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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

AND

ADVISORY COMMITTEE ON NUCLEAR WASTE

NOVEMBER 14, 2001

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

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

ADVISORY COMMITTEE ON NUCLEAR WASTE

(ACRS)

(ACNW)

MEETING OF THE ACRS/ACNW JOINT SUBCOMMITTEE

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WEDNESDAY

NOVEMBER 14, 2001

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ROCKVILLE, MARYLAND

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The ACRS/ACNW Joint Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 1545, Rockville Pike, at 8:30 a.m., Mr. B. John Garrick, Chairman, presiding.

<u>Subcommittee Members Present:</u>

Mr. B. John Garrick, Chairman, ACNW

Dr. Thomas S. Kress, Co-Chair, ACRS

Mr. Milton N. Levenson, Member, ACNW

Mr. Dana A. Powers, Member, ACRS

ACRS/ACNW Staff Present:

Mr. Howard Larson

Mr. Michael T. Markley, ACRS

Mr. Richard Savio

Mr. Sher Bahadur

Also Present:

Mr. Peter Hastings (via phone)

Mr. Ken Ashe (via phone)

Dr. Dennis Damon

Mr. Yawar Faraz

Mr. Carl Yates

Ms. Lydia Roche

Mr. Felix Killar

Ms. Marissa Bailey

Mr. Lawrence Kokaiko

Mr. Alan Rubin

Mr. Jack Guttman

Mr. Christopher Ryder

Mr. Brad Hardin

Mr. Moni Dey

Mr. Jason H. Schaperow

Mr. S. Khalid Shaukat

Mr. Ed Hacket

A-G-E-N-D-A

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

8:30 a.m.

MR. GARRICK: Good morning. Our meeting will now come to order. This is the meeting of the Advisory Committee on Reactor Safeguards and the Advisory Committee on Nuclear Wastes Joint Subcommittee.

I am John Garrick, acting as chairman of the Joint Subcommittee. Tom Kress, on my right, is co-chairman. The committee members that are in attendance are Milt Levenson of the Advisory Committee on Nuclear Waste, and Dana Powers of the Advisory Committee on Reactor Safeguards, a distinguished group to be sure.

The Joint Subcommittee will continue its discussion on risk informing activities of the Office of Nuclear Materials Safety and Safeguards with emphasis on the proposed final version to the Standard Review Plan, Chapter 3, for integrated safety analysis. We will discuss the use of risk informed case studies and development of a probabilistic risk assessment for dry cask storage.

The subcommittee will gather information, will analyze relevant issues and facts, and formulate positions and actions as appropriate for deliberation by the ACNW full committee.

Mike Markley is the Cognizant ACRS/ACNW Staff Engineer for this meeting.

The rules for today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on November 2, 2001.

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

It is requested that if we have speakers they identify themselves and speak clearly and loudly so that we can hear them.

We haven't received any comments or requests for time to make oral statements for members of the public regarding today's meeting. However, we do have a request from Mr. Peter Hastings of Duke-Cogema to participate via telephone. I guess we are accommodating that request.

One of the things the committee has to decide and will be influenced by staff on this is whether or not they wish to have a letter from us. It seems as though one of the key issues associated with at least the initial part of our meeting having to do with the Standard Review Plan and having to do with integrated safety analysis in particular is the issue of scope. What actually should be in the summary.

As a kind of aside and a curiosity, I find it very interesting, and maybe the folks that present to us today can answer this, that an institution like the Army Chemical Corps who definitely has a chemical culture, the culture that developed the process hazard analysis methodology.

The Chemical Corps has chosen to use probabalistic risk assessment, or PRA, on their chemical waste disposal facilities, while the NRC, the culture that developed probabalistic risk assessment, seems to be choosing process hazard analysis as the cornerstone of their integrated safety assessment. Maybe that will all be -- the reasons for all of that paradox will become clearer to us as we get more deeply involved.

The committee has been discussing for its last two or three meetings the risk informing activities of NMSS and other matters. Maybe what we're seeing here is a little difference between subcultures, namely, something like the differences between the NRR and their philosophy about methods and techniques and the NMSS, but I'm not sure.

Okay. Unless the members have some

preliminary comments they would like to make, Dana, Milt, Tom, I think we'll turn the time over to Mr. Faraz for the initial presentation.

MR. FARAZ: Good morning. Can everyone hear me?

MR. GARRICK: You want to tell us a little bit about yourself and your involvement in this?

MR. FARAZ: Yes. I'll do that. My name is Yawar Faraz. I'm a senior project manager in the fuel cycle licensing branch in the Division of Fuel Cycle Safety and Safeguards in NMSS.

Within the next 30 or 40 minutes I'll be providing you a very brief overview of Subpart H of 10 CFR Part 70. That's what the Chapter 3 of the SRP is really based on.

I'll also provide you very briefly a status of where the fuel cycle licensing branch stands in terms of ISAs for fuel cycle facilities.

I've kept my presentation to a minimum. I have a total of 10 slides. That's to allow a good discussion on this topic. Anytime you have any questions, please feel free to ask.

Immediately following my presentation, Dr. Dennis Damon will provide a roughly 60 to 70 minute briefing on how to conduct ISAs and how we would be reviewing ISAs.

The question is why did we devise 10 CFR Part 70 and why did we include Subpart H in Part 70? As you know, Subpart H was included in CFR Part 70. The required fuel cycle licensees, as the name implies, to integrate all the safety disciplines.

Subpart H requires the use of systematic methods to (a) identify all potential accident sequences, (b) determine the likelihoods, and (c) estimate the consequences.

Another very important aspect of Subpart H that it requires the licensees to identify items relied on for safety, or IROFS. As you know, this can both be hardware as well as administrative requirements.

Who is required to comply with Subpart H? It is those whose cycle facilities are authorized to possess greater than a critical mass of SNM, or special nuclear material. And who processed enriched uranium and mix oxide fuel?

Currently there are six operating fuel fabrication facilities in the U.S. that are required to comply with Subpart H. Those are the six that I've listed. In addition, there is also the MOX application that we're currently reviewing. The MOX facility would also have to comply with Subpart H.

In addition to this, if there are any future enrichment facilities that need to be licensed, they would have to comply with Subpart H as well.

MR. GARRICK: How many of these facilities already have something like an ISA?

MR. FARAZ: I would say most of the facilities are already doing an ISA type -- they have ISAs established in their systems. There are some that are fairly forward and fairly advanced in their application of ISAs and some that are not as advanced.

The rule requires that for a site-wide ISA to be completed, it requires that it be done by October of 2004. I would say that it appears that the facilities are going to comply with that requirement.

What does Subpart H require in terms of ISAs? One of the primary requirements that I just mentioned is to have licensees conduct ISAs for their facilities.

By conducting an ISA a licensee can ensure for themselves and demonstrate to the NRC that the facility that they operate would comply with the performance requirements of Subpart H. These are listed in 70.61.

Another very important aspect of ISAs is the identification of items relied on for safety, or IROFS. To ensure that these IROFS are available and reliable, Subpart H requires the licensees to establish management measures. Some examples of management measures I'll show you in just a minute.

On this slide and the next slide I'll just briefly go over what the performance requirements of Subpart H are. I'm sure most of you are already aware of this. First of all, the licensees are required to identify all credible accidents that can occur at their facility.

Once they have done that, the licensees need to ensure that certain accident sequences are highly unlikely. These would be the ones that result in the following consequences. For the worker, a dose greater than 100 rem or a chemically caused fatality.

For a member of the public located outside the controlled area which you don't think of as the site boundary, the limits are 25 rem. A soluble uranium intake of greater than 30 milirems or irreversible chemical injury. This is for a member of the public outside the site boundaries.

MR. POWERS: Since this is an intention to integrate together a number of safety disciplines including environmental safety discipline, whey are there no environmental contamination constraints in this definition?

MR. FARAZ: There are and I'll get to that in the next slide.

MR. LEVENSON: I have a question. Under the worker you say chemical caused fatality. Is that intended to exclude OSHA type physical mechanical fatalities?

MR. FARAZ: Yes. There are certain accident sequences that are required to be unlikely. We just talked about the highly unlikely ones. Now I'll talk about the ones that need to be unlikely.

For a worker this would be a dose between 25 rem and 100 rem or irreversible chemical injury. A member of the public would be between 5 and 25 rem or a chemically induced transient illness.

For the environment it would be 24 hour average air concentration outside the restricted area which you can think of as the fence line which may or may not be within the site boundary. The air concentration there if it's greater than 5,000 times, Table 2 of Appendix B of 10 CFR Part 20.

Incidentally, if you can word that the 24-hour air concentration to a dose, it ends up being about 1 rem. If you compare this to the member of the public residing outside the controlled area it's less and you're talking about a dose at the fence line or the restricted area which is within the site boundary.

MR. GARRICK: Is that 1 rem due to inhalation?

MR. FARAZ: Yes. It's a 24-hour dose. Really this would be the controlling mechanism.

MR. GARRICK: But you don't get a contribution from any ground shine or any other source?

MR. FARAZ: No.

MR. POWERS: Could you explain to me how these things come up? Why 5,000 times and not 3,000 times?

MR. FARAZ: We went through a fairly lengthy process of coming up with Part 70. It was a participatory rulemaking process. This was something that all the stakeholders, including in our city, agreed upon as being a reasonable level.

Now, I was involved in that process but this is something that was already included in the rule. I think there might have been something in the statement considerations that might shed some light on that. These are levels that all the stakeholders including NRC thought were reasonable. That's why they were established in the rule.

MR. POWERS: I guess what I'm trying to understand is what leads one to conclude that these are reasonable? I mean, there must be some thought process.

MR. FARAZ: Right. I'm sure that went into the rulemaking process which is, as you know, a very lengthy process.

DR. KRESS: This air concentration outside the restricted area, is that meant to be a maximum in case atmospheric conditions make it jump over locations?

MR. FARAZ: It's a 24-hour average.

DR. KRESS: It's a 24-hour average where? Right at the --

MR. FARAZ: At the fence line.

DR. KRESS: At the fence line.

MR. FARAZ: Right. But you're right, somebody can argue that theoretically there could be an elevated release or buoyant release --

DR. KRESS: That's what I had in mind.

MR. FARAZ: -- that might go with the fence line and come down on the site boundary. In that exceptional case, it would not be the controlling factor.

DR. KRESS: Does this performance requirement come with a specification on what analytical models are to be used?

MR. FARAZ: No.

DR. KRESS: Does it talk about means or uncertainties in the calculation?

MR. FARAZ: No.

DR. KRESS: It just specifies a number?

MR. FARAZ: Right. Right.

MR. GARRICK: So when you say average, are these average atmospheric stability conditions or are these for a special set of atmospheric conditions such as F?

MR. FARAZ: Yes. I think when the licensees look at their accident sequences and try and estimate the consequences, I'm sure they would build in the conservationist that is reasonably required for coming up with air concentrations.

I think generally what the licensees do and what the NRC accepts, the staff accepts, is a conservative estimate at the fence line. We would look at whether they are using annual average type meteorology or are they using fairly conservative data.

MR. LEVENSON: Is there a rationale for

why one of those is outside the controlled area and the other is outside the restricted area because they are both public.

MR. FARAZ: Yes. That's a good point. As I said, I wasn't really involved in the development of the rulemaking process. I would tend to think that with member of public maybe thinking about the nearest resident.

The question may have come up is that members of the public can come into the controlled area because sometimes these facilities have roads and there is really nothing restricting anyone coming up to the fence line.

In that case, they could be exposed to the environmental contamination while they are in that area. That's why maybe the environmental requirement came in. That's why I said the restricted area and not the control area.

MR. YATES: I have a question. My name is Carl Yates. I'm with BWXT in Lynchburg. A comment really. We have been using the restricted area in our analyses of our accident scenarios to mean the radiological restricted area which is much closer than the site boundary or the controlled area boundary.

MR. FARAZ: Right.

MR. YATES: So we have been looking at air concentration levels on site to the restricted area fence line.

MR. FARAZ: Right.

MR. YATES: Also, I had a question. We were also wondering does it say air in the regulation? We were wondering if it also included liquid releases because Table 2 gets both air and liquid concentrations. We were looking at some accident scenarios involving liquid releases and whether or not we needed to apply that 5,000-times limit to that.

MR. FARAZ: I'm not absolutely sure if it specifies air or not.

MR. YATES: Okay.

MR. FARAZ: That's a good point. That's something I'll need to look into.

DR. DAMON: My name is Dennis Damon. I was involved in the process by which the Part 70 evolved. My memory of why the distinction between controlled area and restricted areas is there were some facilities that we had been looking at.

It turns out not to be the facilities that are being regulated under this but facilities that might come under it where they had very large controlled areas. They control the whole Hanford

Reservation.

The idea was we didn't think it was appropriate to contaminate a very, very large area of the landscape to these kind of levels. That's why it was made the less restrictive definition. I mean, the air concentration gives you one rem and the one above gives you 5 rem so it's kind of backwards from what you've just said is the ratio.

DR. DAMON: I think all I'm saying is that we didn't want our licensee to simply be able to use the fact that they controlled an area to permit them to contaminate it to these levels. In other words, you see what I'm saying? They move the control area out and inside that they don't need to -- they can exceed this limit. The point was to deny -- to prevent that.

The other factor that I would point out about these is that these are all fairly high levels of consequences. They are not low levels like you would normally talk about in the context of environmental contamination and so on.

There was, I believe, a consideration to make that environmental requirement more comparable to those other requirements for workers and the public. These are very substantial accidents. These are not insignificant ones.

I think the rationale there is it was desired that the requirement not be applied to very low levels of accidents because they are sort of like a cost benefit consideration there. The licensees had enough to do to just consider the more severe things. I think that concept comes in here.

DR. KRESS: That brings to mind another question. These do look like high-level -- could I call them safety goals? They relate to the safety goals for operating reactors, or do they? Do they have any relationship at all to those?

MR. FARAZ: I'm not sure how they would relate to the reactor safety. Dennis, are you familiar with --

DR. DAMON: I mean, there's no discussion that I can remember in the evolution of the rule that related them to the reactor safety goals. One other thing. These are not goals. These are requirements in the sense that they are required to make them a certain likelihood level.

DR. KRESS: I understand. I understand that.

DR. DAMON: So they are not at a goal level.

DR. KRESS: The rationale I was thinking of is if the safety goals were to be requirements, which they are sort of ambiguous right now whether they are or not and, therefore, a summation of sequences.

You could view fuel fabrication plants as an essential part of nuclear power so it seems to me like an essential part of nuclear power the cost benefit type of assessment would tell you the safety goals ought to be about the same because it's the same benefit so you ought to be able to accept the same risk.

Since these are for individual sequences, they must be some fraction of that safety goal. I don't know what fraction it is. It depends on how many essential sequences you have in the unlikely category and in the other category.

My question was to see if there was some rationale process it went through to show that these are indeed of the nature that might be equivalent to the safety goals.

MR. GARRICK: I think it's obvious they did not go through an apportionment process or an allocation process.

DR. KRESS: That would be an allocation.

MR. GARRICK: I wanted to ask who decides the restricted area and can it be a variable? Is that the licensee?

MR. FARAZ: The licensee would decide where the restricted area is and they would present that to the analyses staff. Then the analyses staff would determine whether it's okay or not. They would establish the area and that would be part of their submittal to the NRC.

MR. GARRICK: And that's something that probably wouldn't change. I guess the licensing process allows for a change if they have a sufficient justification for it?

MR. FARAZ: Yes.

MR. GARRICK: There are still a lot of questions on that. Go ahead, Milt.

MR. LEVENSON: An incidental question is how do these definitions of likely and unlikely compare with those in the proposed Part 63?

MR. FARAZ: I'm not very familiar with Part 63. Go ahead, Dennis.

DR. DAMON: They really have nothing to do with it. We had a discussion with Tim McCartin and the Division of Waste Management about the issue of whether there needed to be consistency and we saw no need for there to be a consistency.

The term unlikely and other qualitative likelihood terms appear many different places in the regulation. I was going to point out some of them in a presentation later today.

They certainly are not used in any consistent manner except to the extent the English language meaning of the word. They are used in that sense consistently but there's no definite numerical probability or anything associated with them.

MR. LEVENSON: Of course, it explains part of the problems we have communicating with the public when we use different definitions for the identical words in different regulations.

MR. GARRICK: But you do have guidelines that indicate what those mean.

DR. DAMON: Certainly in the case of Part 63 that's what they are going to do. They are going to tell the public exactly what the staff thinks it means. In the context of Part 70 here it was not stated in the rule but the Standard Review Plan indicated what the staff thought.

MR. GARRICK: Yes, this was 10 to the minus 5 and 10 to the minus 4 for unlikely and highly unlikely.

MR. FARAZ: What I'll do is we'll hear some of the management measures that I talked about, some examples of management measures that are needed to ensure that the IROFS have really been reliable.

You have the configuration management program, training, QA, procurement, maintenance, functional testing, surveillance calibration procedures, signs, tags, shipping, storage, human factors. The list goes on and on.

What I'll do next is I'll try and give you a brief overview of where --

MR. POWERS: Let me ask you a question about it. You've listed down a host of things with no indication that this is complete. What am I supposed to drive from this list?

MR. FARAZ: Let me just get to it. Okay, yes.

MR. POWERS: There are 10,000 things here and there are probably 10,000 that are not listed on it. Are these the things that NRC proposes to control and regulate?

MR. FARAZ: These are management measures that the licensees are required to establish and that they will provide to the NRC when they complete their ISAs. The NRC would look at them and review them and determine if they are okay or not. What I want to do is give some examples of management measures that will be included in their ISAs.

MR. POWERS: I guess I'm a little -- suppose they have a written policy and procedure for tags? I supposed NRC could review it. How do they decide that is a good one or a bad one?

MR. FARAZ: There's no definite criteria for what is okay or not. I think the NRC would look at the entire management program as a whole and then determine if they are good management measures or not. If they determine that additional management measures are required or needed to assure safety, then the NRC would ask licensees to revise or change those management measures.

MR. POWERS: So if the NRC did not like the workload that the management was imposing on an individual, they would say don't do that?

MR. FARAZ: If the licensee says that overtime is authorized up to $100 a week for an individual that is relied on for safety, then clearly that is something the NRC staff would question. There are things like if the NRC staff sees there's some out of the ordinary management measurement being proposed, then we would look into it and question it.

MR. MARKLEY: How is this being links to the risk-informed oversight process, or is it?

MR. FARAZ: You mean the whole ISA process?

MR. MARKLEY: Well, the oversight process which is your inspection and verification process and what they've done in looking at cornerstones of safety with the reactor program. I understand they are doing some of that with the fuel cycle programs as well. It seems to me like most of these types of verifications would fall within an oversight process of some sort.

MR. FARAZ: Right. They would be included in their license application all the ISA. That's something that the licensing group would be reviewing. Then once the licensing group feels that they are fairly good management measures in place, then the inspection process would confirm whether they are okay or not.

DR. DAMON: This is Dennis Damon again. The key thing to focus on in this slide is that first top bullet, "Measure to assure that IROFS are available and reliable and needed." There is actually a requirement. If you read the rule language, the requirement statement in the rule language, this is actually almost a quote from it.

It says, "The licensee must establish these measures to assure that IROFS are available and reliable when needed in the context of the 70.61 performance requirements."

What the staff intended that to mean was you had to do these things that are on this list to whatever extent was sufficient to achieve highly unlikely for high consequence accidents and so on. That's the direct requirement statement.

If the accident is highly unlikely given the whole ensemble of all the things that they do in this thing with respect to that one accident, then that is sufficient so the staff cannot make them do a better maintenance program just because they like better maintenance programs. It has to be tied directly to the highly unlikely issued.

Then the other thing is it says "when needed." It's obvious that was to preclude the idea that you have to have these programs in place and everything has to be done all the time. Like I say, this whole thing is tied -- the whole idea of the rule was to tie these programs to the items relied on for safety that come out of the ISA analysis. It's that linkage that is the key thing that the staff had.

The reason was because some of these

programs that some licensees had not been part of their formal license commitments. Some licenses did not have configuration management program descriptions in their licenses with commitments as to what they would or would not do and the same with maintenance.

This is an attempt to compel that be done uniformly across the industry that licenses will contain descriptions of these various programs. Then the content of those programs should be tied to the results of the ISA and should be done in a manner sufficient to achieve the highly unlikely by performance requirements.

MR. GARRICK: So these are more in the context of examples of measures that could be taken?

MR. FARAZ: Exactly.

MR. GARRICK: Rather than necessarily prescriptive.

MR. FARAZ: Exactly.

MR. GARRICK: It would be very facility dependent and serve the systems that do surveillance, dependent, and so on.

MR. FARAZ: Exactly.

MR. LEVENSON: I have a question. You said that basically the metric is to make sure that the accident is highly unlikely. Does that mean that if there are accidents by their inherent nature are highly unlikely you don't need to identify IROFS related to those accidents because you're already at the cutoff put?

MR. FARAZ: Yes, that's true. What the licensees would do is they would look at all the accidents that can occur that are credible for their facility. If an accident is not credible, then it won't require IROFS.

MR. LEVENSON: Are you using the word credible and highly unlikely to be identical?

MR. FARAZ: It's very hard to exactly quantify credible and highly unlikely.

MR. LEVENSON: My whole point was if I'm trying to do this, how do I know where my cutoff is for preparing IROFS? That should be fairly clear.

DR. DAMON: It's described in Chapter 3, the one that we'll get to, the chapter on ISA. The issue of credibility is discussed there. The language in the rule is the licensee is required to identify all credible accidents and to make them -- if they are high consequence make them highly unlikely. It's that kind of language.

The way it was understood by the staff and which is explained fairly carefully in chapter 3 is that to be credible means not to be included in the ISA at all in a sense. This certainly doesn't have to show up in the summary or whatever. The staff's interpretation is that credibility must be obvious.

It must be obviously something that doesn't need to be considered. Things that do need to be considered because you maybe need to estimate their frequency or make some judgement about them, they ought to be -- they would be considered in the ISA and documented in the process of doing them.

Credibility, in other words, is a criterion for whether it's considered and documented, whereas highly unlikely is a criterion for once you've considered it, you've made it sufficiently unlikely.

In other words, what I'm saying is in doing an ISA you would consider accidents that would be far more unlikely than highly unlikely because of natural reasons like an extreme earthquake or something. You should have thought about that in doing the ISA. It's part of the process.

It's just that you don't need to do anything about it so you don't need to write down an item relied on for safety on your list so there's nothing for the facility to do. I think it should be included in the process that you went through when you considered all the accidents.

MR. LEVENSON: So you're saying we require analysis and regardless of the outcome of that analysis, you don't do anything with the results so why do it?

DR. DAMON: Well, it shows completeness. What I'm saying is if something is obvious that it does need to be considered, yeah, they don't need to put it in there. But if you're talking about communicating with like, say, future people at your own plant or with the NRC staff, it's important, I think, for a licensee to document what they did consider in doing their ISAs.

If they thought about earthquakes and they said, "Okay, this earthquake is one sufficient to do the damage we're worried about here," but is too infrequent to worry about because of the specifics of that site, they should write that down in their documentation so that the next time somebody does this type of analysis, they don't have to replicate that whole process over again. It's that kind of thing.

In other words, how does the staff know that you've considered all accidents unless you have considered all accidents because that's what the rule requires, that you identify all so the staff needs to understand that the licensee did try to look for everything.

Then there's a subset of that that they found. I think the language is stated they don't have to tell us in the ISA summary about ones that they found that didn't meet the credibility criterion or whatever, or didn't even meet the highly unlikely criterion.

They only have to tell us about ones that did meet that threshold. But in their own process that they went through at their plants, I don't see how you can do that process without documenting everything you've thought about.

DR. KRESS: Are sabotage events excluded from this and put into some other category?

MR. FARAZ: Yes, sabotage is not something that is typically included.

MR. GARRICK: Maybe you had better proceed.

MR. FARAZ: Okay. What I'll do now is I'll kind of give an overview of where the fuel cycle licensing branch stands in terms of ISAs.

As of April 18, 2001, all the licensees had submitted ISA plans. These are plans that will give the ISA approach that the licensees are going to follow. The processes at their facilities will be analyzed and a schedule.

DR. KRESS: Each process that the licensee decides to analyze has to meet these performance measures?

MR. FARAZ: Exactly.

DR. KRESS: So a lot may depend on what the licensee selects as a process.

MR. FARAZ: Well, they have to look at all their processes. In the ISA plan there may be a chemical process that's away from their license material.

DR. KRESS: Is there a firm definition of what the process is?

MR. FARAZ: No, there's not.

DR. KRESS: So the licensee just decides this is a separate process and this is a separate process and I'll do the ISA for each of these?

MR. FARAZ: Right. Right. I would think of the process as, for instance, if they do decontamination activities, there might be a building and all the decontamination activities would come under the decontamination process. They would look at all the various processes and integrate them all together as part of the ISAs.

MR. GARRICK: So when you say approach, you must be looking for something different than the guide or the Standard Review Plan?

MR. FARAZ: That's right. As the name implies, it says to guide. If they want to follow it, fine. If they want to propose something different, that's fine, too.

MR. GARRICK: Okay. Thank you.

MR. FARAZ: We've already reviewed and approved BWXT's ISA plan as well as NSF's. The other reviews are ongoing,

As far as Subpart H is concerned, one of the submittals that are required to be made, as I mentioned before, by October 18, 2004, all the currently operating licensees are required to have their site-wide ISAs completed and submit to the NRC their ISA summaries.

In addition to that, by the same date the rule requires all the licensees to identify and correct any deficiencies that may have been identified as part of doing the ISAs.

However, Subpart H also allows an extension to that date as long as sufficient justification is provided to the NRC, acceptable sufficient justification.

I will just mention that we anticipate submittals to begin as early as spring of next year because, as I mentioned before, some of the licensees are ahead of the ballgame. That will give a good opportunity for both the licensees and the staff because this really hasn't been done before to this extent.

This will give the licensees and the staff a good opportunity to actually get into the thick of things and conduct and review an actual ISA. None of the licensees appear to be behind and don't appear to be in danger of exceeding the enroll date.

Some of the challenges that we are currently facing and that we expect to face are listed in the slide. The first one that I've listed is the SRP itself. Last month we finally reached an agreement on the contents of the entire SRP by reaching agreement on what is required to be or what is needed to be in Chapter 3.

We're in the final stages. We hope to finalize an issue of the SRP within the next couple of months. This was a very lengthy process. It was a multi-year process. The stakeholders were very heavily involved; NEI, the licensees, the public. Finally we have come to a point where we think that we can finalize the SRP.

