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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: January 29, 1991

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DEFUELING/FUEL POOL STORAGE SUBCOMMITTEE

Nuclear Regulatory Commission

Room P-110

7920 Norfolk Avenue

Bethesda, Maryland

Tuesday, January 29, 1991

The above-entitled proceedings commenced at 8:30 o'clock a.m., pursuant to notice, William Kerr, Committee Chairman, presiding.

PRESENT FOR THE ACRS SUBCOMMITTEE:

David A. Ward, Member

Herman Alderman, Cognizant ACRS Staff Member

PARTICIPANTS:

C. Haughney	F. Sturz
L. Fischer	R. Carlson
J. Roberts	J. Schneider

PROCEEDINGS

[8:30 a.m.]

MR. KERR: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Spent Fuel Storage. I am William Kerr, Subcommittee Chairman. Dave Ward is also in attendance. The purpose of the meeting is to review the standard review plan for reviewing Safety Analysis Reports for Dry Metallic Spent Fuel Storage Casks. Herman Alderman is the cognizant ACRS Staff Member for this meeting.

The rules for participation in today's meeting were published in a Federal Register notice of January 17, 1991. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. I ask that each speaker identify himself and herself, and use a microphone.

We have received no written comments or requests to make oral statements from members of the public. We will proceed with the meeting as soon as I ask Mr. Ward if he has any comments.

MR. WARD: I have none.

MR. KERR: I have none so I will turn things over to Mr. Charles Haughney, who will introduce the proceedings.

MR. HAUGHNEY: Thank you, Mr. Chairman. I am Charles Haughney, Chief of the Fuel Cycle Safety Branch, the branch on the NRC staff responsible for this undertaking.

[Slide.]

First of all, let me thank the Subcommittee for allowing us to make this presentation this morning and to provide us their views on this effort. It is very important that we receive your independent technical thinking on this subject, because it is a matter of keen importance to our staff.

[Slide.]

As part of my introductory remarks, I would like to show you where we fit in the staff organization. The Director of NMSS is Bob Bernero. The Director of one of his four divisions is my boss, Dick Cunningham, Division of Industrial and Medical Nuclear Safety. I run the Fuel Cycle Safety Branch, and one of the three sections in that branch is led by John Roberts who is with us this morning and available to answer questions. John has long experience in this subject.

This section is responsible for licensing of spent fuel storage facilities as well as developing the regulatory basis for such facilities. My other sections are involved in the commercial fuel fabrication and enrichment and other topics involving the fuel cycle.

One of the things that I would like to show you this morning -- it's not stapled in your packet but it's an aerial photograph of a spent-fuel storage installation at the Surry station. It will perhaps set the stage a little bit for this presentation. That is the James River in the background on the site down, I guess it's Hog Island. This is a fenced in area surrounding their spent-fuel storage installation.

There is a concrete pad, and then four of the metallic casks are in place in a vertical orientation on the cask. A fifth one is on a transporter that has just entered the gate and being ready for placement. Perspective fence posts are here. There are some personnel in this location. You can see the large tractor that is used to haul the transporter. That gives a relative picture of the relative size of the installation at Surry.

MR. WARD: Charlie, where is that relative to the plant site now; is that within the security boundary of the plant?

MR. HAUGHNEY: Yes. There is the protected area fence out here. Fritz is going to show some other pictures of this later. This is their service water canal there, of course, the containment building and here is the transporter going on that road. That separate fence around the pad is a separate security barrier.

[Slide.]

We are going to try to accomplish several things in this morning's briefing. One is, I am going to ask Fritz Sturz to spend some time this morning reviewing the history and background on spent fuel storage licensing. It has undergone quite an evolution in the past decade, and I think it would be well for us to spend some time this morning discussing that so we understand how we got to this point today.

Then we will get more specific and talk about the safety review process that we use for these casks and the c. .teria that are used to implement the regulatory requirements which are codified in 10 CFR Part 72. As do that then, we will get into a discussion of normal, off normal and design basis accident conditions that are considered in the review, and talk about our experiences that we gained in past reviews of these types of metallic casks and differences in cask designs that relate to the review process.

[Slide.]

The centerpiece of this morning's meeting is to discuss the standard review plan. I think many people are familiar with what standard review plans are but just to set the record straight, they are a document that is used by the staff to provide a set of procedures to ensure a consistent level of quality in the safety reviews that are conducted. In this case the items under review are dry metallic storage casks for spent fuel.

These standard review plans define the technical review areas in a discipline like fashion that can cover a variety of metallic cask designs. Finally, the standard review plan, we have not yet issued one for this type of review. But when we do as a result of this effort, it will provide a well defined base from which we can evaluate proposed changes in the review plan in the coming years as requirements and designs change.

MR. WARD: Charlie, let me ask you a question at this point.

MR. HAUGHNEY: Yes, sir.

MR. WARD: The Commission has, over the past ten years or so, promoted standardization in nuclear power plant design and by several different means. They see some safety improvement perhaps in that. Is there any sort of thrust in this program to promote standardization of dry metallic cask design?

MR. HAUGHNEY: I think there is. I am going to ask John Roberts to amplify on this because I'm a little bit new to this game myself.

MR. WARD: If he was going to cover something like this later we can wait.

MR. HAUGHNEY: He is not one of the presenters. Perhaps you could get his views on the subject. I don't think it has quite the play that it has in the reactors.

MR. ROBERTS: We have over the last number of years, the Commission has been interested in standardization and compatibility at the back end of the fuel cycle. Just to define that, compatibility with storage and transportation designs. What has evolved is a policy on the part of the Commission and, in fact, we report to the Commission every six months on progress by DOE and the industry towards compatibility.

What we are looking at is the ability to move the fuel ultimately from dry storage directly to either an MRS or disposal, depending on whether there is an MRS. Designs are working their way toward that. The Commission has not made this a hard and fast requirement, but they have encouraged it in the particular rulemaking of which we are speaking where we are talking about cask certification. That encouragement is in the rule.

The problem, of course is, defining what the ultimate repository and back into the fuel cycle is still rather vague.

MR. WARD: Is the requirement for compatibility or actual standardization?

MR. ROBERTS: What you are working for -- Bob Bernero made a presentation a couple of years ago to the Commission on this -- you have a multiplicity of reactors and a multiplicity of fuel designs. In fact, it is a moving target in the sense as reactors go to higher enrichment this means higher burn up fuel, so there will necessarily be another change in design for casks and so forth to accommodate that. We are already seeing that.

To the extent that you can accommodate the various types of fuel and reactors, assure the interfaces are such that you can get that fuel readily off site and that sort of thing, that is what the Commission is aiming at. As I say, it's a policy and the idea is to essentially guide the evolution of industry and DOE requirements toward compatibility. That is occurring as I say, we report on this to the Commission on a half-year basis. We are at present reviewing a cask which is a dual-purpose cask. It is a metallic cask. We have an application in from them and so does the transportation branch. They will ultimately seek certification of Part 71 and they will also seek certification of Part 72.

Then that cask could be used in the fashion similar to what you see in the one at the Surry site. In fact, Virginia Power is interested in this cask, where the cask would simply be able to move itself directly off the site. So, there is progress being made. There is some other types of designs too that meet this. It is not germane to this particular aspect, but there is a dry storage building design at Fort St. Vrain for the HTGR fuel that we are presently viewing. There is a transportation cask that can dock and receive the fuel and either load it into the facility or move it out.

That's the situation.

MR. KERR: I think the answer to your question is no.

MR. WARD: No on standardization, yes on compatibility.

MR. ROBERTS: As I was trying to emphasize, standardization you are dealing with many different types of fuel, physically different and the fuel itself is in the process of changing. The enrichment of the fuel is going up and the burn up is going up. So, to the degree standardization I think has to be viewed in terms of what we are dealing with.

MR. KERR: I don't think Mr. Ward was trying to push standardization, he was just trying to find out whether --

MR. ROBERTS: That's what I am saying. The definition of standardization, you are trying to standardize the process so that you can handle all of this fuel and meet the interfaces and ultimately be able to dispose of it and maintain a compatibility back in the fuel cycle.

MR. KERR: You have heard of this moving off site and Mr. Haughney did too. Off site to an MRS, not to a permanent storage.

MR. ROBERTS: Either one. The DOE is obviously pursuing an MRS. Whether one will be part of the overall process or not is yet to be determined. There is a waste negotiator now.

MR. KERR: I asked because I did realize that the characteristics of a permanent storage cask have been well enough defined that you know whether it could move into that yet or now.

MR. ROBERTS: Maybe I have mislead you a little. That is exactly the point. When I say compatible back into the fuel cycle, we are talking simply the compatibility between storage and transportation to MRS or repository. Clearly, the ultimate package for the repository cannot be defined at this point. Yucca Mountain isn't even yet determined as a site.

The Commission addressed this in the latest waste confidence decision. Theoretically a dual purpose cask could be set at an MRS if there is one.

MR. KERR: Thank you, Mr. Roberts.

MR. HAUGHNEY: There is one other aspect of our presentation later that will indirectly relate to your question, Mr. Ward, and that involves a licensing procedure by which we have a general license vehicle now for certain casks. There are four casks that have been granted under a rule change to Part 72, a general license status. I think you will see that, in and of itself -- although an administrative procedural matter -- is an incentive toward standardization although not directly stated. We will talk about that later.

[Slide.]

Let me switch to the next slide, and again focus on some of the key aspects that we will ask you to help us with as a part of this process. First of all and examination of the adequacy of the review criteria that we have developed and their appropriateness to the generic basis of dry metallic storage cask and any guidance that you might have on the use of the parameters that we have selected in the various technical disciplines that make up these safety reviews. Finally, questions on guidance on the safety margins that are used in the design.

MR. KERR: What does one mean by a safety margin in this context?

MR. HAUGHNEY: One example might be in the structural, the selection of values of allowable stresses. It will depend on the discipline involved. I think we will point out examples later in the morning during the presentation.

MR. KERR: Okay.

[Slide.]

MR. HAUGHNEY: My final slide involves a synopsis of our interaction with either the ACRS or ACNW in the past. We first interacted during a review of the Castor V cask, which is the one that you saw in the photograph at the Surry Station as a preliminary to the issuance of a Part 72 license for that facility in the 1985 timeframe.

The second interaction involved a rule change to Part 72 which allowed Part 72 to be suitable for licensing the monitored retrievable storage or MRS facility. Also, although it certainly hasn't been used in that fashion, to allow Part 72 to be used to license the storage of solidified high level waste when that is produced in the future.

Finally, the ACNW was involved at two stages of the rule change I alluded to a moment ago, that allowed the general licensing of certain certified casks.

MR. KERR: What do you mean by solidified high level waste as you used the term?

MR. HAUGHNEY: An example would be the glass logs that will be produced at West Valley.

MR. KERR: Okay. Would the V/21 cask be acceptable under the rule and the proposed review system that you have -- it would pass muster?

MR. HAUGHNEY: It is suitable for storage of spent fuel. It is licensed for the storage of the Surry spent fuel.

MR. KERR: If one used the proposed standard review plan, would it be approved?

MR. HAUGHNEY: This one that we have in front of us, yes. Yes, it would pass muster. That's our view. At this point I would like to turn the presentation over to Mr. Fritz Sturz of my Irradiated fuel section.

MR. KERR: One question before you do. As I read the proposed standard review plan and the Reg Guide, I was struck by what seemed to me to be a situation in which the standard review plan read more like the Reg Guides that I have seen in the past and not the standard review plan; did I miss something?

Typically a standard review plan is sort of a recipe of what an applicant must do or what he can do to satisfy the Commission. As I read the Reg Guide it was rather general, more like general design criteria that one might find in a rule rather than what I would have expected to find in a usual Reg Guide.

MR. HAUGHNEY: I guess I didn't particularly have that reaction. Mr. Roberts?

MR. ROBERTS: The Reg Guide that you are talking about is format and content. There is a design reg guide which is expressed in ANSI 57.9 which is Reg Guide 3.60.

However, that guide covers essentially all designs, if you will, that people have considered when the ANSI group work together on this. It covers vault storage, cask storage, module storage and so forth.

It is a -- 57.9 is a document that does have the criterion there, but I am not sure it would be appropriate for a presentation. In other words, you have to from section to section in other words. It is not specific to cask. It does have cask in it, but it also has other types of multiple designs.

MR. KERR: It seems to me that my perception was perhaps valid, that this is more like a Reg Guide for cask design which doesn't prevent it being used for the purpose for which it is designed either I suppose. In a sense it seems to me that you have a dual purpose document.

MR. ROBERTS: Right.

MR. HAUGHNEY: I think that's correct. Thank you, Mr. Chairman.

MR. STURZ: As Charlie said, I am Fritz Sturz. I work as Senior Project Manager in Irradiated Fuel Section of Charlie's Branch. Just before we go on any further, there are a few administrative things that I would like to mention about your package. The pages are numbered, and there are a few missing pages which have been pulled intentionally. You are missing page 43 and 62. We may reverse the order of some of the slides in the presentation, and there are a couple of pages that you will note have pen and ink changes.

MR. KERR: That is done to confuse us, I assume.

MR. STURZ: Yes.

[Slide.]

This morning I just wanted to cover a little background on where Part 72 rules started out, where they have changed through the past decade, and kind of give you a brief overview of what we have been doing under spent fuel storage licensing today. I will talk a little bit about this cask certification under a general license, and we will talk about -- I have a little video to show about the dry cask storage demonstration at Idaho and Surry.

[Slide.]

Back in the late 1970's when reprocessing didn't come about, the idea was to go to interim storage away from reactor sites. The result of that, the Commission did develop their licensing requirements for storage in an independent storage installation which was issued in 1980. The first license under Part 72 was issued, it was a renewal for the G.E. Morris facility at Illinois which is a pool storage. That facility now is full, and they are no longer receiving fuel.

[Slide.]

With the passage of the Nuclear Waste Policy Act, it put the responsibilities on the facilities for storage of the fuel. The went away from the Federal Interim Storage concept and also directed DOE to conduct research and development, and provide for some cooperative demonstration at the dry storage casks.

Also in the Nuclear Waste Policy Act it did charge the NRC with developing a rule to the maximum extent practical to store fuel on site without site-specific approvals. As we referred to, Surry was the first license issued under Part 72 for dry cask storage. The same year H.B. Robinson had a demonstration facility license, about eight modules. Both of these were part of the DOE cooperative agreement.

We mentioned earlier, Part 72 was amended in 1988 to cover high level waste and MRS. The most recent licensing action has been the issuance of license for the OCONEE facility, and that is horizontal concrete modules similar to Robinson.

MR. KERR: It says 10 CFR Part 72 was amended?

MR STURZ: It was amended in 1988.

MR. KERR: I was looking at 1990.

MR. STURZ: Also was amended for the cask certification. It became effective last --

MR. KERR: What does that mean, amended?

MR. STURZ: It was a rule change. These are two items under 1990.

MR. KERR: Maybe you are going to talk about this later.

MR. STURZ. I will talk about it later, yes.

MR. KERR: Okay.

[Slide.]

MR. STURZ: Just a quick run through on some of the requirements in Part 72. It is a one step licensing process. There is no construction permit and operating license stages. It does cover [illegible]rage at a reactor site and independent study for an MRS. It is a 20 year materials license, and MRS would be for 40 years.

MR. WARD: What is the basis for the 20 years for the ISFSI? I mean, why 20 years instead of 40 years?

MR. STURZ: I am not really sure what the basis was. John could probably could help me out on that.

MR. ROBERTS: This is history. One comes before the other. The 20 years was adopted at the time of the original rule, and I think historically it was felt that about 20 years of storage before the repository. It was also tied in with the GEIS.

The 40 years came about later because of the wording of the Nuclear Waste Policy Act. Legally it talks of long term storage, and a legal differentiation was made then and was decided basically as an OGC concern. They decided that to be true to the law MRS should be 40 years to differentiate it from the ISFSI.

MR. KERR: The answer is 20 years is arbitrary, right?

MR. ROBERTS: I would say that, yes. It was a horizon tied in with the idea of disposal. It is 20 years renewable as well as 40 years renewable, so it can be renewed.

MR. WARD: There really isn't a technical basis for it, corrosion of the fuel or something like that?

MR. ROBERTS: No. It was just what people were looking ahead in --

MR. KERR: I think the standard review plan must contemplate at least 100 years. This is for age spent fuel that has been decayed at least a year, though most designs received for storage casks are for five years or longer. It is limited to handling packaging receipt, transfer or solidified high level waste. It does have requirements for environmental reviews on site-specific licensing actions.

[Slide.]

Under Part 72 it does have provisions for physical security requirements, training, emergency planning and quality assurance. I think the two we are going to focus on today for the casks are for siting criteria and a general design criteria.

MR. KERR: Indeed, I notice that in the standard review plan spent fuel is defined as fuel that has undergone at least five years of decay.

MR. STURZ: Five years decay, that's pretty much what the designs are for.

MR. KERR: I thought you said one year of decay, and I wondered if --

MR. STURZ: John --

MR. ROBERTS: I hate to keep interjecting. One year comes out of the original rulemaking at that time to allow the rapid decay of short-lived products. Five years really comes out of the historical development since then. For one thing DOE had early on taken a position at least five years aged fuel. The designs in terms of the designs of the larger casks we are seeing such as the Castor V, basically five and ten years -- we are seeing five and ten years in terms of age of fuel for purposes of that.

It is a historical development there. There really is no interest in less than five year old fuel, drawing essentially from the DOE position. We are not likely to see it. We could, of course, review it.

MR. KERR: I was just curious as to why that differenc is there.

MR. WARD: I guess just out of curiosity, the glass logs from West Valley would be transported under this rule.

MR. STURZ: I believe they would be transported under Part 71, the transportation criteria.

MR. WARD: Storage would be --

MR. STURZ: At an MRS, yes.

MR. WARD: At an MRS. How about the glass logs at the defense waste processing facility. Do they ever fall under this 72 or 71?

MR. STURZ: This is for commercial fuel.

MR. WARD: Yes, but the Yucca Mountain site would be for both supposedly, as I understand.

MR. STURZ: That would be licensing under Part 60.

MR. WARD: Okay.

[Slide.]

MR. STURZ: Again, we talk about the most recent amendment to Part 72 was at reactor storage of the spent fuel in NRC approved casks. The utility licensee would be issued --is issued a general license to store their fuel in an NRC approved cask. The change talks about cask certification, which is very similar to the transportation cask certification. I will get into this in a little more detail in a minute.

[Slide.]

Getting back to some of the criteria in Part 72 for siting limitations there are dose limits. Basically this is derived from EPA's fuel cycle standard 25 MREM per year and 72 MREM thyroid, and at reactor sites this does also include the reactor operations as well. There is a control area boundary criteria for accidents of five REM and a minimum distance to the controlled area boundary of 100 meters. In most cases we see at the Surry, the site boundary is on the order of 500 or 600 meters. At the Fort St. Vrain site it is right at 100 meters, so there is a wide spectrum of parameters there.

MR. KERR: I remember when Appendix I was formulated, there was a discussion of whether the dose limitation should be on a per reactor basis or a per site basis. It was decided to make it on a per site basis because they did not want to discourage putting more than one unit on a site.

Did this take into account the possibility that this would discourage putting spent fuel or could discourage putting a spent fuel storage facility on a site with say two or three reactors?

MR. STURZ: No, I don't think this would discourage. I believe the EPA standard was based on all fuel cycle operations. Generally we find that the dose contribution to a nearest resident from the storage facilities is on the order of a few MREM per year.

MR. KERR: I would think it would be -- if you measured it would probably be zero, but the calculations that you do --

MR. STURZ: The calculations, yes.

MR. WARD: I am trying to figure out what that first one means to the real individual on or beyond the controlled area boundary. O. or beyond, it means everybody, right?

MR. STURZ: It is actually to a real individual, the same criteria. I guess it could be that the individual could eventually locate up to the controlled area boundary if that was unrestricted property.

MR. WARD: Okay, but it says on the controlled -- on or beyond the boundary. Okay, not on the -- I'm sorry, I was misreading it. There is no limitation on workers at the site?

MR. STURZ: That would be controlled under Part 20.

MR. WARD: There is nothing else. Workers at the site associated with reactor operation for example are treated as workers at the site, I guess.

MR. STURZ: They are limited to the 500 MREM a year. Usually at the storage installations they have a radiation protected area which complies with the Part 20 requirements for unrestricted access around that site. But being on the reactor site usually, they limit -- the dose projections are based on limited occupancy time on the reactor site.

[Slide.]

One of the principal criteria that we have is that we rely on the cask and the safety systems to really confine that spent fuel under all conditions, normal, off normal and credible accident conditions. I will get into more detail on this later on. Under storage conditions the principal criteria is to protect the fuel cladding from degrading over the storage time. We want to be able to pull that fuel out 20 or 40 years from now when we take it to a MRS or repository.

Because of that criteria it has put limits on fuel clad temperature and having the cask sealed and filled with an inert gas to prevent corrosion.

MR. WARD: Maybe you are going to get to this later, but I just don't know enough about it probably. What about known leakers, fuel that is known to have cladding leaks; is that separated out somehow?

MR. STURZ: We don't want to put fuel in that has gross damage, but fuel leakers have been put in. There are provisions in the rule that for damaged fuel it can be put in a container and then put in a cask. That is possible, some other barrier for damage fuel. Nobody has done this as of yet.

MR. WARD: Nobody has done it, but will people have leakers in their basins but haven't faced up to putting them in.

MR. STURZ: The idea is that the small pinhole leak, that the cladding will, as a barrier still to the fuel -- you don't want that pinhole to leak to grow and degrade so that you have the fuel oxidizing and falling to the bottom of the cask.

MR. KERR: The shielding and leakage calculations do assume a certain fraction of the fuel as --

MR. STURZ: Yes.

MR. KERR: Damaged.

