UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

Meeting of the Panel on the Waste Management System

Spent Fuel Transportation Safety

November 19, 1997

Sheraton National Hotel
Arlington, Virginia

NWTRB BOARD MEMBERS PRESENT

Dr. John Arendt, Panel Chair
Dr. Daniel Bullen
Dr. Norman Christensen
Dr. Paul Craig
Dr. Debra Knopman
Dr. Jeffrey Wong

CONSULTANTS

Ronald B. Pope, Consultant, Oak Ridge National Laboratory

NWTRB STAFF

Dr. William D. Barnard, Executive Director
Dr. Sherwood Chu, Senior Professional Staff
Dr. Daniel Metlay, Senior Professional Staff
Michael Carroll, Director of Administration
Linda Hiatt, Management Assistant
Davonya Barnes, Staff Assistant

I N D E X

P R O C E E D I N G S

8:30 a.m.

ARENDT: I wonder if you could all be seated, please? I understand I slept through a fire drill last night. I suspect this will keep me awake all day.

Good morning and welcome to the meeting of the Waste Management System Panel of the Nuclear Waste Technical Review Board. I'm John Arendt, Chair of the Panel. I'm a Chemical Engineer and have my own consulting firm. I specialize in various phases of the nuclear fuel cycle with national and international standards, transportation and quality assurance are a few examples.

I'd like to introduce the rest of the Panel. Daniel Bullen. Dan is in the Mechanical Engineering Department at Iowa State University where he specializes in Nuclear Engineering, and in particular, Nuclear Waste Management. He Chairs our Panel on Performance Assessment.

Normal Christensen. Norm is Dean of the School of Environment at Duke University, and brings expertise to the Board in the areas of biology and ecology.

Paul Craig. Paul is Professor Emeritus of Engineering at the University of California at Davis, a physicist by training. His special expertise and research interests are in energy policy issues related to global environmental change.

Debra Knopman is not here yet. I will introduce her when she comes. But Debra is Director of the Center for Innovation and the Environment in Washington, D.C. She's former Deputy Assistant Secretary at the Department of Interior, a former scientist and science manager at the USGS, and an expert in ground water hydrology. She Chairs on Panel on Site Characterization.

Jeff Wong. Jeff is a Board member, although he's not a member of this Panel. He is Chief of the Human and Ecological Risk Division of the Department of Toxic Substances Control of the California EPA, Sacramento. He is an expert in risk assessment and Chairs our Panel on environment regulations and quality assurance. And I don't believe we have other Board members here that I see.

Also with us today are several members of the Board Staff. Woody Chu. Woody serves me on the--or provides Staff report for the Transportation Panel. Mike Carroll. Mike also assists. Bill Barnard--there he is. I almost lost you, Bill. Bill is Executive Director of the NWTRB.

Anybody else here from Board Staff? I don't think so. Linda Hiatt helps with whatever you need help with.

We also have with us this morning Ron Pope, and Ron is serving as a consultant to our Panel. He's an international expert on radioactive material transportation.

His 35 year career has included work in a number of aerophysics and energy fields, including radioactive material transportation and high-level repository systems engineering. Ron was responsible during his tenure at IAEA, actually for three years, for completing the International Regulation for the Safe Transport of Radioactive Material, Safety Series Number 6, 1985 Edition, and its companion, Advisory and Exploratory Document, Safety Series Number 57 and Series Number 7 respectively.

We're only able to conduct an in depth review of a limited number of topics at a single meeting. There are other important safety topics that deserve review, and these will be covered at a future panel meeting.

Today's meeting has three parts. Part One provides us with an overview of the federal regulatory framework for spent fuel transportation. Part Two, the longest session of the day, is devoted to analyses that relate to risks associated with spent fuel transportation. We will hear about data on the historical safety performance of the many shipments in the past, and about more quantitative analyses and tools to predict the risks of prospective shipments. There are many models and studies about risk, and again we have to limit ourselves to a few. We are reviewing this subject because these analyses and methods are used to assess the potential safety of future shipments. As we shall see, they are not without controversy. There will be a critique of some of the past DOE NRC sponsored transportation studies as the last talk of the session.

Before we begin, I need to announce that we will have a public comment period this afternoon shortly after 5 o'clock, and tomorrow morning at around 11:30. If you wish to comment during either of these times, please sign up at the registration table in the back, and we will call on you at the appropriate time. Each speaker will be limited to five minutes, but there's no limit on the length of written material that may be submitted for the record. We consider these comment periods to be a very important part of our meeting.

And now we'll begin with today's session, first session, and we'll start with the federal regulation framework, and Richard Hannon will make the first presentation, followed by the NRC. Each will have about 45 minutes, about a half hour on the talk and 15 minutes for questions. Mr. Hannon will lead off for the DOT. Dick is the Director of the Office of Hazardous Materials Planning Analysis within the Research and Special Programs Division for Administration of DOT.

Before you start, Dick, I will try to keep us on schedule. We have a lot to talk about and we may come to an end of a particular talk and question period, and I may have to stop at some point in order to stay on schedule, or if we don't, we'll never finish. Dick?

HANNON: Thank you, John. I think we'll handle that last comment first. I will be serving primarily just to introduce Rick Boyle and other members of DOT. If I were making the presentation, I'm afraid we would violate your sanction at the beginning. So Rick will be making the presentation.

I would at this time like to recognize some other members from the Department that are here in the audience. They will be available for either fueling questions that we had, or I think take advantage of their presence, engage them in conversation at breaks, and so forth. This is an opportunity for us to meet with the Board and the Panel. I enjoyed it four years ago, so we look forward to that.

We have representatives from the Federal Rail Administration. We have Mr. Ed Pritchard, we have Kevin Blackwell--if they would stand and wave. We have Claire Orth. They're both from the safety side. Claire is with the research side in Federal Rail, and has responsibilities in the nuclear area.

Federal Highway, we have Richard Swedberg, who came in from Denver. He's probably the most knowledgeable person in Federal Highway on routing issues. And from the Research and Special Programs Administration, we have Jim O'Steen, who is the director, my counterpart on the technical side. We have Dave Lehman of my staff. We have--anyone else? Anyone else from DOT that wants to identify themselves at the beginning?

Okay, without anymore delay, Rick will be making the presentation. He's on the technical side, and he will be making the presentation.

BOYLE: Good morning. I'm Rick Boyle, and the first thing I'd like to do is thank the Board for the opportunity, although Mr. Hannon was here four years ago, I was not. It's always nice to get a chance to tell everybody what we do. We're proud of what we do, and the safety record we had, and we appreciate the opportunity to share it with you.

I'm the head of the Radioactive Materials Group in the Office of Hazardous Material and RSPA in DOT. It's a long title. You'll see it as we go through the organization, where we fit in, so I won't try to explain it now. Your web site is much better than the one I'm listed on, so I had all of your BIOs, but you didn't have mine.

I have a bachelor's from Virginia Tech, so with respect to John Arendt, I wish the previous chairman were here so we'd have a fellow Oakie in the room. I have a master's in engineering from Catholic University and I spent seven and a half years working across 395 with the Navy in Crystal City, and the last five and a half years at DOT, half the time working as a packaging specialist in the Radioactive Materials Group, and the last two, two and a half years being the Section Chief in that group.

The first thing we'd like to do is give you an overall view of the federal roles and responsibilities, move into DOT's role, some of the ongoing operations. We had a meeting with Mr. Chu, or Dr. Chu, who gave us some of the highlights that you may be interested in, so we wanted to hit on those. We'll then turn it over to the NRC, Mr. Charlie Haughney of the Spent Fuel Program. We'll move into the NRC's roles and responsibilities, and then highlight some of their operations.

This slide, the first point as you look at the federal government and spent fuel transportation, you really have three agencies involved. Two of them, the Department of Transportation and the Nuclear Regulatory Commission, serve as regulators, and one, the Department of Energy, serves as I guess the regulated. I don't know if that's a proper use of the word, but that's the way we see it.

I'll let Charlie further explain the role between NRC and DOE, but there's a little bit of a good cop/bad cop role here, in that the Department of Energy is not a licensee to the NRC, so there's a little bit of a difference between the way they treat the Department of Energy and the way they would treat their licensee.

As far as the Department of Transportation is concerned, though, they are a licensee type regulation, and with the exception of national security shipments, which they do in safe secured transport systems, they are under our regulations and have to comply.

Where does our DOT authority come from? If you look in the top left of the slide, the Hazardous Materials Transportation Act, the first one was passed in 1975, which gave the Secretary of Transportation the authority to regulate HAZMAT. The first major reauthorization came in 1990. Probably you've heard of HMTUSA, the Hazardous Materials Transportation Uniform Safety Act, long words, but that was the first time we got reauthorization.