Another challenge that I've listed is guidance on failure rates. This is something that we intend to work with again the stakeholders on and it is information that would be helpful in determining what's unlikely and what's highly unlikely.

These would be failure rates of hardware systems. We really haven't begun this process but once we issue the SRP and finalize the SRP, we hope to get into that as well.

MR. POWERS: It seems to me that it would be very complex guidance to give because you have over here a fairly lengthy list and any failure rate that is high can be compensated for by a lot of other things. It looks like it's very challenging to set up guidance.

MR. FARAZ: It will be challenging. We will go through pretty much the same process that we followed for the SRP. In other words, we would engage the stakeholders on this. It's at its infancy and the picture is not very clear right now.

Another challenge would be for the licensees to conduct the ISAs and for the NRC to do the reviews of the ISA summaries as well as the ISAs. As I had mentioned before, it could be as early as

April 2002 that the NRC staff begins reviewing some of these ISA summaries and ISAs.

A very important challenge that I see is to risk inform the staff's licensing reviews and inspections and enforcement actions once the site-wide ISAs are approved.

MR. GARRICK: Are you comfortable that the ISA process will achieve that last bullet?

MR. FARAZ: I'm not sure if we will reach 100 percent but clearly it will be a major, major improvement and a major step forward. Clearly in risk informing our licensing reviews and inspections and enforcement, the ISA process is a great help and a necessity.

MR. GARRICK: Okay. Thank you.

MR. FARAZ: Are there any other questions?

MR. GARRICK: Questions from the committee?

MR. FARAZ: I'll ask Dr. Dennis Damon to provide his presentation.

MR. GARRICK: Thank you.

Dennis, I trust, our questions notwithstanding, you will organize your presentation to meet our schedule of 10:15. We are very pressed today to stay right on our schedule. I guess we have a break scheduled at 10:15.

DR. DAMON: Yes. My intention was not to present everything that's in the big thick handout there. That material is something you have already seen.

It was presented back in January but I included the whole thing because I'm going to proceed to talk about one of the examples near the end and then proceed on to other things. I don't think we're in any danger of running too long.

MR. GARRICK: Thank you.

DR. DAMON: Maybe I can start talking and when he gets the slides going, I can proceed with the stuff that's on the slides. My intention was there's two parts to the presentation. One of them is based on what's in the Standard Review Plan, Chapter 3, which is the ISA chapter.

More specifically it's Appendix A to that chapter which I wrote. Appendix A is an example of one method that the staff would consider an acceptable way of documenting and presenting an ISA and ISA results. That's what Appendix A is all about.

Appendix A, as you remember, basically describes a method where each accident sequence if it is identified is laid out as such just basically with the same exact meaning of the term accident sequence as you would have in a PRA which is a sequence of events, an initiating event followed by subsequent events, and ending in consequences.

The licensee will identify these accident sequences and lay them out. In the example in Appendix A they are displayed in a tabular form with each accident sequence and one row on the table. Then it uses a scoring method that basically is a log rhythm of the failure rates, outage times, unavailability.

Whatever probabalistic information appears in that sequence is converted into order of magnitude index that reflects either the frequency of the initiating event or the probability of failure or the probability of occurrence of some subsequent event.

It's an index method. The indices are added up and that's your metric of whether you are highly unlikely or unlikely in the language of the rule.

That's what the Appendix A method is. Since that presentation in January BWXT and NSF have both submitted ISA plans in which they describe their approach to doing ISA.

In my second handout, the short one, what

I've done is put some information related to the BWXT method which also is an index scoring method for evaluating systems.

What I would like to do in the presentation is point out some subtle differences between the two index methods to show you what these methods are like and what they do for you and what they don't do for you and so on.

Then one other thing I intended to present was to discuss the last example that's in the large handout which is -- there are three examples in there and the last one is an example of something I chose because it's very characteristic of a large number of processes in these facilities.

It's kind of a situation where you can, in fact, imagine the accident but what is very difficult to do is to quantify it. It's an example of an accident where I believe that the reason why having the accident is highly unlikely is because of a subtle interaction between having a very large safety margin and an absence of a reason for why you would exceed such a large safety margin.

It's a very difficult thing to quantify. I wanted to show the members of the committee why it is that there's reluctance to mandate across the board quantification for its own sake, but rather to focus on qualitative characteristics of processes because a very large fraction of the processes of the facilities are kind of like this one that I describe in the example, and that is they have qualities about them that will convince you that it is highly unlikely to have an accident but it's very difficult to put a number on them.

That's not to say I'm against using an index method to categorize these things. I think that's a useful thing to do is to identify qualities that would convince you that something is sufficiently unlikely and then when it has those qualities you put it in that category of being something you think is highly unlikely. What I'm trying to communicate is how difficult it can be to actually come up with numbers for some of these things.

On the other side of the coin, there are processes that are no different from reactor subsystems. They are automatic hardware safety controls.

On the other side of the coin there's many situations in these facilities that involve human actions that are also no different from things that are very characteristically analyzed in human liability engineering.

There are things very clearly you could do a good job quantifying things, and there are other things that are very -- that need work. They need I don't know what, standardization or something.

MR. GARRICK: Of course, the concept that allows quantification of the reactor scenarios is the notion of uncertainty and the characterizing of those uncertainties in some form such as a probability of density function if it's for a fixed variable or something like a frequency of exceedence curve if it's for a variable measure of risk such as fatalities or injuries or what have you.

Has there been any consideration for the accidents that are really important to carry it a little further than, say, the index method?

DR. DAMON: You mean something further like --

MR. GARRICK: Like actually doing an uncertainty analysis.

DR. DAMON: I think that's a good idea for the staff to consider when they are developing this guidance document. In fact, if I remember, the early drafts -- Yawar is working on this thing, this guidance. He characterizes it as guidance on failure rates.

What I would sort of characterize it is more guidance to the staff in general about how to review the quantitative likelihood aspect of these ISAs. In that context, yes, uncertainty is something he's considering.

The issue, I think, is to communicate to the staff member to give him guidance how to identify things that he perhaps ought to take a more careful look at.

Something that triggers his -- you know, if the staff reviews to serve any function at all, I think one of the functions it can do is an independent technical review of whether, in fact, these systems are adequately safe. Do they meet highly unlikely or not?

Now, I don't think the staff has the resources nor the information to do that for every single process. I would envision it considering the uncertainties involved.

I mean, as a simple example, my own view is if the licensee comes in and claims that a given piece of hardware, whether it's passive or active safety hardware, has an extremely low failure rate, 10 to the minus 3 per year or something like that, the challenge there is that if they are wrong, they can be wrong by -- let's take 10 to the minus 4 per year.

If they are relying on that for safety and you're saying it's a once in 10,000 year type failure rate, you're basically placing a very heavy reliance on that item.

Yet, there is no way to verify whether that assignment is correct or not based on subsequent events at the facility because you don't expect to see any events at the facility if the facility won't have events occurring.

Whereas the licensee says, "I expect this type of failure once every 10 years," or says something equivalent to that, and the uncertainty in that is a lot less.

The staff should take that into account that there are certain things where they need to focus on where they need to review what the licensee has done and other places where you can rely on the fact that the licensee has a corrective action program and if they're wrong, those failures will occur more often and they will be picked up in the system.

MR. GARRICK: Dennis, are you satisfied that the ISA process is a building block towards a PRA?

DR. DAMON: Well, I think it's a building block towards using the thought processes, the conceptual structure that is used in PRA. And to using PRA, I think eventually -- there are licensees who have used quantitative risk analysis.

It comes up in some context where they feel it's to their benefit to do so but not comprehensive across the plan, every single process basis, when they have one particular thing.

I can think of two examples. One of them was a license amendment and they thought because of the complexity of the hardware involved it would be more convincing to submit quantified fault tree model.

The other case was a case where a violation was being proposed and the licensee felt that this was such a low risk situation that it shouldn't be a serious violation so they presented a quantitative risk analysis argument that the risk of what happened was very low. They do this sort of thing.

What I think is interesting about Part 70 is in developing the language of the regulation itself. What was abused the architecture of a risk based argument. That's what held the whole structure together. The conceptual structure is there.

What I would hope would happen in the future is that we would all learn to talk the same language between the licensees and us. As of now it's not fully there but over time that's what I would hope to see happen is that you evolve to a point where you are talking the same language.

MR. LEVENSON: You mentioned that some thoughts or guidelines on when the staff might decide to go a little father, etc., based on things like probability. Would it make sense instead of things like that to use as guidance when to go farther only those accidents that have potentially significant consequences?

DR. DAMON: Yes, that's the kind of thought process I'm talking about. I see a big difference in the thought process between someone who has become fluent with risk concepts like you mentioned. You know, think about the severity of the consequences of what you're talking about and people who don't. There's a tendency on the part of the staff sometimes to get concerned about issues that don't relate to risk. They've just lost sight. They've lost the bubble there. I think that's the point here. I mean, later today when we talk about the Risk Task Group's charter and so on and SECY-99-

100 that's what that's all about.

Both the NMSS staff and the licensees in this process we would like to encourage people to all start understanding the conceptual logic of risk so that they can start talking about the things that are being required to be done in a way that directly addresses consequences and likelihood and identification of all accident scenarios, risk concepts like that.

This is just the presentation that you have seen before that Yawar has talked about. There's one thing that is important to keep in mind. The chemical acts and consequences are obviously very carefully restricted to the things that are -- those chemical accidents that relate to the license material, not to chemical accidents in general.

MR. GARRICK: Of the chemical accidents that relate to licensing material, is there any tie between that and EPA standards on chemicals such as come up in the RCRA process?

DR. DAMON: There are -- what do they call those? AEGLs. The language that was put into the regulation mimicked the qualitative language that described the emergency action guidelines that EPA uses.

The intent was -- it was a one-time thought that those guidelines would be prescribed in the rule. It would say in there, "This is what you use a threshold for defining what is a high consequence event, one that is life threatening," and use the exact language of EPA. Then it was decided that had disadvantages in that these guidelines don't exist. For example, you have six so that is one disadvantage. Also it's a little too prescriptive so it was left at the qualitative language level, life threatening as high consequence and permanent or serious injury, I think, is the language that goes with the other one. The intent was to point directly at the AEGLs and say, "This is really what we mean by this."

MR. LEVENSON: The second triangle you have up there defines that only HF that comes from UF6 is involved. If I've got a plant I'm using HF. Some of it is maybe recycled from UF6 and some is what I buy for makeup. Do I have to differentiate and keep track by inventory and records as to which is what.

DR. DAMON: Well, there's not a requirement to track it. The point is when you do the ISA analysis and identify accidents that can happen, the material that is perhaps in a storage location is not intimately connected with the process that the NRC staff has responsibility for. That would not be included in this even though it's used in the process eventually.

MR. LEVENSON: No, no. But if the source of the -- way that reads is even if this is in a warehouse a mile away, if the HF came from decomposition of UF6, I have to consider it quite differently and independently of purchased HF. Is that correct?

DR. DAMON: That's right. In other words, anything that's connected with the UF6 since the enriched uranium is the license material, anywhere that licensed material, whatever chemical form it's in, that's fair game. That has to be considered in the ISA analysis, any accidents in UF6 storage. Not just the processing of it, the storage of it. Any UF6 on site would be --

MR. LEVENSON: I understand that but I'm talking about the HF separated from UF6.

DR. DAMON: Once it's separated and not actually intimately involved in some process, then it's not within the -- then it doesn't need to be considered in the ISA.

MR. LEVENSON: But that's not what this

says. It says "chemicals produced from licensed material." If I'm decomposing UF6 then HF is a by-product that's produced from licensed material.

MS. ROCHE: Dennis, may I?

DR. DAMON: Yes.

MS. ROCHE: I'm Lydia Roche, Section Chief for Licensing. In response to your question, January 1986 there was an accident at Sequoia Fuels in which a UF6 cylinder ruptured and killed a worker. What killed the worker primary was the HF. If it is licensed material, yes, it's part of the ISA. It's part of the process that we regulate.

MR. LEVENSON: I understand and I am familiar with that accident. This is very ambiguous because what you're talking about is a chemical produced during an accident and that is quite different than what is produced in a processing plant.

MR. FARAZ: What I would say in response to that the language may be a little misleading. You are correct that if it's part of the accident and --

MR. LEVENSON: Part of the accident I understand but one of the routine processes sometimes used from UF6 to decompose it down to UF4 is to make by-product HF. If HF is produced from licensed material, it seems to me that should not be covered.

MR. FARAZ: It's not covered. If a licensee has a process to extract HF from licensed material and then stores the HF a mile away from the site and then there's an accident there, that would not be included.

MR. LEVENSON: This wording does not make that clear.

DR. DAMON: Right. I mean, certainly the words you can fit on a view graph are very few. This is like a succinct statement. The MOU has extensive guidance and there's guidance in the chemical section of the Standard Review Plan as to what things should be considered and what shouldn't.

That doesn't mean that all issues have been resolved. I mean, there probably are some cases where that issue will have to be discussed in the context of what's done. I think between the staff and the licensees I think we have a reasonably close common understanding of which ones should be in and which ones are out.

It's mostly the idea that, like you say, HF evolved from UF6 during the course of an accident or MOX or something. We don't want you saying, "That's not your licensed material that's causing the fatality." Then items relied on for safety, this is just to point out how broad this is. Activity of personnel is underlined up there. That will come up as I get further in here.

This is just to point out that if you read the Standard Review Plan chapter on ISA, the Appendix A that has this index method in it and so on and so forth, that is an appendix.

What is stated in the body of the chapter as acceptance criteria is much more qualitative and it's really stated in terms of getting down to the fundamentals of whether an adequate job is done.

There's many more aspects to it than just whether you use a scoring method and what exactly the scoring method is and so on. It's really important that there be completeness of accident identification because that was really one of the major reasons for asking that ISAs be done.

That's just to point out that's what is dealt with in the body of the chapter is completeness of accident identification, correctness of consequence evaluations, and then finally you do get to the adequacy of likelihood evaluations.

Again, Appendix A is just an example. It was really not intended as "use this method." It was intended as an example of something that had the structure of something that you might use. The reason it was stated that way is because the NRC staff could not, nor could a licensee, I think, anticipate how any given scoring method would end up being applied as they went through all the diverse processes in their plant.

It was envisioned that a licensee would establish a qualitative method defining what is adequately unlikely and what isn't, but that process would evolve as they went through their facility and identified different types of situations that needed to be dealt with.

This just is talking about doing an ISA. NUREG-1513 has been published. That was the ISA guidance document. It focuses primarily on process hazard analysis and on the sort of project management level of what is involved in an ISA. That has been published.

It has in it one key thing, I think. It has a flow chart for selecting an appropriate method for identifying accidents. I think that is probably the most important single thing in that guidance document. If you use a "what if" method for a very complex process, that's just not appropriate. I think you need a method that is appropriate to the complexity of the process.

There is also NUREG/CR-6410 is the Accident Analysis Handbook. It's about this thick. It gives a lot of guidance on doing the kind of consequence evaluations that come up in the context of the fuel cycle facility.

It's actually fairly rare that one would actually need to do very many quantitative calculations of off-site consequences for a number of reasons. In an uranium facility it's very difficult to cause a release of material.

The material has such a low specific activity and such a non-volatile form most of the time that it's very difficult to give off-site radiological consequences that reach the thresholds we were talking about because we're talking about 5 rem off site to the public.

For chemical consequences likewise it usually is not that necessary to actually do quantitative evaluations. If you did need to do one, it can get -- these chemical transport models can get quite involved because UF6 is a very heavy gas so the 6410 has some guidance on that kind of thing.

MR. GARRICK: You might be a little generous in saying that you have defined some of these thresholds quantitatively because I think in the risk world when we think of something -- when we think of a quantitative result, we don't think of a number.

We think of a probability distribution because it tells much more of the story than is told by the number. I'm just saying that because one of the issues we're always dealing with in the risk informed world is the consistency of the language.

DR. DAMON: Well, this reminds me -- the issue of consequences reminds me of something that came up in Yawar's presentation. The question was -- he was talking about off-site consequences and whether those had to be calculated for average conditions or whatever, that issue.

The point is actually they have to be calculated for the most extreme possible condition that could ever occur. In other words, all we're saying is if there is a spectrum of possibilities and if one of those in that spectrum, even if it's a far outlier exceeds the thresholds of the rule, then to that segment of the spectrum of everything that can happen must be addressed.

The fact that it would take extreme -- it might take extreme weather conditions or whatever to cause a 5 rem dose or whatever, they would have to consider that.

MR. GARRICK: Then, again, there's an inconsistency in the jargon of what we mean by risk because what you're suggesting here is that your basing your risk-informed results on the basis of bounding analysis and extremely conservative assumptions.

Again, that is kind of a contradiction of the whole concept of risk assessment which was invented in order to have a mechanism by which we could have what is our best shot at what the risk is.

We want that because that gives us a baseline against which to know how conservative, for example, we should regulate it. It's a philosophical point but it's one that both the ACRS and the ACNW is constantly working on.

DR. DAMON: What I was meaning to say about that, and it actually says this in the Standard Review Plan ISA chapter, when it talks about consequences I recognize in writing that that you have this question. You have a release.

Well, a release could be large ones, some small ones, the weather conditions could be different, the wind could blow in one direction or the other. The question is what do you need to consider. What it says in there is that if there is any scenario that would exceed the threshold of the rule, then that needs to be considered.

The unlikeliness of that can then be credited in evaluating whether it is highly unlikely or not. All I'm saying is there's a spectrum of things. I don't think it's appropriate to say I get to select the average thing that could happen and if that average thing doesn't trip the threshold, I get to throw away and I don't need to consider or limit that or regulate that risk at all.

No, you look at the tail and you have to go all the way out. Could you ever exceed these threshold and then you can credit yourself. We all know stability class F and so on doesn't occur very often and they can credit that in their likelihood evaluation.

Like I say, it doesn't come up very often that they have to worry about these things. This is getting into what I said earlier, is that the Appendix A method talks about -- uses this index scoring method. It's a tradition, a standard, an industry consensus standard within the criticality community to try to achieve whenever possible a thing called double contingency.

This is the statement of double contingency. You can see the community in the criticality safety, which is one of the predominant things that could cause a fatality among all the accidents identified, the community already is using what I call risk-based language.

They are talking about independence and unlikely and redundancy and these characteristics. Usually their understanding of these things is not exactly the same as someone who comes from a quantitative background. That's what I say, I would like to start talking the same language.

This is an example of what I mean by the fact the index method in Appendix A really just lays out an accident sequence. This is for a system of two active redundant controls. The equation for the frequency of the accident, namely the accident being the two things happen, is expressed this way where the lambda's are the failure rates and the U's are the unavailabilities.

You have two controls, control 1, control 2. There's two different ways you can have an accident. Control 1 can fail first and then while it's out, while it is unavailable the control 1 can fail or vice versa. You have this equation and that's what the method of Appendix A does. It explains that is what these indices mean, that they refer to these concepts.

MR. POWERS: Does it deal with common mode failures?

DR. DAMON: Common mode failures? It alludes to them in the thing. If the common mode failure is something explicit that they can identify, it should be a separate item.

MR. POWERS: We usually have trouble identifying common mode failures.

DR. DAMON: That's certainly true.

MR. POWERS: I don't know that you can excuse them by saying we can't identify it so it's not there.

DR. DAMON: There's a whole discussion in Appendix A on the question of independence which involves common cause. I think it is one of the most important things and it is discussed in there that you can't treat this cost of independence lightly.

It comes up even more strongly when you start talking about the fact that many of these processes are operated by human operators. If you've got requirements on the operator as to the correct way of operating a process, when can you count on mistakes being independent of one another?

That's a serious question. We might get into that in the guidance document that Yawar is talking about. There are certain standardized ways of looking at that issue as to what is sufficiently -- I mean, for example, one of the criteria would be that human errors are independent if they are committed by people on two separate watches, two separate shifts.

In other words, you don't ever count human errors as being independent if they are committed by two people who are communicating with one another because they are standing the same shift together.

It's like the incident that happened with the submarine off Hawaii. They had a redundant system there. The captain is supposed to look through the periscope and look for ships on the surface and the sonar watch is supposed to be looking for them, too.

But the guy who was plotting the sonar watch heard the captain look around with his periscope and said there was nothing there. He said, "Gee, I think there is something there," but I'm not going to say anything. He's the captain. That's not independent. It's not an independent failure. That kind of thing I think is extremely important in the way these --

DR. KRESS: On that particular side is T2 something that is knowable ahead of time because of frequency of inspection or test or something like that?

DR. DAMON: Right. That's what I'm trying to point out here. We are expanding the unavailability number out here, the U2, into lambda 2 times T2. That's done deliberately in the method in Appendix A to point out to people exactly what you just said, which is you should often know what that outage time is because you will have a surveillance interval or you will know something about the process. It will tell you it's not as indefinite as a failure rate is.

DR. KRESS: The lambda 2 is a failure rate that -- does it count things like the fact that they did maintenance on it and the maintenance caused it not to be operable for some reason the next time? Is that included in the failure rate?

DR. DAMON: They should.

DR. KRESS: Count all failures.

DR. DAMON: Yes.

DR. KRESS: So it needs a database ahead of time for this failure rate.

DR. DAMON: Well, the kind of facilities

we're talking about people don't usually have anything that would amount to a database but they have to rely on their own memory. They do keep track of things that have happened at their facility.

In fact, in the PHA methods for how you do a PHA, one of the things that is mentioned is you should go back -- when you're doing the PHA on a particular process, you go back and retrieve whatever performance history you have on this thing, what have been the maintenance failures.

Has somebody done maintenance and failed to restore the system or do a post maintenance test and that kind of thing. That guidance is given to them so that is something they should consider.

I can remember going to BWXT and that's one of the first things they showed me. They marched through their methodology and that is a standardized part of it, you know, Chapter 1.6 or something and that's it. That's what they do.

DR. KRESS: In a PRA they would have used lambda 2 times T2 over 2. I guess in this kind of --

DR. DAMON: Yeah.

DR. KRESS: It's such a small difference that --

DR. DAMON: That's why the approximation

sign is in there.

DR. KRESS: It's probably not worth worrying about.

DR. DAMON: All I'm saying this is what was laid out in the Appendix. It's just a direct translation of how you quantify an accident sequence approximately.

DR. KRESS: Why is it felt that inviting up these things like frequency of occurrence into units of a factor of 10, why is it thought that is a sufficiently small unit to divide it up?

DR. DAMON: I would say -- I mean, in retrospect I would say it's probably -- I mean, I could be easily convinced that you would use half orders of magnitude would be a little better. At the time --

DR. KRESS: It's sort of a finite difference in approximation of sorts.

DR. DAMON: Yeah. I hadn't had much experience in actually doing quantitative analysis of fuel cycle type systems at that point so I put it as single integers.

In retrospect after having done a little bit of this as an exercise to see how things work, I am convinced it would be worth going to half orders of magnitude but not much beyond that because of the way things are being treated here these are --

DR. KRESS: Maybe about as close as you can get them.

DR. DAMON: Yeah. Considering the range, the uncertainties involved in these things, there's not much point in going further than that.

DR. KRESS: If you had a set of identified accident sequences and most of them fail up near the 10 to minus 4 if your range was minus 4 to minus 5, would you treat that differently than a case where most of them fell down near the 10 to the minus 5?

DR. DAMON: I'm not sure what you're saying.

DR. KRESS: Would you give it more of a regulatory look at it? Would you consider it more problematic if you were very near -- most of them were very near the one edge or the other so the summation of all of them might look differently.

DR. DAMON: There was some discussion of that in the Standard Review Plan as to how to deal with that. It's somewhat -- how do I put it? It would be somewhat problematic as to the regulatory status of trying to pursue that argument because of the way the darn rule was written.

It's written as per accident sequence. It was understood at the time that it was written that's a problem to state it that way. Given that you're not going to require quantification, then you can't require accumulating risks from different accident sequences together in some other way. It was a dilemma you're stuck with with this kind of intermediate --

MR. GARRICK: So what you're end up with is a -- the word integration needs an asterisk because you're integrating horizontally but nor vertically.

MR. LEVENSON: I have a question. Appendix A provides guidance and examples for determining likelihood. Is there somewhere else guidance as to how to estimate consequences?

DR. DAMON: There's discussion in the main body of the appendix. There's a consequence section that talks about evaluating consequences and some of the issues that will come up in the process of doing it. But it doesn't get into the technical details of what constitutes a realistic model that the staff would find acceptable or not acceptable.

That's discussed in this NUREG/CR 64-10, that accident analysis handbook gets into what the staff thinks about the adequacy of the current state of models as of about three or four years ago when that thing was published.

MR. LEVENSON: Since that is published three or four years ago means it was written maybe five years ago. Is there any risk-based significance in that guidance or is it pretty much all historical empirical?

DR. DAMON: I'm not sure. I mean, mostly what it talks about is methods for calculating or estimating the consequences of accidents whether chemical or radiological so it's standard atmospheric dispersion, wake effects.

MR. LEVENSON: Yeah, yeah, yeah, but a lot of the stuff done five or six years ago had somewhere from two to four orders of magnitude of over estimation in the methods which is not exactly compatible with risk-based analysis.

DR. DAMON: This method here -- I mean, the Part 70 structure again, like I say, is pretty rigidly risk-based. It's not encouraging people to do anything that's what I would call bounding analysis or conservative.

It really is one that is focused on managing the risk by identifying what are the consequences that could happen really and really identifying what you think of the likelihood. None of the language in here is -- there is a use for bounding consequence evaluations in doing an ISA which is if you can -- it can be used as a screening method but it's not embedded in the regulation as a screening method. What I mean by that is you can think of very extreme case release of material if you show that even the most extreme case does not exceed the threshold specified in the rule for off-site consequences.

Then you just can wave your arms and say I don't need to consider off-site consequences for any releases of that type in the plant because I bounded it by this one evaluation. You can use screening analyses like that. That also is described in the Chapter 3 how that's to be done.

It is actually I think in the consequence section the idea of using screening analysis, but it's also explained that if it comes out the other way, namely an extreme case does exceed the threshold of the rule, then you need to have considered that.

I would like to kind of get on to --

MR. GARRICK: Yeah, you've got about five minutes.

DR. DAMON: Let's see if I can get to the end of this thing. I've got here -- I just wanted to talk a little bit about BMXT is one of the two licensees that have submitted an ISA plan and described their approach and it has been approved by the staff. I thought I would briefly go over what they did so you can see how that relates to what this Appendix A thing.

BMXT uses various hazard identification methods, PHA type methods. The hazard office uses it very frequently which, if you are familiar with it, is a very structured rigorous way of going through a piping system that has things about it like flow, temperature, pressure and marching through these various parameters and asking yourself what happens if this parameter is on the high side or the low side and so on. It's a nice structured method for dealing with certain types of systems that frequently occur in the plant so they use it a lot.