MR. STURZ: Yes. We will get into more detail about the leak calculations.

[Slide.]

The design criteria, Part 72, covers natural vents, earthquakes, tornadoes, missiles, et cetera. The designs for earthquakes are bounded by the tip over accident. Tornado winds and tornado missiles are reactor criteria we have applied to the cask since they are on the reactor sites.

[Slide.]

Also, for the cask we look at extreme conditions, accidents including explosions, fires, cask tip overs and drop. Normally for site-specific applications we do look at the site to see what the probability or possibility of explosions are.

MR. KERR: In the standard review plan I looked for some discussion of probabilities of these and I must have missed it.

MR. STURZ: A lot of these accidents, the probabilities are -- since we have based for tornadoes based on Reg Guide 1.76, the probability --

MR. KERR: For example in reactor situations there is a cut off of about cut off likelihood that one has to consider. I didn't see anything like that in here. Did I miss it in the standard review plans?

MR. ROBERTS: No. We really have taken a -- from the beginning of deterministic approach. On things like the fire we historically took the transportation accident, although it has really --it's hard to conceive of any accident -- first off, this is non-flammable material and you are going about four miles an hour when you move those casks out there. The idea of getting the full type scale transportation accident -- nonetheless, we were looking ahe even at the time when the rule was early on toward the idea of being able to move fuel off the site in casks.

Historically we have tended to do this. The other thing is that we have intended to go with the reactor site criteria such as Reg Guide 1.76, the Region 1 tornado and that sort of thing.

MR. KERR: I was curious as to why you didn't permit a licensee to eliminate certain things that might have a probability of less than say ten to the minus seven per year. This is sort of standard on review of reactor systems.

MR. ROBERTS: In a site specific licensing people can propose that sort of thing. In this case for example, in the SRP, we are going -- this is oriented toward certification of the cask for essentially all reactor sites. It is, if you will, overkill to that extent because it is trying to bound parameters for essentially all sites.

Thus, as I mentioned, Reg Guide 1.76 tornado missile normally chosen in the review is the 360 mile per hour maximum wind in casks because a cask may be used essentially at any site, Region 1 or Region 2 or whatever.

MR. KERR: You still could have it general, and if one could demonstrate that the likelihood of these things tipping over at 360 degree wind is less than ten to the minus seven or the likelihood of penetration. They could be neglected. Since techniques exist for doing this and it might avoid a certain amount of useless calculations, I was curious that I didn't see any reference to anything like this. Apparently it does not exist in the standard review plan.

MR. ROBERTS: That's right. This standard review plan is for certified casks which will be certified to be used at all site.

MR. KERR: Look, if I can show that this cask is so big and so heavy that a 360 mile wind won't affect it anywhere with a probability greater than ten to the minus seven, it seems to me that's a possible approach and you chose not to do it, at least it appeared to me you did.

MR. HAUGHNEY: Certainly that would be a reasonable situation, but then again we are looking at a variety of different cask sizes and designs. I think it's a little difficult for us today to eliminate that accident out of hand for all cask designs.

MR. KERR: You don't eliminate it out of hand, you just say that if an applicant can demonstrate that the likelihood is less than that he doesn't have to do anything more. I don't see that that interferes with non-site specificity in some situations since it is fairly standard in the reactor business. I was just curious that it didn't seem to enter here.

MR. ROBERTS: It's not there at this time, you are correct.

MR. STURZ: Now I would like to move on to what we have been doing in licensing and what we are doing, and bring you up to date there.

[Slide.]

We have issued three dry storage licenses under Part 72. H.B. Robinson and OCONEE facilities are concrete modular design. Surry is presently the only license we have issued that does provide for storage in casks. Presently Surry is authorized to use three casks, the Castor V/21 which you saw the slide of, Westinghouse MC 10 cask and the NAC I-28 storage transportation cask. They have an application in to use the Castor .. which is a new design that we are reviewing, and are in the process of finishing that up.

MR. KERR: Which reactor was it that is reinforced concrete?

MR. STURZ: H.B. Robinson has demonstration of eight modules and OCONEE uses a larger version of the concrete module system right now.

MR. KERR: There will presumably be a standard review plan developed for concrete casks if that --

MR. HAUGHNEY: It's downstream, Mr. Chairman, but it is in our thinking to do that as well. We have a bit more experience with the metallic casks, but I think we will be back to see you with that package.

MR. WARD: In the spirit of standardization.

MR. HAUGHNEY: As much as anything, right.

MR. WARD: That was supposed to be an ironic comment. I have been hearing so much about standardization for reactors I feel we have a relatively more simply process. Go ahead.

[Slide.]

MR. STURZ: This slide shows the license applications that we have received. Essentially Carolina Power and Light is putting in the same design at its Brunswick station to store H.B. Robinson fuel that has been transferred to the Brunswick site. We received an application from Palisades to use a ventilated storage concrete cask. They subsequently withdrew their application when a rule change to allow cask certification became effective, and they want to proceed under the general license rather than a site-specific application.

This concrete cask we are still currently reviewing right now. Once we complete our safety review we expect an application for certification.

MR. KERR: Somebody with sense of humor chose that acronym of NUHOMS.

MR. STURZ: That stands for new tech horizontal modular system. We are working on the Calvert Cliffs application. Essentially this is very similar to the OCONEE design of the concrete modules. The Fort St. Vrain reactor is being decommissioned in order to speed up decommissioning. They want to remove all the fuel from the reactor, so they have chosen to proceed with an on site independent spent fuel storage installation. This is a modular vault design which John mentioned before about having a transportation cask, bring the fuel to the facility and being able to ship it away.

We have an application from Northern States Power for the Prairie Island site, and they have in their application included the design of a transnuclear TN-40 cask. They have decided to go with a site specific application rather than submitting a topical report for this cask design.

[Slide.]

These next two slides list the topical reports for dry storage designs that we have reviewed and approved. We reviewed nine and approved nine designs. You can see here that several are metal casks, which ones are the vaults, concrete modules, and it gives you an idea of the capacities of each one of the systems.

[Slide.]

Again, most of our topical reports that we have reviewed have been metal casks and that's why we feel we have more experience in this area and that's why we proceeded with the standard review plan for metal casks first. There have been other topical reports that have been reviewed, but for one reason or another the reports have not gone to completion or approval. The vendors have withdrawn their application.

MR. KERR: Who has done most of the reviewing of these?

MR. STURZ: Metal casks, Lawrence Livermore Laboratory has been our principal contractor for reviewing the metal casks.

MR. KERR: You don't have in-house capability to do these reviews or choose not to do them in-house?

MR. STURZ: We choose not to do them in-house at this time. It is more expedient to have Livermore do them.

[Slide.]

Currently we have three topical reports under review. This concrete design, I have Pacific Sierra Nuclear which is destined for the Palisades Site and Point Peach site under the general license provisions.

MR. KERR: Does the development of a standard review plan mean that you are no longer going to use Lawrence Livermore exclusively, or that you are --

MR. STURZ: No. We may go to other contractors. We will have to decide that in the future, I believe. In case we want to do things in-house --

MR. HAUGHNEY: I would like to keep my contracting options open both through the National Lab and through commercial sector.

MR. KERR: Lawrence Livermore must surely have developed a standard review plan that only they can --

MR. HAUGHNEY: Perhaps you can ask them later, when they are up to bat.

MR. WARD: Fritz, what standing does a topical report have in this scheme of things?

MR. STURZ: Up until this recent rule change what we had allowed is the topical applicants or vendors to come in with topical reports so that these designs could be referenced in site-specific applications. We will still proceed with the topical reports for designs that do not meet the cask certification of the vaults or other modular designs that could be submitted as topical reports.

For metal casks or concrete casks that are to be certified it will be a separate safety analysis report submitted for certification. It is just a means of having a site-specific license not review that design again that has already been reviewed. We would look at it in the context of a site which means we wouldn't have to go back -- the Castor V was going to be used at five different sites, we wouldn't have to go back and review the same thing five different times. It would just simply reference this topical safety analysis report and has been reviewed and approved.

As I mentioned before we are working on the Castor X which Virginia Power hopes to use at their Surry site. We are working on the NAC storage transport cask which is the first dual-purpose cask that we are working at, and expects to be certified under Part 71 for transportation and Part 72 for storage. The TN-40 cask for Prairie Island is not a topical report, but it's another design that we are in the process of reviewing.

I would like to move on --

MR. KERR: Excuse me. Is the concrete cask eventually expected to be compatible with transportation --

MR. STURZ: The idea now for the concrete cask and the NUHOMS modular vault is that the fuel is in a canister, and eventually the idea is that the canister would fit inside some sort of transportation package.

MR. KERR: Thank you.

[Slide.]

MR. STURZ: I would like to go into a little more detail about spent fuel storage under general license. It does permit, as I said before, the utilities to store their fuel on the reactor site in the certified casks without coming in for a site-specific application. I mentioned before the Nuclear Waste Policy Act required NRC to develop this rule, and it became effective just this past August. This is relatively new to the utilities.

MR. KERR: Does license renewal or extension, or however one might describe a process --

MR. STURZ: I'm sorry --

MR. KERR: Does license extension beyond the 20 year require a public hearing?

MR. STURZ: I am not sure what the license extension requires.

MR. HAUGHNEY: We haven't faced that yet. The oldest Part 72 license, the one issued for the G.E. Morris pool which was at the front end of the reprocessing plant in Morris, Illinois that never operated, it was issued about ten years ago I believe. It has over another decade to run.

In materials licensing typically when we do the renewal process, we at a minimum have to write an environmental assessment in support of that review. Upon issuance of that environmental assessment, a finding of no significant impact would be published in the Federal Register along with a notice of opportunity for persons to request a hearing.

We really don't have any experience at this stage in the spent fuel --

MR. KERR: The rule itself is not specific as to whether license extension requires a hearing.

MR. STURZ: Requires a hearing, I don't believe it is.

MR. ROBERTS: There is no required hearing on the site-specific licenses for example. There is no required hearing but we do publicly notice an application. Say in 2002 G.E. comes back in with the Morris site we would notice that we had received an application for renewal and that would be an opportunity to the public. Under the particular situation with the new rule where reactor operating licensees have a general license and the cask vendor comes in for recertification of a cask at the end of the 20 year period, that is a rule making, the cask certification. Consequently, presumably, we would have to do something along those lines again of going out with a proposed rule for public comment which would satisfy the administrative procedures.

That was specifically the way the --

MR. KERR: You have a rulemaking on each individual cask design?

MR. ROBERTS: That is correct. This is something that was legally set up in order to satisfy the administrative procedures Act, where in a site specific instance you have an opportunity for public hearing. In this rulemaking instance you have an opportunity for public comment on a cask design before it is finally approved.

MR. KERR: It is designed presumably for 20 years.

MR. ROBERTS: No. We review for 20 years at a given time under the license. The design life is typically a lot longer. I will give you an example. One of the NAC designs that we had reviewed earlier was asked this very same question in a public meeting. He said they had figured that the cask would, due to fatigue and so forth, last about 700 years.

I think we are not planning on that long a period of time, but the Commission in the Waste Confidence has looked at periods of combined pool and dry storage in excess of 100 years in the latest Waste Confidence review.

[Slide.]

MR. STURZ: Continuing on with an overview of the general license rule change, the rule change did not change any of the safety or safeguards requirements for independent spent fuel storage installations. It is really set up as an administrative mechanism for allowing utilities to store their fuel on a site without seeking site-specific approval. The rule change did approve four cask designs in the rule change.

As John mentioned, the new cask designs and recertification to meet the Administrative Procedures Act would have to go through a rulemaking procedure and allow public comment.

[Slide.]

The utility licensee, before they would have to use a cask, I would have to perform several different evaluations. They would have to do the 50.59 evaluation to assure that the handling of the cask would not cause any safety problems for the reactor; they would have to check the technical specifications to make sure if there were any changes required; if they did have to have a technical change it would be under Part 50, and that would open up the possibility of having a hearing on the issue.

They have to make evaluation that the conditions in the certificate of compliance have been met.

MR. KERR: What is a certificate of compliance?

MR. STURZ: Basically I will get into that in a minute.

MR. KERR: Okay, if you are going to get into it.

MR. STURZ: The specifications on how you use the cask. You have to evaluate their site parameters to ensure that the cask has bounded these parameters, and they have to make evaluation of the site dose limits. Again, all these evaluations would be subject to NRC inspections.

[Slide.]

Again at the reactor site the utility would have to check some of their on site programs and modify them according to include the operation of a storage cask facility, and obtain any approvals under the Part 50 license that they need. They would have to change their security plan to include this new provision for safeguards at the fenced in area of the cask facility to see if they had to modify their reactor emergency plan, quality assurance program, and the radiation protection program to include cask handling operations.

[Slide.]

When a utility decides to use a cask they would have to notify the NRC first, 90 days before they intend to store fuel under this general license provision, and then they have to register each cask design with us so they could use four or five different cask designs as long as they were certified. We want to know which four or five designs they are indeed using.

Administratively they have to maintain on site their certificate of compliance and any other documents that are supplied by the vendor; the maintenance history and what not. Again, they have to conduct all their operations under written procedures the way they do for reactor operation procedures.

[Slide.]

On certificate of compliance, again, it's a 20 year renewable certificate and the 20 years --

MR. KERR: I thought I just heard that after the 20 years there has to be a new rulemaking; is that not what you said?

MR. STURZ: The certificate can be renewed for that design, and we would go through another rulemaking, another safety review --

MR. KERR: So, it's not really renewable, you have to do it all over again, don't you?

MR. ROBERTS: Renewable, in the sense that it can be renewed. You are not cut off --

MR. KERR: It's a new rulemaking, so --

MR. ROBERTS: That's right.

MR. KERR: You don't renew the old one, you have new one, don't you? Am I missing something?

MR. STURZ: It would be the same certificate, but it would be renewed for another 20 years.

MR. ROBERTS: Extended for 20 years. The emphasis on the review would be primarily on the potential for aging aspects in the particular type of cask. Any problems that might have shown up in the previous 20 years and that sort of thing, rather than starting from scratch sort of thing. It would be essentially renewing that certificate with a rulemaking.

MR. STURZ: The idea here with the 20 year certificate -- if a cask was manufactured in the 19th year that cask could still be used for 20 years under that certificate. Then, if the certificate was renewed that cask could be used again for an additional 20 years.

The certificate of compliance contains a description and references and drawings that we review that are in the safety analysis report submitted as part of the application. Some of the conditions that it has for this conditions for using the cask requires that it has written procedures; that the quality assurance program has to be in compliance with Part 50, Appendix B; and, sets forth certain conditions for use in primarily dry run exercises and training exercises.

MR. KERR: The Appendix B, 10 CFR Part 50 is for reactors, and under reactors --

MR. STURZ: We have upgraded the program for quality assurance, and we do accept in Appendix B, Part 50, quality assurance requirements.

MR. KERR: That must require a good bit of interpretation on the part of the licensee or you, or somebody, since you have to decide what cask is safety related --

MR. STURZ: That is set forth in the safety analysis report, what is important to safety.

MR. KERR: In the safety analysis report, that is the staff's --

MR. STURZ: That is what we review.

MR. KERR: So, you decide at the time of the review what is safety related and what is not?

MR. HAUGHNEY: Yes, based on the proposal from the licensee, much like you do in a reactor review. There are safety grade boundaries on systems in the reactor plant as well.

MR. KERR: I recognize --

MR. HAUGHNEY: It is a difficult area, I agree.

MR. KERR: And somewhat artificial, I would think. You have had some experience so you probably have made decisions and tradition being what it is, you will stick with it.

MR. HAUGHNEY: Yes, sir.

MR. ROBERTS: Also, I might add that what we have done historically and are continuing to do is work with the QA branch in NRR to assure that basically the type of problem that you are talking about, the licensee who is using this cask as opposed to the vendor, the licensee is the reactor operating licensee and the vendor is the one who has a QA program going through that certification. That is reviewed through the QA branch in NRR, so there is a continuity there of review.

MR. STURZ: Again, the certificate of compliance does have what is referred to as functional and operating limits that are now listed as technical specifications that puts a criteria on what type of fuel can be stored in the cask and characteristics of that fuel such as initial enrichment burn up, cooling time, to meet the safety requirements that we have reviewed.

There is usually some sort of lift height restriction that we have now analyzed in a cask drop type accident. We will get more into all these details later on in the presentation on how some of these are developed. There is dose rate contamination limits for the cask, limits on leak tightness, internal gas pressure, and some sort of requirements for surveillance and maintenance.

We do have a copy of one of the certificates of compliance that we can pass out to you, and you can look and see what one is actually like.

MR. KERR: Okay. My agenda shows that your presentation is completed in about five minutes; does that make sense?

MR. STURZ: The videotape takes about 15 minutes.

MR. KERR: We should get to that fairly soon then.

MR. STURZ: Okay. The rule contains some requirements for the cask vendors, and one that they have to have their quality assurance program approved by the NRC. As John mentioned we do have the QA branch in NRR to perform those reviews for us. They have to have our review completed and the certificate of compliance before they fabricate the casks. They have to maintain records for each cask, and they provide written procedures for the utilities to use.

[Slide.]

Quickly, these are the four casks that were approved in the latest rule change.

MR. KERR: We have those, so why don't we stipulate those.

MR. STURZ: We have received one application for certificate of compliance for a standardized concrete horizontal modular design. We have just received that. Essentially, that completes tha viewgraphs. What I wanted to get onto next is a 15 minute video about the DOE demonstration of direct cask storage out at Idaho.

MR. KERR: Why don't we take a break and see if you can get the video working.

[Brief recess.]

MR. KERR: Okay, let's move on.

[Videotape played.]

MR. STURZ: Next we will hear from Larry Fischer, at Lawrence Livermore Labs.

MR. FISCHER: I am Larry Fischer, Lawrence Livermore National Laboratory. I am Associate Program Leader for Waste Storage and Transport Systems.

[Slide.]

I am going to talk today about the storage cask review process and, also, how the standard review plan was developed. This is an outline of this portion of the presentation. First of all, I am going to say a few words about the generic and site-specific application which had already previously been talked about by Fritz.

Then I am going to go into some of the details about the regulations and how we implement them through various industry standards, and how the standard review plan relates back to these implementation standards and holds them together, integrates them and gives guidance to the reviewer and anyone who is interested in the review process. Then, I will give a brief overview of the review process itself.

MR. KERR: When you developed this standard review plan, did you have any particular type of reviewer in mind?

MR. FISCHER: I will get into some of the details. Yes, we have had this experience also with the transportation branch of the NRC and with the Department of Energy. We have developed similar type of review plans for transport casks. We will get into the details about the way we think the review should be conducted and the attitude of the reviewer and so forth.

[Slide.]

The two types of storage applications, of course, first of all is the generic application. This usually involves a topical safety analysis report. Of course, several casks have already been certified under that approach. It can be located at any nuclear power plant.

There are certain bounding characteristics of the site. If this cask is going to be put on any particular site they have to show that they meet those requirements.

Then there's also the site-specific approach. This is with the safety analysis report for that specific site, and it's only at one nuclear power plant. It uses site-specific characteristics, and Northwest Power is the one that is taking that approach at this time.

The review process in itself is similar for both types of applications, but the standard review plan is aimed only at the metallic dry cask and it's more aimed towards generic type of review, although it could also be used in a specific type of review.

MR. WARD: Let me ask you a question. Fritz, the previous speaker, talked about topical reports that were reviewed. Is that the same thing as the topical safety analysis report?

MR. FISCHER: Yes, that's correct. CSAR.

MR. WARD: Those were topical SAR's then.

MR. FISCHER: Right. That's the full name for it.

MR. WARD: Thank you.

[Slide.]

MR. FISCHER: The storage regulations come down to three basic safety requirements, and they are expressed in terms also in performance standards. The three basic requirements is the material must be contained within certain specified limits, and that is seen as site boundary limits. Of course, you must maintain subcriticality and some kind of shielding must be provided. Again, it is in terms of the site boundary and other exposure limits.

When these requirements are on the cask they are expressed both in terms of normal conditions and accident conditions, and those were briefly talked about by Fritz but will be gone into more detail by Roger Carlson, exactly what those normal and accident conditions are.

[Slide.]

When we have the regulations and general requirements, we are going to have to be able to implement those into details where a structural engineer can do his part in reviewing a SARP to see if things are structurally sound, there has to be some kind of guidance given to a thermal engineer, a containment engineer and so forth. So, where do we go to find some of those requirements or guidance to determine if something is acceptable or not, if they actually meet these storage regulations?

What we do is we go to codes and standards and other NRC requirements like Reg Guides. Two of the most important reg guides --

MR. KERR: Excuse me. The copy of the slide that we have seems to call that Reg Guide 3.43.

MR. FISCHER: It's 3.48. That was a typo, and I thought we had caught all of them. Apparently, we didn't. That was a typo, 3.48.

The 3.48 is the general regulatory guide which covers all spent fuel storage facilities. Regulatory guide 3.61 is specifically for cask type storage facilities. The 3.61 is kind of a combination of 3.48 plus the transportation reg guide 7.9, because the casks are very similar to transport casks. In fact, that's what we find out that in many cases portions of transport cask guidance has been adopted by the storage industry and for SAR review.

Keep that in mind, that these are not something new. They are new in the sense they are being used for storage, but much of the experience is being carried over by the transportation industry which has been here for the last 30 years or so. A lot of that experience and know how comes from the transport industry and then it's adapted for storage type requirements. It turns out the storage type requirements are usually less stringent than the transport requirements. You will see that throughout this presentation.

We also look at the ASME code for guidance, that is, primarily Section 3 of the ASME Code but also includes Section 2 on materials, Section 5 on inspection, and Section 9 on welding, and also Section 8 on non-nuclear pressure vessels. We also turn to the ANSI standards for some of our guidance, especially ANSI N 14.5. It covers leakage testing and how to leak test these. That was set up specifically for transportation, but it is used also in the storage industry.

