in on accident per se as more directly as this does. But I think there is a lot of good information regarding consequences since it's consequence based and not risk based -- risk-informed as a consequence document. But it has a lot of good and interesting information in it. So I think if sufficient time exists for the Subcommittee members, it's a good document to read as well.

CHAIRMAN POWERS: In your SER you have a set of sentences that appears sufficiently frequently that I'm surprised you didn't develop an acronym for them. You missed a real opportunity to expand the acronyms used in government here.

This set of sentences begin with "The applicant has determined this sequence to be 10 CFR 70.61.C threshold for facility worker, but below the 10 CFR 70.61.C threshold for the public and site worker. The staff has independently evaluated this sequence and agrees to its categorization."

DR. KRESS: It'd be a long acronym.

MS. WESTON: Can you give me the citation?

CHAIRMAN POWERS: Well, I can. It is

endemic to the report. I bet it shows up a 150 times. And like I say, the opportunity for developing an acronym here was just -- I'm surprised you could resist.

It's 5.0-22 that I quote from.

What I'm interested in is can you in the course of the presentation give me a thumbnail sketch of what you meant when you said the staff has independently examined this sequence and has looked at the categorization. Does that mean that the staff took the description of the sequence and developed its own source terms for this sequence, and then compared it to the requirements in the cited section of the 10 CFR?

MR. PERSINKO: We did some rather detailed look into that. And maybe Dave could expand on that.

CHAIRMAN POWERS: I'm not looking for a comprehensive discussion in this. It appears, like I say, 150 times. It is probably a lower bound estimate. But a few examples of it might be very useful. And if it can't be done here, maybe there's some other things that I should look at.

MR. BROWN: Well, my name is David Brown. I'm a health physicist on the licensing staff.

I think maybe your question is best here, looking at the subjects for the day.

What the staff did was look at those events which really define what principle systems, structures and components needed to be in place. There were about 40 of those types of events. And that's the level at which the staff did from conformity analysis.

It does require that we depend on the applicant's proposal for how much material's going to be in a certain area and what the hazard is, whether it's a fire, a spill or an over pressurization.

CHAIRMAN POWERS: I agree. You have to believe at the applicant when you look at the material at risk. But now when you look at the release fraction and the transport of that material, you don't have to be dependent on the staff.

MR. BROWN: Yes, sir.

CHAIRMAN POWERS: And what I'm asking for is that done independently?

MR. BROWN: That was done independently in the sense that we looked at the staff's handbook where we have what you referred to earlier as the Machima type release fractions and replicable fractions. That was also the reference used by the applicant.

CHAIRMAN POWERS: Okay. Now, if I look at the Machima database, I find for events involving plutonium in a fire, for instance, experiments with plutonium on a filter paper that's put into a fire and various things done with it. And then when I look at it applied here, I find 830 kilograms of material at risk. A hell of a piece of filter paper we're talking about here.

How does the staff do the extrapolation and scale what's involved here?

Then I look at how the material is transported and I see transport fractions cited, and whatnot. And I say, gee, you know, usually when I think about aerosols moving, I see things like turbulent deposition, gravitational settling, thermophoresis, diffusiophoresis and I don't see that here. So how does the staff independently evaluate how much material goes from the site of release to -- to site of generation to the site of release from the plant?

MR. BROWN: For Construction Authorization Request, the staff did not extrapolation from the experimental values published in our handbook from the studies, you know, referring to, as you say, perhaps a filter paper.

We did try to get some reasonable

assurance that at least those experimental values are bounding. For example, if I've got 800 kilograms in a glovebox inside cans that are sealed, it's not as susceptible to release as the material on the filter paper. Nonetheless, the value was used.

CHAIRMAN POWERS: Yes.

MR. BROWN: With respect to transport fractions, the applicant largely did not credit removal mechanisms between the source of release and the SAC, except for HEPA filters. So the staff also focused on that removal mechanism.

CHAIRMAN POWERS: So what you're saying is that what you've done is try to assure that you're bounded?

MR. BROWN: Yes, that's a good summary of what we've done.

CHAIRMAN POWERS: Okay. That that really is what you're talking about, an independent evaluation and there's some assurance that it's bounded?

MR. BROWN: Right. And especially where there --

CHAIRMAN POWERS: There's nothing to apologize for.

MR. BROWN: No, no. Especially in those

cases where the dose was adequately mitigated below the performance requirements we did not continue the review.

CHAIRMAN POWERS: Okay. Now let me ask you this question. Having struggled through this and now coming back and telling you that we got five more facilities, different in nature that you're going to do, would you like to have a better database?

MR. BROWN: I'm sorry?

CHAIRMAN POWERS: Would you like to have a better database and easier computational tools for the analysis?

I mean, the Machima database is interesting, because there is -- it's a huge amount of experiments and a certain discretion in which one you take as your example.

MR. BROWN: I think, by in large, the staff does not need additional refined data because other than for this facility, which is a plutonium facility, we're largely dealing with low enriched uranium in the fuel cycle division. And the level of refinement that you're suggesting just --

CHAIRMAN POWERS: Yes, but my ground rule was that you got five more of these coming down.

MR. BROWN: Just like this?

CHAIRMAN POWERS: At least as bad as this one.

MR. BROWN: Oh. Yes, I would like additional data.

CHAIRMAN POWERS: Okay. There is a challenge in using the Machima database, it seems to me when I try to use it. And what I select is my choice of the experimental data to use there.

Go ahead.

MR. PERSINKO: That concludes my presentation.

Next Chris Tripp will talk about the criticality safety, I believe.

The Subcommittee has asked for a presentation on criticality safety to the extent that there may be some unique aspects to discuss.

CHAIRMAN POWERS: This is our drive toward completeness. And it's useful for us to be reminded of what's done in the area of criticality safety. And in that regard we need to understand the double contingency principle and the ANSI standard in this area.

MR. TRIPP: I'm Christopher Tripp. I'm the criticality reviewer for the MOX fuel fabrication facility.

I can certainly talk extemporaneously about the ANSI standards or double contingency. But that wasn't really planned as part of the presentation, but I'd be more than willing to answer any questions.

CHAIRMAN POWERS: Well, just remind us what those things are.

MR. TRIPP: Well, certainly.

Well, double contingency is very similar to single failure criteria. You basically have to have at least two unlikely independent process upsets occur before criticality is possible.

And there are a variety of ANSI standards that have been developed by Subcommittee 8 that relate to this. They have to do with programmatic issues such as that's where double contingency is discussed, also code validation and so forth. There are specific criticality limits, training requirements and so forth.

CHAIRMAN POWERS: We recently, two or three years ago, there was a criticality event in Japan that at least created a stir in Japan. If one complies with the double contingency, would you get into that kind of criticality event? Could you still get into that kind of criticality event?

MR. TRIPP: Well, of course it's not a guarantee of safety. You could have two failures occur by coincidence by just -- you know, that occur at some frequency on the order of highly unlikely, it could happen. But I think it would be much less likely.

I think in Japan you had a number of factors that you wouldn't have in a facility that is-- this is not in accordance with double contingency. There I think you essentially had a single failure where, you know, the system was set up such that a single operator making a mistake as to the amount of-- the type of material to add to the system caused a criticality.

CHAIRMAN POWERS: It seems to me we had a -- that we've had some recent -- again, recent is a relative term. Recent events in U.S. facilities where operators have made errors in what materials they put and leave in the vessels. Is that a violation of double contingency or is that just something that gets allowed by double contingency?

MR. TRIPP: Well, that would be a violation of double contingency. That would be where one of the two controls was lost.

CHAIRMAN POWERS: Remind me, Mag. I think we had an event -- a near miss event at General

Electric. Is that true?

MS. WESTON: Yes.

MR. TRIPP: Yes. I believe in that case that it was a case of the operation not being done in compliance with the approved safety basis. So I know the inspectors are starting to develop procedures and so forth to come about that part of the process.

CHAIRMAN POWERS: But your essential point, I mean the salient point that you're making here is double contingency is not the guarantee that you will not have a -- compliance with double contingency does not mean that you're assured of not having a criticality event?

MR. TRIPP: Right. Right. It should give us reasonable assurance if, you know, other things such as reliance on engineered controls, which I think that we've seen so far is tends to be the case here more than in some of the older facilities we license.

CHAIRMAN POWERS: Okay.

MR. ROSEN: In that sense, then it's exactly like the single failure criteria?

CHAIRMAN POWERS: Yes. Well, it's only--

MR. ROSEN: No guarantee that you're going to have one failure.

CHAIRMAN POWERS: Yes. But I think it's

more than that. I think that the operator is capable of doing things that simply are not covered by the double contingency. You can do things, especially when you employ -- use administrative controls as part of the process.

MR. TROSKOSKI: Just by way of background -- my name is Bill Troskoski. I'm with the NMSS staff.

The Tokaimura event involved mixing up, I believe it was 16 percent enriched in a system that was designed to handle only about 5 percent enriched. Most of our low level facilities only handle 5. There are a few that are involved in the downblending operations, and the possibility of mixing up the low and the high level controls has been looked at.

MR. TRIPP: Okay. If there is no more questions for the time being on double contingency, one thing that we were told that the ACRS was particularly interested in was discussing any unique aspects of MOX and plutonium versus uranium facilities.

And there are several unique aspects of that that we're prepared to talk about here. One, of course, is that plutonium chemistry and physical properties are a lot more complex than uranium in a number of ways. For one thing there are more valence states of plutonium, which means that plutonium chemistry tends to be more complex. Although that's primarily a chemical safety concern, there are some criticality impacts. Because the form and type of material has an impact on the value of effective for the system. It can be quite sensitive to that.

And in addition, there's a concern about efficiency of solvent extraction where if you don't have the right valance state you can concentrated plutonium in your waste streams, which would be a criticality concern because that's eventually discharged unsafe geometry.

In addition, there are a variety of different phases and a variety of different oxide forms. Typically they tend to have a greater amount of porosity than U02 type oxides. And that's important because it's credited in several parts of the process, being less than theoretical.

And another factor is the morph complex isotopic nature. It becomes a multidimensional issue because instead of controlling just one isotopic, that of us U-235, which you do in most of our facilities, there's a number of different isotopes that have to be controlled. Particularly the plutonium 240, 241 in the incoming feed material with most of the balance being plutonium 239. Also there's a slight amount of uranium in the incoming steam. And, of course, once the oxides are blended together than the relative amounts of plutonium and uranium are a key physical perimeter that you need to control.

So this generally leads to having material that's almost completely plutonium 239, and we have a schematic of that on the following slide. But it leads to having lower limits typically, smaller critical masses and so forth than either low-enriched, high-enriched or spent fuel that's used for reprocessing.

In terms of the process, the main unique step that's different than what you normally have in a traditional fuel cycle facility, traditional sort of experience that we've had in regulating facilities is this blending of oxide powders. We do have some licensed downloading operations, and they mostly consist of combing uranyl and plutonium nitrate solutions together. And in this case we have a powder blending process.

That's credited for criticality and it's important particularly when you have the powders to ensure the powders are dry and that they are adequately milled and homogenized and so forth so that you don't have unwanted variations in plutonium assay. So I think if it gets to the licensing stage, that's one of the key things that we would be interested in looking at and focusing on that step of the process.

In terms of the isotopics, I think some of you many be familiar with the reprocessing experience. What we've done here is we've contrasted the incoming feed isotopics on the left to what you would typically see for the feed material for a reprocessing plant. In this case it assumes that you have plutonium refeed in a closed fuel cycle which results in having higher proportion, higher mass plutonium isotopes. It's not necessarily indicative of French plants, but it's indicative of a typical situation.

And so the material being that much purer has a much higher reactivity. You may need to have lower, smaller dimensions, more bounding criticality limits and so forth.

And in terms of open issues, there's one main open issue in criticality, and that was identified early on as being one of the main issues that we knew would be an issue. We identified the validation, which is a part of setting the upper critical limit, the maximum $k_{(eff)}$ as being the design basis value. And that's important because you have to know that in order to design a facility. You have to know what value of k-effective you're allowed to design up to. And so it's necessary to do it before the design is complete.

This really has two issues involved in that. One is the issue of benchmarking, how you benchmark the criticality codes and do you set the subcritical margins once that's done.

There are limited benchmark data available for a range of important perimeters, and these include the neutron energy, moderated or fuel ratio, plutonium 240 content and so forth that have been identified as the main perimeters, so you have to determine the code biases, the function of.

There's also cases where the applicant has indicated they plan to take credit for a number of absorbers, including cadmium borated concrete and so forth. And the issue there is they're not allowed plutonium benchmarks that contain these materials.

In terms of setting the subcritical limits, all processes are required under 70.60.1.D to be subcritical under abnormal -- under normal and credible abnormal conditions.

The past licensing practice at other fuel facilities we've accepted a maximum $k_{(eff)}$ exclusive of all bias and uncertainty is a .95 for the abnormal condition. And that's identified as a design basis value.

We originally considered setting a limiting value, design basis value for normal conditions which in some cases, as our two licensed high-enriched facilities is a lower value than the abnormal case. We considered setting that as a hard limit. But after a number of discussions with the applicant, it was thought that a more risk-informed approach would be to consider that a system specific basis.

Some systems are more sensitive to changes in $k_{(eff)}$ with respect to perimeters of the system, such as if you have a plutonium solution system it tends to be -- small changes can have large changes in $k_{(eff)}$. So you may expect to have a large amount of margin in those cases.

There's other systems such as MOX powder system where you may have large amounts of powder and a small change in the mass is not going to effect the $k_{(eff)}$ that much. And it may argue that you don't need to have as much as margin for those cases.

So because that's largely system dependent, we had decided to look at that more as a limiting condition of operation type of limit to make an analogy with the reactor world and say "Okay, we're not going to call that design basis value, but we are going to say the methodology for determining that is part of the design basis." And so that remains an open issue exactly how you do that.

Because of the fact we had limited number of benchmarks, there are special tools required including one thing that has been used in the applicant's validation report and something that we're looking into acquiring is Oak Ridge's sensitivity/uncertainty methodology. And that's typically the way a validation has been done in the past is you tried to find experiments that are close to the systems you're trying to model in terms of they look similar, given physical terms or if they have similar neutronics. You know similar energy, neutron energy, spectrum and so forth. But that may not always be possible if you don't have a lot of benchmark data. So these more analytical techniques that have been developed in recent years to try to determine whether benchmarks that may not look like the cases that you're trying to model are in fact applicable or not.

DR. FORD: How rate-limiting, the fact

that you say those few benchboard for validation, how limiting is that? How rate limiting to the movement forward of this licensing process? Is it years, months before you can resolve that issue?

MR. TRIPP: Well, we have made a lot of progress toward resolving that. The first validation that came out had a lot less benchmark data applied to it. There is more out there that has been added.

DR. FORD: And, again, I keep coming back to the French when we MELOX facility. Are there any informations that you can get from that facility to resolve this apparent lack of data?

MR. TRIPP: Well, that --

DR. FORD: Have either you or DCS approached them?

MR. TRIPP: We have not really talked to them in detail. I think you have the problem where if you go back to this graph, there's large differences between the French plants and the U.S. plant in terms of the isotopics. So the French benchmarks and validation may not be applicable.

DR. FORD: They are not applicable at all?

MR. TRIPP: Well, they're certainly not bounding because the material the French use, it would be less reactive neutronically than what we're dealing with here. It's much more purer isotopically. However, there may be other ways to deal with that in terms of conservative calculations that may be well benchmarked but may be more conservative.

DR. LEVENSON: Do you have access to the classified information on this?

MR. TRIPP: No. We haven't obtained any of that. Certainly there hasn't been any classified information in the validation that's been presented to us.

DR. LEVENSON: The licensee may not have access to the classified information, but I wondered if staff had access for its validating.

MR. TRIPP: Yes. We haven't looked to see if there's any that's applicable, and that's a suggestion that we can probably take.

CHAIRMAN POWERS: You're considering the investment that's been made over the last 30 years in criticality safety within the DOE framework, I would assume that there is adequate.

DR. LEVENSON: That's my question.

MR. TRIPP: We can certainly look into that.

In doing the validation the applicant has basically divided the plan into five different areas of applicability and found a separation determination of bias on each one. Here we can talk a little more specifically about the number of benchmarks that are available for the plutonium nitrate solutions and for finished MOX fuel there are relatively a large number of benchmarks in data out there. I think there's over a hundred experiments, I believe, of these two systems.

Some systems, particularly the MOX powder systems and plutonium compounds dry up to wet solutions using things like oxalates and plutonium fluorides and so forth. They're not so well benchmarked. And in those cases if there's not available benchmark data for those, there maybe need to be other things like additional margin or things applied that the -- we're not quite to that stage yet.

What we have done is we have reviewed a validation report that we received in January of 2003. We'd received parts of that before, but we received a more complete revision to that in January.

We had a meeting in -- this should say March. I apologize for the first -- different meeting. There was a meeting in March to discuss what we considered to be the big picture items in the validation. When we identified some basic concerns with the analysis they'd done, we decided to communicate early and try to come to resolution. And those are basically a comparison of the stated area of applicability to the range of perimeters covered by the benchmark data and how to deal with the lack of benchmarks in some cases. And basically what the applicant is doing now is going back and reevaluating whether they need the full range in each case or whether maybe the area of applicability may have been too broadly defined, which it looks like it may be the case in some cases. So we're waiting on the results of that.

In addition, we're trying to acquire the new SCALE code which will have this sensitivity and uncertainty methodology built into it to help resolve our open issues.

Another issue that came out of the validation recently was an issue over dual versus single perimeter control and meeting double contingency where the CAR has committed to the preference for dual perimeter control such as controlling both mass and moderation where you'd have to get a change in both perimeters in order to reach criticality. That's clearly preferable because when you realign a single perimeter, you have a lot more potential for common mode type of failures to occur. You don't know if you identified all the possible ways and that perimeter could change.

But in talking about the subcritical margin, there was some question about the degree to which that was being applied. So that remains an open issue that really deals with control implementation; how do you implement double contingency in the plant. But we've identified it as something that will need to be looked at, and clearly will be looked at more closely in the following stage.

So just to conclude, our major issue is the setting of the design basis $k_{(eff)}$ limits which includes all of the aforementioned items. And we knew that this would be an issue early on in the review. Up until now we basically licensed two types of facilities, a low-enriched and high-enriched fuel facilities, uranium which have a lot of benchmark data available that has been historically used successfully by the applicants over a number of years. Wherever we're going outside that traditional framework in terms of composition, form and material this could be an issue. It was an issue somewhat in the ABALAS review. It could be an issue in going to greater than 5 percent type fuel, and so forth.

So we're in the process of reviewing the validation and trying to get the codes answered, the questions about benchmark applicability and we're essentially waiting on DCS' response to some of our questions back in March. And that's really the status. Currently we are, as with the other open items, on track for closure by September of 2003.

DR. FORD: I'm sorry. This is not my area, so forgive me if it sounds a simple question.

The SCALE-5 code, that's a neutronics code, an NRC neutronics code?

MR. TRIPP: Yes. It was developed by Oak Ridge under a contract and it's used by a number of applicants.

DR. FORD: Okay. Now, in this particular applicant also using the SCALE-5 code?

MR. TRIPP: Yes. Yes. When they do the validation, they would validate a specific code, a specific version of that code for use.

DR. FORD: And you're seeing that the main problem here is that there's few benchmark data to validate that code for these various areas of application?

MR. TRIPP: Right, for certain areas. Some areas are well benchmarked, other places there are holes in the data and so forth.

DR. FORD: Well, how big are these holes?

CHAIRMAN POWERS: The MOX powder, it's going to be pretty big.

DR. FORD: So does that not therefore put a large onus on us to try and get relevant data from the French?

CHAIRMAN POWERS: The trouble is, Peter, that they don't have the relevant data.

DR. FORD: Well, any data of any sort that might be -- it may not be precisely the right data.

CHAIRMAN POWERS: Your definition of precision is different here. To you the isotopics is no never mind, it's everything here.

DR. FORD: Okay. I'm trying to put us in a position of being in, say, 5 years time suddenly thinking oh heck, this is wrong. Is there anyway the code is wrong or the predictions from the code is wrong for the particular conditions that we have at this plant?

Am I fishing unnecessarily here?

What I'm hearing from this message is that you have other code which both the regulators and the applicant use. And there's some questions about the validation of that code for the various applications, the five areas of application. Now, how comfortable or uncomfortable should we feel about that lack of benchmark data?

MR. KLASKY: I'm Mark Klasky from DCS.

I'd like to clarify a couple of things.

I think as Chris has pointed out in a couple of cases there are not specific experiments that precisely match the conditions that could exist.

DR. FORD: Right.

MR. KLASKY: And those conditions could be accident conditions, for example.

DR. FORD: Right.

MR. KLASKY: And the issue, and I think what has really come to the forefront in the last let's say 5 years or so, that one recognizes that the neutronic properties of systems that may not precisely have the same characteristics, but yet when one looks at neutron energy spectrum, more closely resemble than otherwise at first glance. And so in this regard certain spectral methods have been developed, certainty techniques applied to try broaden the area of applicability. But I think the important point to note is that what we're talking about is basically just enhancing or perhaps expanding upon the -- how do I want to characterize this -- the area of applicability or the margin, if you will.

I think what has been applied in some fuel facilities is a margin of .05. And so, obviously, when one has fewer experiments, one enhances the margin. I think that's what we're really talking about here. Putting some more quantitative assessment into further our justification of the margin that we've chosen for the facility.

CHAIRMAN POWERS: Peter has written to the Commission. And among the things that he recommended to the Commission was to continue those activities to expand the spectral character capabilities of the code. So he -- he was an enthusiastic supporter of that effort.

DR. LEVENSON: When you say it is missing data and you listed things like plutonium in solution or evaporation, etcetera, these are all steps that have been done thousands of times in our reprocessing plants because the DOE reprocessing plants, unlike the French reprocessing plants, do have this isotopic mixture. And it seemed to me that at most there is one new one, and that's the MOX mixture itself. But for almost everything else you do, there's a huge, huge database out there.

You know, the NRC licensed MOX fuel for

both BWRs and PWRs in the mid-70s, and some assemblies in both types of reactors back then. That was largely on the basis of the government database. I guess we've lost it?

MR. TRIPP: Well, I would assume it's still out there, but you know how well you validate the code, like Mark Klasky said, has all to do with the amount of margin you use. I don't know how much margin was in those facilities or how they were designed --

DR. LEVENSON: No, no. It's the experimental data that led to their designs that I'm talking about. Not their design. You wouldn't work from their design. But there's a huge amount of data.

MR. TRIPP: Yes.

DR. LEVENSON: As our Chairman mentioned, you know a lot of people have often questioned how much money, was it all really necessary that went into the DOE criticality program. But it was huge.

MR. TRIPP: Yes, and there probably is data out there we haven't seen. All I can say is that it hasn't been presented to us.

CHAIRMAN POWERS: I'm really totally unfamiliar with the availability of those data to uncleared personnel, thought I don't imagine it's enormously protected. And it definitely covers evaporation to dryness including fluorides and things like that, because they arise naturally in our processing steps.

The database is geriatric relative to a lot of things, but more criticality data is fairly old. But we don't have anybody on the Committee that we can ask to go check on that very easily.

MR. TRIPP: Yes. Well, we haven't really taken an active role in trying to pursue that.

CHAIRMAN POWERS: And I can chat with the folks up at Los Alamos.

MR. PERSINKO: Early on in the project DOE has informed us that not having access to classified material would not be an issue. So, you know, if there is data out there that you can classify data that would be pertinent to this, I would expect the Department of Energy, who is also playing a role in this even through they're not the real applicant, to identify that data so that we could go look at it.

CHAIRMAN POWERS: Yes. It might be useful just to sniff around a little bit, chat with people at Los Alamos especially at TA5 and see what they think they have available. It might give an ear to give you some specificity when you talk to DOE about that.

Because, I mean quite frankly what happened was we had a few criticality accidents in the complex and the decision was that ain't going to happen again.

Now, the database collection activities were aggressive, but we rely on the double contingency a lot, and probably more than we should.

Chris, go ahead.

MR. TRIPP: I had finished my presentation.

CHAIRMAN POWERS: You're done? Okay. Thank you.

What you're telling us, I think, is we're going to tune into this more especially in the operational -- when we go to the possession and operational licensing.

MR. SIEBER: Maybe I could ask a question before we leave the subject.

It seems to me that when you describe what the feed stock is, that there is a presumption of a certain level of various isotopes whether it's weapons grade, reactor grade and so forth. And if you go to critical or not, accidentally or otherwise, depends on precise knowledge of what the isotopic composition is. So I presume for every batch there is a set of samples that are taken and analyzed --

MR. TRIPP: Yes.

MR. SIEBER: -- so that you know what the reactivity is for each batch, is that correct or not?

MR. TRIPP: Well, the approach they've taken is to define a set of bounding isotopics for the process. That the feed is supposed to stay within some specification. And they've assumed it to be 96 percent plutonium 239 and 4 percent plutonium 240.

MR. SIEBER: Which is pretty reactive.

MR. TRIPP: Which is pretty reactive.

MR. SIEBER: Yes.

MR. TRIPP: And I would assume that would be sampled up front to insure that it is maintained within those boundaries.

MR. SIEBER: And probably more likely 80 percent of 239 with the rest 240 and 241? So that's where you get the conservatism from?

MR. TRIPP: Well, they've told us it would be between 90 and 95 percent.

CHAIRMAN POWERS: Yes, it's going to be a lot more.

MR. KLASKY: Mark Klasky.

Just to answer your question, the material I think Ken mentioned at the beginning and all through expanded upon that. We have two source feeds.

Certainly the material that's coming are being source feed is very well characterized and will be the 96 percent. The alternate feed stock, perhaps, you know it's in essence waste that's being collected from a number of different facilities and will undoubtedly have some variability.

MR. SIEBER: So you're going to have to characterize the alternate feed stream?

MR. KLASKY: Well, that material, again, it would be conservative to assume the 96 percent.

MR. SIEBER: Okay.

MR. KLASKY: For criticality.

MR. SIEBER: Okay. Thank you very much.

MR. SIEBER: Well, thanks, Chris.

At this point we have adjusted the schedule. We're going to discuss a little bit about my buddy red oil here. We have two presentations on this, one from DCS and one from the NMSS staff. I intend to break for lunch between those two.

And, Mark Klasky, I caution you and because of various rules, that should somebody from the public show up and ask me about hearing red oil after lunch, you may get to repeat your presentation. I don't anticipate that, but I caution you that that's a possibility in making this change.

At this point I'll introduce Mark Klasky. He's going to talk about one of life's little mysteries, red oil.

This is not, by the way, oil that comes from the former Soviet Union.

Mark, if you're going to wonder around loose up there, we're going to have to wire you up. And the gentleman right behind you will do that wiring.

MR. KLASKY: Mark Klasky. I lead the AP Safety Review for DCS.

I guess we're here this morning to discuss two different aspects. First, I want to present our approach to preventing TBP degradation or red oil phenomena, and we'll discuss the details of that.

In addition, I also want to basically address some of the issues that arose last time, I think it was last year at the ACRS meeting.

Next slide.

And it's the content of the presentation.

I'm going to discuss our approach to understanding tributyl phosphate, it's degradation and red oil. And there's certainly a lot of misunderstanding of the different approaches that have been attempted in the past. And I want to basically start from the perspective that what we've done here is to really go more into the details here, the fundamentals, dissect the problem into small parts and move forward, while at the same time recognizing that there's 50 years of experience, much of it largely engineering, but at the same time that experience is very important in formulating a comprehensive robust safety approach to preventing red oil events.

I finally want to mention that we do plan to do confirmatory testing during the integrated safety analysis to validate our approach.

I want to also mention that we're working in conjunction with the national laboratories and also MIT, and MIT will be involved in the confirmatory testing.

I want to point out the general portions of the process where we either won't have or don't have organics present.

DR. FORD: You're moving it too fast. There it is.

MR. KLASKY: In the initial part of our process we dissolve plutonium oxide into solution, and that is a nitrate solution. And that nitrate solution is then fed into a purification process where we separate plutonium from the feed stream and we send it onto the process. We precipitate it to a oxalic acid addition and finally we produce powder. And so the solvent is obviously present in the purification unit. It under normal conditions should not be present in the precipitation unit, and likewise in the solvent recovery unit we obviously expect solvent to be present in the acid recovery and oxalic mother liquor recovery, nominal organic content is very low.

CHAIRMAN POWERS: When you use the word solvent, you're not just talking about norprophenic hydrocarbon, you're talking about prophenic hydrocarbon with the tributyl phosphate as well.

MR. KLASKY: That's correct. In this process one has to use a diluent to provide the requisite density separation or phase separation, and also change the viscosities of the medium as well. So, indeed, when I speak of TBP, recognize that it's only 30 percent of the solvent itself.

Having gone through the nominal locations of the solvent, I think one important point to recognize is this is where the solvent is supposed to be, but you know we do have potential to move it into other process equipment. And so we have to design our facility with that in mind. And that certainly is a lessons learned through the 40 or 50 years of experience with tributyl phosphate in the diluent.

Okay. So now I want to talk about red oil, per se. I really want to get into its molecular form, if you will, in the next couple of slide. But first before doing so, we'll just briefly introduce it.

Back in Hanford about 1950, 1953 the term was first coined. And a very vague qualitative definition was attached, and it basically has accompanied red oil for 50 years. And I think that the major characteristics that have been used to describe it are, in essence, a phase inversion that is a density of 1.1 to 1.5, which in essence causes a phase inversion. The nitric acid density is, obviously, between 1.1 and 1.4 or so depending upon the normality.

I want to talk about the energetics of red oil. It's also used in trying to -- in a qualitative sense, describe it.

Experiments were conducted by Stieglitz out of Germany to characterize the energy of a TBP uranial nitrite addict. And what they found was that basically at about 225 degrees the uranyl nitrate addict underwent thermal decomposition. And through DTA measurements they obtained about 390 joules per gram. So, you know, it's energetic but it's not TNT. I think the important point is to really understand that it's energy content is significant, but it is not truly an explosive.

Red oil has been synthesized it about 5 different or four different location, and it has been synthesized to a number of different methods, including reflux, reflux distil and followed by distillation. And it also produced in a closed vessel. And what nominally the means by which one produces this, for example, in reflux is to take a solution of tributyl phosphate and add nitric acid nominally in about a one to three ratio. And basically just reflux for about 48 hours, 76 hours at boiling, 110 degrees or so, and depending upon what the diluent is, indeed one can produce red oil. And I think there was a number of points that I want to make.

Red oil is not synonymous with run away reaction. Red oil is a material that we're going to talk about in the next slide or next point.

Let's see, what else did I want to say?

MR. ROSEN: Well let me ask you a quick question.

MR. KLASKY: Okay.

MR. ROSEN: When you say 110 degrees or

so, you're talking centigrade?

MR. KLASKY: Centigrade, yes. I'm just giving you a representative means in producing it. In closed vessel synthesis the temperatures rise. In fact, in a close vessel production of red oil has raised to pressurization of the vessel itself as well.

In the majority of cases where the phase inversion and energetics have really differed from that of the tributyl phosphate uranyl nitrite addict, the diluent contained large cyclic hydrocarbons or large quantities of the diluent was a cyclic chain hydrocarbon. And that seems to be the most profound finding of the investigations where basically they tested a number of different diluents; straight chain, branched chain, and the cyclic chain diluents and really found that in the case of the cyclic chain diluent it was much more readily -- or I should say red oil is much more readily formed.

So in attempting to understand the molecular structure, a number of different experimental techniques have been utilized, including NMR, infrared spec, gas chromatography and elemental analysis.

The major results of these experimental tests have been to characterize the residence structure of the addict. And I think the most important aspect is that they've peak down to the P-31 residence, a peak at about 2.4 parts per million, and that is the uranyl nitrate addict. They also found residence peaks at, I think, .5, 2.4, 4.5 and 5.4.

And these are peaks that really accompany -- they could be 3 -- that really hasn't been investigated all that much. That's one area that I think during our confirmatory testing that we can add some insight into precisely what is seen. These results that I'm referring to were done at Los Alamos by Pamela Gordon.

CHAIRMAN POWERS: Those shifts were all on addicts.

MR. KLASKY: Excuse me?

CHAIRMAN POWERS: Those shifts were all on the addicts?

MR. KLASKY: Yes.

CHAIRMAN POWERS: And do we have to have the addict to have red oil? I think not.