The BWXT method does use -- has used integer indices for consequence very unlikely evaluations. They categorize consequences in various bins. Two of those bins are highly unlikely and unlikely, but their system is actually more -- goes beyond that on both sides. They consider less severe events which they have reasons why they want to consider that in managing their plant.

They also consider ones that are more severe than the ones that are in the rule but it includes the two that are in the rule. Like I way, they have a consequence index and they have a likelihood index or score.

Then the combination of the two defines which -- that matrix of consequence indices one way and likelihood indices the other way defines a matrix full of squares and they define which of those are acceptable risk.

Basically, for example, one of the ones that concerned us was high consequences in their system requires a score of minus 4 in likelihood. That's basically the method they use. Of course, it facilitates a direct translation for us into whether that's compliance with the rule.

The likelihood index that they use, the one that I described to you in Appendix A, the number of factors or number of indices that could be added together would depend -- it would be situation dependent. It would depend on how many events in sequence had to happen, how many outage times, and so on.

The BWXT method is simplified down to

really only two indices, an initiator index and a protection factor index. The initiator index is -- again there are tables of qualitative criteria. Here is one of the tables for the frequency of initiating events. There are qualitative criteria. You can call them qualitative or quantitative or whatever you want to call it but there are criteria to get a score for the initiating event part of the score. Like I said, it's used --

MR. GARRICK: Dennis, I know there's quite a bit of effort given and some of it is certainly quite creative given to establishing these indices and what I might call utility functions or scores or what have you.

Mathematically often what we are trying to do here is scalerize a vector, something that describes a system in terms of specific elements because people sometimes have trouble grasping and making decisions on the basis of multiple elements try to transfer that into some functional form or a utility function such that it accommodates a simple ranking system.

I believe in our business, in the safety business, it's very important for us not to obscure, if you wish, what is really happening in terms of the accident sequence.

Whenever I'm involved in reviewing an accident analysis of any kind whether it's a HAZOP based on or a PRA based one, I'm not comfortable until I really see what's going on phenomenologically and how you get from the initial condition or the initiating event to the end state or the consequence.

I trust that the NRC is not getting too wrapped up in what I would call this tail end exercise of casting these results into pretty much a dimensionalist unitless form. I'm basically against those in this business but I can understand and appreciate why that's being done. It has a nice clean structure to it.

If you read the Harvard Business School or the Stanford Business School reviews you'll find that a lot of the papers in there are on just this, on how to establish utility functions for decision making. That's not, in my opinion, something we want to give too much emphasis to.

We really don't want to allow ourselves to get into the position of not asking what's behind this and the kind of physical terms and physical processes and calculations that really give us a firm grasp on what's happening. That's a long comment and speech but I think it does represent sort of something that we want to be very much on guard for in licensing these facilities.

DR. DAMON: I certain concur with that. I think the licensee's professional safety staff, the people that do this stuff and the ones that use it, they also have that concern.

I think it's actually, to tell the truth, my belief -- which I don't know how credible this is but my belief is it's at the root of their concern about using PRA is that they are afraid it will be used in this sufficial way.

I think they don't realize that in general people who have been using PRA long enough, they have learned that lesson that you have to -- this is not just a game of putting numbers on things. It's a game of focusing on the reality of what's going on. I know I learned that lesson. I spent a lot of years doing maintenance on hardware and one of my beliefs is that failure rates

-- how do I put it? Failure rates are made, they are not born. They are made by the staff of the facility. In other words, there is no inherent failure rate to a piece of equipment. It's how you operate it and maintain it.

MR. GARRICK: All right. We've got to wrap this up. Dana, since I overtook my time on questioning, I'll allow the committee, of course, to ask whatever questions they want.

MR. POWERS: The most striking thing about this, giving an example, a redundant system not to include the concepts of common mode failure is striking.

MR. GARRICK: Yes.

MR. POWERS: I'm not sure how illuminating it is to tell people to multiply two small numbers together to get a much smaller number. That won't be very helpful in understanding how the system avails itself.

The general difficulties of uncertainties and these numbers seem to be handled better by the scale than I had anticipated. I mean, if we're only working in decade scales whether you've quantified the distributions of a particular parameter accurately or not may be less consequential than perhaps I'm used to.

The common mode failure, I just don't think you can ignore that. It's just misleading to multiply 10 to the minus 2 times 10 to the minus 4 and get 10 to the minus 6 and then walk away happy.

Milt.

MR. LEVENSON: Well, I just am not at all sure that the very significant part of this whole issue which is consequences has had anywhere near as much attention as the probability.

For instance, if I look at the example in Appendix A in Table A-12, I think there's probably orders of magnitude of conservatism. Nobody is studying the probability of the consequence. In essence, now likely is the proposed consequences?

For instance, if you drop U02 on the floor and there's some water, the model says it stays critical for an hour. I don't think there is any place in the physical world where that kind of critical mass doesn't disassemble itself in fractions of minutes.

I just think that the whole area of consequence -- maybe I'm wrong but my perception at this point is that the issue of consequence has not been addressed nearly as adequately as the matter of probability.

MR. GARRICK: Tom.

DR. KRESS: Well, I agree with what I've heard so far. One thought is this is an overall risk allocation process of accident sequences. I've yet to see a real over-arching philosophy on how you go about doing that.

Include things like uncertainty, risk contribution of each accident sequence and how those uncertainties, contribution, and defense in depth in general add up to an overall risk acceptance criteria. That over-arching philosophy to me is not transparent anyway. It may be there.

The indexing process, while it is clever and doesn't look to me like it has any technical problems with it other than this common cause thing that Dana brought up, does in my mind tend to do what you said. It obsticates the real issue to some extent. I worry about that, although I think you could deconvolute the numbers and treat it like individual parts.

MR. GARRICK: You only read two-thirds of the report.

DR. KRESS: Yeah, that bothers me. A third thought I had is I think in terms of quantitative risk with uncertainties, pretty much like you do, and here we have a process that is some sort of approximation of that. I wonder if any thought has been given to taking the natural ISA out of some facility and doing both an ISA and a quantitative risk analysis as a sort of validation of the process.

I'm sure the ISA is intended to approximate the PRA in a sense that it is a conservative approximation. It would be nice to know what the margins are and how conservative is it. The only way I know to do that is to compare it to a real PRA.

In that sense, I think there is still a need for overall summation risk acceptance criteria as contracted to the individual sequence risk acceptance criteria. I see those as not exactly being there. That is the only way I know how to make a correspondence with the PRA type of analysis.

I worry about selection of accident sequences and selections of processes as being a way to manipulate the system.

MR. GARRICK: It's a selection in partitioning of sequences.

DR. KRESS: I worry about that to some extent, too. Basically that's the thoughts I had.

MR. GARRICK: Okay. Dennis, thank you very much. I think we'll take a 15-minute break and that will put us about 13 minutes behind.

(Whereupon, at 10:28 a.m. off the record until 10:40 a.m.)

MR. GARRICK: Can we come to order? Our next talk is going to be given by Felix Killar. He'll introduce himself and tell us what he's up to, as well as make a presentation.

MR. KILLAR: Thank you. As John said, I'm Felix Killar. I'm with Nuclear Energy Institute. I've been involved in this process and, as I go back and talk in my presentation with the history of it, I'm part of the history of it I've been involved with it for so long.

What I'll do this morning is give you a history of the rulemaking, how we got to Chapter 3 which is the focus of today's meeting. What are some of the future actions which, from this morning's presentation, it's a little bit of repeat.

And the integration of the safety program which is important because there's some aspect here I think they haven't touched on and I want to talk about that. Then specifics on Chapter 3.

The history goes back to 1986, the Sequoia Fuels event, which you touched on this morning.

MR. GARRICK: It just seems like it was in the 1800's.

MR. KILLAR: I know. In fact, I was

looking at some of this the other day and I said it seemed like it was just the other day that this happened and it was that long ago.

Anyway, as was touched on this morning, that was actually a chemical event. There was a subsequent event there at Sequoia Fuels about 1987, '88, where they had another chemical event.

There was a lot of issues raised as far as the NRC's responsibilities and authority in relation to EPAs and OSHAs. There was a lot of work done to try and help clarify the responsibilities and make sure that there isn't either an overlap or a gap.

Part of this came out in 1990 with the update of the OSHA memorandum of understanding with the NRC as part as chemical events and clarification with EPA as far as responsibility on site and off site and what have you. That was sort of the basis for where we started on the rulemaking and changed the Part 70.

Then in 1991 there was an event at the General Electric facility. This was viewed from two sides, very different perspective. From the NRC staff perspective this was a near criticality and major event.

From the industry's perspective this was an upset condition which they understood and they knew what was going on and they knew how to control it, but the information was not clear to the two sides and they were never able to really connect and understand that.

As a result of that, they needed to come up with a better way of understanding how the licensee runs their facilities and is comfortable with the safety of their facilities.

They started a process back then of taking a group, a task force, that went out to the facilities, all the major licensees including some of the radio pharmaceuticals and things on that line and said, "If we had to regulate these guys from scratch with a blank piece of paper, how would we do it? How would we change our existing systems? How do we go out to make sure that we're looking at the right things?" And what have you.

In 1992 they came out with NUREG-1324 and that was a synopsis of this study that they did on how to regulate the facilities. There are a number of findings. The principal findings were, first of, the NRC staff needed better training and understanding of the facilities.

Secondly they felt there needed to be an integration of the various safety programs. There were reports done back in the '70s and '80s on the risk of these facilities. The primary risk of these facilities is a fire. Nuclear criticality risk is further down the road. Radio protection for the workers is down the road and things on that line.

Looking at the risk of these facilities and when you're focusing primarily on the nuclear safety, nuclear criticality, and radiation protection second, you weren't really focusing on maybe what was the major risk of the facilities.

We wanted to determine a process for integrating the various forms of risk whether it's a chemical risk, a fire risk, a nuclear safety risk, radiation protection risk, things on that line.

When we started a process of talking about integration and the ISA, this is what we were talking about is the integration of those various programs. We had a number of go-arounds back and forth with the staff in the mid-'90s to try and explain that and why it needed to be done even tough the 1324 kind of pointed that out.

Finally in 1996 we petitioned for a rulemaking to explain specifically what we wanted to have in these integrated safety assessments and why we needed this integration. Our rulemaking was accepted with some modifications and then we began working on and revising the Part 70 rule to reflect this. The rule was finally released in October of 2000 after a number of iterations.

The staff proposed several different forms of the rule which we found were not meeting the intent of what we felt we needed and was not meeting the intent of what we felt was the initiating events back in '86 and '92. We went back to the commissioners and various people and got the staff to kind of focus down on the issue that we were really trying to resolve.

Finally after going through several iterations October of 2000 we came up with the NRC finalized rule initiative. They issue it without the SRP which is the thing that's been kind of ongoing since then.

As alluded to this morning, April of 2001 the licensees had to provide their plans for submitting the ISAs to the NRC and all the existing licensees have done that.

What are the future actions? By March of 2002 the NRC needs to approve the ISA plans submitted by licensees. As mentioned this morning, they have already approved two of them, NSFs and BWXTs.

There is a total -- I'm trying to remember the number off the top of my head. I think there are like eight facilities that have submitted these plans so they've got about six to go. That's changing because of consolidations and shutdowns at some of these facilities.

The NRC is currently working on some industry guidance or some guidance on facility change process which is 70.72 and a backup provisional which was also in 70.76. We've are kind of indifferent on those.

We felt that there's value in those but, at the same time, for the most part the licensees have already gone through and implemented their change processes to 70.72 so additional guidance may help but we really don't see a whole lot of need for it.

Similar in the backup provision. The back fit provision comes in once you have your ISA approved. We don't feel that there's a big need for the guidance for the backup provision but it may be helpful having it there.

Come October of 2004 all existing licensees must have completed their ISAs and submit the ISA summaries to the NRC for approval of the ISA summaries. We're working on that schedule. As the staff mentioned this morning, some of those will be submitted prior to that so the NRC will be working on those.

Also in 2004 anything that is identified as an unacceptable performance deficiency must be either corrected or a plan for correcting that deficiency must be completed.

These are the various chapters of the Standard Review Plan. I left out Chapter 1 and 2. Chapter 1 is just a general description of the site. Chapter 2 is a description of your organization.

These make up what I would call the meat of the licensing application with Chapter 3 being the new chapter on Integrated Safety Assessment, and Chapter 11 being the new chapter on Management Measures. Those two came out of the two events as I mentioned.

How do you integrate the various safety aspects of it and how do you manage those safety aspects to assure they will be performed when they need to?

The other things, radiation protection, nuclear criticality safety, chemical safety, fire safety, emergency management, protection decommissioning, they have not substantially changed in years. We've done tweaks and modifications and stuff but they have not substantially changed in years. These two chapters, 3 and 11, are the two chapters that came out of the events in this time to process it.

What are the issues that we have with Chapter 3? We have very few issues with Chapter 3. Because of this process that we went through to get to the rulemaking and as we've gone through with the staff working on the Standard Review Plan, we do not have any problems at all with the Standard Review Plan and with the rulemaking at this point in time.

Our issues now are what we call implementation issues and the implementation issues are what is acceptable. We've only had two ISA plans submitted so far. We have not had a full ISA summary submitted and approved by the staff so we are out there trying to make sure the package we are putting together is acceptable to the staff.

Some of the issues we have is how detailed does the ISA summary need to be? That has been the biggest stumbling block that we've had in this whole process.

In fact, a number of times we threw up our hands and said, "Hey, look. If the staff isn't happy with our ISA summary, come and look at the whole ISA or we will put the ISA, the full ISA, on a CD-ROM and ship it to you and you can sit there and look at it all you want because we cannot come to terms on what the level of detail needs to be in the ISA summary." I think we have come to terms but now it's a matter of do we really understand the terms we've come to.

How quantitative does it need to be? I think Dennis gave you some of that this morning. The industry is basically a chemical industry. Part 70 facilities are basically chemical industry that handles radioactive material.

As Dennis alluded to also, a lot of the work is done on HAZOP because HAZOP is what the chemical industry typically has used for years and what this industry has used for years for doing their typical safety analysis for the chemical safety of the facilities and they've taken that and expanded that to look at nuclear safety radiation protection.

We don't do a whole lot of quantitative type analysis. Ours is more qualitative type analysis so we have a question about where the -- how quantitative it needs to be. There are certain areas in the plant where a quantitative analysis will make sense.

It's a unique situation, a very integral component or operation where you have to go through and look at it. For a lot of the operations at the plant a very basic type analysis, even what-if type analysis, will be adequate for evaluating those processes.

I might allude, too, I talk about evaluating processes. One of the things I want to point out is that when we talk about a process, that process can be defined as just changing it from this table to that table or the complete process from beginning to end to get it from one form to another form.

It's a function of the detailness or sensitivity of that process in the analysis that we do. When we look at processes, it can be chopped up in individual steps in the process it we can look at the whole nine yards.

DR. KRESS: I'm trying to decide on the reasoning behind NRC thinking an ISA summary is sufficient. Is that just to save time in their review? You have the full ISA. How big is it? Is it huge?

MR. KILLAR: They are fairly huge. BWXTs, I think they're probably in the order of about eight to 10 three-ring binders so they are similar to back at the FSAR stages.

DR. KRESS: Back in FSAR.

MR. KILLAR: Back in those days. And they are rather detailed. One of the concerns and reason why we went to the submittal of the ISA summary rather than the ISA. What we found with our facilities is that they are very consistent but they change every day.

The basic process stays very much the same. We make U02 to F2 routinely every day. For today we may tweak this parameter or we may tweak that parameter and tomorrow or next week we may go a different direction.

The process still has changed but we've tweaked these things in here and we need to have the ability to look in and say as we change or tweak this thing, what impact does that have on safety without having to go back through and do a complete ISA and submit a complete ISA to the staff for their review and consideration.

The other thing that we want to get out of all this program is that one of the biggest issues the NRC and the licensees have is timely license renewal. Part 70 licenses run anywhere from five to 10 years.

Under the Part 70 rule when we submit a license application for our license renewal application, we can continue to operate under existing license until that renewal application is finalized. In some cases that renewal application has lingered in the organization in getting it completed for four to five years.

We felt, and the NRC probably felt, that this was not the way to do business, so one of the things we want to do with this process with the new Part 70 and with the ISA process is keep a living license. When our nine or 10 years are up, five years are up, whatever the time period is, they have kept abreast of the changes in the facility.

We will keep them abreast of the changes with the ISA summary. There should not be any major program changes so we would think that the programmatic programs such as radiation protection, nuclear criticality will not substantially change. It should be a fairly simple license renewal at that time period. That's one of the major benefits we see in going through this program.

And just to touch on a last point here, how do all safety programs together. That's the issue that we have is that we want to make sure the understanding is how the safety programs work together.

If we want to put more emphasis in this area because we feel it's more important to spend more time and resources on fire safety than it is on nuclear safety or radiation protection, we should be able to demonstrate the balancing of those between themselves as far as safety to the facility and to the public.

That's my quick pitch here this morning because, like I say, we don't really have any major issues with Chapter 3 right now.

MR. GARRICK: Questions? Is this issue of the scope of the ISA summary resolved now in your opinion?

MR. KILLAR: Yes and no. It's resolved in our understanding of what the expectations are. Until we actually have an IGA summary submitted and approved by the staff it's still an open issue. We do not have an ISA summary that has been submitted and approved by the staff according to the new rule.

We have had some ISAs that were done for parts of facilities prior to the rule that have been approved so we have an idea, but now the rule has changed a little bit of the basis and things on that line.

One of the things that we did with the April notifications is identify what changes had to be done from what the previous ISAs we submitted in order to meet the new rules but we have not had an ISA summary that has been submitted and approved under the new rule yet. Until we get through that process, we still have that question in our minds.

DR. KRESS: My interpretation of what you said earlier is that the licensee is more or less committed to the summary as its licensing basis as opposed to the full ISA. Is that an interpretation that is correct?

MR. KILLAR: That's borderline. The way the rule reads is the NRC does not approve the ISA. They approve the ISA summary. But the way they approve the ISA summary is that they look at the ISA summary, look to see if there are any questions in there about what they've done based on their knowledge of the facility or knowledge of operations and things on that line. If there are questions, they have the ability to go down and do a vertical cut of the ISA itself at the facility to see how part of that is reflected in the ISA summary. They quasi approve the ISA by approving the ISA summary. Per the rule, they are only approving the ISA summary.

MR. GARRICK: One of the problems I've observed in the application of the PHA technology in some plants is it's not always easy to make the connection between the individual contributors and the end results or the end state results of the sequences.

What some of the people that are heavily engaged in using this kind of technology are doing is beginning to look at specific contributors that pop up as important in more detail and, in fact, probabalistically building a little PRA model of those contributors.

In a sense, that is proven to be very constructive. It provides some of the things that Tom was talking about earlier of baselining the difference in results you might get from an ISA and a PRA but at a level that is not quite the commitment that you would have if you would try to do it for the whole report.

MR. KILLAR: Let me address a couple of points. That reminded me of a point that was brought up earlier this morning. One of the things that the industry was concerned about is that our facilities are not connected and interconnected similar to a reactor facility.

Like I talked about earlier, when we review a process we can either chop it up in pieces or we can do the whole process because if this piece fails it has zero impact on the rest of the operation up there. It has zero impact on it as far as radiation protection, criticality safety or anything along that line.

We can look at these as individual pieces or we can look at the whole process because they are not interdependent as far as the safety is concerned. Now, there certainly could be some interdependence.

If this causes a fire, it may impact those operations down there. As an independent device, as an independent operation, the operation safety does not necessarily require this operation here as well.

Secondly, in some of the facilities I've gone through and did the ISAs, they've put together ISA teams and they felt that -- they found a lot of value of putting these ISA teams together because of some of the issues you just brought up.

Some of the things that the nuclear criticality guy is sitting there working on and thinking about, he may not have thought about in radiation protection.

I said, "Hey, did you think about this?"

He said, "No, I need to put that in there because of what ifs or whatever and stuff." The teams have help provide more depth and more understanding of their facilities, a better handle of the safety of their facilities.

To the other extent, one of the things one of our members found is that they got into doing a lot of the analytical type analysis and things on that line and they found that they got distracted because they were focusing on the numbers and not the real life.

They said, "Oh, gee. Is this 10 to the minus 4th or 1.3 times to the minus 4th?" In the crux of things it didn't make any difference but they were focusing so much on that they were kind of getting the picture.

MR. GARRICK: But PRA is not to do that.

MR. KILLAR: Right.

MR. GARRICK: You are supposed to focus on what can go wrong and keep the attention on the scenarios if you wish. People that tend to get hung up on the numbers, they themselves are not practicing the art the way it was intended.

MR. KILLAR: And that is exactly the point I was trying to make. There was a concern when some of the members said they saw the ISA team getting involved in the numbers and not really looking at the understanding of what they were doing and stuff and they corrected that.

There was another point I was going to mention but I can't recall off the top of my head what it was.

MR. GARRICK: Any other questions? Okay. Thank you. Thank you very much.

I guess we are now going to hear from the NRC staff. We'll ask each member to introduce themselves and tell us a little bit about their job and proceed with their presentation.

MS. BAILEY: Good morning.

MR. GARRICK: Good morning.

MS. BAILEY: I'm Marissa Bailey. I'm a Senior Project Manager in the Risk Task Group. I'm here this morning to basically -- turn on the mic -- give you an overview of our activities, our risk informing activities in the Risk Task Group.

I and Dennis Damon will be doing this presentation because our section chief Lawrence Kokaiko doesn't have a voice today.

MR. GARRICK: Sounds like an excuse to me.

MS. BAILEY: Basically our activities in

the Risk Task Group fall into three categories; supporting the risk initiatives and risk related activities in the different NMSS divisions, developing and implementing risk related training, and then developing and implementing a framework for risk informed regulation in the materials and waste arenas.

What I want to do is just go very briefly over the first two bullets. I and Dennis Damon will then spend most of the time going over the status of the third bullet as far as where we are in implementing risk informed regulations and conducting the case studies, and also developing safety goals.

As far as assistance to the divisions in NMSS goes, this is a list of some of the activities that we have been involved in or that we expect to be involved in during the next year.

I think most of you have heard this before, but basically our goal here in our assistance and peer review activities is to ensure that risk methodologies are applied consistently, to basically make sure that the staff's regulatory positions are consistent with their risk significance, and also to just provide general guidance and assistance on the use of risk information and risk assessment methods.

In regard to training, we have implemented several training courses or we are developing or they are in the development phase. At this point there are three introductory courses in risk assessment that's being offered. There's one for the technical staff, one for the technical manager, and then one for the administrative staff.

We are offering a course on quantitative frequency analysis for fuel cycle. We are in the process of developing a training course on the use of the by-product material risk study, and also developing a handbook for that. And we are assessing other risk-related training with the technical training center.

DR. KRESS: Are those courses held here in White Flint?

MS. BAILEY: Yes. Or in the region.

DR. KRESS: Or in the region.

MS. BAILEY: Now I want to basically get into what's been I would characterize the major activity in the Risk Task Group over this last year. Basically that is implementing and developing a framework for risk-informed regulation in the materials and waste arena.

SECY-99-100 and the SRM for that has really provided the basis and guidance for what we've been doing in the Risk Task Group for the last year. The first phase of that has involved conducting case studies. Just very briefly, let me go over Secy-99-100.

This was issued by the staff back in March of 1999. In this commission paper we proposed a framework for risk informed regulation in the materials and waste arenas. That framework also involved a five-step process for moving forward with risk-informed regulation.

In that five-step process the first step was to identify candidate applications that would be amenable to risk-informed regulation. Although in NMSS we are probably -- there are areas that are further along in this five-step process, in general we are in step one of this five-step process. In other words, we are still pretty early in the process of trying to identify candidate regulatory applications.

IN the SRM SECY-99-100 which was issued back in June 1999 the commission approved the proposed framework. They also directed the staff to develop materials and waste safety goals that would be analogous to the reactor safety goal.

DR. KRESS: Did they give you any guidance on what the word analogous meant?

MS. BAILEY: No.

DR. KRESS: You have to do that yourself?

MS. BAILEY: I think we're feeling our way through it. Dennis will be talking about where we are in this process as far as development safety goes as soon as I'm finished here.

So basically what we've done is we have developed draft screening criteria to help us identify those candidate regulatory applications that are amenable to risk informed regulation which, again, was step one of that five-step process.

We also adopted a case study approach to help us test the draft screening criteria and also help us begin to process and develop safety goals. The case studies would be retrospective looks at a spectrum of activities in the materials and waste arenas.

Individual and cumulatively they should tell us or illustrate for us what has been done in the materials and waste arenas with respect to using risk information. To what extent have our activities been risk informed or not risk informed.

The objectives of the case studies were to test the draft screening criteria and produce a final version, to examine the feasibility of safety goals.

If they are feasible, develop a first draft.

Then the subsidiary objectives of the case studies were to gain insights on how we could risk inform our regulatory processes and also gain insights on what tools, data, methods, guidance we would need to implement the risk-informed approach.

MR. GARRICK: Now, the Risk Task Group came into being after the ISA process was pretty well developed. Is that not correct?

MS. BAILEY: Lawrence, can you answer that?

MR. KOKAIKO: I have a little voice. Just not a sustained one. The ISA process had already started before the Risk Task Group had come together. With Dennis Damon we followed the activities of it. We revisited BWXT and Global Nuclear Fuel and were aware of what's going on. We have not been in charge of development of the SRP Chapter 3.

MR. GARRICK: Okay. I'm just trying to get focused on what the Risk Task Group really is doing to risk inform the office given that the ISA is kind of the driver of the analysis effort and that it has already been pretty well established.

MR. KOKAIKO: The ISA is the driver in fuel cycle for fuel fabrication facilities.

MR. GARRICK: I see.

MR. KOKAIKO: But in other areas of NMSS other things will have to be utilized. NMSS is a broad regulatory spectrum from moisture density gauges, gamma knives, all the way to the repository.

MR. GARRICK: Thank you.

MS. BAILEY: These are the AK study areas, the areas that we conducted the case studies on, gas chromatographs, static eliminators, fixed gauges, uranium recovery, the decommissioning of the Trojan Nuclear Plant, transportation to the Trojan reactor vessel, the seismic exemption for the dry cast storage facility for the TMI defuel debris and INEL, and the seismic upgrades for the Paducah gaseous diffusion plants.

Now, these areas or activities were chosen as case studies because we felt that they had elements of risk informed decision making in them, or because it was felt that these were activities that could benefit from risk-informed decision making.