Mr. Hannon is here. If I go too far astray on this, I'm an engineer, he'll reel me back in, and if you have too many more questions about our authority, meaning the Department's authority, Mr. Hannon would be the best one to see at the break.

But rather than read you the act and read you our regulations and say this is what we do, I'd rather just give you an overview of our program, and a sample of some of the numbers of what we're dealing with.

Right now, the secretary has defined nine classes of hazardous materials for transportation. You look at our flammables, liquid solid gases, our non-flammable gases, our poisons, corrosives, explosives, other regulated material, and the one we're interested in, Class 7, is radioactive material. Now, each one of those, the Secretary in Title 49 has set up regulations for packaging, transportation standards, and communication standards. Communication would be the labeling that's put on packages, the placarding, the shipping papers, all of that is in Title 49 of the Code of Federal Regulations.

Right now, our--1.2 million packages per day of hazardous materials are shipped within this country. If we give ourselves a generous outlook and say 5 per cent of that is radioactive material, that would be about 60,000 packages a day of radioactive material.

If we turn to our colleagues at the NRC, they'll tell us roughly 1,300 shipments of spent fuel has been made in this country since 1979, and as Yucca Mountain or some other repository--I don't know if that's fair to say Yucca Mountain all the time, I do refer to just a repository--were established, you're looking at about 2,000 shipments a year would be a fair ballpark of what you'd be looking at. So we certainly deal with a much broader sense than just radioactive material.

As you can see from the last slide, we had a co-regulator situation between the NRC and the Department of Transportation. So what we did in 1979 is we established a

Memorandum of Understanding between the two agencies, and formalized who would be responsible for what.

I think the most important aspect to let you know is this is a very active and living document. As you can see, or I hope you'll see that even from this presentation, the slides merge together very well. We're not talking over each other. We work together, see each other probably at least on a weekly basis. If I return my phone calls promptly, we probably talk to each other every day. But they tell me I don't quite achieve that. But we're very hand in hand with the transportation staff at the NRC, and certainly rely on them for the technical assistance.

DOT's responsibilities; we have the responsibility for the overall classification of radioactive material, and anything under the Type A quantity, classification meaning we set the definition for what is radioactive material all the way at the bottom. So what needs to fall under the regulations, we set that.

A Type A quantity is a quantity that imposes hazards, but not a large hazard, so that has to be in packaging withstanding normal conditions of transport. We define where that line shall be for each nuclide. And then you can take a case; we regulate underneath that line. The NRC would regulate above that line. And those are set nuclide by nuclide. We have a mixtures rule and everything else.

The one exception to that is listed as LSA/SCO. That means low specific activity or surface contaminated object. Just as we have an exception if you have a very, very small quantity of material, a limited quantity, we also have exceptions if you have a very low concentration. If you have a small amount of nuclide mixed in dirt, say, you may have a greater than Type A quantity, but its concentration is so dispersed that it gets a packaging and kind of falls below the line. We regulate that.

Transport operations is our next responsibility. We set the safety standards for the mechanical conditions, the carrier. We do all the mode and the vehicle, we set all those standards at DOT. We do the handling and communication as well. And, again, communication would be the shipping papers, the placards, the labels, the marking that's required on the packages. That's what we refer to as the communications.

DOT also serves as the National Competent Authority. Briefly stated, that's the U. S. representative at the IAEA transport meetings. With they get together to discuss the international regulations, which form the basis of our domestic regulations, we serve as the head of the delegation. And in my two and a half years representing the country in that role, the NRC or multiple NRC people have always been right there with me, both at the preparation meetings and at the meetings. So we further team in that regard.

In the essence of time, I don't think it would be a good idea for me to go over what the NRC's role is, because Mr. Haughney will be doing that later. I do just throw out that they are responsible for the receipt, possession, use, transfer of by-product, source and special nuclear materials. And they set the standards for the design and performance of Type B packages and fissile material packages.

Those of you that are familiar with the IAEA regulations, you're going to see air transport standards coming up in the '96 version. Hopefully, we'll adopt that just after the year 2000. It's not in the MOU, but Type C packaging for air will also be the NRC's responsibility.

In this case as we deal with special nuclear materials--excuse me--spent nuclear fuel, not special nuclear materials, we also have a Memorandum of Understanding with the Department of Energy. I think, as you can see, because of the 1.2 million shipments a day, we're dealing with HAZMAT. Since the Department of Energy isn't moving too much product now, our MOU is active in the sense that we have it on paper and we know what each other's responsibilities are; it's inactive from the standpoint we do not meet with them on a weekly basis to see what they're doing. We do not call them every day to say how are things going. It's certainly not as lively and active as the one we have with the NRC.

We do see, however, that it is in both agencies' best interests that we have this Memorandum of Understanding, and we define further what the Nuclear Waste Policy Act told us we had to do.

I think first of all and foremost, the Department of Energy is responsible to manage and transport the material, and that the Department of Energy will act in accordance with the DOT regulations when they move it.

Secondly, in the Memorandum of Understanding is there are provisions for compliance and enforcement, that the two agencies will sit down, develop the, if you will, enforcement or compliance jointly, and the program, as you see, will cover pre-shipment, en route, and post-shipment requirements.

Finally, as you get into the smaller words of the Act, the Secretary of Transportation is tasked with the overview, if you will, of ensuring that the public carriers will economically and efficiently transport this material. Also within the Memorandum of Understanding is a compliance--not compliance--a teaming effort where all studies run through DOE, DOT would collaborate on. We do those studies jointly and, therefore, when the conclusion was being reached, DOT would be participating in that decision. We wouldn't have to start over at a late date. So it is set up as those studies are run, the Department of Transportation would participate in them.

Briefly looking at the Department of Transportation, I'm going to concentrate, and the next slide will show it better, on the four spheres on the left side, the Research and Special Programs Administration, where I work, the Federal Highway Administration, the Coast Guard and Federal Railroad Administration. We believe those are the administrations actually working on the spent nuclear fuel transport. For completeness, we have listed the other side of the organizations on the chart, Saint Lawrence Seaway, Maritime, Federal Transit. FAA is not mentioned in this case because we do not anticipate this material to be flown any place. They are certainly an active participant in RAM transportation. As anyone familiar with the pharmaceutical industry would know, they are not listed on the important spent fuel side because we don't see it to be air shipped.

If we could just break down the four operating elements, you see the Coast Guard because there is a possibility of inland waterway or barge transportation. They're deeply involved. Federal Highway and their Office of Motor Carrier Safety as well are both involved for surface transport over the highways. And as Mr. Hannon said, Mr. Swedberg is here from the Denver office. He's available at coffee breaks, or if you ask too tough a question, I'll yield to him for highway issues. Federal Rail is also involved in it. They have branches working with the actual railroads, with the power, the locomotives. They have an equipment group as well as a HAZMAT group. As we said before, there are three representatives from Federal Rail, Kevin Blackwell, Ed Pritchard, and Claire Orth are also here.

And then RSPA has the overall HAZMAT program where we set the standards for the Modal Administrations to enact. And I sit in that office from RSPA. Your next level down is the Office of Hazardous Material Safety. The Associate Administrator is Allen Roberts. In his office, I sit in the technical office, the Hazardous Material Technology office, which is headed up by Mr. O'Steen. And I head up the Radioactive Material Transport group. So that's how you trace the Secretary, all the way down to my desk.

Some of the issues that we were asked to touch on were highway and rail routing requirements, the preemption requirements, enforcement program, training, mode and route study, and dedicated train study.

Highway routing. Simply put, I get off the hook here. Spent nuclear fuel routing is the responsibility of the Federal Highway Administration. Now, management said just say that and go on to the next one, and let Highway fend for themselves. I thought I'd give you a few bullets before

I skipped right onto the next topic. So although Jim's here to catch me doing this, don't tell my management I went beyond their recommendations.

Basically, spent nuclear fuel must travel preferred routes. Preferred routes are defined, absent of the state selecting of alternative routes, it's the interstate highway system, is a preferred route.

Now, a state certainly can select an alternative route, and there are guidelines for that. I have that book here, and it's available through Federal Highway, the "Guidelines for Selecting Preferred Highway Routes," it gives them the primary and secondary criteria for use in designating alternative routes.

What are some of these factors? I'll just touch on the chapter headings rather than read the chapters to you. The first thing and the primary side of the house that they'd have to consider is comparing radiation exposures, the health risks of selecting these alternative routes, accident release frequencies and what the consequences would be, and the economic risks to the areas that you are now routing them through in the alternate routes.

If you can make a decision based on those primary considerations, you would not have to go to the secondary. If you were still at a wash between the interstate highway system and the alternatives, you have a list of secondary considerations, including what's the emergency response capability, would you have a timely emergency response, are there evacuation criteria for the areas you're routing the material through, and are there any special facilities located along the route. A special facility would be a hospital, schools, churches, stadiums, and the like, something that would be a special consideration.