MR. KLASKY: Okay. I'll talk about that.

I think certainly to get the phase inversion you need the metal addict or the metal ion, I should say. You also see, if you look at the carbon and also proton, you'll see a large -- and even the phosphate -- you'll see a large percentage of the carboxylic acids, you'll see also butyl nitrate, some other degradation products. And so really I think what's seen is really a collection of different species. I mean, that's -- so red oil per se is not one species, rather it's a collection or a mixture of carboxylic acids, degradation products along with the addict.

So, when we speak of red oil, it's this mixture of degradation products that we're really speaking to.

Next slide.

CHAIRMAN POWERS: Well, I mean if you just think about it, anytime that you put a strong reducing agent in with an aromatic hydrocarbon, you're going to get a red product if you do it -- I mean, you get a carbeme that polymerizes on you and gives you a dissociated electron that gives you the red color. Okay. And that strong reducing agent is going to give you garbage. I mean, it's going to be a mix of stuff.

MR. KLASKY: I think that's certainly the case when we start forming all the NOX products, we're certainly going to have oxidation products with hydrolysis occurring. I mean, we'll speak to more of that as we go through some of the degradation products that are possible in just the dyhrolysis of TBP. I think that's where we're headed next. It's on our next slide.

CHAIRMAN POWERS: Yes. It seems to me that you've set yourself up to get aromatic groups in this mixture when we went with tertiary butyl as the addict of the phosphate.

MR. KLASKY: You want to hydrolyze the TBP. I mean that's certainly the case.

CHAIRMAN POWERS: Yes. And it's set up to give you -- well, what you've indicated up here, butene.

MR. KLASKY: That's true. I think in the next slide, what I want to try to do now is to differentiate between red oil with the metal addict and tributyl phosphate.

DR. LEVENSON: Let me ask a question.

MR. KLASKY: Yes.

DR. LEVENSON: When you measured the energy or decomposition, do you get any from those measurements, any indication whether -- what the time constant was? Was it an instantaneous thing or over a finite period of time?

MR. KLASKY: Okay. I want to go into the rate laws in the next couple of slides.

Mark, do you want to pull up the DTA for thorium nitrate.

This is a DTA and also a TGA of thorium nitrate. The DTA is up top and the TGA is just a mass loss here.

What you see here is, I mentioned 225 is where just in a pure TBP uranyl nitrate addict you had thermal decomposition. And this is an experiment that's conducted with TBP and the uranyl nitrate, and nitric acid also present. And what you see is a very broad exotherm here. And what you have here in essence will show, and it's a following slide, really a phonomania that's given by something else, and that we'll show in the next slide, in addition to the thermal decomposition of the addict.

Also I mentioned at about 275 or 200 you get finally an endothermic reaction, the formation of butene is then present. It's an endothermic reaction.

The TBP. Perhaps this is a little clearer. You have heating followed by, in essence in the 120 degree range evaporation taking place. And then finally you have the exothermic reaction taking place. And if you go back to the other slide, you'll this is precisely where that broad exotherm appeared.

And so I think what you can conclude from this is that it's the attack of the nitric acid on the tributyl phosphate that's giving the predominant source of energy prior to the 225 thermal decomposition of the metal addict. And so what you take away from this is that if we understand the decomposition of TBP, we can in essence understand how one prevents a runaway reaction. And so we can in essence remove ourselves from the metal.

So from this point forward we're really going to examine TBP and its degradation recognizing, of course, that the metal ion species does have potential to catalyze hydrolysis and it's something that we plan on examining during the ISA.

CHAIRMAN POWERS: Yes. If you come back to your previous slide, you indicate some use of thorium as a surrogate for plutonium.

MR. KLASKY: Yes.

CHAIRMAN POWERS: And, gee, it's a remarkable choice because thorium does not have the valence variability that plutonium does, whereas cerium does have that capability. Why did you pick thorium rather than cerium?

MR. KLASKY: I think in these experiments thorium is simply used due to the fact that it valence 4 representing plutonium 4. You don't have the redox reaction that couple, and I think when the experiments are done -- you know, a testing regime they certainly don't want to use plutonium.

CHAIRMAN POWERS: No.

MR. KLASKY: So, you know, to first understand things, just to separate the metal addict from the TBP, for that purpose, it was sufficient to use plutonium -- or I'm sorry, thorium.

CHAIRMAN POWERS: Thorium.

MR. KLASKY: I think we'll get into, and I think Bill is going to talk about some of the experiments that I think -- some of the experiments that we're going to do. Is that correct?

So our plan, of course, is to investigate plutonium and to understand the difference between thorium and plutonium. Because I think what we're really interested in here is can it catalyze the oxidation and hydrolysis reactions. And we're certainly not learning that from using thorium.

CHAIRMAN POWERS: Yes. You'll never get it with thorium. Because there's no mechanism to it. If you're looking for a surrogate that does not have the experimental difficulties of plutonium, cerium has proved very good for this.

MR. KLASKY: Okay.

CHAIRMAN POWERS: Because it does have the three four change at about the right kinds of energies and things like that.

DR. KRESS: Okay.

CHAIRMAN POWERS: No substitute for the real thing, though.

Go ahead, please.

MR. KLASKY: Okay. So recognizing that many of the salient points to be learned as to be obtained just by understanding the decomposition of tributyl phosphate, we've outlined the decomposition scheme here. And in essence what you have is phosphate underlying hydrolysis to produce the butyl alcohol and dibutyl phosphate. Dibutyl phosphate and monobutyl phosphoric acid also undergo hydrolysis, but at somewhat slower rates. So for the purposes of this discussion, we'll restrict ourselves to TBP.

CHAIRMAN POWERS: You're going to forgive me.

MR. KLASKY: Sure.

CHAIRMAN POWERS: My interactions with red oil have been sporadic. But I got the impression that the presence of the dibutyl phosphate was considered by some to be an essential step.

MR. KLASKY: I think the dibutyl phosphate by itself -- I mean, dibutyl phosphate can precipitate materials. It's less soluble. But I don't really view that as an essential step. It's only essential to the extent that it's accompanied by the butyl alcohol.

So having said that, I guess I view the degradation products that really matter as the butyl alcohol and butyl nitrate. And I guess that's the next step that butyl alcohol either can be oxidized or it can be nitrated. So, obviously if it's oxidized, it's producing the end products and/or the carbic cyclic acids and likewise, it's nitrated it's producing the butyl nitrate.

In addition, TBP can undergo paralysis at elevated temperatures, 225 or thereabouts.

And finally, TBP can also undergo deacclamation to produce butyl nitrate as well.

CHAIRMAN POWERS: Of course, what you've written down here are thermal type decompositions. Do we have to worry about the radiolytic processes? Do we have enough activity here to --

MR. KLASKY: Yes, we're going to talk about that in fact. That's the next slide.

DR. FORD: You mentioned in one of the very first presentations, you mentioned this particular process is modeled after that use at La

Hague. Is that correct?

MR. KLASKY: That's correct.

DR. FORD: I'm sorry to keep coming back to this, but it seems as though you're in a time crunch here; that you're talking about doing some experiments, etcetera, to come up with the inetics and therefore onto the process control. Are there any lessons at all to be learned from the processing experience at La Hague?

MR. KLASKY: I think not only the experience at La Hague, but at DOE there are certainly a lot of lessons learned to be obtained. And I think we've incorporated those lessons learned into the formulation of our safety approach.

The experiments to be done, I think I mentioned earlier, are to be done during the integrated safety analysis. They're largely conformity analyses. They're analyses that I really don't view as largely effecting the design, rather they're to substantiate our design basis and select precise limits. You'll see in a minute the limit that I'm referring to.

DR. FORD: But it would have an impact on the quality control you'd be using for your process, whether it be a 6-sigma or 4-sigma, or whatever the process control matrix that you might use, the outcome from these experiments, the definers -- is that right?

MR. KLASKY: What's that?

DR. FORD: The outcome from these experiments, the kinetics, the process path, etcetera would define therefore the degree of quality control that you would have to apply at this plant?

MR. KLASKY: I think you're correct in the sense that one of the controls that one might obtain from this experimentation is a limit on the resonance time. That is to say, don't leave tributyl phosphate in conjunction with a nitric acid or a plutonium source for more than 3 months or 6 months or a year. And so certainly, you know, that data will be incorporated and controls will be implemented to ensure we don't exceed those limits.

DR. FORD: So you are talking about months, years before something can occur?

MR. KLASKY: I think that's the -- the evidence that we have now is that this is a phenomena that occurs, that is the build up --

DR. FORD: Okay.

MR. KLASKY: -- of sufficient degradation product. And we'll speak to the quantity of degraded organic, that's something that -- a point that I want to emphasize in the synthesis of red oil. They were able to obtain red oil, but the quantity of it is very limited. This isn't something where you start with a 100 milliliters of tributyl phosphate and, you know, 300 milliliters of nitric acid and wind up with 100 milliliters of red oil. It's very limited. There's a small fraction that is truly what one would call if red oil, if red oil hasn't a specific meaning.

MR. ROSEN: Take your example and give me the rest of that sentence. So how much red oil would you end up with if you left it for months? Would you end up with a milliliter, 10 milliliters, 50 milliliters?

MR. KLASKY: It's a function of time. And I think in the next slide we're going to present the rate equation. And I think what we can tell you right now is that the rate limiting step here is hydrolysis. And you see that the rate -- this is a kinetic rate of hydrolysis of TBP is per hour. Okay. So under nominal processing machines we're operating a majority of our plant where we expect to have organics at under 60 degrees. So we're talking a degradation rate of ten to the minus five or thereabouts, or less.

So that's the rate limiting step of our production of degradation products, it's hydrolysis.

CHAIRMAN POWERS: Do I understand your slide is saying you have a thermal and a radiolytic rate?

MR. KLASKY: Yes.

CHAIRMAN POWERS: So you become non-uranious down in your normal operating conditions?

MR. KLASKY: Correct.

CHAIRMAN POWERS: And that's radiolytic rate is a 4 year process?

MR. KLASKY: Yes. Let me talk about the radiolytic component of this.

Basically, this radiolytic rate was derived just using the specific activity of the plutonium with the 240 content at 4 percent that we envision. Actually, there's an upper limit as well for 240 content. Obviously, for just these purposes or just this purpose.

Also, we assumed 62 grams per liter, which is in essence in the organic phase the solubility limit. And, you know basically what one does in characterizing a radiolysis rate is to define a G value. And G value have been obtained in numerous investigation have revealed a G value of about 2. So in essence, putting that altogether you get a radiolytic decay rate of something times ten to the minus 4. I think it's eight times ten to minus 4 per hour.

So that's just, of course, a consequence of having alpha particles that micropart bonds just as the chemical degradation occurs, something that obviously has to be accounted for. Because, as you see, it's the -- you know, a substantial part up until 60 or so -- 40 or 50 degrees. But we recognize it. The radiolysis has to be accounted for.

So the question, your specific question I think was well how much do we produce. And that's sort of the million dollar question. And that's of degraded organics.

Yes, put that slide up. I'll speak to that slide.

The reason we're interested in how much you can produce is butanol and butyl nitrate, as I think we showed in the previous slide, are let's say the first byproducts of tributyl phosphate, first and second phosphates. And they're oxidized at relatively low temperatures. However, you need relatively high nitric acid concentrations. It should be pointed that in most cases absence the evaporators we don't have those nitric acid concentrations present. Our extraction process, in fact, relies upon a relative low nitric acid concentration. In the extraction process, that is to remove the impurities, you want to use an acid concentration of about 4 or 5 normal nitric acid. When you strip the plutonium from the uranium, you want to go as low as possible. So in that case, we're talking about a normality of one. So the purification unit is clearly a unit that one does not normally encounter high nitric acid concentration.

Of course, you know, for safety analysis purposes, we assume the worst. We assume, okay, what would happen if you did have this high concentration? Now, the reason we assume it is simply it's conservative to assume it and we don't have to implement controls such so that we, you know, have to assume something else. If one can accommodate a more conservative approach, one does so. And that's what we're doing here.

So the important point is that the energy that is liberated is substantial. And so consequentially what we want to do is to assure ourselves that we don't built up a quantity of these byproducts of TBP that can produce energy and heat, and gas as well. And these are much more easily oxidized in tributyl phosphate.

I think I mentioned before that the

hydrolysis of TBP is the rate limiting step. So it really is important to ensure that these products that are oxidized more quickly don't build up. And that's, in fact, what we want to do. And also a lessons learned that the Tomsk event, which we'll speak to later, is certainly a case where it is believed that substantial quantities of these degradation products did build up over time and consequently what you had was in essence these products raised the temperature to the point that the hydrolysis of TBP did become significant, and then you basically involved the majority of your organic in the overall reaction scheme.

So this is a real key in providing for safety.

To answer your question how much degraded organic can one build up, one has to know a number of rate constants. Rate constants that receive the most attention, and rightly so, has been the hydrolysis rate constant. Less information is really known about the oxidation of the degradation products, or I think what's not shown here as well is the nitration rate constant as well. So it's a goal of our experimental program during the integrated safety analysis to begin getting back to first principles here to determine the rate constants, such that we can predict the concentration of these degradation products at any point in the process, at any time, at any temperature and any normality. So then we'll really truly have a firm handle on the rate constants and the quantities of degraded organic that can build up in the process. But to date, not all these rate constants are known.

Go ahead.

CHAIRMAN POWERS: I'm surprised that you don't have terms of higher order in here. That is, you have a rate constant for this hydrolysis rate constant, but why don't you have a term with a square of the TBP concentration?

MR. KLASKY: The hydrolysis rate constant has been shown to be pseudo-first order in TBP. We're talking -- here we're only talking about the organic phase. And the reason we're talking about the organic phase, is that the solubility of TBP in the aqueous phase is exceedingly low, about --

CHAIRMAN POWERS: I understand that.

MR. KLASKY: But I think the only -- the only answer that I can give you with respect to the order of the reaction is simply the experimental evidence suggests that the rate is pseudo-first order in TBP. I don't know if that answers your question.

CHAIRMAN POWERS: Well, I mean it could well be that the data accrued enough you can't see the higher order term, but you clearly have it. Because your aromatic ties and things. There's got to be some point at which you've got this hydroxide clipped off the tertiary butyl alcohol to create something which is either ionic or a radical hermitage.

MR. KLASKY: Mark, do you want to --

MR. VIAL: Mark Vial, DCS.

I didn't quite understand the equation. Why would you be looking for an order two in your TBO concentration while it may only -- the mechanism of the hydrolysis or de-alcoholization is more likely to be an SN2 type mechanism. So you wouldn't involve a power 2 in your concentration.

CHAIRMAN POWERS: The hydrolysis is clearly -- you would expect to be first order.

MR. VIAL: Correct.

CHAIRMAN POWERS: But it's the subsequent formation of a -- something -- you got to have something that becomes red in this system. Nothing up there is going to be red, okay. And the only thing that's going to be red is something with an aromatic diluent.

MR. VIAL: Correct. But in your case and

you are talking about the rate -- so you are talking about a situation where you have an aromatic diluent. In our case and unlike BNFL, for instance, we have just a branched alkane. We don't have any impurity of aromatic group, such as nasty group of the chaz benzene unless, unlike -- which is used by BNFL. So what you say is with your byproduct from the decomposition of these diluents, not necessarily on the solvent itself now, but on the diluent. And in our case it doesn't apply. It doesn't apply.

CHAIRMAN POWERS: What you're saying is red is a coincidence?

MR. KLASKY: No. I think what we're saying is that the -- I think we mentioned earlier the properties of the diluent are very important and when you get down to the early work that was done in Hanford, I mean this was part of the learning experience. Early on in the project, you know, different diluents were tried. And it eventually turned out that they were using -- I think the diluent at the time was a shell based spray which had a very high naphthalene content. And subsequently when they went exploring, you know, different diluents, that they clearly saw the presence of the diluent as a major factor.

And as Mark mentioned, the branched chain and the straight chain alkane really has been found to be rather robust in that regard to nitric acid, or basically is not attacked by the nitric acid and is also rather resilient to radiation fields.

The diluent does play a large role. And the red color I think is more attached to the diluent than anything else. So clearly it's an important factor, and I think we'll mention that in our safety strategy as a major control that we want to evoke in justifying our safety basis here.

DR. LEVENSON: Are you really saying that, as Dana pointed out, the bulk of the degradation products do not have red color, but in a way they're the source of the energetics, if there is going to be any from exothermic reaction that the red color is a second ordered thing and probably can't contribute much to any energy issue? Is that really --

MR. KLASKY: Well, I guess two things. That's largely correct. But the diluent, again, as they found out early on, certainly can produce energetic byproducts. And so --

DR. LEVENSON: But they're necessarily red?

MR. KLASKY: No, it depends what diluent

one uses. That the naphthalene group happened to be such that, you know, one got a red color. And when they formed in a limited number of experiments or one experiment where they formed a phase inversion with dodecane, they got a yellow color. So it largely is a property of the diluent. I think I'd leave it at that.

MR. VIAL: I think the color is not the issue. The color just reveals that you have aromatic cycle with certain number of double bonds. And here the only source of double bond would be the formation of butene at truly high temperature. So it would be really in the end of a decomposition, it would already have started to run away.

DR. FORD: Will we be talking at anytime about the materials of the construction for this polishing plant?

MR. KLASKY: I don't think that's the intent.

DR. FORD: It won't be talked about at all today?

MR. KLASKY: No, I don't think so.

DR. FORD: Okay.

CHAIRMAN POWERS: I was a restriction I put on the meeting that there would be no discussion of corrosion.

MR. SIEBER: And that's why it's a one day meeting.

CHAIRMAN POWERS: That's right.

MR. KLASKY: So, we talked about the energy generation.

CHAIRMAN POWERS: See, we're discussing important stuff, chemistry here.

MR. KLASKY: We talked about energy generation, and obviously we have material that is capable of being oxidized in liberating energy. But equally as important is the mass and heat transfer afforded to the system. And so really to understand the system, one has to, in essence, perform a heat balance and just if you want to prevent a runaway action, just ensure that your heat transfer is sufficient. It's that simple.

CHAIRMAN POWERS: Guaranteed to work. Sometimes a little challenging, but guaranteed to work.

MR. KLASKY: I think there's one aspect that I want to mention, it's an important aspect and it sort of -- it's followed red oil for a number of years, and that is the idea that one can, you know, just simply operate below a certain temperature. And we're clearly not saying that.

What we're clearly saying here is at every temperature that either under normal or abnormal accident conditions that we may encounter, we have to ensure that this heat balance is maintained. And I think that is fundamentally our safety strategy here, to focus on that energy balance and assure that we have the requisite heat transfer afforded to the system sufficient to overcome the energy generated. And obviously we have to do both.

So we talked about the somewhat more fundamental or theoretical aspects of TBP and red oil, but obviously we have 50 years of operational experience, that is collectively. And, you know, it's important to understand what was tried and to really learn from that history. And so we have done that by analyzing the experiments, or the experiments, the accidents and really understanding why is it that this event occurred. And I think we start back in the early '50s, I think there were two aspects that really come out of those accident, and those are as follows.

They didn't at first recognize the overall importance of the diluent. They saw degradation in subsequent experiments of the diluents occur at much lower temperatures where TBP was basically inert; that is some of the diluents were reactive at 110 degrees. And clearly that's a problem. If one can encounter temperatures in excess of 110 and your diluent is being attacked by nitric acid or nitrous acid, that's a problem. And so a large experimental effort was undertaken by Hanford back in the early mid-'50s to really resolve this issue of the diluent. And I think to date that aspect of the problem has largely been tackled.

The other aspect of the '53 events was that they didn't have redundant equipment. That was, you know, they had the nominal equipment. Their mission was to produce a product, and consequently that idea of single failure criteria just simply was not implemented in the facility at that time.

It's about 25 years later, they found out that, well, you know, tributyl phosphate itself if you heat it high enough or hot enough, you can loosen the bonds, hence the name paralysis. And although they had adequate venting and they did their best to restrict the quantity of TBP into evaporators, they also found that one could get phase inversion, one could concentrate TBP in evaporators, the diluent is more volatile than TBP and consequently one is left with TBP, and if left on its own, if you heat, you're going to break the bonds and you're going to produce butene. And so they learned, basically, that you really have to provide that heat transfer mechanism to ensure that one does not heat to the point of producing butene. Because once you get to the butene, you're producing flammables, and that obviously can be a problem.

The final accident or last accident occurred in '93, and that is obviously much published, the Tomsk event. And I think there are a number of lessons with Tomsk. But I think the most important one that stands out is that, you know, again it's a heat balance. They felt that they were operating at relatively low temperatures, 60/70 degrees, and attached to this red oil phenomena was this 135 number. And they felt, well, you know, we're under 135 and consequently it shouldn't be a problem. But they learned that these degradation products are much more energetic and if left to build up, they can provide that initiation energy to raise the bulk temperature of the organic to the point where hydrolysis becomes significant and consequently, you know, involve the bulk quantity organic and you run away.

MR. ROSEN: Which is to say, I think, that they didn't pay attention to the rate steps. You said if left for long enough, which implies a time, a rate.

MR. KLASKY: Correct.

MR. ROSEN: And they didn't know anything about the rate. Well, they assumed the rates were low enough at those low temperatures that they wouldn't have to worry in essentially infinite time, which turned out to be the wrong answer.

MR. KLASKY: Correct. I think that there's also something, if you look at the rate equations, you'll see -- Mark, if you want to put the rate equations back.

You'll see the second equation, there's a loss, or actually there are to lost terms. Evaporation, that's the exponent and there's a k4 which is in essence an oxidation rate.

So theoretically if you're at a low temperature, you minimize those two terms. And so -- but of course k1 hydrolysis also goes down. But remember we also have radiolysis.

Now our facility is fortunate in the respect that we're dealing just solely with the plutonium, we don't have fission products present. So our radiation fields are somewhat restricted from what one encounters in a fuel processing facility. But the point is that at low temperature you still have to be concerned with radiolysis. And, you know, if you allow the tributyl phosphate or if you use the wrong diluent -- it's unclear what they used at Tomsk actually, it could have been a cyclic change diluent. The information just isn't there. But you can build up degraded organic.

And so I guess what we're saying is, yes, it's very important to understand from the fundamentals what the phenomena is, what the rate laws are, what the mechanisms are. If you truly want to understand something to prevent it, in my way of thinking is a prerequisite.

CHAIRMAN POWERS: I mean if you look at your rate equation, you in fact to get to a steady state.

MR. KLASKY: Well, it's --

CHAIRMAN POWERS: I don't know what it is.

MR. KLASKY: Right. That's -- you may get to a steady state.

CHAIRMAN POWERS: I said if you wait long enough, you'll get to a steady state.

MR. KLASKY: Right. And, hopefully, it's not all degraded organics.

In any event, so our approach is to characterize these degradation products, their rates and their energetics and develop --

CHAIRMAN POWERS: Well, I mean it's because of that, in your unsteady stateness of your rate equation, somehow I just cannot believe there's not a higher order terms in here someplace.

MR. KLASKY: Okay. Sort of pull back a little now and talk about what is our safety strategy here, what are we implementing into the facility to assure that we don't have runaway reactions. I think we've spoken to most of these, but I want to go over them.

We identified the diluent as it being a branched chain hydrocarbon or I think more correctly, excluding cyclic diluents from the process as a principle SSC.

In addition, we talk about the confirmatory testing to assure that our diluent does not create foam such that it could, in essence, insolate the material and cause subsequent temperature and pressurized by clogging the vents, for example. And that, obviously, will raise the temperatures.

CHAIRMAN POWERS: Have you going to put an anti-foaming agent into your --

MR. KLASKY: We haven't planned on that yet.

CHAIRMAN POWERS: Right. You haven't gotten there. Because that's just going to complicate things.

MR. KLASKY: Yes. We have to make sure that, you know, we don't have surfactants and whatnot as well. And I think, again, this is something that we're going to investigate during the ISA.

We have identified venting both from two different perspectives. One, that the venting has to be sufficient to allow for evaporative cooling. We clearly need to be able to vent the water, the soluble and the organic to allow for the cooling. That's providing the predominant cooling mechanism, although conductive heat transfer out the sides in our tanks because of criticality constraints, that also might be significant because of the surface area-to-volume ratio.

Also our vent also can accommodate pressurization.

Finally -- or I shouldn't say finally. Two more.

The steam temperature on our evaporators we're restricting to 135 degrees. And that is not to say that our solution temperature is raised to 135 degrees, rather it's our steam temperature and the temperature of the solution will just be the boiling point of our low boiler, in which case it's water and nitric acid.

DR. FORD: But you said just now that at Tomsk there was an accident with temperatures below 135.

MR. KLASKY: Correct.

DR. FORD: So in other words you don't know all the other interactions between the other process variables that would lower that limiting temperature, or do you?

MR. KLASKY: We're going to get at that in the next control, limiting the exposure time to prevent the degradation products. If we --

DR. FORD: And you know that's what happened at Tomsk? They did not limit the exposure temperature time?

MR. KLASKY: Well, we suspect that they had given that the evidence that we have is that they initiated the runaway reaction at temperatures 60 to 70 degrees. We suspect that the energetics of both butyl and butyl nitrate support that hypothesis.

I think during the ISA we also are going to do testing on the heat transfer mechanism as well. So I think we'll be able to provide a much more definitive answer into what possibly occurred at Tomsk.

Of course, you know, it will never be known 100 percent, just because the precise details of the starting conditions aren't known 100 percent.

CHAIRMAN POWERS: And they blew up the experimental labs.

MR. KLASKY: So I think we can just create, you know, just apply a scientific method and look at steps and try to deduce what the mechanism was and confirm that, both due to the experimental data that we take and the models that we develop.

DR. FORD: You're rightfully pointing out that there's some unknowns and that you're going to do experiments to resolve that. Does that data collection and understanding development, does that become a rate limiting step to this whole project?

MR. KLASKY: I don't think so. Our plan for tributyl phosphate, I don't envision as a rate limiting step. It's something that we feel we can do over the course of the ISA.

CHAIRMAN POWERS: My interpretation, they're required to be state-of-the-art. And the 135 limit is the state-of-the-art right now.

DR. LEVENSON: Is this an atmospheric

event? Have you evaporated atmospheric pressure?

MR. KLASKY: One of them is actually sub-atmospheric, the other is basically atmospheric, yes.

MR. ROSEN: You see, I'm having the same trouble that Dr. Ford is having.

MR. KLASKY: Okay.

MR. ROSEN: And that is all of this makes eminent good sense to me, and the determination of these rate constants is clearly necessary. And yet it seems to be necessary before one could be at the stage you're at. I mean, it seems like you should arrive at more of these fundamental understandings to me, before you could get to the laying out a set of components on a flow diagram.

MR. KLASKY: I think what we've tried to illustrate is that what these rates constants are really doing is they're just restricting operations so one could view the final product of these experiments as, in essence, tech specs. So I really don't think that the ultimately that the facility design is changed by the results of the experiment. Rather what may change is perhaps how you operate the facility.

DR. LEVENSON: Isn't the only potential impact on design the size of the solvent recirculation and cleanup system?

MR. KLASKY: Or just the exposure time. I didn't mention, but as part of the --

DR. LEVENSON: Well, the exposure time is really controlled by how frequently --

MR. KLASKY: Yes.

DR. LEVENSON: I mean, it isn't exposure time in the process equipment. It's integrated exposure time over many passes?

MR. KLASKY: Yes, exactly.

DR. LEVENSON: So that the limiting step really isn't exposure time. It's the length of time between solvent cleanings.

MR. KLASKY: Or we're not even taking credit for the solvent cleaning. I'd characterize -- for safety, that is. I'd characterize exposure time as just, you know, T equals zero, you introduce tributyl phosphate. And, you know, T equals -- I don't know, one year as the time that the tributyl phosphate has been in your process. So what might change is we might conclude that every 8 months we remove all solvent and we just send it to SRS. Yes.

CHAIRMAN POWERS: Help them out.

MR. KLASKY: But I think the important aspect of this is, again, it's not facility design that's going to change. It's going to be how we operate, how long we allow the solvent to remain in process.

We currently have a process where we draw off a percentage of solvent each time, and we add fresh solvent. And, in essence, you know that's a decay rate in essence. So --

DR. LEVENSON: Well, I don't know whether overall -- you know, it may be an easy answer, to say we're just not going to take credit for solvent cleaning. But that means you're going to significantly increase the rate of solvent disposal and generate a big waste disposal problem that maybe doesn't have to be there.

MR. KLASKY: I think with respect to the crediting or noncrediting, we have a neutralization process. And that naturalization process removed primarily the tributyl phosphoric acid and monobutyl phosphoric acid along with those degradation products that are soluble in the aqueous stream.

There are certain degradation products that are soluble in the organic stream. And so, you know, in the end given the rate constants of hydrolysis and the oxidation, what we believe to be order of magnitude estimates of the oxidation products we don't suspect that this is going to be a problem.

But having said that, you know, we're going to quantify this and demonstrate this. We need some basis for our estimate of degradation time, and that's what we're going to obtain here. And the fundamental changes to the facility, I just don't foresee and instead we're talking about resonance time. I think that's in the end what we're getting at. We're not talking about modification of equipment, per se.

MR. ROSEN: That's a very unsatisfactory answer to me, in the sense that by analogy to the reactor systems, which we know a lot more about, the idea that the designers would say "Well, leave this to the operators, we'll take care of it with tech specs. Sure, we have some fundamental issues in design, but we'll take care of it with tech specs and leave it to the operators to figure out."

It has always been anathema to me and to operators, too. And now you're saying the same thing about this facility, and that's what it's very unsatisfactory.

MR. KLASKY: I think what we're saying is that clearly from operational history, 40 years of operational history, we clearly know that people operated the plants without these rate constants. I mean, to a varying degree of safety. And what we're seeking to do now is to quantify that safety, how long one can go in this environment prior to exceeding some limit of degradation products.

DR. FORD: Yes, but it's too small like a mountain underneath the ocean floor. You don't know how much leeway you have. We might have just grazed an accident and you didn't know about it.

MR. KLASKY: I'm not disagreeing with that. That's true. I think what we're doing is trying to quantify -- to come up to some conclusion that after 6 months of sitting in a tank if that's the, you know, unexpected event that were to occur, that we have sufficient margin. But really fundamentally the process will not change. It's just we'll know what our limit is. And I guess I can't foresee any fundamental change if we were to know that data today. We'd simply be able to state a number. Don't allow it to remain in a nitric acid environment for 3 months or 6 months, but fundamentally if we obtain that information a year from now, we're still going to have the same number.

MR. ROSEN: What if it's 3 days?

MR. KLASKY: Well, I think we know that based on the hydrolysis rate constants, that it's not 3 days. You can obtain -- if you want your most conservative answer, just take the hydrolysis rate of TBO and just assume that nothing's lost. And, in essence, you'll arrive very quickly at the conclusion that it's not 3 days.

We're talking a rate of hydrolysis that's nominally ten to the minus 5 per hour.

MR. ROSEN: At 60 degrees?

MR. KLASKY: At 60 degrees. And I think we've indicated that in the process equipment that we expect to TBP to be present, 60 degrees is a hard limit for a number of different reasons. In other process equipment, we're at somewhat higher temperatures to 135. But one recognizes that oxidation rates at those temperatures are much faster than hydrolysis rates, or can be.

MR. ROSEN: Well, let me postulate something for you.

MR. KLASKY: Okay.

MR. ROSEN: At 60 degrees you have these times, long enough to give you some comfort. But in abnormal conditions, how long do you have? Well, how abnormal? Well, let's say you lose temperature control and the rate constants are really 3 hours, not 3 days, not 3 months, not 3 years.

I just don't know enough to be able to

postulate in a bounding way or to state in a bounding way that you can't get into trouble, and that's why I so much applaud your evaluations of these rate constants. But I think we've got the cart a little bit before the horse here, and I think that's where Dr. Ford started this discussion.

MR. KLASKY: I think what we've done with respect to your hypothesis that we, in essence, lose control of temperature, clearly we recognize temperature to be a major driver, and so consequently we have IROFS or will have IROFS to preclude that, we'll have redundant controls to ensure that temperature doesn't exceed specified limits. But on the other hand, I think, Mark, if you go up to the oxidation slide, the table, you'll see that the oxidation rates are very dependent on acidity. And so, you know, what we're again trying to do is we're not trying to argue that we're controlling the normality. We're trying to take the fewest -- implement the fewest controls with respect to assuring the -- how would I say this?