I guess I would like to point out that at this point in time we have completed our case studies. In fact, last month we held the last of the series of stakeholder meetings on the case studies.

During that meeting we presented the

insights that we gained from the case studies and also tried to get some feedback on how we could integrate the individual results of the case studies and move forward with risk informing our regulatory processes.

Now, at this point I would just like to summarize for you some of the general insights that we've learned or that we've gained from the case studies.

With respect to the screening criteria, we basically found that they did encompass the relevant considerations for what we ought to be thinking about or what we ought to be considering as we try to decide whether an activity can be risk informed.

We did find that there should be considerations rather than criteria. That's really just to reflect the fact that the screening considerations is a decision-making tool. It's not to be a check list that gives you a black and white answer and that forces you to go down a certain path if the answer happens to be yes or no.

MR. GARRICK: It's kind of in the spirit of being more risk informed and less prescriptive, I would say.

MS. BAILEY: Okay. Yeah. Basically the outcome of the screening considerations is just another factor you ought to be taking into account when you try to make your decision.

Let me just go back to that slide. The other thing I did want to point out was that we did find that the screening considerations is a useful decision-making tool and we're pretty much ready to finalize it.

However, we did find that the application of it can be very subjective and guidance on how it should be applied needed to be developed. We are also in the process now of trying to develop guidance for how to use the screening considerations.

Screening considerations themselves are a series of seven questions that we would ask. The first four questions basically addresses the agency's strategic goals of maintaining or improving safety, improving efficiency or effectiveness, reducing unnecessary burden, helping or enhancing public communications.

The fifth criterion addresses the availability of sufficient information to risk inform. The sixth criterion basically asks whether a risk-informed approach could be implemented for a reasonable cost.

Then the seventh addresses other

precluding factors. Given that an activity meets the first six, is there anything else that would or should stop us from risk informing a process.

This next slide just gives you the exact wording of the screening considerations.

As far as safety goals go, which is the second objective in the case studies, the case studies showed us that it is feasible to develop safety goals and that a multi-tiered structure, similar to the reactor safety goals, is more possible approach, and if we did take that approach, we would have to develop subsidiary objectives for each program area.

We also found some implicit and explicit safety goals in the case studies. We also found some examples where decision making could have been facilitated if a clear set of safety goals existed. Dennis will go into the safety goals in more detail as soon as I'm finished.

As far as the value of using risk information, the case studies showed us that the use of risk information, at least in those eight activities, did help the staff to make decisions that were in retrospect consistent with the agency's current strategic goals. They also found that the risk information can be useful in helping us identify shortcomings in our regulations or regulatory processes.

However, for us to fully realize the benefits of a risk-informed approach. there are probably several things that we need to do in the future. One, we need to continue with staff training.

We probably need to introduce or develop risk-informed guidance on rulemaking and licensing and inspection and enforcement. We have to develop safety goals. We probably need to recognize that zero or zero risk is not possible, that it's impossible in the real world. And we need to address human reliability.

With regard to tools and information and methods and guidance, the case study showed us that it exist in varying degrees. In some cases there are tools and methods that would support a risk-informed decision making. But, in some areas, some would have to be developed or some would have to be further developed. Whatever tools and methods are out there, they all shared a common weakness of the human factor.

As far as where we go from here, we've completed our eight case studies so now we're on that yellow block. We're in the process of trying to integrate the results of the case studies.

By December we hope to put out an

integration report that would have the final screening considerations, have a first draft of safety goals, and could address some of the process improvements that we could make in the materials and waste arenas.

Also by December we hope to have developed guidance for how screening considerations should be applied. Early next year what we want to do is start applying those screening considerations systematically to the program areas within NMSS and start trying to identify what areas could be risk informed. In parallel with that, we also want to further develop and refine the safety goals with the help of the Office of Research.

I think that pretty much concludes my part.

MR. GARRICK: Questions? Thank you.

DR. DAMON: Good morning. I guess I didn't introduce myself before. My name is Dennis Damon and up until two years ago I had been working in the Division of Fuel Cycle Safety and Safeguards. One of the things I worked on was the Part 70 rulemaking and the ISA chapter, the Standard Review Plan.

Then about two years ago I became part of the Risk Task Group which at that time was under John Black. Currently now it's under Lawrence Kokaiko.

I've been now involved in this broader spectrum of all the different risk-informed activities in NMSS since that time.

What I wanted to do here was to try to get fairly quickly to some of the interesting issues that come up when you talk about safety goals on the nuclear material side.

I don't want to de-emphasize the importance of having done these eight case studies because if you go off and you try to develop safety goals in the abstract without looking at very specific cases, there's a danger that what you develop just doesn't apply to the real world of what these people are dealing with.

That was the purpose of the eight case studies was to look at risk information in the context of eight very specific cases and see does this all make sense. The idea would safety goals be useful to anybody in this NMSS area.

One of the conclusions from looking at case studies was, yes, it is sometimes. It's not always a useful thing to have but quantitative measures of what is safe enough which would be a safety goal, a quantitative measure that would be a useful thing in certain specific situations that come up.

Then I just want to make it clear that I'm sure you gentlemen haven't been probably involved in the reactor safety goal side understand what is meant by a safety goal but I wanted to communicate that what the Risk Task Group's understanding of it is and this addresses that.

It is a level that is safe enough but, as you notice in the third bullet, it's a level of risk that is low enough without explicit consideration of whether it's possible to achieve that value. This is our understanding of it. It's a level of safety that is inherently safe enough, not one that's conditional on whether you can achieve it or what it would cost to do that.

The purpose of these safety goals is to facilitate risk management. It is important to remember, and this is often forgotten once you start to get right into this risk management.

When you start using risk information to manage safety, it very quickly assumes this flavor that these goals you're setting for yourself are requirements. Like I say, by the definition of what I think they are supposed to mean, they are not requirements.

MR. POWERS: Can we go back over this? Define how safe is safe enough without any economic considerations? Why did you conclude that?

DR. DAMON: Oh.

MR. POWERS: I'm not sure what you're driving at here.

DR. DAMON: What I'm driving at is that there are different concepts for what is safe enough. One concept is in one aspect of being safe enough, it's the thing I should be. I should be this safe.

When you say you should be that safe, that implies it's possible to achieve it, it's reasonable to achieve it. It's that kind of thing. There are requirements in the regulations like ALARA that that is the concept. It's a level of safety that is a reasonable level to require that you achieve.

A safety goal is not -- my understanding of a safety goal is not based on reasonableness. It is based upon an inherent look at the risk itself and a consideration that level of risk is in some sense -- in some higher sense it's safe enough. It's not conditional on whether you can achieve it or not.

MR. POWERS: Let me explore a little bit because I'm not really sure what you're driving at. When we think about adequate protection, we do not take into account economic consideration.

When we think of a ALARA, we do because there's a point at which we say, well, it's not reasonable to achieve because it cost too much money. Then we put a specific number on that, a dollar figure.

When we think about safety goals, we've said once you achieve this level of safety, the public interest has no -- the public has no interest and you would be safer to go to expenses to which you have a greater level of safety. They don't say you can't but you can. I'm not absolutely sure what you're driving at here.

DR. DAMON: I think you're saying the same thing as what I'm getting at.

MR. POWERS: Okay.

MR. GARRICK: So you are saying that the ALARA principle applies here? At least the principle. If you can make something safer with very little cost, and even though you have met the safety goal, why not do it?

DR. DAMON: That's one of the interesting questions. That's the kind of stuff I think is useful to talk about because --

MR. POWERS: Because I thought he was

capping the ALARA.

DR. DAMON: That's what I'm saying. Some people will say this consummate of safety goes a four to ALARA and other people say no, it's not. That's what I'm saying. It's a very interesting point to bring up.

MR. POWERS: Let me encourage you very much to cap ALARA because otherwise it just hamstrings you because I can always consider a way to do things with less radiation dose. No matter what you come up with, I can always think of another way to do that. What you want to say is there's a point regardless of whether it be done at zero cost that you quit thinking about those things.

DR. DAMON: Well, that's what I say. We're early on in the stages of analyzing and talking about safety goals, but some of the people involved, like myself and Bob Bari and Viuod Mubayi at Brookhaven, have been doing this a long time so they know there are these issues out there.

What we're trying to do is elevate this stuff, put it out in public and start reexposing people to it and clarifying these things. Some of the things seen in reactor safety goals, a reactor is just one particular kind of device and situation. Because of that, it's possible to simply the consideration of safety goals.

When you get to NMSS with the broad spectrum of things they deal with, one of my views is you have to be sure that the set of safety goals you're coming up with are covering everything that you want to and that you need to deal with.

Like the second bullet up here, "To identify proper safety roles, to identify risk metrics to manage," is kind of getting to this. We've got to make sure that we were addressing the things that they really have to worry about in NMSS. That means it has to be -- what I would like it to be is a complete set.

What this slide is intended to call out, and maybe it doesn't do it quite well enough, is that safety goals, as I've said before, they are aspirations, not limits. But there are risk-based requirements in the regulations right now and they come in in two different ways is the way I look at.

One way they come in is really as an explicit risk-based requirement. The performance requirements of 7061 that we were just talking about, the highly unlikely for high consequence, that's what I mean by that. It's an explicit risk-based requirement. It's a requirements that something about the licensee has to meet.

10 CFR 32.23 and 24 also have such a risk-based requirement so that's one type, a risk-based requirement statement. It's a requirement stated in terms of risk, likelihood and consequences.

The other type of what I would call a risk-related requirement statement is something like ALARA. The way I think of this is as a conditional risk-related requirement. It's a requirement that you continue to lower risk conditional on what it cost and whether it's feasible and other considerations.

Safety goal is, like I say, something different from that. That's why I'm trying to draw this distinction that we understand. This is just to emphasize the fact that the statement I made before about the fact that the case study showed that quantitative risk information be useful.

The first one up there, transportation, has to do with the Trojan reactor vessel shipment. In that study a quantitative risk analysis was done. What they calculated -- one of the things they calculated -- they calculated two interesting things.

One of them was the probability of an accident that would exceed the design conditions of the transport vessel and shipment package. In other words, a collision that you could not be sure that the reactor vessel would not be breached.

They calculated probability of these very severe accidents and they got a number about 10 to the minus 6. Well, the only trouble with that is they calculated it but nobody was telling them 10 to the minus 6 was acceptably low. They made that decision on their own.

It would have been useful if they had quantitative guides telling them, "Yes, this is an acceptable value." The only problem is they didn't calculate consequences. They just calculated probability of whether the accident would be severe enough that it would possibly lead to consequences. That's one thing they did.

Another thing they did in the context of that study is they calculated -- that's a probability. Basically since a shipment is a one-time only thing, this is a one-time only probability of a one-time only consequence.

The other interesting thing they calculated was they calculated the cumulative person rem to both the workers who were preparing this shipment package and also to the public incident to making the transport. The transport package was a reactor vessel in its internals in a shipment package so there is some shielding. There is some dose involved in preparing that package for shipment.

The interesting thing that came out of the study was is that this cumulative total person rem figure was actually lower for shipping it by the barge method which is what they proposed.

To me what was an interesting example of is why I said before it's useful to have all the risk metrics identified that you're trying to manage so that when you tell somebody to do a risk analysis that they analyze -- they calculate the risk with respect to all those metrics because otherwise you get this biased picture if you only calculate one risk metric and you don't look at the other ones.

That's one of the things I think we learn from this is look at all the different risks involved. This is pointing out that the gas chromatographs, which is one of the other case studies, the regulation that applies to them is 10 CFR 32.23 through 27.

I'm going to show you what that looks like. This is what it looks like. This is what I call a risk-based requirement. This is what they are required to do. If you look down at not the last row but the row that says "whole body" there. This row here, "whole body."

This applies to gas chromatographs which are a device which is a typical thing that NMSS regulates. Devices or pieces of equipment that are used by certain persons in the public. This is normal use and disposal. This is normal storage.

This is really intended to address the manufacturing facility and the warehousing and the distribution of the things where they might be present in large numbers. This is the case where a user has got one of these things out in a lab somewhere using it.

There's 1 millirem. It must be unlikely in one year for that person. For this person who works at the facility where they are manufacturing or storing these in a warehouse, 10 millirem must be unlikely in one year. These are requirements, not safety goals.

Out here one unit in one location. As we march what we're doing is marching out in consequences along this whole body dose thing. Half a rem, 15 rem. Half a rem probability is low. 15 rem probability is negligible.

What I see here is a risk-based requirement statement. It raises all kind of interesting questions when you're trying to formulate safety goals. Why should this be different from this. This guy gets -- it's the same unlikeliness and this guy gets 10 times more.

I think the reason is because they are treating this guy as a worker, a radiation worker. He works for a manufacturer of radioactive material and this person is being regarded as a member of the general public. That would be the way I would interpret that. That's why they did the difference.

All I'm saying is there's a lot of risk-related requirements and reasoning that is already embedded in the regulations and that's why we're having to go through these case studies, to tease this stuff out and then try to figure out how that relates to safety goals.

On the previous slide it said right down here, "15 rem probability must be negligible." They have interpreted this right in the regulation. This is a direct quote, "Negligible is defined to be not more than one such failure per million units distributed."

There's a flaw in this reasoning. They say negligible probability. Well, what if you got a million units in your warehouse. There is sort of inherent logic flaw in the way they stated this. That's why I say there's a virtue to going through this safe goal stuff to try to explain to people how to formulate these safety requirements.

It was also identified that safety goals might have helped in some of the other case study areas that they worked on. Safety goals might be useful in these areas. There's dry cask storage which you'll hear about later.

This is really a much more interesting slide. One of the things we did was we -- one of the issues to consider in formulating safety goals is why should there be more than one. What is it that makes you have more than one safety goal.

In the reactor site they identified individual societal. What we did was we went around and looked and tried to figure out what are all the other factors that would cause you to have more than one safety goal.

Certainly individual versus societal is one of them and I'll talk about what I think it means. Maybe you can tell me what you think it means. Anyway, that is one parameter that causes you to have two different kind of safety goals.

Then there are all the different factors that influence the population at risk. In other words, you might need to have a different safety goal for different populations. One rationale for that being voluntary versus involuntary.

One example of voluntary versus involuntary is worker versus public. With the outside public person the facility is plunked down next to them and they derive only a general benefit from it. Nothing specific, yet they are inflicted with all the risks. Whereas the worker, in a certain sense, it's voluntary that he assumes the risk of working in a facility that handles radioactive material. Since there's a difference in -- and that's embedded in our 10 CFR 20.

That concept that there should be a difference is embedded in 10 CFR 20 which is a requirement statement, 5 rem for a worker, 100 millirem for a member of the public. As a unit would that be reflected in a safety goal, that difference.

MR. POWERS: I have frequently questioned whether the workers are voluntarily assuming risks when they go to work at a radiation facility. The reason I question that is if we compare the education, we provide the workers on the radiation risk to the kinds of statements that doctors ask you to assign when you have an operation or some medical process operated on you, there's no comparison.

The education on risk can consist of telling you there's no problem, whereas the doctors tells you, "You're going to die on this operation that I'm going to perform on you and it's horrible beyond belief and nobody in his right mind would ever do that. Do you want to do this?" So it's always been an open question to me whether one ought to make this distinction or not.

DR. DAMON: Well, that's the kind of questions and comments we're looking for. We're just in the early stages. We haven't even really -- we haven't fully aired this in public. We did present this slide in a public meeting but that's the kind of issue that -- I mean, I wrote a little paper talking about this.

Voluntary is, like you say, yeah, it's voluntary but if he doesn't go to work there, he doesn't get paid either. It's not like 100 percent voluntary.

Then there's another reason why it might be appropriate to allow him to be exposed to higher risk and that is he gets a benefit out of it. He does get that salary. In fact, that's not on this slide but what I was going to say is individuals/societal and voluntary/involuntary are just two parameters. We consider 13 parameters -- no, 15.

There's 15 different parameters that could influence whether you give somebody higher or lower. One of them is benefit. In the case, like you said, the guy who is getting an operation, the reason he is willing to take that risk is he's going to get a benefit from it. It's a risk benefit trade off.

It points out what the real difference here is between worker and public where one of the other differences is a different difference, and that is the worker gets a benefit; namely, he gets the pay. The public guy's benefit is at a very remote level from that thing.

When you do a risk benefit trade off kind of thinking about these things, the worker might say, "Oh, yeah. I get more morasses. That's too bad but I get paid." The interesting thing is all this risk benefit trade off thing comes up at two other ends of the spectrum.

It comes up at the end of the medical spectrum, of course, where there's a risk that if you undergo a procedure that involves radioactive materials, you might get -- you are subject to the risk of misadministration, not of the dose that you are supposed to get but that they would screw up and actually kill you with the radiation.

There's a risk there but there's a big benefit to trade off. A huge benefit and a substantial risk. At the other end of the spectrum, there's risk benefit trade off in that there are safety devices that have radioactive material in them like smoke alarms.

An infinitesimal radiological risk traded off against the benefit of having smoke alarms that work according to that principle. All these 13 factors come into as issues to consider in formulating safety goals. We have gone through and thought some of this through but, like I say, we're still in the early stages.

This is an interesting one. There are chemical risks, nonradiological risks. Also it's interesting to think bout long-term risk which comes up, of course, in waste disposal sites. It induces difficulties in how do you deal with this.

MR. GARRICK: I know there's an environmental impact statement, but have you considered at all bringing environmental impact into the safety goal domain?

DR. DAMON: We have considered doing environmental and property damage. These are some of the risk things we are considering here. We are considering a tiered structure like they used in reactor safety goals where the top level is qualitative and then is quantitative down here.

Environmental and property damage are two things. In addition to risk to individuals and societal risks, there is environmental and property damage being considered. Like I say, we're very early stages in trying to think about what the heck can you do with this thing.

MR. GARRICK: Yeah, I was curious particularly about the quantitative part, what you might be thinking about there.

DR. DAMON: The individual versus societal one, I would like to make a statement in case somebody wants to object to what I say. In my mind there's a very dramatic difference between individual and societal risk the way I think of them.

Individual is a question of justice that derives from the idea that -- it really, I think, derives from the other end of the spectrum; namely, a case where a facility would say -- local a facility which would subject someone to a risk of 50 percent of being killed due to them locating there.

Just a gross risk imposed on some innocent bystander would be intolerable. Since that is obviously unjust, they are driving the benefit, that person is driving the risk and there's an injustice. It's a goal to lower that down to some level.

When you reach a lower level that's low enough, that's okay. If you lower it to zero you lose all flexibility in society. You can't do anything because everything you do imposes a risk on somebody. Somewhere in between is a concept that that level of injustice is something we have to live with in order to allow society to function.

The other one, societal risk, in my mind is a total grand integral of all risk associated with something and it comes into the process of thinking whether that process is being conducted in a way where there's a net -- how do I put it? It's a net benefit kind of a reasoning.

In other words, risk is one of the disbenefits you get when you do something and you would like to keep it down. Since you are getting this benefit from doing the thing, you are probably going to continue to do it and the question is how low a value is this total risk impact going to be.

It's not an issue of justice because you're already -- if you've complied with an individual safety goal, then this thing is already -- it's not a question of justice to the individual. It's simply a societal question of whether we are willing to incur this level of risk associated with this type of activity.

MR. POWERS: You might want to think also in terms of general uncertainty. When we tried to formulate a worker protection goal for some of the DOE facilities, we quickly ran into the problem we don't where the guy is.

In most of your individual risk things you can say he's at the site boundary or somewhere beyond there so you can kind of locate him. You really can't locate him when you are trying to do a worker sort of thing.

You could in that scenario gravitate toward a societal goal for the society of workers because of the uncertainties of where they are located. You can integrate over the population but you just can't do one individual.

There is some of that built into larger societal goals in that you don't know which members of society might be particularly receptacle to radio or chemistry or something like that. You create societal goals to compensate for that uncertainty.

You quickly find that societal goals suffer from extrapolation to the limit because you start getting things like one gram of plutonium dispersed in the atmosphere will kill three people when you integrate over a million population and things like that.

You might think of it in terms also of just uncertainty of what's going on in this population of individuals.

DR. DAMON: I think I can generalize what -- that's a very interesting observation because you can generalize that in saying that some of the things I have seen about -- how do I put it?

When you look at a safety requirement or a regulation, and it may be stated in terms as either an individual risk limit of some kind, or it might be stated as an integral measurement, it's not always true that is actually what they are trying to manage.

It may be that it's done that way for practical reasons. Like you say, you can't measure it so we're going to average or some reason like that. It's very important, I think to tease out what they really are trying to do. What is really the purpose of this regulation.

Yucca Mountain is kind of an example of that. They are regulating to an individual risk limit. But why did they locate it in a remote location where there's few people? Because the risk limit to an individual doesn't have anything to do with how many people there are. You have to be careful that you understand why people are using it.

What I would say is that's one of the reasons for subsidiary objectives down here is there are practical working level quantitative tools, whereas I would hope to try to keep these things -- the higher up you go, the more you should be based on something that's stated in terms of strict principles and general principles and things that would always be true.

This is especially true in NMSS because there are so many diverse things going on that you want to keep this stuff as general as you can.

MR. KOKAIKO: Dennis, excuse me. Dr. Powers, I appreciate your comment on that. I agree with you. in NMSS we have real life applications where this happens and the most obvious is a construction site. You have one radiation worker but everyone there is involved in the enterprise of construction. Yet, they are all assuming a part of that risk. I appreciate that comment.

MR. POWERS: It's the same. I mean, your construction sites are the same as new facilities. You have a few guys doing the actual manipulation but then you've got all the secretaries and the janitorial force and construction workers getting their share of the risk, but you don't know who is getting what so you just integrate over the whole population.

It actually works very well for those kinds of finite populations because you can do things to reduce the societal -- that small societal risk. It makes sense and you can think about how to do them, whereas you can never figure out how to protect an individual from doing something stupid. I mean, there's a limit to where you can go on something really stupid.

The other thing to bear in mind on the subsidiary goals is you call them practical. One of the problems you have with very high-level goals is you can calculate them. You can calculate them but you can't calculate them without controversy.

Sometimes those controversies become irresolvable or the cost to resolve them is so high you just don't want to go there. I mean, that is certainly what happened with CDF, core damage frequency.

We have evolved. The technology that we generally all agree is you can get a core damage frequency. Nobody can agree how to calculate the actual risk. We use a working goal that everybody thinks is about right.

They come to why they think it's about right by circuitous invariable routes but they all agree the number is about right and avoid calculating the actual risk because nobody can ever agree on whether they've got that calculation right. Technologies are not routinely available to calculate that. That's another way to look at your subsidiary.

DR. DAMON: So here is something Bob Bari laid out showing over here is reactors and this is materials and waste and we are trying to use the same tiered structure is what he's trying to say. Down here at this level we're trying to think of what types of safety goals would apply.

Another interesting thing about safety goals and NMSS is, you see, it might be one of the reasons for safety goals. There are two reasons why I think safety goals are a valid concept. It's not that there's just a level of risk that's insignificant. Yeah, you can say that. That's like relative to other things. There are two other reasons besides that. One of them is the cost benefit thing. That is eventually you go down so low that you are probably tripping ALARA cost benefit criterion anyway. But the other one is what they call secondary effects. What I mean by secondary effects was something alluded to my Lawrence, and that is in the NMSS side when you impose a requirement on somebody to do something to manage the radiation risk, you're actually perturbing the process that they do in their everyday work.

If they work at a construction site where the construction risk is like -- the risk of getting killed in a construction accident is about 2.5 times 10 to the minus 4 or something like that. It's a substantial risk.

If you perturb that and you double that while you are minimizing some radiation risk, what have you accomplished? The point is is NMSS applications run into this real world where if you try to make things too safe, you are actually making people unsafe.

MR. GARRICK: What do you mean on this chart under tier 3 under materials and waste by chronic? I know what chronic means but I want to know what you mean here.

DR. DAMON: That is operational health physics. That's 10 CFR 20.

MR. GARRICK: Why would you put that in this category? I mean, reactors have operational health physics, too. That's something you can calculate in advance and determine in advance. If it's too high, you won't build the facility. It's not a disturbance. It's not an upset.

DR. DAMON: Right. Well, is the question the same as before? In Part 20 there's an ALARA requirement. The question is is there a flaw on ALARA. That's what he means by that.

Here's what Bob Bari came up with. That we got individual and societal goals and the only difference here -- there are a couple differences but I'll point out one. The worker was put in here in this individual one. That's different than reactor. The reactor one doesn't have that.

That breaks down to five QHOs in this list and then there's another one on the next page. What I'm pointing out here is there's an individual public acute, individual public latent, and individual worker acute, and individual worker latent.

You don't have to necessarily do things this way. The United Kingdom combines these two together. The United Kingdom has safety assessment principles in which they put out quantitative limits and quantitative goals for different types of risk. They add these together. That's like saying there's no difference between whether you are acute or latent fatality. They add them together and they --

Now this one here, like I say, this is just an early first draft proposal. Up here in the public risk area, the QHOs for that we use the same thing that was used in the reactor, one-tenth of one percent of the corresponding risk from other things.

For acute it's other accidental fatalities. This is the 3.5 times 10 to minus 4 which is one-tenth of one percent of that. Then this QHO here is one-tenth of one percent of the sum of cancer fatality risks which are 2 time 10 to the minus 3 per year.

Down here for workers there are different ways you can do this one. The U.K. uses basically 10 to the minus 6, I believe, as their one. It's not tied to a relative scale. What we're saying is here is one way of tying it to a relative scale.

This one-tenth of occupational fatality risk. Or you could do it the same way and say why should this be different than the nonworker. Let's use the same one up here, a tenth of a percent of prompt fatality risk from all other accidents.

The difference here is occupational fatality risk is very low. Dying on the job is not the way people get killed accidentally. You get killed in your car, you know, or you fall down and break your neck. Occupational fatality risk is only 5 times 10 to the minus 5 per year. One percent of that is five times 10 to the minus 6.

MR. LEVENSON: Is it intended that that apply to accidents that are nuclear type? Because, as worded, again are you saying that they should be only one percent of industrial average?

If they're working in that plant and there were no radioactive material in it, you are requiring that plant to be 100 times as safe as any other plant. I think it's intended to mean that the radiological aspects should not add more than one percent rather than that being the total risk.

DR. DAMON: Yes, that's what intended. In other words, yes, this is the increment added by the part the NRC regulates.

MR. LEVENSON: Right. Not because of the operation of the facility.

DR. DAMON: Right. We're not saying that you need to do this. This is not a requirement. It's just saying if it was one percent of occupational fatality risk, which is already a very low number, why would anybody object.