Then there are ANS standards which are used specifically for dry storage, criticality control, and also wet storage criticality control. Then, of course, we have the American Standards for testing materials for materials and properties themselves, and also testing techniques, particularly for non-productive testing.

We have all of these standards but there's always the problem of how do you relate them and which ones do you want to use, which ones are valid, which ones are acceptable. That's essentially where the standard review plan comes in. It tells the reviewer and the person who is coming in for review which of those codes and standards are important, how do you apply them to the storage cask requirements. That's exactly what we see, is that the standard review set up for that review guidance. Reg Guide 3.61 provides a format and content for the safety analysis report.

MR. KERR: Again, I am puzzled that 3.61 doesn't provide more guidance for the licensee.

MR. FISCHER: It does provide guidance in the sense that it describes what it expects to see there, but it does not give acceptance criteria. That is the main difference. When you come to the standard review plan --

MR. KERR: It's also a main difference from previous reg guides.

MR. FISCHER: Well, what you see -- here it describes what you expect to see in terms of content. Yes, I think that there are implied requirements but it doesn't necessarily say exactly where they want them to go to and so forth, where the standard review plan ties to the regulation where the requirements comes.

MR. KERR: I thought that the philosophy reg guides when they first developed were to provide guidance to a licensee, in effect saying if you follow this recipe this approach will be acceptable to the NRC. I don't see that sort of guidance in this reg guide at all. I find the guidance in the standard review plan.

It seems to me that the standard review plan ought to be called a reg guide. I think that's what it is.

MR. FISCHER: In the sense that there is not specific enough criteria, acceptance criteria?

MR. KERR: Acceptance criteria or guidance or any sort of thing.

MR. FISCHER: What we are trying to do is parallel NUREG-0800 for standard review plan for reactors.

MR. WARD: Bill, I think this Reg Guide is a little different, but it's parallel with the reg guide for standard format and content for reactor SAR's, which really provides just that and not acceptance criteria.

MR. KERR: Yes, but this is not a reactor. This is more like --

MR. WARD: There is another reg guide for design. This is just the reg guide for --

MR. KERR: There isn't a reg guide for design of metal casks. I was just told that there was a reg guide for design of all sorts of things.

MR. WARD: Right. Well, it includes metal casks. The problem is that it's not specific to metal casks. The ANSI/ANS 57.9 which was generated covers a variety of designs, hence the approach here of trying to narrow it down to the cask review --

MR. KERR: To me that makes a lot of sense. It just seems to me that the guidance for the designer is found in the standard review plan rather than the reg guide. Generally in the past it seems to me, designer guidance was found in the reg guide.

MR. HAUGHNEY: I think your comment bears reflection by the staff. One thing that I will mention though, when we publish this standard review plan it will be published as a NUREG CR. It will be available to anyone who finds reason to use it, and it will be useful in that regard.

MR. KERR: Alice in Wonderland said things are whatever I name them. I suppose that one could follow that guidance in other areas. I have said enough. To me, I think the standard review plan as it is developed is very well developed, very detailed, a lot of guidance. It just seems to me that it's almost a regulatory guide, and a pretty good one. I won't interrupt anymore for another five minutes.

MR. FISCHER: Let's move on. I think this is what you are talking about, what are the objectives of the standard review plan. Perhaps we should review this a little bit. First of all it provides format and content in parallel with Reg Guide 3.61, it follows 3.61 and we don't want to be in conflict with that, so what we do is look at each Section and Subsection of 3.61 and follow the same format and address the same kind of content. But now we provide general and specific guidance, what do you need to do in order to meet the overall requirements in the reg guide and also for meeting the regulation.

What we do in trying to provide that general guidance, and somewhat fairly specific as it turns out, we end up establishing systematic procedures so that another reviewer can come in -- it doesn't have to be with Livermore and can be external from Livermore. If someone were to retire at Livermore, then we would be able to show what type of procedures to use.

It also assures quality and uniformity in the review between the various reviewers. We want to establish a balanced effort; that is, we don't want all the effort to go into structures and none into criticality and vice versa. We also want it to go also into thermal containment operations and so forth. Finally, once you do have a standard review plan you know what you have been doing in the past. So, if you need to change it in the future you have some kind of reference to go back to and examine to know what you are changing from.

Finally, it makes NRC review procedures known to the applicant and to the public and other people that are interested.

[Slide.]

For this standard review plan the scope cover of course, metallic dry storage casks is very specific. It would also then hopefully address some of the interfaces with transportation casks. We have been careful in doing that. We try to cover every aspect in the package designs, fabrication, use and operation, and the maintenance of the cask and also decommissioning of the cask and what is involved with that.

We try to cover each technical area of review, we try to provide complete procedures for each of the areas of Reg Guide 3.61. We define the interfaces between the various disciplines, and I will get a little bit more into that later. We also allow partial reviews; that is, like with the NAT cask. They have come in with essentially the same cask body and design so that we don't have to redo an in depth review each time we look at a cask body. We can do a partial review and say we have reviewed that in detail and it's similar except for these features, and those are the only features we review rather than doing a full blown review each time on a similar type cask.

[Slide.]

The general philosophy that we have used in developing the standard review plan is that first of all, we believe that the safety is the responsibility of the designer/applicant. They know the most about their design, they know most about how it's fabricated and what the limitations are in use. They have spent probably a year or two of their lives trying to design this cask, so they should be fully responsible for its safety. They know where the weak links are and so forth, so they should know that they are going to be responsible for that safety.

As for the reviewer, he is responsible to verify that the applicant fulfills his responsibility. He is to go in and try to determine did the applicant do a good job, and he does some confirmatory calculations and checks and so forth, to actually verify that indeed the cask is safe and does meet the 10 CFR 72 requirements. I want to point out that 10 CFR 71 reporting requirements for safety deficiencies apply to both the applicant and the reviewer; that if they find a deficiency in a cask that is in operation that turns up they should report it to the NRC.

We want to point out the reviewer should not perform design analysis or modify the design for the applicant. Instead, the reviewer is to perform confirmatory analysis and just review the design to see if it is reasonable. The reviewer should have an open mind towards new technology, materials and methods. Very frequently we some of the times find a reviewer that says this is the way I have done it for the last ten years and that's the way we are going to do it for the next ten years. We want the reviewer to come in with an open mind towards new technology. Then again, they have to be careful in these new areas and spend a reasonable time reviewing it.

Again, a reviewer should make judgments based on technical information and not on personal opinions. We try to emphasize that in the guide, that we always follow a rational basis for making our judgments.

MR. WARD: I guess it wasn't clear to me in the second and third bullets there, I think are important. I am glad to see them. It wasn't clear to me in the review plan where that is implemented.

MR. FISCHER: I believe that is implemented in the introduction.

MR. WARD: Okay, that's fine.

MR. FISCHER: We could, perhaps, reinforce it in each of the sections but it is in the introduction.

MR. WARD: I mean, in order to -- the third bullet for example -- does the standard review plan provide the reviewer with tools to help him be open to different technology than he has seen before?

MR. FISCHER: Yes. We do specifically talk about some of the new technologies, and I will bring those up later on. Like borated stainless steel, that's a new technology and also cast iron is a new technology, and how does it apply to storage requirements versus perhaps transportation. There is a difference.

MR. WARD: You have made the standard review plan -- when you say new technology you mean things that are included in the standard review plan but perhaps not in the reviewer's previous experiences.

MR. FISCHER: What happens is, the standard review plan is intended to be a living document to be updated from time to time. As new technology comes on board and is reviewed and found to be acceptable, that would be documented later on in the standard review plan through a revision.

MR. WARD: All right, thank you.

MR. FISCHER: Also, there is some research provided. Let's bring up burn up credit. We are being funded by the NRC to look at burn up credit, and trying to come up with an acceptance criteria for burn up credit that is acceptable to both storage and transportation. Hopefully, we will come up with some kind of acceptance criteria.

MR. KERR: That's another story. I wondered why no burn up credit was to be given.

MR. FISCHER: It is still under review.

MR. KERR: I am puzzled that that takes a lot of research, but I guess it does.

MR. FISCHER: For cask applications it is somewhat different, yes. Are there any other questions?

[No response.]

[Slide.]

MR. FISCHER: These are the contents of the standard review plan, and it parallels Reg Guide 3.61 giving the detailed acceptance criteria and guidance. Roger Carlson will talk about some of the more important portions of these. Rather than going into a lot of detail in each of the sections, Roger will cover the most important items in the review on normal and accident conditions and how criticality reviews are held and so forth.

I would like to go on and talk in general terms of the review process itself. You can see there are several parts in the review process or phases. First of all, the applicant has to go and develop its package and do some design analysis and finally prepare the safety analysis report, and then submit it to the NRC. Once it is submitted in, there is a quick technical review performed where we look for overall completeness of the safety analysis report and any inconsistencies and glaring deficiencies that might occur. We look at each of the areas.

Before starting that review we usually meet with the applicant briefly and get an overall feel of the design and ask some preliminary questions. I will talk about each of these areas specifically in a little bit more detail.

Then confirmatory calculations are performed, and from these various activities there may be questions that are sent back to the applicant for clarification, more information and so forth. The safety analysis report is then revised.

MR. KERR: It would be inconceivable not to send some questions back, I assume?

MR. HAUGHNEY: I would say it's conceivable, but highly unlikely. We haven't had that experience thus far.

MR. FISCHER: We have only had it once in the transportation area out of tens of safety analysis reports. Unfortunately, it turns out usually there are questions. We only generate questions if there are safety concerns, by the way.

This all kind of culminates with the safety evaluation report which then is followed by the rulemaking and the issuance of the certificate.

[Slide.]

This is the meeting with the applicant. The applicant described their design. Even though we look at the safety analysis report, some of the times there are vague parts in the design. At this time we ask initial questions with them, and we try to become familiar with the package and try to get an idea of what their overall design philosophy is and approach, which they may not put very clearly in the safety analysis report.

At this point in time people get to know each other a bit so that as the review goes on we can at least attach a face with a name and so forth. That's the way things kind of start out and get the ball rolling.

MR. WARD: At this point is there just a design on paper or typically has a prototype been built?

MR. FISCHER: Typically what has happened is the safety analysis report has already been submitted. John and his people have looked at it to see if it's at least good enough quality to pass on to Livermore.

MR. WARD: I do not mean the --

MR. FISCHER: The do not pass safety analysis reports on to us that are --

MR. WARD: I mean the cask itself, typically would there have been a prototype cask built at this point?

MR. FISCHER: Usually vendors or applicants do things in parallel, yes. In fact, that's one of the reasons we do have difficulties later on downstream. They may have the entire cask built and basket and so forth, and then they find out that the safety analysis report turns up some deficiencies. Then they have to go in and modify and scrap, yes. Some of the times it's very difficult. They choose to do that. They go at risk, and they know they are at risk.

MR. WARD: But there's a pretty good precedent for modifications being made at that point if they are necessary?

MR. FISCHER: In order to get certified they would have to make modifications in some cases, yes, or else they will not get certified.

MR. KERR: I notice that one of the requirements for the CSAR is that it must be sufficiently detailed so that reactor fuel can be stored at the reactor site in harmony with the health and safety of the public. I was struck by that phrase. Is that in keeping with the new kinder and gentler Administration that we now have, because --

MR. FISCHER: I think that may be a little bit poetic.

MR. KERR: Previously we talked about undue risk to the health and safety of the public and now we are doing this requirement. I rather like that phraseology.

MR. FISCHER: I think we are being more poetic.

MR. KERR: I think it's worthy of note.

MR. FISCHER: Okay.

MR. WARD: Let me go back to the hardware again. Is a typical reviewer going to look at the cask that is built since it probably has been built and take advantage of that, or is he going to be satisfied with the design on paper for it?

MR. FISCHER: We haven't gone out to the site yet, but John's people have gone out and seen some of them. We have seen photographs though of the actual fabricated hardware.

MR. ROBERTS: You will notice on that videotape that Fred showed that they mentioned the shielding on the Castor V/21. We did subsequent to that testing -- there were modifications to that. This involved the head and foot piece Cobalt 60 gamma, so that the final design was a modified design.

I can think of a couple of the other designs like the TN-24 and the Westinghouse MC-10, there were significant basket changes as a result of our analyses for structural reasons.

MR. WARD: Is that as a result of the analysis or results of the -- the video showed us some tests --

MR. ROBERTS: The Castor V/21 was clear cut test results. We had the radiation spikes that we could see. The others were probably more a result of our analysis and the disagreement on the use of -- it was originally the Westinghouse MC-10 basket -- if I recall correctly it was originally aluminum basket and structural analysis showed that it was not satisfactory. I think that would have been true under both normal and accident conditions for the materials used.

I am kind of going back in my memory and this is several years, but the TN-24 basket was also modified. Part of this is the results of tests we can see. A lot of times though it works the other way. The tests confirms things like the thermal analysis approach and things like that. So, a lot of this has been helpful from the point of view of confirming and basically moving towards a better understanding. If you do proceed from a purely analytical point of view then you are constrained, if you will, more conservative because you do not have a prototype to see it in operation.

I think it's fair to say that the industry, DOE demonstrations at Idaho and so forth have been helpful. In the H.B. Robinson data gathered subsequently it was helpful in terms of the OCONEE licensing I think.

MR. WARD: Okay, but the process doesn't require prototype testing.

MR. ROBERTS: No, it does not require prototype testing. Let me make a caveat there. If we came across something 'here somebody was trying to prove something in t: design and analytically we could not resolve it, we might have to say go to testing. This is, I think, the thing that transportation has somewhat fallen into with larger casks on the transportation area.

MR. FISCHER: We will discuss this a little bit more later near the end of the presentation -- not this one but the one at the end of this whole presentation. That is a safety margin area that we were talking about that we want to discuss a little bit more.

[Slide.]

When we do the technical review, of course, the entire safety analysis report is reviewed. Most of the reviewers, independent of their discipline, will read through the entire safety analysis report in order to make sure that it is consistent, integrated, and it interfaces with their area of expertise and their discipline. First of all we have developed questions to correct inconsistencies, we try to assure that all data is there if we are going to do a confirmatory analysis if a confirmatory analysis is required.

We want to make sure there is enough data so that we can do that independent analysis. We identify areas of concern based upon our experience and previous analysis. This then can be summarized and sent as a package of questions which we send out to John, he reviews those and so forth prior to sending them on to the applicant.

[Slide.]

Once we have enough information we go on ahead and do a confirmatory analysis. It is usually done in these five different areas unless they have done an exceptional job, but even in criticality we always do an independent review there. We independently evaluate the safety margins.

MR. KERR: You said that you were going to talk about safety margins more in detail later on?

MR. FISCHER: Yes.

MR. KERR: I am curious --

MR. FISCHER: Some of the concerns there and what we see happening.

MR. KERR: Margins compared to what?

MR. FISCHER: You can come up with a very realistic design that is based on nominal conditions that says it meets the regulatory requirements, whereas from a conservative point of view you would have to say you have to at least look at the bounding case.

MR. KERR: We are talking about safety now, and this assumes that you have some sort of goal as to what safety is. Now you have a margin, and I wondered what your benchmark for safety is from which you extract the margin.

MR. FISCHER: Okay, let's take a structural analysis, structural integrity --

MR. KERR: No, I am talking now about safety and not structure, some safety goal inherent when you talk about margins.

MR. FISCHER: The safety goals are expressed in terms of radiological limits. Of course, you want to stay within those radiological limits.

MR. KERR: But you can't really tell what effect structure is going to have on those radiological if it's a slight change of structure.

MR. FISCHER: That's correct. Obviously, if the structure doesn't conform you have a high confidence that--

MR. KERR: Instead of safety margins you are really, I think, talking about margins in various aspects of things that you think finally will contribute to safety. You are talking about structural margins and dose margins.

MR. FISCHER: Yes.

MR. KERR: Those really aren't safety margins.

MR. HAUGHNEY: It's probably better to call them design margins.

MR. KERR: I would think so.

MR. FISCHER: Design margin would be a better word. We call them safety margin when we are doing structures, but you are correct, they are design margins and not safety margins -- not nuclear safety margins -- it would be structure safety margins. I think design margins would be a better terminology.

MR. KERR: If they are structural margins, whether they have any influence on safety, it has to require further analysis.

MR. FISCHER: That's correct. We will call them design margins. I think that would be better.

[Slide.]

We try to be conservative when we do a confirmatory analysis, but we still try to be realistic. Obviously, it can be so conservative that nothing can pass if you try to be too conservative. The safety evaluation, the documents and review process itself and the results -- it summarizes the technical highlights, praises the technical information conclusions. If there are any discrepancies between what the applicant's design calculations say and what we do, we will document that. One of the main reasons why is, if they use an incorrect procedure we want to highlight it because we don't want them to repeat it again. Other people read their safety analysis report and think that they have done it correctly, and they will do it the same way.

We would like to make sure that people understand that we may disagree with an analytical method that is used or technique used. We identify limitations and restrictions, and it provides a reasonable assurance that casks can be certified or license issued.

[Slide.]

The certificate or license is the final step in this process, and it provides limits on a quantity and type of radioactive material to be stored and also the limits and requirements on operation, inspection and maintenance, quality assurance and decommissioning of the cask.

Are there any questions? This is the end of this part of the presentation.

MR. KERR: Questions, Mr. Ward?

MR. WARD: No.

MR. KERR: I have no questions yet.

MR. FISCHER: Roger Carlson will now speak.

MR. CARLSON: My name is Roger Carlson. I am with Nuclear Systems Safety Program at Lawrence Livermore National Laboratory. I am going to talk today about the evaluations that we perform as part of the technical review, specifically the confirmatory calculations that Larry mentioned in his talk.

[Slide.]

The first set of evaluations that I am going to talk about are the evaluations for the normal conditions of storage. The limits that we are working to primarily are the limitations that requires that the fuel has to remain in tact during the storage process so that it is removable at the conclusion of the storage for transfer to a transport cask or for transfer to any other operation that wants to be performed on that fuel. I will talk for a few minutes about the radiation limits and the confinement limitations that we place upon the casks that we review.

[Slide.]

The most important part of this first discussion here of the reviews is diffusion controlled cavity growth. We went through a few years ago, a careful review of all of the mechanisms that were possible for affecting clad integrity during high temperature dry storage of spent fuel. The conclusion that was drawn at that time and which remains valid, is that the limiting process for degradation of fuel rod cladding integrity is diffusion controlled cavity growth.

This is a process where small imperfections in the clad that are developed during irradiation can diffuse during the storage process and degrade the ability of the cladding to maintain confinement of the fission products and the fission product gases that are contained within the fuel clads.

This mechanism results in a limitation on the peak fuel temperature that can be tolerated by the cladding during dry storage of spent fuel, and that limiting temperature is dependent upon the internal pressure within that fuel rod at the time of storage which then is related backward in time to the initial pressurization within that fuel rod and, also, the operating history of that fuel rod as a result of the production of gases during the irradiation which combines with the initial pressurization to produce the pressure that is produced at the end of the radiation period.

MR. KERR: That assumes some sort of time for the fuel to be in storage I assume, because the degradation is something that takes place over time.

MR. CARLSON: Right.

MR. KERR: Does that assume that the fuel will be in storage 20 years or ten or 30, that temperature limit?

MR. CARLSON: The recollection that I have right now without looking up the specific numbers is, it presumes that the fuel was in storage for 20 years.

MR. KERR: You can relicense the cask but you can't necessarily relicense the fuel; is that --

MR. CARLSON: During those 20 years in storage the energy that is being released as a result of the decay of the fission products is going to have dropped off considerably --

MR. KERR: Of course, but the total degradation takes place over time, whatever temperature you have.

MR. CARLSON: Right.

MR. KERR: If you have geared this thing for a 20 year life, there's not --

MR. CARLSON: Let me back up for a minute here. Implied within what we are talking about right now is essentially the assumption that the fuel clad temperature is staying constant during that storage period.

MR. KERR: Really?

MR. CARLSON: The limitation comes about --

MR. KERR: Why would you make an assumption like that?

MR. CARLSON: It gives us a reasonable bounding case.

MR. KERR: It gives you a bounding case, I can't see that it's reasonable.

MR. FISCHER: That was the original position we took, was the constant temperature. As you pointed out, that is not reasonable and we started to reject applications and was not a reasonable one. They do allow for the temperature to go down with the decay of the fuel. We look at it for 20 years, and during the recertification process it would then have to be extended. It is likely it would make it because of the nature of the decay process and so forth, and dropping temperature.

I think it has been thoroughly checked on out for 40 and 50 years, and it might be a good idea to see if the process can continue.

MR. KERR: Incidentally, I noticed that the definition of decay heat given in the text is the heat generated by radioactive decay of fission products. That assumes that you do not take into account the decay of other radioactive material in the fuel which is a small contribution, I suppose.

MR. FISCHER: No. It includes the actinide, and the actinide become the predominant heat source after about ten or 20 years.

MR. KERR: Okay, you probably ought to change the definition given on page 1-2, because it says fission products.

MR. FISCHER: It does include the actinide also.

MR. CARLSON: Decay heat has been benchmarked against experimental data that measures all of the heat being released from a fuel assembly, so it has to include everything.

MR. KERR: I was just quibbling about the English language which is sometimes a poor median for communication, especially if it is not used carefully.

MR. CARLSON: Another point that I would like to make with regard to this point here about recertification of a cask with regard to the fusion control cavity growth, the limiting temperature that we are looking at when we review a cask is the clad temperature of the hottest fuel rod. A substantial component of that temperature is the contribution to that temperature that comes from the transfer of heat from all of the other assemblies in that cask through the same heat flow pass to the outside environment.