We're basically conservatively taking the worse case and all the other variables that were not controlling. So we're not attempting to make arguments with respect to well we'll never have a problem with butyl nitrates since we don't expect the normality to go above 8. Rather, we're assuming it's above 8.

And so, you know, I think those features, we call them additional protective features, are implemented throughout the design. That's, I guess, all I can say.

DR. FORD: That's 10 molar nitric acid?

MR. KLASKY: This is in the aqueous phase. With a case of butyl nitrate, butyl nitrate only resides in the organic phase. So with TBP of a distribution coefficient of about 3, so in essence the highest nomality that you get in the organic phase is about 5. So just take these numbers and divide by 3, and that's roughly what you have in the organic phase.

CHAIRMAN POWERS: This is concentrated chemistry.

DR. FORD: I'd love to see what the materials of the construction are. I just love it.

MR. ROSEN: That's why we don't have that discussion today.

DR. FORD: That's right.

MR. KLASKY: Any questions?

CHAIRMAN POWERS: Any questions?

This is fine. I encourage on this. I like the fact that you're not relying just on the temperature criterion, because that's always been a dissatisfactory thing. And it is true that every radial event that I can think of involved old material, and whatnot.

Members have any other questions to pose to the speakers?

Our intention is to come back to this issue right lunch, and we will come back right after at 1:30.

(Whereupon, the Subcommittee was adjourned at 12:25 p.m., to reconvene this same day at 1:31 p.m.)

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

1:31 p.m.

CHAIRMAN POWERS: Let's continue our discussion of red oil, which may or may not be red and may not be oil.

So, Bill, your show.

MR. TROSKOSKI: Okay. I'll have to confess, I've never seen red oil in my life. I know it's going to shock somebody.

CHAIRMAN POWERS: Maybe we ought to ask, what your qualifications for being here?

MR. TROSKOSKI: Well, I am a chemical engineer.

CHAIRMAN POWERS: And you did some work at Savannah River?

MR. TROSKOSKI: And I worked at Savannah River building the reactor department.

CHAIRMAN POWERS: Well, that puts you in good stead with the rest of us, so go ahead.

MR. TROSKOSKI: All right.

MR. ROSEN: Especially the chemical engineering part.

MR. TROSKOSKI: Okay. My name is Bill Troskoski. I am a chem safety reviewer in the fuel cycle safety division. I would like to discuss the staff's review of the tributyl phosphate nitrate runaway reactions that can occur at fuel cycle processing facilities. It is also known as red oil, though as we know, it's not necessarily red. And in many respects it's similar to other chemical runaway reaction phenomena that is well known in the chemical process industry.

These are highly exothermic reactions that involve large amounts of thermal energy and noncondensible gases. If the reaction rate is not properly controlled or adequate venting applied, process components could be ruptured releasing license material, possibly injuring any operations and personnel nearby.

The staff has reviewed the applicant's approach based on first principle, as well as the literature and passed operating events including those from DOE and Russian facilities. The staff also notes that the French facility is using a very similar process to that proposed by DCS for the aqueous polishing system, have had no red oil events that we know of.

In conducting our review the staff is aware of the chemical process industry's response and approach to dealing with runaway reactions through the

Process Hazard Analysis methodology, a process a very similar to the ISA that the applicant has yet to perform.

CHAIRMAN POWERS: You know, that's an insight that really hadn't dawned on me, but the Process Hazard Analysis is much like the ISA, isn't it?

MR. TROSKOSKI: Very much so. And what the applicant is proposing to do here is a very rigorous and in my view the way to go, they're going to do a HAZOP supplemented with a What-if/Checklist. And the What-if/Checklist, of course, you can get valuable insights from other operating events to highlight, make sure you look at certain key points regardless of the disciplined -- the approach that you take in looking at step-by-step for each component.

The first principles. By way of illustration, a runaway reaction can be evaluated in the classical fire triangle terms. You conserve fuel, oxygen and heat presence that you need for this reaction to occur.

For red oil, the fuel is a tributyl phosphate and associated degradation products; dibutyl phosphate, monobutyl phosphate, the butanols and/or butyl nitrate, maybe even butene as well as any metal adducts that may be present.

Each constituent has its own reaction initiation temperature. Consequently, it's important then to have a known starting point to understand how much heat can be liberated and to what rate.

The applicant has committed to identifying and limiting the initiation temperature and possible energy generation through the conduct of confirmatory experiments and implementation of appropriate process controls.

Nitric acid is an expected constituent of the process, often in high concentrations. For analysis purposes, the applicant has assumed that the organic phase is saturated with nitric acid, which is a conservative bounding assumption.

With the first two legs of the reaction triangle in place, we come to the third bullet, the reactions initiation temperature, which has been determined generally accepted to be about 137 degrees C.

For the reaction to take place the applicant has pointed out that the tributyl phosphate and associated degradation products must reach this temperature. The applicant is proposing to ensure adequate evaporative cooling to prevent this from occurring. This approach provides a certain level of independence from the external heat sources such as the evaporator steam supply system.

The applicant's overall strategy is to ensure that heat removal rate is greater than the heat generation rate. To be successful, one must know the reaction constituents, understand the reaction rates and the initial conditions.

The first PSSC that the applicant has chosen is the Chemical Safety System. The diluent is to be selected based on properties that limits it vulnerability to get degradation through both chemical and radiation exposures prevalent in the process. Diluent properties related to foaming are also considered to limit the possible events on the gas treatment systems venting function, which is vital for evaporative cooling.

The second PSSC is the Process Safety Control Subsystem. There are two main features:

First, the residence time limits on organics in process vessels containing oxidizing agents and potentially exposed to high temperatures and in radiation fields.

The second is to ensure that the temperature of the solutions containing the organic is restricted to temperatures within safety limits to control the energy generation rate. Again, this is classical heat balance.

The third PSSC is the Offgas Treatment System. Again, there are two major functions.

First, it provides an exhaust path for the aqueous evaporative cooling. As the applicant has indicated, the design basis value will be determined through experiments.

Secondly, for closed systems, venting is provided to provide adequate heat removal. The vent size will accommodate enough mass transfer to prevent initiation of the runaway reaction. However, it may not be large enough to fully relieve the energy and pressure generated by a full scale runaway reaction. So the applicant is taking a purely preventative approach for a limited number of components, mainly their evaporators.

DR. FORD: Excuse me.

MR. TROSKOSKI: Yes, sir.

DR. FORD: The safety structure is really the balance between the heat removal rate and the heat generation rate.

MR. TROSKOSKI: Correct.

DR. FORD: Which means, I suppose, that as

I understand from the previous speaker, it's going to take a long, long time to create the various tentacles involved in this exothermic reaction.

MR. TROSKOSKI: It may, we have to look at that.

DR. FORD: And then, presumably, the accident is going to take off at a fairly rapid rate?

MR. TROSKOSKI: Oh, yes, I would expect a reaction once initiated to go very rapidly.

DR. FORD: So what will the system monitoring process be to tell you when you're about to start to go onto this rapid --

MR. TROSKOSKI: I don't think you can do that. I don't think you can really tell when it's going to go off on you. That's why you need a margin. And safety factors are to keep you from it.

DR. FORD: So you've got no way of monitoring the system?

MR. TROSKOSKI: What way?

DR. FORD: I have no idea what the monitoring would be, but I mean --

MR. TROSKOSKI: What you're doing is you're going to limit the constituents. You're going to limit the temperature and you're going to make sure that the material that you have, say, in your evaporator, that you're pulling off enough through evaporative cooling that you'll never reach the self heating portion, which is where the reaction take off. And what the applicant has proposed do was give us a safety factor of about 1.2 times the energy input plus the energy generation, being able to pull that off through evaporative cooling.

DR. FORD: So the monitoring is the temperature? You're going to monitor the temperature continuously.

MR. TROSKOSKI: You're going to be monitoring a lot of stuff.

DR. FORD: Well, that was my question. What are the things you're going to be monitoring?

MR. TROSKOSKI: For one thing, yes, you're going to be monitoring temperature. But, remember, you also have to know where you're starting at, and where you're starting at means what are the constituents in the degraded products that you have built up. So that's just another interrelated link in this whole.

You've got to define the diluent so it doesn't take part in this. You have to define what the effect of the radiolysis was going to be, what the effect of the other degraded products and metal adducts that may be present. And you define that, then you know what your starting point is.

Then as this stuff is being evaporated off, you've got a steam supply, an external heat source to it. You're pulling off water, nitric acid that's evaporating there. And the rate that you're pulling it off has to have a significant margin so that you never reach the self-initiation temperature.

DR. FORD: As far as the NRC is concerned--

MR. TROSKOSKI: Yes. Now that --

DR. FORD: The NRC will be satisfying themselves that there's enough system controlling -- monitoring temperature, whatever you're going to monitor.

MR. TROSKOSKI: We will be getting to that in a minute.

DR. FORD: Okay.

MR. TROSKOSKI: But, yes, there is a lot of staff discussion on what the margins are going to be, where they're at, how you're going to ensure that the reaction is going to be highly unlikely, defense-in-depth.

DR. FORD: Okay.

MR. TROSKOSKI: All that's to be considered.

MR. ROSEN: You know, so far what you've told us is sort of a -- you talk about bulk parameter monitoring and --

MR. TROSKOSKI: Yes.

DR. FORD: -- bulk parameter strategies. And yet this system is comprised of pumps and pipes, and valves. What can you say about, to give us assurance, that local conditions can't vary so much that you can get into trouble locally even though the bulk conditions are okay?

MR. TROSKOSKI: A very good question.

Right now I cannot give you the assurance on a component-by-component basis, because that step won't be done until you do your ISA Process Hazard Analysis. That's where you get into the nitty gritty on a component-by-component and how the components relate to each other upstream and downstream. That's a systematic approach where you ask what happens if this variable goes outside of certain limits. And that's part of the final design approach, the ISA approach that the application is still to do.

MR. ROSEN: Vents and drains, and places like that where you could --

MR. TROSKOSKI: External heat sources, anything you can think of, yes.

MR. ROSEN: Were you could conditions locally which could get you in trouble?

MR. TROSKOSKI: Oh, yes.

MR. ROSEN: Even though on a broad thing, the goes-into minus the goes-out-ofs is okay.

MR. TROSKOSKI: Yes. What you have to do is you have to protect all of your assumptions, all the initial conditions in your heat transfer calculations from --

MR. ROSEN: So from a chemical engineering standpoint, you're going to draw one big black box around this and make sure the arrows are going in the right direction, and you're okay? Then you're going to draw increasingly smaller boxes around --

MR. TROSKOSKI: And see how they interconnect.

MR. ROSEN: -- each component and see how they interconnect and do the same kind of mass and heat balances around each component?

MR. TROSKOSKI: Absolutely. Absolutely.

MR. SIEBER: I think that's also contained in the staff's comments, which are in the SER, the fact that actually have to do that component-by-component. That's the way I read the SER.

MR. TROSKOSKI: And actually from a

chemical processing point for any system, that's what should be done if you have to do a Process Hazard Analysis if you're dealing with highly hazardous materials or a process. And in the chemical process industry, that is the practice that they do. So there's nothing new or unusual about this, this is a tried and proven methodology.

MR. PERSINKO: As I said in the opening remarks, for construction we're worried about the design basis of the principle structure systems and components. And at this stage the applicant has chosen to define the PSSCs mostly on the system's basis.

MR. TROSKOSKI: So we still have to get down into it. And we get the second bite of the apple at the licensing phase.

Okay. I've already discussed briefly the vent size. It's going to be sized to accommodate the mass transfer to prevent the initiation of the runaway reaction.

Let me see, next one I'd like to go to is Industry Events.

Now, there have been a number of red oil events in the nuclear industry. Three of the known events are just shown for reference. The Hanford was very similar to the Savannah River one in 1953.

A review of those events really surfaced two strong themes. One was the unexpected presence of tributyl phosphate and/or the degraded products, which often accumulated over an extended period of time. And the second one is either a lack of or an inadequate Process Hazard Evaluation.

While the applicant's proposed safety strategy and PSSCs appeared to address the various known initiation conditions, they have still to perform their ISA, which will be needed to support the licensing phase of the process.

The staff does note that DOE has previously reviewed the red oil events and has developed a number of recommendations that we have found in published accounts and various documents.

DOE has also established a fine safety record at various facilities involved in plutonium separation and processing. We know the applicant is aware of the DOE actions and many of the applicant's proposed safety features envelope the DOE's recommendations, but not all of them. The applicant has determined that some do not apply to their process which they developed from the French. And specifically, DCS is not limiting the evaporator steam temperature to 120 degrees, but is proposing about 133 or 135 degrees. While the question of margin can be raised regarding the 137 degree accepted initiation temperature, again as long as they are able maintain heat removal rate and keep it greater than the heat generation rate with the safety margin that they're committing to, the tributyl phosphate and associated degradation products cannot reach the initiation temperature.

The applicant has already indicated that they will be performing a number of conformity measurements to verify or determine the key safety characteristics of several process variables. These experiments, generally identified by the four bullets I've got up there, will define the heat generation rate and the heat removal capabilities. I've already conducted a number of experiments relating to venting size and I believe still have some to go.

The staff is determining whether the design basis of the proposed PSSCs provides reasonable assurance against the consequence of potential accidents. While the applicant's proposed approach does not exactly match the current published DOE approach, the applicant has provided a rational basis for their specific process to be supported by laboratory experiments and the safe operating history of a very similar process in France. The issue remains open to any resolution of the applicant's approach to achieving highly unlikely, identifying values and ranges of values for certain safety functions as the degraded product concentration limits and related safety margins.

The staff is reviewing additional clarifications of the design approach recently provided by the applicant. The staff review will also consider whether the proposed approach can support the defense-in-depth requirements of 70.64, which will be finalized in the ISA process.

The staff also acknowledges that additional changes to the PSSCs and the design values may occur at the ISA stage. This possibility is expected and it's recognized in the Standard Review Plan.

That would conclude the formal part of my presentation. If there are any questions, I don't understand why you were holding back this long --

CHAIRMAN POWERS: Let me just interject. This is Bill's first meeting in front of the ACRS. He's learning quick, isn't he?

DR. FORD: I know we have joked about materials and we are entering the construction authorization phase, my interactions with the chemical process industry, materials are kind of an Achilles' heel, the theory of materials. Has anyone in this process looked at the integrity of the proposed structural materials?

MR. TROSKOSKI: Process --

DR. FORD: Ten molars salt and placing acid with chloride is not a nice environment.

MR. TROSKOSKI: I recognize that. Before this I had another job, I was an inspector for the fuel cycle group, so I've got to go to all of our fuel cycle facilities, including some that handle hydrogen fluoride and a few other really nasty chemicals. And I can appreciate where you're coming from on this.

The short answer is from a regulatory point of view, we have not yet. The licensee is -- their mechanical integrity program is to ensure, I think, gross integrity. They're not that concerned with small leaks. They're assuming that they're going to occur and they're going to deal with it as part of normal operating conditions, very similar to what other facilities do.

DR. FORD: Well, I'm thinking more in case -- in one of your things here you say the rapid evolution of heat and non-condensible gases can breach the process equipment. So I'm looking at an accident situation.

MR. TROSKOSKI: Sure. That would be where you would have a pressurized vessel. And, again, I believe the two main evaporators of concern here, they are going to be atmospheric.

MR. MURRAY: If I could just interject a little bit. I'm Alex Murray, Bill and I work together on the chem safety issues.

In the case of materials of construction, the applicant has stated, just in a descriptive manner, that they will compatible materials such as 300 L-grade stainless steels. They do have material surveillance programs which they have identified as PSSCs. These will include the monitoring both on a longer term point of view, such as with corrosion 2 in testing, and also as part of a periodic inspection program. So they will have that in place.

DR. FORD: And is there experience in Europe or anywhere else of L-grade stainless steel in these environment?

MR. MURRAY: 300 L-grade stainless steel is typically used for these types of evaporators. There can be some pitting phenomena which has been observed, but generally if it is an L-grade and if there's appropriate heat treatments are done after welding to avoid hazardous and so on, it's generally acceptable.

DR. LEVENSON: They generally been used for solvent extraction type things since the first solvent extraction plant was built in 1945.

CHAIRMAN POWERS: '44. There's been quite a lot of work with this, which basically a glorified PUREX process. Yes.

MR. ROSEN: Notwithstanding all that, is there typically an in-service inspection like program to check the key components in service?

MR. MURRAY: That is what they are planning, and they have it identified as a principle structure system and component.

CHAIRMAN POWERS: Okay.

MR. SIEBER: It seems to me that since most of this operates at very low pressures, that you don't have the hazards of ruptures, but you might have the hazards of pitting, cracks, small leaks and so forth which are within the realm of an operator being able to handle.

MR. TROSKOSKI: Right. And that's what the applicant has indicate they expect.

DR. FORD: Well, I'm thinking in terms of

-- if you had some intergranular attack, not cracking, attack.

MR. TROSKOSKI: Okay.

DR. FORD: And then you had an exposure, the line, would it still be all right.

MR. SIEBER: I think that it wouldn't make any difference if you have an explosion in the line and the line could be -- have perfect structural integrity and still rupture.

MR. TROSKOSKI: Once you've got the event.

MR. SIEBER: Once the event occurs, you know, settles that sort of. You aren't trying to contain the explosion, is that not true? You're not trying to prevent it?

MR. TROSKOSKI: No, what we're trying to-- the applicant it taking a preventive approach, they're not taking a mitigative approach. So they're not designing pressure vessels for an explosion. They have not proposed that to us at all. Although, i they would like to, we'd certainly listen to them.

DR. LEVENSON: The evaporators which are maybe the most questionable things are not pressurized vessels. They're atmospheric. So any reasonable rate of increase pressure can't overpressurize --

MR. TROSKOSKI: Right. And --

DR. LEVENSON: It might splash some liquid out, but with very limited consequences.

MR. TROSKOSKI: And, again, pressure also plays a part in the reaction rate, too. So that's why you've got to be very careful to prevent -- to protect the venting so that you don't have a back pressure should a reaction occur.

MR. SIEBER: All right. I have an additional question, which probably will reveal that I don't fully understand the temperature phenomenon. But I got the feeling that if you let this solvent sit long enough with enough nitric acid in it, that that temperature or the rapid exothermic reaction is really not fixed, that it could be lower than that. And you can get that reaction with a temperature less than 130.

MR. TROSKOSKI: Well, the initiation temperature was the function of a number of things. Your constituents.

MR. SIEBER: Right.

MR. TROSKOSKI: Pressure, concentrations. I mean, that's all classical reaction kinetics.

MR. SIEBER: That's right. So when you set a hard and fast number and say I'm not going to let this get any hotter than this amount --

MR. TROSKOSKI: That's based on a number of assumptions further down the line that you have to protect for that to be valid.

MR. SIEBER: Yes. Well, maybe it would be good if you told us what are the things are you controlling to make that number valid?

MR. TROSKOSKI: Okay.

MR. SIEBER: And how are they doing it?

MR. TROSKOSKI: Sure. That was one of the slides I think Mark had up earlier.

You're controlling the diluent, and that's important for two different things. One, so it doesn't impact the venting capability, and two so it doesn't add degraded products to the process.

Second, they're going to be controlling the resonance time of the tributyl phosphate, and what they're doing there is in effect controlling the concentration of the reaction products and constituents that you have built up over a period of time to within that assumed in the bounding heat analysis calculations.

Once you define that, how much mass you've got, what the constituents are, what your temperature is, then you pretty much have it enveloped where you start off and where it can end up.

MR. SIEBER: Okay. That's the box you have to build?

MR. TROSKOSKI: That the box. And around that box what they're doing is they're going to say, ultimately I'm going to be able to remove 20 percent easy, more heat than I could possibly generate either through the reaction or through the external sources.

MR. ROSEN: And what you said earlier is that sort of rational is going to be applied globally and then locally?

MR. TROSKOSKI: Yes. Well, you have to component-by-component. That's the only way you can do a valid HAZOP. You can't do one HAZOP for the entire aqueous polishing system. You have to do by logical component-by-component. And that methodology is well known and practiced very widely throughout the chemical process industry. There are many books on it. There are companies that make their bread and butter giving training courses on it.

You can read it in a lot of the OSHA related process safety management literature.

Now, do you still feel uncomfortable about something.

MR. ROSEN: No.

MR. TROSKOSKI: Oh, okay. I'm not sure

whether I was --

MR. ROSEN: I'll let you know.

MR. TROSKOSKI: Don't be shy.

CHAIRMAN POWERS: It's a real problem with this committee, shyness, so I'm glad that you encourage them.

MR. TROSKOSKI: Yes.

DR. KRESS: We've been given some indications of the possible chemical reactions to produce heat. We're going to balance this heat with the rate of evaporation. What sort of equation are they using to determine the rate of evaporation?

MR. TROSKOSKI: They have not provided that to us yet.

DR. KRESS: Oh. They just said that will be the -- okay.

MR. TROSKOSKI: Yes.

CHAIRMAN POWERS: Any other questions?

DR. LEVENSON: Just an order of magnitude, what's the heat capacity, for instance, of the evaporator when it's full of liquid compared to the amount of energy we're talking about here?

MR. TROSKOSKI: Well, Mark, can you help me out on that one, since your evaporator?

MR. KLASKY: Well, the solubility, I think we mentioned earlier. Solubility of the aqueous solution in the organic, get about 2 molar or 2½ molar. So ultimately that for a given fixed quantity of organic, that's your cooling capacity. In addition you have nitric acid, which is also going to participate in the evaporative process.

DR. LEVENSON: I'm not asking about the evaporative process. I want to know the heat capacity of the total system evaporator plus its load of liquid if you have an incident.

MR. SIEBER: You may have enough heat sink to take a significant part of that.

CHAIRMAN POWERS: Milt, that presumes you can rapid heat transfer to the bulk of the apparatus, and it's just not going to happen.

DR. LEVENSON: Well, it's going to transfer to the liquid. It's in the liquid. It's going to be instantaneous transfer to the liquid.

CHAIRMAN POWERS: But the steel is not going to observe an instant --

DR. LEVENSON: The liquid is probably the bulk of it.

CHAIRMAN POWERS: Well, then it's just a liquid heat capacity, it's not the whole apparatus.

MR. KLASKY: I think one thing that will

clarify, I think what we're really talking about in the way of heat transfer is really at the evaporative point it's providing the real removal -- the conductivity or the thermal conduction under certain situations if you're talking about --

DR. LEVENSON: Yes, I understand that. I just -- to get a feel for the significance of it, to get some kind of feel for how fast the temperature might spike or something, I need to know the heat capacity of all of the liquid in there versus the --

MR. TROSKOSKI: You're asking how sensitive the system is.

DR. LEVENSON: Yes.

MR. KLASKY: I think we gave you an energy content. You get about 400 joules per gram of tributyl phosphate. And we have an evaporator that's about 50 liters. And we'll assume tributyl phosphate, equivalent of water capacity. Does that help in terms of characterize the thermal mass that we have?

DR. LEVENSON: Well, the answer that you've given is that you haven't considered this issue.

MR. KLASKY: I think what we've considered is that evaporative cooling in the heat transfer, not the conduction.

DR. LEVENSON: Yes, yes, I know. But if you tell me that the energy you release is going to spike the bulk temperature up 20 degrees, then your evaporator rate goes way up also.

MR. KLASKY: Correct.

DR. LEVENSON: But if you haven't done that analysis, then you just haven't taken the --

MR. KLASKY: I think we have spoken to the means by which we were going to provide heat transfer, not having done a formal count.

CHAIRMAN POWERS: Any other questions.

We've got to get on to not Han Solo, HAN nitric acid, right?

MR. KLASKY: HAN nitric acid. Yes.

CHAIRMAN POWERS: Mark, you start us on this? And this one's not so mysterious, this one's easy, right?

MR. KLASKY: Yes. Hydroxylamine nitrate reacting with nitric acid.

Okay. Briefly we'll outline our approach to safety and then get into some of the reactions that are possible in a system that is comprised of hydroxylamine, plutonium and nitric acid. And finally we'll speak on the hydrazine that also accompanies the hydroxylamine, and finally discuss our safety strategy.

I think our approach is precisely the same as that we described for red oil. Again, we're focusing on really understanding the fundamental chemical reactions that are taking place, their kinetic rates and the thermodynamic that accompanies those kinetics or chemical reactions.

Again, we've incorporated the pertinent or salient features of the DOE lessons learned. And, again, we envision testing to be performed during the integrated safety analysis or next phase of our safety analysis.

CHAIRMAN POWERS: Well, you're going to have done an heroic amount of work by the time you're done doing that, an exhaustive review of the literature of hydroxylamine nitrate. You have given any thought to putting it together, publishing it and get some peer review on it.

MR. KLASKY: I think that's precisely with respect to both red oil and hydroxylamine nitrate, I think we have, you know, a number of papers in all this work, so review papers and also the experimental results and the models that we build to, you know, in essence explain more data into something that is then used to, in essence, predict the behavior of the material in our system. So, yes, we certainly do.

I want to put some things into perspective here where hydroxylamine nitrate is used. It's used precisely in one part of the process, that is the purification unit. And to insure that it does not, in essence, move into other areas we have sampling that we perform to insure, for example, that it doesn't move into the oxalic precipitation unit and also down into the acid recovery unit as well. So we're very much aware of restricting the location of hydroxylamine, and this is something that we've committed to in terms of providing for safety, to really limit its propagation through the system. And I want to go into more detail in terms of precisely where with even the purification unit that we have hydroxylamine. It's a very simplified flow sheet, if you will, on hydroxylamine nitrate.

I think that's missing from the figure, I'll just point out that plutonium nitrate in the valent state 4 enters the extraction column. The first box. I've lost my pointer.

At that point what we're doing is removing the plutonium from all the actinides, so the uranium will accompany the plutonium in the extraction columns.

Then we have a scrub, a moving left to right, following the plutonium itself. We scrub the organic solution further removing any impurities it might have either through entrainment or just their distribution into the organic phase, we remove those impurities with a nitric acid scrub.

And finally we talk about where we actually introduce hydroxylamine nitrate in the hydrazine. That's the plutonium stripping column. And there what we're doing is we're using hydroxylamine nitrate to reduce the balance state of the plutonium and move the plutonium from the organic phase into the aqueous phase.

The uranium is subsequently moved downstream and we treat the -- we actually remove uranium in a separate unit. We have diluent wash. What that does, is we have entrained material or tributyl phosphate that's soluble in the organic phase and we can preferentially put the TBP into the organic phase and so further reduce the propagation of tributyl phosphate into the accompanying units.

CHAIRMAN POWERS: Before you do the strip, that's a bounded vessel?

MR. KLASKY: During pulse columns -- actually we have a plus column and we have a mixer settler. The answer is yes.

CHAIRMAN POWERS: Do you get accumulation of ammonium nitrate in the vent?

MR. KLASKY: Not to my knowledge. Maybe when we move into the reactions that characterize the system we can talk about it. But I don't know of any accumulation of ammonium nitrate.

CHAIRMAN POWERS: It's always been a concern.

MR. KLASKY: Okay. I just want to point one more thing out. This is a once through system; that is the hydroxylamine that we use moves through the plutonium stripping, diluent wash and then we destroy it in the oxidation column. So we're not talking about continual degradation of HAN or anything of the sort. It's a once through system and in the oxidation column, that's where we change back the plutonium from 3 to 4 to facilitate its precipitation in the subsequent unit.

Now I want to talk about some properties of hydroxylamine. And the first point is that it's only soluble in the aqueous phase. And, as I described, it's used to extract the plutonium or separate plutonium from uranium. It's a very good reducer in that capacity. So, then on the other hand, we have the possibility of reactions with both nitric acid and itrous acid, and we describe some of the kinetics associated with those reactions.

There are two possible -- depending upon the ratio of plutonium to hydroxylamine nitrate, so in fact you see the reduction of plutonium and the accompanying acidification of the medium as well.

CHAIRMAN POWERS: The reduction by adding the nitrate to the ammonium -- to the hydroxylamine or other way around.

MR. KLASKY: The reagents here are hydroxylamine nitrate, which is formed in the reagent building and then it's sampled, brought in. We introduce it in two streams into the process, one into the pulse column one in the subsequent mixer/settler that is our plutonium barrier. So we form hydroxylamine nitrate in our reagent building and that is basically -- we purchase hydroxylamine nitrate, we actually dilute it to the required specifications in the process.

Now we get to the real meat of the issue here, why we're here. Hydroxylamine nitrate and the possible other catalytic reaction. The previous slide was really just basic plutonium reduction, which has been done for 50 years. I mean, that's precisely how this material that we are receiving was produced, by reduction. Not necessarily with hydroxylamine or other older techniques. We've chosen hydroxylamine to reduce the waste, because as I pointed out, we destroy it in the oxidation column whereas some of the other reducers that were used basically have lead to an accumulation of liquid waste. The ferrous sulfamate, for example.

So anyway, these are the two reactions that we have to concern ourselves with. The first of the possible autocatalytic reaction, that is we're producing three moles of nitrous acid each nitrate, and we have a scavenging reaction. HAN actually scavenges nitrous acid as well. So, again, this is a balancing act between production of nitrous acid and consumption of nitrous acid.

So, in order to understand this balance between these two reactions, we could develop a equation. And what we have here basically a reaction scheme that is -- or a mechanism that has been investigation for probably the last 40 years. Most of the work actually has been done, part of BNFL's work. What they basically determined is that the mechanism proceeds through the production of dinitrogen tetroxide. And under most conditions the equilibrium lies to the left. And the key to understanding this is to understand the rate at which dinitrogen tetroxide is produced.

Dinitrogen tetroxide reacts with HAN to produce dinitrogen trioxide and that also can react, actually water, to produce nitrous acid or the dinitrogen tetroxide can react with the nitroxyl to produce dinitrogen trioxide. The stoich geometry is basically given by the last reaction, which is a repeat of the previous slide just summing components, balancing.

MR. VIAL: Just something to add. We're going to show you some constant, kinetic constant layer that are referring to the first -- the two first reaction. Index 1 is going to be in reference to the first reaction and the second one, index 2, will refer to the second reaction, which has a two limiting step in the mechanism.

MR. KLASKY: The third and fourth reactions are very fast. You can -- that governs the behavior of this system. We spoke about these scavenging properties of the hydroxylamine. Here we're using hydroxylamine ion, which is just the ionized HAN. And as Mark referred to, we have reaction constants k1, which is the rate at which dinitrogen tetroxide is produced. K-1, which is the back reaction. K-2 which is the reaction between HAN or hydroxylamine ion and the dinitrogen tetroxide. And k-3, which is the scavenging late constant.

CHAIRMAN POWERS: I don't understand why you put a stay state approximation on the HNO and N_2O_3. I can understand why you take the rate of change of the concentrations of the HNO and the N_2O_3 is zero. I don't understand why you can set the rate of change in the concentration in the N_2O_4 to zero.

MR. KLASKY: We are not doing that. Are you referring to the third reaction, the dinitrogen tetroxide with the nitroxyl?

CHAIRMAN POWERS: I'm referring to you're deriving it by applying the steady state approximation to the species. Now, to me that means that you're saving the rate of change of that concentrations to zero in order to drive this whole overall rate constant. Because you're arguing that thy are low concentration intermediates in the reactions.

MR. KLASKY: Yes.

CHAIRMAN POWERS: And that's perfectly understandable for the HNO and the N_2O_3. I'm not sure I understand why it's justified for the N_2O_4.

MR. KLASKY: Reaction 1 we're not taking

the steady state. We're deriving the rate law for the first reaction. We're taking the steady state -- we're making the steady state approximation for reactions 2 and 3, as you indicated.

CHAIRMAN POWERS: Why do you list N_2O_4 in your slide as being part of the steady state here?

MR. VIAL: Well, actually we use a steady state approximation for reaction 2 as well.

CHAIRMAN POWERS: Put your next slide.

MR. VIAL: Yes. This one.

CHAIRMAN POWERS: See, you say we take the steady state approximation 2, N_2O_4, HNO and N_2O_3. And the last two I can understand why you do that. It's not clear to me why you make that approximation on N_2O_4. Now you're saying you misprinted on the slide?

MR. VIAL: No, no, no. It's --

MR. KLASKY: I think he's referring to the third -- it's the third reaction. It shouldn't be the second reaction where that approximation is made.

CHAIRMAN POWERS: I will bet that in fact when you went through -- that you still set the N_2O_4, the time rate of change of the N_2O_4 concentration to zero. But I don't know.