And, finally, as you identify alternate routes, you have to look at the coordination between local jurisdictions and neighboring states. One state can't say we want an alternate route to go to the north, and the following state says no, we want it to go to the south, because you have to respect, it can't just drop down along an imaginary path. So there is an intermingling from state to state and locality to locality.

Now, rail routing is even easier. We could have just put up none. There are no requirements really. But to let you go a little bit farther than that, there are no specific rail routing requirements. As you know, the railroads themselves are privately, or publicly held. But I did again want to carry you a little bit farther. Rail routing is determined by the carriers in conjunction with the shippers.

We have some experience right now in the research reactor return shipments that we're bringing research reactor fuel back from Europe. I've been involved in the process of how they've been routing that in through the Carolinas. I don't know if that process is applicable to a Yucca Mountain, just because of the numbers of shipments you're talking about. In that process, though, I have been impressed with the coordination between the Department of Energy and the states and the local government, and in this case, it was CSX railroad.

It was almost a conglomeration around the table, the railroad saying this is what's possible, because where the tracks are, meeting the needs as to we have locomotives to do dedicated train if that's what you would like, DOE taking that information back to the localities, and what were their needs and times. So it's a very iterative process.

Again, I don't know if they'll go to that length for this number of shipments, but I do see that it will be somewhat like that.

We do have preemption. And what would a meeting be without a lawyer? One person we didn't identify--maybe we were trying to hold him in reserve, our ace in the hole--Mike Hilder from our legal counsel staff is here. So, again, if I go way off base on preemption, or if you have real hard questions or you want to discuss it further, Mike Hilder is here. I can't see him, but trust me, he is here, and when I go off base, he'll jump up and tell me.

Basically, you have three conditions where your states or locality--I'm just going to say state, but it is state, local, Indian tribe, it's the whole ball of wax. I just say states; I'm not trying to cut anybody out. Three conditions for preemption; when compliance with both the federal and state regulations is impossible, when the state government is an obstacle to complying with the federal regulations, or when a subject that is covered in the federal regulations is not uniformly covered in the state regulations.

I think no surprise to anybody, RAM Class 7 leads the way in preemption efforts. Most of them have been along routing criteria where a state has selected an alternative route that was in violation of the standards. I held up the book before. It was deemed in violation of the way we told them to designate alternate routes. What happened is they used different criteria. They wouldn't evaluate the criteria the same way we did. And those were preempted.

We also had preempted cases where a local government was selecting alternative routes. And if you remember, we said the state could identify alternate routes, but we were not allowing localities to identify different routes. So those have been preempted.

And finally, as I said, you have to work within county to county, state to state. Some were preempted because they hadn't done that. They hadn't worked with the local government.

That's preemption in a nutshell. As I said, that's a very complicated case. We did bring along one of our lawyers to smooth that out if you need more information.

Our enforcement program, again, Charlie Haughney will explain the NRC and the actual actions that take place. And I think the actions the NRC take enforcing Title 49 would be uniform, whether either one of these organizations or any of these organizations take those actions. So rather than getting into detail of what goes on in an enforcement program and numbers, I'll leave that to Charlie.

I'll just say for enforcement of our hazardous material regulations, in-house, we have an office of enforcement. They're just right below us, three floors down. We're in constant contact with them. So that's in-house, and they have four regions throughout the country.

DOT Modal Administrations also have programs. We referenced Federal Rail's HAZMAT program. Some of the representatives are here from that program. FAA is an ever-growing HAZMAT program based on the Valu Jet incident, they've been growing. Also, Coast Guard is an obvious one, the research reactor shipments, they were definitely involved as we were bringing those into U. S. waters. The Nuclear Regulatory Commission enforces Title 49 as well as their own

Title 10. State, local, tribal governments also if they have adopted Title 49 would have an enforcement role. As I said, rather than duplicate Charlie and give you the particulars of the enforcement program, I'll defer.

Training, a relatively new rule for us. Subpart H of Title 49, Part 172 requires a hazardous material employer to provide function specific training encompassing general awareness and familiarization training, specific training for the job function performed, and general safety training. There are a repeating basis. You can't have it once and then you're done for your career. You're redoing that on I believe it's a bi-annual basis. You have to have documentation that you've trained the people. You have to have documentation what function they perform and how that was defined. That's all spelled out in Part 172, Subpart H.

Similarly, the last paragraph says Modal organizations must do the same thing. So as you drop out to Section 174, 175, 176, and 177, which not in this order are highway, rail, water and air, they also have requirements for training of HAZMAT that are set up in there.

The two issues we'll just touch on, the Mode and Route study, under Section 15 of the Hazardous MTUSA in 1990, the Secretary was asked to do this study determining mode and route, with the purpose being to determine which factors, if any, should be taken into consideration by shippers and carriers in order to select routes and modes which, in combination, would enhance public safety. And then, second, purpose, assess the degree to which various factors affect the public safety of such shipments. I apologize for just reading that, but I was kind of led into don't stray from the points on mode and route. Stick to the point.

The study, we've been promising it, I liken it to when we were adopting the 1985 regulations from the IAEA, it took us seven years to do it, so we has seven years worth of meetings where we kept saying next month, or six months from now, it will be available, and we went through that. I kind of feel like we're doing the same thing here. We're still close to it. Six months or a year is the official party line till you see something.

And I think I'll just leave it at that. If you have direct questions on mode and route, I would refer you to the gentleman that introduced us, Mr. Hannon. His office is putting it together in conjunction with Volpe up in Massachusetts. They'd be the best to answer your questions on that.

Also, under the HMTUSA Act, Federal Rail was assigned to do a dedicated train study, with the purpose being to assess the comparative safety of transporting these materials either in general rail service or by dedicated trains.

Again, same story; it's in the final phases. The study is generally done. They're working on the conclusions, and we're six months to a year away from that. It's my personal assessment Federal Rail is responsible for publishing it. And I do kind of hate to just deflect everything off to other people, but as you can see, the RAM program is rather large. The representatives from Federal Rail, Mr. Blackwell, Pritchard and Claire Orth, will be happy to talk to you about dedicated train study, either at the break or when we get into the question and answer phase later on.

That concludes my presentation. Again, I thank you for the opportunity to speak, and I would just defer back to the Chairman. Is it better to do questions and answers now, or let the NRC speak and then both of us kind of come back up?

ARENDT: Before we do that, would you introduce the DOT people that are here with you?

BOYLE: Certainly.

ARENDT: And ask them to stand so that everybody can see what they look like, and so they can talk to them during coffee breaks, and so forth?

BOYLE: Certainly. Mr. Richard Hannon is right here on the corner. If you have questions about mode and route study, anything with a legal or past basis, Mr. Hannon from our Office of Planning would be the one to ask. We also have from Federal Rail for dedicated train, for rail routing, for rail safety criteria, Mr. Blackwell, Kevin Blackwell, Fred Pritchard, Ms. Claire Orth, any one of the three would be available. We have Mr. James O'Steen, who is my boss in the Office of Hazardous Material Safety, the Technology Branch, any HAZMAT question is fair game for him. Put him on the spot. He'll answer anything.

We have Richard Swedberg from Federal Highway, so if you had questions on highway routing, Mr. Swedberg would be able to answer those. Mike Hilder from our legal staff is here. He would answer all your questions on preemption. And then if you have questions about the RAM regulations, again, my name is Rick Boyle and I would cover those.

And I believe--did I leave anybody out? I guess not. Paul Zebe is here from Volpe, so if you have questions on our mode and route study and how we're doing that, I believe he would be able to address those.

ARENDT: I think we'll go ahead and just take questions now. Any questions? Paul?

CRAIG: Yes, Paul Craig, Board member.

I wonder if you'd discuss the public's right to know, and particularly, right to know in advance of shipments, and separate that between road shipments and rail shipments and marine shipments?

BOYLE: The right to know, the notification, again I don't want to defer to the NRC, but the NRC has--these are safeguarded shipments, so they aren't announced in advance. Again, I'll defer that to Charlie Haughney to give all the details of their safeguarding program.

My understanding from the Department of Transportation, the government, the state governments, the governor of states are notified when shipments are coming through. I believe of highway route control quantities, that's no less than seven days in advance. On safeguarded shipments, my understanding is that he's not allowed to release that and say this material is coming through at such and such a time on a particular route. This would violate the NRC's safeguarding rules.

CRAIG: Who is the person within DOT who specializes in this area?

BOYLE: I would say Mr. Hannon, just so I can defer this, but you do need to make a distinction between highway route control quantities, which is, for simplification, very large quantities of radioactive material, which require notification, that goes to the governor and there's no safeguarding policy on that. He could release that material freely.