You would say we're only adding one percent to your risk of getting killed. You still have all this other 100 percent risk. When you work in a nuclear facility you don't forgo the other risks. They are just added.

In fact, people get killed in these facilities from these other risks. Like I say, this is just an early first draft of the thought process of imitating what happened for public. We're imitating that for here and asking people what do you think.

What I really think this last one is a much more problematic thing, societal risk. What I managed to convince Bob Bari, I think, is societal risk goal has two components.

One is that risks from nuclear applications be low relative to other risks in society. Well, I can tell you right now that risks from all nuclear applications all added up together are infinitesimal compared to the risks of all the other risks. 90,000 people a year die by accident in this country. 90,000.

MR. GARRICK: Half of them from automobiles.

DR. DAMON: Yes, half from automobiles. That's an enormous number. There's no way nuclear applications are going to start approaching that. So, you know, fine.

What's the other one? The other one was the risk from a nuclear power plant should be comparable to competing methods of generating like -- you know, viable competing methods of generating electricity. Well, we tried to apply that analogy in NMSS and I don't think it works very well. Some of the applications don't have viable competing technologies or they are different in some way.

The other one is it goes of scale at both ends of the spectrum. At one end of the spectrum is the smoke alarm. Suppose you've got a smoke alarm and the nuclear risk from that is trivial. Why should you make it any lower just because it happens that there's a non-nuclear smoke alarm. Okay?

I don't see the rationale for that. At the other end of the spectrum I don't think it works either. Suppose you have a nuclear application where the risk is phenomenal. It's extremely risky, but the competing technology is even worse. "Are you okay? I met my safety goal. I'm lower risk than all of competing technologies." I don't think so. I think societal risks we need something here.

DR. KRESS: I think you're right. The problem I have with it is now you have to have common units for the denominator end of the numerator. The only one I see in common is dollars.

You have to reconstruct your risk in terms of dollars and you have to reconstruct your benefit in terms of dollars. It looks like a difficult task to me but it makes a lot of sense.

DR. DAMON: Yes. In effect, that's the issue. You see, what bothers me is it is clear to me that we are regulating to societal risk because it's the reason for remote siting of facilities and it's the reason why we don't dissolve our nuclear waste in the public drinking water supply and dilute it down. We are using this as a consideration in regulating. The question is what is a level that is low enough. I say it's a difficult question.

MR. KOKAIKO: Dennis, may I compound the problem even further? We may have another health objective between worker latent and worker acute. Also in NMSS you have applications that can cause severe burns radiologically. In fact, a radiographer just recently received a very high exposure to his hands. We've gotten some feedback to say that perhaps we should also be looking at that risk as well and try to quantify that which is somewhere between your worker latent and worker whole body dose that would kill you.

DR. KRESS: It's comparable to just what you would call injuries.

MR. KOKAIKO: Yes.

MR. GARRICK: Well, you're right that they can get very complicated if you try to calibrate this in too fine a detail. Some people don't even like to go as far as using dose. The cutoff ought to be fatalities.

There's all kinds of ways to make this unmanageable and I think you have to be very astute as to what you end up with as your metrics. To the extent that it's applicable you also ought to be guided as much as possible by precedence.

DR. DAMON: I certainly concur with that. Anytime we can find something like this one that's been well worked over, we're just going to buy off on it. It's only when we come to something that it just doesn't seem to work for what's going on in NMSS that we need to worry about anything else.

DR. KRESS: That's one reason I like that bottom one on there is because you can actually include things like injuries. If they are all put on a dollar basis you could include it all in that bottom.

DR. DAMON: This is another one that is tough. I don't even know if this meets -- I mean, it was expressed in the first public meeting that environmental -- how do I put it? Protecting the environment was not done for human benefit or something to that effect. Different people have quite a different view about what environmental objectives might be.

MR. POWERS: Have you chatted at all with the Swedes on this? They come out and they just say, "Okay. Thou shalt not contaminate the land with more than X amount of cesium." That's their safety goal. Don't worry about people. Just don't contaminate the land.

I don't know what rationale by which they came to that conclusion but it might be interesting to chat with them just to find out because maybe that gives you some insight on how to handle this sort of thing.

DR. DAMON: This one we haven't even begun to hardly think about. It's just a very --

MR. POWERS: Of course, the other way is to call up Dr. Kress and ask him for the dollar value of human life, take his number, and then you can come up with a dollar equivalent for environmental contamination.

DR. KRESS: It's worth thinking about.

MR. POWERS: Well, you spend a lot of time and, in fact, Bob Bari's group did it, on surveying what regulations ascribe to the value of a human life in order to set our ALARA limits so he's acutely familiar with it. That may be the way to handle it. Just make them equivalent dollar values.

DR. KRESS: That's the only metric I see.

MR. POWERS: Those were all quickly controlled.

DR. KRESS: -- what value they assign to human life.

MR. POWERS: That's an argument I've made for a long time. I think you're right.

DR. KRESS: It's the one we got dribbled on the floor and booted out.

MR. POWERS: Yeah, kicked right out.

DR. KRESS: Kicked out of the office on that one.

MR. LEVENSON: I'm afraid that doesn't solve the problem because even if we all agreed on the dollar value of the human life, what we're talking about here are very low doses and no agreement as to whether any human lives are involved or not.

MR. GARRICK: It might even extend life.

DR. KRESS: The contamination of land --

MR. POWERS: It's going to cost so much.

DR. KRESS: -- will cost so much it will control everything.

MR. GARRICK: Okay. Let's move along.

DR. DAMON: I think we're done. You mentioned chronic risk. I mean, we don't -- we haven't really had a conversation on this one. I think 2 millirem is used as a chronic risk goal objective by the United Kingdom. That's where the 2 comes from. I've seen people use 1. I've seen them use this. Maybe it shouldn't be an absolute number. Maybe it should be relative to something.

MR. GARRICK: Well, maybe one thought would be to not necessarily try to start with everything included but start with something that you have high confidence in that allows you to add to it as you figure out what these other things ought to be. In other words, phase in your safety goals is a possibility.

DR. DAMON: And the second one here, Bob Bari has been working on -- he's been working on two things. He's been tabulating these things. These are different NMSS applications. These were different frequency or probability values that might be used to manage these sort of analogous to CDF. These are CDF analogs for different things.

The other thing he's doing is he's quantifying -- he's going to the NUREG/CR-6642 and other risk assessments that have been done in NMSS and he's putting down the -- we are trying to estimate with the risk assessments that exist what are the risks in these different areas.

We are doing a bunch of stuff but I can't show it to you all because it's sort of in the middle of being developed. That's the kind of thing we're doing. We're looking at safety goals, what should be considered in principle, what are the options to pick from, what are the considerations, and then also trying to quantify what the risks really are so we can get some feel about where we're at.

MR. KOKAIKO: Dennis, if I might just point out, this is really just sort of a strawman. This is subject to radical revision.

MR. GARRICK: Well, it also looks like it's more than just an analog with core damage. It looks like it's analog with core damage plus containment release or containment failure.

MR. KOKAIKO: Yes, sir.

DR. DAMON: Yes, that's true. It is more analogous to large or early release.

MR. GARRICK: Any more comments? This helps us a great deal to get an insight on where you are and what you're doing. Does the Risk Task Group operate on a meeting basis? Do you get together periodically or how does it operate? Can you answer in a very short time how it functions?

DR. DAMON: I mean, the Risk Task Group is a regularly functioning unit. It's constant.

MR. GARRICK: So it's a group.

DR. DAMON: It's a real organization.

MR. GARRICK: It's not an ad hoc?

DR. DAMON: No, it's not ad hoc thing that gets together irregular or vague intervals. No, we work daily together.

MR. KOKAIKO: It's our day job.

MR. GARRICK: Very good. Thank you very much.

If there's no further questions, we will adjourn for lunch and be back at 1:00.

(Whereupon, at 12:10 p.m. the meeting was adjourned for lunch until 1:00 p.m.)

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

1:02 p.m.

MR. GARRICK: The meeting come to order. Our next topic is going to be the Risk Assessment for Dry Cask Storage, and we will have Messrs Guttman and Rubin to start off, and I understand there's going to be a team. Why don't you introduce yourselves and tell us where you work, etcetera.

MR. GUTTMAN: I'm Jack Guttman. I'm the Chief of the Technical Review Section B in the Springfield Project Office in NMSS.

MR. RUBIN: I'm Alan Rubin. I'm a Section Chief in the PRA Branch in the Office of Research which is conducting this dry cask PRA in response to a user need from NMSS.

MR. GARRICK: Okay. Proceed.

MR. GUTTMAN: I'm very pleased to introduce some excellent in-house activities to develop a spent fuel dry storage PRA. I hope this meeting will convey the outstanding technical contributions and analytic capabilities that various entities within the Office of Research and the Spent Fuel Projects Office have developed and continue to enhance.

In the future, we plan to solicit your

comments, expertise and support of the findings from this important program. This is an important initiative for several reasons which I will highlight in my introduction.

MR. POWERS: In our research report, didn't we characterize this research as some of the most important that was being done?

DR. KRESS: We did.

MR. POWERS: Preaching to the choir, at least two members of the choir.

MR. GUTTMAN: As a brief background, the Spent Fuel Project Office issued a user's need letter to research to develop a dry storage PRA. In support of this effort, the Office of Research and the Spent Fuel Projects Office and NMSS established a task force comprising of a group of experts in various fields. The ground rule was to develop a generic PRA using a certified cask for which the staff has readily available information, thereby optimizing our limited resources. The PRA would then be used by the Spent Fuel Projects Office as appropriate. The PRA is being developed in-house with limited contractor assistance such as human factors considerations.

The Spent Fuel Projects Office planned use of the PRA includes to risk inform 10 CFR Part 72, to support NMSS risk task group activities such as safety goal evaluations and development, to risk inform our inspection programs, to maintain safety, to enhance public confidence and to reduce unnecessary burden. Enhancing public confidence has taken a significant role as the staff is being requested to meet with local concerned citizens on the safety of dry cask storage. This program will assist our interactions with the public. Performing the analysis in-house enhances our technical and regulatory credibility.

MR. POWERS: That really is true. If you're going to have to explain this to the public, you've got to have the expertise to answer the questions in real time. You can't say well, I'll get back to you on that. You really do need to do this when you're in-house, don't you?

MR. GARRICK: One of the things I think the committee would be very interested in as we go along here would be what that influence has meant in terms of the way in which you're doing the PRA. Has it led to any fundamental change in how you do it? I'm talking about the business of involving the public and trying to enhance public confidence. What are you doing specifically to do that besides interact with the public?

MR. GUTTMAN: Typically, the Spent Fuel Projects Office is requested and is becoming more frequent by state representatives and the utilities and local communities to come to local public meetings and explain the regulations and the reasons why a utility should be permitted to remove their spent fuel from the pools and store it in dry casks. This is becoming a more important activity as more reactors are decommissioning and unloading their fuels from the pools.

MR. GARRICK: Or the pools are just simply filling up.

MR. GUTTMAN: The pools are just simply filling up. That's correct.

MR. GARRICK: Yes. Okay.

MR. GUTTMAN: As I highlighted, the PRA is performed in-house. A task force of Research and Spent Fuel Projects Office technical experts was established for that purpose. The task force consists of the following technical expertise. Project management, PRA, structural dynamics, material sciences, seismic, criticality, thermal, consequence analysis, statistics and human factors.

DR. KRESS: Is each one of those a different person or is one person all of those?

MR. GUTTMAN: Each one is a different person.

MR. POWERS: There are no Tom Kresses.

MR. GUTTMAN: Actually, there are several people for each category.

MR. GARRICK: Is the PRA category or structure dynamics category or where are you with count for external phenomena?

MR. GUTTMAN: The PRA practitioners would basically come up with the eventries and faultries. Let's say for example, if they're moving a cask and there's a potential for drop, then the structural people will perform dynamic analysis. We're using, for example, ANSYS/LS-DYNA. Identify the stresses and loads on the casks. Then the structural people look at the results and determine if there's a potential for a failure and try to quantify that.

MR. LEVENSON: For something like a cask, are there ever conditions where the seismic loads exceed the drop loads?

MR. GUTTMAN: No. Drop loads are in the order of 45 to 60 Gs.

MR. LEVENSON: I know. That's why I wonder why we have a seismic category and do a bunch of analyses when it's clearly subsumed within --

MR. GARRICK: Because the public would ask, why didn't you consider seismic?

MR. LEVENSON: You say it's not nearly as severe as dropping it.

MR. GUTTMAN: With that introduction, I would like to turn to Alan Rubin for the technical overview.

MR. RUBIN: Thank you, Jack. I just wanted to just go back and remind you that back in May of last year, 2001, I presented a proposed plan and approach to this joint subcommittee on what we were going to do on the dry cask PRA project. At that time, work had not begun. We were getting the team together. So what you're going to hear today is a work in progress. We're probably at the mid-point, maybe somewhat past the mid-point of this project. So you'll hear some conclusions in some different areas of the work and you'll hear some status and approach in other areas. And then in the future when we're finished with our integrated results and analyses, we will present that information to the subcommittee at the time.

MR. GARRICK: When do you expect to finish? You're going to tell us that, I guess.

MR. RUBIN: I'll tell you that. You're

jumping to my last slide at the end of the day, but basically --

MR. GARRICK: It's a bad habit of mine.

MR. RUBIN: Our schedule now is to have a draft report to NMSS in the late spring or early summer of this year.

This is an overview of what you're going to hear today following my introduction. These are the different steps and the people who are involved in those tasks are going to be giving these detailed presentations.

First is an overall modeling approach of the code that we're using, the Saphire code, which we're using to do the PRA to model the dry cask. You'll hear about then the external events that are considered in the dry cask analysis and how we've calculated the initiating event frequencies for those events.

You'll hear in particular one of the events which is a fire scenario and how the thermal loads were developed based on modeling of fire, the dry cask fire resulting from an aircraft crash. You'll hear about those analyses, both of thermal load from the fire, are calculated in determining what the temperature conditions are on the cask. You'll hear results and discussion on the mechanical loads. What loads are imposed on the cask for mechanical events, be they drops, impacts from tornado-generated missiles, or drops or tip-overs.

DR. KRESS: Does this include what happens internally to the fuel itself?

MR. RUBIN: There is some fuel failure modeling that is going on. It's not completed yet. But the fuel itself is contained in a canister, a multi-purpose canister, and that is encased into an overpack, a large concrete structure, in the storage pad. You'll hear more about that with the structural analysis. The real focus is for things to cause problems, the multi-purpose canister has to fail, and that's what the focus is of both the thermal and mechanical failures.

And then once we have those loads, both the thermal loads, the temperatures and time conditions, as well as the stresses from the different mechanical impacts, we'll have a presentation on how those go into the calculation of the probability and likelihood of cask failure. Each of them tie into different sequences.

Then there is some consequence analysis in terms of how we're going to look at the source terms and evaluate the overall risk to the public, integrating the consequences and the frequencies in our PRA. At the conclusion of these detailed presentations, we'll tell you what the next steps are, where we are in the analysis, and I've already given you one bottom line of our schedule for the draft report.

These are the objectives taken from the user need from NMSS. First, the dry cask PRA has not been done before, so there is really a first of a kind project. The intent was we wanted to develop a methodology for performing such a PRA on dry casks. You hear a lot about that today.

DR. KRESS: Since you got decay going on, do you pick out a specific decay time for these or do you do a time variable PRA?

MR. RUBIN: We're doing a nominal analysis where the fuel, first of all, is aged five years before it's put into the cask.

DR. KRESS: So you picked out five years.

MR. RUBIN: You pick out a time and then look at the decay heat following that. But we're also looking at scenarios if there's misloading of fuel from human error. We'll get into some of that. What impact that could have.

DR. KRESS: What I was wondering is there may be motivation to start getting that stuff out of the spent fuel pool faster and would your PRA be amenable to backing up, say, one year?

MR. RUBIN: Yes, it would. We would put in different decay heats and the consequence analysis we put in different source terms. Yes.

MR. GARRICK: But you might end up with mixed stages for the fuel. Different fuel of different ages, as long as it met the five year requirement, but it could be 10 year, eight year, six year.

MR. RUBIN: It's realistic to take five years but certainly the fuel could be 10 years old and then you're going to have lower decay heat so the impacts are going to be less.

MR. GARRICK: But I mean you could have fuel elements that are of different age.

MR. RUBIN: Absolutely. Yes, and you would.

MR. GARRICK: In the same cask.

DR. KRESS: Which brings me to another question I had. Say you've got 10 of these casks. Is the source term coming from all 10 or what would come from any one of them?

MR. RUBIN: We're doing an analysis of one cask and assuming that that cask has got five year old fuel, and you'll hear some more about that. And then typically the kinds of events, initiating events. If they are not common mode cause failure, they're going to impact one cask.

DR. KRESS: One cask at a time.

MR. RUBIN: A seismic event could impact a number of casks on a pad. So that's where you look into different levels of consequences, depending on whether you have a common cause failure or not for multiple casks. So as Jack Guttman said, we're doing a pilot PRA and the specific cask that we're looking at is called a Holtec HI-STORM cask and the reason that was picked is because of its availability of information as well as the likelihood that that cask will be used at a number of different reactor sites in the country. We're looking at a BWR site for our analysis.

Our final objective is to look at the potential risk to the public from dry cask storage and to identify what those dominant sequences are. This will hopefully provide a lot of information, useful information for risk informing NMSS activities. Again, we can apply the same methodology to different sites.

Jack mentioned the broad scope of the participants involved in this project. I won't read off all their names but they're listed here, and you're going to hear from a lot of them this afternoon. These team members include members from the PRA Branch, section chief and the overall management of the project is our responsibility in the PRA Branch as well as the PRA modeling. The analysis of initiating events and the fire analysis.

This project involves all three divisions in the Office of Research, so it's a cooperative joint program, joint effort. In the Division of Engineering Technology, the Engineering Research Applications Branch is responsible for the analysis of mechanical loads and the same division, Engineering Technology, the Materials Engineering Branch is involved with the failure analysis for both thermal and impact loads and mechanical loads on the casks. This is a mouth full. The Safety Margins and Systems Analysis Branch of the Division of Systems Analysis and Regulatory Effectiveness are doing the calculations of the thermal loads on the cask, the consequence analysis and criticality.

As my final slide, I just want to give

some perspective on the overall scope of the study so you'll see what's included and what's not included. There are three phases of the cask that are being looked at. The first one is the handling phase which takes place in the reactor building where fuel is loaded from the spent fuel pool into what's called the multi-purpose canister, and you'll see a picture of that diagram in the next presentation.

That canister is then dried, inerted and sealed before it's inserted into an overpack, which is the large concrete structure that holds the spent fuel in the storage pad. This cask is then transferred on site from the reactor building to the storage pad. It's called the transfer phase, and we're looking at accidents that can occur during that phase. And finally, looking at events that can occur during 20 year storage. Twenty years is the nominal license for these dry casks.

What is not included in the scope is probably equally as important as what is included. First of all, the fabrication of the cask. We're assuming the cask is built as it's designed, so fabrication errors are not covered. Off-site transportation is a different PRA than the transportation studies and modal studies being handled looking at risk from transportation, and acts of sabotage are also not included in this PRA.

MR. POWERS: How about aging?

MR. RUBIN: Aging of a cask over 20 years? I don't think there's any particular effects looking at aging. We're looking at errors at drying and inerting the cask which could cause some different problems on the materials. That is part of it. But if the cask is sealed and dried and inerted as the procedures say it should be, then I don't think there's any aging problems that we're looking at.

DR. KRESS: In developing a frequency for handling, you assume every five years you load up the cask?

MR. RUBIN: Cask could be loaded more frequently than that.

DR. KRESS: More frequently than that.

MR. RUBIN: Depends on the site, depends how much fuel is being moved into the storage pad. It could be a number of pads over the license period for the reactor.

DR. KRESS: But you have a number for that.

MR. RUBIN: Well, we will have a number for that. You're not going to hear that today. The handling phase is being covered in analysis of the liabilities analysis being done by a contractor. We don't have the final results yet to present today. We will in the final report. But that's looking at errors that could cause a cask to both drop because of human error as well as potential mechanical failures of the crane.

DR. KRESS: You don't include the effects of the drop if it drops into the pool itself?

MR. RUBIN: No, that's different. That's a heavy loads analysis.

DR. KRESS: That goes with the operating reactor.

MR. RUBIN: Correct. We're looking at the effects of the drop on the cask but not the effects of the cask dropping on other equipment in the reactor building or over the taurus, for example, the BWR.

So if there are any further questions, I will be happy to answer them. I will continue on with the presentation. Will the next two members come in. The next presentation is going to be done by Chris Ryder. Why don't the next two people come up. Brad.

MR. RYDER: Good afternoon. My name is Chris Ryder, and I'm going to be talking to you today about the methods that we're using to determine the risk of dry cask storage.

I'll give you a little bit more details about the system that we're studying. The cask consists of three components, a multi-purpose canister that contains the fuel, the transfer cask which provides shielding inside the reactor building, and the overpack which provides protection and shielding during storage.

DR. KRESS: When you say multi-purpose, that means it's good for dry cask storing and transportation and sticking in Yucca Mountain?

MR. RYDER: Yes. The canister can be pulled out of the overpack which in this case is just good for on site storage and put into another container and then shipped off site. That's why it's called multi-purpose.

Here are some dimensions that you can look at at your own leisure.

MR. LEVENSON: What's that word mean? Leisure?

MR. RYDER: This is the system. Here's the multi-purpose canister. This is where the fuel is placed. This is placed into the transfer cask which is used for handling. Both are put in the spent fuel pool where the fuel assemblies are loaded. The top is put on the shielding. It's brought out to another area for preparation and there it's dried and sealed, inerted and sealed up and then this transfer cask is placed on top of the overpack. With the stays, the MPC is lifted off of the bottom lid and the MPC is inserted into the overpack. The overpack has four vents on the bottom, four on the top. Air enters the bottom vents, pulls the MPC and exits the top vent.

MR. POWERS: What's the electrical chemical potential between the lead and the steel?

MR. RYDER: Say it again, please.

MR. POWERS: The electrical chemical potential between the lead and the steel?

MR. RYDER: I don't know.

MR. POWERS: Doesn't corrode though?

MR. RYDER: I couldn't answer that at this time. In the transfer cask, it's steel/lead/steel water jacket, and that's used just temporarily for the handling operation. There's no long term storage for that.

MR. POWERS: Concrete. Just concrete?

MR. RYDER: Say it again, please.

MR. POWERS: Concrete. Just concrete?

MR. RYDER: Just ordinary concrete. It has no structural support at all. The structural members on the overpack is the steel.

MR. POWERS: Steel.

MR. RYDER: And the concrete is just for shielding.

MR. POWERS: And there's nothing specified about the aggregate, other than size?

MR. RYDER: It's just ordinary concrete. I don't know the specifications of it.

MR. POWERS: What about the PSI concrete? Just ordinary sizing on the stones and things like that?

MR. RYDER: But the structural members themselves is the steel.

MR. LEVENSON: What's the little wedge shown blown up on the drawing?

MR. RYDER: This?

MR. LEVENSON: Yes.

MR. RYDER: That's just a section showing that this is the steel. This is the concrete.

MR. LEVENSON: It's not a wedge going into a hole?

MR. RYDER: Any other questions about this?

DR. KRESS: I see this thing is cooled by natural circulation.

MR. RYDER: Yes, it is.

DR. KRESS: Is loss of cooling accident one of the PRA --

MR. RYDER: That's one of the initiators which I'll get to.

You heard about the three phases of the operation handling transfer and storage. Here are some of the steps. Loading of fuel, lifting it from the spent fuel, the issue you heard before. We find it convenient to talk about these because this is how we actually structure our PRA around those three phases.

DR. KRESS: Going back to this natural convection cooling. Is there just one inlet vent or is there a ring of them?

MR. RYDER: There's four of them. Four in the bottom, four in the top.

DR. KRESS: And then they're baffled so that they --

MR. RYDER: And then there are channels on the inside which help to support or align to keep the multi-purpose canister from tipping and the air passes between the channels and along the MPC. Also, if the cask were to tip over, the channels collapse and so they provide some cushioning.

DR. KRESS: Okay. And is there just one outlet vent or is there?

MR. RYDER: There's four inlet vents on the bottom, four outlets on the top. There's a screen over them to keep out debris and inside the vents are baffles to keep radiation from streaming out.

DR. KRESS: Okay. Thank you.

MR. RYDER: There are two possible approaches that we could have done in conducting our PRA. We could have looked at all initiating events, no matter how low their frequencies or we could do a screening analysis, and to use our resources effectively, we chose to do the screening analysis.

What we did was we began by compiling a list of initiating events and we began with the external events in the PRA procedures guide. Then we looked at plant procedures. We observed some of the operations, talked to NMSS staff and looked at the design and we added our own initiating events.

With that complete list, we can then apply that to other plants if we need to. But in applying this to a particular site, we started looking at eliminating events by various criteria. To begin, we looked at which events were not applicable to the site. For example, if it's not in a seismic reaction region or a volcanic region or subject to Tsunamis, we can eliminate those events to begin with.

Then we also did engineering analysis to look at what events would have no effect on the cask, and we eliminated those. And then we are in the process of looking at events which have low risk. By that, we mean low frequency or low probability of occurrence.

MR. GARRICK: What was your frequency cut-off? Did you have a cut-off?

MR. RYDER: Nominally, we're taking 10^{-8}, but this is a screening study and we're going to look at our results and, if need be, revisit that.

In the handling phase, we have mechanical events. You can drop the cask when it's open. You can drop it when it's sealed. In the transfer phase we have mechanical events and thermal events. The cask can be dropped. It can be tipped over. The thermal events can occur if, for example, the transfer vehicle, if the fuel were to catch fire in that and eat the cask.

MR. POWERS: Would that happen if lightning strikes?

MR. RYDER: That's coming up.

MR. POWERS: During transfer, I mean.

MR. RYDER: Say it again, please.

MR. POWERS: During handling part of it.

MR. RYDER: Say it again.

MR. POWERS: Do you have lightning strikes during the handling part of it?

MR. RYDER: During handling, that's inside the reactor building.

MR. POWERS: That wouldn't count the outside --

MR. RYDER: Transfer is outside. We don't consider that there. The procedures call for the transfer being done only when there's good weather conditions. So if there's like rain in the forecast for the afternoon, either they'll put the operations off until the next day or they'll try to move them up, so they'll start earlier in the day to be sure that they're finished before hand. So if there's inclement weather, the cask is not moved.

MR. POWERS: It must be something they're worried about. What is the concern?

MR. RYDER: I think they just don't want to --

MR. POWERS: Zap a worker or something like that.

MR. RYDER: Say it again, please.