MR. KLASKY: No. My recollection is that the reaction two HAN and N_2O_4 is not -- we do not make that approximation. But we can get back to you on that.

CHAIRMAN POWERS: I'm just reading what you said on your slide.

MR. KLASKY: Right. And I think it's taken out of context. N_2O_4 reaction with the nitroxyl is where we made that approximation. And that's the only place where we made it with respect to N_2O_4.

CHAIRMAN POWERS: You had to do something with the N_2O_3 as well.

MR. KLASKY: The N_2O_3 is definitely a fast reaction, either between --

MR. VIAL: But I think N_2O_4 refer to this reaction.

MR. KLASKY: Yes. We'll check that.

CHAIRMAN POWERS: I mean, I'm just reading what your words are.

MR. KLASKY: So the question is why are we interested in this reaction. Well, I think as we have shown in the previous slide, it's autocatalytic and also it's releasing a substantial amount of energy accompanying the autocatalytic reaction. So it's important to prevent this runaway reaction in our process. So, consequently, what we're going to do is to try to understand our system and understand those rate constants to predict stability. But before we do that, we introduce one more detail, and that is we're reducing plutonium to valent state III. There's always potential under certain regimes for plutonium to reoxidize. And in so doing, the re-oxidation of plutonium basically proceeds much in the same manner as the mechanism by which we produce autocatalytically nitrous acid, that is we go through a dinitrogen tetroxide mechanism. So another aspect of this problem is to prevent re-oxidation of plutonium, because it's another source for producing nitrous acid.

CHAIRMAN POWERS: Is it true that only the dimmers has reacted toward the trivalent?

MR. KLASKY: I don't know the answer to that question.

MR. VIAL: I don't know --

CHAIRMAN POWERS: Well, I mean that's the way you've written it. You've written it as though --

MR. KLASKY: But I -- you know --

CHAIRMAN POWERS: The monomer is nonreactive and --

MR. VIAL: Yes.

CHAIRMAN POWERS: And assuredly the --

MR. VIAL: If you combine and it's through the N_2O_4, yes.

MR. KLASKY: I mean, this is one postulated reaction mechanism.

MR. TRIPP: The fact is in the literature you're going to see that some people like this equation instead of considering dinitrogen tetroxide. They're going to consider the nitrous acid. But it's not the reactive species that's going to react. The reactive species in -- is N_2O_4 because you have the equilibrium where you have -- this equilibrium is really to the right. So the species you have in solution is mainly N_2O_4. And what you're going to have is, you're going to have this exchange of electron. You're going to have your two nitrogen is your 4 oxygen and -- and you're going to have a kind of -- where you going to reduce -- where you're going to oxidize your plutonium by transferring an electron and thus removing one molecule of NO_2 out of your N_2O_4. That's why you are producing these two species.

CHAIRMAN POWERS: Going to take an inner sphere transfer?

MR. VIAL: Well, I think what you're going to have is you won't have a 1, 2, 1. What you're going to have is you're going to have your plutonium and you might have 2 and 2 and 4 on each side in a kind of assembly like this where you're going to -- and you're going to have the exchange. That's what's going to justify the formation of -- because you're going to have one that's going to catch more electron than the other one. This one is more stable species. And you're going to have your negative charge because of -- in your system you won't have a strictly one to one ratio of plutonium over N_2O_4. So depending ont he arrangement of the molecule between themselves, you're going to produce these -- well, one ionic species and the other one, which is just NO_2. That's going to going recombine very quick with another NO_2. Because they are really close together. You have a really fast reaction of -- not dimerization, but formation of N_2O_4 that this will happen. And that's why over all you're going to start -- what you have to consider is not one cycle, it's two cycle and every -- well, actually, three cycle every -- three cycles which you're going producing -- you're going to produce 1.5 molecule of nitrous acid. That's why this reaction is also autocatalytic. Because it's going to produce more nitrous component that you use.

You follow me? No, maybe not.

CHAIRMAN POWERS: Yes. It just seems to me that I would have run an inner sphere reaction on it.

Because then I don't have to substitute in on the plutonium, which will give you flow step in the process that you haven't built here. I mean an inner sphere reaction seems to me -- okay.

I mean, I -- I just don't know this chemistry, so I can't tell you what the kinetics is. But I wouldn't have guessed that it was only --

MR. VIAL: Well, the other component to take into account is the media. And depending on the acidity of the association coefficient -- and it's going to also drive the prediction of your NO two minus.

MR. KLASKY: Okay. I think that's the important thing. Remember this reduction reaction is we're really maintaining low acidity. And, Mark, we have a backup slide. Let me go to the written law for plutonium reduction.

And the reason is that we have a dependency to develop a written law for plutonium reduction which is dependent on -- or inversely proportional to the fourth power of acidity. So we basically want to operate, you know, as low as possible but we have other constraints as well on the process.

CHAIRMAN POWERS: Are we going to discuss plutonium hydroxide precipitation in this?

MR. KLASKY: We weren't planning to today. You're talking polymerization as well. Polymerization is something that we can talk about.

CHAIRMAN POWERS: Go ahead.

MR. KLASKY: Okay. So basically with respect to the control of hydroxylamine nitrate, the DOE has developed an empirical relationship, an instability index.

And, Mark, you throw back the weight law you can see that the weight law -- no. Throw the nitrous acid back.

Basically you have a competition. You want to insure that the k3 term is larger than the first term. And in so doing then, you have a decaying solution of nitrous acid.

So the bottom line is that, you know, if you want a strong nitrous acid scavenging agent. If you can -- now and to a certain extent if your concentration of hydroxylamine nitrate is large enough, hydroxylamine nitrate can hold the plutonium or, in this case, prevent the autocatalytic reaction in so doing. But when you do this, you have to be very careful in terms of temperature. Nitric acid constraints. Because those constants, k1, k minus 1 and k2 and k3 are very dependent on temperature and also nitric acid concentration, also ionic strength of--

CHAIRMAN POWERS: I hope the k3 -- I mean, k1 and k2 are not concentration.

MR. KLASKY: Of nitric acid?

CHAIRMAN POWERS: Yes.

MR. KLASKY: Well, k1 is the production of dinitrogen tetroxide and it actually is very dependent on nitric acid concentration.

CHAIRMAN POWERS: IF they were rate constants, they better not be dependent on concentrations or we're going to rework this whole thing.

MR. VIAL: Exactly. And that's why you have the term -- and not the minus. That's where you have HNO_3. Okay. One is mainly dependent on the temperature.

MR. KLASKY: Okay. I stand corrected.

Let's see. So k3 is the scavenging properties of the hydroxylamine nitrate. And the instability index that DOE had developed is built on control of both temperature, concentration nitric acid and the hydroxylamine concentration.

MR. VIAL: Want to show it?

MR. KLASKY: No, that's okay.

But I think what we've recognized in that we use hydrogen in our process to basically hold the plutonium to make sure that we don't have re-oxidization of the plutonium. And we can also use hydrazine to demonstrate that the production of dinitrogen tetroxide is basically -- we're interfering with the mechanism. That is, we're scavenging the nitrous acid. So in so doing we basically prevent the autocatalytic reaction from occurring.

So the next slide depicts relative reaction rates for hydrazine to show you just how effective hydrazine in scavenging nitrous acid from the system. And this is precisely what we want to utilize to insure that we don't have an autocatalytic reaction, that is by ensuring that we have a concentration of hydrazine present that is sufficient to balance the production that is going through the production of dinitrogen tetroxide, we can assure that we don't enter an autocatalytic regime.

So the equation that we presented the rate law, obviously, would be modified to add an additional term, and that is the scavenging of nitrous acid via hydrazine.

And this is, in effect, what we've

describe in the Construction Authorization Request. We've identified the fact that hydrazine has this property of being a very effective nitrous acid scavenging agent and so this is an open item with the NRC, but we intend to demonstrate a de minimis quantity of hydrazine is effective in precluding the autocatalytic reaction. And currently we've identified concentration of HAN and hydrazine along with constant safety control as providing for a stable boundary.

CHAIRMAN POWERS: You used the work "de minimis."

MR. KLASKY: Yes.

CHAIRMAN POWERS: Which has long ago been forbidden from this room by act of Congress. Some people know the story, so I won't go into it.

I assume you were just being colloquial in your use of de minimis?

MR. KLASKY: Yes, yes, yes.

MR. ROSEN: It means "a little bit of."

MR. KLASKY: I think, you know, the relative rates -- I guess if you start of with the -- you know, understanding that you can demonstrate and DOE has established an instability index. And we've pointed out, and Bill, I think you'll go into the rational for why we're not using it. And I can -- I don't want to step on Bill's toes, but we can go into that if you want.

CHAIRMAN POWERS: No. I mean just the language you used, what you're talking about is that you're going to use a low concentration of hydrazine in the solution.

MR. KLASKY: Correct.

CHAIRMAN POWERS: So that you're going to bring those rates so they're roughly equal or what is it?

MR. KLASKY: No. I think we're going to be just order of magnitude estimate. You know, we said we were going to do testing, and this is certainly one of the areas in which we're going to do testing.

There have been two studies to my knowledge that have attempted to quantify this de minimis concentration, if you will. And they found about five times to the minus four of molar or normal to be sufficient.

We're starting with .14. So that just puts things in perspective. That's why I say die minimis. I just meant it with respect to what we're adding.

CHAIRMAN POWERS: In my world those are highly concentrated solutions.

MR. KLASKY: Yes. So, I think we're

certainly operating this plant with a pretty sufficient, or I should say a sufficient margin. But this is something that we're going to validate in the ISA.

CHAIRMAN POWERS: Okay.

DR. FORD: Could I follow up on Mr. Rosen's question later on about controlled by monitoring either globally or locally?

What this is sensitivity of this control to where you do the monitoring?

MR. KLASKY: Right now what we do is we monitor -- or I should say we sample to ensure that the quantity of hydrazone that we have is, you know, the requisite amount going into the process. And I think I've described the fact that it's a once through system so that, you know, each step through once it hits the oxidation column it's destroyed. If isn't destroyed right there, before it goes into the next process unit -- or I should say process operation, we sample, we ensure that it's gone. That is, hydrazine is removed and also hydroxylamine as well.

So, the sampling is coming in and going out. That's where we're implementing these controls.

I think that's it.

DR. RYAN: Mr. Chairman. I think this is

our last chemistry presentation. And before we leave, I've been --

CHAIRMAN POWERS: Don't count on it.

DR. RYAN: On the agenda, anyway.

CHAIRMAN POWERS: We have at least one more.

DR. RYAN: Okay. That's great.

The thought strikes me have you tried to optimize any of these processes with regard to your waste generation? It looks like you're going to generate lots of mixed waste, and I'm not sure if it's mixed TRU or mixed SNM, or mixed spent fuel, or all three. But in your process analysis, particularly your hazard analysis, looking at waste generation might not be a bad thing. You might end up producing less troublesome waste if you took a look at that end point in order to help you figure out your chemistry.

Have you done that sort of thing yet?

MR. KLASKY: I think the adoption of hydrazine and hydrogen is precisely done for that reason.

DR. RYAN: What reason is that? What is the -- it's to minimize quantity or --

MR. KLASKY: To minimize quantity of waste, yes.

DR. RYAN: Okay.

MR. KLASKY: Before, as I pointed out, the ferrous sulfamate used to be used and there were a lot of material issues that were introduced when one uses the ferrous sulfamate. And in addition, in the end you were left with, you know, certainly waste. And if you go to Hanford or Savannah River early, you wind up with waste. And in this process, you know, sort of the whole benefit of this is that you minimize that or you eliminate that from your outgoing stream. You don't have that.

So, I think that's a large part of the reason for selection hydroxylamine.

DR. RYAN: Thanks.

You know, I guess I would extend that from this particular chemical to your entire process. Analysis to think carefully about what waste you might be generating, what metals you could be leeching because you might end up with either characteristic mixed waste or true mixed waste that you can't, you know, have an outlet for. That's something certainly to think about.

DR. LEVENSON: How far do you go in your waste treatment, or did you ask that? What's your end point for your waste?

MR. KLASKY: Oh. Let's see, Mark, you want the first slide up on the process.

DR. LEVENSON: I saw one arrow that said your organic waste goes to SRS.

MR. KLASKY: Okay.

DR. LEVENSON: You didn't say anything about any of the aqueous wastes.

MR. KLASKY: All of our wastes go into a waste treatment unit. I think you'll see it's a waste treatment -- we have a unit --

DR. LEVENSON: What does waste treatment consist of? What's your end product? Do you go all the way to glass. Do you ship the liquid somewhere?

MR. KLASKY: The liquids are shipped to Savannah River for treatment.

DR. LEVENSON: So the ultimate disposal is Savannah River's problem?

MR. KLASKY: Correct. Well, let me just point out what we do in waste treatment. We're combining a number of waste streams. And before we combine a couple of the waste streams, we have a process that -- we destroy any azides that might have formed. So that's our main focus of the waste unit. And the subsequent volume reduction and whatnot is done, to my knowledge, at Savannah River.

DR. RYAN: There's another dimension that you've got to take into account, and that is to the best you can predict what end points the wastes are going to have, what they're going to look like both in terms of chemical and constituents and radiological constituents.

Please be careful that you have an outlet for those wastes, because you might find that you want to modify your treatment in order to make the waste acceptable for disposal somewhere, whether it's WIPP or somewhere else. You need to think about it. But don't think about it in terms of chemical process. That's certainly one way to think about it. Think about it in terms of making an acceptable waste for disposal.

MR. KLASKY: Right. I think we have -- maybe Ken, you can speak to this. The WAC.

MR. ASHE: Right. Ken Ashe.

That's correct. We do have with Savannah River site Waste Acceptance Criteria, and we are actively looking at the waste that we product and make sure that they can receive it before we send it.

DR. RYAN: Okay. So that fits into the treatment and disposal scheme?

MR. ASHE: That's correct.

DR. RYAN: Thanks.

CHAIRMAN POWERS: Let me see, I was going to ask you where your azides formation step is.

MR. KLASKY: Okay. Mark, go back to the second figure.

In the plutonium stripping unit the -- when nitrous acid is consumed by hydrazine and produces and hydrozylic acid. And if impurities happen to be present, in the presence of impurities, different metal azides may be formed.

Again, it should be in the aqueous stream. They're going to be moved into an oxidation column and those azides in an acidic medium, again you'll basically retransform or you'll never -- you shouldn't really produce metal acid. You should have hydrazylic acid, and that hydrazylic acid also undergoes a rapid reaction with nitrous acid and should be destroyed in the oxidation column.

Again, we sample coming out of the oxidation column to make sure it doesn't propagate.

In addition, coming out of the plutonium stripping unit the organic stream is moved into in the end a solvent regeneration process. This solvent regeneration process uses sodium hydroxide, sodium carbonate as reagents. And if there is, in fact, hydrazylic acid in the organic stream, sodium azide will be formed. That's precisely the unit function that I just described for the waste treatment unit will add sodium nitrite and then we'll sidify and we'll destroy the hydrazoic acid, so we'll retransform to hydrazoic acid.

So there's a couple of areas where we know we have hydrazoic acid and we have to be careful, of course, with respect to the hydrazoic acid. And we've described the safety controls to control hydrazoic acid and its closed.

CHAIRMAN POWERS: What species -- what is the least soluble azide in your system here?

MR. KLASKY: The least soluble? Silver azide has a low solubility, I believe. And in our normal processing that we've described, we of course limit -- the solubility -- I mean, there shouldn't be any silver in the plutonium stripping unit. It is a very, very low distribution coefficient, it's not extractable. So, you know, entrainment of course, however, can occur. That's why we have a scrub unit as well.

Within the plutonium stripping unit, of course, if it is trace quantities present, we could form silver azide. But, again, it would be in essence destroyed or retransformed to hydrazoic acid and destroyed in the oxidation unit. And I think we describe the specific controls or principle SSCs so as to preclude moving that azide into heated equipment. I mean, that's our real focus is to ensure that we don't introduce azides into -- and also to -- excuse, insure that we don't dry out equipment that may contain azides.

So, it's sort of a safety philosophy that recognizes that such azides may be present and is ready to deal with their presence as opposed to saying that we won't form any.

MR. VIAL: Yes. There were some -- that initiated the formation of azide react really fast or slow with nitrous. So --

CHAIRMAN POWERS: Yes, that's what he was saying.

MR. KLASKY: Yes. I guess that's one additional remark that I'd make, that we spoke re-oxidation of plutonium. It occurs both in the aqueous stream and the organic stream. And the nice thing is, you know, you do have hydrazine, it is attacked by nitrous acid, it forms hydrazolic acid. Hydrazolic acid is a very large affinity to the organic stream. And so in essence hydrazolic acid is your mechanism is scavenge nitrous acid in the organic stream as well.

CHAIRMAN POWERS: Clever.

Any other questions for the speakers?

Thank you, gentlemen.

Bill, you're on again.

MR. TROSKOSKI: All right.

CHAIRMAN POWERS: And those of you that think this chemistry discussion is going on too long, just look upon this as the HAN dynasty

MR. TROSKOSKI: Ladies and gentlemen, this next discussion will cover the challenges associated with the spontaneous autocatalytic chemical reaction that can occur in the HAN-nitric acid solution typically found in your plutonium uranium separation processes.

Again, this type of runaway reaction is generically similar to those encountered in the chemical process industry. And the approaches used by the chemical process industry, mainly the Process Hazard Analysis, are valid for the HAN reactions.

The HAN autocatalytical oxidation reaction is strongly exothermic and has overpressurized process vessels through the production of large amounts of gaseous products, mostly nitron oxides. The reaction rate is multiperimetered ended, which include the reagents and products, temperature, normality, biontic strength and impurities which can act as catalysts.

The reaction can occur in the organic, aqueous and gaseous phases, and in short it is a complex phenomena that has occurred more often than the red oil reactions we previously discussed.

The staff is reviewing the applicant's initial approach that has been put forth in the Construction Authorization Request, and that we've discussed in several meetings with them. However, the staff notes that at this time the applicant has not yet finalized its safety strategy.

The staff has gathered the published operational event history related to the HAN reactions and the DOE, and the associated DOE technical reports.

HAN also has non-nuclear applications and the staff is aware that there have been runaway reactions with this process in the chemical process industry.

We believe that actual field data are invaluable in reviewing the technical viability of any safety strategy approach.

I have already alluded to the complexities of the HAN nitric acid system, that is multiperimeter and multiphase. In terms of the classic fuel, oxygen, heat triangle, HAN concentration is certainly a key perimeter and safety limits need to be defined for it.

For the oxidation leg of the triangle, in simplified terms, HAN reacts with nitric acid to produce nitrous acid, which is related to the subsequent formation of another chemical intermediation N_2O_4. It's the rate of N_2O_4 formation that is also a function of temperature and normality. Controlling the rate and formation or the availability of NO_2 is the key to really preventing an autocatalytic reaction from occurring.

Finally, the temperature at which an HAN reaction occurs is another complex variable, dependent on concentrations and ratios of nitric acid in HAN, as well as the presence and concentration of potential catalysts such as iron.

Did I miss one? Yes.

CHAIRMAN POWERS: But you've changed what's presented to us from what we have here. Go back.

MR. TROSKOSKI: That's First Principles. Do you have that?

CHAIRMAN POWERS: No. We have the principals of schools here instead of principles.

MR. TROSKOSKI: I confess. I'm going to

have to stand up and confess. That was my mistake. My studious project manager caught it and he tried to catch it, but apparently --

MR. ROSEN: He caught it in most places.

MR. TROSKOSKI: In most places.

CHAIRMAN POWERS: It was a bad strategy on your part. See, we could have -- there was an entire paragraph in our letter that we could have written on the spelling and now we're going to have to search through to find something else to fill that paragraph.

MR. TROSKOSKI: I assure you, it is not deliberate.

MR. SIEBER: You just want to be our pal.

MR. TROSKOSKI: Okay. I'm the Applicant's PSSCs now. I did spell PSSC correct.

The applicant has indicated that they are considering a safety strategy involving use of hydrazine to scavenge nitrous acid before N_2O_4 can be produced in the quantities and concentrations necessary to support the autocatalytic reaction.

Looking at the entire process, the applicant has identified safety strategies for three distinct process applications. First, for those that have HAN and hydrazine nitrate without NOx. That occurs in the 3000 pulse column of the purification cycle where HAN is introduced to reduce the plutonium.

The second is HAN with no hydrazine nitrate. And this is the HAN feed system in the aqueous polishing process. I believe the applicant is now considering a possible change to this portion of the process.

The third one has to do with HAN and hydrazine nitrate but with the addition of your NOx gas. This occurs in the oxidation column in recycling tanks. The NOx is used to destroy the HAN, the hydrazine nitrate and the hydrazoic acid to prevent propagation to downstream process units and the front end of the purification cycle via the aqueous phase.

The PSSCs for the first two strategies are similar. Both use the Process Safety Control subsystem to maintain the temperature of HAN solutions within safety limits.

Both also use the Chemical Safety System to control and maintain the concentrations of HAN, nitric acid and metal impurities to within safety limits.

The third strategy is different because the NOx is being added destroy the HAN hydrazine nitrate and hydrazoic acid. The Chemical Safety System is used to limit the concentration of these reactants. The offgas treatment system provides an exhaust path for the gaseous byproducts of the reaction and as a means of heat transfer pressure relief.

Finally, the Process Safety Control Subsystem controls the flow rates of the oxidation column limiting the quantity of reactants to maintain the heat generation and pressure increase to within vessel design specs.

CHAIRMAN POWERS: Bill, have you thought about the possibility of accumulation of ammonium nitrate in the offgas treatment system?

MR. TROSKOSKI: No, we have not until today, but we will be looking into that.

CHAIRMAN POWERS: You might want to look at it. It's something that we struggled with a lot in connection with some of the Rocky Flat systems and up at Hanford. I mean, we would occasionally find ammonium nitrate there. Whence it came from, I can't tell you. But we would find it there and whatnot. And, you know, like I say, the origins of it and things like that, you really never know. Because we were looking after 20 years of operation.

MR. TROSKOSKI: Sure. Offline, could you give us a contact or do you know of anybody offhand?

CHAIRMAN POWERS: I'd have to --

MR. TROSKOSKI: We'll do the work.

CHAIRMAN POWERS: You know, let me think about it and I'll see if I can come up with --

MR. TROSKOSKI: If not, I know some other people.

MR. ROSEN: The implications of that, Dana, are is it's a little bit explosive now and then.

CHAIRMAN POWERS: Yes, it's a material of concern.

Let me say that we agonized heroically over it, as did the operators there. I would never-- myself that the matter began, but we worried about it.

MR. TROSKOSKI: Okay. Well, that's what I was asking. You're not sure it's a problem, but --

CHAIRMAN POWERS: Not sure at all.

MR. TROSKOSKI: Okay. So there's not an operational event history?

CHAIRMAN POWERS: None.

MR. TROSKOSKI: Okay.

CHAIRMAN POWERS: Except that we did occasionally find ammonium nitrate.

MR. TROSKOSKI: We'll look --

DR. LEVENSON: Dana, I'm not -- I know Rocky Flats, etcetera, they found it. Ever find it in any of the plants that did solvent extraction, I'm not aware of that.

CHAIRMAN POWERS: Milt, you're taxing my memory here. But it's something to at least give an afternoon's worth of thought over, I think.

MR. TROSKOSKI: Okay. I appreciate that.

Going on to industry events.

Understanding the data provided by real industry events is a vital check of the proposed safety strategies. Most of the HAN related events involve significant elements of what I would term conduct of operations. When strong azides are added to HAN heels in a tank that are thought to be empty, solutions are concentrated over a long period of time, or external heat sources provide initiation temperature, you're going to end up with problems.

The applicant proposed PSSCs which would envelop these types of events. In addition, the staff still excepts that the initiators for each of the known events would be addressed in detail in an adequate ISA Process Hazard Analysis.

This is just classic chemical industry approach.

MR. KLASKY: Bill, could I interrupt one second.

MR. TROSKOSKI: Yes, sir.

MR. KLASKY: Go back to the previous slide.

MR. TROSKOSKI: Okay.

MR. KLASKY: Again, give further justification for our approach, I think what you see here is that there are numerous mechanisms by which the hydroxylamine concentration, or I should say the nitric acid concentration can increase due to evaporation or heating, the Hanford event of 1989 is the only event you'll see there with hydrazine present. And, in fact, I guess we argue after one year you have a situation where you can destroy hydrazine over long periods of time due to producing nitrous acid due to radiolysis.

So our intent again is to not allow for the storage of material, either HAN or hydrogen.

DR. FORD: Well, I seem to remember the last presentation meeting that we had on this. There was a presentation from someone who was talking about process control, use of digital controlled equipment. The reason I'm bringing it up, is at least two of those items are because of human factors.

MR. KLASKY: At last from our perspective--

DR. FORD: Is that still a factor or not?

MR. KLASKY: What we're attempting to do here is to basically eliminate that from -- as a possible initiator in that we're going to utilize hydrazine, which in essence eliminates that possibility of in essence steady autocatalytic reaction due to concentration of the nitric acid. So we're going to have a strong nitric acid scavenging agent to eliminate the previous events that have occurred, in essence.

DR. FORD: Okay.

MR. TROSKOSKI: Next.

DOE's approach to controlling possible HAN reactions can be found in their technical report EH0555 that was issued in the '98 -- it contains a number of specific recommendations and it correlates process temperature with an instability index, which is a function of nitric acid molarity, the nitric acid to HAN molarity of the iron.

The applicant has noted a number of limitations when applying the index to its process, as considering other strategies previously discussed.

The staff that use of the index and associated recommendations may be an acceptable strategy if applicability of each item is validated for the specific process. The DOE approach provides a number of valuable insights that merit consideration. However, the staff does recognize that alternative strategies may provide the same or greater level of safety.

The applicant has proposed a number of strategies for three distinct process applications, each with its own set of PSSCs as outlined in the revised Construction Authorization Request. However, the applicant is still considering a hydrazine scavenging approach and has indicated that additional information with this approach will be submitted to the NRC for review. We have not received that information yet.

CHAIRMAN POWERS: Let you finish, and then I'll ask you the question.

MR. TROSKOSKI: Oh, okay.

This issue remains open pending finalization of DCS's approach. If they choose to implement the revised CAR approach, the staff still needs to review the PSSCs design basis values and ranges of values, such as concentration, pressure and temperature limits.

And that pretty much concludes what I have to say. So my presentation's over.

Fire away, please.

CHAIRMAN POWERS: A couple of questions.

First of all, you're going to have to look at a lot of things here. You have any quantitative tools to help you look at these flow streams that they're passing through? I mean do you chart an ASPEN model on this or something like that?

MR. TROSKOSKI: We do have a risk group, and we are thinking of a number of things such as doing our fault tree analysis.

CHAIRMAN POWERS: How about setting up a flow model here?

MR. TROSKOSKI: That certainly can be explored, as though right now we still don't have the detailed --

CHAIRMAN POWERS: Yes, you don't have anything now.

MR. TROSKOSKI: Yes.

CHAIRMAN POWERS: I was just wondering if -- I mean, you've got things where you have some great data and things like that here.

MR. TROSKOSKI: Oh, yes. We're given the chance to do some independent calculations and reviews. So we certainly intend to.

CHAIRMAN POWERS: I don't know if this

deserves setting up something as sophisticated as an ASPEN model, but something of that nature.

The other question is in the course of the discussion we hit upon this idea of silver azide precipitating. Have you given that any thought?

MR. TROSKOSKI: The azides, I believe, is still one of the open issues.

Alex?

MR. MURRAY: Yes. Just to let you know, we have reviewed that aspect, and the nitrite -- I should say the azides will be destroyed by nitrite before they'd be able to be contacted with silver nitrate. And the applicant has identified controls to render such an event highly unlikely.

CHAIRMAN POWERS: I mean, all that works well when the system works well. What about when the system doesn't work well?

MR. TROSKOSKI: Well, you're back to your Hazard Analysis. You're back to doing your Process Hazard Analysis on a component-by-component basis. You know, what happens if.

CHAIRMAN POWERS: Again, let me hypothesize that.

MR. TROSKOSKI: Sure.

CHAIRMAN POWERS: I've got a saul of

silver azide floating around in my solution. Does the azide get destroyed, these particulate of the azide get destroyed by the nitrous acid then with an efficiency such that it doesn't pass on through the system?

MR. KLASKY: Dana, let me add some insight into all this.

The quantity of silver azide, of course, is limited by the quantity of hydrazoic acid that one can produce, which basically we have developed a model to quantify the quantity of hydrazoic acid that can be produced in this stream.

The answer to your question in terms of the efficiency, I think I'd mentioned to you that coming out -- we're not taking credit for the destruction of the azide per se in the oxidation column. Rather, we define on sampling to ensure that the azide not present.

CHAIRMAN POWERS: Here's what I'm asking is, when did you know that you have a two phase saul in your sampling process? I mean --

MR. KLASKY: Yes.

CHAIRMAN POWERS: You will?

MR. KLASKY: In terms of kinetics, just look at the kinetic rates. Hydrazine is first destroyed by the nitrous acid. Hydrazoic acid is destroyed next. Hydroxylamine is destroyed subsequent. And furthermore, you'll have plutonium in your stream.

If you have any hydroxylamine, that will mean that you have plutonium III. So by inference, one can conclude that one does not have azide -- this is an approach that we're talking about. It won't have azide based on the valent state of the plutonium.

CHAIRMAN POWERS: So what you're quoting to me are kinetics for homogeneous reactions. And I'm asking you what if I have a particulate there, does the reaction rate -- I mean, do we know what it is? Do we know that it's rapid, that it's commensurate with the rate for the homogeneous species is different? Do we get a --

MR. KLASKY: I think two things. I'd point out that we'll have -- we'll obviously have a concentration in solution as well, just an equilibrium to establish between the solid or the precipitate and the solution as well. But in terms of kinetic rates, at this point we have not concluded that the homogeneous reaction kinetics are acceptable. That's something for us to look into.

One further point you had mentioned

ammonium, Mark, is located. The source of the ammonium.

MR. VIAL: Well, so we haven't talked about another property of hydrazine. Hydrazine also reduce plutonium IV to the trivalent state. And in excess, while you have two placebo reactions, one if you are in excess of plutonium IV, another one if you're in excess of hydrazine.

If you're in excess of hydrazine, you can produce one mol of ammonium that can therefore react with your nitrate and form your ammonium nitrate. That's a possibility.

This reaction, that's one of the reaction we're going to investigate. But this reaction so far from what we've seen so far is really slow compared to the main reaction -- reaction of plutonium to trivalent, plutonium by either ammonium -- we're going to address this issue.

CHAIRMAN POWERS: Good.

DR. LEVENSON: Can I ask a question?

CHAIRMAN POWERS: Only one.

DR. LEVENSON: Okay.

CHAIRMAN POWERS: At a time.

DR. LEVENSON: What's the scope of this nitric acid organic worry as far as your review? Does it include the chemical makeup areas of the plant where there's no plutonium present, or is it only in the process area?

Context to my question is that the first really big bang that I'm aware of in 1944 blew one end out of the 205 building and somebody pumped nitric acid into a tank in the makeup area that happened to have a heel of formic acid from a previous operation.

MR. TROSKOSKI: Okay. Now, if I'm not mistaken --

DR. LEVENSON: I assume a plant like this has a chemical makeup area.

MR. TROSKOSKI: They will. And the -- what's the name --

DR. LEVENSON: By the way, I'm not implying it should be. I'm just trying to find out what your scope is.

MR. TROSKOSKI: Where they do make up the reagents, it's not -- there is no licensed material in it. And for that we are looking at, but it's --

DR. LEVENSON: So your scope did not include that? There's no license material.

MR. TROSKOSKI: That part since it's not licensed.

CHAIRMAN POWERS: But the requirements of

Part 70 include chemical hazards.

MR. TROSKOSKI: Right. And if you look at that, it's chemical hazards derived from licensed material. It's chemicals like, for example, HF that can be off-gased from UF 6 water reaction. But it's not just your chemicals, unless they can affect the safe operating and handling of licensed materials. IF they can affect the control room, operations, which is an important safety function, yes, then it's in our jurisdiction.

MR. ROSEN: Well, that puts almost everything in your jurisdiction, doesn't it?

MR. TROSKOSKI: Right. A lot.

MR. ROSEN: Very little of it falls out.