Under the NRC's safeguarding rules, when you're dealing with spent fuel or other safeguarded issues, he's not allowed to then transfer that and announce it to the public that certain shipments are coming through at a certain time. So there are two different issues at play here.

ARENDT: Debra Knopman has arrived, and I wish she would hold her hand, or even stand. Debra, if you wish, please? And she also has a question.

KNOPMAN: Thank you, John. Actually, I have two questions. The first is would the person who can speak to the timeliness or lack thereof of these two studies that you mentioned please explain why, if they're almost done, it's going to still take a year?

BOYLE: Is the second question related to that one, or is the second question--

KNOPMAN: The second question is different. Why don't you do this one first.

BOYLE: I'll turn mode and route over to Mr. Hannon, and then Federal Rail I guess can use the center microphone to discuss the dedicated train.

HANNON: A point of clarification in Rick's remarks was I think the mode and route study is much more imminent than the dedicated trail study. We're thinking of a matter of weeks or months.

When I appeared before the Board four years ago, I would say three or four months. Burned once, I don't want to say that. But the report is in final, it's all, you know, in fact printed. We have the final version. We're just awaiting the political process of sign-off. It will not be a report to Congress, as the dedicated train study will be. I think the explanation for its gross tardiness is the sense of priorities. We did send one out for public comment several years ago, and comments were received and incorporated. I believe the report is, you know, it should be available in the next month or two.

I have the summary in front of me, and we're ready to go. We would have liked this forum to have released it, but the process, the priorities of management precluded that happening.

KNOPMAN: The second question just has to do with logic, I guess. We have an elaborate, somewhat elaborate process of highway routing and coordination, and we have virtually--

BOYLE: Did you want to get your answer on dedicated train study?

KNOPMAN: Oh, I'm sorry. Yes, if there's a different answer there.

BOYLE: Sorry, Kevin.

HANNON: Well, Claire Orth will be giving the answer for Federal Rail. Both these studies were mandated in 1990. There was a requirement that the dedicated train study be reported to the Congress within a year. The mode and route had a different language, so it had less priority.

Now, putting you clearly on the spot, Claire.

ORTH: We have very similar problems with trying to get the report out, priorities from our higher up management. We are still working on the report, and since this will be a report to Congress, we're estimating about six months to go through the review process. This would be going through the departmental review, OMB review, and at least--and I'm basing that on some of the recent reports on our programs dealing with high speed rail. It's taken six to nine months to get that through the DOT and the OMB review process.

KNOPMAN: So in both of these cases, it's really at the Secretarial level at DOT where that review process has to proceed, or is out of the Rail Administration?

ORTH: The dedicated train report will go through FRA management review. Since we have a new administer since the Act was initiated, we have to go through an internal review process. Then it would go through the departmental review process, then OMB.

HANNON: I believe there is a difference and Claire has captured much of it. Ours would not have to go through the full OMB review, you having served in the executive know that can be the valley of death sometimes.

KNOPMAN: One of; right.

HANNON: But I think basically no one has really been--also from your experience, no one has been yelling for it, neither the Congress nor agencies. And, you know, we respond to pressure. I've gone as far as I've gone with some staff members I think just--I think if the Board chooses to do that, that could well be effective.

KNOPMAN: Okay, good. Thank you.

Now, the second question just has to do with this incredible disparity between procedures for rail routing and highway routing. Can you offer any logical explanation for why there is a difference? I mean, if you're living in a neighborhood and you've got a highway not far from the front of your house and you've got tracks behind your house, you find out on the one hand, your neighborhood would be disqualified for any highway routing, and then the next thing you know, there's trains going behind you carrying the same stuff. Can anyone give an explanation?

BOYLE: My opinion is it's the nature of the beast. The railroads are publicly held. They own the railroad and they set their own routing requirements, within the industry, the industry has some sort of--you know, they've been de-regulated, but there's some regulation as to what the railroads will and will not be able to do, yet the public highways are just that, they're public. So they do fall under Federal Highway Administration's rules as to how they're used, and it's just the nature of railroad versus highways.

KNOPMAN: Well, that's not the way we usually deal with safety issues. I mean, even though there is a difference in owner, we have a whole set of environmental laws that, in effect, do not distinguish between public and private.

BOYLE: If we restrict our conversations to spent nuclear fuel, the safety rests in the packaging, and that's how the regulations are set up. And then those packages are intermodal to a large degree. We are not relying on rail to provide some extra measure of safety that highway doesn't or vice versa. So, therefore, I don't think that--again, my opinion, you're not under any more risk by putting it on rail or putting it on highway. The choice of routing and the regulations defining how routing will be selected is based more on railroads being private ownership, and highways being public ownership.

KNOPMAN: Well, on that logic, you then wouldn't do any of your routing on highways. I mean, you wouldn't have any of your routing procedures on highways.

HANNON: If I might add a point? I think clearly the Department and the federal government does have authority over, whether privately or publicly owned, rights-of-way and it has exercised that. I think the genesis of the routing requirements, they're specific for the highway mode and they've had a long and checkered past over 20 plus years, they responded to questions in the New York City area. I think as the volume of spent fuel shipments go, I think there's going to be clearer regulatory requirements. Whether they're going to come from the Department or whether they're going to just be mandated by status, I think that's going to happen.

I think the richness of the networks between a highway system and a rail system was one of the major differences back in the '75 or early '80 time period for not getting specific requirements for the rail mode.

KNOPMAN: Okay. That's very helpful. Thank you.

ARENDT: Dan?

BULLEN: Bullen, Board. This is just a quick question of clarification.

In your preferred routes from the highway routing, you mentioned that spent nuclear fuel falls under that type of jurisdiction. But the special nuclear materials, specifically research reactor fuel, has the same kind of requirements; is that not correct?

HANNON: Yes, it does.

BULLEN: Okay, thank you.

ARENDT: Any other questions from Board? Ron, do you have any? Staff?

(No response.)

HANNON: Again, thank you for your time. I'll be here through the whole seminar. If you think of a question later, feel free to ask. And with that, I'll take off the microphone and turn it over to Mr. Charlie Haughney from the Nuclear Regulatory Commission.

ARENDT: Thanks very much. Charles Haughney was Director of Spent Fuel Projects Office for the NRC, and he will be our next speaker. And, Charlie, if you would, also introduce people that have accompanied you and have them stand so that they can see their faces.

HAUGHNEY: Thank you, Mr. Chairman.

I am Charlie Haughney. I'm the Acting Director of the Spent Fuel Project office at the Nuclear Regulatory Commission. As the name implies, there's a heavy emphasis on spent fuel, not only from the transportation standpoint, but on storage, and I must tell you that probably 80 per cent of my time is placed on dry storage issues and problems with power plant refueling schedules and all that sort of stuff. But nonetheless, we have our transportation regulatory group embodied in that project office spread through three different sections.

My own background, I started off as a Navy Nuc after graduating from RPI, served on active service in submarines for about 12 years, and have been at the NRC most of the last 20 years, other than a brief manifestation of an early mid-life crisis.

Throughout this entire time, I've really spent most of that 32 years on reactor operational safety issues. I've been involved with transportation for three years, and storage for the last six. I do have two very able assistants here, and with your permission, Mr. Chairman, I'm going to give them a chance to present the last couple of slides. Earl Easton is not going to be just a slide shower, but he is one of my real experts on transportation safety, and he's accompanied by John Cook, who's sitting at the table with close access to a mike. So at this point, I'm ready to start.

I'm going to go quickly through some of the slides, but not this one, because as I look at the agenda, the topic of the discussion is explain what our agency does with respect to transportation safety, and I think these five points here are key.

We really spend most of our labor on the top one. Package certification is really is design review process where we examine the design, the drawings, the calculations, the qualitative analysis that may be present to determine whether or not a certain package may in fact comply with our regulations for both normal and conditions for transport and hypothetical accident conditions that the package is postulated to encounter.

We don't do this for every type of radioactive materials package, but do it for a smaller set, that is the so-called Type B packages, and these include spent fuel, radiography sources and other larger sources, higher activity sources, and then fissile material, for unlike Rick Boyle's group in DOT, we have a cadre of criticality engineers that can do criticality safety analyses. So we do all the fissile packages. And typically, this group approves about 100 licensing actions a year. Most of those are amendments, some renewals, and then a smattering are new packages. We also revalidate some foreign certificates that are for packages that will be coming into the states.

The next bullet is becoming increasingly important. We do sort of a licensing review of quality assurance programs for package fabrication and loading, and approve these as necessary throughout the year. But most of that labor is involved in actual on-site inspections of fabrication activities, or even at design shops of how they do design control, do their calculations, et cetera, and these we find are increasingly important, because of something that was mentioned a few moments ago, and that's the safety philosophy of these packages. And that's that the packages will not fail in rather extreme accident conditions, should they experience that out in the public domain.