MR. POWERS: Zap a worker.

MR. RYDER: Yes, basically. They also just want to have the workers working under ideal conditions.

In the storage phase, you can have mechanical events due to tip-overs, strikes by heavy objects, explosions from gas main, a passing truck or a barge.

DR. KRESS: Excuse me, Chris. Are these initiating events you've identified or are these the ones that have survived the screen?

MR. RYDER: No. These are ones that we've identified. We are eliminating many of them. I'm just here giving you some examples of the ones that occur. We have a list of about 50 in detail.

Thermal events. You could have vent blockage. Like I say, from flood waters or from debris. Mechanical thermal events would be the effects of an accidental strike by an aircraft and then there's lightning.

MR. GARRICK: The lightning is just a people problem, isn't it?c

MR. RYDER: We believe so at this time. There is some speculation that there might be some effects on the concrete and the overpack, and we're also continuing to look into what could happen to the MPC, but we believe right now that the current will just pass through it.

MR. GARRICK: You don't know how good a Faraday cage it is.

MR. RYDER: That's the primary concern is for worker exposure for the workers, but no, I don't know that at this time.

MR. LEVENSON: Is the vent blockage including concern for rodents and insects and birds which are probably much more likely than floods?

MR. RYDER: Yes. Actually, one of the initiating events which we are going to be looking at is long-term accumulation of insects or debris accumulating inside the vents.

MR. POWERS: Squirrel nests.

MR. RYDER: I mean it's a warm environment and so it would tend to attract creatures.

Method of analysis is, of course, the event trees. We're using fault trees to look at the human errors and some equipment failures. Then we have other analyses going on. I have a stylized event tree in the package here. The event trees are much simpler than you would see in reactors. I'm not going to go through this. You can look at it on your own.

But they're nowhere near the detail that you see the power plant PRAs.

Inputs to the event tree are the initiating event frequencies. Some of those you'll hear about later on. We have the probability of MPC failure. To do that, we have analyses that determine mechanical and thermal loads on the cask and then those results go into a fracture mechanics analysis to give us the probability. We also are looking into the ability of the reactor building to isolate, the ventilation system to isolate, and then we have our consequence analyses, too, and you'll be hearing more about those.

DR. KRESS: Does the fracture mechanics part of this start out with some postulating cracks and crag distributions in the cask?

MR. RYDER: Yes, and you'll be hearing about that. There are flaws and welds that normally occur and which are acceptable.

MR. GARRICK: Chris, before you do the risk assessment. Did you do any threshold analysis? That is to say, did you try to get a handle on what kind of forces and impacts and temperature conditions you'd have to get to even get a problem?

MR. RYDER: We did some of that. We

looked at the submittal, of course, and then we had Jason doing some calculations as well. But it was limited in that respect. We basically postulated various events that could occur and then we asked other analysts if they could tell us if these could indeed happen.

MR. GARRICK: Well, there's two ways to do this. You establish a scenario and see what the end state of that scenario is in terms of the effect. But the other way, in order to kind of get a sense of the magnitude and also very helpful in the screening is to analyze it in terms of what the threshold values are for getting any kind of a release condition.

MR. RUBIN: We're doing that along the way as we go. You'll hear some of the results on the interim analyses looking at, for example, what temperatures can cause the MPC to fail.

MR. GARRICK: Right.

MR. RUBIN: And if no temperature scenario or sequence will reach that temperature, then it's not going to go into the PRA model.

MR. GARRICK: It's a very useful exercise to keep the problem under reasonable management.

MR. RUBIN: That's exactly what we're doing, and it's an iterative process.

MR. RYDER: And I would ask some of the people if the cask experience, this initiating event, what would happen to it, and they would give me some kinds of judgments in which case we would pursue it in more detail.

With that, that ends my portion.

DR. KRESS: Is somebody going to talk about the consequences later?

MR. RYDER: Yes. That concludes my discussion.

MR. POWERS: I may be leaping ahead in the presentation and, if so, I'm willing to wait for the answer, but do we have information that would tell us what kind of fracturing and fragmentation of fuel rods would happen given a mechanical insult at various levels?

MR. RYDER: I'm going to leave that to that discussion.

MR. GARRICK: That's kind of what I was trying to get at, Dana, too. Threshold for a source term.

MR. POWERS: I know that the transportation folks have wrestled with that problem and it strikes me that if we do have information, it may not be applicable to the higher burn up flags that we would encounter in the future.

MR. GARRICK: Yes. Out in your laboratory 20 years ago or so, they did train impact and truck impact tests on fuel casks.

MR. POWERS: They didn't stick a bunch of fuel rods inside it.

MR. GARRICK: They were very impressive in terms of establishing some sort of --

MR. POWERS: A lot of people over-interpret those just a tad.

MR. GARRICK: They were expensive tests, too.

MR. POWERS: They were expensive tests and they were done for particular purposes, not necessarily what people want to use them for today.

MR. RYDER: Are there any other questions?

MR. GARRICK: Questions? Okay. Thanks, Chris.

MR. POWERS: I guess one of the questions that comes up. You've been following the PRA procedures guide probably because that was what was available when you started this work. Can you derive anything useful that's appeared since the procedures guide came in?

MR. RYDER: I'm not prepared to answer

that right now. I could get back to you on that.

MR. POWERS: I mean I happen to be a big fan of the procedures guide.

MR. RYDER: We used the procedures guide to get a list of initiating events and then, through our own study, we added other events to it and discussions with the NMSS staff.

MR. POWERS: So it's not likely to be anything.

MR. RUBIN: We also looked at all the initiating external events, for example, analyzing the IPEEEs. We included them in this study as well in our list. It's fairly comprehensive.

MR. POWERS: I mean since we've been going to this effort to produce standards for PRAs, I just wondered if there was anything out there.

MR. RUBIN: We went through a lot of effort and discussions with the user office, the spent fuel project office and ourselves, to make sure we had an all inclusive list. It seemed to the point of almost getting a little bit ridiculous in some points. We went overboard in being inclusive rather than excluding events.

MR. POWERS: Did you add volcanism? That's the question.

MR. RUBIN: We did, but some sites don't have a volcano.

MR. POWERS: But they might.

MR. RUBIN: But if it did, it would be a block vent scenario with debris build-up, and we have that analyzed. So I'd say we could cover that if we knew the initiating event frequencies of the volcano.

MR. POWERS: Talk to the guys at Yucca Mountain. They seem to find volcanos where other people can't find them.

MR. RYDER: Brad Hardin will now continue the discussion.

MR. HARDIN: Good afternoon. I'm going to talk to you about our analysis of the external events of the initiating frequencies. This is a list of the events that we looked at.

MR. GARRICK: Are these essentially based on the reactor's PRA?

MR. HARDIN: No. I wouldn't say just that. I think we considered this particular application and we actually looked at some things that maybe for reactors we don't look at too much any more. I guess for the IPEEE we had gone through a number of these types of things just fairly recently here and in the case of the dry cask storage, I think maybe Chris and Alan both said we tried to be very inclusive at first and then we tended to look at things that were very unlikely. We screened those out. But we started with a pretty long list of things. Accidental aircraft crashes and then tornados. We were interested in determining what the likelihood would be of the cask sliding during a tornado from the high winds and perhaps striking other casks and then tipping over onto concrete pads. What kind of damage might we get from that? What's the likelihood of it?

I'm not going to talk to you about any of the damage areas because other people coming up after me will talk to you about the analysis of the potential for failing the multiple container and then flooding and lightning.

DR. KRESS: All these things are site specific?

MR. HARDIN: Yes.

DR. KRESS: One would do a site specific PRA.

MR. HARDIN: That's right. For this particular site.

MR. GARRICK: Yes. That's why I was asking the question because the reactor is site specific, too.

MR. HARDIN: I'll talk to you a little bit about the data. This one has a lot of interest. Looking at it from the viewpoint of accidental aircraft crashes in this case. We put in an equation up here, partly to show you an example of the type of analysis that was done on most of these external events. The form of the equation is fairly similar where the analysis result that we would like to get is, in this case, the number of crashes per year into the site where we might get damage.

The summation takes place over the four local airports that are in the area of this particular site. We did an analysis of the likelihood of a crash during take-off and landings in some detail because we had good data for that. We attempted to also analyze fly-overs, but it's been very difficult to get data for the number of flights flying over the area. It's somewhat complicated and even today we learned of a new reference where we might be able to get some information on that. But at any rate, right now I'm just going to talk to you about the take off and landing analysis.

There are four airfields that are in the vicinity of this particular site.

MR. POWERS: Is C_a a generic term?

MR. HARDIN: It's a generic term that's been derived from analyzing crashes all over the United States, and it depends on the distance from the site to the particular airfield. In this case, each of the airfields was fairly distant from the site. They ranged in distance from 16 miles to 29 miles, and the data that we had, when you try to look at something as far as 16 miles, it's a very, very small number. It would be a better analysis if we had airfields that were closer to the site. It turns out that the C is the same for each of the airfields because they're all fairly distant ranging in distance from 16 to 29 miles. These airfields were identified --

DR. KRESS: Is that a circular area?

MR. HARDIN: That's the way it's analyzed, as if a plane --

DR. KRESS: With the center at the airfield and the end of the radius at the plant?

MR. HARDIN: Yes.

DR. KRESS: What you said earlier is you really don't have good information on direction of the flight so that you could narrow that.

MR. HARDIN: For this particular analysis, when we did the first run at it, we tried to do a little bit fine tuning to take into account direction and we did get a little bit of information that indicated that the one airfield that we were most interested in because it had larger planes landing and taking off, that the flights tended to come in all directions except from the east. The eastern quadrant didn't have that many flights coming into it. So we've done a little bit of analysis along that line, but it didn't change the number very much. It just ended up making it a little bit smaller by reducing that quadrant.

The term that summed the multiplication of C_a X N_a which is the number of operations in and out of the airfields might be considered to be like a crash density and then if you multiply it times some equivalent area, then you get the total number of crashes that you might expect.

MR. POWERS: Is it the target area that you want to do there or the area that an aircraft crash occupied?

MR. HARDIN: I'm sorry, Dana?

MR. POWERS: I mean I slam an airplane into the ground. It creates a damage circle so big which I think is bigger than the cask.

MR. HARDIN: That's right.

MR. POWERS: So it's that area that you

want to use, not the cask area, isn't it?

MR. HARDIN: That's right. There's a skidding area that's typically added, depending on the terrain, and we used I think a distance of about 100 feet for that and then the projected area of the pad with the casks on it was used and then we added 100 feet to that to come up with an area. The final result in this case was something on the order of 10^{-9} crashes per year. It was a pretty small number.

While we're talking about aircraft crashes, we needed to pick a particular type of airplane to analyze in terms of the results of the potential for damage to the cask and we were given pretty good information from the Federal Aviation Administration in the area of the site. They were able to tell us how many operations were at each fields, which fields were used more commonly, and what type of aircraft used them.

It turns out that the aircraft are limited by whether the runway is long enough. Of course, some of the larger planes just can't land at certain airfields because the runway is not long enough. Out of the four airfields, there was only one airfield that had a large enough runway that all of the planes that used those areas could land at that one particular place. So we sort of focused our analysis on that.

MR. POWERS: You're going to be worried about 20 years from some time.

MR. HARDIN: Yes.

MR. POWERS: There's a substantial evolution that occurs in aircraft over a 20 year period. That usually is not in the direction of smaller. Did you try to correct for that?

MR. HARDIN: We asked the people at FAA that were familiar with these airfields if they thought that would change very much in I don't remember how many years, but it's possible that this would have to be returned to and re-analyzed at some point if there are some major changes there. But right now they thought the data they gave us was pretty good, at least out to I think maybe 10 years or so. The Lear Jet 45 was one of the planes that was a larger one that had a fairly large amount of fuel of all the ones that landed at these four airfields. It was not the largest plane, but we chose it to analyze because the two planes that were larger than it were restricted in which fields they could land at because of this runway distance and so we thought that the Lear Jet 45 would be a good one to start with to see and knowing the weight of the thing. Is that right?

MR. HARDIN: I think that Khalid should answer that. He's the one that did the details on it. He'll be up here in a few minutes.

DR. KRESS: We'll wait for that.

MR. GARRICK: Approximately what's the center of gravity of a full --

MR. SHAUKAT: That is correct. It is based on drag force and friction.

MR. GARRICK: What's the center of gravity height? The height of the center of gravity approximately on a fully loaded cask and approximately how wide are these casks?

MR. SHAUKAT: I can answer that question. It's slightly higher than the mid height of the cask. It's 878 inches from the bottom.

MR. GARRICK: How wide are these casks?

MR. SHAUKAT: The cask is about 11 feet in diameter. The overpack I'm talking about, not the MPC. It's about 11 feet in diameter.

MR. HARDIN: Well, the highest recorded tornado in the United States to date has been about 300 miles an hour. We were given a good bit of help and information from the Wind Science and Engineering Research Center in Lubbock, Texas. It's operated by what we would get from that. So you're going to hear some results of that analysis.

DR. KRESS: And even though it's 10^{-9}, you decided to go ahead with the rest of the analysis even though it likely would have been screened out based on the screening criteria because you needed the methodology or the consequences anyway. Probably some sites that may not screen it out.

MR. HARDIN: Yes, and because we had a team of people working on this and we started all of these analyses some time ago --

DR. KRESS: In parallel.

MR. HARDIN: -- we weren't sure sometimes what kind of probabilities we were going to get at the time and so some of the consequence areas were looked at also.

For tornados, looking first at likelihood of sliding and tipover. Khalid Shaukat, who's going to talk to you a little later, did an analysis and determined that in order for the cask to slide, we need to have 400 mile per hour wind during a tornado or greater and for a cask to tip over, it would require a 600 mile per hour wind or greater.

DR. KRESS: These analysis are rather simple drag versus frictional resistance to sliding

Texas Tech University. And so we tried to get some feeling from them about what's the likelihood of getting wind speeds and tornados reaching 400.

MR. POWERS: After they stopped laughing, what did they say?

MR. HARDIN: Well, they indicated that this data hasn't been taken for I think it's maybe 15 years or 10 years, and so they can only speak for that time when they've had fairly reasonable data. But they don't think there's any physical phenomena that would limit it to go slightly above 300 but there are some people, experts, that think that it would be unlikely to get wind speeds that go much higher than 400.

DR. KRESS: I don't think you can get the temperature difference between the layers of air that would generate that much energy. I think it would be that sort of consideration.

MR. HARDIN: Well, to analyze the probability of getting up to 400 miles an hour, we used the data that we had that went up to a little less than 300 and we did a regression analysis on it to get a curve so that we could extrapolate it out to 400, and we did that recognizing that we really don't know what accuracy we have in doing that. But we came up with a value of something like 10^{-9} again for the likelihood of having a tornado that would result just in sliding and so for tip over, since it takes a considerably higher wind speed, we presume that that's also a very small number.

DR. KRESS: Did you look at tornado generated missiles?

MR. HARDIN: Yes. That's the next slide.

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

MR. POWERS: You pretty quickly get the conclusion here, Tom, that no matter what we think of, you've got an answer for it. This is frustrating.

DR. KRESS: That's frustrating.

MR. POWERS: You've got to leave some blanks for us to jump into to feel like we've accomplished something.

MR. HARDIN: As far as tornado generated missiles, the design basis tornado of 360 miles an hour in the standard review plan has a number of different items that you would typically look at. Utility pole, 12" schedule 40 pipes, steel rods, and automobiles. And in looking at these, it was predicted that there would be no penetration of the concrete shell and no MPC failure. Again, I'm not intending to talk too much about these kinds of results. If you have questions about that, someone else can answer.

MR. POWERS: Is there enough impulse provided by any of these projectiles to cause the thing to tip over?

MR. HARDIN: No. Not without a very, very low probability. It would take a very high wind speed, again, to create a missile with enough speed to do that.

MR. GARRICK: In the maintenance of these casks, is there anything that people could do accidentally or intentionally or whatever that would make them more vulnerable?

MR. RUBIN: If that would occur, it would be during the handling phase because there's really not much going on other than surveillance when it's in storage. So, for example, if there's a misloading of fuel over the long-term, what effect could that be if it was improper drying or inerting, sealing the cask?

MR. GARRICK: I was just thinking of things like the cap being loose or something and 300 or 400 mile an hour wind creates quite a Bernoulie effect.

MR. RUBIN: Are you talking about the top being lifted off?

MR. GARRICK: Yes.

MR. RYDER: The overpack top is bolted on and the MPC is sealed for the 20 years. It's got redundant sealing, redundant welds. It's supposed to be just a passive system that is placed on the storage pad and, except for surveillance to check the vents, there's nothing really --

MR. GARRICK: They don't do any maintenance that would require them to remove the cap?

MR. RYDER: No. It's meant to be placed on the storage pad for 20 years and left there.

DR. KRESS: How do they inspect these things?

MR. RYDER: So far, we've learned that it's just visual observation of looking to be sure that there's no debris on the vents.

DR. KRESS: You just look at the outside of the vent.

MR. RYDER: Look on the outside.

MR. HARDIN: We conclude that because of the low likelihood of getting high enough winds that the frequency of occurrence of a missile failing the cask is very small.

Flooding has been screened out also

because the topography in the area of the site is such that rain water, even during the maximum precipitation that we look at during the IPEEE review, would not have any way for water collecting. It would drain away from the particular site. The elevation of it also precludes having river-related flooding including dam breaks. We weren't able to actually calculate anything on that. We didn't have the kind of data that we might have needed. There have been some calculations done by the licensee and those numbers that they calculated were very small. I think 10^{-8} or something like that.

This is the last one. It's lightning. Lightning is monitored in the United States by the National Lightning Detection Network which includes about 100 sites spread out around the country and this network is operated by a company called Global Atmospherics. They sell data for particular areas. You can get data down to one-tenth of a mile. And so we bought data from them for 10 years from a tenth of a mile out to three miles, and we were able to calculate a density of occurrence of lightning flashes in the area that we could then, using a target area for strike of the casks, we estimated about a 10^{-2} strike per year frequency of lightning strikes.

DR. KRESS: That's one every 100 years?

MR. HARDIN: I'm sorry, Tom?

DR. KRESS: That's one strike every 100 years?

MR. HARDIN: Yes.

DR. KRESS: It's not like my place. I get one every year.

MR. POWERS: That explains a lot about you.

MR. GARRICK: I think you started out by saying that these have a 20 year life.

MR. RUBIN: Twenty licensed. The life time could be longer but the license is for 20 years.

MR. GARRICK: That's my question. What kind of life do these casks have? Do they last 100 years?

MR. RUBIN: I'll leave that to Jack Guttman to answer.

MR. GUTTMAN: We license it for 20 years and we have ongoing a license renewal program. We just issued a standard review plan and the first application for license renewal is expected next year. The vendors are saying it will last approximately 100 years or so, but we haven't performed any calculations to identify the length of number of years that a cask would be acceptable.

MR. GARRICK: Have you done enough analysis to know what part of it ages the fastest?

MR. GUTTMAN: At this point with the data that we've received through research from the INEO, casks that were monitored and instrumented, we did not see any active degradation occurring at this point and those casks are approximately 17 or 18 years old.

MR. HARDIN: If you don't have any questions on this, Moni Dey from the PRA Branch is going to talk to you now about the fire analysis that was done.

MR. DEY: Thank you, Brad. I'm going to cover the fire analysis and Jason Schaperow following me will present the thermal analysis that utilizes the results that will be developed.

I'll start off with the statement of the problem. As Brad mentioned, we're going to be analyzing the fuel spillage from Lear Jet 45 aircraft. The assumptions are to ensure that we're conservative, that the dry cask remains upright and is totally engulfed in a fire. We're analyzing the effects of the fire on one dry cask. Normally there are 12 casks on a pad but to be conservative, we're analyzing the effects of the fire on just one.

As was mentioned, the dry cask, the outside diameter is 11 feet and 19.3 feet high, so it's a fairly massive object. The amount of fuel in the Lear Jet 45 is 6,080 pounds. So that's the amount of fuel that could be spilled in fire.

The objective of the fire analysis is 1) to determine the duration of the fire, assuming all the fuel leaks out and secondly, to determine the temperature distribution of a hot gas from the fire surrounding the dry cask. Specifically, the temperature of the hot gas near the inlet and outlet vents which Chris described earlier.

A brief presentation of the analysis for the duration of a fire. In order to estimate the duration, one needs to postulate the way the fuel spills. The duration of the fire will obviously be a lot less if there's a very big leak as a result of a crash and the fuel spills all at once. So in order to be conservative, a minimum spill rate was chosen so that the 1) the dry cask will be totally engulfed in the fire. So in that sense, this is a worse case fire effects analysis, worse case in the assumption of the leak size.

Therefore, in order to determine the duration of the fire, one can estimate the equilibrium diameter of the fuel pool that would be related to the spill rate and the burning rate, and the burning rate for fuel is available. Various measurements have been made and this data is available in fire protection handbooks. The burning rate for this particular type of fuel is about 4 mm/minute. I've attached some data at the end of the slides if you're interested in looking at some of the curves from the handbooks.

As I mentioned, assuming the fuel pool size that's needed to engulf the fire is approximately twice the diameter of the cask so about 22 feet diameter fuel pool that would burn. Based on this, one estimates that the duration of the fire would be about 24 minutes for the fuel spillage.

The next question is what is the temperature of the hot gas that Jason will use in his analysis. I had two sources of information that I used for this. One is over the last decade, several plume models have been developed and secondly, recently there were some tests done at Sandia on horizontal transportation casks where temperature was measured and the temperatures measured near the cask and this was near the ground level. It was approximately 1,800 F.

Secondly, the plume models, as mentioned, several plume correlations developed over the last two decades and the temperature and velocity in the plumes have been measured. Typically, the plume is divided into three regions. First region right above the burning area is a consistent flame region followed by an intermittent flame region and then just a plume of hot gases with no flame in it. And these different regions produce different temperatures and velocities. I've attached some figures that document these measurements that have been made in empirical plume models.

Based on these correlations and the height of this particular dry cask, the entire dry cask would be in the consistent flame region. The temperature of the hot gas around the dry cask is estimated to be about 1500 F. What I recommended was using a temperature of 1832 F for the hazard analysis which Jason will cover.

Finally, the conclusions of the fire analysis for this type of jet. The duration of the fire is estimated to be about 24 minutes and the inlet and outlet vents, both of them will be exposed to hot gases at approximately 1830 F.

MR. GARRICK: Did you look at any extreme of values like if you had 10 times as much jet fuel?

Six thousand pounds is about one hour driving time for a 747 jet engine. Did you try to examine supposing you had 10 times as much fuel what that do to the environment?

MR. DEY: Well, basically 10 times more fuel that you mention that would be in a 747 would increase the duration of the fire by a factor of 10.

MR. GARRICK: And what about the temperatures? Would they be pretty much the same?

MR. DEY: The temperatures would be pretty much the same.

MR. GARRICK: So it would increase the duration probably to hours. Right?

MR. DEY: Yes, about four hours.

MR. GARRICK: Yes. Okay.

MR. GUTTMAN: I'm not sure that if you had a larger amount of fuel that you actually can extrapolate that to hours. You'd have to have a small trickle.

MR. GARRICK: Yes.

MR. GUTTMAN: If the plane crashes in, probably the entire fuel will be spilled all over the place and using this conservative bounding analysis that it sticks within a diameter or so of circling the cask is a very conservative assumption.

MR. GARRICK: So you think the 1800 degrees -- well, the 1800 degrees is not in dispute. It's just the duration.

MR. GUTTMAN: Yes. Much bigger.

MR. GUTTMAN: Thank you.

MR. SCHAPEROW: I'm Jason Schaperow from the Safety Margins and Systems Analysis Branch. The objective of my analysis was to assess cask heat up to allow the structural people to evaluate the cask failure probability. The approach we took was to look at three scenarios for the HI-STORM cask. We looked at a blocked vent scenario, buried cask and external fire.

Our conclusions are for the blocked vents and the buried cask scenarios, the heat up is slow due to the low decay power of this fuel and for the external fire scenario, we saw that the temperature rise was limited by the fire duration.

This next slide shows the HI-STORM cask. This is taken from the safety analysis report for the cask. This cask consists of a sealed metallic canister, as we mentioned a couple of times already. This shows it partially inserted into the overpack. This MPC is the confinement boundary and the overpack which is steel and concrete provides the mechanical protection and radiological shielding and, as has already been mentioned, this concrete and steel overpack has air ducts in it. There's actually an annular region between the MPC and the overpack, and there are some so-called channels in there to kind of keep the MPC centered in the overpack, but there's basically an annular region in there.

The approach we took was to assess three scenarios. This is to develop a range of conditions that can be used to evaluate the cask failure probability. For the blocked vent scenario, we estimated the heat up resulting from blocking all four of the intake vents and with the one-dimensional model that we used, that shut off flow through the vent. For the buried cask scenario, we again shut off the vents but we also put the cask in a condition where there's no heat transfer from the outside surface, no conduction of radiation off the outside surface of the cask which is a very extreme condition.

Finally, for the exterior fire scenario, we calculated the heat up from the external fire which Moni provided the boundary conditions for. We applied the MELCOR code to assess cask heat up. MELCOR is an integrated accident analysis code for severe reactor accidents. It can be used for thermal hydraulics, as we've used it for here. It's also got modeling for core melt progression and fission product source term which we are planning to use in the consequence.

DR. KRESS: Is this thermal hydraulics or is this strictly conduction and radiation heat transfer? Is there a natural convection inside the cask itself?

MR. SCHAPEROW: In the nodalization I've chosen here, you'll see there's nothing inside the MPC. For the fire scenario, I'm allowing natural circulation of the hot fire gases through the annulus. For the first two scenarios, no, no flow. This is just conduction and radiation but for the third scenario, we're allowing flow of hot gases through the annulus.

The major inputs to this code. The thermal hydraulic input for the control volumes, the flow paths and the heat structures and finally, the DK power which is the heat input. I've noted on this slide the DK power we use in our analysis. This is important because this is a very small number, and this is what drives the calculation for the block vent in the buried cask scenario.

DR. KRESS: When you say each assembly. That's each fuel assembly.

MR. SCHAPEROW: That's correct so for the whole cask it's about 21 kilowatts. This is a BWR-type canister and holds 68 BWR assemblies. About one-eighth of a core.

This slide shows the nodalization we used with the MELCOR code. I would like to mention this is simple. It has only five elements. Three control volumes and two heat structures. As Tom pointed out, we're not considering convection within the multi-purpose canister. It's one volume. No flow.

This next slide gives the MPC shell temperatures we calculated for the scenarios which only had DK heat. That is the block vents in the buried cask scenarios. We just ran it out in time out to about a million seconds. It takes a long time to heat up with the low DK power here.