MR. KLASKY: Let me just clarify things a little. We have performed two different analyses, the concerns in the reagent building. A chemical release in the reagent building we have to assure ourselves does not create a possibility for a radiological release in our AP process building. So we've performed the chemical evaluations.

In addition, we've performed external explosion analyses that address the possibility. In the reagent building we have higher concentrations of hydroxylamine and also hydrazine. And so consequently we have to assure ourselves that they cannot effect the process building.

Within the AP process, I think Bill alluded to the fact that our intention is to change our reagent tank to include hydrazine. So the concern of having hydroxylamine nitrate alone in conjunction with nitric acid is diminished due to the presence of the hydrazine.

CHAIRMAN POWERS: I can't help but comment in that area of the country with people so attuned to stock cars, there'll be a great deal of experience dealing with hydrazine.

Any other questions for Bill?

Okay. Let's move on to fire.

Lary, you have to explain to Dr. Kress that we're talking about "far" here.

MR. ROSEN: And "rad all."

DR. KRESS: But I know about this hydrazine.

MR. ROSENBLOOM: Good afternoon. My name is Lary Rosenbloom, I'm the lead fire protection engineer on the MOX fuel fabrication project.

And my page turner is Tom St. Louis, who is the lead mechanical engineer.

What I'd like to do for you today is give you a high level look at what the design of the fire protection systems are at the facility and also the program --

CHAIRMAN POWERS: You know, when I began this Subcommittee meeting I raised the issue of how you approach defense-in-depth for fire protection. And in particular your definition of defense-in-depth for fire protection. Will you go into that in the course of this presentation?

MR. ROSENBLOOM: It wasn't the intent, no.

CHAIRMAN POWERS: No. Okay. Okay. Can we do so?

MR. ROSENBLOOM: Well, are you coming at this from the fire -- defense-in-depth sense of a nuclear power plant? Because the nuclear power plant defense-in-depth is a different definition than defense-in-depth is utilized here.

CHAIRMAN POWERS: Well, what I know for sure is your definition of defense-in-depth and that that's in Appendix R of 10 CFR Part 50 are two different things.

MR. ROSENBLOOM: Right.

CHAIRMAN POWERS: And they're pretty similar up until we get to the third step. And in your third step of your definition you say, and will extinguish the fire. Okay. Whereas the third step in Appendix R says and we will make sure that while this fire smolders away, we don't get any damage to equipment, we will prevent damage to the equipment. And I wondered why you took this obvious distinction between the two?

MR. ROSENBLOOM: I guess I don't see those distinctions like you're saying it.

The defense-in-depth nuclear power plant is basically the fact that there is multiple levels of protection. It isn't just a single feature that they use for fire safety. They got fire prevention, fire detection, fire suppression; all those work together. That what's defense-in-depth of a nuclear power plant is.

For defense-in-depth as regards to this facility, is the defense-in-depth that applies to the IROFS. For our facility, really, that's restricted to those detection suppression systems that are located in areas where we have dispersal of radioactive materials.

So there's two different meanings entirely, as I see it.

CHAIRMAN POWERS: Okay. Your first level of defense-in-depth is to prevent fires. Your second is to detect and suppress.

MR. ROSENBLOOM: Right.

CHAIRMAN POWERS: Then your third is, you say, and extinguish the fire. Okay. What I'm asking here is that in our reactor world when we look at these fires, we start -- the first step we say is prevent the fires. That's the first step.

The second one is to detect and suppress.

And then we say and in the interim make sure that the fire -- prevent it from damaging equipment, which what we mean is safety equipment in this case. Your equivalent to IROFS.

MR. ROSENBLOOM: Right.

CHAIRMAN POWERS: Okay. What I'm asking is why didn't you say that? Why didn't you say that while I'm waiting for this fire to be -- to extinguish, that I'm going to make sure I don't get any other IROFS damaged by this process?

MR. ROSENBLOOM: Well, you can have damage to the IROFS. In the Fire Hazard Analysis we look at the damage that could occur to those IROFS and see what the effects are of that. Because in general for the IROFS we have where you have redundancy. And if we have a fire that takes out those particular IROFS, a redundant set is available elsewhere.

CHAIRMAN POWERS: Okay. I think we'll explore this as we go kind of system-by-system.

That does bring you up nicely to the next question I have, is one of circuit analysis in this system. How do you view fire in circuit and in your electrical circuits in these systems?

MR. ROSENBLOOM: Well --

CHAIRMAN POWERS: And here's where I'm coming from. For just about everything else, when we look at a facility, we look at does the IROFS, in this case, it either works or it doesn't work. And we analyze it accordingly.

With fire we have the potential of systems working, but working badly. And does that come in into your fire analysis? That's basically what I'm asking you.

MR. ROSENBLOOM: Well, it does because the routing of the IROFS, the electrical routing of the IROFS is such that they are kept in separate areas. But where they happen to be in the same areas, we do analyze them and show that the situation is acceptable.

CHAIRMAN POWERS: Okay. Please go ahead.

MR. ROSENBLOOM: Okay. The big picture I want to get into is basically give you an overview of design, an overview of the program. We already started getting into what the Fire Hazard Analysis is all about, some fire modeling, talking more in depth about our fire barriers, summarizing what our fire safety strategy and concluding.

Well, the primary features as I would think is our -- we have multiple fires areas facility with all the barriers rated for at least hours. Now those ratings are based upon ASTM E-119 definitions. And the whole purpose of the fire is to keep the fire to that origin. Now, these fires areas are structural barriers that segregate the fire is, and there's about 300 fire areas.

In addition, we have the automatic detection systems and we have an automatic and manual fire suppression.

CHAIRMAN POWERS: ASTM E-119 tells you whether a fire barrier qualifies to be 2 hour or 1 hour, or 10 minutes, whatnot. Why did you pick 2 hours?

MR. ROSENBLOOM: Well, because when we looked at the facility in France and saw the ratings they had over there, we saw that basically there were little fire loads throughout.

Also, so the 2 hours seemed acceptable.

And also when you look at the requirements themselves, when it comes to definition of fire areas, the typical number you see is the low number is 2 hours. So that's why by definition I'm saying a fire has minimum fire barrier rating of 2 hours.

CHAIRMAN POWERS: What's the total inventory of dodecane in this facility?

MR. ROSENBLOOM: Total?

CHAIRMAN POWERS: Yes.

MR. ROSENBLOOM: Total quantity off the top of my head.

CHAIRMAN POWERS: A 1,000 pounds?

MR. ROSENBLOOM: Probably in any single fire area, probably that's the maximum.

CHAIRMAN POWERS: Yes. Is 2 hours reasonable for a 1,000 pounds of dodecane?

MR. ROSENBLOOM: Considering how it's stored. Basically it's in welded containers. That's where you have the maximum quantities happens to be in process cells where there's no chance of a fire occurring in there anyway, because there's no ignition sources.

CHAIRMAN POWERS: Okay.

MR. ROSENBLOOM: Now the large number of fire areas I've shown here by just showing the first floor of the MOX processing building and also the shipping and receiving building. And as you see on the first floor, we have 18 fire areas, and we have 65 fire areas on the first floor of the MOX processing area.

The next slide just shows an enlargement showing how the fire areas all over the place and they're well separated.

Going on, fire detection systems. We have fire detection systems throughout the facility. And those are basically working from the gloveboxes outward. We have them within the gloveboxes. And then the rooms surrounding the gloveboxes. And also we have them in exhaust plenums of the process cells because we don't have anything electrical in the process cells themselves.

Now, suppression types, again, working inward -- working from the glovebox out, we have a portable carbon dioxide bottles that we can use to manually suppress a fire inside the glovebox. In the rooms we have the clean agent. And working out into the corridors and stairwells, we have a water based systems. And then we fire extinguishers throughout.

MR. ROSEN: What is this clean agent? IS that like Halon?

MR. ROSENBLOOM: That's -- no, it's a substitute for Halon.

MR. ROSEN: Well, I meant that, yes.

MR. ROSENBLOOM: That's what it is, it's a substitute for Halon. When they talk about clean, they're talking about clean environmentally.

MR. ROSEN: Right. And what kind of substitutes are you talking about?

MR. ROSENBLOOM: What we're using specifically at our facility, it's called Intergen. Intergen.

MR. ROSEN: Have you looked at the interaction of that substance with the process materials?

MR. ROSENBLOOM: It's inert. It has nothing that can interact. It's carbon dioxide, nitrogen and argon.

MR. ROSEN: Okay.

MR. ROSENBLOOM: On the carbon dioxide systems, again, those are for suppressing fire inside gloveboxes, and those are using basically carbon dioxide extinguishers that are being modified to be able to inject at quick connects. And in order to make sure I'm compliant with the intent of suppressing incipient fires, the travel distance to these extinguishers met NFPA 10 requirements.

Like I said, those are in the process areas. Now, the cleaning agent will be Halon free. The reason it's Halon free is for process reasons because -- things that are not halogen free could impact the -- adversely impact the product, let's put it that way.

The storage containers, the clean agent bottles, they're stored throughout the facility but they're kept in the vicinity of the hazard. And because we have a decentralized system, we have multiple storage locations.

Water-based systems, like I said, those are in corridors and stairwells. And we're using a preaction system so we can maximize criticality safety. These are not located in any of the process areas.

In order to get one of these systems going, normally, you basically have to have a detection. And then once you get the water flowing into the pipe, then you have to have one of the heads actually reach the heat which defuse the leak melts and the water starts flowing.

And also in support of the need to maximize criticality safety, we're using dry stand pipes instead of the normal wet stand pipes you'd find.

The water for all this is connected via a loop that we have around the whole facility to the Savannah River site in that area, which also is a loop system. And this has been sized to handle the biggest demand plus a 500 gpm hose strength.

CHAIRMAN POWERS: You consider seismically induced fires?

MR. ROSENBLOOM: That issue has been brought up. And it's been asked by the DOE and we've had back and forths about that. Basically what we've concluded is that their concern is addressed by the clean agent systems that are going to be providing suppression in those areas that have dispersal of radioactive material. And those systems do the seismic qualification will be available in a post-seismic event.

CHAIRMAN POWERS: But your water systems are not going to be available?

MR. ROSENBLOOM: That's correct. The water systems are not.

CHAIRMAN POWERS: But you think your clean agents will be?

MR. ROSENBLOOM: Excuse me?

CHAIRMAN POWERS: Your clean agents will be but the water won't be?

MR. ROSENBLOOM: That's correct.

CHAIRMAN POWERS: Presumably the bottles are? The CO_2 bottles are available?

MR. ROSENBLOOM: Oh, yes. Because those are just -- now they're just like your extinguisher -- your portable extinguishers are.

CHAIRMAN POWERS: Yes. Okay.

MR. ROSENBLOOM: Okay. So that was basically it for the systems. The other part, of course, is the program that's in place. The main focus is employee training we have in place. And that basically covers what a person would do in the event if they find a fire, actions, also training on what they do if they see some type of fire event and see if they can help extinguish it, put it out and call certain people.

The other part is the fire brigade, which provides on-site support for our fire fighting activities. And that's would be a fire brigade in accordance with NFPA 600. Have a fire brigade leader and fire brigade members.

MR. ROSEN: I'm surprised that you don't mention the Savannah River area fire brigade, or there is more backup? Why do you have a specific fire brigade for this facility?

MR. ROSENBLOOM: We did a baseline needs assessment to see if they could -- see if the site, the Savannah River site fire department could respond in a timely fashion. And basically we concluded that they could not. And for that reason we decided we had to have our own fire brigade.

MR. ROSEN: Do you integrate the Savannah River fire brigade with the MFFF fire brigade? Are there provisions to integrate those two forces?

MR. ROSENBLOOM: Well, there will be training as part of the requirements to have the training between our fire brigade and the fire department. They have to know enough in order to come in and provide backup. So, yes, there will be integration.

MR. ROSEN: Is that part of your program?

MR. ROSENBLOOM: It will be part of the program, yes.

DR. LEVENSON: You're adjacent or very close to the pit disassembly and conversion facility, right?

MR. ROSENBLOOM: That's correct.

DR. LEVENSON: By implication are you

saying that the site fire department can't get there in time?

MR. ROSENBLOOM: I'm not saying anything about PDCF.

CHAIRMAN POWERS: And doesn't want to, either. Can't speak for them.

MR. ROSENBLOOM: Can't speak for them, that's correct.

All right. One of the main parts of the fire protection program is the Fire Hazard Analysis. What it is, documents the fire hazards, the fire protection features and the overall adequacy of fire safety at our facility based on a current design information.

And you ask what goes into an FHA. Well, quite a few things. Basically within the body of the document you'll find out how fire is determined, how we have fire safety with respect to our HVAC and electrical design, it gives more details about the fire protection program, goes into greater detail about the fire water supply and manual fighting capability. It talks about life safety, fire exposures, potential for fire spreading from one area to another. The impact of natural phenomena hazards on the systems, like you'd mentioned about the post-seismic event. Compensatory measures.

We summarize our conclusions by comparing also to the Appendix D of the SRP. And also as an appendix to the whole document there's an area-by-area analysis.

In each of those analyses -- if you're looking for meat about any particular area, it gives a description of what goes on in any area, the fire hazards within that area, the ignition sources within that area, the fire protection features as I've described them to you. It also identifies and evaluates the principle SSCs that you spoke of. It goes into design basis fire scenarios and consequences and also does a brief life safety analysis.

CHAIRMAN POWERS: Do you have and do these fire hazard analyses a frequency versus size of the fire?

MR. ROSENBLOOM: No. Not frequency, but size yes.

CHAIRMAN POWERS: Size but not frequency?

MR. ROSENBLOOM: That's correct.

CHAIRMAN POWERS: Okay. So you're basically saying I have a fire with probability one.

MR. ROSENBLOOM: Correct.

CHAIRMAN POWERS: And it can be big enough to damage a quarter or a half or a third of this area?

MR. ROSENBLOOM: That doesn't happen. Because of the lack of continuity of combustibles in this facility, we basically have a fire that would start in a panel, a motor and whatnot. And because of the low heat releases rates you would have and the low heat fluxes, it basically starts there and stops there. That actually goes into the next slide.

What we found so far in design is that the fire safety design meets the applicable requirements and the intent of the NFPA standards and national building code. Like I said, the potential fires were small, nonpropagating so basically we keep our fires as we desired, within the fire of origin. And it was also, as an add on, it was a management decision as a defense-in-depth to the fire barriers to make those detections and suppression systems in areas that had dispersal materials the principle SSC.

MR. ROSEN: I presume you've done a catalogue of all the process materials that we've been talking about all day today?

MR. ROSENBLOOM: If they're combustible, yes.

MR. ROSEN: And assured yourselves that the process materials are not combustible?

CHAIRMAN POWERS: Oh, the process materials are very combustible.

MR. ROSEN: Oh, okay. Then why do we have potential fires of small and not propagated?

MR. ROSENBLOOM: Because where the fires start, they don't spread.

MR. ROSEN: They're not small, though?

MR. ROSENBLOOM: They are small.

MR. ROSEN: You spill tributyl phosphate on the floor and it hits an ignition source and that's a small fire? We're talking about terms here. I don't know what you mean.

MR. ROSENBLOOM: We're talking about with the normal configuration.

MR. ROSEN: Is tributyl phosphate flammable?

MR. ROSENBLOOM: It's combustible, yes.

MR. ROSEN: Combustible? Okay. So now you spill it on the floor and you have an electrical gear in that room which happens to change state, so you get an ignition source. What happens?

MR. ROSENBLOOM: Well, now you're talking about the -- that's not a normal fire as it would occur. But that aspect is dealt with by taking all of the combustibles in an area anyway, even though it's not going to happen and assuming those all burn and assuring the fire barriers are adequate to contain that fire.

MR. ROSEN: What do you mean it's not a normal fire? I don't get it.

MR. ROSENBLOOM: Because the fire starts with the ignition source. But that aspect that you were dealing with anyway is part of the conservativism of our analysis is dealt with to consider all the combustibles in an area as being --

MR. ROSEN: So you want to take my postulate and turn it around and say, first, we have an ignition source? First we have a sparking relay or something like that?

MR. ROSENBLOOM: Right.

MR. ROSEN: And then -- or at the same time you have a serious leak of one of these combustible materials? I mean, you're just arguing about what happens first? But you get to the same place. You get an ignition of one of these flammable materials?

MR. ROSENBLOOM: Right. And the concern there is still going back to ensuring the affects of those fires are maintained within that fire area. But what's looked at in the Fire Hazard Analysis is what--

where the fire can credibly start on its own, not with all these conditional accidents coming into play.

CHAIRMAN POWERS: One of the things that puzzled me about your characterization of the fire is starting and not propagating. I harken back to an event we had at the San Onofre plant where we had an electrical equipment cabinet fire. Not an unusual event.

MR. ROSENBLOOM: Right.

CHAIRMAN POWERS: It propagated right to the next cabinet, to the next cabinet, to the next cabinet. Do you recognize that sort of problem?

MR. ROSENBLOOM: I recognize that that is a possibility and I deal with that by checking to ensure that if I could burn all the combustible in a room, that the fire barriers would contain all that material burning.

So, I mean there's two aspects that I know we're dealing with here. One is everything in a room going up, and that is done by checking to ensure the combustible loading can be contained by the fire barriers. But there's also the scenario of are fires going to start and can they propagate.

MR. ROSEN: I have the sense that you're ducking the question. I mean, that's -- you know, this sort of gets me to push the question some more.

I'm thinking of the possibility of a real fire.

MR. ROSENBLOOM: Yes.

MR. ROSEN: Not these constructs you're talking about. A real fire that starts because there's a leak of these flammable materials in a room.

MR. ROSENBLOOM: Okay.

MR. ROSEN: It's leaking, it's been leaking for a while.

MR. ROSENBLOOM: All right.

MR. ROSEN: And then it gets worse. This is the way things happen. It just so happens that the room is a fairly good sized room and it has a lot of electrical and other equipment in it, something or other of that is an ignition source to this leaking flammable liquid that's in the process stream.

Now you have a good size fire going.

MR. ROSENBLOOM: Correct.

MR. ROSEN: Being fed by a process stream that's leaking.

MR. ROSENBLOOM: Yes.

MR. ROSEN: And I'm asking whether you've analyzed those kinds of circumstances? Looked at the kinds of processed fluids that can leak into a room and what would happen if they did; not just about taking a sterile room, say, a room like this with no-- you know, the flammables that are here. My jacket, Pete's tie and the electrical gear; yes, they could burn. But a room which is also being fed by a flammable liquid?

MR. ROSENBLOOM: In a sense of addressing that specific scenario, the answer is no.

MR. ROSEN: Why not? Isn't that the risk we're dealing with?

MR. ROSENBLOOM: Because -- no. Because I'm insuring that even if I could get everything in that room to burn, the fire barriers can contain it.

MR. ROSEN: Everything in that room to burn is the part I'm arguing with. It's not necessarily just what's the room since this is a fire that's being fed by a leak of the flammable fluids.

MR. SIEBER: But these process streams are batch processes, right, as opposed, you know, some oil tanker sitting off shore pumping fluid through the plant? You know, there's a certain charge of reagents and solvents that go in there, and that becomes the fire load. Is that correct or not correct?

DR. LEVENSON: Well, I think the question is when you say everything in the room, does that include the total contents of any tanks of organic liquids in the room?

MR. ROSENBLOOM: It does. It does.

MR. SIEBER: And so in the --

MR. ROSEN: And still you say the fires are small?

MR. SIEBER: Pardon?

MR. ROSEN: But I don't get a sense of that being a small fire.

MR. SIEBER: Well, small is subjective.

DR. LEVENSON: The small -- it sounds to me like you're defining small as being confinable within your fire barriers. It won't breach your fire barriers, is that your definition"

MR. ROSENBLOOM: That's -- well, two different things here. Again, when I look to see if I could burn all the combustibles in a room, I'm not dealing with any specific fire scenario.

DR. LEVENSON: Right.

MR. ROSENBLOOM: Okay. I'm just saying if I could get everything to burn. But then when I actually look at where the fires can start, that's where I'm saying that the fires are small and nonpropagating.

MR. SIEBER: But there's a probability

associated with that. There is some probability somewhere that you could burn everything in the room.

MR. ROSENBLOOM: And for all fires, I look at it anyway.

MR. SIEBER: Right.

MR. ROSENBLOOM: So in a sense I look at as a --

MR. SIEBER: So you envelop that?

MR. ROSENBLOOM: Right.

MR. SIEBER: And so the statement as to whether it's a big fire or a little fire is not relevant to the hazard analysis? It's just a conjecture that --

MR. ROSEN: And what you've said now is what I thought you should have said, which is that the fire loading includes all the combustibles in the room.

MR. ROSENBLOOM: It does.

MR. ROSEN: Which includes all the combustibles in the process?

MR. SIEBER: Right.

MR. ROSEN: The tanks in the room?

MR. ROSENBLOOM: It does, yes. Yes.

MR. ROSEN: As well?

MR. ROSENBLOOM: Yes.

MR. ROSEN: Does it include a look at what could drain into the room from other rooms if the room itself has a failed tank and everything -- and it's lower than things in adjacent room to which it's connected by piping?

MR. ROSENBLOOM: I think that that's -- isn't that prevented?

MR. ST. LOUIS: All of our process vessels have catch trays underneath of them.

Tom St. Louis with DCS.

All of our process vessels have catch trays underneath them, drip trays to collect the contents.

MR. ROSEN: Yes. So it's now burning in the catch tray?

MR. ST. LOUIS: Right.

MR. ROSEN: And the catch tray's big enough in every case to collect the entire contents of the process vessel?

MR. ST. LOUIS: Yes. Now, this is a batch operation, as you mentioned. And most of our quantities are very small, typically 55 to 75 gallons--

DR. LEVENSON: Criticality keeps --

MR. ST. LOUIS: Pardon?

DR. LEVENSON: Criticality.

MR. ST. LOUIS: Yes. For instance the total organics in the AP process is about 20 liters.

MR. ROSEN: That's interesting, but it's not what I was talking about.

MR. ST. LOUIS: Okay.

MR. ROSEN: I was talking about 2 tanks in adjacent rooms. The room with the low tank is the one with the piping failure or crack, or whatever occurs. And that tank drains into, I know, it catch tray now. But there's another tank in another room adjacent to it which drains by gravity into the room where the fire has occurred, overflowing the catch tray, etcetera?

MR. ST. LOUIS: Well, if there is two tanks that drain by gravity and the failure of one could drain both tanks, the catch tray is seized to catch the total quantity.

MR. SIEBER: The catch tray doesn't cover everything. For example, you've got to have interconnecting piping. And I will bet you a floor drain. So, the transport path is typically in chemical liquid processes through the floor drains.

MR. KAPLAN: This is Gary Kaplan. Maybe I can add some more to this discussion with the safety analysis.

What we have done is we looked at all the radioactive material in each area where you could have a fire and assume that was involved in the fire regardless of the size. That's one of our basic things we looked at.

And what we didn't look at was assuming that you have a leak and a fire simultaneously as one that you're postulating where you multiple things happening, if the leak in one fire area results in a fire, we would have that. But we wouldn't postulate that you have multiple tanks leaking and then a fire starts. We wouldn't have done that.

So what you're basically asking is, you know, when Lary does his Fire Hazards Analysis he assumes all the combustibles in that room are on fire and his two or three hour fire walls can handle that. What he didn't say was, well, I have 5 interconnected tanks and is it possible that all those tanks could end up in one area, one process cell and then I have a fire simultaneous to that. We didn't analyze it that way.

And let me add one more part, that remember most of the liquids are in process cells where there is no ignition sources. So we're talking just one or two areas where there's a couple of gloveboxes where you have a mixer settler or a dissolution unit and other area where there are ignition sources.

So the scenario postulating where I have multiple leaks and then a fire starting in a separate area, we don't postulate multiple.

MR. ROSEN: I think you misunderstood the scenarios.

MR. KAPLAN: Okay.

MR. ROSEN: Only one leak in my scenario.

MR. KAPLAN: Okay.

MR. ROSEN: It's in a, say, pump seal. And the pump seal leak, maybe it has a tray underneath it, which is okay. And that pump seal leaks and it leaks enough to basically fill up the tray. And then overflows the tray because it's being fed from another room, not just what's in that room.

MR. KAPLAN: Right.

MR. ROSEN: Like through the piping from another room.

MR. KAPLAN: You would detect that leak.

MR. ROSEN: And that leak catches fire. And that's all. It's a simple thing. I think a realistic case. And I'm asking whether that was analyzed. What's unrealistic about that?

MR. SIEBER: I sort of have a misunderstanding, perhaps, of the way these cells are constructed. But for a given process the cells in the process equipment is not very big. I presume you'd have it all in one room?

MR. ST. LOUIS: No. It's spread.

MR. SIEBER: It's spread around.

MR. ST. LOUIS: It's spread in multiple rooms and in multiple fire areas. The equipment is highly segregated.

MR. SIEBER: It's highly segregated?

MR. ST. LOUIS: Right.

MR. SIEBER: But it's connected together with piping?

MR. ST. LOUIS: That's correct. And most of our transfer means are airlifts.

Now there is, just responding to your comment, there are no floor drains in these areas.

MR. SIEBER: Okay.

MR. ST. LOUIS: There is no interconnecting floor drains that would transfer fluids between rooms.

MR. KAPLAN: Let me go back to your question are you worried about the radionuclide release or are you worried that the walls has 2 hour barrier, 3 barrier is not significant?

MR. ROSEN: Well, the first step is to worry about the fire. Have you bounded the fires that could happen by your analysis technique. And it sounds to me like you have not.

MR. KAPLAN: Well, you're assuming that we have a leak that goes undetected and then a fire occurs?

MR. ROSEN: Right.

MR. KAPLAN: That's your scenario?

MR. ROSEN: Right.

MR. KAPLAN: Right.

MR. ROSEN: And the leak is fed by more than just the process fluids within that room?

MR. KAPLAN: Right. And we didn't consider 3, 4, 5 multiple failures in a row --

MR. ROSEN: That's not a failure. Those pipes are -- there's only one failure. I don't know why you don't understand that.

MR. KAPLAN: Well, I have a failure to detect the leak and a failure to --

MR. ROSEN: Oh, a failure to detect? Oh.

MR. KAPLAN: And also the failure -- and also I have a fire that happens.

MR. ROSEN: Well, the fire happens as a consequence of the leak, that's what I'm proposing. You only have one -- you do have a failure to detect or you detect but you're not able to do anything about it right away.

MR. KAPLAN: Yes.

MR. ROSEN: I mean detection doesn't necessarily imply suppression.

MR. KAPLAN: I'm talking about detecting the leak.

MR. ROSEN: Yes, detecting the leak.

MR. KAPLAN: As it occurs, right.

MR. ROSEN: But that doesn't imply suppression. You know you have a leak. Okay. It's tributyl phosphate or some other flammable liquid. It's being fed by more than the process equipment within that cell because there's more than one cell -- they're interconnected.

MR. VIAL: (Off microphone)

MR. ROSEN: Simple. Nasty but simple.

MR. VIAL: The piping is designed in such a way that we prevent finding siphons. So we have siphons breaks where needed and it's not possible to keep on fitting through a leak within the plant.

MR. ROSEN: You have no pumping loops

with--

MR. VIAL: We have pumping -- yes, we have pumping. But in case we have pumping, we designed the piping in such a way that it's not possible to prime the siphon through the piping.

We have siphon breaks along the lines, that is to say we are venting the lines in high points. I don't think the lines you're mentioning is credible.

DR. LEVENSON: Well, what's the total volume in all connected tanks, pipes, etcetera at any given time? Fifty gallons? Seventy-five gallons?

MR. ST. LOUIS: I don't have that number off the top of my head.

DR. LEVENSON: It must be quite small, though.

MR. ST. LOUIS: Well, it is. It's very small. And the bulk of the material is in aqueous material. It's not a solvent material.

DR. LEVENSON: I think, Steve, the thing is unlike Hanford or Savannah River, the big plants, the tanks are, you know, critically safe so they're all quite small. So even if you drained them all, you probably don't get much.

MR. ROSEN: Well, this is all support for your statement that fires are small and not propagating. It's a statement that there's no -- I see no proof of that, just an ascertain.

MR. ROSENBLOOM: You'd have to read the Fire Hazard Analysis.

MR. ROSEN: I suppose I'll have to.

MR. ROSENBLOOM: All right. Next slide.

We also do some fire modeling. The primary reason we do fire modeling is to see the impact of fire on these temperatures and heat fluxes on specific targets for key fire events.

The secondary reason we do that is also to insure we have an adequate safety margin with regard to fire severity in relation to the ratings of the fire barriers. And we include transient combustibles within the fire models. And the codes we're using right now are CFAST and FPEtool.

CHAIRMAN POWERS: Now, do these codes look at the effect of fire on the performances of electrical circuits?

MR. ROSENBLOOM: No, they don't.

CHAIRMAN POWERS: How do you handle that, the performance of electrical circuits in a fire area?

I mean, the question is do you get spurious actuations of things? Do strange things happen to you when you have an electrical circuit exposed to a fire?

MR. KIMURA: Steve Kimura from DCS.

We'll be doing hot short analysis of the electrical system in response to fire as part of the ISA. Right now we have not considered multiple independent failures of electrical equipment in response to a fire. So I'm not sure exactly where you're going with your question.

CHAIRMAN POWERS: Well, where I'm actually going is out and around the barn and back again. What you told me is that you're going to just -- your electrical -- detailed electrical analysis, part of your ISA. What I really want to understand is what's the design basis for what's here. And the question really is are you going to have and assured pathway for shutdown regardless of where the fire take place?

MR. KIMURA: The design basis will be that a single fire will not knock out both channels of a safety system when we have a redundant channel. We have in some instances more than two channels that protect us.

CHAIRMAN POWERS: I hope in a lot of instances.

The trouble is I never see it so clearly and starkly stated in the fire section as what you did. I mean, what you said was fine. No single fire will frustrate our ability to safely handle this system. I never see it that it historically said, and that's what I want when I'm looking at the design basis here. So if you can put those words in nice and stark, gosh I'd be happy. Because that's what I'm worried about. Okay. That's what I'm worried about on the defense-in-depth situation.

If it just came down to my design basis is such no single fire's going to kill me here, then all these questions would go away.

There's a lot of traditional fire discussion. That's fine. I mean I'm used to that. But I was really looking for a design basis here in this regard. And that lovely statement that he made is what I was looking for.

MR. ROSENBLOOM: Steve is good at doing those kind of things.

The next slide has to do with dealing with the issue of the robustness of our fire barriers. And what I want to do is deal with the structural elements of the buildings that are required to have type 1 construction per NFPA 220, which is the standard types -- standard on types of building construction.

Now, this type 1 construction applies to our fuel fabrication building, our emergency generator building and our emergency fuel storage building. Basically what we have in these buildings is between 8 inches and up to 36 inches of reenforced concrete.

Now, when you look at the requirements -- well, I shouldn't say the requirements, but the guidance from ACI, you can see that regardless of the aggregate we use, that we have structural barriers that are at least rated for 3 hours. And so we conclude that our structural elements all have a fire rating of at least 3 hours.

CHAIRMAN POWERS: And what you're saying here is that you've set up a departments that no single fire will be caused because of building collapse, is that right?

MR. ROSENBLOOM: That's one aspect of it. To me the other key aspect is insuring that a fire in it will be contained to a single fire.

CHAIRMAN POWERS: And that really is your design basis then? Is that any fire will be contained in -- there's zero probability of going from one fire area to the other?

MR. ROSENBLOOM: Correct.

CHAIRMAN POWERS: That's a tough design

basis.

MR. ROSENBLOOM: There's a lot of fire areas.

CHAIRMAN POWERS: A lot of fire areas, and I was going to comment, you'll learn to regret making so many fire areas.

MR. ROSENBLOOM: So, getting to summarize what our fire safety strategy is. As we talked about, we have lots and lots of fire areas, far in excess of 300. We have detection suppression for those rooms containing disperse reactive materials to provide defense-in-depth to those barriers. We do prevent fire in certain locations in our process cells because there are no ignition sources. We also have a controlled combustible and controlled ignition sources.

CHAIRMAN POWERS: I will comment to you that that at the Savannah River site, and I know that's not you, it's historically had a tremendous difficulty with control of transient combustibles. I mean, it seems to be a part of the culture there to --

MR. SIEBER: Safety culture.

CHAIRMAN POWERS: This is the transient combustible culture here. I just comment.