Transportation packages are not like reactor vessels, but are surrounded by a containment of high pressure injection and containment spray and all these defense in depth systems, plus a cadre of nuclear trained personnel that can immediately come to the scene. These packages are in normal commerce. They are in transport on the highways and rails. I live a hundred yards away from a main rail line that is likely to have quite a number of these shipments if this large campaign of spent fuel ever gets moving. So this is a very, very important part to ensure that the thing is built the way it was designed and approved.

Now, in the area of physical protection, which we'll talk on later, what we do is to look at the route that's been selected through the process, whether it's highway or rail, to see that the appropriate safeguards contingencies are available and in place from a physical protection standpoint. And even right now where we're in a very quiescent stage, it's interesting to note that we do about 15 route approvals a year in terms of safeguards routing, and most of that is for, I would say, for research reactor fuel.

Finally, we've got the explicit authority to enforce DOT regulations, and we make use of that. I would like to think that at times, we've become necessarily the bad cop, but at any rate, our inspectors are free to enforce all of Title 49, as well as our own component of the regulations, and we get into some of those issues.

Emergency response, we're primarily an advisory and an assistant, and I'll talk about that later.

The next two, I'd like to propose that we skip because I think Rick Boyle covered them. They're all on the MOU, so if you could flip past that, I know that the text is a little bit different, but it really doesn't say anything, and I think we're already a little bit behind. So with your permission, Mr. Chairman, I'll show the next one, which involves a little bit of statistics.

The NRC is directly concerned with the bottom row, the Type B packages, and you can see the accident history there. Incidentally, the time span, we should have labeled it, but it's from 1971 to 1995. The different types of packages shown there, as you go down the left-hand column, the design requirements become more and more stringent because the package contents are higher in terms of their relative radioactive material hazard. So the Type B are the most robust. And you can see also that those types of packages not only have fewer accidents, but their failure record, failure being a breach of the package or a violation of a fundamental design basis like criticality, so far has been zero.

The other packages don't have the same requirements, so some of them have been breached, but the contents are relatively modest. I'm not dismissing that as a non-event, but it's the sort of thing that you can't get an immediate or even a near-term public health and safety consequence.

We typically use a figure that there are about 3 million package shipments a year, but I must tell you that some of them in the small quantity range are not really recorded. They're just in normal contents and have such modest quantities of material that they aren't tracked in such a fashion that there's a nationwide reporting system. We're trying to do a re-estimate of that package shipment rate, and I expect it's going to be higher, but there will always be some uncertainty in that number, It's not within an order of magnitude, but if you're looking for a couple of significant figures, I doubt if you'll ever get it. That's not true for the Type B packagings where we can tell you those shipments quite accurately.

I mentioned that the design basis includes two main parts; the normal conditions, and you see the list here. Let me just give you an idea of what those mean a little more explicitly. The package is assumed, like the high heat load, to be in a 100 degree Fahrenheit day, plus full solar insulation, and the solar heating being absorbed into the package contents. Cold is minus 40.

The increased or decreased external pressure is really meant to accommodate air travel as the package goes up and down through the atmosphere that the plane experiences.

The free and corner drops are meant to consider the normal sort of drops that you would have in handling, like in warehouse situations. There's several feet both onto the sides and corners.

Compression is designed to include the fact that many packages may be in the same shipment and, thus, their weight adds together and that you may get some sort of effect there.

I might say something else about these design parameters because people like to quibble with them, you know, and say, well, let's go up to 125 degrees, it gets that hot in the middle of the Arizona desert, and all that sort of stuff. All that is true, but the conditions aren't just U. S. borne. These are really international standards that are adopted by the International Atomic Energy Agency, and then intended for really subsequent adoption by all competent authorities, such as Mr. Boyle. And in this country, we do that through the rule-making process where both DOT and NRC changed their appropriate rules to modify these standards.

So at any rate, I feel compelled that if we were to look at one of these standards and perhaps want to modify it, to consider very seriously whether that would need prior adoption by IAEA. In actual fact, there's no legal requirement that we do that, and there's times that we can and have deviated from those. But I think we have to be cautious, because there is the weight of the scientific understanding of the international community that is present in these values.

In addition, for some, in fact many types of packages, they will in fact cross international boundaries, and you can imagine the chaos you would have at customs points if you had to be shifting packages, you know, Canada's particular package for a type of material into ours, and all that sort of thing. So the international nature of these standards I think is admittedly a little bit of a two-way sword. It has the advantage of this large consensus, but it also causes us to be cautious about making unilateral changes that might seem initially attractive.

The accident conditions involve a 30 foot drop onto an unyielding surface. That's a very extreme accident from an engineering standpoint, because of the unyielding surface. All the energy is reflected back into the package. In reality, there are no unyielding surfaces. No soil, no rock, no boulders, no bridge abutments are unyielding, especially when hit by a railroad train. But from an engineering standpoint, it's very difficult to predictively and repeatedly quantity real surfaces in terms of their performance and their dynamic loading situations such as this impact. So, thus, the structural engineers yields ago picked this particular criteria.

A puncture is onto a pin from a drop of 40 inches, and then there's the half hour fire at 1475 degrees. Incidentally, those tests or accident conditions are all sequential. The same package has to have the same damage sequence. So it is intended to represent to some degree a particular accident sequence. In some cases, you may not have a fire, you may not have a puncture, the puncture may not be just so, but nonetheless, this is intended to be representative of a fairly extreme accident.

There are acceptance limits on leakage after the accident sequence, and they're quite small. These are spelled out in the regulations and amount to a so-called A2 quantity that's radionuclide specific for each week, and we adopt the quantities that the International Atomic Energy Agency has adopted, and changed those from time to time based on changes and updating into the dose calculations.

Subcriticality of course is important, again because the package is out in the public domain.

Now, Earl is putting sort of the list of available casks for spent fuel. It's not very long, and there's all these acronyms that the vendors have come up with, and I don't want to talk about the design of each of these. Some are rail; some are truck. There's something very significant to know here, especially for people on this Board.

The actual fleet available in this country is minuscule. We're talking onesey-twosies of all these cask designs, and some of them are so-called grandfathered so they can't be built again. They're based on a much earlier version of the international regulations, so it's unlikely they could survive a licensing review of the new standards. And so if there's going to be movement of spent fuel in this country, we need a new fleet, and this hasn't changed very much in the last few years, but there's something in the offing; applications in-house at the NRC. And these are all, interestingly enough, dual purpose.

In other words, the fuel would be loaded at the reactor plant, stored there for some number of years, or maybe hopefully a small number of decades, and then moved in the same package. An over-pack may be added or something like that, but the thing is you don't have to transport the spent fuel from the storage canister to the transport canister. That's the design basis for dual purpose. And you can see here we have quite a list of applications that are all in-house and undergoing active review in my group. I'm not going to predict the outcomes of any of these or give any dates. I'll just tell you they're in very vigorous review, but we're not five years away. You know, it's months, or a very small number of years. Some may fall by the wayside, too, that sometimes happens.

Now, I'm going to talk for a few minutes about what

I in my job find to be my biggest problem, and that's the performance of the vendors. When I use that term, I mean cask designers and the fabricators, and by implication, and really by required quality assurance oversight, the utilities. They're buying and paying for these things.

This tale of woe that I'm going to mention isn't true in all cases. There are examples where there's outstanding fabrication going on. The casks that have been loaded, the storage casks that have been loaded are performing well within their design basis. That is, things like radiation exposure rates on the surface are factors of two or three lower than predicted. Heat transfer remover rates are typically about 50 per cent high. I base that on measurement of the delta T across the convective chimney for some of these that have natural convection heat removal.

But nonetheless, in some cases, we've had problems, and the problems stem in two areas programmatically. One is the design output information, that is, the drawings, the notes on the drawings, the fabrication specs, the instructions of requirements for welding, concrete aggregate selection and mixing, all these kinds of things. In some cases, those instructions are a bit vague. Although the design is good, there's not enough--in my own opinion, there's not quite enough for the fabrication shop to easily stay out of trouble.

Another factor is that although the fabrication shops tend to have all the paper that shows that their QA programs are perfectly acceptable, they're a bit out of practice. I mean, there isn't much nuclear construction of any kind going on here. People aren't building high pressure injection pumps. Occasionally you get a new steam generator built, you know, or a new diesel engine, but there's not this wave of nuclear quality construction that we experienced in the Sixties and Seventies, and that stems to all kinds of things if you think about trying to keep a fabrication shop alive, first of all, maintaining the procedures current and up to date, the qualification and proficiency of the crew, you know, they may be able to pass a written test, but how many times have they done this type of weld.