So that, as the amount of heat that is being released by these fuel assemblies is reduced, that peak fuel temperature is going to come down dramatically over the life of the cask. What we are looking at when we review an application is the peak fuel temperature at the beginning of the storage period, presuming that all the fuel assemblies are producing their maximum amount of heat. When we get to a recertification process the peak fuel temperature will be dramatically lower.

MR. KERR: You don't assume that the peak temperature is constant throughout the 20 years, apparently?

MR. CARLSON: From the point of view of looking at an application for certification we look at it only at the beginning of the storage period.

MR. KERR: Then I completely misunderstood Mr. Fischer, I guess.

MR. CARLSON: From the point of view of looking at the limitation -- from the development of the limitation we are doing what Larry has said.

MR. KERR: Okay.

MR. CARLSON: Am I saying things to confuse you? I am not trying to. We have two things that are going on here. One is the development of the foundation for the limitation and the other is the analysis that we do to decide whether we have satisfied that limit.

MR. KERR: Please continue.

MR. WARD: Is this degradation process, the cavity growth, is that a function of the temperature of the cladding?

MR. CARLSON: It's a function of the temperature of the cladding and it's a function of the pressure.

MR. WARD: The cavity growth itself?

MR. CARLSON: Yes. The diffusion of the cavities.

MR. WARD: Yes.

MR. CARLSON: It's a diffusion process where the cavity --

MR. WARD: In effect what that does is reduce the strength of the cladding; is that right?

MR. CARLSON: Yes.

MR. WARD: I can see where the pressure and the temperature cause -- the stress in the cladding is related to the temperature and pressure, but is the strength of the cladding relate to those also?

MR. CARLSON: The effective strength of the cladding is also related to the pressure, yes.

MR. WARD: For long term storage you have sort of a race between the decreasing stress and the decreasing strength, and I guess you have satisfied yourself that it is good for 20 years. It seems like you really have to look at -- do you understand the shape of those two curves all the way? I am puzzling I guess over the same thing Dr. Kerr is, why there isn't a clearer picture of --

MR. FISCHER: I believe I can answer that best. Yes, we do characterize that curve and we have it documented in a UCID report which is referenced in the SRP. John has passed out copies of that curve. It is actually a little computer code that has been developed at Livermore so you can compute the damage that is done to the shield over the 20 year period of time, given initial temperature and the decay characteristics of the fuel and the temperature that follows that and pressure and so forth.

That is all accounted for actually in a computer code which -- with a rather meager data benchmark. They are doing additional research in this area. I must point out that people feel that we are too conservative. Given the state of knowledge today we are going forward with what we do have, and that might change once some of the conservatisms taken out.

MR. WARD: The problem apparently is not so much that it's not calculable but to validate and verify the calculations that's --

MR. FISCHER: That's correct. Validation at this point in time, the main criticism is that we are too conservative. There is not adequate data to reduce that conservatism.

MR. KERR: But they are open to new ideas all the time.

MR. CARLSON: New ideas and new data.

MR. KERR: Please continue.

MR. FISCHER: I was going to say that I believe EPRI is going ahead on this, but that's in the industry research.

[Slide.]

MR. CARLSON: Switching to the radiation area. The acceptance criteria that we use for normal storage --

MR. WARD: Roger, I'm sorry. Before you go on, are you going to talk -- back to the thermal performance. Are you going to talk about how this relates to when you have an assembly that you known leaking pins. Somebody said earlier that those can go in a special can that goes inside this cask. Then the heat transfer becomes different. How is that dealt with? Are you going to talk about that, or is that just --

MR. CARLSON: The easy answer is no, I am not going to talk about that.

MR. WARD: Okay.

MR. CARLSON: If you would like me to talk about that, I will.

MR. WARD: Maybe just quickly, how are assemblies with known leaking pins dealt with in this whole process?

MR. CARLSON: Within the reviews that I am aware of that we have done at Livermore, we have not reviewed any of the casks for storage of assemblies that had leakers which required that the leaking fuel assembly be put in the same can before it was put into the cask. If that was to be done the mechanics of doing that heat transfer analysis are a relatively minor extension of the analysis that we are doing currently.

We have a computer program that calculates the heat transfer within the fuel assembly that tells us the temperature of the hottest fuel rod relative to the temperature of that can. Then we would put into our model of the basket, the existence of that can and the gaps between that can and the basket that surrounded it. In our model we would have already represented that basket.

MR. WARD: If I look at this -- this is a certificate that we pass out, right?

MR. CARLSON: Right.

MR. WARD: Does this say they can't store assemblies that are in cans?

MR. CARLSON: I would have to defer to John.

MR. ROBERTS: Yes. I think -- I forget the exact part of the tech spec there, but there is a fuel known to be defective there is a condition in there. I might also add that the --

MR. WARD: What does it say about fuel known to be defective?

MR. ROBERTS: You should not store it.

MR. WARD: Okay, that's a problem to be dealt with in the future somehow.

MR. ROBERTS: Yes. There is no point in assuming that problem for these. One other point that I would make.

Where you have a pinhole leak the rod has essentially depressurized to the existing pressure. This mechanism that he is talking about, there is no pressure mechanism so it doesn't apply. Actually, a fuel rod with a pinhole leak is the one that has no problem at all essentially if you follow me, because there is no stress -- internal stress --

MR. WARD: I can see it, if the leak is --

MR. ROBERTS: You are dealing with helium as your inert atmosphere, so there is no degradation.

MR. WARD: Okay, but you haven't credited that problem.

MR. ROBERTS: No, we haven't taken credit for that.

MR. WARD: Right now you are saying they can't put them in.

MR. ROBERTS: That's right.

MR. WARD: Perhaps if somebody says gee, I have a whole bunch of assemblies with leakers they will have to come back to you. Is there a process here?

MR. ROBERTS: Realistically if you were a utility and you had fuel and you had no history that suggested these were leakers, you are still going to presumably have some pinhole leakers in there.

MR. WARD: Yes.

MR. ROBERTS: I am saying that we also know that it makes no difference. If that fuel rod has a pinhole leak in it, it is actually less prone to this problem that we have just outlined. It will simply not -- there is no mechanism for degradation.

MR. WARD: Okay, why don't you say in this certificate then that it's okay to put in --

MR. ROBERTS: Because somebody -- if somebody sees that they have fuel that has suffered physical damage to the assembly and so forth we don't want to put that in there, particularly if you know there is something technically --

MR. WARD: You are differentiating between --

MR. ROBERTS: Pinhole leak type that you could --

MR. WARD: Got in a lot of bundles statistically --

MR. ROBERTS: Yes, and stuff that has suffered real degradation where somebody has broken the cladding or something, we don't want to put that in there and basically if you will, cause -- it doesn't facilitate the handling of the fuel, let's put it that way.

MR. WARD: Thank you.

[Slide.]

MR. CARLSON: Moving on to the radiation acceptance criteria. The first part here is a repeat of what Fritz said earlier this morning, with the specific reference to the paragraph in 10 CFR .72, annual dose to an individual who is located at or beyond the controlled area has to be less than 25 MREM to the whole body and 75 MREM to a specific organ, to the thyroid and 25 MREM to any other organ. This limit includes direct radiation from the spent fuel storage that we are dealing with, it includes any dose to any gaseous activity that is released from the fuel that we are storing, and it includes any other nuclear facilities at that site.

MR. KERR: The review actually requires that the calculated dose be less than that, doesn't it?

MR. CARLSON: The review that we do requires that these two both be calculated, yes. If we are doing a topical safety analysis report, one that is generic to a large number of facilities, the typical limit -- and I have this on the next slide -- is that we tend to limit this to something like ten percent of these numbers so that we have room -- so that there is room for this --

MR. KERR: The point I was making, however, is that you actually in the review process are talking about a calculated dose which is probably a conservative calculation, so that the actual dose will probably be less.

MR. CARLSON: Exactly. We do our darndest to make sure it is a conservative --

MR. KERR: Now, 10 CFR 72 just requires that the dose be less than that, doesn't it?

MR. CARLSON: Right. We work very hard to make sure the calculation is conservative.

[Slide.]

I threw this in here, the flux to dose conversion factors are from one of the --

MR. KERR: How conservative do you work hard to make it be, a factor of two, ten?

MR. CARLSON: I don't think I can quantify that.

MR. KERR: Then you must not have worked very hard.

MR. CARLSON: We have worked very hard. The reason why I can't quantify it is because conservatisms build upon conservatisms. We allow that to happen to some extent.

Typical approach. This is not typical, this is not a limit that we enforce. The applicant usually restricts their surface dose at the cask to something around transportation limits. Transportation limits are 10 MR per hour at a meter from the surface of the cask. That is not a verbatim quote of the transportation limits, that's a rephrased -- that is a little bit conservative in there.

We usually restrict the dose at the site boundary or at the 100 meter radius to ten percent of the limit to allow for other facilities. This is one area where I find it very difficult to quantify our conservatism. When an applicant or a utility says that they are go to put an earth berm around their storage facility to restrict or reduce the amount of direct radiation from the storage facility to their site boundary, then sky-shine becomes important which is where radiation is scattered by the atmosphere down to the simulated person at the site boundary.

This is a very difficult calculation to do accurately, because it is a de-penetration problem for radiation. There is a lot of conservatism that is built into this calculation just because the numerical characterization of that problem is extremely difficult to --

MR. KERR: I puzzled that it's so difficult, because it certainly has to be done for BWR's all the time since that is an i portant contributors to BWR's to off site dose.

MR. CARLSON: Yes. It's important there and it's important here, it is still difficult.

MR. KERR: It is more difficult than calculating the neutron dose from these things? I can't believe it.

MR. CARLSON: Yes. I am talking about usually gamma that have got to go what, something over 100 meters in air --

MR. KERR: Most of the contribution comes from single scatter.

MR. CARLSON: Single scatter, right, in air.

MR. KERR: That's not a very --

MR. CARLSON: With build up.

MR. KERR: You don't get much build up on single scatter. Go ahead

MR. CARLSON: This last point here is another area where there is conservatism built in, and that is in the rate of placement of these casks at a facility. We are looking at the Prairie Island safety report right now. When they get approval they are going to put about six or so casks on their pad within the first year, and from thereafter they are going to put out one to two casks a year until they get up to the 48 that they are asking permission to put out there.

By the time that they get to the end of that process the casks that were placed out in the facility at the beginning are going to have approximately 20 more years cooling time. In the calculation of the dose at the site boundary, that additional 20 years of cooling time will make a significant difference on those initial casks.

If we were to go and assume that they were all out there with minimum cool time fuel, that we would predict those would be a great deal higher. That's simply an example of one of the conservatisms that we have built into our analysis or that we have to control within our analysis.

MR. KERR: I can see that is important to a specific site but I don't see how you take that into account in licensing a prototypical cask.

MR. CARLSON: It's an area where we always have to have discussions with the applicant to try and identify a sequence for putting the --

MR. KERR: This makes the licensing process very site-specific.

MR. CARLSON: And, when we are dealing with a topical safety analysis report we have to talk to the applicant and --

MR. KERR: You don't really. All you have to do is to say look you guys, you have to recognize that no matter how many casks you put on here you can't exceed these limits, and then it's up to him to determine in what sequence he does it. I thought that this was an effort to be as site independent as possible. Now you are telling me that this licensing business has to be very site specific.

If an applicant is going to put 20 casks on a site immediately and license a cask in one way and if he is just going to put one or two, it's a different ball game.

MR. CARLSON: The information that we have to get from the applicant is what is he going to tell the utility that wants to use his casks are the limits or the philosophy that they may use in placing those casks on their --

MR. KERR: I am not disagreeing with the fact that you eventually at some point need to know that for a specific site, it just seems to me that you are making the licensing process very site specific if you do it that way.

MR. CARLSON: We are getting into, as John was saying over here, we are getting into a mixture of site specific licensing and topical licensing.

MR. KERR: Well, it seems to me that this particular thing is very site specific, it's not very generic at all.

MR. CARLSON: Yes. The details have to be, yes.

[Slide.]

Pushing on, I would like to say that there is a reversal of pages here. We took out page 43 and going to 45 and then coming back to 44. That should have been taken care of in all the copies that were distributed at the back of the room.

Talking about confinement here, this is essentially a duplicate of the previous slide that talked about radiation to emphasize that this is a part of the radiation limits at the site boundary. The typical approach that we find applicants following is to restrict their release rates to the release rates that are allowed within the transportation requirements. We recognize that the releases from a storage cask are primarily the helium filled gas and not fission product gases. Note there that the helium filled gas is -- the pressure of the helium filled gas is a quantity that is monitored on a regular basis after a cask has been placed out at the storage site.

[Slide.]

On this next slide we have a typographical error that has again been fixed in the back of the room. This word down here is plum but is now fixed to read plume. Both of them passed the word processor spell checker.

This is a brief list of the assumptions that are used in the confinement analysis. We had talked about before, there is an assumption of the number of fuel rod cladding tubes that have failed, to provide a bound or definition of what is to be assumed for normal operation.

MR. KERR: Now, Reg Guide 1.25 refers to releases during accidents. So, it doesn't take account the normal storage condition situation release, does it?

MR. CARLSON: No, but we have to have something.

MR. KERR: I am sure you have to have something, but I don't see why the something has to be something that doesn't make sense.

MR. CARLSON: Larry wants to state something.

MR. FISCHER: I think we need to clarify that only one percent of the fuel is assumed to have failed. Assuming that one percent has failed, the release fractions of the releasable radioisotopes then becomes those given in Reg Guide 1.25; that is for xenon and so forth. Of course, if this failure occurs during normal storage we assume that amount of xenon is released for that particular rods for one percent of the rods.

MR. KERR: I understand the process.

MR. FISCHER: It's like 30 percent of the xenon or krypton is assumed to come out following Reg Guide 1.25, but it would only be for one percent of the rods and not 100 percent.

MR. KERR: I am just a little puzzled that you would refer to Reg Guide 1.25 for normal operation when, presumably, it has something in it about accidents.

MR. FISCHER: Yes, I understand.

[Slide.]

MR. CARLSON: We also take a quick look at decommissioning, principally to make sure that the cask itself is not going to become activated during the normal life of that particular cask. When we are dealing with a cask that weighs some 200,000 pounds it is hard to imaging having to put shielding around that in order to ship it off site when you have to decommission the facility.

The site itself, essentially we don't worry about it because it will be governed by the surveys for the radioactivity.

[Slide.]

I stick up here a slide that talks about the summary of normal storage conditions. Basically what I am trying to say here is that the limiting condition for normal storage is usually the heat transfer; that the assurance that the fuel rod temperatures do not exceed the limit for diffusion control cavity growth is usually the most difficult part of the design of a cask and then of our evaluation of that design for normal operation. The shielding, the radiation is not a severe problem and the confinement is not usually a severe problem.

[Slide.]

Moving along to accidents --

MR. HAUGHNEY: Excuse me, Mr. Carlson. Mr. Chairman, I have to apologize. Looking at our progress on this presentation, I would say we are about 45 to 50 minutes behind our planned schedule. We did allow time for assumed questions and answers. Although we were less behind at the first half, we have been slipping a bit. If you can indulge us, I propose that we keep going.

MR. KERR: I can indulge you, but I am not sure about my colleague who has another meeting this afternoon. What time is your meeting?

MR. WARD: It's been cancelled.

MR. KERR: Okay then, we have time for indulgence.

MR. HAUGHNEY: Okay, thank you, sir.

MR. KERR: Indulgence is for sale --

MR. HAUGHNEY: We have to be aware of the conflict of interest thing.

MR. KERR: Please continue, Mr. Carlson, before this gets out of hand.

MR. CARLSON: Thank you.

[Slide.]

Talking about the accidents now. I start off with the free fall accidents. The requirements that are placed upon the consequences of a free fall accident are that there be no loss of confinement, there will be maintenance of the shielding integrity. Following a free fall the package, the cask, shall maintain the shielding of the fuel that is inside it. There shall be no loss of criticality control and no reduction in the heat removal capacity of the particular cask.

When we first started looking at storage casks, the free fall accident we looked at as a side drop, based upon the operation that the cask was transported from the fuel handling building out to the storage site on a flat bed truck in a horizontal configuration. Since that time the principal mode of operation has changed to be a vertical orientation in transport, as you saw in Fritz's slide from the VEPCO operation, where the cask is transported in the hauler that is essentially a wheeled support structure and the cask is transported vertically.

The free fall accident that we look at now is a vertical fall usually for a short distance, 15 to 18 inches, and that the distance that we have used in that free fall analysis which the applicant supplies first because they have done the initial calculations and we are doing confirmatory calculations, becomes a limitation on the operation of that cask. We will put in --

MR. KERR: When you talk about a free fall, you are talking about a free fall from a vertical position.

MR. CARLSON: From a vertical position.

MR. KERR: You assume the thing tips over in some fashion from the vertical?

MR. CARLSON: No. We do two separate accidents now. We will get to the tip over in a half a minute. For the free fall accident that I am talking about right now, we call that an end drop, and we are presuming that the cask starts in a vertical orientation and simply drops downward by 15 to 18 inches, hits an essentially unyielding surface and comes to rest.

MR. KERR: I thought this was based on some sort of physical assumption about the way in which it is transported?

MR. CARLSON: And, that is based on --

MR. KERR: You assume that some robot comes along and lifts it up and then drops it?

MR. CARLSON: The robot is the operators that are transporting this cask from the fuel building out to the --

MR. KERR: I am just trying to think of some mechanism that could lead to a free fall in a vertical position under those circumstances.

MR. CARLSON: Fritz, do you have the picture of the transporter that was used at VEPCO?

MR. KERR: I saw the picture of the transporter.

MR. CARLSON: It is transported in a vertical orientation, and if the grappling mechanism that is grabbing onto the transience on the top of this cask happen to somehow fail, it could fall.

MR. KERR: Okay, your imagination is better than mine. You have thought about it more, so go ahead.

MR. CARLSON: We have pictures of that transporter that we can show you.

MR. KERR: I just didn't see any picture that would indicate to me that you could get a free fall of 10, 12 or 18 inches in a vertical position. My imagination is not very well developed today. Go ahead.

MR. CARLSON: Once we have looked at the free fall accident and that is over and one with, and then we separately go and say we are going to look at a tip over accident which is a different event, unrelated to the free fall accident. Essentially this is an accident that is there as the limiting structural event to make sure that the basket has sufficient strength to support the fuel assemblies.

MR. KERR: Which is more difficult to achieve? What is more of a challenge to the container, the free fall or the tip over, or maybe there is no answer to that question.

MR. CARLSON: They are independent. The one is essentially a sideways loading and the other is an end loading.

MR. KERR: I know they are independent, but one of them might cause more damage than the other, and that's what I am asking.

MR. CARLSON: That's design dependent. That is design dependent. There are some designs where the tip over accident is more severe and there are other designs where the end drop is more severe. I can't give you a general answer.

We definitely want to look at a tip over accident to make sure that we have looked at the transverse loading and the longitudinal loading on the basket to make sure that the basket has sufficient strength in both loading mechanisms.

MR. WARD: Normal handling of the cask once it has fuel in it, is always in the vertical position; is that right?

MR. CARLSON: Normal handling is in the vertical position.

MR. WARD: I am going back to the tape that we saw that showed casks going from vertical to horizontal and vice versa, but that was just for the tests.

MR. HAUGHNEY: I think that was the transportation casks. Remember, it had gone from the site to Idaho. It had gone from the reactor site, so it had to be able to be configured in a variety of orientations.

MR. CARLSON: The other time in the video that we saw a cask being up ended was when it was first arriving at the facility and they were unpacking it and standing it up.

MR. WARD: It was just am empty cask.

MR. CARLSON: It was just empty, yes.

MR. FISCHER: During normal operation the cask is also analyzed for horizontal position, only as precautionary in case somebody puts it in a horizontal position we want to make sure there is no problem. So, it is looked at horizontally for normal conditions also, structurally and thermally.

MR. KERR: You mean, tip over and fall is looked at?

MR. FISCHER: No. Tip over an fall is accident. He was referring to normal --

MR. KERR: If it were --

MR. FISCHER: Yes, it is looked at for normal conditions in a horizontal condition in an event that an error is made. For a vertical drop that could be accounted to an operator error where he pushes the wrong button and drops the cask during transport or handling.

MR. WARD: The last item there, ability to remove fuel as part of recovery, that is presumably after it is made vertical again; is that right?

MR. CARLSON: That's correct. After cask is tipped over and the accident has come to an end, then the recovery process involves getting the transporter out to the accident site and up ending it and then getting it back to the fuel building and being able to remove that fuel, essentially unimpeded by substantial mechanical deformations within the basket.

MR. KERR: When you talk about no loss of confinement and no loss of heat removal capability at least as a safety requirement, that must assume that those things were right on the ragged edge to begin with and that any loss will now make a cask unsafe.

MR. CARLSON: The fundamental assumption that we are making there is more to the point that we don't know when this accident is going to occur. We have to assume that it is going to occur at the worst point in time as far as the initial conditions are concerned. If you want to characterize that as being right on the ragged edge, I wouldn't.

MR. KERR: I mean, suppose the confinement was twice as good as it turns out, as it needed to be. If you have a requirement that there be no loss of confinement your really going beyond -- at least on first impression -- going beyond a safety question and saying the thing has to be so massive and so strong that no matter if it's way over designed it can't suffer any damage at all.

MR. WARD: You say no loss of heat removal capability, your limit is 380 degrees centigrade. Let's say in normal operation it is sitting there and the peak temperature is 250. It tips over and you calculate that it goes up to 300. That is a loss of heat removal capability, but you still haven't exceeded the 380. Which do you mean; do you mean no loss or do you mean just so that you don't exceed the limit?

MR. CARLSON: We mean no loss. We are not anticipating -- once we have done our analysis we are not anticipating that temperature is substantially going up at all.