MR. SIEBER: Well, I think it's my

understanding that the protective systems here are quite different than a power plant, for example. You're trying to maintain ventilation to keep the gloveboxes at a negative atmosphere, and so forth. That would be difficult to prevent a failure of some thing fan HEPA filter combination. Because you probably only have one fan per box, right? But it's not a radiological disaster if the fan shuts down. So I presume that that's okay, right?

MR. ST. LOUIS: Well, I will be getting into the ventilation in the next presentation, and the number of fans and how it's all connected together.

MR. SIEBER: Yes. You'll let that answer the equipment.

MR. ST. LOUIS: Well, I'm the guy, so --

MR. SIEBER: All right.

MR. ST. LOUIS: Hopefully I'll answer it then.

DR. LEVENSON: Let me ask a question about your definition of no ignition sources. Does that mean that there's nothing electrical inside the room or what is inside the room is explosive proof electrical, or what? What does that mean?

MR. ROSENBLOOM: It's your former one. There's no electrical devices within the room.

DR. LEVENSON: No pumps, no motors, no lights, nothing electrical?

MR. ROSENBLOOM: That's correct.

MR. ROSEN: No lights?

MR. ROSENBLOOM: That's correct.

MR. SIEBER: Well, some of your fire areas are gloveboxes, right?

MR. ROSENBLOOM: Right.

MR. ST. LOUIS: Just a clarification. We're just talking about one series of rooms in the buildings and not all of the room.

DR. LEVENSON: Yes. No, no. But those were did you say there were no ignition sources, let me get a definition for what that meant.

MR. ST. LOUIS: There is no ignition sources other than process fluids that inside welded tanks, there's no combustibles in the room either.

MR. ROSEN: Now you said there were no lights in these rooms.

MR. ST. LOUIS: That's correct.

MR. ROSEN: So when you go in to do maintenance on them, on compliments in these rooms, you would bring the lighting sources with you?

MR. ST. LOUIS: That's correct.

MR. SIEBER: There you go.

MR. ROSEN: Very unusual.

CHAIRMAN POWERS: I don't know how unusual it is for process facilities. I mean, that's not -- that's pretty common to have -- to have to bring your own lighting. Of course, that means you bring your own ignition sources, too. I mean, most of our fires in process facilities occur when we're doing maintenance.

MR. ROSENBLOOM: Again, talking about multiple fire areas as to why we have those. Here's some key factors here.

It limits our combustible loads so that we contain -- contain them to a single fire and that includes transient loads. It limits the extent of any individual fire, of course. It limits the MAR, the material at risk.

CHAIRMAN POWERS: Material at risk.

MR. ROSENBLOOM: Material at risk.

CHAIRMAN POWERS: And I wanted to ask you about that, because I read one of them -- I'm sure I read one of them that said there was -- the material at risk was 890 kilograms. Yes, it's limited, but not a very big limit.

MR. ROSENBLOOM: And the fact that we're talking, again, about multiple fires that effectiveness of having multiple fires is shown by a long history of fire safety, analysis and tests.

DR. KRESS: What kind of access do you have for these rooms?

MR. ROSENBLOOM: Oh, the process cells?

DR. KRESS: Yes. Are there doors in between?

MR. ROSENBLOOM: No. None normally. These are cells that you'd only go into maybe once a year, if likely.

CHAIRMAN POWERS: Once in a leap year is more likely.

MR. ROSENBLOOM: And we're in the process of actually designing those access ways. But just think of them as removable panels that would be bolted in place.

I mentioned the control combustibles before. We control our combustibles and we limit their use by using noncombustible and nonflammable materials to the maximum extent possible. We use a thermally stabilized form of our pyrophoric materials, the plutonium oxide and uranian oxide, so it's essentially noncombustible.

The sulton diluent we use in the process of buildings are usually handled within welded equipment and it's a NFPA 30 compliment. And we use fire retardant electrical insulation.

And as mentioned before --

CHAIRMAN POWERS: When you say fire retardant electrical insulation, what particular insulation are you talking about?

MR. ROSENBLOOM: IEEE 383.

As mentioned before, by controlling ignition sources, we talked about restricting location of electrical equipment. That applies to the process cells. We don't have any. We ground all our equipment. We also have a hot work permit system, as you talked about, where maintenance is the most likely place you're going to have a fire. WE have a hot work permit system.

CHAIRMAN POWERS: How many fires have we had at facilities with a hot work permit system?

MR. ROSENBLOOM: How many?

MR. ROSEN: It's equal to very close to the total number of facilities that have had a fire.

CHAIRMAN POWERS: That's almost identical, in fact. Per year.

MR. SIEBER: Well, it's to aid in figuring out who started it.

CHAIRMAN POWERS: I didn't hear you, Jack.

MR. SIEBER: It's an aid to figuring out who started the fire.

CHAIRMAN POWERS: I think that's what it is.

Go ahead.

MR. ROSENBLOOM: All right.

So in conclusion, we call it multiple layers of fire protection. We have low combustible loads, control our ignition sources, we have multiple fire areas, we have our fire detection systems, fire suppression systems, fire brigade and we also have a fire prevention protection program in place.

Next slide.

CHAIRMAN POWERS: In the -- it may be premature to ask this, maybe it's not, is there a fire engineer on the staff of this facility?

MR. ROSENBLOOM: Right now?

CHAIRMAN POWERS: To be when it's built.

MR. ROSENBLOOM: It'll probably be me.

CHAIRMAN POWERS: Okay. That's good, actually. I think --

MR. ROSENBLOOM: But also I can tell you it's part of the fire protection program, there will be a fire protection engineer on staff.

CHAIRMAN POWERS: Okay. Okay. Good.

MR. ROSENBLOOM: Any questions?

MR. KAPLAN: This is Gary Kaplan again.

Steve, I'm uncomfortable with how we left you on your question. I don't think we answered your question fully. So I want to -- if you want to bring it up again, I'd want to try to answer it.

MR. ROSEN: Well, I don't think you've answered it.

MR. KAPLAN: Okay.

MR. ROSEN: But I -- the facility that has numerous flammable fluids in it. And that while it's true that it is designed to not have a lot of external flammable or combustible materials, it does have piping and it does have pumps and I presume it has valves that are electrically controlled. So it must have wiring and other stuff. And it has people, so you know it can end up with errors being made and stuff being left around.

And my feeling is that there are enough of those sources that there ought to be a look at how fires could be fed by more than just the combustible loading within a given cell. And a look to see that cells that are adjacent to a cell where a fire starts for some reason, could not feed that cell with additional flammable fluid through piping, and that's the question.

MR. KAPLAN: That's a reasonable request. We'll -- I think we've covered that in our initial analysis, but we'll go back and look specifically at that and make sure that we handle that appropriately.

MR. ROSEN: And I hear a lot of the cautions -- I appreciate that. And I hear a lot of the cautions to my question which don't worry about because this is a very small fire, and it's very -- there's not that much stuff. But even so --

MR. KAPLAN: Right no.

MR. ROSEN: -- you ought to go back and look for it.

MR. KAPLAN: We'll look.

MR. ROSEN: And make sure you can't exacerbate an existing fire.

MR. KAPLAN: Okay.

MR. ROSEN: Thank you.

CHAIRMAN POWERS: Any other questions to the speaker?

In that case, I propose we take a 15 minute break and we'll come back and attack fire again.

(Whereupon, at 3:58 p.m. a recess until 4:17 p.m.)

CHAIRMAN POWERS: Let's come back into session and have any discussion of fire protection?

Sharon Steele, are you ready to present? I don't see Sharon. There she is. Sneaking up on me again, aren't you?

And just DCS doesn't feel discriminated against, Sharon, I'm going to ask you also to talk a little bit about the defense-in-depth philosophy for fire that DCS had adopted and what you understand about their treatment of the effects of fire on electrical circuits.

MS. STEELE: Okay. You mentioned in the reactor role, defense-in-depth the objective is to prevent fires from starting, detect them quickly and extinguish them or control them, and to provide protection for structures important to safe shutdown.

I believe DCS's main strategy would be to confine any fires that occur. That's why they're providing so many fire areas. They want to contain -- divide the combustibles into small amounts, contain the fires to one fire area and certain areas they will provide detection and suppression as defense-in-depth. Those are treated as principle structure systems and components, which may become IRAs.

And in terms of protection of structures important to safety, the main features I would think of to compare that to the reactor world, would be the exhaust systems that are provided for the gloveboxes and the process rooms. In other words, these C3/C4 confinement systems, which are supposed to remain operational during a fire. And those are active systems. They are redundant systems and they are provided with redundant electrical trains that come into the building, into the facility and are separated at least 150 feet apart when they enter and in conduit inside the facility.

In terms of electrical fires, my understanding and what we have the draft SER and the first draft SER, I believe, is that electrical hot shorts or faults would be detected in the systems. And that there would be some sort of fault interrupter. And those sort of initiators do not propagate throughout the systems.

And so I feel that they are looking at defense-in-depth from that point of view. They are providing successive layers of protection at each area, or at least they're attempting to do that.

CHAIRMAN POWERS: Do we have scenarios where we fail the bust bar providing power to C3/C4 --

MS. STEELE: Well, we feel that they are

not providing sufficient power?

CHAIRMAN POWERS: No. Where we lose all ability to provide -- we would have a station blackout.

MS. STEELE: Okay.

MR. WESCOTT: Let me answer that, Sharon.

MS. STEELE: Okay.

MR. WESCOTT: I'm Russ Wescott. And I'm the ISA lead.

And, no, the C3/C4 systems are -- it's not considered a credible accident to lose them, because the number of redundance; fans, power sources. And I think possibly probably Tim Johnson can talk a little bit more about that when we -- in fact, he's ready to right now.

MR. JOHNSON: For the C3 and C4 systems there are four power supplies to those systems. The normal system, the emergency, the standby system and uninterruptable power supply. So for those to fail, all four of those would have to fail.

CHAIRMAN POWERS: And the way to fail them is fail the bust bar. The power comes into the system.

MR. KIMURA: Steve Kimura, DCS.

There are two separate bust bars for each system, for the C3 and the C4.

CHAIRMAN POWERS: You guys have an answer for everything, don't you? Here I come up with this great idea and you're just -- okay.

MR. WESCOTT: Could I add one more real quick one?

I was the person who wrote the fire protection part of the SRP. And when we started writing the SRP, we had a lot of discussions about putting in Appendix R type requirements in this. And we made a conscious decision not to, because we thought the facility was considerably different from a reactor, not only in design and combustible loadings, but also in the basic objective of what you're trying to accomplish with Appendix R as opposed to the fire protection here.

So I think that's one of the reasons you don't see the Appendix R type requirements here.

CHAIRMAN POWERS: I guess when you think about -- when I think about it, it's hard for me to believe that the combustible loads of this facility are going to be less than those of the fire areas in a reactor. I mean, it just seems implausible to me. Steve, am I --

MR. ROSEN: No, and that's why I was

pursuing this business that I was pursuing earlier. You've got all of these flammable fluids around, something we typically avoid in reactors except where it's unavoidable.

MR. WESCOTT: Well, in course in reactors you have a lot of pump lubricants. And, of course, here your cable tray loadings and so on. I don't think they're all that much different here. I mean, they're significant here, they're significant in the reactors.

MR. ROSEN: I think you can fires in either. I mean, that's what you should conclude.

MR. WESCOTT: Sure. Sure.

MR. ROSEN: And then see what happens if you have a fire. Now, what do you have a stake? Well, here you have solutions bearing plutonium. That's something you don't have in a reactor. And the consequences of release of those solutions after you have a fire, it could be quite significant.

MR. WESCOTT: Well, I'll let Sharon address the different types of fire protection.

MS. STEELE: Okay. One area that Lary talked about quite a bit was the Fire Hazardous Analysis, which is a systematic approach to looking at the combustibles in a particular area, looking at all the fire protection features that are provided in that area and making a determination as to their adequacy.

I know that currently on NRR's side they also used -- they're promoting Fire Hazardous Analysis more often now, because in spite of whatever requirements they have for Appendix R, they still have to ensure that each particular fire scenario as they come is addressed by the particular features in the facility. And so I think the Fire Hazardous Analysis is sort of a risk informed sort of tool that we promote on this side, and particularly with Part 70, or I should say with the SRP. And that is really the way that more facilities are going.

MR. ROSEN: Well, I think that's great. And just all I'm trying to do is make sure that the right inputs that do that analysis are used.

MS. STEELE: Right.

MR. ROSEN: And I guess they heard earlier that they might take another look at that and make sure that they're not missing some of the right inputs.

MS. STEELE: Right. And I have some open items that could address some of that concern, too, that they're still addressing.

So, can I go ahead?

CHAIRMAN POWERS: Please.

MS. STEELE: Okay. For those of you that didn't hear, my name is -- well, it's up there. Sharon Steele.

CHAIRMAN POWERS: Oh, I thought it was Fire Protection Engineer.

MR. ROSEN: And you're still Sharon Steele.

MS. STEELE: Yes. Yes. And I'm the fire safety review for the MOX facility.

And my presentation today will focus on the resolution of the status of open items that were identified in the draft safety evaluation report that was issued in April of 2002.

In a nutshell, there were four main areas. WE've closed two items, and they pertain to the glovebox window material and to the facility wide system. However, we still have concerns regarding the fire barriers and the soot loading analysis.

Our Standard Review Plan, NUREG-1718, recommends that the facilities follow the applicable guidance or requirements in the National Fire Protection Association codes and standards. And in particular, DCS -- the applicant has adopted NFPA 801 as a design basis for their facility.

And NFPA 801 says that facilities shall not use combustible materials for their glovebox, including the glovebox windows. However, the application is using polycarbonate in order to reduce the seismic risk and overall risk at the facility.

In addition to the Construction Authorization Request, the applicant submitted the polycarbonate report, which is really formally know as "The Choice of MOX Fuel Fabrication Facility Process Glovebox Window Material," but we call it polycarbonate report for short. And that report indicated that polycarbonate had superior seismic inertia and deflection properties when compared to glass, which is allowed by code. And superior fire protection properties when compared to other plastics, such as polymethyl methacrylate, which had been used in other similar facilities.

CHAIRMAN POWERS: I wonder what the authors of NFPA 801 had in mind when they said none? I mean, had they no experience with gloveboxes whatsoever?

MS. STEELE: Yes. Well, one of the concerns -- a lot of these requirements came out of -- because of a result of the Rocky Flats fires, where the gloveboxes were in fact polymethyl methacrylate and Benelux and there were some significant fires which led to contamination of the facility. And so they felt that if you reduced the number of combustibles, reducing the combustibles by design through the use of noncombustible materials in the gloveboxes, that that would go a long way to reducing the fire hazard.

CHAIRMAN POWERS: Yes. But they -- the trouble is that the term noncombustible.

MS. STEELE: Right.

CHAIRMAN POWERS: IF they're poorly combustible or something like that -- limited combustible capability.

MS. STEELE: Right.

CHAIRMAN POWERS: We would have gotten out of the problem here. But they instead they used something that drives you toward glass, which is probably the worst thing to use.

MS. STEELE: One of the things about the NFPA codes is that it encourages a lot of discussion between applicant and regulator. And, for example, there's a little caveat that says that if the authority having jurisdiction allows you to do something differently, then you may if you have sufficient justification.

CHAIRMAN POWERS: The problem is that it's very misleading to a member of the public.

MS. STEELE: Yes.

CHAIRMAN POWERS: He comes along and he reads this word noncombustible and he comes and he says -- and the NRC allowed them to use this horrible combustible material, this carbon --

DR. LEVENSON: Not only that, but he used combustible gloves.

CHAIRMAN POWERS: Okay. Continue on.

DR. LEVENSON: Let me ask a question. When the comparison was done to glass, was it done with laminated safety glass or just plain glass?

MS. STEELE: Just plain, and the report talks about plain glass.

DR. LEVENSON: Because see at Argonne for many, many years they've used laminated safety glass.

MS. STEELE: Right.

DR. LEVENSON: Which does answer the seismic thing, etcetera.

MS. STEELE: This is just a picture for those of you who are not familiar with gloveboxes, showing a typical installation. I believe this one is from the MELOX facility.

As a result of the information in the

polycarbonate report, we've requested that the applicant provide a design basis criteria to assure that the mechanical fire and seismic properties as stated in the polycarbonate report were in fact bounding and valid for the end use of the gloveboxes.

In reading the construction authorization report requests, we determined that there were additional protective features provided for rooms that contained gloveboxes, such as automatic detection and suppression systems, which were already described. These are principle structure systems and components. There are manual -- the operators are able to use CO_2 manual injection ports that are in the gloveboxes to suppress incipient stage fires.

Most of the gloveboxes are inerted with nitrogen, and that helps with -- helps to reduce the fire hazard.

And also the applicant is proposing combustible loading controls as a principle structure system and component for gloveboxes that store large amounts of radiological material.

When we looked at the Fire Hazards Analysis we determined that polycarbonate was in fact accounted for in their analysis. And that helped with our accepting the use of the polycarbonate glovebox material.

Also, the applicant has agreed to evaluate in the safety analysis whether the values provided in the polycarbonate report are bounding for the expected us, and they will look at normal operating conditions such as material creep due to excessive temperatures, radiation and aging.

As a result, NRC considered the polycarbonate material as a candidate material for use at the facility.

And just -- I'm sorry.

MR. SIEBER: Do you have any gloveboxes that the fire is in and of themselves?

MS. STEELE: That a fire zones in those areas?

MR. SIEBER: Zones.

MS. STEELE: No. The gloveboxes would be contained within a fire area.

MR. SIEBER: But they in themselves are not the boundary of a fire area?

MS. STEELE: No. They're not the boundary of the fire area. In fact, in their safety assessment they assumed that if there is a fire inside of the gloveboxes, that the glovebox would be consumed by the fire.

MR. SIEBER: Disappears? Yes. Okay.

MS. STEELE: And Lary just showed me a sample of polycarbonate. This one had the propane torch exposed to it for 30 seconds. I can pass it around.

MR. ROSENBLOOM: Self-extinguishing.

MS. STEELE: Right. I don't like to use that term, but if you remove the flame from the polycarbonate, it does not sustain combustion. I have numbers on the ignition temperature. The self-ignition temperature is over 1000 degrees F for polycarbonate.

CHAIRMAN POWERS: These gloveboxes use aluminum?

MS. STEELE: They are stainless steel. The frames are stainless steel. And they follow -- what is it? ANSI N-690 criteria.

The next item that was open had to do with the propagation of hot gas through the pneumatic transfer systems. And these systems carry materials throughout the facility, usually in convenience cans or sample vials between the gloveboxes. So they go across process atmospheres.

And the last time I was here I think someone likened it to driving up to a bank teller and withdrawing money.

So, the concern was that hot gases could be transported across fire area boundaries.

These transfer tubes are composed of double wall piping, and while that offers some protection against fires, the revised CAR indicated that the applicant would be providing combustible loading control as a PSSC in the rooms that contain these automatic transfer systems.

They have also committed to analyze in the integrated safety analysis the impact of hot gases being transported throughout the tubes. And they will determine where isolation valves could be required and if so, they would provide them as IROFS.

DR. KRESS: What kind of gases do they use?

MS. STEELE: Just hot gas -- smoke and gas from a fire.

DR. LEVENSON: No, the transport gas.

MS. STEELE: I'm sorry?

DR. LEVENSON: The transport gas.

DR. KRESS: The transport system. What's the propellant gas?

MS. STEELE: Oh. Oh, I don't know. For the vacuum system. Does anyone know what that is?

MR. ST. LOUIS: Tom St. Louis. DCS.

It's just ordinary air. They have blowers that provide motive power.

DR. LEVENSON: How does that interface with the glovebox as it has inert atmospheres? Do they vent into those boxes?

MR. ST. LOUIS: No. There's a seal where you introduce the vial into the transport system. It is like the bank system. You transport a container and the principle purpose of it is to move samples from the gloveboxes to the lab.

MR. ROSEN: So you take the sample out of the glovebox, put it in this pneumatic container and put that -- you don't transport directly from the glovebox?

MR. ST. LOUIS: No. There's a seal. And you do transfer it inside the glovebox.

MR. ROSEN: Well then Milt's question is not answered. The glovebox has an inert atmosphere and the pneumatic tube has air.

DR. LEVENSON: What does it have, a little airlock or something?

MR. ST. LOUIS: Yes, it has a little airlock.

DR. LEVENSON: So if it has an airlock, then hot gas is moving down the system don't automatically get into the other gloveboxes?

MS. STEELE: Right. Not automatically. But that is something that we want them to evaluate, wanted them to evaluate --

DR. LEVENSON: It takes another failure --

MS. STEELE: Right.

DR. LEVENSON: Failure of the airlock?

MS. STEELE: Of the airlock.

So their commitment to evaluate the impact of hot gases in the ISA stage along with combustible loading controls gives us a confidence that the finalized design would be acceptable. And so we closed that open item.

One open item has to do with the fire barriers. And, of course, you know that this is one of the main PSSCs for all fire events, and it is a PSSC for many other kinds of events.

In the draft SER we determined that the margin of safety that was provided for the fire barriers was insufficient. At the facility their barriers are rated a minimum of 2 hours. And I believe there was a question as to why 2 hours.

Well, one answer is that, perhaps, our Standard Review Plan also recommends that a minimum of 2 hours be provided throughout the facility.

I'm sorry?

MR. WESCOTT: Do you want me to answer that one why?

MS. STEELE: Oh, okay.

MR. WESCOTT: Yes. Well, we borrowed the criteria from a lot of existing DOE criteria. And DOE had picked 2 hours for plutonium facilities for fire area boundary. I guess after looking at the type of fire loads and consequences, and so on.

As you recall, Appendix R for reactors required 3 hours. So the problem with the 3 hour barrier is you cannot build it all of noncombustible materials. One of the reasons they had a 3 -- they specified 3 hours because it practically had to be basically reenforced concrete construction or fire doors or something of that nature. And we didn't really think there was a justification for going quite that far unless the fire loads justified it.

So basically what we did, we had a minimum, we arrived at a minimum 2 hour barrier. Now, if you have a fire load in there, like let's say you had -- you were storing a diesel fuel day tank or something like that, you might very well want to consider making that a 3 hour or greater barrier.

The 2 hours is just a minimum. But we had picked that based on -- and also I think 801 specified one hour barrier.

MS. STEELE: That's true.

MR. WESCOTT: So, really, this was kind of in between the ANSI -- or excuse me. The NFPA 801, the NRC Appendix R, and it was pretty much right in line with existing DOE requirements. So it appeared to be a good minimum.

CHAIRMAN POWERS: The other issue in that standard is the time temperature curve, which ultimately comes from combustion of a wood frame hotel in 1910.

MS. STEELE: Right.

CHAIRMAN POWERS: It's applicability to anything else is a mystery to me.

MS. STEELE: Right. We have a slide that we can put up. I'm not sure how we -- well, this is not. I'll get to the other.

This is somewhat related.

CHAIRMAN POWERS: Have to use the microphone.

MS. STEELE: Oh, okay. The upper -- well, as you can see, there are three curves there. There you go.

Okay. This curve represents the ASTM I

think it's 1929 curve, and that's a more recent development, which applied usually in the protrochemical industry to reflect what an unprotected steel might -- unprotected steel columns might see when there's a hydrocarbon fire.

And this lower curve here is the ASME E-119 curve which, as you said, was based on office furnishings from 100 years ago which is not similar in today's environment. And, in fact, what this curve is showing here, this is from a test that was done on some office furniture fires in 1970s. And that exceeds the balance of the ASTM E-119 curve.

Now, the next slide that I want to show -- Russ, can you put that second one up. Yes.

What the applicant that was --

DR. LEVENSON: Excuse me. What is that top curve from again?

MS. STEELE: ASTM E-1929.

DR. LEVENSON: Yes. Yes.

MS. STEELE: The one I'm pointing?

DR. LEVENSON: Yes.

MS. STEELE: That is the one that is used in the petrochemical industry to reflect a hydrocarbon fire.

MR. ROSEN: What's the axis? I can't read it.

MS. STEELE: Okay. Time in minutes.

DR. LEVENSON: 1100 degrees.

MS. STEELE: Oh, on the X axis from zero to 60 minutes. And then from zero to 1200 degrees C.

MR. ROSEN: So it goes to 1100 degrees C in five minutes?

MS. STEELE: That's exactly right. That's the criteria. That's a flash fire.

MR. ROSEN: That's C? C degrees?

MS. STEELE: Yes. And I might be incorrect about the flotation -- I believe -- somewhere in the back of my mind I'm thinking it's ASTM 1729, but I can't read it. So I'm thinking it's 1929. I can verify that for you later.

This is the ASTM E-119 curve, which is used typically. Yes. Yes.

MR. WESCOTT: Once you start getting away from the E-199 curve, you really don't have any basis for comparison. Because, you know, when you talk about a 3 hour wall, normally, or a 2 hour wall or one hour fire barrier, this is all based on the E-119 curve at this time.

MS. STEELE: There are a lot of criticisms of the ASTM E-119 curve. It's not representative. But there's also a lot of resistance to change or to try to find another type of standard curve. So this is what we've been stuck with for the last 100 years, and I think probably for another 100 years, unfortunately.

MR. ROSEN: It's okay to have a bad century, now and then. It's kind of like what the Cubs did.

MS. STEELE: Right. And what is typically done is that you add up all the combustibles that available in a room.

And you can put up the other curve, the other graph, please.

And use the equal area hypothesis method to relate the fire severity to the fire barrier rating. Now that's another rule of thumb that's commonly practiced, commonly used in the fire protection community and there are criticisms of it.

For example, the assumption is that this curve, which reflects -- well, it says here real fire, and this curve which would be the ASTM E-119 curve, that the areas under those curves at a certain baseline would represent similar severity.

And I would not argue with that too much if the fire that we were looking -- were interested in was below the standard curve so that, in other words, it was bounded by that standard curve. But -- yes, temperature.

But, for example, one of the measures of the severity is the heat flux to a particular item. And heat flux is based on temperature to the fourth power. So when you start comparing this way, technically you cannot justify -- you cannot defend what's going on.

And so we asked DCS to find other methods to analyze the fire barriers.

Okay. We can go back to regular.

So DCS, the applicant went back and they used FP to -- I think Lary mentioned that -- to demonstrate the duration of the fire. And they were able to show that four most of the fires at the facility that the duration of the fire was less than the fire barrier rating. However, they used a slow growth fire assumption, which is conservative if you're looking at just duration. But I felt that it was nonconservative when you're looking at temperature effects.

CHAIRMAN POWERS: Or heat flux effects.

MS. STEELE: Heat flux, yes.

So for the Construction Authorization, the applicant will evaluate those scenarios that could exceed the temperature profile in the ASTM E-119 curve. They're going to use a rapid group fire assumptions. And where the temperatures do exceed the ASTM E-119 curve, they'll look at whether it could withstand thermal shock. They'll look at, perhaps, some sort of heat flux, heat transfer analysis to make that determination.

They've also committed for the integrated safety analysis to look at issues such as flashover, whether that would be credible for any of the scenarios. And, of course, flashover if that occurs there would be accounting for whether the barriers actually fail and could involve more than one fire area.

CHAIRMAN POWERS: Will they look at how systems and structures respond to fire suppression activity?

MS. STEELE: I don't believe that is part of what they're be looking at to resolve this particular issue. The idea is that fire suppression is defense-in-depth, and although it's not credited in the ISA, it provides an additional layer of protection.

CHAIRMAN POWERS: Well, what I'm thinking about is in the integrated safety analysis.

MS. STEELE: Okay.

CHAIRMAN POWERS: Because they are going to have suppression.

MS. STEELE: Right. They assume -- all of this is assuming that the fire suppression does not work.

CHAIRMAN POWERS: And if it does work, does it cause the structure to fail because it's working.

MS. STEELE: Yes. You're looking at issues, for example, like the -- well, this would not be water, but this would be clean agent, effective clean agent.

MR. WESCOTT: I think overpressurization maybe be --

CHAIRMAN POWERS: Actually, the first thing that comes to mind is thermal shock, because thermal shock is much worse in cooling than it is in heating. And a lot of other things. Thermal contraction, destruction of breakage sorts of things.

MR. WESCOTT: No, we had not looked at that. But I think for the --

CHAIRMAN POWERS: Well, I think it's more appropriate to look at it in the integrated safety analysis.

MS. STEELE: Right.

MR. WESCOTT: Right. It's probably much less than you would with a water sprayer sprinkler. I mean, water's going to take a lot more ---

CHAIRMAN POWERS: You betcha. You betcha.

MR. WESCOTT: -- then -- you know, a gaseous agent like intergen is going to.

CHAIRMAN POWERS: But on the other hand, summary is that you fight with water.

MR. WESCOTT: You mean like when the fire brigade comes.

CHAIRMAN POWERS: Like when the fire brigade comes.

MS. STEELE: My understanding was that -- well, I see Tim St. Louis out there. But that the fire brigade would respond with additional clean agent suppression in certain areas as well.

MR. ST. LOUIS: Yes. Just to go back to the analysis question. We have this part of our ISA, we are looking at both temperature and distribution, or pressure and distribution transients when we discharge clean agent into a room to make sure that there's no structural damage to either the glovebox or the structure.

And as far as responding to a fire, we do have additional clean agent bottles that can be installed and discharged into a room if it's necessary to do that.

MS. STEELE: So at any rate, this particular issue remains open until we receive further information in the Construction Authorization stage.

MR. WESCOTT: Can I say something real quick to answer a question?

One of the requirements the SRP when we do get to the ISA stage is to have e fire plans for every area. So if you don't have the fire data, for example, using water in a moderation control area, you know, you plan all those things out beforehand so if the right agent is used for the right fire in the right --

CHAIRMAN POWERS: Yes, that's good. I mean, you do have that criticality concern. The opposite concern has arisen so often that we have electrical fires and people are afraid to put water on them, that we let the damn things burn forever.

MS. STEELE: Okay. The next open item is out of the soot loading analysis. As you know, as I said before, the process -- the facility's designed so that even during a fire, the process room and glovebox exhaust systems remain operational. And to protect the final HEPA filter, the hot gases are diluted with air from other area. Spark arresters and pre-filters are provided.

In reviewing the calculations in the Construction Authorization Request, we found insufficient justification that the final HEPA filters could perform their safety functions under fire soot conditions.

For one, analysis provided for the glovebox exhaust system and the one that was provided for the process room did not appear to have inadequate capacity to remove expected soot loading.

CHAIRMAN POWERS: What do you anticipate the blowout loading is?

MS. STEELE: The blowout loading?

CHAIRMAN POWERS: Upon the HEPA filter? How much can they take before they blow out?

MS. STEELE: Yes. Well, Tim Johnson will talk about it some more.

MR. JOHNSON: The assumed blowout loading was ten inches of water.

MS. STEELE: Right.

CHAIRMAN POWERS: That's the blowout pressure drop. What does it take to get to that?

MR. ST. LOUIS: Right. What DCS did was they used a method that had been developed in the literature involving -- they had a sample fire that I think used tributyl phosphate, no dodecane source. That created soot. And they watched the loading on some sample filters over a period of time and they developed a correlation based on that. And that was the basis for their calculation. But what their intent was, was to limit the loading to under 10 inches of water. And by doing that they felt that that would not present such an aggressive loading that it would fail the filter.

CHAIRMAN POWERS: Okay.

MS. STEELE: Another issue with that correlation was that, that correlation in particular was developed using solvent fires and we didn't feel that it reflected combustibles at the facility.

CHAIRMAN POWERS: It's not going to cover polycarbonate fibers, that's for sure.

MS. STEELE: Right.

The applicant is revising the final filtration analysis. They've provided the information in February and April of this year. We've not incorporated that into the revised draft SER because of the timeliness of the report.

And soot loading analysis will be experimentally verified, and we look forward to that.

In conclusion, we do plan to have more technical meetings with the applicant on the open items. And they will be providing additional information to us, which -- in order to address the open item. And we hope to receive that before the final Safety Analysis Report is issued.

CHAIRMAN POWERS: Questions of Sharon's presentation?

MR. SHACK: Yes, just one question. You mentioned that the separation requirement in the electrical system was entering the building. I couldn't find anywhere the separation requirements within the building for the redundant systems. Do they have a formal requirement, or they just assumed it's in conduit and it's okay.

MS. STEELE: It's in conduit. I've seen-- I wish the electrical reviewer was here. But I think it's all in the concepts in IEEE 384. Separation requirements there?