So we're seeing this thing show up, and we're seeing it show up with problems with welding and non-destructive evaluation, with an improper selection of a paint that tended to cause a lot of hydrogen evolution when the cask was lowered into the spent fuel pool, and finally an improper puncture test on a radiography camera. All these things undermine this, you know, one or more elements of the safety basis for the design, and it required us to issue directives that would stop work at fab shops or design activities or require firms to embark on some rather expensive, elaborate and lengthy get-well programs. And some of them--actually, none of them are done that we've straightened out, the ones that we've started. You know, those sort of document our opinion.

The last thing, 72.48, is a part of the storage rule which involves changes to the design that can be done by the designer without NRC approval, prior approval, provided the change does not constitute a so-called unreviewed safety question. And those of you on the reactor side are familiar with it. This is a virtual identical analog to 10 CFR 50.59.

So when we delegated, you know, even partially this rather important activity, we expect it to be done properly. In some cases, it hasn't, so we've landed on that one pretty heavily.

Mr. Boyle was kind enough to mention several times that we can enforce DOT regulations, and this slide gives you some facts associated with that. You can see our particular regulatory cite wherein we incorporate Title 49. Then we do about 2000 different types of inspections a year, and most of them include at least a brief look at transportation activities. Most of these inspections that I'm talking about here, unlike the other ones, are at the licensees where they're loading and packaging and filling out the manifests and the attended paperwork, some at the receiving end, so that's what these are about. That's all on that.

Let's go to the next issue, which is, we touched on a little bit in the public's right to know, and that's the issue of protection against sabotage, theft or diversion. I certainly can talk about this for a while, but I would like to let John Cook know about this--or talk about this. He much more versed in the subject than I. But let me mention a couple things to think about that are a bit more general, and first, the spent fuel cask is very, very robust, very large, very heavy. It's not the sort of thing that's easily accessed in any fashion because of its mass and its inherent strength, yet of course it's not completely impenetrable to extreme cases.

The other thing is it's not very easy to steal. You don't find too many people running around stealing trains. I know that happens in the movies sometimes, but if you're interested in really stealing the material, there are much more inviting ways to get the material than stealing a spent fuel cask, whether it's truck or rail. Now, I don't want to dismiss that as a possibility, because we have all this protection in place in case it may happen, but it's still--it's quite a challenge, and certainly it's never going to be the sort of thing that a prankster is going to make any headway with.

The other thing to keep in mind is that there are also many other materials out there that are very, very hazardous, in fact, I would argue are far more hazardous than spent fuel, and they're in normal commerce. And of course my colleagues at DOT, as I understand it, spent a great deal of their time worrying about those materials far more than spent nuclear fuel, even if we get this large campaign of some tens of thousands of shipments moving.

Now, having said that and sort of implied that perhaps a terrorist might be more attracted to these more common shipments that are not in accident resistant packages, I might add, at all, I don't know that--certainly I can never get inside the minds of a terrorist and tell exactly what they're going to do, but if they're thinking about killing people, this is one of the worst targets imaginable.

Mr. Cook? Why don't you make yourself comfortable there. You're only on for a slide or two.

COOK: I'm John Cook of NRC, the Spent Fuel Project office.

Just to provide a brief introduction to the physical security program that we have at NRC, as Charlie mentioned, when you build the cask, in order to make it comply with all the accident testing provisions in order to make them accident resistant, you end up with a very robust package. That's just the way they're constructed. So these things are very robust. They can be highway packages in the 40 ton range, railway packages into the 100 ton range and beyond, and although they're not designed to withstand, there's no particular design requirements with respect to protection against sabotage, their mass in construction and the material that they're made of nevertheless provides that they provide a very considerable degree of protection against sabotage.

But the point here is that we don't rely on the packaging alone. We have a program in place to provide additional protections against sabotage. And as the slide indicates, the basic objectives here are to minimize the likelihood of sabotage in the first place, or other malevolent act, and then should such an event occur, to facilitate location and recovery of those packages.

The basic approach is to provide detection and assessment of any attempts to gain access or control of those shipments. That's kind of working in the background at NRC. We maintain liaisons and relationships with the Federal Bureau of Investigation and other intelligence agencies, and in the event that they should identify a threat against a spent fuel shipment, we would be advised of that and take action accordingly. But I would add that so far, at least to date, we have received no such identification, although should one be identified in the future, that information would be passed on to us.

As far as when the packages are out and in transport, the principal response is to provide the capability for those shipments, to notify response forces that they've encountered a difficulty. And as we'll see in the next slide when we talk about the actual means, physical means in place to protect the shipments, we'll see how that's accomplished.

And then finally, there are measures in place to try to impede the sabotage attempt in the first place, those being principally through advanced arrangements with local law enforcement agencies about the shipments, providing notifications to state agencies about the shipments, and finally, there's some physical means as well.

So if we go to the two slides on physical protection here, speaking briefly about our requirements, which are found, as indicated, in 10 CFR, Part 73.37, we have a series of requirements which come into play when an applicant comes to us and requests approval for a spent fuel shipping route.

The first thing that the applicant must demonstrate is that they have a communications center with redundant call capability from the shipment. Normally, that's accomplished these days by a mobile phone and cellular phone.

I might mention that in addition to these communications requirements, most of the trucking companies now use satellite tracking for logistical purposes. That is, they have devices on board their trucks whereby they can keep track of their presence in realtime. Now, there's no requirement in our rules for those devices, but they still provide yet another form of communication between the shipment and the shipper. The shippers are required to call into the control center every two hours during the shipment's progress.

There are escorts with all of the shipments. As a practical matter with truck shipments, for example, there's a driver and an escort with the driver. They are trained and they have written procedures as to what to do in the event of an incident. When the shipment goes through urban areas, armed escorts are required for those areas. Urban areas are identified through the U. S. Census Bureau. They have urbanized areas defined in the United States. What triggers the escort requirement is that portion of the route that passes within three miles of that urbanized area is where the escorts are required. Normally, again as a practical matter, armed escorts are off-duty state or local police, but the shipper has arranged to be present for the shipment.

We coordinate during the application process with local law enforcement agencies. The purpose here is to make sure we have identified who is the appropriate contact at each point along the route. Should you encounter difficulty, who do you need to call, and also to find out whether there are any route construction underway, or other activities that might interfere with the shipment.

We have requirements for advanced notification to both the NRC, which occurs ten days prior to the shipments, and for state governors, which occurs seven days prior to shipments, and also a route approval process, some of which I've already described. But basically, applicants in submitting their route approval request to us need to demonstrate that they have complied with the Department of Transportation's routing rules which you heard described earlier. They need to arrange for the armed escorts in urban areas, and to provide--well, to protect safeguards information, that being information regarding the time of he shipment, and the safe havens identified along the route.

If a route has not been used recently, the NRC will survey the route, that is, inspectors from our regional offices will physically drive the route. Basically what they're trying to do is check for any communications gaps and to identify what we call safe havens, which are places along the route which a shipment could be pulled into in the event of an unforeseen difficulty.

If the applicant's application meets all of these requirements, we'd issue them an approval for the shipment, which is valid for two years, and it is renewable.

In part of their planning, they need to consider avoiding intermediate stops. These shipments all go pretty much straight from origination to destination without stops. And, finally, there is a requirement for vehicle immobilization on truck shipments. That's a device which if activated, prohibits the vehicle from moving for 30 minutes.

Again, we do have some published information about the shipments. Last point, we have a circular on information that we compiled about spent fuel shipments called NUREG 0725, and that's readily available and describes the numbers of shipments and provides other statistics. That's a brief introduction on physical security.

HAUGHNEY: Thank you, John. That circular is updated yearly.

Earl, you and I will swap spots for a moment. I'll even turn your slides.

EASTON: The last topic we wish to cover is the NRC's role in emergency response. This has been a role that has been misunderstood over the years, and I think it is important that we go over it to say what we do and what we, as importantly, don't do.

But to put that in context, let me go through what happens should an accident occur real quickly. An accident may occur. The truck driver, somebody passing by will typically call the state police, the fire department, et cetera, et cetera. It is those guys that actually do the responding in 99.9 per cent of the cases. When they get to the scene, these people are trained to look for shipping papers. They're trained to look for placarding. They're trained to look for other indications of identification of what is being shipped in that particular truck or train.

These regulations fall under the Department of Transportation. They're more or less uniform for all hazardous materials. There are some particular things that apply to radioactive material. But a state policeman or fireman will get to the overturned spent fuel cask, they'll look for a placard. They'll see a U.N. identification number, that from that number, they can go to what is known in DOE parlance the Yellow Book, it's the emergency response guidebook that's updated every three years. They'll get the number off of the placard. They'll go and be able to have an idea of what the contents is and what the proper response is.