MR. FISCHER: What we are doing is looking at the ideal case where you are not going to have to go in and look at any damage to that cask. If you can show you can survive all of this without any heat loss, then hopefully you can just turn the cask right up and leave it there on the pad.

Now, that may not occur and may still want to take it in after people say it's tipped over and they want to look at it. The analysis would not require you if you meet this requirement to take it in necessarily if you show that the cask can be tipped over and everything is okay, you may pull -- let's say it's an earthquake and you may knock down 20 casks you may select to take in one and do an inspection. If it looks okay and if you have already analyzed it and said it was going to be okay, the other 19 casks don't have to be taken back in.

I think it is maybe a conservative philosophy, but it's one where you are trying to minimize the handling of these casks in the fuel assemblies.

MR. WARD: For some reason I am not connecting here. This is all just an analysis. There isn't any accident that occurred, this is just analysis. Let's take the example that you have analyzed the casks for certain bundles in it and you calculate the normal vertical position, the heat clad temperature and there's going to be 250 degrees. Then you analyze it after it is tipped over, and you find that the temperature you calculate is a little bit higher, 300 degrees.

Is that acceptable or not acceptable?

MR. CARLSON: That is not acceptable.

MR. ROBERTS: Wait a minute. Larry just pointed out that we do already analyze the horizontal orientation, so that is taken into account. You are still not above what you have analyzed.

MR. KERR: If you have a tip over accident and you have a finned cask, the thing that is most likely to deal with the heat removal capability it seems to me is bending those fins. You can bend the fins a little bit or a lot, and a little bit is probably not going to interfere with much. It will decrease the heat removal capability a little. I gather that is unacceptable, which means that those fins have to be strong enough so that they will withstand --

MR. ROBERTS: No.

MR. KERR: They don't?

MR. ROBERTS: No. The thermal inertia of these casks is sufficiently -- I think we are talking in the neighborhood of 12 to 24 hours. You are going to be out there presumably upriding these casks long before --

MR. KERR: No, I am not talking about whether it is upright or vertical, I am talking about you are going to bang these fins enough so that they are pushed together or not as capable of removing heat as they were before.

MR. ROBERTS: If that were the case in that specific design where it is depending on the fins, I think the Westinghouse MC-10 was probably the most of an example of those large fins. Then you would take the cask in and remove the fuel or, if you knew the age of the fuel --

MR. KERR: But this says I think that the design has to be such that those fins can't be damaged at all in this tip over.

MR. ROBERTS: That's not the intent.

MR. KERR: Well, that English up there is misleading.

MR. FISCHER: How about if we change it to no significant loss, though that's a little bit vague. It might answer the question. Obviously, we would not toss out a design that could have minor damage, that is correct.

MR. KERR: I would hope not.

MR. FISCHER: Yes, we would not. We will change that to no significant loss. Perhaps all of these should be modified as no significant loss except maybe criticality control. We still may say no loss on that one.

MR. WARD: I'm sorry, I still don't understand it. It seems to me you have a limit on both criticality of .95, you have a limit of heat transfer of 380 degrees. Are you saying that as long as you don't see either of those you are okay?

MR. FISCHER: That's correct.

MR. WARD: Okay. That's not what the words on the chart say.

MR. FISCHER: That's correct, they need to be changed.

MR. CARLSON: Can I stick up this picture to illustrate the points that we are talking about here a little bit better.

[Slide.]

This is the Castor V/21 I believe it is, in its transporter supported just off the ground by the support mechanisms as it is being transported out to the cask. As far as the heat transfer is concerned, notice that these fins are circumferential fins. In the vertical orientation those fins are not oriented for maximum effectiveness.

When this cask, if it were to somehow tip over, those fins you could stand some crushing of them and the fins, because they are now in a vertical orientation would be more effective. You could stand some loss of the fins and, because they were now changed 90 degrees, they would even be better.

If after you stood this thing back up maybe you will have some problem later on, I don't know. In the accident itself those fins would wind up being more effective than they would --

MR. KERR: Yes, but the problem is that if you really are analyzing this you don't know what is going to happen during the fins during an accident.

MR. CARLSON: Right.

MR. KERR: So, you sort of have to assume that you can't have any damage. If you are really saying no --

MR. CARLSON: Right. Any more questions or comments about the structural accidents?

[No response.]

MR. CARLSON: Confinement. The limits on an accident and then on that talked about the confinement limits on an accident, somehow they are not here.

MR. WARD: The one on fire, too.

MR. CARLSON: There is one on fire too, that's right. I don't know where they are. Maybe they are in the back here.

[Slide.]

A hypothetical fire is one of the accidents that we look at. If we are looking at a topical safety analysis report, we assume that the fire is going to be 30 minutes long and essentially duplicates the transport fire. The acceptance criteria is based upon preventing short term failure of the fuel rods due to over pressurization, overheating the rods and causing the fuel rod clad to fail due to build up or pressure inside.

These conditions here are identical to the transportation fire, identical. If we are looking at a site-specific safety analysis report, we are considering right now limiting the duration of the fire if the applicant can prove that the transport of the cask from the fuel building out through wherever to the storage facility does not pass by or involve close proximity to any fuel sources that are significant, then we would consider limiting the duration of the fire to the fire that could be supported by the fuel that is available.

The picture that Fritz showed earlier you saw a tractor pulling the transport vehicle. That tractor certainly has to have some fuel on board. That would probably become the limiting duration of the fire.

MR. KERR: This is where one would use a 20 mule team instead of --

MR. CARLSON: This is where a 20 mule team become practical, yes. Would we then have to worry about the droppings?

[Laughter.]

MR. WARD: What does that statement about ignore transporter for conservatism mean? I don't understand that.

MR. CARLSON: If I have a fire that is down here around the base, the transporter components are going to serve as lower temperature components right in the vicinity of the cask --

MR. WARD: Heat sinks, you mean.

MR. CARLSON: Yes, heat sinks. The structure up here could also interfere with the natural circulation heat transfer from the flame mechanics. So, if we simply assume that this transporter isn't there, then we don't have any lower temperature heat sinks around to share the fire with the cask. All of the fire heat is being transferred into the cask.

MR. WARD: I think somebody mentioned that the thermal inertia of the whole cask system is 12 hours.

MR. CARLSON: No, it's more than that.

MR. WARD: More than that?

MR. CARLSON: More than that, yes.

MR. WARD: I am surprised that a 30 minute fire has much effect.

MR. CARLSON: It doesn't. You are right, it doesn't.

MR. WARD: When people go to a site specific one, there isn't much incentive probably for somebody to look at a site specific argument here, is there?

MR. CARLSON: That is correct.

[Slide.]

Radiation acceptance criteria is similar to the normal operation -- similar but not identical, in that this is a single event and the dose is limited at the site boundary to 5 REM to the whole body or to any organ. Again, this part of it is the same. The boundary must be at least 100 meters or it's the site boundary. It's the dose that we have to worry about that includes direct radiation and any activity release.

MR. KERR: That turns out probably not to be a very difficult criterion to meet.

MR. CARLSON: That one is not very difficult to meet, I agree.

[Slide.]

When we are worrying about the confinement, these are the assumptions that we throw in here. Again, we had our typographical error here that made this a plum meander instead of a plume meander which we fixed here. We have a study that we did at Livermore where we demonstrated that the fuel assembly essentially would not break up in a fall accident, but for conservatism in the confinement analysis we assume that there is 100 percent tube failure.

MR. KERR: Why?

MR. CARLSON: It's almost why not. This isn't a limiting case. This is usually not something that even comes close to --

MR. KERR: It isn't now, but it might be someday.

I suppose you could change the reg guide if it becomes difficult. You are saying it is not at this point?

MR. CARLSON: Yes.

MR. WARD: On the earlier chart for normal operation you had ten percent --

MR. CARLSON: Yes, ten percent for off normal --

MR. WARD: For off normal events. What is the difference between off normal and what you are assuming here?

MR. CARLSON: Probability of occurrence.

MR. KERR: This is a zero probability occurrence.

MR. CARLSON: Yes. Would you define zero for me?

MR. KERR: The fact that probability of 100 percent of the clad will fail is certainly zero.

MR. CARLSON: Yes.

MR. KERR: I think.

MR. WARD: Yes.

MR. CARLSON: Zero being defined as something less than ten to the minus tenth or something like that.

MR. WARD: I guess my problem is I don't remember how you used the ten percent. What did that apply to?

MR. CARLSON: It was the normal condition.

MR. WARD: But for off normal events. It was one percent for normal storage conditions, ten percent for off normal events--

MR. CARLSON: We basically don't analyze any cases that we consider to be in that off normal event category.

MR. WARD: Okay, so you really don't use that ten percent for anything.

MR. CARLSON: Yes.

MR. WARD: Just cross it off here.

MR. CARLSON: Cross it off.

[Slide.]

To wrap this part of it up, I put up here a summary of our experiences and reactions to the accident conditions. The structural analysis of the basket is usually very an area of large concern, and we have to demonstrate that there are no large deformations and no buckling. We tolerate slight deformations in the shielding. Usually the shielding is not a very substantial problem. The direct radiation dose during an accident is usually small. The shielding is very massive in these casks.

Confinement transport limits are typically applied usually not very much of a problem. Radiation hazard, ich is the combination of these two, usually is not very much of a problem. If there are no more questions about the accident, then I will move on and talk about criticality for my last few minutes before I take us violently past the schedule.

[Slide.]

The fundamental concept that we adhere to in our criticali'ÿ analysis is that subcriticality must be assured and we treat it as a go, no go process. You either win or you don't play the game. The consequences of a criticality accident that are listed here, we feel, are sufficiently severe that they are unacceptable under any conditions, normal conditions, off normal conditions, or accident conditions.

Subcriticality must be assured by either limiting the fissile mass which in general is not practical or by an engineered design, which is the approach that we find used in every cask that we look at.

[Slide.]

Subcriticality safety, the requirement that we have to assure ourself exists is the cask and its contents remain subcritical during all normal operations and all hypothetical accident conditions. The goal that we set is that we would like to see k-effective less than .95 under all conditions. K-effective that we have calculated here must include all uncertainties which includes uncertainty due to convergence, an uncertainty for biases, and any allowances that are appropriate for modeling imprecision.

We make every effort to make the modeling imprecision to be conservative, but if we feel that it is appropriate that there be a correction for that in the other direction then we will apply it.

MR. KERR: Have you thought of any way in which this cask could become filled with water?

MR. CARLSON: Cask is filled with water at the time that it is loaded. Once it has been dried, as Fritz described in the slides at the beginning, vacuum dried and then backfilled with helium, it is our contention basically there is no way that the cask can become refilled with water. Where site specific analysis has been done the site has all been located substantially above 50 year flood plane.

MR. KERR: You are only worried then during loading in a pool.

MR. CARLSON: The only time we are worried is during loading in a pool or unloading in a pool, which is why these criteria are essentially -- which is why we have the criteria on the accident analysis that there be no loss of criticality control. We have to be able to put it back into a pool after that accident to unload.

MR. WARD: In other words, whether the thing stays void of water forever doesn't really matter, does it?

MR. KERR: In terms of criticality.

MR. WARD: In terms of criticality.

MR. CARLSON: In terms of criticality there is going to be -- we have to plan -- let me phrase myself correctly. We have to anticipate that at some point in time at the end of storage these casks will be unloaded in an underwater environment. Whether there has been an accident in between or not, we have to anticipate that the event is going to occur.

[Slide.]

The first slide that I stick up here talks about the bias that we worry about as one of the three areas of convergence. Bias, I defined up here as the difference between a set of calculations that we would do for a critical experiment where we knew the assembly of materials had gone critical and the results of our calculation. If we take an experiment and model it as best we can, that we know it is critical and we get a K of .99, that says hence forth we should consider our calculations to indicate criticality whenever they say K was .99.

It is not that cut and dried though, because it has to be approached on a statistical basis because we are dealing with a computer codes that use Monte Carlo methods, that are inherently statistical. We are dealing with a large number of experiments to evaluate, and we have to approach it statistically.

MR. KERR: What code do you typically use at Livermore?

MR. CARLSON: The answer to that is two codes. We frequently use Keno 5-A which is operational on the IBM mainframe at Oak Ridge National Laboratory, and we use the cross-section librarie. that are available with that at Oak Ridge National Laboratory. We also use the COG code that was developed at Livermore and is operational on our Cray Computers, and we have the cross-section libraries that go with those. Cross-section libraries for COG are essentially ENDF B-5 data files. COG is a point-wise code that essentially doesn't require any group collapsing of the cross-section. It goes right from the ENDF libraries. Those are the two codes that we typically use for criticality reviews.

MR. KERR: Thank you.

[Slide.]

MR. CARLSON: I said up here biases of function of the materials because the neutron reaction rates that we are calculating are dependent on the spectrum. It would not be appropriate to use as a bias ..mparison between calculations and experiment for some small fast critical experiment when we are trying to represent a cask that has 40 fuel assemblies in it and it is 12 feet in diameter and things like that We look very carefully to make sure that our experiment and our case that we are evaluating are comparable.

MR. KERR: As long as you don't go any farther than critical say .95, you don't have to worry too much about the cross-sections changing with subcriticality.

MR. CARLSON: Right. But we do have to worry about the cross-sections changing from one case to another. I am going to talk in a moment about missed calculations, where we do calculations with varying amounts of water clear down to relative humidity in the air. The cross-section set we use there should be different from the cross-section we would use for a case that is fully loaded with water and likewise the biases should be different.

[Slide.]

Uncertainty due to the convergent of the calculations, this is an uncertainty that is present simply because we terminate the calculations after a finite number of dollars have been spent. However you want to characterize that, I am saying typically we run between 30,000 and 100,000 neutron histories in one of these Monte Carlo calculations.

There is some uncertainty associated with the fact that we terminated it before we have done an infinite number of histories. This is simply inherent in the adoption of a Monte Carlo type of method but a Monte Carlo type of method is called for here because of the inherent accuracy of modeling of that type of a code and because of the need for worrying about penetration of the neutrons into the shield and then being reflected back.

MR. KERR: I would be surprised if that contributes as much to your uncertainty as your inability to model this specific geometry of your cask if you use some reasonable number of histories.

MR. CARLSON: Geometry modeling is one of the real strengths of Keno.

MR. KERR: I know it's a real strength, and if you have this kind of detail you have to be very careful that you are doing it correctly.

MR. CARLSON: Yes.

MR. KERR: Human beings, being what they are, I just doubt if this is a big contributor to your uncertainty comparative. Maybe you have more confidence in your computer guys that I do, and I don't know them.

MR. CARLSON: We are all human. We typically have a couple of people check the input to calculations for these cases.

[Slide.]

I have put up here some modeling details that we worry about. Conservatisms are appropriate if and when we do not include some of these things, and down here are a few that we do not allow. Spacers, we usually represent them. Poisons, we represent them in -- poisons in the basket materials are characterized. Water gaps in the basket are well characterized. Conservative enrichment, when I put that up here we look at an upper bound on the enrichment of a fuel assembly.

That upper bound has to represent the upper bound on the fuel that a vendor supplied to that utility including uncertainties in that supply. We at present do not allow any credit for the fuel depletion, no fission product poison credit and no burnable poison credit. If there is burnable poisons in a fuel assembly we look at an un-irradiated fuel assembly as if it had no burnable poisons in it.

MR. KERR: Why no fuel depletion credit?

MR. CARLSON: I'm separately -- outside of my activities here I am working for John Roberts and Chuck McDonald examining the whole area of depletion credit.

MR. KERR: That's enough.

MR. CARLSON: I could carry on for hours on that subject. It is essentially a topic that is unsupported by experimental verification at the moment. Without experimental verification there are enough uncertainties in the ability of the Monte Carlo codes to predict the effects of burn up that it can't be justified.

When Larry Fischer was up here earlier he talked about the interaction of the various reviews that go on here. For the criticality I wanted to stick this up to show you in a flow chart type of thing how everything fits together, where the structural and thermal analyses feed into the criticality analysis by proving that the materials that were designed into the basket by providing that the geometry that were designed into the basket remains in place following the accidents.

We calculate the k-effective of the cask, we calculate bench mark experiments, determine a bias that feeds into here which goes into an acceptance criteria whether we decide if it's acceptable or not, and we come out with any operational limitations that should be placed upon this cask.

The list of cases that we look at here -- this list is a reflection of the way a particular cask is going to be used. This list can either be expanded or contracted, depending on peculiarities of operation of a particular cask. We first look at normal operation, that's our base case. We look at the cask partially filled with water, we look at what we refer to as a mist calculation. This is where the partially filled with water case is where the cask -- where the height of water in the cask is varied.

Below the point where we say is the water line it is full density water, and above that it is essentially air. In the mist calculation the cask is filled with water of varying density representing densities all the way from normal operation down to relative humidity in the air. We also look at the possibility of the fuel assemblies being off center within their basket locations as a bounding type of event.

We do all of these cases looking at any uncertainties in the inventory of any poison materials that might be included in the basket design.

[Slide.]

A little more detail here. The filling or draining analysis, we look at various water heights, water surrounding, and above and below the cask for all calculations assuming that it is in the pool. We have on occasions found that when the water level is near the top of the fuel, on occasions, that can be the worst case.

MR. KERR: Do you expect a licensee to have done all of these as well? I am asking this in a sense that if he sends in an application and it doesn't have this, do you send it back to him and say do these mist calculations and do these?

MR. CARLSON: What we have done in the past is, in the meeting that Larry talked about in the review process with the application that comes very early on, if the applicant hasn't done these we usually tell him it would be a good idea to have them in here. Send us a change that has them there.

We have never sent one back that says we won't look at it because they are not there. We know as part of our confirmatory analysis we are going to do them to confirm that they are correct. To confirm not that they are correct, but to confirm that we get comparable results.

MR. KERR: How much longer are you going to spend, Mr. Carlson?

MR. CARLSON: I have one more, and then I am going to sit down.

[Slide.]

We look at all of these cases, the range to cover everything. We have found cases where there is a spike in k-effective down at very low densities, and we want to make sure that we have that case bounded; that it is not the worst possible thing.

[Slide.]

Here, I am showing the results of one of the cases that we have done, where we looked at the fuel assemblies all being moved towards the center of the cask not sitting in the center of their holes in the basket but all displaced. There is no mechanism that we can identify that would cause that. Here, we are showing that k-effective still came out below .95, so that we felt comfortable with that review, in that we looked at a case that was non-mechanistic and it was still okay, still met the acceptance criteria.

MR. WARD: What is the abscissa there on those plots?

MR. CARLSON: K-effective.

MR. WARD: No, the --

MR. CARLSON: I'm sorry, this is hydrogen to fissile ratio. It is the ratio of the number of hydrogen atoms to the number of fissile atoms in the fuel. This is, in effect, a mist calculation here in the range of nearly fully loaded.

MR. WARD: What is the difference between the center and off center. I am trying to -- in the centered all of the assemblies are pushed toward the center.

MR. CARLSON: All the assemblies are --

MR. WARD: Presumably the one right in the middle doesn't move at all. Off center, they all go to one corner or something.

MR. CARLSON: Let me say it differently. In the case that we have listed here as centered, all of the fuel assemblies are in the center of the opening in the basket that is allowed for that fuel assembly.

MR. WARD: Okay.

MR. CARLSON: They are nominally right in the center of the opening. The gap between the fuel assembly and the basket is the same on all sides of every fuel assembly --

MR. WARD: It is the nominal --

MR. CARLSON: Nominal case. In the case that is listed here as off centered, we assumed that something happened that moved every fuel assembly into one corner of the opening that was allowed for that fuel assembly and we did it quadrant wise, so that every fuel assembly moved into the corner that was closest to the center of that particular basket. So that, one quadrant they are moving this way and another quadrant they are moving at a 90 degree angle to it.

MR. KERR: Sort of a Maxwell's demon for fuel elements.

MR. CARLSON: Definitely. Criticality is a thing that transcends all normal operations and accidents, and we treat it with a great deal of respect.

MR. WARD: I agree that you do, but I think I have to crab a little bit about your first chart. You said subcriticality is a go/no go process, but then you go on to talk about uncertainties and Monte Carlo analyses and two limits which is not really go/no go. I am not objecting to what you have done, but I guess I am objecting to the characterization that somehow your criticality analysis is a go/no go process anymore than the heat transfer structural analysis.

There is uncertainty in it, and some of those uncertainties clearly have a statistical characteristic.

MR. CARLSON: I hear what you are saying and am agreeing with you, expect that in evaluation of what we call the final k-effective that was down at the bottom of my flow chart here. That k-effective has in it a correction for the bias, it has entered a correction for the convergence. If we are putting in a safety evaluation report a statement that k-effective is less than .95, more likely when we calculate a k-effective with our Monte Carlo code we have a k of down around .92. We go and start adding on a bias and we start adding on something for this, that and the other.

Those are all conservatively included. I agree with you that --

MR. WARD: You used for more than likely, and you haven't eliminated statistics.

MR. CARLSON: No. I am not eliminating statistics. My more than likely was simply because I can't say precisely what the calculated k was. It will be down in that range.

MR. WARD: That's right. On Chart 57 I recommend that you take off the go/no go process.

MR. CARLSON: Okay. I am finished, and I will turn it over to Larry Fischer.

MR. KERR: I would like to restrict you to about five minutes because there are some specific questions that I want to ask about parts of the report, and I want to try to get finished here not later than 12:30.

MR. FISCHER: Okay. We will talk about some of the trends that we see coming out after doing several of these safety analysis reviews.

[Slide.]

These are the areas that I am going to cover, these three areas. First of all when we look at a safety analysis report and we are doing the initial evaluation, the areas that are looked at are for completeness and inconsistencies. Most safety analysis reports have some of these. There can be lack of data, lack of significant analysis, and maybe an inadequate description of the package components and the models might not be quite what we would like to see. There can be some unsupported assertions and assumptions, and certainly some ambiguous statements.