DR. KRESS: This is the temperature on the shell?

MR. SCHAPEROW: That's right. This is the boundary of the multi-purpose canister shell. This is the boundary for fission products.

DR. KRESS: Does this have a maximum fuel temperature inside that's calculated also?

MR. SCHAPEROW: I did not calculate a fuel temperature inside. I didn't even put fuel in here.

I just have helium.

DR. KRESS: Oh, you just had the heat going --

MR. SCHAPEROW: Helium with a constant density heat source. Just uniform heating of the helium. We are developing a MELCOR input file. We're going to be doing some calculations. We're actually putting fuel assemblies in there.

DR. KRESS: Your focus here was on what would happen to the cask.

MR. SCHAPEROW: That's correct. Whether it would rupture or not. This is going to be used by the structural people to estimate failure probability.

DR. KRESS: When you get time involved in it, you will go back and say I've got so much time to do corrective actions to get the failure probability or something like that. You'll have a temperature at which you don't want to exceed and then you'll have so much time to get there.

MR. SCHAPEROW: I don't know how they're going to handle that.

MR. RUBIN: This might be where some of the risk informed insights might come into play in the results of this in terms of procedures and other things, looking at the time before you run into problems and what could be done.

MR. SCHAPEROW: This was an issue on the spent fuel pool risk study from last year. This is heat up just based on slowly draining pool. People have days to take care of it.

DR. KRESS: Do you have a temperature that you don't want to exceed yet based on structural analysis?

MR. SCHAPEROW: I'd have to turn to the structural people for that. Ed.

DR. KRESS: The question is do you have a limiting temperature that you want to say that you don't want to exceed yet?

MR. HACKETT: This is Ed Hackett, Materials Engineering Branch and Research. I think Doctor Kress asked a question about limiting temperature. We were looking at, I believe -- I didn't do these analyses. I'll be subbing here later today for Tanny Santos. I think we were looking at about 1,000 F. as sort of the ball park answer. There was not a whole lot of damage that was contributed in a creep mechanism before 1,000 F.

MR. GARRICK: And the damage is where that you were most worried about?

MR. HACKETT: The damage would be largely to the areas like the welds, for instance.

DR. KRESS: Does the helium get internally pressurized at these kind of temperatures? That would be significant pressure.

MR. SCHAPEROW: That's correct. The structural analysis used both the temperature and pressure results from these calculations.

DR. KRESS: Okay.

MR. GARRICK: Let's pull out all the water from the concrete?

MR. SCHAPEROW: We didn't consider water in the concrete as the -- this is for the multi-purpose canisters. It's only the helium and the fuel inside that pushes outward.

We also ran a test using a temperature of 1830 F. for the environment. This was my attempt to simulate a fully engulfing external fire, and it's described --

DR. KRESS: That's the maximum temperature you would get in combusting jet fuel in a stoichiometric mixture with air or what?

MR. GARRICK: It's about 1500 degrees I think was your maximum, wasn't it?

MR. DEY: Yes. The temperatures that have been measured typically for various fields, it doesn't vary very much. It's around 1500 degrees. Just to get some margin, I recommended using 1830 because there have been some measurements.

DR. KRESS: That's when you take a stoichiometric mixture of combustion and put all the heat back into the mixture. You get 1500 or something like that.

MR. GARRICK: See, really what you're ending up with here is not so much a risk assessment as a bounding analysis because we don't really know what the answer is to the question. From this analysis, we don't know the answer to the question what is the risk? We know some other answer.

DR. KRESS: We know that the risk is less than some value.

MR. GARRICK: Yes.

MR. POWERS: In the engulfing fire, you're heating from the outside through the concrete and through the flow through the ducts. Right?

MR. SCHAPEROW: That's correct. All I've done in this calculation is very straightforward. I've just changed the boundary condition as the environment is now very hot.

MR. POWERS: In this concrete field region, is it vented?

MR. SCHAPEROW: No, it is not and I think that issue was discussed as far as the concrete giving off steam. I'm not sure how that was resolved. I'd like to refer back to the PRA Branch.

MR. RYDER: We're not looking at the effects of the overpack. Our concern is the confinement boundary which is the MPC.

MR. POWERS: I think we'll get to that. Suppose that I indeed pressurize that outer package. How does the steel deform? Does it deform into the overpack or does it just all push outwards?

MR. RYDER: We have not looked at that in our analysis. Our focus has been on the MPC and the pressurization.

MR. POWERS: I suspect you'll find out that it'll all deform outward, but it's worth looking at because at these kinds of surface temperatures, if someone were to use limestone concrete, you'll get some fairly impressive pressures within the concrete fill regime. It's a little tricky to figure out exactly what it is because in fact the CO_2 pressure will get so high it'll keep the limestone from decomposing. But it'll be impressively high pressures.

MR. LEVENSON: And I think the reason you can be almost sure the bulge will be out is the inside steel is nowhere near these temperatures. It may be 700 - 800 degrees or 1,000 degrees lower. I mean if the MPC inner canister only goes to 260, then the inside part of the overpack only goes to 260.

MR. SCHAPEROW: That's temperature rise.

MR. LEVENSON: Right. So if the inside is 260 and the outside is 1800, it's going to bulge out.

MR. SCHAPEROW: That's 260 plus the initial temperature.

MR. LEVENSON: It doesn't matter.

MR. SCHAPEROW: It isn't going to make any difference.

MR. LEVENSON: It's 300 versus 1800.

MR. POWERS: I'm not so good at these complicated structures deciding which things move where. It's worth looking at because you may get some impressive pressures.

MR. SCHAPEROW: That concludes my presentation.

DR. KRESS: I wasn't quite clear earlier on how you estimated the fire duration. Is that saying the jet fuel is in a pool of a certain dimension and the rate of burning off of the pool or something like that?

MR. DEY: That's correct.

DR. KRESS: You get four-tenths of an hour out of that, and then you did the four hour as a sensitivity study.

MR. SCHAPEROW: That's correct. Just say well, what if it's 10 times as great. How would that affect it. Basically it goes up proportionately, the temperature. It's a linear rise at this point.

MR. GARRICK: Okay. Thank you. We are supposed to be having a break now, but I'd like to get through this next presentation.

MR. SHAUKAT: I am Khalid Shaukat from Research Applications Branch and I'm going to talk about mechanical loads on the dry casks and the stresses on the MPC. There were two objectives for my work, the first one being testing the mechanical loads on the cask system for all the scenarios during handling, transfer and storage phase of this operation.

The second objective is to determine the stresses in the multi-purpose canister and those stresses would eventually be used for estimating the probability of failure of MPC or the consequences to the public.

For the handling events, we looked at the drop of the MPC and on the refueling floor when the cask is moved horizontally like so, hung from the crane, it is usually 12 inches above the floor. We tried to calculate that if it falls down due to any fault of the crane, would it tip over or not? We found out no, it will not tip over. So then we calculated what height would it require to fall from that it could tip over.

DR. KRESS: Doesn't that require you knowing some sort of angle at which --

MR. SHAUKAT: Some sort of an angle, so the bounding case is an angle of 20 degrees tilt from the vertical.

DR. KRESS: Where did that come from, that curve?

MR. SHAUKAT: That angle came from the CG and the geometry of the cask.

DR. KRESS: It would tip over if it fell at that angle.

MR. SHAUKAT: Yes. The CG of the cask falling outside the tipping edge of the cask would cause it to tip over. That angle we have calculated to be about 20 degrees from the vertical and that angle can not be reached unless the fall is more than 28 inches from the ground.

DR. KRESS: That's what I don't understand. Doesn't that depend on the way the thing fails or something?

MR. SHAUKAT: No, no. If it fails, then it will drop down. But we calculated that as long as the cask is 28 inches above the floor and it falls at a tilt, its one edge would touch first and the CG of the cask would still be inside that edge so it would just rest like this. It will not tip over.

MR. HACKETT: If it's higher than 28 inches.

MR. SHAUKAT: If it's higher than 28 inches--

DR. KRESS: Its momentum wouldn't carry it on over the other way?

MR. SHAUKAT: If it's higher than 28 inches, it could tip over. Now, the load is such that it will not sway in the other direction. It's very heavy, 360,000 pounds weight.

DR. KRESS: My question is is there ways for this carrier device to fail so that it lands at a bigger angle than that? Is it held up with two straps or one strap?

MR. SHAUKAT: It is hung with a -- which has two sides holding on it.

DR. KRESS: And if one of them fails?

MR. SHAUKAT: If one of them fails, we have not looked into that situation yet. Then we tried to calculate the stresses on the MPC for various drop heights.

DR. KRESS: No. The question is if it tipped over, is that a problem?

MR. SHAUKAT: If it tips over?

DR. KRESS: Is that a particular problem?

MR. SHAUKAT: A non-mechanistic tip over, for example, just falling and then because of the tilt it falls over, the non-mechanistic tip over we have calculated is not a problem.

DR. KRESS: Not a problem. Okay.

MR. GARRICK: And that's a handling accident.

MR. SHAUKAT: That's a handling accident. Then we tried to calculate what would be the stresses on the MPC for various drop heights and we found out that the height could be during that transfer phase of the MPC from HI-TRAK into the overpack could be a great height like about 80 feet or so and then we tried to --

DR. KRESS: There you don't have to worry about an angle.

MR. SHAUKAT: There you don't have to worry about the angle, but we said we wanted to calculate what would be the stresses on the MPC for various heights and we found out that a threshold value of 62 foot drop could cause the stresses in the MPC very close to the buckling strength of the material which is 64,000 psi so that is a 62 foot threshold value. And in that case, the circumferential stresses on the MPC shell are very small.

DR. KRESS: My recollection is is they took these casks and dropped them off the top of cranes that were higher than 62 feet.

MR. SHAUKAT: And nothing happened.

DR. KRESS: Nothing happened. That's what I thought I remembered.

MR. SHAUKAT: We calculated the buckling strength reaching up to the ultimate strength of the material. We're not saying it would fail at that 62 feet height.

During the transfer of the MPC from HI-TRAK into the overpack, it's a direct vertical drop of 20 feet which is the height of the overpack. So it goes inside the overpack and we calculated what will be the stresses on the MPC for that fall, and that is

11,000 psi.

Now we go to the transfer events when the overpack is being carried by a crawler from the refuel building to the concrete pad outside, and we calculated if the crawler vehicle is traveling at its maximum speed and if it drops the overpack, would it tip over? During this procedure, the crawler is carrying the cask only 11 inches high from the ground so we calculated that if it falls either on the asphalt or gravel or even the concrete pad, it would not tip over.

We also calculated that if the cask fell on the ground and the crawler operator fails to stop the vehicle, what would happen? The finding was that the cask weighs about 360,000 pounds and the crawler weighs 158,000 pounds. It can not push it. Its track would start slipping.

DR. KRESS: That requires you to have a coefficient of friction between the track and the road itself.

MR. SHAUKAT: We checked those different coefficient frictions.

DR. KRESS: Are these tracks like a tractor? Do they have treads?

MR. SHAUKAT: Yes, they're like tractor

and they would slip. They could not push it forward. We also calculated if the overpack digs into the asphalt or the gravel surface and the crawler pushes it, would it tip over? And it doesn't.

Last area in this case we looked was the crawler carrying the cask near the concrete pad and hits another cask on the pad, what could happen to the stresses in the MPC? We found out that if it hits another cask, the struck cask will not slide or tip over and the stresses in the MPC would be very, very small.

Then we go to storage events and we looked into the seismic and we found out that almost no sliding would be for the design earth quake of .015 G. Then we performed some sensitivity analyses to show that it would take 10 times design earth quake to move the cask up to half the separation distance, assuming that during the earth quake the two casks adjacent to each other move in the opposite direction, although this is a very unusual phenomena, but this is the worse case it could ever happen, it would move in the opposite direction. So we said okay, if the two casks move up to the half of the separation distance, we can conclude that it would not collide and we found out that up to 10 times of design earth quake, it will still not collide and no tip over could occur at any earth quake level up to 10 times of design earth quakes.

MR. HACKETT: Can I just interject. This goes back to Doctor Garrick's point at the beginning of the presentation.

MR. SHAUKAT: The threshold events.

MR. HACKETT: These are obviously very much bounded by the drop events for the most part, mechanical impact.

MR. GARRICK: It makes me wonder where we're going with the PRA approach here, and I'm not one to ever say we shouldn't do a PRA, but if there was ever a case that we may be able to standardize something and design it such that it was site insensitive and perform one comprehensive safety analysis, it sounds like this might be it.

MR. HACKETT: I think Alan mentioned at the beginning --

MR. RUBIN: You'll find a lot of things, phenomena, sequences, will be screened out based on frequency, initiating events or lack of impact on the cask, and you're seeing those today. There are, however, some instances of sequences which are not screened out yet. We particularly don't have the human error factored into this yet, and you'll hear some more about that later. But the PRA portion will be probably very simplified.

MR. GARRICK: Yes. Okay.

MR. RUBIN: But we had to do this analysis to come to that conclusion.

MR. GARRICK: Right.

MR. SHAUKAT: We looked into the aircraft impact. We chose the largest aircraft that could go in one of the four airfields nearby in that area within 30 miles radius and Lear Jet happens to be the largest aircraft and we calculated that at its landing or take off speed of 140 miles an hour, it would not slide or tip over the cask. Then we calculated at bounding value what speed impact would cause sliding or tip over of the cask, and we found out about 235 miles an hour speed could cause a tip over or slide.

MR. LEVENSON: Was that done with an assumption that the 20,000 pound weight of the jet was a solid piece of metal with no energy absorption capability?

MR. SHAUKAT: Right. Based on the assumption it's just a solid piece of --

MR. LEVENSON: So you've got two orders of magnitude in that.

MR. HACKETT: Probably a lot.

MR. LEVENSON: At least that. Yes.

MR. SHAUKAT: Tornados. As Brad Hardin mentioned earlier, tornado velocity of 400 miles per hour could slide the cask and the probability of that is 10^{-9}. This was calculated based on the drag force and the coefficient of friction between the cask and the pad. A tornado velocity of 600 miles per hour could tip over the cask and it was estimated that it would be orders of magnitude less than 10^{-9} to have that kind of tornado.

Tornado-generated missiles. We have calculated all missiles that are in the vicinity. We found that none of them could penetrate the cask. The worst one for the automobile would be the worst one to check for the sliding or tipping over, and we checked that automobile as a tornado missile will not slide or tip over the cask.

DR. KRESS: I'm intrigued by these calculations, if you don't mind.

MR. SHAUKAT: And this is based on certain coefficient frictions we have taken. We have taken a range of coefficient friction. WE have found that the smallest coefficient of friction would be governing for the sliding case and the highest coefficient of friction would be governing for the overturning case and we found that it would not tip over or slide for different ranges.

DR. KRESS: Going back to the airplane crash and tip over analysis. My first thought on that would have been I would get the momentum of the plane and then I would look at how much potential energy it takes in getting the center gravity of the cask to tip over. Is that what you did?

MR. SHAUKAT: Yes. Exactly.

DR. KRESS: So it seems all the momentum goes into tipping it over.

MR. SHAUKAT: As if one ball for the total weight of the aircraft hits it.

DR. KRESS: Okay. That's a pretty conservative analysis.

MR. LEVENSON: That's what I was saying.

DR. KRESS: That's what you were saying about absorbing some of that energy in the jet.

MR. LEVENSON: An airplane does not do the same damage as a wrecking ball.

DR. KRESS: Mostly it's the engine that does the --

MR. RUBIN: You'll find this is typical, that the approach we tried was to do either simplified calculations. If we need to do more detailed calculations later on because we could not eliminate events, then we would do that.

DR. KRESS: I don't fault that. I think it's the way to go.

MR. RUBIN: So that's generally the kind of approach we've taken.

DR. KRESS: Yes. I think that's what you ought to do.

MR. RUBIN: I just wanted to clarify that.

MR. SHAUKAT: Shock waves. We located that the nearest natural gas pipeline is about four and a half miles from the site and an explosion from such a distance would not affect the structural integrity of the cask.

DR. KRESS: That's not much of a surprise.

MR. LEVENSON: But what restrictions are there that would prevent over the next 20 years somebody putting a natural gas pipeline? Did you do the other case? How far away does it have to be before it doesn't do any damage?

MR. SHAUKAT: No, we have not done that case.

DR. KRESS: It would have to be on the site, I think.

MR. POWERS: It would have to be under the cask.

MR. SHAUKAT: For flood we did the bounding calculations. What kind of flood would it take to slide or tip over the cask? And we found that a flood velocity of 25 feet per second or 17 miles per hour will not slide or tip over the cask. And this is very small probability to have such kind of flood.

MR. POWERS: On your airplane impact in this cask analysis, you've looked at the airplane hitting the cask. What if it hits the ground underneath of it?

MR. SHAUKAT: The bounding case would be the airplane hitting near the top of the cask. We have taken that case.

MR. POWERS: Why wouldn't it be gouging a hole right in under the corner of the cask?

MR. SHAUKAT: That would not put such a heavy impact on the cask as --

MR. POWERS: -- going down from under and it tips over.

MR. SHAUKAT: If it does not hit directly, then it is a non-mechanistic tip over. A non-mechanistic tip over, we have found that it's no problem. A mechanistic tip over when it hits and tips over, that could be a problem. But a non-mechanistic tip over that it falls down because something is digging here would not impose high stresses in the MPC to cause it to fail.

MR. POWERS: What does it do to the fuel inside?

MR. SHAUKAT: We have not looked into the fuel inside.

That finishes my presentation.

MR. GARRICK: Okay. I think we'd better take our break now. We've got how many more?

DR. KRESS: Two or three.

MR. RUBIN: Two more and then a brief summary.

MR. GARRICK: I unfortunately will not be here when we reconvene, but the able co-chairman here will take over the meeting. But we'll take a 15 minute recess.

(Off the record at 2:44 p.m. for an 18 minute recess.)

DR. KRESS: Can we get started again, please. I'll turn it back to you. Where are we?

MR. HACKETT: I think what we're onto is moving on from what Khalid talked about and structural evaluation. This is sort of the response of the cask as a materials and structural system to the loadings that he talked about. I'm Ed Hackett and I'm Assistant Chief of Materials Engineering Branch. I guess all I get is some of the managerial credit for this work. The other two folks on here did all the work.

DR. KRESS: Take all the credit you want.

MR. HACKETT: Okay. Thank you. This is a nice piece of work. Again, as Jack and Alan led off with, all this work was done in-house in MED and they did a very nice job. Tanny Santos and Doug Kalinousky.

Just in terms of I think Jason had the larger overview of this thing as a system, but what you're looking at with the cask is really a stainless structure which is a good thing from a fracture material response perspective because it tends to be a very forgiving material as regards potential for brittle fracture, other things we've talked with the ACRS about on many occasions and some other systems.

So we considered three failure mechanisms: fracture, limit load and then creep rupture. Creep rupture obviously in response to the high temperature scenarios. Limit load is really a gross section failure of the cask, the cask wall in that kind of case. What Tanny did was to create failure models for those three mechanisms with an Excel spreadsheet and what they call this at risk add on module which basically performs Monte Carlo simulations on the material properties. So that's the way things were done.

In terms of some more general information that's provided in your packages, there's really two scenarios that were addressed. One is the situation with the mechanical accidents that's been discussed extensively already today. In that case, you have basically the drop accidents from handling and tip over. In that case, you really only have the two failure mechanisms which are really fracture or limit load failure of the cask.

DR. KRESS: When you're looking for, say, the loads and stresses on a drop cask, I envision an initial contact with something. Your forces, you've got momentum being offset by impulse, integral forces times time. Somehow you have to get those forces out of this, and that depends on how things deflect and deform including what it lands on.

MR. HACKETT: Right.

DR. KRESS: Did you just neglect what it

lands on and say it didn't deform at all?

MR. HACKETT: I'll turn to Khalid for the detail. I believe that's the case. I believe it was assumed as a --

MR. SHAUKAT: Yes. We considered that the actual case is such that there is a shear wall below the concrete floor going diagonally in the area where this could fall and we considered that because of the presence of the shear wall, it is more rigid. But any impact would have to be absorbed by the flexibility of the floor and the shear wall. But we considered it as rigid.

MR. HACKETT: This builds on also, Doctor Levenson mentioned the aircraft impact, and the crush of the aircraft structure was not modeled. Probably the most sophisticated analyses of that sort that are done are the ones that are done with automobile crashes. So you could do that, and there would be a different distribution of forces resulting from that, but that wasn't done, at least not yet.

The other side of this chart really talks about the thermal situation where you'd have the blocked vents, the cask being buried or an external fire that have been discussed. There are stresses there. Some discussion earlier from the internal pressurization from the inert atmosphere. In that case, you add a failure mechanism in the form of creep rupture if you get the temperatures high enough to cause deformation of that sort.

So just to run through these real quick. First one is fracture mechanics which is basically assuming that you've got a structure with a flaw. In most cases, that's a pretty good assumption. Most engineering structures. The flaw parameters. There was some discussion of that earlier, and I know we talked to the committee extensively, at least the ACRS, about the flow distribution for reactor vessels. For instance, in pressurized thermal shock. We used the program from that also on here. This program called Prodigal, which is an expert code that basically from weld fabrication parameters will yield the distribution of flaws that may be expected in that type of structure. So the flaw parameters did come from Prodigal. Again, that was done in-house.

There were some assumptions here that were conservative, the assumption being that those flaws from the Prodigal analysis were assumed to be surface breaking which would be again a conservative assumption. Toughness and strength properties in that case were also taken from the literature and were sampled per a Monte Carlo type routine.

For the next failure mechanism limit load which is very often stainless structures will fail in a limit load fashion, and I know we've also been before the committee talking about a lot of examples of that. Most recently, probably the control rod drive mechanism housings, for instance, would likely fail in a limit load scenario. They're an ostonimic material.

So really what you're saying is by the time you get to a limit load scenario, the structure is behaving like it doesn't care whether there are flaws there or not. You're into gross plastic yielding of the structure. In this case, we just did something as simple as -- or Tanny did -- looking at applied stress exceeding the flow stress where the flow stress was calculated as you see it there, taking into account bending and membrane stresses so basically you ended up with a scenario that's considering sigma flow at about three-quarters of the combined yield and ultimate material properties.

Creep rupture is more complicated because you're now considering another dimension to the problem. In addition to stress and temperature, you're considering the time variability of the properties with the temperature.

DR. KRESS: You use constant temperature in there.

MR. HACKETT: Yes. I know that came up. I think that's the bottom bullet. What Tanny did is he assumed that the initial steady state temperature was applied. This say for 40 years. It might have been 20. I'm not sure. But at any rate, that's what he did. He didn't project ahead for the heat decaying with the decay in the fuel. The creep rupture strengths were obtained from the literature.

The evaluation procedure in this case is very much like what you do for fatigue damage. You're basically using a dimensionalist parameter like Larson-Miller and your summing damage fractions to get to a creep damage. When the sum adds up to greater than one, you're assuming you have a failure from creep rupture.

So that's sort of background on how it was done and then in terms of some results.

DR. KRESS: When you use the Larson-Miller, doesn't that imply you're using the transient temperature?

MR. HACKETT: Larson-Miller actually as far as the input goes, the input temperature would have been considered steady but it is then a transient case -- you're right -- in terms of the Larson-Miller analysis.

MR. POWERS: Wasn't Larson-Miller's work done for isothermal conditions?

MR. HACKETT: I don't know.

MR. POWERS: I think we have extrapolated it substantially in going to the transient cases.

MR. HACKETT: I know Doctor Powers is getting into an area that was disputed when we did some work previously on -- Alan probably remembers this -- on Three Mile Island vessel where we looked at stress control versus strain control and there was some debate there also in terms of the transient case.

MR. POWERS: Significant debate.

MR. HACKETT: I remember some discussions with Doctor Rashid, for instance.

MR. POWERS: I mean Rashid's contention is that we just don't have the really empirical data-based work at those kinds of temperatures and kinds of bi-axial stresses and things like that.

MR. HACKETT: And I think you have to admit that's very true in terms of the data. There's no question.

In terms of results that they achieved--

MR. POWERS: Probably ought to quit investigating irradiated heavy section steel and start looking at bi-axial strain and heavy section steel.

MR. HACKETT: Another level of complexity.

We did look at the failure probability, just to share with you a few of the results here, and there's still some work in progress. These slides show the failure probability as a function of time and temperature for at least two of the thermal scenarios. I think Moni Dey mentioned earlier the fire duration was considered to be 25 minutes. In this case, the conclusion was that was not long enough to cause failure of the MPC, so you're looking at the case of the fire is actually over here in the red. You can get, as you can see, some very high temperatures from the fire and pretty much above -- I think this is shown above about 1,200, probably really anywhere from 1,000 above you're transitioning from sort of a fracture-dominated mode to a creep-dominated mode or maybe even creep crack growth in between. I think by the time you're up in this range, you're probably looking at a pure creep type behavior, at least a stage one or stage two creep. Below 1000 F. you're probably looking at a fracture-dominated scenario.

For the blocked vents or the buried cask over on the other side in blue, you're looking at a situation again that's dominated by fracture or fracture controlled up to 1000 - 1100 F. and then creep control beyond there if those temperatures get that high. And then you can move over to the axis to look at the kind of failure probability you're talking about.

DR. KRESS: Just to give you a test, what's this little hump in the curve?

MR. HACKETT: The one at 1120?

DR. KRESS: Yes.

MR. HACKETT: I would assume what's going on there is probably a disconnect. At some point, there's not a smooth transition between those two types of failure mechanisms.

DR. KRESS: Oh, you're right.

MR. HACKETT: I don't know if it's exactly a step function.

DR. KRESS: It's the transition between failure mechanism.

MR. HACKETT: Exactly.

MR. LEVENSON: Is that little X that says 1000 F. way over on the right hand side of the first chart, is that a point?

MR. HACKETT: I'm just looking at that for the first time here. I should have paid more attention to that. Yes, that's right. So that is just one data point and it is actually that low. As I recall a conversation with Tanny, it is actually that low in the failure probability.

DR. KRESS: Sure.

MR. HACKETT: The next slide shows the vertical drop for the transfer cask. In this case, dropped from looking at from zero to 100 feet. I think it's also fair to say that this graph beyond about 60 feet is probably more than a bit but it's not exactly the most certain part of the analysis at this point. I think up to 60 feet you're looking at again probably largely a fracture-dominated scenario with some aspect of limit load. Beyond that, I'm sure you're probably talking probably complete crush or limit load gross plastic deformation of the walls. So the upper part of that curve, if it is indeed correct, is going to be limit load-dominated, and then you can see the failure probabilities will go up significantly when you increase that drop height in terms of gross plastic failure of the wall.