Again, local responders receive training in this book. They also have a number that they can call, which is a requirement on the shipping papers. It has to be a 24 hour a day manned emergency response number, that once you get access to the shipping papers, you can call and get whatever information, emergency response effort that you need. There's also a clearing house called CHEMTREC. It's a 1-800 number that you can call in and tell them what you see on the shipping papers or what you see on the placarding, and they will give you advice on how to respond.

Often times, the event is called into the other NRC, the National Response Center, and through that vehicle, it makes its rounds to the NRC and DOT. And we all are in the loop at some point.

Typically, if it's a severe accident, the state police or firemen who respond will take it up to the state radiological control officers. It will be escalated up to the state. At some point if it's beyond the capabilities of local or state, then the feds can be called in to either offer advice or assistance, and there are mechanisms in place to do all of these things.

And this leads us to the first slide, after this introduction, it leads us to the first slide. We have a Policy Statement, which I'll go over very briefly. It's actually the second slide. But we have a Policy Statement that was in the Federal Register issued in the mid Eighties that's very detailed, defines the NRC role in emergency response. So guidance is out there for all to see.

We did a survey in 1990, and it looks like this. We went and did a questionnaire, a pretty detailed questionnaire about each state or tribe, we identified some tribes, about their capability to respond to events. This was done by Indiana University in 1990, and basically their answer was that yes, all states and the tribes that we looked at had systems in place to respond. So I think it was a verification we felt that the system was working as designed.

And the last bullet is there is an overall Federal Radiological Emergency Response plan, and what this plan is is a coordinated plan by agencies at the federal level on how to deal with accidents. It defines the roles of agencies. It defines how the federal effort is coordinated.

And basically, the point I would like to make, this is a way for states to call upon the federal government for assistance. For example, one of the elements in this plan is that if the states don't have the capability to respond to large accidents, they can call and preposition DOE response teams to come and actually respond to accidents. You might think of a spent fuel accident, if there is ever a very severe one, might fall in this category. But this is a written down method by which federal agencies exercise their role in what would otherwise be local or state jurisdiction actions. Enough said on that.

The final slide, these are just bullets that come out of the NRC policy on emergency response. It assures that if we learn of the accident first, that we notify all these other entities. It tells the states that we are standing by willing and able to provide technical information on the packages that we certify, which is a large part of what we do.

We also have an emergency response center that we would activate, and it's basically staffed by technical experts standing at the ready of a state, local government, et cetera, for any assistance we might offer.

And this is a--the last bullet is very important. We will assume control of the scene only if we're notified first and get to the accident first, which almost never happens. the implicit assumption is the state and local authorities are trained and in place to provide the initial response.

So those are basically the points I wanted to make about the NRC role. It's a very narrow but well defined role. And I guess with that, any questions?

ARENDT: Questions? Dan?

BULLEN: Bullen, Board. I have sort of three quick questions for Mr. Haughney.

As a reactor director and someone who realizes how license modifications need to be made, or license amendments need to be made, do you feel that you have the staffing? If you're doing 100 amendments a year, and I've been waiting very patiently for my amendment, by the way, if you do 100 amendments a year, do you think you'll have the capability when the regional servicing agent, regional servicing contractors come into play, to do that evaluation, or are you going to have to have a significant staff up in your department to do that?

HAUGHNEY: That's an excellent question. Let me just-- I'm going to have to answer the question a couple of different ways, and it may not be as directly as you would like.

The budget process that we go through, which is pretty much the same as the rest of the government, as I can see, although we have the advantage of being an independent regulatory agency, at best the minimum time out in the future that I can look at is two years away. So it's in the two to five year time frame that we do our budgeting, and then I have a chance to argue.

I have found in this job that virtually nothing comes true that you budget for, and all kinds of different things do. And of course people say, well, that's happened all around Washington for decades, you know, you play the game anyway and you hope you've got enough staff to do the job.

To be honest, I'm a little bit in that mode, just based on this reality of what's going on. For instance, the whole reason I've got a staff of what is it now, Earl, 55 or 66, up from 20 two years ago--that's right, the federal government, and we actually grew--the only reason I have it is because of the Multi Purpose Canister, the MPC, which of course was this program, the burgeoning program that was going to at least solve the intermediate stage of the spent fuel crisis. I don't have an MPC application in house.

So I think if these regional initiatives come, that's going to put a strain on us. But what I expect to happen is that some of the--one large application, what I used to call the elephant in the canoe, has gotten out of the canoe and now everybody else is jumping in. And so that's probably a little tougher to plan for and manage.

BULLEN: You just led right into my next question, if you don't mind if I--

HAUGHNEY: No, go ahead.

BULLEN: As you talked about the dual purpose cask licensing, does that include burnup credit for the fuel in the transportation, or are you going to require burnable poisons included, which means you'd have to put the burnable poisons in at reactor before you closed it up?

HAUGHNEY: The whole issue of burnup credit is hinging on a topical report which the Department of Energy submitted to us a couple of years ago, and it's in active review. In fact, we're about to send out another round of questions now, I might say a much smaller round of questions than the first time. I'm confident that the Department's burnup credit topical will eventually be approved. I have to sort of see how this round goes. It's very crucial to telling timing.

If that's the case, presumably, that topical can be referenced by a whole variety of cask designs, either the new ones or in terms of amendments. Now, I'm sure there will be certain cases where it won't be as useful, and it's also depletion only, it doesn't have poison buildup and some of those sort of things. But that's going to make, if that gets approved and it works for a given cask designer, that may well in many cases eliminate the need for installed burnable poisons.

BULLEN: And then finally, could you comment on the lifetime of the interim storage cask, or the dry cask storage?

HAUGHNEY: It's an excellent question.

BULLEN: Licensed for 20 years potentially, extended to 40 years, and specifically I'm interested in how the NRC is going to evaluate long-term evolution within the container. They're not always dry. There may be water. There may be enhanced degradation of the fuel elements inside, which means that if I transport it early, I wouldn't have problems, but if I wanted 40 or 100 years, do I know what the evolution is, and how would you license that? I guess that's a tougher question for you.

HAUGHNEY: Well, I think you gave me about eight of them. I should have been taking notes.

Administratively, legally, we can renew the storage certificates an indefinite number of times procedurally. But obviously we need a sound technical and safety basis for doing it even once. The first renewal will be in the 2006 time frame when Surry Station comes up for license renewal.

The fact is about a year ago, we had started the early scratching in the dirt, so to speak, of the composition of a research program in the NRC parlance, confirmatory research, that would address the question that you asked about fuel cladding degradation, and how well is the helium holding, these kinds of things. Can it go for another 20 years, or as the Congress might tell us, for 100 years? You know, that's the technical basis for those kinds of licensing terms.

I've had some informal discussions with EPRI on the same subject, and they seem interested in working on those. So that's something we need to dust off and work on more urgently in the midst of these kinds of budget questions you were raising earlier.

BULLEN: By the way, there is an EPRI draft report that should be coming out soon on essentially identification of the types of research necessary to do the extension. I don't know if you've talked to John Kessler about that, but I know that that's in the works.

HAUGHNEY: Thank you. Did I answer your question?

BULLEN: Yes, you did.

HAUGHNEY: Norm?

CHRISTENSEN: Christensen, Panel. A question on the slide dealing with accident history, which I think is about the fifth overhead.

HAUGHNEY: Right.

CHRISTENSEN: And it is that the, unless I'm misunderstanding, the number of events that lead to accidents among these different package types differs considerably, and yet the number of accidents is roughly in the same order of magnitude, which implies a very significant difference in accident rate. Am I misinterpreting that, or is it something I don't understand? The question I would have is if--what is the number of events, that is, are these travel events, and how does that relate to the accident rate?

HAUGHNEY; Okay. Well, the one thing we didn't show were number of shipments. Most shipments of course are unscathed, and that's the one I was talking about in the 3 to 5 million a year where you've got some uncertainties. These accidents are real events. These are accidents that have been recorded into the system, into NRC, or maybe it's a DOE shipment, and as a matter of fact, Sandia tends to collect all these as best they can, I think they do a terrific job, and compile them. The packages involved are larger if you can have multi-package shipments. So that's why you don't see a correlation between those two columns.

But the number of packages that have failed then, for instance this case would be, on the top, strong/tight packages, 76 out of 1,354 packages that experienced an accident over a 20-whatever it was--25 years.

CHRISTENSEN: I guess the question really comes down to the number of shipments.

HAUGHNEY: If you're going to do a risk assessment, you really need the number of shipments, in fact shipment miles.

CHRISTENSEN: Well, the sense that I had is that the differences might be over as much as three orders of magnitude between the different package types, that the strong/tight might involve literally, over that period of time, millions?

HAUGHNEY: Yes.

CHRISTENSEN: Whereas, the Type B might involve, over that period of time, a thousand, which would imply, given the same number of accidents, a three order of magnitude difference in risk, that is, the risk of an accident, and that's what I'm trying to understand.