This may not be adequate to turn down a safety analysis report. The ones that we are more concerned about that we have seen happen in the past, and I think you have gotten a flavor of that today, are areas like in a basket design. I think that it is fair to say that every single safety analysis that has come into us and we have evaluated we have found problems with the basket design. The structural integrity has been found to have been inadequate and in some case also, the thermal analysis, so they would have to go back and modify the design and maybe beef it up so they can structurally take the tip over accident. In some cases in the thermal analysis the increased webbing or perhaps put in a higher conducting material to make sure that all the heat gets out.

Another area that we found problems with is the impact limiter design. There is usually inadequate test information and conflicting information, so they may have to actually go out and do some additional tests to prove the impact limiter can limit the loads to the structure without basket failure occurring.

Another area that we have run into is material selection application, ductile cast iron has been introduced. We have founu that to be inadequate material for storage of spent fuel, not necessarily for transportation. The transportation people do not accept ductile cast iron because they do have to look at higher accident conditions and lower operating temperatures.

Borated stainless steel is also another material which has been found to be adequate for spent fuel storage but not necessarily for transport. Again, it is a problem of temperature and also impact loading and brittle fracture type failure and a margin of safety that have to be included there. Roger just talked about some of the criticality limits and biases and how that is done. There are some disagreements in those areas.

[Slide.]

Finally, I want to talk just a little bit about some of the trends that we are seeing happening with these submittals. Certainly, as times goes on and more designs are submitted, we have found that some of the competitiveness that has gone on between the designs that have put in one more bundle or two more bundles in the same volume or the same weight is leading to more efficient designs of course, but they are also becoming more and more complex. We start to see these design margins are as I call them here, safety margins. Let's correct that as designs margins are tending to go down.

What we are seeing is a reduction in the undefined design margins like we may use ASME code and it has a safety factor of a three for an elastic analysis, but now we start looking at elastic, plastic type analysis. Now, what kind of margin do you want to put on it and how close do you want to go.

Also, in the thermal analysis we sort of start to see the same thing. The modeling becomes more precise, and now we are beginning to do a realistic calculation of the actual cask and its contents. There is less and less conservatism built in. Everything is defined explicitly. This so-called conservatism that is built in by conservative assumptions is disappearing and we starting to see ourselves going towards lower and lower design margins; that is, the undefined ones. Things are becoming more precise.

We are starting to require more and more bench mark testing to do these codes because actually these casks are not actually tested. They are almost always analyzed because they are very large and very expensive and difficult to run tests for, so they rely on analysis.

Our latest examples of burn up credit type applications are starting to come in. We find out that they have refined things in the criticality area. Indeed, if we can give them credit for burn up -- that seems to be the direction to go at least for storage -- what we are starting to find now is that baskets are much lighter because they don't have any flux traps. They don't have other things in there for controlling criticality because now it is taking credit for burn up, but now the structural integrity is going way down. We are starting to put more fuel bundles in. Instead of 25 there are 33 fuel bundles in the same volume, but this makes higher loads occur to the internal basket because there is now more fuel there.

What we are starting to see is structural integrity being more and more challenged. The same thing on thermal conduction within the basket. There are thinner webs, less webs, less heat pass to get the heat out. So, what we are starting to see is that the problem of criticality of keeping up the low .95 with the fuel and controlling it, we are now starting to see more and more problems arising with structural integrity of the basket and in the thermal area.

These are the areas that we see coming up that we are getting into more complex analysis. We take more time, more money --

MR. WARD: In the second bullet you say reduced confidence level, increased cost.

MR. FISCHER: Right.

MR. WARD: The cost of the licensing review?

MR. FISCHER: Yes. More exact analysis rather than making nice assumption that you know are conservative with a simplified calculation. Of course, the best one would be on the back of an envelope but now we are talking about very sophisticated finite element and structural and thermal analysis, not even simplified ones. Very realistic, detailed modeling going on like in structural slide lines and very sophisticated methods pushing the state of the art.

Are there comments or questions?

MR. WARD: You see this as a real problem? I mean is society as a whole saving money, or are they --

MR. FISCHER: I kind of wonder. I think I would like to see a little more simplistic -- where we do have some undefined design margin in it. We would feel more confident in it and it would keep the costs down. I think it's not a good trend, but it is one tnat comes on with competitiveness.

MR. WARD: I mean, are the casks so much cheaper to manufacture for example?

MR. FISCHER: Certainly the vendors say that and advertise that to the utilities. I question some of them personally. It's a personal opinion. The fact is that they do come in and do request this, and apparently the market place bears it out.

I just want to raise the issue that we are getting into more complex sophisticated designs. Testing might be more appropriate in some of these cases like they do in transportation rather than just by analysis.

MR. HAUGHNEY: Mr. Chairman, that concludes our presentation. Thank you for your interest and patience.

MR. KERR: I want to ask some specific questions on the document itself, if I may.

MR. WARD: I have one question on the presentation, but I will just wait until you are through.

MR. KERR: On page 2-5, there is a description of the missile being considered and it says the second type is a rigid object to test penetration resistance of a cask, represents an armor piercing artillery shell. And then I find that the speed of this thing is assumed to be 126 miles an hour.

I would not have thought armor piercing artillery shells move that slowly, but it may be. I was just curious about that. It probably makes sense.

MR. ROBERTS: I believe that comes out of NUREG-0800 and I think that's the vertical impact when you take basically 30 percent of the wind velocity. I think it's --

MR. KERR: I knew there must be a good reason for it, I just couldn't feature armor piercing artillery shell coming in that slow. Let's hope they do.

On page 3-13 where it is discussing feretic steels and again on 3-17 on the possibility of low temperature fracture, what is assumed about the cask temperature as driven by the heat load? Is it assumed that the outside temperature is the ambient temperature of the air or that it's --

MR. ROBERTS: What line are we under?

MR. KERR: On 3-13 there is a paragraph 3.3.2.3.2, and on 3-17 there is review the package for the effects of an ambient temperature of minus 40 degrees. Does that mean that the cask wall is at that temperature or that is the ambient temperature with the cask wall is whatever it would be.

MR. ROBERTS: That's right, the cask wall is what the cask would be.

MR. KERR: It may be obvious to a reviewer that this is the case, but it seems to me there is still some ambiguity there.

MR. ROBERTS: I agree.

MR. KERR: On page 4-2 reference is made to the effects of thermal loading must reflect the worst credible combination of these loads, what does that mean? Unless one is more specific, it sort oi leaves things up to the reviewer which may be the thing to do. We used to alk about mass credible accidents years ago and I think we gave that up. I would suggest that somebody look at that a little more.

MR. FISCHER: It is not only design dependent. I think what the tacit assumption here is, they are looking at Reg Guide 7,8, the transportation reg guide that does the load combinations that says you must look at certain temperature conditions and certain accident conditions and so forth. This, I think, has been taken --

MR. KERR: If you want to be that ambiguous, go ahead. I just think that's pretty ambiguous.

MR. FISCHER: We can be more specific like they have done in Reg Guide 7.8, but it did not directly apply to storage in this case.

MR. KERR: Page 5-4, paragraph 5.3.3. shielding evaluation, it says neutron dose rates must includ the primary neutrons and subcritical multiplication. What is a primary neutron?

MR. FISCHER: Which page again -- the primary neutrons should be clarified. Those are the ones coming from the plutonium and curium.

MR. KERR: I thought probably -- maybe that is obvious.

MR. FISCHER: It's a fast fission. Maybe a fast fission would be better.

MR. KERR: I think that makes sense, or spontaneous fission perhaps.

MR. FISCHER: Spontaneous. I'm sorry, spontaneous fission is the correct terminology.

MR. KERR: On 6-3 -- we have already taken care of that. The conservatism about max initial enrichment you are looking at, and I guess I can't ask for any more than that.

On page 6-4 paragraph 6.2.3.2, there is reference at the very last sentence in extreme cases increases as much as .04 had been calculated. It doesn't say increases in what or the units.

MR. FISCHER: K-effective. We have corrected that, thank you.

MR. KERR: On page 6-5 at the bottom of the page, this is a legal statement of the fissile material loading. What is the significance of that sentence, a legal statement?

MR. FISCHER: What page again?

MR. KERR: At 6-5, next to the bottom line the sentence starts this is a legal statement of the fissile material loading. I don't know what that means.

MR. ROBERTS: That is verified by the statement below it that this is the statement that should appear in the cask certificate in terms of the limitation in the certificate of compliance.

MR. KERR: It may mean that. To me, it didn't mean anything.

MR. ROBERTS: In other words --

MR. KERR: Page 6-7 the top paragraph the second sentence, what does tolerance build up mean?

MR. FISCHER: That's like when they build a basket and they fit many parts together and there is a tolerance on each of the parts, the basket is made and there is an overall tolerance and a tolerance on the cask. Then when they put the basket in the cask there will be some build up of the different tolerances and you want the maximums and minimums.

MR. KERR: You might say dimensional tolerances. Maybe it's obvious to designers.

MR. FISCHER: Okay.

MR. KERR: Page 7-4 that total seems rather conservative, but maybe it needs to be that conservative. That 100 percent of gaseous inventory for example, but that's just a comment. There's not much you can do about that, I suppose.

On 9-4, it seems to me that the first paragraph, 9.1 general is rather vague. I read it, and it just didn't say much to me.

MR. FISCHER: We agree.

MR. KERR: Maybe if I re-read it, it will.

MR. FISCHER: We agree.

MR. KERR: On page 9-3 under the neutron shield paragraph, there is a suggestion that verification should use a neutron source of adequate strength to verify the shielding effectiveness. That assumes, I guess, that you do a separate keno calculation for a point source or something. It wasn't clear to me what you had in mind. I don't think you can --

MR. FISCHER: I believe the way that it is actually done is we just verify that the neutron material has been put into the basket and they check to see that it is there. They usually do not put out a neutron source and do a check that way. It's a fabrication record and a visual check, is a more normal way of doing that.

MR. KERR: Page 9-4, paragraph 9.3.2.1 refers to periodic testing to ensure the proper function in the components is important to safety. The interval between period testing should be provided by the applicant. You accept anything that the applicant provides, or do you have more guidance than that?

MR. FISCHER: More guidance should be given, and I think that it did not go into specific components. There should be specific guidance for each component.

MR. KERR: In 9-6 there is on the bottom paragraph discussion should include dimensions of the grid pattern or description of the scanning procedure that demonstrates inspection of 100 percent of the cask area. Presumably what you are trying to do is satisfy dose rates at various points. For the life of me, I can't see why you want to do 100 percent surface measurement. What you want to do, I think, is to find out what the doses are at critical points.

It seems to me that this is not a good ALARA. If you have a guy having to crawl over the surface of the thing to do 100 percent inspection to see if there's any significant dose, I don't think he is going to find anything that is useful. That's a comment -

MR. FISCHER: This was actually put in primarily for lead filled type casks, but that can also be done by radiographs to check for voiding. That's why that was put in there. You are correct, we would want to look more for streaming paths rather than necessary cracks or anything.

It could be modified and clarified.

MR. KERR: It seems to me what you really ultimately interested in is whether dose is where the worker has to be and where the dose is off site. You can measure that without doing a 100 percent surface calculation. If you find that they are too high, then maybe you want to go back and look for it.

MR. FISCHER: This is acceptance test when the cask has just been manufactured before they put fuel in it or any high source. This is a low source that they are putting in to try to find gross manufacturing discrepancies.

MR. KERR: Okay, I misunderstood. I thought it was something that had to be done periodically.

MR. FISCHER: No, this is looking for gross problems in the manufacture and later on looking for -- they may measure the outside to see if something gross has happened during the storage lifetime. It had to be a big change in the characteristic that you are looking for.

MR. KERR: Page 10,3, it seems to me that the ALARA injunctions were somewhat vague but maybe that's the nature of the beast. I don't know.

MR. FISCHER: That's correct.

MR. KERR: In 10-5 I can't see why you require a 40 hour per week, 50 week per year exposure there. Maybe that is inherent in the regulations. This is in the top paragraph.

MR. FISCHER: I think that comes to Part 20. I believe so -- we will double check it.

MR. KERR: Those are the things -- these are minor details but things that I encountered in reading. You said that you had a question?

MR. WARD: I just had one question. I am still puzzling over the heat transfer situation when you have assembly in a can in a cask. If I look at this certificate -- and this is a license, right? I mean, this is what people are trying to get?

MR. ROBERTS: Yes.

MR. WARD: On page A-3 it says fuel assemblies known or suspected they have structural defects sufficiently severe to adversely affect fuel handling and transfer capability unless canned shall not be loaded into the cask for storage. That means that somewhere somebody did analysis for this for canned fuel assembly.

MR. ROBERTS: No. What it means is that we don't care if it's canned. In other words, we are concerned about the structural cladding of the fuel. If the fuel structural cladding does not exist and the fue. is in a situation where it has to be canned, that will be processed as a canned defective element. We are not then in the business of determining that.

MR. WARD: So, if this thing goes in there and it has some structural defects in it but it's in a can and then the whole thing is so hot that it all goes to pot over the next 20 years or something you don't care, is that the point?

MR. ROBERTS: Basically that's it. It is going to be handled as a defective element wherever it goes for disposal. It is not going to be handled as in tact fuel assembly.

MR. WARD: The fact that the process may cause a fuel assembly to go from 10 percent failed to 100 percent failed doesn't matter?

MR. ROBERTS: I think the answer is that it is going to be handled as a defective fuel element where material is out and contaminating and, consequently, it is not going to be handled as an in tact fuel assembly. I think you are not going to stand there and say only 50 pins were damaged as opposed to 75 or something like that in that assembly, it is simply going to be canned and it will be handled in that can.

MR. WARD: I repeat, you really don't care whether 50 pins are damaged or they are all damaged?

MR. ROBERTS: That's right, because now the can is the barrier. It is no longer treated as an in tact assembly.

MR. WARD: You really believe in that can and everything is all right?

MR. ROBERTS: Personally, I would hope that they would not put any of that stuff in there. Let it be handled in the pool because it --

MR. WARD: It doesn't say that this license permits them to do that.

MR. ROBERTS: I know. We have to leave some flexibility to people, I think.

MR. KERR: That is where you use personal opinion.

MR. WARD: I just wonder what sort of analysis has been done of that. You are saying you don't need any, but I can't quite get you to say it. You don't care whether the small number of pins are failed completely or all pins are failed completely, as long as they are in the can.

MR. ROBERTS: That's correct. Effectively what your unit of storage is now is the canned fuel as opposed to an in tact assembly.

MR. KERR: Are there any further questions?

MR. WARD: No, that's all.

MR. KERR: What I am going to propose is that we not have any presentations at the full Committee meeting. I think the written material is very well done and as far as I am concerned it looks like a good job. There may be questions from the Committee, and we will write a letter. I don't think it's necessary to make presentations. I hope you won't feel hurt by this, but I think the presentation this morning have been very well organized and quite informative.

We have an hour allocated for that procedure on Friday, Mr. Alderman tells me. Thank you again, gentlemen.

[Whereupon, at 12:45 p.m., the meeting concluded.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission

in the matter of:

NAME OF PROCEEDING: ACRS Defueling/Fuel Pool Storage

DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, 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.

Mary C. Larkin

Official Reporter
Ann Riley & Associates, Ltd.

NRC STAFF PRESENTATION TO THE ACRS

Methods for Reviewing Safety Analysis Reports for Dry Storage Casks (ISFSI)

January 29, 1991

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SUBCOMMITTEE: Defueling and Fuel Pool Storage Subcommittee

NSSP

Nuclear Systems Safety Program

Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

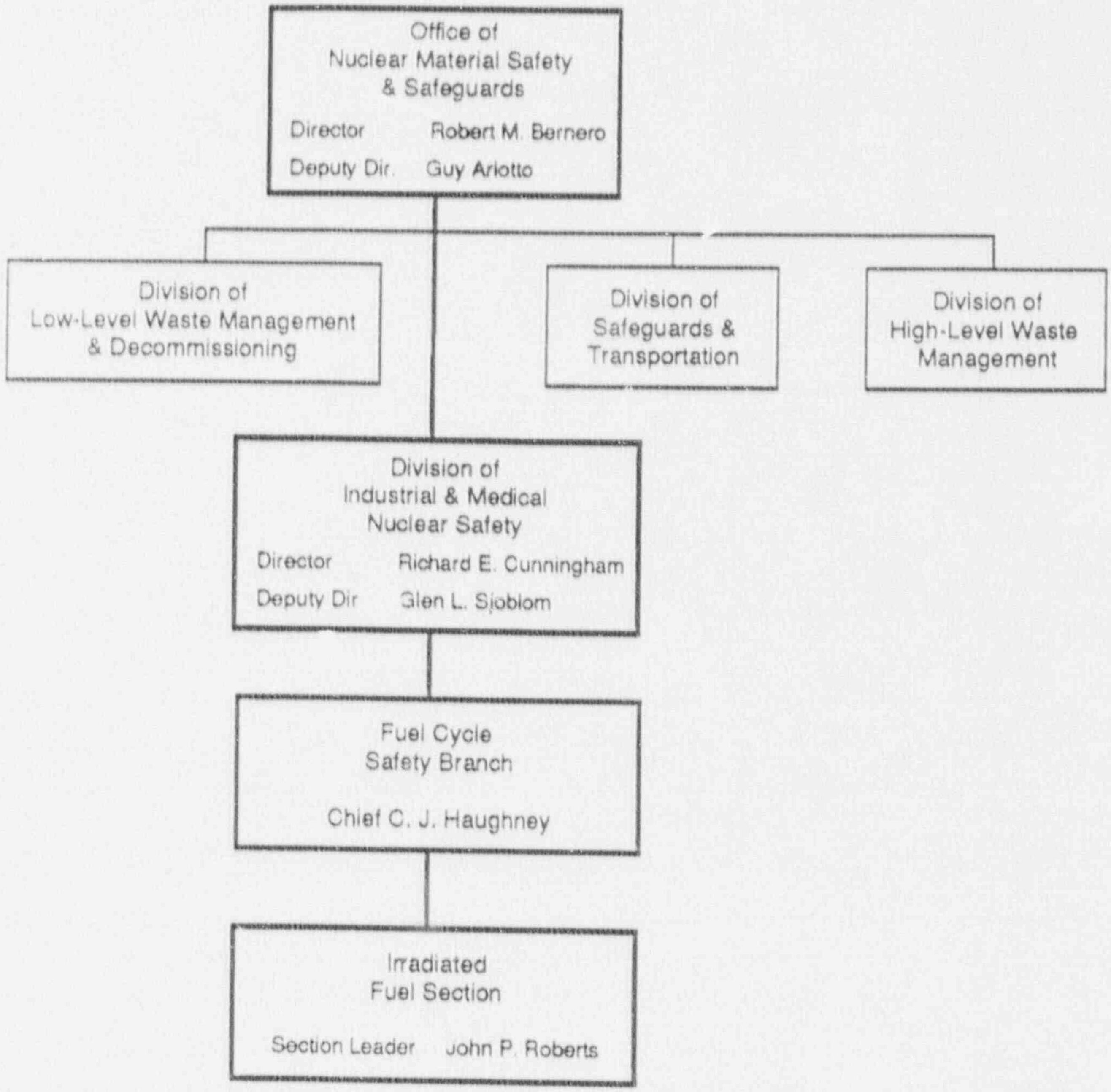
Introduction and Organization

Presented to
Defueling/Pool Storage Subcommittee
of ACRS

Presented by
Charles J. Haughney
U.S. Nuclear Regulatory Commission

January 29, 1991
Phillips Building
Bethesda, Maryland

U.S. Nuclear Regulatory Commission Organizational Chart



Purpose of this Briefing

- Provide an update on dry spent fuel storage licensing
- Provide an overview of the safety review process and criteria used to implement regulatory requirements
- Discuss evaluations of normal, off-normal and design basis accident conditions
- Relate experiences, past reviews and discuss trends in cask designs as related to safety reviews

Purpose of the Standard Review Plan

- Provide systematic procedures to assure consistent and quality safety reviews of metallic dry storage casks
- Define technical review area interfaces that will cover a variety of cask designs
- Present a well-defined base from which to evaluate proposed changes in the scope and requirements of reviews

ACRS Review

- Critical look at the adequacy of the review criteria and how they are applied on a generic basis
- Guidance on use of generic parameters for safety reviews
- Provide guidance on minimum safety margins as cask designs push the limits of analytical techniques
(how much unanalyzed conservatism do we retain?)

ACRS/ACNW Involvement

- ACRS – Castor V/21 Cask – SURRY ISFSI (1985)
- ACRS – Rule change – HLW + MRS (1987)
- ACNW – Rule change – General Licensing Cask Certification (1988, 1990)

NSSP
Nuclear Systems Safety Program

Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

NRC Perspective

Presented to
Defueling/Pool Storage Subcommittee of ACRS

Presented by
Fritz Sturz
U.S. Nuclear Regulatory Commission

January 29, 1991
Phillips Building
Bethesda, Maryland

NRC Perspective

- Spent fuel storage background
- 10 CFR Part 72 siting and design criteria
- Status of dry spent fuel storage reviews
- Spent fuel under a general license
- Past ACRS/ACNW involvement
- DOE demonstration/SURRY ISFSI

Spent Fuel Storage Background

1977 Commercial reprocessing of spent fuel deferred

Federal away-from-reactor spent fuel storage planned

1979 Final generic environmental impact statement on handling and storage of spent light water power reactor fuel (NUREG-0575)

1980 New rule – 10 CFR Part 72 – licensing requirements for the storage of spent fuel in an independent spent fuel storage installation

1981 Reprocessing deferral rescinded – federal away-from-reactor spent fuel storage plans cancelled

1982 Materials license for spent fuel storage at GE Morris Operation renewed under 10 CFR 72

Spent Fuel Storage Background (cont.)