MR. WESCOTT: There's no mention of a 20 foot requirement.

MS. STEELE: Right. Right.

MR. SHACK: That was sort of what I was looking for.

MR. WESCOTT: Right. But it's my

understanding that it's probably much more than that--

MS. STEELE: More than that.

MR. WESCOTT: -- in most places. And since you really got four redundant, you know, feeds. I mean, you might have two of them that are within 20 feet, but another couple that are far away.

That's something we're certainly look at, because that is, to our knowledge, the only accident where we're concerned about total loss of an active system.

MS. STEELE: Okay.

CHAIRMAN POWERS: Any other questions?

That was very nice.

MS. STEELE: Thank you.

CHAIRMAN POWERS: That was very nice.

Now we're going to give the bosses the chance to give us closing comments. Is that -- confinement ventilation. Okay. So we're going to start with confinement ventilation, and it looks like a cast of thousands here before me. Tom St. Louis and Steve Kimura.

MR. SHACK: Although shouldn't we be doing fire and the HEPA first?

MR. ST. LOUIS: What I'm going to do is, I'm going to start off. Steve and I are going to be a tag team. I'm going to start off and define or describe the HVAC systems in the facility. And then he will describe the final filter units, the devices we're using to protect them in the event of fire and our analysis of the filter units.

Okay. This part of the presentation is for an HVAC system -- description of the HVAC systems in the MOX Fuel Fabrication Facility. What I want to go through in my presentation is the confinement principles, how we've applied them to the facility, what features in the facility we have that implement these principles. A brief summary of the HVAC systems and then just a brief discussion of how the systems would respond to a fire event.

MR. ROSEN: I had a confinement principal like that at PS 26. I still remember her.

MR. ST. LOUIS: Well, they're both spelled right, they're just wrong.

MR. ROSEN: It's spelled correctly, that's true.

CHAIRMAN POWERS: As I often point out to my colleagues, I spell very well, not always accurately but very well.

MR. ST. LOUIS: What we tried to do at this facility is we've used multiple confinement barriers, that these confinement barriers perform their function effectively during normal and abnormal conditions, that they confine radioactive materials as close to the point of origin or use as possible. That they present uncontrolled release of these materials.

With regard to the multiple confinement zone, we have three confinement zones; a primary, secondary and a tertiary. And we maintain differential pressures between each of these zones. And the HVAC system is capable of running an operating during a facility fire.

This slide is just some of the terminology that we will use in our discussion of the C1 confinement zone where there's zero potential for contamination. The C2 and PC confinement zones are very low occasional contamination potential, and it's equivalent to Reg Guide 3.12, zone III.

The C2 -- well, I'll go into a little bit what's in each of the rooms in the next slide. Next couple of slides.

The C3 is low to moderate risk. The material is more easily disburseable. And the C4 is basically the internal of the gloveboxes.

Now in applying these confinement principles, we use the walls, gloveboxes, vessels, cladding as the static separation devices. All the doors are gasketed. Penetrations have seals on them.

We use air locks when transitioning between confinement zones, and we have HEPA filters at HVAC openings in the confinement zones.

We have a relative pressure gradient with C5 being the most negative, C3 and C2, and then of course the ambient.

We permit fully welded enclosures in the C2 and PC zones. And then we utilize two stages of HEPA filters in the final filters prior to discharge from the atmosphere.

We also use intermediate filters on the gloveboxes. There's one inside and one outside of each glovebox.

When we transition from C3 into the C3 rooms, we have a HEPA filter on the inlet and on the outlet. And we have HEPA filters on the intake. And we have two stages of HEPA filters on the exhaust, as I mentioned previously.

This slide here is a schematic depiction of what I just described. The outer areas represents the C2 boundary, so the outside of that is the C1 or environment. The inside is the C2 boundary. Instead the C2 boundary is the C3 areas which are process rooms. Process rooms contain the gloveboxes.

Also inside the C2 area is a process cell area which contains all the welded equipment for the aqueous polishing units. As you can see in this diagram, the rods are out in the C2 area.

You can see from the illustration also the various filters that we have located in the facility at the boundaries where we transmit from one confinement zone to the next.

There's HEPA box -- glovebox filters. There's the filters on the C3, the inlet filter and the dual stages on the final filters before we discharge to the environment.

This slide is a depiction of part of our facility showing the different confinement zones. This area is the C2 confinement zone. This area is the C3 confinement zone. You can see the air lock here. And this is the process cell confinement zone, which has plugs in the wall. It's really not an accessible area.

Now the HVAC systems that we have at the facility consist of the supply air system, which distributes air to all rooms, a medium depression exhaust system which exhausts the C2 zone which consists primarily of electronic units, IO cabinets, control rooms and the corridors.

Process cell exhaust system that exhausts the PC zones where all the process aqueous polishing process equipment is. A high depression exhaust system exhausts the C3 confinement zone, and it exhausts the process rooms that contain the gloveboxes.

And finally, the very high depressurization exhaust system exhausts all of the gloveboxes.

Now, the next slide is a schematic depiction of how this all fits together. And let me start by saying that the whole facility has 500 some rooms in it, so it becomes difficult to boil this down to a simple little picture.

This is the intake assembly, up in the top. And the center part represents the various rooms and spaces in the facility.

These areas here represent gloveboxes. These areas, depending on system they are, exhausted on could be C2 or process cell areas.

And then around the outside here we have the various final filter units.

You will note that we have 100 percent capacity supply fans. We have 100 percent redundant capacity exhaust fans on the MV system. On the C3 system, on the process cell system, but we have four 100 percent capacity fans on our glovebox system.

As far as filter capacity goes, we have about 110 percent capacity in the C2 exhaust system. We have one spare filter housing.

In the C3 exhaust system we have 100 percent spare filter capacity. We could take a whole bank out of service, it would still have enough capacity to handle all the exhaust flows.

On POE and HDE, we also have a 100 percent spare capacity. We can take the whole filter bank out of service and we'd still be able to handle the exhaust flow.

Now, you can see on here our intermediate filter locations. Generally when we transfer between confinement zones with ventilation duct work there's an intermediate filter. The practical aspects of that -- of applying that confinement principle means that we've grouped rooms together into circuits and flow paths to route them into a common intermediate filter.

This is just a summary of the air flows. And I put this in here to give you an impression of the magnitude of the HVAC system and the diversity of the system. Our VHD system, which is the gloveboxes, is about 3500 CFM. We have 240 gloveboxes. And our largest glovebox is 117 CFM.

And if you go through the rest of these, you will see that we have large systems, a large number of rooms and each room represents a relatively small fraction of the total flow for the exhaust system.

DR. LEVENSON: A thousand rooms?

MR. ST. LOUIS: Five hundred.

MR. SIEBER: It's a big hotel.

DR. LEVENSON: Oh, that last one is the supply. Okay. I was adding that to the other.

MR. ST. LOUIS: Oh, no.

Just briefly to go through the function of each of the HVAC systems. The supply system provides conditioned air for ventilation and environmental control.

It also is a principal PSSC in that it provides air for emergency cooling of our storage vaults and some of our PSSCs, for instance, the fan rooms for the fans. It incorporate the necessary controls to distribute and regulate the air. Portions of it are seismically designed, those that are associated with the PSSC. It has tornado dampers in it and it is not an active PSSC. The element that is a principal system structure or component is the duct work to distribute are for emergency cooling and the HEPA filters on the inlet to the unit.

Now the MDE exhaust system, again, is the system that exhausts the C2 area, which is principally the control rooms, corridors, electronic rooms. The system is controlled to maintain a negative pressure differential or maintain the C2 area more negative than the outside.

It has filters on the exhaust air prior to discharge. It has tornado dampers on the exhaust system. It is not an active PSSC in that the fans do not have to operate, but the exhaust filters and the exhaust path out of the building and downstream of the filters is seismically designed.

CHAIRMAN POWERS: Are the looked at tornado effects on the facilities have tornado sucking out HEPA filters?

MR. ST. LOUIS: We are dual tornado dampers, self-closing tornado tampers in the exhaust system and in the supply system.

Now, our systems operate fairly at relatively high pressures, at 27 to 50 inches of water is what they'll be designed to operate at at the house.

DR. LEVENSON: If the tornado dampers

close, you lose the emergency cooling of the vault feature?

MR. ST. LOUIS: Yes, you have no air flow, but it's a short duration and there is a lot of thermal mass there that's not a problem.

The process cell exhaust system is pretty much a duplicate o the C2 area. It is not an active system. It does have tornado dampers. It operates at a different pressure in the building. It's more negative than the C2 or the C3 area. So we've set up with a separate exhaust system for that area.

The HD exhaust system, this is basically the work horse of the facility. It exhausts all of the process rooms that contain gloveboxes. It maintains those rooms negative relative to the C2 confinement rooms. It provides the motive force to ventilate the PU storage area and selected other equipment rooms.

It has intermediate filters at all the boundary areas. And, again, this is an active system. It's on standby power and emergency power. It has tornado dampers. It is seismically designed and it has automatic tornado dampers in it.

The VHD exhaust system exhausts air from the C4 zone, which is the interior of the gloveboxes. It maintains the gloveboxes negative relative to the

C3 areas. It has intermediate filters as they show, both one filter inside, one filter on the outside of the glovebox and then another set of filters when we pass from the -- into the C3 to the C2 zones.

It is seismically designed. It's on standby emergency and uninterruptable power supplies. It's an active system. It actually can run during a seismic event.

It is sized to maintain a 125 feet per minute through either two glove ports or a bag port. Actually, it's a bag port is really the seized -- the opening that sets the size of the -- okay.

This is just a brief summary of how the system is designed to operate in the event of a fire in the C3 room. All the supply and exhaust fans remain in operation. There's no trips, no automatic shutdowns. The exhaust dampers remain open. They are manual dampers.

Clean agent is discharged into the room to suppress the fire. The fire dampers on the supply side are automatically closed after discharge of the clean agent.

The HD exhausts that passes through the intermediate filters can be bypassed in the event that the filters get loaded with soot. That way we're able to maintain that room at a negative pressure.

Products of combustion are cooled by flows from nonprocess rooms. As I noted, there's many circuits. The final HEPA filters, again, are designed to handle soot generated by the design-basis fire.

We've looked at the two largest rooms with the highest combustible loading when we're evaluating the operation of the final filters.

CHAIRMAN POWERS: Is that the right basis for deciding? Just because I have this large fire, does that mean it has the largest soot loading?

MR. ST. LOUIS: We picked the largest combustible load.

CHAIRMAN POWERS: Yes, that does not translate into the largest soot loading.

MR. ST. LOUIS: Possibly it's correct. We picked two rooms.

MR. KIMURA: No. We picked the rooms with the highest soot.

MR. ST. LOUIS: Was it with the highest soot? I know when we started, it was just the highest combustible load. And we did do a full yield analysis on each of the rooms.

CHAIRMAN POWERS: Okay.

MR. ST. LOUIS: Based upon their materials that are in the room.

CHAIRMAN POWERS: Good.

MR. SHACK: And the soot load comes from gloveboxes?

MR. ST. LOUIS: It's all combustible materials.

MR. SHACK: But I mean, is that where you get the highest -- the room with the highest, the one with the gloveboxes?

MR. ST. LOUIS: Yes. The C3 rooms have gloveboxes in them.

And finally, the C2 confinement zone provides a buffer around all the C3 rooms in the event -- during a fire event.

And lastly, the space can be manually isolated from the exhaust if deemed necessary to button up the fire.

The glovebox internal fire is somewhat similar, although not on the same scale. All the supply and exhaust fans continue to remain in operation. The glovebox fire detectors sound an alarm. The fire brigade or operator responds with a manual CO_2 unit. But all the other gloveboxes remain to be exhausted and are continued to be exhausted through the VHD system.

There are multiple circuits and multiple gloveboxes so the products of combustion are cooled to below the normal operating temperatures or the maximum operating temperatures of the HEPA filters.

And lastly an involved glovebox can be isolated from the exhaust.

DR. LEVENSON: Can it also be isolated from the supply system so you don't overpressurize it?

MR. ST. LOUIS: Yes.

MR. ROSEN: Could you go back to the prior slide just for a minute on a room fire? It just occurs to me that you say that the products of combustion are cooled by the flows from the noninvolved rooms. But isn't there a discharge also from the water fire suppression systems?

MR. ST. LOUIS: No.

MR. ROSEN: There's no water fire suppression?

MR. ST. LOUIS: Not in the C3 rooms.

MR. ROSEN: Not in the C3?

MR. ST. LOUIS: Water is only -- we have water -- we went into that. But we have water in the corridors and ceratin other parts of our facility where there's no material at risk.

In the C3 confinement zone, which is where the gloveboxes are, we have clean agent. And in all the electronics room, which is in the C2 zones, we have clean agent also.

MR. ROSEN: Well, it's been experienced typically, not in these kinds of facilities, but in a lot of facilities that the way you finally extinguish a fire is to cool it off. And the really only way to do that is to get water to it, "put the wet on the red," is what the fire people say. The wet stuff on the red stuff.

MR. ST. LOUIS: Yes.

MR. ROSEN: And here you've got a philosophy not to do that. And I'm worried about getting the thing cool enough, also it doesn't reflash the minute you bring in outside air or outside air infiltrates. What do you think about that?

MR. ST. LOUIS: Well, one of the reasons that we do have the capability to isolate the room completely is to -- and we've done an extensive analysis of the capacity of our fire walls, is to be able to isolate the room and let the fire burn itself off and cool off.

MR. ROSEN: By itself without any water?

MR. ST. LOUIS: Yes. As part of our fire barrier evaluations that we've conducted, we've looked at the fire profile in all of the rooms. In fact, we ran the analysis to maximize the duration of the fire. And they all are -- I believe it's 80 percent of the rating.

MR. ROSEN: Where would I look for this analysis? If I wanted to check this analysis myself?

MR. ST. LOUIS: For the fire barriers?

MR. ROSEN: For, say, one of the rooms, the C3 rooms? See what the times involved are. The only cooling mechanism you've got is air flow from noninvolved areas, am I correct?

MR. ST. LOUIS: This is not cooling the room. This is cooling the protective final filters.

MR. ROSEN: Cooling to protect the final filters?

MR. ST. LOUIS: Yes. Not to cool the room. This is -- this cooling flow is to maintain the gas stream that enters the final filters, cool -- cool enough so that it's below their continuous operating temperature.

MR. ROSEN: How do you put the fire out?

MR. ST. LOUIS: With the clean agent.

MR. ROSEN: It doesn't have any heat -- it doesn't absorb any heat. It smothers the fire.

MR. ST. LOUIS: Yes, it removes the

oxygen.

MR. ROSEN: Removes the oxygen.

CHAIRMAN POWERS: As soon as you stop the flow.

MR. ROSEN: As soon as you take that stuff off, guess what happens? The stuff is -- it's still as hot as it ever was.

MR. ST. LOUIS: But we've removed the air supply, the fire damper on the supply side is closed.

MR. ROSEN: Yes.

MR. ST. LOUIS: So there's no oxygen for the fire.

MR. ROSEN: Understand. And that goes on for one minute, one hour, one day. And then someday you have to put air back in this room and the stuff is still at 1500 degrees C. It's never cooled off. Well, maybe a little conduction.

I'm trying to figure out -- how do you ever get the fire out? I mean, you have -- well, the fire's out. The minute you put air back in there, it starts again, doesn't it?

CHAIRMAN POWERS: Yes, we've seen these things happen where they've stood around for an hour, and then opened up a cabinet fire and boom.

MR. ROSEN: I saw a very interesting film of this by the British Fire Safety group, and I think I reported that to the ACRS last year. Exactly this phenomenon, a test of a cable tray fire in a room where the fire was clearly out. They had video of it. It was clearly out. But the minute you turn the fans back on, you have a full conflagration again. Because there's no heat removal. You have to remove the heat somehow, otherwise it flashes right away. So I don't understand.

I mean, I understand it up to a point. I don't understand how you get down from this peak that you've got yourself up on.

MR. ST. LOUIS: The temperature in the room.

MR. ROSEN: And in whatever is in the room that burned, very hot. Clearly it has no oxygen so it can't burn anymore, but it's still very hot. Don't you get it?

MR. ST. LOUIS: Well, yes. I mean, we have the capability to isolate the room and let it cool off. Now -- and we can maintain a negative pressure on it so that it draws air in through any leaks or cracks. And it can be just cooled off.

Now, we have extra gas capacity to put in the room, clean agent. But with these rooms that have material at risk, our design philosophy is not to put water on them, although we do have water in the building. We have a stand pipe and a hose system.

CHAIRMAN POWERS: I think what he's worried is that you're going to have maintain inerting on this thing for a very long time. You may not have the capacity -- I mean, I don't know what capacity you have to have if you have something akin to a cable tray fire.

MR. ROSEN: I'd like to see an analysis of this that's carried for -- for as long as it needs to be carried out that ultimately gets you to conditions where you can stop feeding it clean agent. Because it's now got cool enough that you can restore air to it without having a flash. How long does that take?

MR. KAPLAN: This is Gary Kaplan.

Maybe I can -- are you asking from just a purely fire perspective or a nuclear safety to meet 10 CFR 61? Because there's really two different answers.

MR. ROSEN: Well, give me both answers. I don't know what I'm asking.

MR. KAPLAN: Okay.

MR. ROSEN: I'm just asking a physical question.

MR. KAPLAN: All right. To meet 10 CFR 61 we're worried about the dose criteria. And so for these glovebox or room fire, we've assumed basically all the MAR in that room is involved in the fire regardless of how long it takes. And we're -- and what we're designing to is to keep the fire in that one fire area. And the Fire Hazards Analysis does that regardless of how long the fire burns. So if it's a 2 hour fire or a 3 hour, it burns all the combustibles. So whether you put it out and let it come back on again, you've accounted for that.

So our design is to insure the HEPA filters work and can mitigate the plutonium that you've released. And that's how you meet 10 CFR 70.61 criteria for those fires.

MR. ROSEN: Okay. So that's for off-site, those protections.

MR. KAPLAN: Right. Now for the person in the room we basically say he leaves the room or he comes back in with protection.

MR. ROSEN: Yes.

MR. KAPLAN: So to meet the criteria we have a strategy that works, and that's why we're talking about cooling, making sure the final filters are cool.

Now your question from a fire safety

perspective, how do I know this doesn't take 20 hours of on and off and on and off, that's -- you know, we would leave it alone from a nuclear safety perspective and not do anything, and we'd be okay.

MR. ROSEN: I agree with that. I think from a nuclear safety perspective --

MR. KAPLAN: Right.

MR. ROSEN: -- your design is sound.

MR. KAPLAN: Right.

MR. ROSEN: From a personnel safety perspective it's sound, because nobody has to be in there. They get out.

MR. KAPLAN: That's correct. What are they really going to do?

MR. ROSEN: No, they're going to do just what you say.

MR. KAPLAN: Right.

MR. ROSEN: And then at some point somebody's going to want to terminate the event. And the question is when and do you have enough clean agent to keep it cool for as long as it needs to be kept cool. You've got an adiabatic situation almost. There's no way of getting any heat of the room. You've got it bottled up.

MR. KAPLAN: No. The HDE is still running and pulling. I mean --

MR. SIEBER: Well, if you're still dumping clean agent in there, that presumes you isolated that area. Otherwise you'd just sweep the clean agent out.

MR. ROSEN: Well, I don't want to solve it here.

MR. KAPLAN: Right.

MR. ROSEN: But I do want an answer someday to what is the fire shutdown strategy for this room. I mean, take one of the seriously big rooms with a lot of combustible loading and track through them beginning to end.

MR. KAPLAN: Right.

MR. ROSEN: There's quite a bit of experience. It says this is a real hazard. And it's not just having a reflash. It's worse than that. Because what you do is you bake off all of the combustible vapors in the room so that when you put oxygen back in the room, it doesn't just burn. It detonates.

MR. KAPLAN: Lary, do you haver a response. Okay.

MR. ST. LOUIS: We have, and this is along the line that you're inquiring, we have committed to do an analysis of flashing of hot gases in the exhaust systems when the gases from the room combine with the other flows to evaluate that.

MR. ROSEN: And that's an analogous question.

MR. ST. LOUIS: Yes. And we have not done that analysis yet, but we have committed to do that.

This is just a little schematic of all the devices that are available to assist in the operation of the ventilation system.

We have -- here's our inlet fire closure devices. Some of them are fire dampers or fire rated valves on the inlet side. On the exhaust side it's a manual fire rated valve. Because on the VHD it's small capacity. We're actually using a thin wall piping. And this here is a fire rated damper that we can close manually.

And here you can see the bypasser on the HEPA filters.

This illustrates the flows from the other rooms and so on coming into the exhaust system prior to entering the final filters.

In closing, I just wanted to say that the systems are designed to mitigate the release and dispersion of materials. They remain functional during abnormal system events. They include a very highly efficient filtration system. They operate during normal events and they meet the intent of Reg Guide 312.

CHAIRMAN POWERS: Have you selected your HEPA filters yet?

MR. ST. LOUIS: Yes, we have a basic specification.

CHAIRMAN POWERS: Paper? Are they paper filters?

MR. ST. LOUIS: No. Glass media, stainless steel housing.

I'm taking Steve's thunder away. He's going to go through all of that.

Thank you.

MR. KIMURA: All right. My name is Steve Kimura. And I'm here to highlight the key features in the MFFF HEPA filter system design to show how the MFFF intends to protect HEPA filter media from damage resulting from severe accident conditions, such as a fire.

The features that I will present have been taken from many previous facility designs where they served different roles unique to each facility in which they were used. We have assembled these features to work together to protect the HEPA filter media from severe environment stress.

The design that I'm going to present may seem a bit new to most of the members of the panel, but the features are fundamentally sound. And we've had reviews by industry experts to that effect.

I'll also present some basic information--

CHAIRMAN POWERS: When you say reviews by industry experts, the industry for running MOX facilities is a bit thin. What do you mean by industry experts?

MR. KIMURA: We have Warner Bergman here who has conducted over 30 years of experiments on HEPA filter and has designed various HEPA filter systems.

CHAIRMAN POWERS: So it is the expertise in HEPA filters and not MOX facilities?

MR. KIMURA: Right. Right.

CHAIRMAN POWERS: Okay.

MR. KIMURA: And I'll present some basic information about the HEPA filters, just to make sure that everyone has a firm foundation in which to base questions about the effects or the impacts that could damage or impair the HEPA filter efficiency.

HEPA filters are really particulate removal systems. The term HEPA is short for high efficiency particulate air filter. The U.S. Army, in fact in World War I, needed to find an effective means to filter out material from the air. And the HEPA filter was the result of some of that research.

In World War II the HEPA filter was found to be the most effective means to remove radioactive materials out of the air, because of the same particle sizes. And that formed the basis of why we use HEPA filters today.

The general term HEPA filter actually refers to a complete assembly of components which includes at least one stage of the HEPA filter media. The other components of the assembly are designed to protect the HEPA filter media from clogging and/or damaging from internal and external sources.

The HEPA filter media is bolted into an accordion shape to maximize the surface area and is installed into the standard size subassembly, called a HEPA filter element.

The HEPA filter media itself is now made of entirely noncombustible material, including the sealants that hold it in place. So they're glass fiber or they can be stainless steel glass fiber mix. and I'll explain how we use those different filtering elements in our design.

The HEPA filter media is designed to

filter greater than 99.9 percent of the most penetrating particle size, which is approximately .15 microns in size.

The small particles will enter the filter media and get ensnared in the fibers. Particles that are either smaller or larger than that size will tend to unity as a capture ratio.

Because the HEPA filter media mess is so fine, larger particles will tend to collect on the surface and, therefore, have a higher tendency to clog the filter and block the airflow. So that's one of the things that we need to prevent.

In order to keep large particulates from blocking the HEPA filter media, less efficient roughing filters are used. These pre-filter elements increase the life and allow the HEPA filter media to effectively filter the smaller particles for a longer time.

Soot is very small. It's on the order of the most penetrating particle size, about 21.2 microns.

Go back. I just want to cover a couple of more points.

CHAIRMAN POWERS: That's not my image of soot. My image of soot is --

MR. KIMURA: There are --

CHAIRMAN POWERS: Long chain of glomerates produced -- I mean, the soot formation is an ionic mechanism so that it gets long chain, high collision shaped factor particles.

MR. KIMURA: That is true. But tests have been done to show that soot will pass through what you would expect would be -- an 80 percent efficient filter, would collect something of that nature. But soot has been shown to pass through that type of media.

The geometric mean tends to be smaller, more on the order of what a HEPA filter would collect. So the efficiency in order to collect that has to be a little bit higher.

HEPA filters are built to standards and are extensively tested both by the manufacturers. And once they're installed to insure that they effectively filter. We're trying to filter out very small particles at a very efficient rate. Small leaks, pinholes, cracks, things like that can seriously degrade the HEPA filter efficiency.

It has been stated in previous -- in the literature, that HEPA filter efficiency is degraded as you go from the first stage to the second stage, and so on. That's not true. The HEPA filter efficiency is the same across each stage.

MR. ROSEN: The two filters?

MR. KIMURA: Two filters in series.

MR. ROSEN: If you did three, would we get nine nines or eight nines.

MR. KIMURA: You get three, you'd get nine nines or six nines, depending on how much you take for the first stage.

DR. BERGMAN: Warner Bergman, consultant for these.

For many years, and even now, many people think the second and third stage is less efficient. And this is primarily due to inefficiencies in artifacts in the measurements.

I '74, '75 time era, Harry Ettinger, Gonzales, a group at Los Alamos tried to really define this point. And they had the highest concentration of radioactivity that they could aerosolize through three sets of filters. And they demonstrated that even if you take very heroic measures to remove the background from the third stage filter, you could still measure it.

They would wait one week before they would count, let the natural decays decay on the background radiation for a week. And even with all these measurements, some studies, and we finally summarized in support with this overall program here, showing that even under these heroic measurements they still suffered from some background measurements on the third stage. The first two stages were unequivocally the same efficiencies. The third one started because they couldn't have enough challenge, the background now came up to a higher level.

And so there's many causes for background radiation and measurements, and people ascribe all kinds of properties then to filters because of these artifacts. And the point is that if you conduct an experiment properly or you measure properly, the third, fourth and fifth stage HEPA filter will have the same efficiency as the first one. And that's substantiated by theory and experiments that can go as far as you can go.

Thank you.

MR. KIMURA: All right. This is a schematic view of the final HEPA filter unit that we're going to be using at the MFFF. It consists of several components.

Number one is a structurally strong stainless steel housing that contains all the elements and make sure that outside influences don't damage the filter media inside.

The first element here, number two, is somewhat different than what most people are used to when they see a HEPA filter. This is a structurally strong roughly filter made with a stainless steel wire mesh filter media contained in expanded metal cage. This filter can be fully plugged up to the differential pressure created by the exhaust fan without collapse. You don't see that in pre-filter media in other sites.

The second one, as I said before, is a structure strong high efficiency prefilter that's designed to collect the soot. What we anticipate is that 90 percent of the soot is still going to pass through the first prefilter, the roughing filter. This filter here is designed to collect the great majority of the soot that's generated in exhaust gas stream.

It's made of a stainless steel wire mesh with glass fibers. And, again, this reinforced with the expanded metal wire cage so that if it gets all plugged up, it can withstand the full differential pressure that the fans can pull without collapse.

Number four filter is more traditional

prefilter media that you would see, glass fiber, that we have in here as an option right now. And it's under evaluation whether this is going to remain.

The final protection elements, the one that keeps all plutonium out the stack is going to be these two elements here. These are the HEPA filters themselves.

CHAIRMAN POWERS: What's the bypass flow? When you install this device, there's going to be some flow bypassing either internally or externally through the device?

MR. KIMURA: Internally they've been tested to 99.95 percent in situ VOP. That has been shown to guarantee that this will be greater than 99.9 percent efficient for the .15 micron particles. That efficiency is guaranteed at the factory, tested at the factory and then once we install and upon replacement will be tested.

So it's tested upon initial installation. There is a periodic test and then tested upon replacement.

DR. KRESS: How do you test for the bypass flow?

MR. KIMURA: The aerosol is injected upstream of the filter media and then measured downstream.

DR. KRESS: Just checking the efficiency?

MR. KIMURA: Yes. Right, overall efficiency. If you collect too much downstream, then you know you got a problem.

DR. KRESS: Right.

CHAIRMAN POWERS: Do you have to worry about knock-through?

MR. KIMURA: Are you worried about the knock-along effect or --

CHAIRMAN POWERS: Yes.

MR. KIMURA: -- alpha recoil?

CHAIRMAN POWERS: Yes. It's not through unfilters, knock-along in ducts.

MR. KIMURA: Can we go to the backup slides. Slide 16.

We conducted a review of the literature on the subject going back over about 30 years. In fact, it was 29 years to 1974.

We have concluded that the knock-along effect is inconsequential in regards to the total amount of material that could pass through two stages of HEPA media. As stated by Gonzales, Elder and Ettinger, the measure of HEPA filter efficiencies remain well within present minimum AEC performance guidelines for each stage. And they quote some numbers here.

And they said that the second stage HEPA filter efficiency exceeds 99.99 percent.

Since that time, this was back in '76, since that time no direct statistical -- significant evidence has been presented that contradicts the basic conclusion reached by Gonzales, et.al. that the protection factor of the two stages of HEPA filters can be shown to be greater than 10 to the 9.

Next, 17.

This is a fairly busy slide. It presents probably what everyone would consider the -- I guess the father of knock-along effect in HEPA filters.

Niels Hetland and John Russell in 1974 were doing a survey of Rocky Flats plants various filter. At Rocky Flats Building 771 they have about 39 grams on average of plutonium on every one of their HEPA filter elements.

They used a drum counter, which picks off the activity from the entire 39 grams, and measures it to an accuracy of plus or minus 2 grams.

In the second stage filter they tried to use the same drum counter and measure 390 micrograms of plutonium. And on the third stage 3 micrograms. And on the fourth stage 0.5 micrograms.

What Dr. Bergman had stated was that when you do that, these two filters get dominated by the background effects. It gets very hard to increase the counting time long enough for you to get an efficient measurement. You would actually probably have to count for several years in order to get sufficient accuracy in those counts.

CHAIRMAN POWERS: It's background dominating, you can count until the end of time it won't help you.

MR. KIMURA: Right. Just to get an accurate count on the source itself.

CHAIRMAN POWERS: It just won't do you any good.

MR. KIMURA: I have several more slides that just show the history of the effects. I don't know if we want to --

CHAIRMAN POWERS: Well, we know the history of the effect. We know that -- I mean, there's this great Los Alamos film of showing it actually happening. I mean, the particles do move because of the recoil effect.

I mean, Ettinger's a great guy. Why he is so confident this thing's not going to work? I mean--

DR. BERGMAN: Warner Bergman again from DCS.

If I could just add to both this knock-along and a very closely related thing of what's called alpha creep.

Both of these phenomena kind of get bashed around without a lot of real detail scrutiny to the point where, like for example, at Livermore half the scientists that actually have working experience with actinides swear by it, the other half say it's a wives' tale.

And so, for example, the alpha creep has only recently been elucidated with funding from Stockpile Stewardship, of which they wanted to know very precisely what happens over long times with plutonium and alpha materials. And papers published within the last two years show that even room air, if you expose a slab of plutonium, or small -- even plutonium metal, very tiny particles are omitted. And even the act of opening up a can or opening up a glovebox door creates sufficient turbulence to release some of these. And so if you come with a measurement instrument, then you find it dispersed throughout the glove.

So this is ongoing research. Only two

papers have been published so far, but the idea is that the thing of popping off ideas is not valid for that particular thing. However, another class of research being done in basic nuclear physics, again primarily supported by Stockpile Stewardship, of which both experimental and theoretical computations that are related to alpha omissions. They're not studying alpha omissions per se, the recoil and then the subsequent chunks popping off. What they are studying is things like spattering the -- where they bombard pieces of metal with high energy ions and other materials. And these, they create external excitations, very similar to what happens with alpha recoil in principle. And they have found the initial studies that McDowell and some of the people many years ago, what they speculated was in fact verified experimentally. And the current, both experimental and theoretical simulation studies, show that the number of particles decrease. You can find 500 popping off parts, up to 500 atoms, they speculate even a 1,000 atoms. The problem is the probability of each one of these events is one over the number of atoms squared.