And the last one we have that Khalid mentioned earlier was the 20 foot drop in this case into the overpack when it's being transferred which again would drop straight down into the overpack. The maximum applied stress was calculated at about 11 ksi. All the failures in that case would be predicted to be a fracture-dominated scenario if they happened at all, and those failure probabilities are down around the 10^{-4} range. So not a very severe situation for the cask.

That's what we have to date. There is some more work under way like the previous slide. We're finding some of that upper area from the higher level drops, but that was basically the task of the Materials Engineering Branch was to take the loads that Khalid generated and apply them to the structure through use of finite element modeling and some assumptions made on the variation in the material properties and see what would result. So far, I don't think there's any real surprises there from what we've seen.

That pretty much concludes what I had to say. If there aren't any questions, Jason is going to continue on with the consequences.

MR. POWERS: You have not looked at all the behavior of this outer shell when it's heated in the engulfing fire.

MR. HACKETT: In terms of the material

properties or --

MR. POWERS: Yes. What I'm thinking of is okay, you're going to heat this outer shell to 1800 F. It is going to be pressurized inside. Milt assures me that this is going to expand outwards. I presume it will rupture. The concrete all falls out. Does that change the temperatures on the inside?

DR. KRESS: Lowers them probably.

MR. POWERS: Why is it going to lower them?

DR. KRESS: Because you already got that temperature going up through the annulus and now you've changed it from a flow up to an annulus to just being surrounded by the temperature. I'm guessing based on what I thought the analysis was. Probably lowers it.

MR. POWERS: Let me make sure I understated. We're getting this gas from someone from a state where pi has the value of three. Right?

DR. KRESS: That's right.

MR. POWERS: So I want to put this in perspective where this gas is coming from.

DR. KRESS: Where road kill is legal.

MR. HACKETT: I don't know how much of that Jason -- Jason addressed some of it earlier. I don't recall the gap between the MPC and the overpack. I think it's on the order of half an inch.

MR. SCHAPEROW: Two and a half inches.

MR. HACKETT: Two and a half inches.

MR. SCHAPEROW: It's all the way around.

MR. HACKETT: I think then again these are things we haven't analyzed but just to respond to that sort of line of questioning, by the time the shell expanded to fill that gap two and a half inches, they would have to be --

MR. POWERS: It's on the outside. Bill tells me it's going to expand on the outside.

MR. HACKETT: Right, so this is the MPC expanding into the overpack.

MR. POWERS: No, no. What I was thinking of is this overpack expands.

DR. KRESS: It disappears.

MR. POWERS: And presumably it breaks. The concrete inside is powder at this temperature. It falls out. Engulfing fire is still going on. Does that cause -- I mean it's got to happen pretty quick. You haven't got a lot of time, but does it have any effect?

MR. HACKETT: As of right now, I guess that's an unanalyzed condition.

DR. KRESS: I would just look at the heat transfer coefficient you get for natural convection up that annulus and then look at the heat transfer coefficient you get from natural convection around the thing if it were unconstrained and see how much different those are. They're probably about the same.

MR. LEVENSON: There's only 24 minutes of fire. You probably deteriorate all that concrete.

MR. POWERS: It may be since we're free to adjust the fire burning rate, maybe we change from the 24 minute to the slower leak with a 44 minute fire.

MR. LEVENSON: More importantly, without getting into the details, I think your point, which I agree with, is somebody needs to look at the overpack which hasn't been looked at.

MR. HACKETT: Yes. Where that would have gotten considered would have been Jason's analysis, and that has not been addressed.

MR. SCHAPEROW: No. The previous project manager, who I understand is on sick leave right now, had thought of this issue. He identified this issue, and I am kind of thinking that he had done something to resolve it, but I'm not sure. We'll have to go take another look at that.

I'm back up here for one more shot before

I quit.

DR. KRESS: Here's where we're going to get a source term. Right?

MR. SCHAPEROW: Well, first I need to know what scenario fails the cask.

DR. KRESS: Oh, okay.

MR. POWERS: -- independent of that.

MR. SCHAPEROW: So this is going to be a very, very short talk. I just wanted to say a few words about the consequence assessment. The objective of this work is to assess the consequences for dry cask storage accidents, and we intend to and we have been applying the MACCS reactor accident consequence code.

MR. POWERS: Let me ask you a question about that. For this particular analysis, you've got a cask setting out in the middle of this flat plane where there's there's nothing around. I mean this is a completely isolated cask. But the guy that actually has casks for a living, they never have that. He has casks surrounded by lots of other casks. Is there going to be any difference between a MACCS calculation and what happens when you're in a field of casks?

MR. SCHAPEROW: If one cask fails and it's sitting in an array or a field of casks, as you suggest, you might expect a little more dispersion than if it's a single cask because you've now got the wind blowing past an array and so you've got a bigger wake than if you just had one cask. Based on the limited work we've done so far, I suspect that our source from uncertainty is going to be much bigger. I think that's where we're going to have some troubles with the source term. You already suggested that earlier today.

DR. KRESS: Let me ask you a more philosophical question. I have 10 casks on the site. I have a probability of failing one due to some of these accident sequences or cumulative frequency of failure and I have a source term for that cask and I calculate a consequence, so I've got a frequency and a consequence which I can convert to a risk. Now, if I've got 10 casks, is my risk 10 times what I just calculated?

MR. SCHAPEROW: I would expect that most accidents, the ones we're considering, would only affect one cask. It would have to be something that hit all the casks at the same time. So it would be very conservative to multiply it by 10. Probably unwarranted to do such a thing unless what it was affected all of them at the same time.

DR. KRESS: That's because these are mass stoichiastic events.

MR. SCHAPEROW: There's a separation. These casks are separated on the pad. In the spent fuel poor or reactor, all the fuel is right there together, but in this situation they're separated. They're in separate containers spaced with whatever spacing they have between them. So it would have to be big enough to hit all the casks at the same time.

DR. KRESS: And you can't drop all the casks at the same time because you're only moving one at a time.

MR. SCHAPEROW: That's correct. Typically inside the building is where they're handling it with a crane.

DR. KRESS: I think you're right.

MR. LEVENSON: I think there's a philosophical question as to whether all of the accidents inside the building which are precursors to loading the cask ought to be called cask storage accidents because they really aren't. I mean storage implies what happens when it's being used as a storage container and dropping the multi-purpose container before it's even in the cask shouldn't really be called a cask --

MR. RUBIN: It's just part of the operations to get the fuel into the cask, and it's included in the scope of work. I understand what you're saying.

MR. LEVENSON: The context of the question is when people start adding up is cask storage safe or not and you've included a bunch of accidents that are irrelevant to the use of a cask, is dropping something into the pool going occur whether you do or don't use dry cask storage?

MR. RUBIN: You have to go back to what the objective is from the user office as to where some of the priorities for looking and inspections or where the risks are for the dry cask storage system.

MR. LEVENSON: I think all of these things are worth looking at, but we've got to be careful what we call them.

MR. HACKETT: I think that's a good point when you call it storage. I think that shows how effective NRR was in handing this problem off to NMSS. That really does fall under the category of the operating plant and where you make that transition. Interesting point.

MR. RYDER: When I do my analysis, I'll be able to distinguish between the operations at handling and transfer and storage and break those out, and it would be up to me to communicate those various risks clearly and not just lump them all together as you're saying.

MR. LEVENSON: That would be fairly important.

MR. RYDER: Yes, very much so.

MR. SCHAPEROW: The approach we took was to use the MACCS code which we use for reactor accident consequences and adapt it by revising the input to be representative of cask accidents. As part of this work, we are examining the effect of what we are considering to be the important parameters and consequences.

DR. KRESS: Did you include some sort of emergency response in that MACCS code or did you just say there's no emergency response needed and we'll just look at the consequences without it?

MR. SCHAPEROW: The initial calculations that I've done have basically left that stuff alone.

DR. KRESS: Good.

MR. SCHAPEROW: As a starting point for my calculations, I'm using a fairly well known surrey large early release calculations that actually come with the code, and I've basically left that alone.

DR. KRESS: Oh, you did, so that does happen. It has evacuation and some emergency response in it.

MR. SCHAPEROW: I'm assuming emergency response. We're doing this at a facility which is an operating reactor, so they have all that stuff in place. This is a cask storage of spent fuel in dry casks at an operating reactor facility. They may not need that.

DR. KRESS: Yes, but it would never trigger the emergency response protective action guidelines probably.

MR. SCHAPEROW: That's right. If the release is small enough, you would not exceed the dose.

MR. LEVENSON: How valid are the release fraction assumptions in that code?

MR. SCHAPEROW: That's an input. That's something that we've been thinking about what to put in for release fractions. A lot of work was done on release fractions last year for transportation accidents by Jerry Sprung at Sandia and some others, and they did quite a bit of analysis to look at the releases of fuel finds, releases of what's considered volatiles, ruthenium and cesium at fuel burst temperature. So they looked at a lot of that. We'd like to adapt some of that where appropriate but right now we don't have a scenario where we're having a release. So so far the stuff I'm getting from the level one analysts is that this is screened out and that's screened out. So we've done some calculations, but I'm kind of in a holding pattern right now.

DR. KRESS: Sort of like a pebble bed modular reactor.

MR. SCHAPEROW: You probably have a little higher decay heat in one of those.

DR. KRESS: I said that just for Dana's benefit.

MR. POWERS: When we go through the ATWOS and those, we'll not only have decay heat. We'll actually have power spiking events. That'll give you a unique source term.

MR. SCHAPEROW: Anyway, the MACCS code treats atmospheric transport, accumulation of dose to individuals off-site, and we do allow for mitigation or relocation and evacuation. Based on all this, it performs estimates of the health effects. Cancer fatalities and -- fatalities.

DR. KRESS: Do you guys do that here?

MR. SCHAPEROW: Pardon?

DR. KRESS: Did you guys exercise MACCS here?

MR. SCHAPEROW: Yes. It executes in about a minute or so. It's a fairly straightforward code to use. In our analysis, we are trying to look at what may be the important parameters. We're doing analysis on inventory of the fuel, release fractions, release start time and duration, initial plume dimensions and the plume heat content. With respect to the site, we're also examining population densities and site specific weather.

I'd now like to briefly discuss what I believe are the two most important parameters in this analysis: inventory and release fractions. First I'd like to note that a cask does have a lower inventory than a reactor for two reasons, one of which is there are fewer assemblies in a cask than in a reactor, about a factor of seven less for a PWR as shown here and about a factor of eight less for BWR.

Also, the fuel is not put in the cask until it is at least five years old, so we have opportunity for a bit of decay and, as I note here in the last bullet, of the 60 isotopes we normally use for reactor accident consequences, only 16 of those are still there for cask accidents.

MR. POWERS: Curious nomenclature because they're always there.

MR. SCHAPEROW: Well, at levels that would influence the --

MR. POWERS: There's a level problem.

DR. KRESS: But the half life, they're always there.

MR. POWERS: Every isotope.

MR. SCHAPEROW: Finally, I'd like to mention a little bit about source term. There are three important parameters that affect the source term. Again, these were strongly considered and discussed in the work on the transportation risk study. That's the fraction of the rods failing, the release fractions for an individual failed rod, and the deposition in the cask. This concludes my presentation.

DR. KRESS: Okay.

MR. POWERS: When your guys come back and tell you, oh my god, you've analyzed this engulfing fire and come up with a scenario that's going to bust this thing wide open like an egg. How do you handle the plume? I mean it's a really funny looking plume. You've got a fire plume. Then you've got the plume of radionuclides coming out.

DR. KRESS: Fire plume probably dominates.

MR. POWERS: And you just treat this one as kind of a leak into the --

DR. KRESS: That's what I would do.

MR. LEVENSON: Because there's no other source of energy.

MR. POWERS: The fire plume goes out at 24 minutes, I'm told.

DR. KRESS: Then just forget it because I've got an on-site release.

MR. LEVENSON: You've got no transport mechanism.

DR. KRESS: I don't think you have enough energy to drive it.

MR. POWERS: I cracked this think open like an egg.

DR. KRESS: And you got radioactive decay energy driving it? You've got no krypton or xenon left.

MR. POWERS: What I have is heat wave coming in.

DR. KRESS: Restored energy. There would be a certain level of that.

MR. LEVENSON: Not much. The transport time through concrete is pretty damn slow.

DR. KRESS: My guess is you don't have to worry about that end of it, but it needs looking at.

MR. POWERS: Because the transport time is going to be dominated by the plume of liquid water, isn't it?

MR. LEVENSON: What liquid water?

DR. KRESS: In the concrete.

MR. POWERS: Every time I've heated up concrete, the back side of it got wet with hot water.

DR. KRESS: It'll do that.

MR. LEVENSON: That's not rapid. Not for the quantity of heat you need --

DR. KRESS: -- to loft a plume. Yes. I suspect you're right.

MR. MARKLEY: Mr. Ashe, you're back on line now.

MR. ASHE: Thank you.

DR. KRESS: We can't see you but you can see us.

MR. ASHE: Well, actually I can hear you. I can't see you.

MR. HACKETT: Alan had some summaries.

DR. KRESS: I guess, Jason, you leave us to wait for developments on these three things here and we'll hear more about them later.

MR. SCHAPEROW: It's kind of hear for me to do too much without a scenario.

DR. KRESS: You have to have some sort of driving force, don't you?

MR. SCHAPEROW: And I think once the scenario is established, then the source term is going to be the all important parameter for the consequences. The release fractions from the cask to the environment are going to be critical.

DR. KRESS: You plan on using the stuff that Jerry Sprung is developing for that?

MR. SCHAPEROW: If we can reach those conditions. His conditions were quite severe. He had a train crash with a fire. The train crash had up to 120 miles an hour with a fire and also the kind of cask he had had a bolted lid on it so the bolts bent a little bit and that provided the opening for the fission products to come out. This is a very thick weld. I don't know how thick it is.

MR. HACKETT: It's three-quarters of an inch on the structural lid and then there's also a shield lid so it's double sealed.

MR. SCHAPEROW: So this is going to have a less severe accident impacted on it probably and it also seems to have a much stronger closure.

DR. KRESS: Have you considered working backwards and saying what is my acceptance criteria and see what release fraction I need for that and say, isn't no way I can get that.

MR. SCHAPEROW: We don't really have one for consequences. We're going to have to do the combination of frequency and consequences.

DR. KRESS: You're going to get a frequency eventually.

MR. SCHAPEROW: Okay. When we do get that, then we'll apply it. If it's appropriate, we'll apply the consequences to that.

DR. KRESS: Thanks.

I guess we'll move on to you, Alan.

MR. RUBIN: I'll be fairly brief in just wrapping this up. what I'd like to do is you've heard where we are and what we've done, and I'm going to just briefly tell you what we're going to be doing to finish up this project. These are the items, the types of analyses that we're going to be doing. You haven't heard about the human reliability analysis. That's ongoing work. It's looking primarily at the handling phase of the accident.

DR. KRESS: Question. You're using ATHENA for that?

MR. RUBIN: Yes. ATHENA THERP.

MR. RYDER: I think they're doing both, but that work is ongoing.

MR. RUBIN: I think it's modeling with THERP.

MR. POWERS: To quote the esteemed chairman of the ACRS, if you've done what you're advertising to be doing in that work, you will have wowed him.

DR. KRESS: Yes. I guess the advertisement was at a recent conference somewhere.

MR. POWERS: It's something that was put out on what they were trying to do with the ATHENA.

MR. RUBIN: Part of the work, there's been a close look at the procedures and observations during actual fuel loading of the cask, looking at events, what could be the likelihood of misloading fuel, of improper drying or sealing the cask or inerting the cask or events that could cause tip over in the fuel handling building or in transfer to the storage pad.

We were looking at coming up with probabilities of cask drops, both from human errors, human actions as well as equipment failure, crane failures. In the mechanical loads, the work that's continuing is looking at drop heights of greater than

60 feet.

DR. KRESS: Why is that? Do you have to lift these things up that high to get them up?

MR. RUBIN: There's an elevation distance when the track vehicle is at one elevation in the reactor building and the overpack is at the lower elevation. There's something like a 98 foot elevation difference between the height and there's a shaft or opening where that cask is dropped. It's lowered. It's not dropped.

DR. KRESS: Lowered.

MR. RUBIN: Take that off the record. It's lowered slowly. This is a very slow process.

DR. KRESS: Slow drum.

MR. RUBIN: Slow motion lowering into the overpack. One of the other mechanical loads is looking at a drop from the crawler which is the transfer vehicle to take the cask to the pad onto a yielding surface. The analysis, as you've heard before, has been done to a rigid surface and we're looking at drops or most of the transfer distance is over asphalt or gravel.

DR. KRESS: Why are you doing that?

MR. RUBIN: Because we haven't got a low enough -- there's some probability of cask failure onto a yielding surface. It's not zero, it's not 10^{-6} number.

DR. KRESS: You just want the number so you don't have such a bounding analysis.

MR. RUBIN: Don't have such a bounding analysis and also it's going to be difficult for us. We're not looking at coming up with frequencies or probabilities of drop of the cask from the transfer vehicle. That would require a whole different kind of separate analysis. So if we can eliminate this event from doing a more realistic analysis of the likelihood of failure of the cask and if it won't fail because it's impacting a yielding surface, then we have means to eliminate or screen out that sequence.

DR. KRESS: I'd be interested in seeing that analysis because this surface, it's asphalt. Not only does it yield, it flows. That would be interesting. It's a non-Newtonian fluid. It would be an interesting analysis which may or may not be needed.

MR. RUBIN: But that's what we're doing and why. Thermal loads. Jason is going to be doing more detailed nodalization for the cask itself.

DR. KRESS: And Dana would like to add one for you to look at the overpack.

MR. RUBIN: We got that message. The effect of temperatures on the overpack, the concrete, and we need to look at that. There was some preliminary discussions, not discussions but looking at what the impact of higher temperatures would be on the overpack. I think it was primarily though from a rapid heat up from lightning, not a long-term sequence or a 30 minute sequence from a fire. The lightning was not the source, but we have not addressed that question.

MR. POWERS: I have no idea what will happen, but it's one that just comes to mind that probably didn't take too long to go chew on.

MR. LEVENSON: An early step might be to try to estimate the failure mode of the overpack.

MR. RUBIN: To escalate the failure mode?

MR. LEVENSON: To estimate.

MR. RUBIN: Oh, estimate.

MR. LEVENSON: Estimate the failure mode because that might eliminate a lot of need for various types of analysis. The worse case, which I think is probably not credible but nevertheless, if the fire generates steam inside and the failure mode is an explosive rupture of the inner liner, it might damage the MPC.

MR. RUBIN: We have to go back and also look, with the limited resources and looking at going back to the initiating event frequencies which you heard which are the aircraft impact. If it's at 10^{-9} frequency, maybe we don't spend our resources and do that. It's an interesting question for sure, but that's something we need to determine. But we hear the message but that's not part of what we looked at right now. The longer term potential impacts on thermal loads from not drying or inerting the cask adequately according to the procedures.

There's also been some development work going on on looking at fuel failure models from both thermal and mechanical loads that you've heard about today. You've heard about the mechanical and thermal loads. You haven't heard about the fuel failure model because that work has not been done yet.

DR. KRESS: Are those designed to feed into maybe a source term calculation?

MR. RUBIN: Yes. Rather than assuming it's in the transportation study 100 percent of the fuel has failed, if we can come up with gee, based on a certain drop height, for example, 50 percent of the fuel failed or less. That would be where that input would feed into our overall source term and consequence analysis.

DR. KRESS: Generally in the reactor area we would have looked upon the difference between 100 percent and 50 percent as not worth worrying about, but if it's a way to look at what the fuel looks like in order to estimate a source term from all the fuel, assuming all of it looks like that, then it's a different story.

MR. RUBIN: We're going to see if we can do a little more than what was done in the transportation study in this area.

DR. KRESS: It might be useful.

MR. RUBIN: We don't have a train car impacting on this cask. The cask is also surrounded by two and a half feet thick concrete.

One of the things we didn't talk about I just wanted to mention that's also going on is an accident during fuel handling. If the cask were to tip over and the lid were not sealed and you had a spill and release of radioactivity in the reactor building, then typically normally you would have secondary containment isolation. But we're looking at what the probability would be given that sequence. If the HVAC ventilation system is not isolated and normally you would then initiate the stand-by gas treatment system and vent through a charcoal filter and if that failed also. So that's the sequence that we'd be looking ta in the fuel handling building, looking at both the probability of failure to isolate secondary containment as well as decontamination factors that could affect the source term.

DR. KRESS: Is this a manual isolation because I can't see any other way that sets it off?

MR. RUBIN: I think with the radiation trip, I think there's a signal on radiation.

DR. KRESS: I don't know if you're ever going to get that high from this accident.

MR. RUBIN: But it's part of trying to be complete in our analysis so we don't over-estimate the consequences from this and, of course, you've heard the work on source term consequences will be going on. Once we have all these pieces, we will be able to finally complete the PRA model and run it to look at where we're getting the overall risk.

DR. KRESS: I'll tell you what the answer is going to be. Focus on the handling.

MR. RUBIN: I think that was my inclination from the beginning.

MR. LEVENSON: Tom, you could get there if this plane crashes into the handling building and you get the fire and the operator is so nervous he then drops the cask from 80 feet into the fire. You might get a release.

DR. KRESS: You're right.

MR. RUBIN: There's not a cask always being lifted, by the way. It's only a once in a while event. So that's the work that needs to be done to finish this. I'll call it the screening study. As I mentioned earlier, we'll have a draft report in the June 2002 time frame which will then undergo a peer review. If there's any need for additional analysis, it will be determined at that time and we will issue a final report. And we hope to be back to you again when we have results and this draft report. We'll let you know what we found.

MR. POWERS: When you began this presentation, you indicated that you had not considered flaws in the fabrication of the casks.

MR. RUBIN: Other than flaw distribution, for example, that you heard about. Yes. It's supposed to be two and a half inch gap or the concrete or steel wall is supposed to be half inch thick and if it's the wrong dimensions or something else, those are not part of it.

MR. POWERS: In light of the relatively

low probabilities that you're getting for all these things that you've looked at so far as far as the storage, doesn't that cause you pause to think well, maybe I better go look at the flaws in manufacture now as the quasi-initiating event?

MR. RUBIN: As far as the dry cask, that could be. First we want to finish up the handling and transfer phase to look at where the impact of human reliability is. It's a question of how far do you go in terms of looking at the really fine detailed analysis of the dry cask system when you have the whole fuel cycle. How much resources do we want to spend on this? That's probably a decision to be made I think in conjunction with the Office of Research and NMSS if we go further along those lines.

DR. KRESS: Generally, risk acceptance criteria end up having a time at risk in it. You're assuming how long for these casks for just the dry storage part? How long are they going to sit there? Have you got a number for that and does that factor into your risk assessment at all?

MR. RUBIN: Well, there's going to be risk during the handling and transfer phase.

DR. KRESS: I'm forgetting about that.

MR. RUBIN: It's an annual per reactor per year basis.

DR. KRESS: It's on a per year basis.

MR. RUBIN: Yes.

DR. KRESS: But you're going to say this is acceptable based on some number or some criteria. My criteria would have said how long is it at risk?

MR. RUBIN: I think you heard this morning some discussion of work going on in NMSS on developing safety goals.

DR. KRESS: That would be part of your safety goal. That's right.

MR. RUBIN: When we started the study and still there are no safety goals that we have to say okay, this is a low enough number or a good enough number. That's something we're going to be working closely with NMSS.

DR. KRESS: That's another aspect. Right now we're just getting what the number is.

MR. RUBIN: Correct. Whether that number is below a certain value so you can say it's okay, that piece is not part of the study but it's being done separately.

DR. KRESS: I understand.

MR. RUBIN: I think you heard about some of that this morning.

DR. KRESS: So we will consider this part a briefing of the status. You don't need any more feedback from us.

MR. RUBIN: Other than the comments we got which were helpful during the meeting. We're not looking for any written comments from the committee.

MR. POWERS: I think I offer one comment. You just have to be awfully impressed about the horsepower of the team that they put together for this.

DR. KRESS: Yes, and I also offer the comment that this was a worthwhile effort.

MR. POWERS: It's a worthwhile effort and it seems to be being done awfully well by a very competent group of individuals.

DR. KRESS: I think those are both good comments, and we appreciate the briefing.

MR. RUBIN: It's nice to hear those kind of comments.

MR. POWERS: I don't know that they get said enough because we've had some people making comments about the capabilities of research and the staff and what not and they ought to sit in on some of these things and see what's going on. Maybe it would change their mind a little bit.

MR. LEVENSON: Maybe if there's marginal reasons for writing a letter, it might be worth doing just so it could incorporate a comment like that because otherwise it doesn't get anywhere.

MR. POWERS: I think we target this June report. Bear in mind that we do that because I mean you and I are familiar with some of these comments that we took a little umbrage at and this just gives us a little more ammunition.

DR. KRESS: Sure does.

MR. RUBIN: And I think you're saying that the Office of Research is getting involved more in areas in addition to reactors which we've been involved in for many years in supporting NMSS activities, and this is a high priority task for the Research Office. It really is. We've put the resources and the manpower on it and think it's going well.

DR. KRESS: So are there any additional comments from anybody? If not, I'm going to declare this meeting adjourned.

MR. MARKLEY: Tom, I'd suggest if you wanted to pass around or ask for comments or see if the staff had any other remarks. Some of the earlier presenters, if they wanted to say anything.

DR. KRESS: I thought I did that. I didn't see any hands raised when I looked around.

MR. MARKLEY: Lawrence.

DR. KRESS: I didn't look far enough, I guess.

MR. KOKAIKO: Good afternoon. Our presentation this morning by the Risk Task Group on the Risk Task Group activities to date as well as some of the work that we are doing on safety goals. If you had any feedback, we would like to hear from you on that.

DR. KRESS: Our intention is for the subcommittee to get together and see if we can come up with some sort of letter on that one to give you some feedback.

MR. KOKAIKO: I appreciate that.

DR. KRESS: We haven't decided what that is yet. We haven't gotten together, but we might have a letter on that.

MR. KOKAIKO: I appreciate it. Thank you very much.

DR. KRESS: With that, I'll declare the meeting adjourned again.

(Whereupon, the meeting was adjourned at 3:52 p.m.)

CERTIFICATE

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

Name of Proceeding: ACRS and ACNW Joint Subcommittee Meeting

Docket Number: (Not Applicable)

Location: Rockville, Maryland

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

Pippa Antonio

Pippa Antonio
Official Reporter
Neal R. Gross & Co., Inc.