1982 Nuclear Waste Policy Act (NWPA)

- Utilities were primarily responsible for interim storage of spent fuel
- DOE to conduct R&D and cooperative dry storage demonstrations

1986 SURRY ISFSI license issued (Dry Cask)

H. B. Robinson ISFSI license issued (Horizontal Concrete Modules)

1988 10 CFR Part 72 Amended to Include

- Monitored retrievable storage facility
- High-level waste

1990 OCONEE ISFSI license issued

10 CFR Part 72 amended for use of certified cask designs

10 CFR Part 72

- One-step licensing
  - Covers interim independent spent fuel storage at reactors or away from reactors ISFSI or MRS
- License term
  - 20 years for ISFSI; 40 years for MRS
- Aged spent fuel
- Scope — Limited to receipt, handling and packaging, storage, and high-level waste for MRS must be solidified.
- Licensing requires environmental assessment for storage at reactor site, environmental impact statement (EIS) for new site (MRS)

10 CFR Part 72 (cont.)

- Contents
  - Siting criteria
  - General design criteria
  - Quality assurance (modeled on power reactor rule)
  - Emergency planning
  - Training
  - Physical
  - Security requirement

10 CFR Part 72 (cont.)

- General license — at-reactor-site storage of spent fuel in NRC-approved casks

- Cask certification

Criteria for Dry Storage Casks (10 CFR Part 72)

Siting Limitations

- 25 MREM/YR (whole body) and 75 MREM/yr (thyroid) to a real individual on or beyond the controlled area boundary (includes other nuclear activities in neighborhood of ISFSI)

- 5 REM total dose (whole body or any organ) from an accident to a real individual on or beyond the controlled area boundary

- The minimum distance to a controlled area boundary allowed is 100 meters

Criteria for Dry Storage Casks (10 CFR Part 72)

- The cask and its systems important to safety provide safe confinement of spent fuel under normal, off-normal and credible accident conditions

- Normal storage conditions
  - Fuel cladding should not sustain degradation leading to gross rupture
  - Maximum fuel clad temperature (design dependent)
  - Casks are sealed and an inert fill gas is maintained

Criteria for Dry Storage Casks (10 CFR Part 72)

Extreme design conditions

- Natural events

— Earthquakes	Bounded by tipover
— Tornado winds	Maximum wind speed 350 MPH (Reg. Guide 1.76)
— Missiles	1800 KG auto 125 KG armor piercing artillery shell 1 in. solid steel sphere (Propelled at 33% of max wind, NUREG-0800)
— Lightning	No significant damage Safety functions maintained
— Floods	Submersion without flooding cavity

Criteria for Dry Storage Casks (10 CFR Part 72) (cont.)

Extreme design conditions

- Accidents

— Explosion	Industrial accident explosion (gas cloud explosion assumed for castor V)
— Fire	Site specific or generic duration Transportation thermal accident (10 CFR 71.73, 30 min. fire at 800°C)
— Cask tipover	Casks withstand tipover without compromising structural integrity
— Cask drop	Casks withstand a drop without compromising structural integrity (height limit is a technical specification)

Status of Dry Spent Fuel Storage Licensing

Licenses Issued

Utility	Reactor Site	Docket and License Nos.	Date of Issuance	Model
Virginia Electric and Power Co.	SURRY Power Station	72-2 SMN-2501	7/86	Castor V/21 MC-10 NAC-128 S/T Castor X
Carolina Power and Light Co.	H. B. Robinson Steam Electric Plant, Unit 2	72-3 SNM-2502	8/86	NUHOMS-7P
Duke Power Co.	OCONEE Nuclear Station	72-4 SNM-2503	1/90	NUHOMS-24P

Status of Dry Spent Fuel Storage Licensing

License Applications Received

Utility	Reactor Site	Docket No.	Date of Receipt	Model
Carolina Power and Light Co.	Brunswick Power Station	72-6	5/89	NUHOMS-7P
Consumers Power Co.	Palisades	72-7	3/90 Withdrawn 8/90	VSC
Baltimore Gas and Electric Co.	Calvert Cliffs	72-8	12/89	NUHOMS-24P
Public Service Company of Colorado	Fort St. Vrain	72-9	6/90	MVDS
Northern States Power	Prairie Island	72-10	9/90	TN-40

Status of Dry Spent Fuel Storage Licensing

Topical Reports Approved

Type	Vendor	Model	Capacity (Assemblies)	Date of NRC Staff Approval
Metal Cask	General Nuclear System, Inc.	Castors V/21	21 PWR	9/85
Concrete Module	NUTECH, Inc.*	NUHOMS	7 PWR	3/86
Metal Cask	Westinghouse	MC-10	24 PWR	9/87
Metal Cask	Nuclear Assurance Corporation	S/T	26 PWR	3/88
Concrete Vault	FW Energy Applications, Inc.	Modular Vault Dry Store	83 PWR or 150 BWR	3/88

* Firm's name changed to Pacific Nuclear Fuel Services, Inc.

Status of Dry Spent Fuel Storage Licensing

Topical Reports Approved (cont.)

Type	Vendor	Model	Capacity (Assemblies)	Date of NRC Staff Approval
Metal Cask	Nuclear Assurance Corporation	NAC-C28 S/T	28 Canisters (for fuel rods from 56 PWR assemblies)	9/88
Metal Cask	Nuclear Assurance Corporation	NAC-I28 S/T**	28 PWR	2/90
Concrete Module	NUTECH, Inc.*	NUHOMS-24P	24 PWR	4/89
Metal Cask	Transnuclear, Inc.	TN-24	24 PWR	7/89

* Firm's name changed to Pacific Nuclear Fuel Services, Inc.

**Identical to NAC-C28 S/T, but reviewed and approved by NRC staff for storage of intact fuel assemblies

Topical Reports Under Review

Type	Vendor	Model	Capacity (Assemblies
Concrete Cask	. acific Sierra Nuclear Associates	VSC	9 PWR
Metal Cask	General Nuclear	Castor X	28 PWR or 33 PWR
Metal Cask	Nuclear Assurance Corporation	NAC-STC (Dual Purpose)	26PWR

NSSP
Nuclear Systems Safety Program

Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

Storage Cask Review Process Overview

Presented to
**Defueling/Pool Storage Subcommittee
of ACRS**

Presented by
Larry Fischer
Lawrence Livermore National Laboratory

**January 29, 1991
Phillips Building
Bethesda, Maryland**

Storage Cask Review Process Outline

- Generic and site specific application
- Regulations and implementation standards
- Standard review plan
- Overview of review process

Two Types of Storage Cask Applications

- Generic
  - Topical Safety Analysis Report
  - Can be located at any nuclear power plant in U.S.A.
  - Assumes bounding characteristics of site

- Site Specific
  - Safety Analysis Report
  - Will be located at only one nuclear power plant
  - Uses specific site characteristics

- Review process is similar for both applications
  - Standard review plan (SRP) is for metallic dry storage casks

Storage regulations address three basic safety requirements in terms of performance standards

- Requirements
  - Containment
  - Subcriticality
  - Shielding

- Performance standards in terms of radiological limits
  - Normal conditions
  - Accident conditions

Codes, standards, and NRC requirements provide acceptance criteria, design margins, and quality requirements for implementing storage regulations

- Regulatory guides
  - Regulatory Guide 3.48
  - Regulatory Guide 3.61
- NUREGs/NRC supported research
- ASME code
- ANSI
- ANS
- ASTM

In many cases, portions of transport cask guidance has been adapted by the storage industry and for SAR reviews

The Standard Review Plan (SRP) integrates storage regulations, engineering practices, and implementation guidance into one document

- Reg. Guide 3.61 provides format and content for SAR
- SRP provides detailed guidance for SAR review

The objectives of the Standard Review Plan are to:

- Provide format and contents for SAR
- Provide general guidance
- Establish systematic procedures
- Assure quality and uniformity
- Establish balanced effort
- Establish base for changes
- Make NRC review procedures known

The scope of the SRP is to:

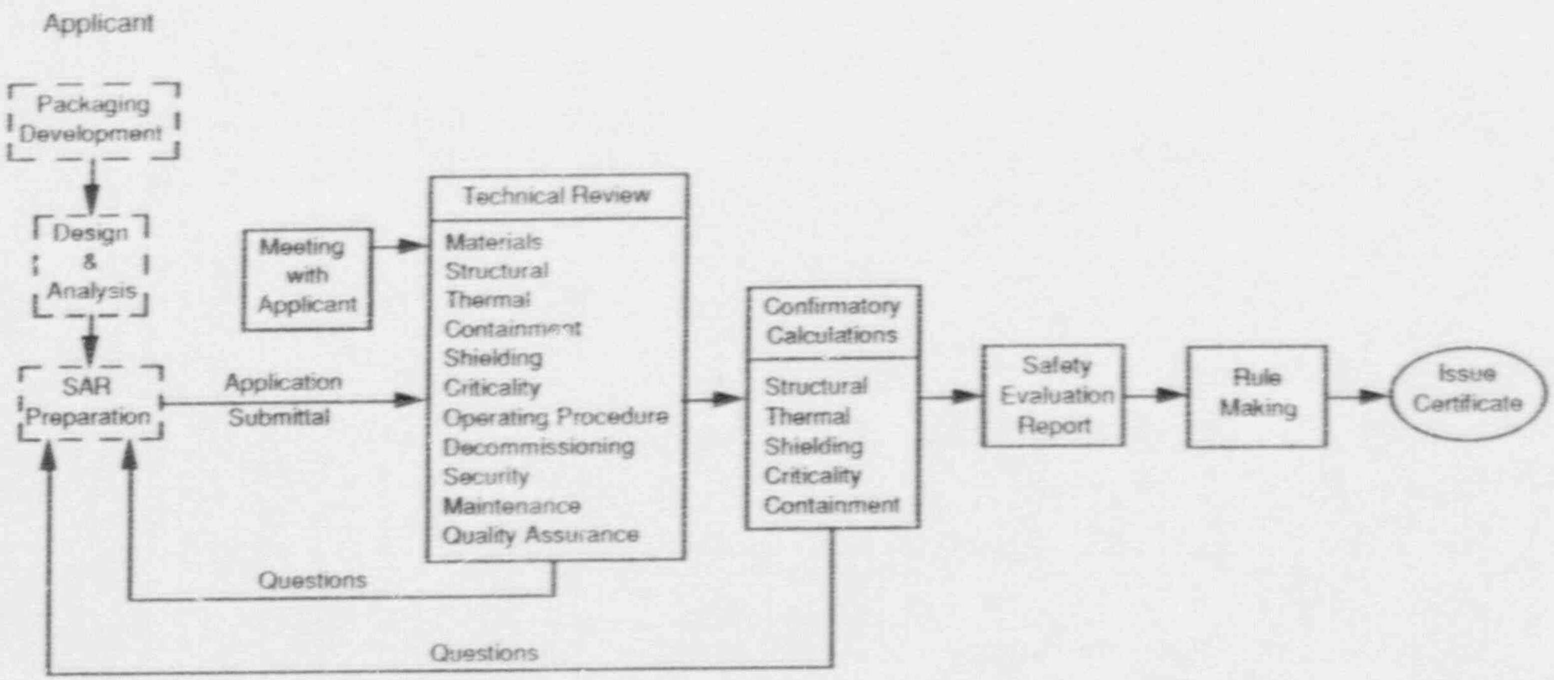
- Cover metallic dry storage casks that require certification
- Cover every aspect of package design, manufacture, use, and maintenance
- Cover each technical review area
  - Complete procedures
  - Interfaces defined
  - Partial reviews

General Philosophy

- Responsibility
  - Safety is the responsibility of designer or applicant
  - Reviewer's responsibility is to verify that applicant fulfills his responsibility
  - 10 CFR 21 requirements apply to both
- Reviewer should not perform design analysis or modify design for applicant—instead, reviewer should perform confirmatory analysis
- Reviewer should have open mind towards new technology, materials and methods
- Reviewer should make judgements based on technical information not on personal opinions

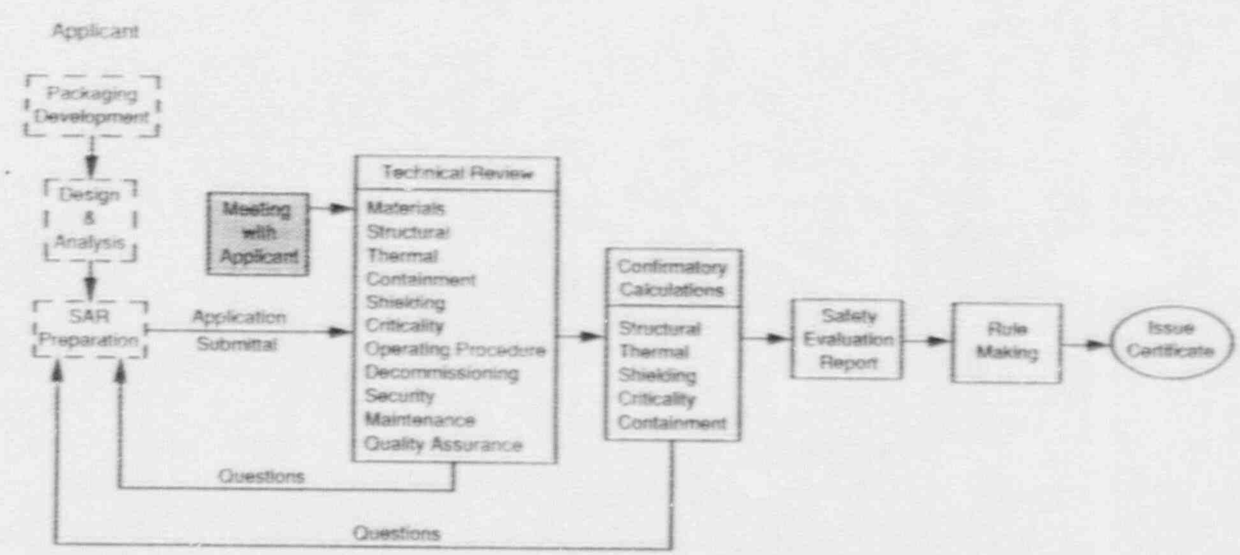
Contents

Review Process



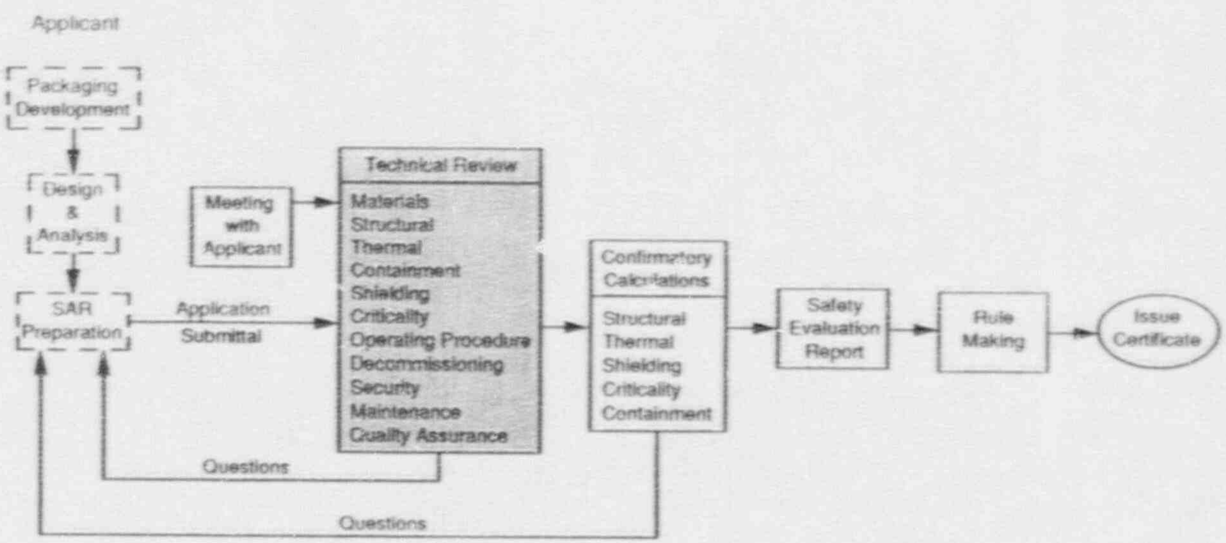
Meeting With Applicant

- Applicant describes design
- Reviewers become familiar with package
- Meeting of applicant, reviewers, and regulators



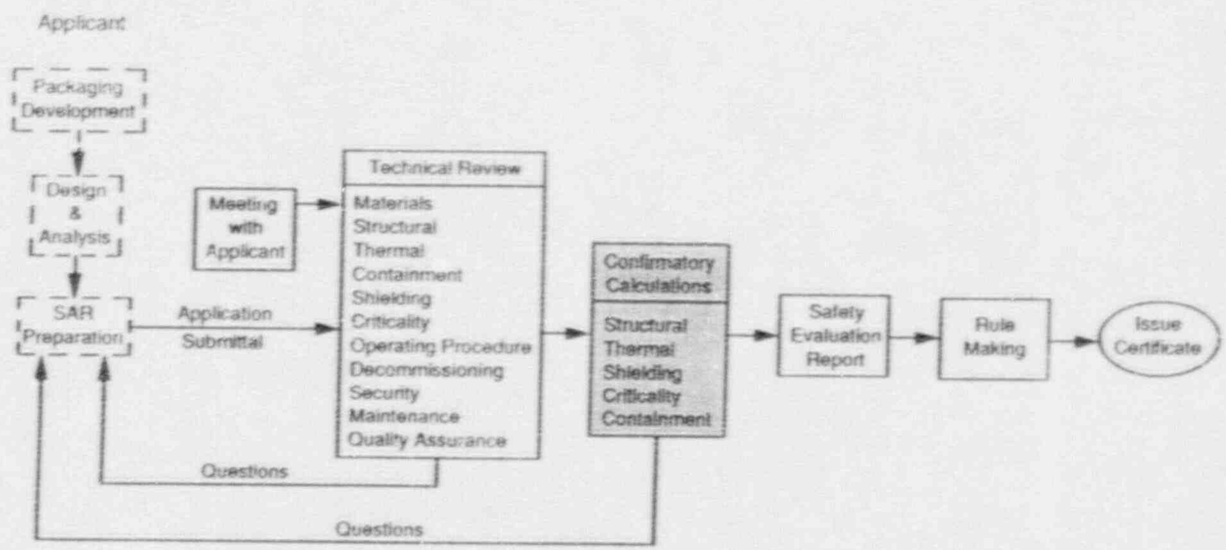
Technical Review

- Review entire Safety Analysis Report
- Develop questions to correct inconsistencies
- Assure all data required for confirmatory analysis is presented
- Identify areas of concern based upon:
  - Experience
  - Preliminary analysis



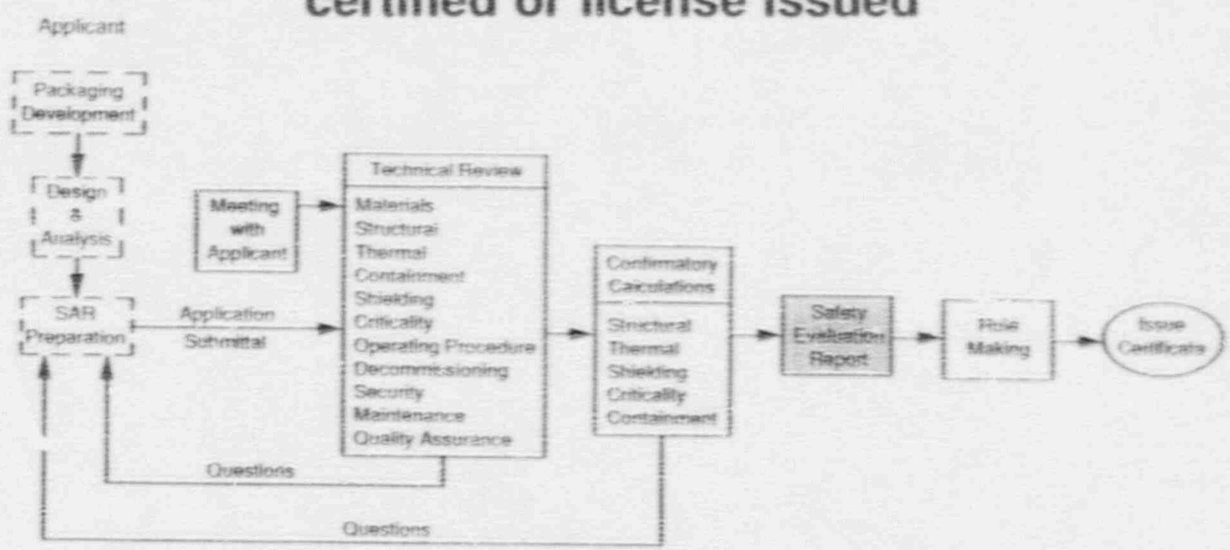
Confirmatory Calculations

- Independently evaluate safety margins
- Model sophistication to be consistent with degree of concern
- Conservative while realistic