So it doesn't take very long before you have ten to the minus ten probability. So even though the phenomena that was speculated 20, 30 years ago is valid, there's no question about that, both theoretical and experimental, the actuality of it it's inconsequential. It's such a small event.

So the unfortunate thing, much of the research hasn't been put into the literature that it's available to everyone at present. And we're trying to correct that situation and maybe publish something in Nuclear Safety, or something of that nature.

So, thank you.

CHAIRMAN POWERS: Nuclear Safety is no longer an extant journal.

MR. KIMURA: I just want to make one concluding remark on that. During the '70s, the late '70s through the '80s a lot of speculation occurred as to whether the ultra-fine particles that you would get from this alpha particle decay would pass through HEPA filter media. Between those ten years, 1988 and 1998, there is a large number of investigators that looked at the retrainment principles and what happens with ultra-fine particles and they found the classical filtration theory that these small particles tend to go to zero penetration or unity on efficiency.

Have to go back.

Any other questions?

Okay. Next slide. I think we covered

everything on this one.

When Tom went through and talked about intermediate filters on the room air, this is just a picture of that.

Next one.

This is actually a picture of the roughing filter, a full sized prototype.

Under typical installation you would see a spark arrester with just this expanded metal cage, and they call that a spark arrester. What we have done is we have gotten this with the expanded metal on both sides and some re-enforcing bars. But inside is stainless steel wool, so to speak. It's stuffed into here to form the roughing filter. And that's going to be collecting the filter media.

Okay. My next slide is just a half sized prototype of the high efficiency prefilter with the re-enforcing bars in this fiberglass wool with stainless steel fibers intermixed into it, inside of a stainless steel box.

This filter is designed to be 99 percent efficient for particles greater than 2 micrograms in size and greater than 90 percent efficient for particles less than 1 micron in size, which is soot.

Okay. Next.

This is a picture of the HEPA filter element. In the past the frames have been made with wood and with stock wood. This is actually more fire resistent than steel in some cases because of the warping capability. But the way this is constructed, the steel is a stronger -- structurally stronger design.

Filters are designed to withstand 400 degree fahrenheit continuous service. And our test did up to 5 minutes at 700 to 750 degrees, so they can still be efficient at even extreme high temperatures. There's a screen on the front and back that helps protect against blowout, but otherwise the filter media itself is noncombustible.

CHAIRMAN POWERS: What is it?

MR. KIMURA: Glass fiber.

And it's tested to be 99.97 percent for .3 micron size particles, and that corresponds to the 99.9 percent at the .1 fine micron most penetrating particle size.

This lip here will actually be filled with a sealant material, and that goes into a knife edge and then forms a robust seal for the filter. And that's part of the anti-bypass design.

The testing, the manufactured tested

design for the efficiency pressure drop rough handling. They shake it three quarter inch vibration table. Pressure, moisture, heated air, pinhole leaks and spot flame resistance. They put a blow torch to it and make sure it doesn't burn through.

Before any filter leaves the manufacturer, they test it for final efficiency before shipment.

Once it gets to our site and gets installed into the filter housing, we do in situ tests to insure that the filters were not damaged during shipment and that they've been installed properly.

And the test, it will insure that we met our efficiency requirement, that they structurally withstand greater than ten inches of delta T across them and with 700 degrees for up to 5 minutes.

CHAIRMAN POWERS: This in situ testing that you do, once you've installed it, that's under your Appendix B program?

MR. ST. LOUIS: Yes.

CHAIRMAN POWERS: Because I have seen installations that had all of this, that you could have borrowed their slide. And the problem is people get tired of doing this and so they slope them together, write down, yes, tested it. And you find out you can put your finger in the gaps that they leave.

MR. ROSEN: Not in the nuclear industry, of course.

CHAIRMAN POWERS: Not in the U.S. commercial nuclear industry, and definitely not in South Texas.

DR. KRESS: You test every one of the filters, of those last three items or you sample them?

MR. ST. LOUIS: No. All the HEPA filter are individually tested. And the --

DR. KRESS: You subject them to ten inches of H_2O pressure --

MR. KIMURA: No. This is a sample. Ten inches is a sample.

The efficiency, everyone is tests for efficiency.

DR. KRESS: But you sample?

MR. KIMURA: But we sample for the ones that could physically damage them, because --

DR. LEVENSON: The problem is those lost two things don't apply to the bullet above it.

DR. KRESS: Yes.

DR. LEVENSON: I mean, the bullet above is installed and this is an insert. It sort of reads like you're testing the installed ones at 700 degrees.

And I don't think so.

DR. KRESS: That's what caught my attention.

MR. KIMURA: All right. I think we've covered everything we need to cover on this slide.

HEPA filters have been studied for a long time. The effects of what they do and how they work, and what causes them to break are pretty much known. There are short term physical effects. Essentially the big categories are they leak, they can clog and they can burst. And what causes that are embers, smoke, soot, high temperature, moisture, water, air flow.

There are long term effects that are lumped together under the category called aging. And these may have to do with chemical exposure, exposure to moisture or water and radiation damage. Other factors could be, you know, you get a bad filter, manufacturing defects. You can install it wrong. You can damage during installation.

Inspection errors. You don't inspect or the inspector misses something.

DR. LEVENSON: While the concept has been around for 50 years, the particular media you're using I don't think is quite that old. How old is -- how much experience is there with the actual media you're using? Media in the HEPA filter itself?

MR. KIMURA: The media we've been using is pretty much been in service since the early '60s.

In 1969, which is the Rocky Flats fire, they had noncombustible HEPA filter media. The previous fire in 1950 was paper, and paper was easily ignited.

DR. LEVENSON: Was the '69 the same media you're using? I mean --

MR. KIMURA: No.

DR. LEVENSON: How long -- what's the history on the actual media you're using?

DR. BERGMAN: This is Bergman.

The media changes every year. The media that existed back in the -- Arthur Doolittle, when they first did the work with the Army to develop the first HEPA filter and then with Cambridge. Cambridge formed as a consortium for them. That started out with asbestos and paper fibers. Then Wendell Anderson and others helped develop with glass. And every year they learned improvements making glass smaller and smaller, different formulations, thicknesses. So each -- there is a development across time, and I'm sure the filter we have tend to be different than what we have now.

The trends are smaller fiber diameters within economic trend and higher strengths. So formulation change to improve the efficiency, reduce the pressure and increase the strength. So those are the changes that evolve over time.

DR. LEVENSON: Yes. And those three can be tested, but the question of the aging you can't go back and say there's X years of experience, but your media is only a couple of years old.

DR. BERGMAN: You're absolutely right. And we had -- that precise point was a great consternation to a problem we had for establishing age limits on HEPA filters. We were comparing apples and oranges and we wondered why there were a couple of papers that were presented. I mean, we're talking about an order of magnitude of variation of data. And it's like a moving target. We were comparing filters 20 years ago with the present time, and in some cases some manufacturers had better media 20 years ago than some today, you know, But this was the variability.

So, it's a very complex issue. And so the latest trend as far as aging is concerned is to use them -- we've used and written a paper using the most conservative numbers and it's in coincidence with Mel First and some of his studies and helped establish age limits for HEPA filters precisely to address some issues like that.

DR. RYAN: You mean age in service or age on the shelf, or both?

DR. BERGMAN: Both. A filter will degrade even if it's sitting on the shelf for 5 years.

DR. RYAN: What is that age limit now?

DR. BERGMAN: Right now based on all of the available data we've had with -- which Jon Fretthold generated at Rocky Flats, for what we call a very dry situation, we say 5 years. And for -- I mean, for a situation where you can have moisture exposure, because filters like most tissue will get soft and that with water. So 5 years for a wet application, ten years for an application that's dry. And by dry, I don't mean the last incipient fire, but where you have like a water spray and other potentials to really wet things down.

MR. KIMURA: All right. The MFFF design in addressing the factors that impact the HEPA filter media, on embers, and as I stated, we have the high strength roughing filter, it collects the embers, collects the hot particles, the brands. It can burn holes through the more delicate HEPA filter media.

Soot, again, if soot collected on the face of the HEPA filter, the delta p's can go up very high, greater than 10 inches and eventually causing bursting. To prevent that, we mitigate it by use of the high efficiency prefilter. And those filters collect the soot, withstand the delta p's. Only a small amount of soot gets onto the final HEPA filters so the delta p across the final HEPA filter stays very low.

High temperatures. We mitigate that just by the design of the filter media itself and the filter element so that they're noncombustible.

The sealing is noncombustible that we use. In the past, urethanes that actually burned have been used and other materials that you wouldn't think, while the entire HEPA filter itself is said to be noncombustible, the wood frame if you get it hot enough will burn.

The other factor that we have is dilution air flow. As Tom said, there is a lot of other noninvolved areas once we have a fire. So all these other flow areas act to dilute and cool down the flowstreams.

High moisture. Again, when you have a fire, fire generates a lot of moisture just in the act of combustion. That's mitigated by dilution air flow, that lowers the relative humidity of the gas stream.

DR. LEVENSON: Dilution air flow protects only your final HEPA filters. It does not protect the regional ones, right?

MR. KIMURA: Right. And what we're doing here on the final HEPA filters is protecting the public. We're keeping the material from leaving the stack or entering the stack.

Entrained water. In 1980, Rocky Flats fire entrained water from the water strays sprayed directly on the HEPA filters was implicated in causing them to be blown out and causing more damage than the fire that occurred on the HEPA filter media itself.

As a result, that's why we depict dilution air flow over water sprays to mitigate that, or prevent that happening.

DR. LEVENSON: You don't really mean you're dilution air goes over water sprays? You mean instead of?

MR. KIMURA: Instead of. In lieu of.

Okay. High delta P across the HEPA filter media is caused by how many things there are to burn, how much soot you generate that's going to clog the filter, that's going to cause the high delta p.

We have combusting loading controls in all the fire areas, and then all the filter elements, not just the high-strength prefilter elements, have defense-in-depth monitoring for differential pressures so we can monitor during normal operations, change out the elements to make sure they're clean before an event happens.

Aging, as we said, can occur because of chemical exposure. There are two sets of filters being used. For the HVAC system, there are no chemicals that the filters are exposed to on a routine basis. The process ventilation fumes where you get most of the chemicals are exhausted off of separate flow screen, which is a very small airflow, 2 -- 300 CFM. That gas gets treated before being released. So that the big filters, the ones that do the ventilation air, have no chemicals.

Radiation exposure. Unlike other facilities we have many, many filters upstream of our final HEPA filter elements. We don't expect to have the high radioactive material load on the final HEPA filters that causes problems. There's some periodic inspection and maintenance to these that go along to insure there is no build up.

Moisture. The moisture has been indicated in reducing HEPA filter media strength after a short exposure and redrying. You can seriously degrade the strength of the HEPA filter media. So exposure to moisture is part of our facility's design features to keep the relative humidities under control in the areas where water can get into the air.

In order to insure that these severe conditions don't impact the HEPA filters, we've done a series of analyses and plan to do a series of analyses for those that aren't complete yet. We have a Fire Hazard Analysis, which looks at the total fire loads.

Fire severity modeling, which does a more detailed finite element type look at what the fire is.

We're still doing the soot loading analysis. As we stated before, the soot loading analysis -- or I think Sharon mentioned that -- the soot loading analysis was done based on a correlation obtained from tests. The tests that we believe we represented a type of soot that we had, but it was based on the solvent fire. It was not based on a classic fire. We're right now going to conduct a series of experiments to confirm that our initial assumptions were correct, that the amount of soot that we're going to generate is equivalent to our original correlation.

The design is such that if we find that there are changes in this correlation and we need to go to a more filter media area, the design can accommodate that.

We're doing moisture analysis to insure that what we said about dilution is true. And we're doing fault tree and single failure analysis of the systems to insure that such thing as global loss of facility power doesn't cause us to lose all the ventilation fans and other single failure type problems.

We're doing an HVAC transient disturbance analysis to make sure that we don't have small perturbations in the system flow causing reverse flow in other parts of the system and then causing operator exposure and dose.

And then we're looking at the effects of internal explosions.

All these analyses consider uncertainties. For the soot loading, we take the two largest soot generating fire events and lump them together. Even though those events occur in separate fire areas.

The same for the dilution error temperature analysis. We'll use the areas that generate the highest temperature air flow total heat content going to the HEPA filters in order to bound our dilution.

And as I said, we're having independent empirical verification of the filtration system performance by the soot loading experiments. And that will be completed for the ISA.

CHAIRMAN POWERS: Do you verify the fact that when you take a very hot gas, inject it with the rest of the gases that you're going to bring into the system that in fact it will mix? It won't get stratified fully?

MR. ST. LOUIS: We've committed to look at that phenomena as part of the ISA process.

CHAIRMAN POWERS: Good.

DR. LEVENSON: Is there any probability at all that sometime in the first teen years or so of operation you might want to change the diluent?

The context of my question is you're doing a fire analysis based on a specific material. You might want to think about whether you want to at this stage take a look at other possible diluents so that if you decide process wise you want to change it, you haven't locked yourself in on something. It would not take much effort right now to do the arithmetic.

MR. KIMURA: The diluent --

DR. LEVENSON: The total amount of soot, total quantity, that sort of thing.

MR. KIMURA: Yes. Where we handle mixed oxide power, we have nitrogen as the main diluent in the gloveboxes.

DR. LEVENSON: The diluent in the solvent extraction.

MR. ASHE: Excuse me. This is Ken Ashe.

Right now we've got a design that we're going to propose, and that's the one that we're going to go forward with. If we change something that significant, then obviously we'd have to go back to the staff with that. But I don't believe it's our intent at this point to change the diluent.

MR. KIMURA: All right. This slide just summarizes the filtration loading experiment program.

As I stated, that the filter design is based on previous studies that have been done. There is a lot of data on burning PMMA cribs. A crib is just a stack of combustible materials, like a stack of firewood. And the studies were done by Gaskill and Fenton, others at Lawrence Livermore in room sized combustion chambers. To characterize the burning of that type of soot, they burned wood, they burned other materials.

Ballinger up at Pacific Northwest characterized burning solvent on top of water. So different types of diluents and stuff, and different soots and combustibles generated different soots. Some were long-chain agglomerates, others were relative dry.

For PMMA Gaskill found that unless he added water to the stream, it was very hard for him to the HEPA filters to clog.

So what we're going to look at is we're going to look at how soot is distributed throughout the filter system. As I stated, our design basis to collect -- to filter out all the embers and brands at the roughing filter stage, collect most of the soot on the high-efficiency stainless stain prefilter and then have very little soot actually appear on the final HEPA filters.

We're going to look at the delta p change as soot is loaded up. And we're going to look at the flow rate through the system, make sure we're not going down to zero and clogging up our filter system. And then we're going to determine the ultimate soot loading capacity based on the characteristic soot that we're generating.

This is what we anticipate to be pretty

much our design for the HDE final filters. Stainless steel housing, bag in, bag out ports for each of the filter elements. Test ports, isolation valves so we can do our testing.

I've mentioned a lot of historical fires and other events that we used in order to evaluate our filter design -- do our filter design. The key lessons learned that came out, was to use noncombustible materials.

You have to some means to protect the final filter elements.

Dilution air is preferable over water sprays to protect them excessive temperatures.

The duct with several bends will attenuate any effects from rapid pressure excursions in order to keep fires from going from one fire zone to the other. There's fire isolation valves that allow us to isolate system or fire wrapping to keep the duct from causing secondly fires in other rooms.

And the building itself has multiple confinement zones, so that if the primary confinement, C4 area, starts to leak into C3, C3 will contain that leak. And if C3 leaks, C2 will contain that leak.

And finally, that we keep the contamination potential of the final HEPA filter element low. We don't allow material to build up.

The conclusion is that we think that we're protecting the HEPA filters from severe environmental conditions. We've accounted for various design basis events scenarios, included the uncertainties in the analyses that we conducted, that we have an historical basis for each of the elements that make up the HEPA filters, and that the combined total of all of these features make the MFFF final HEPA filter design very robust.

CHAIRMAN POWERS: Any questions of the speaker.

Thank you.

We'll move to Ms. McDonald.

MR. JOHNSON: My name is Tim Johnson, and I'm the principal reviewer for the ventilation system.

And what I'd like to -- if I can get this thing to move here. Is to talk about our ventilation system review.

Basically we're looking at the ability of the principal structures, systems and components to perform under various conditions during the required confinement. And in addition, we were also looking at defense-in-depth, and that's primarily redundancy of system components.

CHAIRMAN POWERS: In the redundancy, there's lot of redundancy that we see in this system, but not much diversity, it seems to me.

MR. JOHNSON: Well, I believe that if you look at the entire confinement system, there is diversity. And the diversities are in both the static and dynamic barriers that are part of the design. And by static barriers I'm talking about walls, gloveboxes and the dynamic systems are the actual ventilation systems that have active components with it.

In our review of the system, we basically have two open items, and I'd like to talk about each of those in a little bit more depth.

In our review of the proposed system we feel that the system can function under severe conditions. The question was what should be the allowable removal efficiency for particulates. And in our guidance we recommended that for severe conditions that credit be not taken for more than 95 to 99 percent removal of particulates under severe conditions. For example, such as a fire.

And what DCS is proposing is to have a release fraction of 10^{-4}, which is basically a 99.99 percent efficiency. And we recognize that there have been fires and filters that have -0 filter systems that have damaged HEPA filters. And we were very concerned about the uncertainties in that. And because of that we asked DCS for further justification on why they felt that 10^{-4} release fraction would be acceptable.

They provided some further information to us in February and 2 weeks ago. We're still considering that response, but we haven't made changes. Basically the information came in too late for us to make changes into the draft Safety Evaluation Report. So we're still carrying that as an open item while our review continues. But certainly what they've proposed is more robust than what they proposed originally in the Construction Authorization Request. So we feel we're moving int he right direction here.

MR. SHACK: What release fraction do they have to have?

MR. JOHNSON: I'm sorry?

MR. SHACK: What release fraction do they have to have?

MR. JOHNSON: At least 99 percent in a well designed system. And what they're proposing is that they retain 99 percent credit for each of the two HEPA filter banks. So basically they're saying that under severe conditions both HEPA filters will survive and be functioning. And by intent each HEPA filter, you know, should be well over 99.9 percent efficiency efficient. But, you know, with various aging effects, maybe problems in installation where there's additional bypass, in practice the NRC hasn't given full 99.97 percent efficiency for HEPA filters. And our regulatory guidance has been 99 percent.

The second open item is one that Sharon talked about, and that's related to the soot loading. And when we try to duplicate their calculations that they submitted to us previously, we couldn't duplicate them. And we asked for additional information on that. And, again, more information was provided in February and April, and, again, we're still considering that, as Sharon mentioned.

If the soot loadings get too high, the HEPA filters could fail under pressure loading, under pressure drop loading.

CHAIRMAN POWERS: They have proposed a lot of experimental studies. And discussed the complexities of soot as far as of the shape. We know the agglomerate -- the primary particle sizes are probably right around the maximum penetrate in size, but the agglomerates tend to be long-chain ugly looking things. And then they're proposing these experiments to validate their models.

If you had thought about this issue, that we know that particles that are made up of agglomerates change their geometry in response to the relative humidity. We have a very dry system here with nitrogen as the purge as, and whatnot. The experiments will be done under some other circumstance. And are we likely to get data that's just not applicable here, or what's your thinking on this?

MR. JOHNSON: Well, you're right, there are uncertainties in here. And that's one of the reasons why the amount of credit that's given is well less than -- you know, a manufacturer's 99.97 percent efficient with .3 micron particles. And it's why they do a leak test on installation. And, again, the objective is to have no more than .05 percent bypass. But I don't expect those kind of changes to substantially make up a difference of two orders of magnitude in the overall efficiency.

So I think we're still conservative. And if you look at actual systems, HEPA filters are used in a number of plutonium systems in DOE. And they get pretty good performance out of them.

CHAIRMAN POWERS: When they install them correctly.

MR. JOHNSON: Yes, when you install them correctly and you don't have fires, like we've had at Rocky Flats.

DR. LEVENSON: Well, the fraction of the gas that might be coming from an inerted facility compared to room exhaust because of your mixing and blending system, you probably can't get very much of a change in the moisture content at the final filters. It'll be whatever is your incoming controlled humidity, won't it?

MR. JOHNSON: Well, the C4 system is your glovebox system. And that is going to have mostly inerted gas --

DR. LEVENSON: Yes. But what I'm saying is that --

MR. JOHNSON: And that's a separate system. So that'll probably stay pretty much the same. But the C3 and C2 systems, they use ambient air that is -- comes in from the supply.

DR. LEVENSON: But isn't the C4 system diluted with the others before it gets to the final filters?

MR. JOHNSON: Well, it's diluted by the C4 streams from different fire areas.

DR. LEVENSON: Okay. So there's not one set of final filters then?

MR. JOHNSON: There's one set of final filters, but it takes input from various gloveboxes and various fire --

DR. LEVENSON: No, no. What I mean is the implication that I got from before was that there was one set of final filters, and the dilution air came from the various areas, is that incorrect?

MR. JOHNSON: There are final filters separate for the C4 system. And separate ones for C3.

DR. LEVENSON: Okay. Each is -- okay.

MR. JOHNSON: And separate ones for C2.

DR. LEVENSON: Okay.

MR. JOHNSON: My only slide is a summary slide, and it basically just restates the two open items that we're carrying in the draft Safety Evaluation Report, and they are the HEPA filter removal efficiency credit and the soot loading. And, again, both of those areas are still under review. But, again, I believe we're going in the right direction with both of these from the responses that we've recently received from DCS.

Are there any other questions?

DR. KRESS: I'm sorry. Where did the standard review plan -- 99 percent credit come from?

MR. JOHNSON: Well, it's based on what has been used prior to that in Reg Guide 1.52 for engineered safety filter systems -- safety feature systems for reactors. That's the primary basis for it.

CHAIRMAN POWERS: It's been in the DOE evaluation for as long as I can remember.

MR. JOHNSON: Yes.

DR. KRESS: My basic question is where does it come from?

CHAIRMAN POWERS: I have no idea.

DR. LEVENSON: It's been around a long time. IT doesn't necessarily apply to systems --

MR. JOHNSON: We got a man with an answer here. Well, Dr. Bergman can fill us in on that.

DR. BERGMAN: As Tim pointed out, Bergman with DCS.

The 95 percent -- 99 percent came from Reg Guide 1.52 which has been, I think, talking with Roger Savadowski, he was kicking it around back amongst the first drafts, he and Humphrey Gilbert.

The issues of what efficiency. The DOE has regularly used under accident conditions credit of

99.9 percent for the first stage 99.8 percent, but that was based on best engineering judgments of a meeting held in Albuquerque in 1971.

The problem with --

CHAIRMAN POWERS: I hasten to point out I didn't attend.

PARTICIPANT: You weren't even born yet.

DR. BERGMAN: There's been a lot of work done since that time. And so if one were to convene the world's experts and establish what kind of credits you can get for it, we attempted to do that. And DOE almost came very close to issuing a DOE standard on this very subject, but there was a changing of the guard in headquarters and monies ran out, and consequently usually when money stops, work stops.

But we did manage to publish a paper. Myself, Mel First, Humphrey Gilbert and Wendell Anderson co-authored -- and Jack Jacox, co-authored a paper in which we reviewed all the available data and we compiled a series of efficiencies you can use for HEPA filters under various accident conditions.

And it's very clear if you meet the conditions, the environmental conditions and assault conditions for a HEPA filter, you can claim a variety of efficiencies.

For example, if you meet the temperature, pressure, moisture conditions, you can very readily claim 99.9 percent for each filter. DCS has chosen to be very conservative and 99 percent. But the idea is you can also find a condition where 80 percent is very questionable, even 50 percent is questionable. If you look at a filter that's been subjected to a tornado, you just see a great big hole where there used to be a HEPA filter.

So the idea, it's not a one cookie cutter, one size fits all. It's on a case-by-case basis. And this was really the bottom line of the whole consensus and analysis from -- in fact, my supervisor, you know, Wendell Anderson, Humphrey Gilbert, Mel First. And so that was our conclusion.

Thank you.

CHAIRMAN POWERS: Okay. We arrived to the point of closing comments. And I'm not sure whose going first here. I know Peter Hastings is not going. We're going to have to do something to Peter. He carries the heavy lifting next time, right.

MR. JOHNSON: I'll pass that along.

CHAIRMAN POWERS: Yes. So Drew is going to go first.

MR. PERSINKO: Yes. I just have a short

concluding remarks here.

I have on the screen a bargraph of where we were a year ago, what's happened in the middle and where we are today in terms of numbers of open items.

A year ago there were approximately 57 open items. That was in the draft Safety Evaluation Report published last April.

The number of items actually went up as we reviewed the revised Construction Authorization Request up to approximately 66.

Where we are today is that there are 19 open items. The revised draft Safety Evaluation Report will show 19 open items. Of those 19 items, 14 of those we are -- DCS will be providing information. And 5 of those are currently under review.

I'd also like to say of the 19 open items, we talked today about 6 of them in depth. When we met with you a year ago, we gave you the across the board view of all the open items. Today we picked 6, what we thought major ones, and discussed them with you in depth today.

So, you can see where we were a year ago, where we are today. Our plan is to continue to review the information and review the information that is provided by DCS, and most likely we'll be having additional meetings with the applicant.

CHAIRMAN POWERS: Well, it's not with the applicant, but the meetings with us, that's the question I want to pose here.

Our obligation, of course, this is something the Commission has explicitly asked to report on to them. But my question is in engineering judgment or administrative judgment issue here, is that as we resolve these and the point where you say, yes, we're happy with everything, do we need to do it in a Subcommittee format before we go to the full committee or can we go directly to the full committee given that I will do my best to educate the full committee prior to you getting there?

MR. PERSINKO: I would think you could go straight to the full committee. I think you could.

CHAIRMAN POWERS: I'm going to ask you guys the same question.

MR. ASHE: This is Ken Ashe.

We believe that we've given you a lot of information today. And if you look at our Construction Authorization Request and the draft SER, you should get a very good picture of where we are.

We also believe that as we go forward with the staff working with the staff, they should be able to keep you abreast of where we stand so you can go to the full committee.

CHAIRMAN POWERS: Right now my prejudice is given that the resolution of the outstanding issues does not elicit controversy. In fact, forget a resolution. That everybody's happy. That we'll go straight to the committee on this rather than having another Subcommittee.

Now, of course, if -- rises in there or things need a bigger discussion, we're perfectly willing to have another Subcommittee meeting. But that's the strategy I would like to pursue is that -- the plan will be success oriented in our planning and will adjust it if need be.

MR. PERSINKO: Okay.

CHAIRMAN POWERS: Good. Any other questions?

MR. PERSINKO: No. That concludes my statements here.

CHAIRMAN POWERS: Nobody wants to ask any questions?

MR. PERSINKO: What I do want to say is staff is very interested in any comments the Subcommittee would have regarding what we have been doing and what we presented, especially if you have areas where you think we need to do something different. Because we are planning to issue a final SER in September. And we would like to -- if there's any corrections we need to do, we want to do them now.

CHAIRMAN POWERS: Yes. Let me comment on a couple of things.

First of all, let me comment that all of your staff presentations were excellent today. Enjoyed them very much.

On the SER, it is a very comprehensive document, and that's good. It is rather well written with respect to providing enough background. I don't think one can read it, just pick it up and say now I know everything about this facility without reading any of the ancillary documents or the Construction Authorization Request or something like that. But as a document for reading, it is quite readable.

What I will comment is that about half the time you come down and you tell what the applicant has written. You tell me something about your analysis and then you draw a conclusion. The other half of the time you tell me what the applicant has done and you say we looked at this and it's fine. That's not very helpful.

The former approach where you tell me

something about what you guys did more than we looked at this, but give some rational for your coming to the judgment that things are okay, those are great. And the more you can do that, the better -- the more satisfactory the document is.

and you're about 50/50 as far as I can tell in there. And it is not a scientific proof that I think people are looking for. It is some indication of what a pain you went through in arriving at your conclusion. It can usually be handled in a sentence or two.

That was my view of the SER. I certainly invite comments from the rest of the Committee on their examination of it.

Jack, do you have a point to make?

MR. SIEBER: Well, no. I'm just prepared to agree with you. I also do agree that it's a likely document, very comprehensive. And it would be good on a CD ROM.

CHAIRMAN POWERS: Yes. There's no question that the staff has done a very thorough job in examining this from the SER. And like I say, it is -- it's very good at getting the appropriate amount of background, the appropriate amount of description of the system. And often times it does a fine job in explaining the rational for the conclusion you did. But there are those occasions where you're pretty abrupt. I forget what the exact phraseology used. It's another one you could easily fabricate an acronym, I think.

But as you go back through it. Of course, there are enormous number of typographical things, as you would expect from any draft and whatnot like that. But quite frankly, they don't detract from the document very much because it's really -- when I first downloaded it I said "Oh, my God, this is going to be pain." And it wasn't. I rather enjoyed reading it. Thank you.

MR. PERSINKO: Well, let me say, the first goal you set, the first example your set is our goal. We wanted to be like that all the time. And it'll continue to our goal so that we explain the analyses. For those areas we're not, we'll take a harder look at.

We also are trying not to repeat the CAR in the application.

CHAIRMAN POWERS: That's right. That's right.

MR. PERSINKO: A short summary. And if you want to read more, you can read the CAR.

CHAIRMAN POWERS: And I think that's what I'm telling you, is you've succeeded in that one. You were not -- it was very evident you were trying not to repeat the CAR, but to give enough background so that you kind of knew what the issue was. And I think you succeeded in that.

MR. PERSINKO: Thank you.

Is there any other comments, please let us know.

DR. FORD: Yes, I've got a point to that. Materials issues, I remain concerned about the materials issues. I've seen too many chemical process plants fail terribly, catastrophically because of the assumption that, for instance in this case, 300 L-series stainless steel will be all right. It's a highly oxidizing environment with chloride, you will undoubtedly get pitting. I wouldn't be at all surprised if you get transgranular stress corrosion cracking. So I really do urge someone to look at that.

MR. PERSINKO: Let me say, we are. But keep in mind, this is also a design basis information at this point. And I think one of the PSSCs is a corrosion control program and the details of that will be established at the possession and use phase. So there will be more information at the possession and use phase.

MR. ASHE: I want to add one thing regarding the materials of construction. I think within our Safety Analysis we have made a point of putting the equipment with process cells and consequently, the radiological consequences or chemical consequences as well are below those requirements of 70.61. So from a pure safety aspect, I think we've accommodated the materials of construction. That is not to say that we can't have leaks. We have provisions to account for leaks. But from a safety perspective within the AP process, I think we have accounted for that --

DR. FORD: You not only have safety issues, but public perception. And also your finances.

CHAIRMAN POWERS: Any other -- Steve?

MR. ROSEN: I just want to quickly summarize a couple of technical points that were made today.

CHAIRMAN POWERS: We'll be going around later.

MR. ROSEN: Oh, we will.

CHAIRMAN POWERS: This is just -- yes. We're going to -- and the plan I have is once these closing comments, we'll take a little break, then we'll come back and we're going to go around and discuss --

MR. ROSEN: Okay.

CHAIRMAN POWERS: You have a closing comment you want to make? How much you enjoyed being in front of us? What a delightful way it is to spend a Monday after Easter? All those things I want to hear, yes.

MR. ASHE: This is Ken Ashe.

We did enjoy ourselves today. And it was wonderful to be here the day after Easter.

CHAIRMAN POWERS: Tell me he doesn't learn quick.

MR. ASHE: We would like to thank you for the opportunity to provide you some of the technical information associated with our program. And, hopefully, we did impart a confidence in our abilities to go forward with this project.

CHAIRMAN POWERS: You've definitely convinced you know more about HEPA filters than I do, if that's what you're looking for.

MR. ASHE: Yes. Thank you.

And that's all.

CHAIRMAN POWERS: Okay. My plan is let's

take a 12 minute break, Jack. And we will come back.

And what I want to do is just summarize some technical points, but more important discuss -- or just as important, discuss what kinds of things we want to say to the full committee in our briefing at the main meeting.

MR. ROSEN: And some of the technical points I would hope the applicant would listen to so that those could be included at the main meeting.

CHAIRMAN POWERS: You don't think he took notes while you were debating him?

MR. ROSEN: Well, someone should be possibly -- I was hoping responsive to those points. But we can talk about it.

CHAIRMAN POWERS: Yes. Okay. We will recess for 12 minutes.

(Whereupon, the hearing was concluded at 6:47 p.m.)