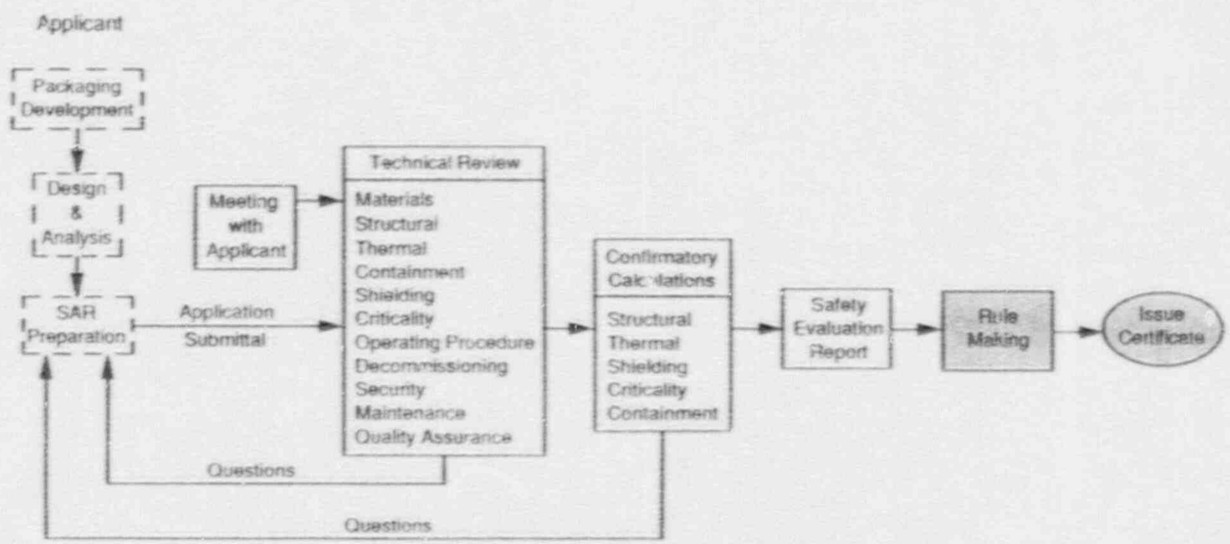
A Safety Evaluation Report (SER) documents the Reviewers findings on the submittal

- Summarizes technical highlights
- Appraises technical information and conclusions
- Describes any discrepancies between applicants design calculations and reviewers confirmatory analyses which reach the same conclusions
- Identifies limitations and restrictions which should be incorporated into the certificate
- Provides basis for reasonable assurance that cask can be certified or license issued



Issue certificate is the final step

- Certificate or license should identify:
  - Limitation on quantity or type of radioactive material to be stored
  - Special requirements on operation, inspection, maintenance, or quality assurance



NSSP
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Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

Evaluation of Normal Conditions of Storage

Presented to
Defueling/Pool Storage Subcommittee of ACRS

Presented by
Roger Carlson
Lawrence Livermore National Laboratory

January 29, 1991
Phillips Building
Bethesda, Maryland

Normal Storage Limits

- 10 CFR Part 72.122(h) requires that the fuel cladding shall be protected against degradation and gross rupture throughout the entire life of the ISFSI

- Radiation Limits

- Confinement Limits

Diffusion Controlled Cavity Growth

- Limiting process for degradation of fuel cladding integrity during prolonged dry storage of fuel assemblies
- Results in peak fuel temperature that can be tolerated during dry storage of spent fuel
- Limiting temperature depends upon fuel rod internal pressure

Radiation Acceptance Criteria for Normal Storage

- 10 CFR Part 72.104(a) requires the annual dose to any real individual who is located beyond the controlled area to be less than:
  - 25 mrem to whole body in a year,
  - 75 mrem to the thyroid in a year, and
  - 25 mrem to any other organ in a year

- Limit includes:
  - Direct radiation from the ISFSI,
  - Dose due to all gaseous activity release from the ISFSI, and
  - Dose due to any other nuclear facilities at that site

- Flux to dose conversion factors from ANSI/ANS-6.1.1

Typical Approach

- Applicant usually restricts cask surface dose to close to transport limits
- Dose at site boundary usually restricted to about 10% of limit to allow for other nuclear facilities at site
- Use of earthen berms makes "sky-shine" important
- Rate of cask placement is important to avoid gross conservatism in site boundary dose estimates

Typical Approach

- Applicant usually restricts release rates to transportation limits
- Releases are primarily Helium fill gas not fission product gases
- Helium fill gas pressure is monitored on a regular basis to indicate leakage

Confinement During Normal Storage

- 10 CFR Part 72.104(a) requires the annual dose to any real individual who is located beyond the controlled area to be less than:
  - 25 mrem to whole body in a year,
  - 75 mrem to the thyroid in a year, and
  - 25 mrem to any other organ in a year

- Limit includes:
  - Direct radiation from the ISFSI,
  - Dose due to all gaseous activity release from the ISFSI, and
  - Dose due to any other nuclear facilities at that site

Assumptions for Confinement Analyses

- 1% clad tube failure for normal storage conditions
- 10% clad tube failure for off-normal events
- Release fractions from Reg. Guide 1.25
- Population weighted inhalation rate from Reg. Guide 1.109
- Inhalation dose and whoie body dose factors from Reg. Guide 1.109
- F-stability atmospheric diffusion
- Wind speed of 1m/s
- Plumemeander
- Continuous occupation of dose point by a person

Decommissioning

10 CFR Part 72.130 "The ISFSI or MRS must be designed for decommissioning ..."

- Review examines cask design to evaluate amount of material that is activated during the storage of spent fuel in dry storage casks

- Site decommissioning governed by survey for radioactivity

Summary of Evaluation of Normal Conditions of Storage

- Heat transfer
  - Clad temperature limited by diffusion controlled cavity growth
  - Contact between basket and cask body is important
  - Size of basket components is important
  - Limiting condition for normal storage
- Radiation
  - Not severe problem due to massive shielding of cask body
- Confinement
  - Not severe problem due to gasketed and bolted closure

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Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

Evaluation of Off Normal Conditions and Design Basis Accidents

Presented to
Defueling/Pool Storage Subcommittee of ACRS

Presented by

Roger Carlson
Lawrence Livermore National Laboratory

January 29, 1991
Phillips Building
Bethesda, Maryland

Free Fall Accidents

- Height limited by operation (transport to ISFSI and placement at ISFSI)
  - No loss of confinement
  - Maintenance of shielding integrity
  - No loss of criticality control
  - No reduction of heat removal capability

Tip Over Accident

- Limiting structural event
  - Maintenance shielding integrity
  - No loss of criticality control
  - No loss of confinement
  - No loss of heat removal capability
- Ability to remove fuel as part of recovery

Hypothetical Fire

- Duration is 30 minutes if large source of fuel is available
- Duration is limited if small amount of fuel
  - Cask vertical
  - Ignore transporter for conservatism

- Fire characteristics per 10 CFR Part 71
  - Flame emissivity 0.9 cask absorptivity 0.8
  - radiation from 800°C source natural convection in still air at 800°C
  - Fire extends 1 m beyond cask

- Acceptance criteria based upon preventing fuel rod failure due to over pressurization (short term failure)

Radiation Acceptance Criteria for Design Basis Accident

- 10 CFR Part 72.106(b) requires that any individual located on or beyond the boundary of the controlled area shall not receive a dose greater than 5 rem to the whole body or any organ

- Nearest boundary of the controlled area must be at least 100 meters from the ISFSI

- Dose includes direct radiation and result of any gaseous activity release

Assumptions for Confinement Analyses

- 100% clad tube failure
- Release fractions from Reg. Guide 1.25
- Population weighted inhalation rate from Reg. Guide 1.109
- Inhalation dose and whole body dose factors from Reg. Guide 1.109
- F-stability atmospheric diffusion
- Wind speed of 1m/s
- Plume meander
- Continuous occupation of dose point by a person

Summary of Response to Accident

- Basket cannot have large deformations or buckle
- Shield integrity must be maintained (slight deformation is tolerated)
  - Direct radiation dose during accident is small
- Confinement must be maintained
  - Transport limits typically applied
- Radiation hazard due to hypothetical accident is small

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Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

Criticality Evaluation Acceptance Criteria

Presented to
Defueling/Pool Storage Subcommittee
of ACRS

Presented by
Roger Carlson
Lawrence Livermore National Laboratory

January 29, 1991
Phillips Building
Bethesda, Maryland

Subcriticality must be assured

- Go – no-go process because:
  - High heat release
  - High radioactive product release
  - High margin of safety required

Subcriticality must be assured by:

- Limiting fissile mass
- Engineered design

Criticality Safety

- Requirement that cask and contents remain subcritical during all normal operations and hypothetical accident conditions

- Numerical limit is usually taken as $k_{eff} < 0.95$ to assure subcriticality

- k_{eff} must include all uncertainties
  - convergence
  - bias
  - allowances for modeling imprecision

Bias in Determining Effective Multiplication Factor

- Bias is the difference between measured and predicted effective multiplication factor for an experimental array of fissile materials that closely resembles the configuration being evaluated

- Bias is a function of the array of fissile materials because the neutron reaction rates are dependent upon the neutron spectrum

- Bias for one confirmatory calculation may not be the same as the bias for a different confirmatory calculation for the same cask

Uncertainty Due to Convergence of Calculations

- Uncertainty due to convergence of calculation is amount k_{eff} could change if large number of iterations were completed (typically 30,000 to 100,000 neutron histories are tracked in a criticality calculation)

- Criticality calculations typically performed using Monte Carlo methods to determine the neutron reaction rates within the cask

- Monte Carlo methods have inherent uncertainties because they try to estimate the response of a large number of neutrons by tracking a finite number of neutrons

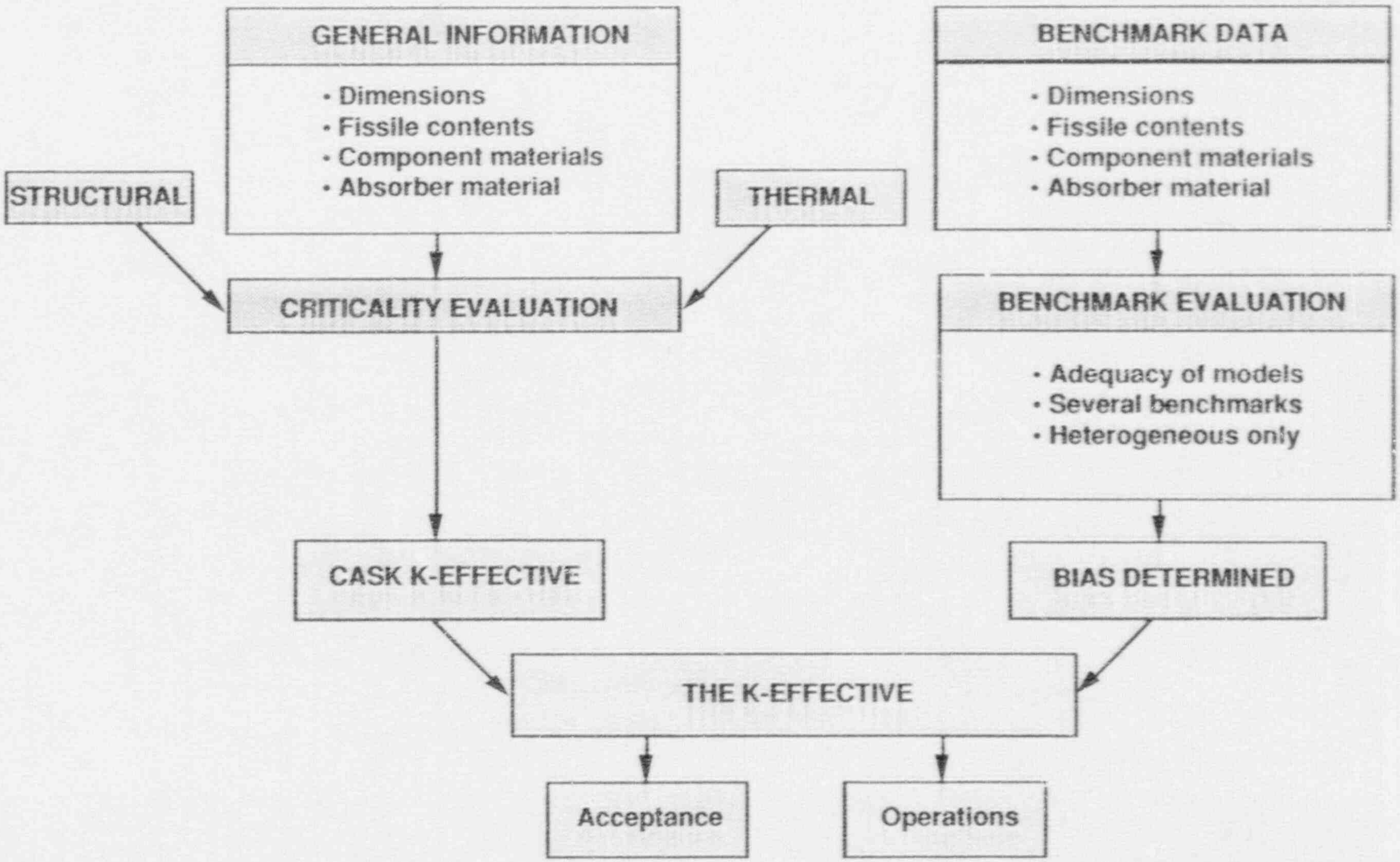
- The possibility of events with low probability occurring with one of the neutrons being tracked would bias the results

Modeling – Conservatisms

- Spacers
- Poisons
- Water gaps
- Fissile number densities
  - Conservative enrichment
  - No fuel depletion credit
  - No fission product poison credit
  - No burnable poison credit

Goal is K-effective $\leq$ 0.95 with bias applied
Mean value $\pm$ 2 sigma

Criticality Review



Cases to be considered:

- Normal operation
- Partially filled cask
- Mist calculation
- Fuel assemblies off center in basket locations

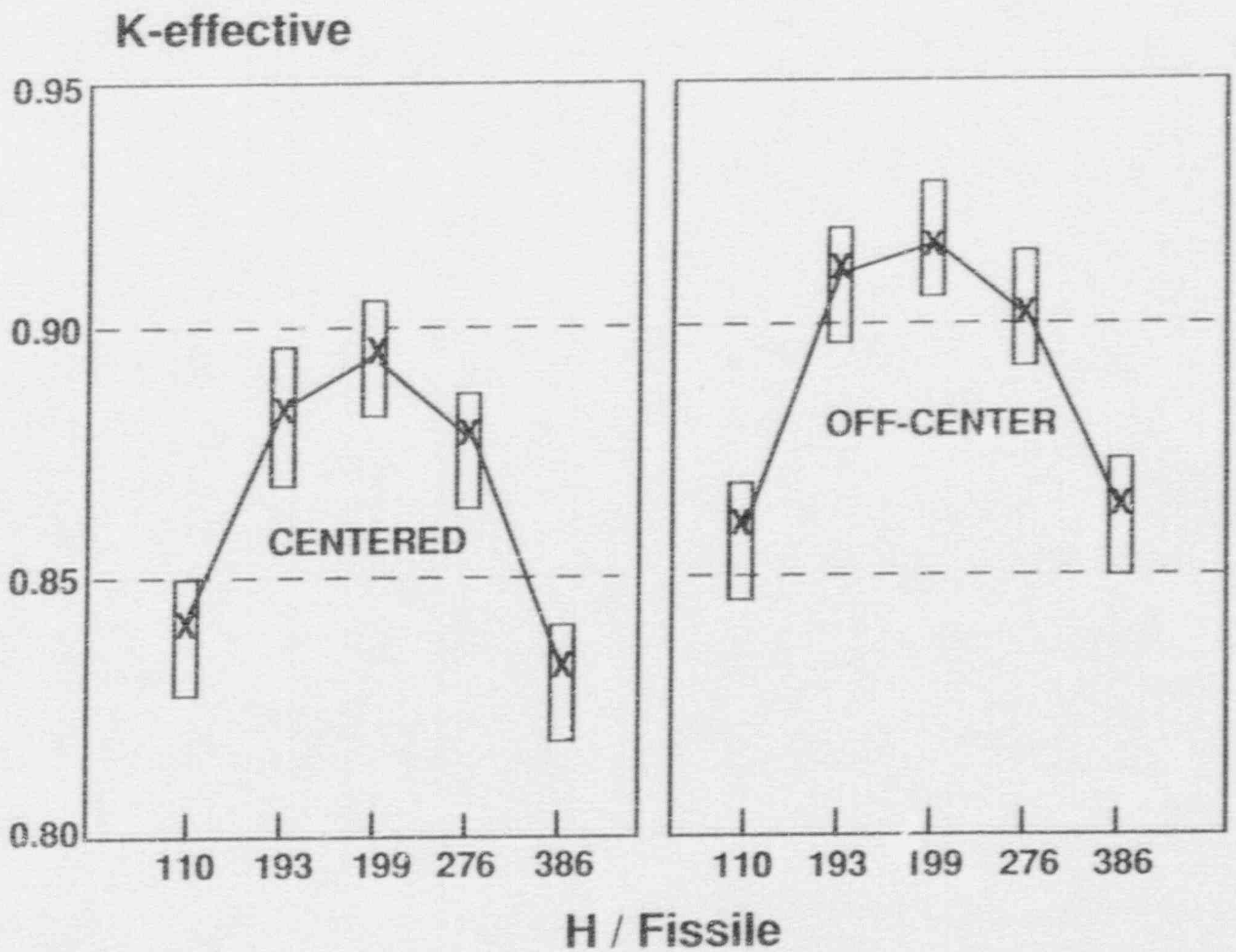
Filling/Draining Analysis

- Evaluate k_{eff} with various water heights in cask from full to nearly empty
- Water surrounding, above and below cask for all calculations
- Water level near top of active fuel region is usually case with highest k_{eff}

Mist Calculations

- Mist inside a cask
- Mist outside an array of casks
- Mist density (ρ) is in grams water/cc of air-water mixture
- Range: $3.3 \times 10^{-5} < \rho < 1$
- ρ of 3.3×10^{-5} corresponds to saturated air at about 120°F and 14.7 psia

K-effective vs. H/Fissile — Fuel in Cask



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Nuclear Systems Safety Program

Methods for Reviewing Safety Analysis
Reports for Dry Storage Casks (ISFSI)

SAR Review Experiences and Trends

Presented to

Defueling/Pool Storage Subcommittee of ACRS

Presented by

Larry Fischer

Lawrence Livermore National Laboratory

January 29, 1991
Phillips Building
Bethesda, Maryland

SAR Review Experiences and Trends Outline

- Completeness and inconsistencies
- Common safety concerns
- Trends in submittals

Incompleteness and Inconsistencies

- Lack of data or incorrect data
- Lack of significant analyses
- Lack of analyses important to safety
- Inadequate description of package components
- Inappropriate models
- Unsupported assertions
- Ambiguous statements

Common Safety Concerns

- Basket design
  - Structural
  - Thermal analysis
- Impact limiter design/analysis
- Materials selection/application
  - Ductile cast iron
  - Borated stainless steel
- Criticality limits and bias

Trends in Submittals

- Competitiveness is leading to more efficient, complex designs
- Reduction in undefined safety margin – more exact/realistic modeling reduces confidence level and increases costs
  - FEA Structural/Thermal Analyses
  - Criticality/Shielding Analyses
  - Benchmark Testing Requirements
- Burnup/boron credit is latest example
  - Refined modeling calculations and limits
  - Reduced structural integrity and higher loads
  - Reduced thermal conduction and higher loads

Spent fuel storage under a General License

- Final Rule permits onsite storage of spent fuel under a General License in NRC-approved dry storage casks
- Section 133 of the NWPA required NRC to develop such a rule
- Final Rule - published July 18, 1990 (55 FR 29181)
  - effective August 17, 1990

Overview of the General License Rule

- General License issued to power reactor licensee for storage of spent fuel in NRC-approved casks
- Safety requirements of 10 CFR Part 72 remain in effect
- Current safeguards requirements of 10 CFR Part 73 for fixed sites remain applicable
- Rule approved four cask designs
- New cask designs to be added by rulemaking

General Licensee Requirements

- Before using a certified cask design at an onsite ISFSi the General Licensee must demonstrate (written evaluation):
- No unreviewed safety questions (10 CFR 50.59)
- No reactor tech. Spec. changes were required
- That the conditions of the certificate of compliance have been met
- That the reactor site parameters are enveloped by cask design basis
- That the site dose limits are not exceeded

General Licensee Requirements (Contunued)

- Review and modify onsite programs to include ISFSI operations and obtain necessary approvals
- Security plan
- Reactor emergency plan
- Quality assurance program
- Training program
- Radiation protection program

General Licensee Requirements (Contunued)

- Notify NRC:
- 90 days prior to first storage under the General License
- Register use of a cask design within 30 days of use
- Maintain a copy of the Certificate of Compliance and other vendor supplied documents
- Conduct ISFSI activities in accordance with written procedures

Certificate of Compliance

- 20 year renewable certificate
- Casks manufactured under a Certificate of Compliance may be used for 20 years (longer if certificate renewed)
- Description of cask and references to appropriate drawings
- Conditions for use of cask
- Requires written operating procedures
- ISFSI QA in accordance with Appendix B, 10 CFR Part 50
- Preoperational Conditions
  - ISFSI training and certification program
  - Dry run training exercise

Certificate of Compliance (continued)

- Functional and Operating Limits
- Type of fuel
- Initial Enrichment
- Burnup/heatloads
- Cooling time
- Lift height restrictions
- Surface dose rates and contamination limits
- Leak tightness
- Inert gas pressure
- Surveillance/maintenance requirements

Cask Vendor/Manufacture Requirements

- Design, fabricate and test casks under an NRC approved QA program
- Fabricate a cask under a Certificate of Compliance (must not start before receipt of the certificate)
- Establish and Maintain records for each cask
- Establish written procedures and test before cask use

Certificates of Compliance Issued
August 17, 1990

Vendor	Cask Model	Capacity	Docket No.
GNSI	Castor V/21	21 PWR	72-1000
Westinghouse	MC-10	24 PWR	72-1001
NAC	S/T	26 PWR	72-1002
NAC	NAC-C28 S/T	28 Canisters	72-1003

Applications for Certificate of Compliance

PNFS	NUHOMS-24P	24 PWR	72-1004
	NUHOMS-52B	52 PWR	