HAUGHNEY: Well, the risk of Type B is zero for 25 years.

CHRISTENSEN: Well, there are 55 accidents.

HAUGHNEY: Yeah, but nothing happened. There's no consequence.

CHRISTENSEN: I understand. But there were 47 accidents in the strong/tight. I understand that nothing happened, but there were 47 accidents and there were 55 accidents, I understand that--

HAUGHNEY: Okay, I see what you're saying.

CHRISTENSEN: --there were no failures. But why is the number of accidents roughly the same between those two.

EASTON; The reporting of these accidents is an imprecise science. They're reported according to the regulations, which involve the amount of property damage, whether lives were killed, people injured or killed, and suspected leakage or damage. So there's some events that are reported because the property damage is high. Okay? Because if you have a spent fuel truck, you might overturn the truck. There's some because if you're shipping a very high package, a person was involved in a traffic accident on that. So it's a very imprecise science and they're not really reported all on the same basis.

CHRISTENSEN: That really in a sense answers my question, but then begs a much more important question in terms of how to use and interpret this kind of data. If one wants to ask the question, and I again acknowledge that in the Type B situation, there were no failures, so acknowledging that, the data still imply that the accident rates, assuming that an accident is defined in the same way, which you're telling me they are not, but if the accidents were defined--an accident was defined in the same way, this would imply to me that the chance of an accident occurring, regardless of failure, is roughly three orders of magnitude higher for Type B. And I only suggest that if we're really going to look at this issue of risk, that we examine that issue very closely.

Let's assume that we have 60 accidents and there is in that 60, one failure, or 100 accidents and there's one failure, that would still tell me that the chance of, from a risk standpoint, of Type B would be considerably greater for Type B than for strong/tight. So we need to denominate this kind of comparison a little bit more carefully before we can really make these comparisons.

HAUGHNEY: I wouldn't try to make those comparisons because of the weaknesses in the data, and I think your point is an excellent one. And we're attempting to get a better denominator to normalize the information in a more precise fashion. Later this morning, I believe Larry Fischer has a presentation on accidents in the Modal study, which is the closest thing we have to a risk type assessment, and as a matter of fact that we're looking at improving and updating and making more precise. This was simply a very coarse illustration. Remember that these rules are deterministic. They are not based on risk.

ARENDT: The second session that's going to start will involve risk and discussions of risk. I think this had really nothing to do with risk. So, Woody, do you have a question?

CHU: Yes, I'll make it short. This is Woody Chu on the Staff.

Charlie, you had a chart on the existing fleet of casks and also the cask designs that are in the pipeline, and you made the point that the existing fleet can carry very, very little, and so if you want to gear up for any kind of meaningful movement, you had to go to the new fleet. What is your estimate of--I mean your estimate as to when we can get a meaningful new fleet up to speed of the kind that's kind of envisioned in people's minds pending legislation, or anything, let's say in round numbers, 1000 metric tons a year?

HAUGHNEY: It could be done in a few years, but there's a demand issue, aside from the licensing, which will be over before that, and that's, you know, is there a location to ship the material, and then you have to complicate this by the fact that those applications were showing were the next one, the dual purpose casks. And what they're really being procured for today is storage, with an extra, with an automatic transmission. They're being procured so they can move whenever, but there is no site for interim storage. That legislation got close, but with the threat of a--

CHU: No, my question was really not one of whether there's a site or not. I'm talking about only one of in terms of your assessment as far as capabilities are concerned.

HAUGHNEY: Oh, I see.

CHU: You know, given that they have to be certified, they have to be manufactured in meaningful quantities, given that there are QA fabrication requirements as well as ramping up difficulties, which you have alluded to, in other words, obeying laws of physics, so to speak.

HAUGHNEY: Conservation of mass?

CHU: Yes.

HAUGHNEY: Well, there's no question that this fleet can be ready before Yucca Mountain will be ready. Designs are in active review right now, and the vendors are pursuing them vigorously.

CHU; Someone in here mentioned before the Red Sox and the Chicago--

HAUGHNEY: That's true, and the Cleveland Indians, I might add, before they win another World Series.

No, I think the licensing will get out of the way, and then it's a question of who's going to buy them? What are they going to use them for? You know, is the Department going to start procuring those? What fraction of money do they get out of the collected nuclear waste fund, how much is held in escrow? You know, all these kinds of questions I think become predominant in deciding whether or not we're going to have a fleet ready.

But I think it's important to note that this first step, the licensing has got to get out of the way, and then at least some of them have to even make sure they're buildable. A lot of times a design looks pretty good on paper, and you try to build it and it's not so easy, and then handling activities. So I am the last person on earth that's going to give you a schedule. I just won't do it because they don't come true. Look what happened to Dick Hannon. He got vilified earlier today.

ARENDT: We're beginning to run a little bit behind, so let's have a couple more questions. Paul?

CRAIG: Paul Craig, Board. Two questions.

First of all, the 30 foot drop test corresponds to 30 miles per hour. Would you help me to understand why that is a reasonable test criterion when the transport vehicles are more likely to run at 60 miles per hour, which will have four times the kinetic energy in the collision?

HAUGHNEY: The principal difference is the fact that it's a design criteria, not a speed criteria. I know it does correspond to 30 miles an hour, but you can't look at the 30 foot drop in isolation. You must look in combination with the impact on an unyielding surface and, thus, all the energy of the impact is reflected back into the package where it can cause the most damage.

In terms of comparison with real accidents at real speeds, you'll end up with a spectrum much above 30 miles an hour, depending on the type of surface that's impacted. So it's really an engineering standard that I think has caused and continues to cause for many years sort of an implication that it's from--that it's not really acceptable. But in fact, in terms of dynamic loading, it's very high.

CRAIG: Okay, my second question, and I expect we'll hear more about that one, but my second question I think is for Earl, and that has to do with the DOE emergency response which you mentioned. And maybe we'll hear more about that today, but if not, perhaps you could tell me who are the folks who can tell us in detail what capabilities exist for federal emergency response?

EASTON: I think for the details, you will have to ask DOE. I know that we have people here from OCRWM program and from some of the other DOE offices. But they have basic capability spread out in different teams throughout the country, and this is recognized as an element of the Federal Radiological Emergency Response Plan. It's something that the NRC really doesn't get too involved in.

ARENDT: I might add that emergency response was not to be part of this meeting. It will be handled at some future meetings, although we did want to hear what you had to say about it. But emergency response will be handled in much more detail at a future Panel meeting, along with other safety problems. Jeff?

WONG: Jeff Wong, Board.

I have a question that's very much along the lines of Paul's first question. And I'm not an engineer so I'm trying to understand the engineering criteria in relation to that 30 foot drop. My question is more like how many times can it survive that 30 foot drop? And I get this question from opposition in California about foreign spent fuel shipment going through the American River Canyon and having the train come off the canyon route and then having the material roll down in the canyon. So I guess what relationship is that criteria to that accident scenario?

HAUGHNEY: Well, the criteria is simply a design standard. It isn't--is wasn't selected on the idea of finding, you know, like the highest railroad bridge, as that one well may be. And it is selected in conjunction not only with the impact on the unyielding surface, which is very conservative, but also with a subsequent puncture to the same package, and then the subsequent fire. So the notion was the following, and again this is for a whole spectrum of package types. Radiography camera are smaller than that viewgraph machine, for instance, you know, up to the large rail cask. The notion was that you would have some sort of an accident while a package is in motion, and the first thing that would happen is it would fall about 30 feet. And to account for the kinetic energy not only of the fall, but of the motion and the varying types of surfaces, a conservative unyielding surface was selected. It's also easier to calculate than the non-linear calculations that would be required for real surface.

Then the notion was it would bounce, and it would impact on a large blunt object, this pin, the puncture pin. So it would rise some number of feet, I think it's 40 inches, something like that, I forget exactly what it was, and impact directly on that at the most damaged portion of the package. And then finally the fuel tanks from the conveyance or whatever would rupture and start a fire, and then it would take about a half hour for the local authorities to respond.

Certainly there can be transportation accidents more severe than that. And in fact, if we get a chance to hear Larry Fischer, he'll talk to you about how the fact that they've been projected through the Caldecott Tunnel fire, which is way beyond the design basis of Type B packaging, and then what is the projection of the consequences there.

So what you have is a standard that's unusual and it has this accident sequence. Any one of the components can fairly easily be projected to see something that's a bit worse, and certainly your example is a good one, and you can make the fire longer or hotter, there's all kinds of things that can be done, but the combination of the two with engineering margins that are present in the design, you know, the margin isn't zero, it's pretty substantial, all those tend to add up to very robust packages that we've seen in service, actually internationally, not just here, that the spent fuel packaging, in spite of the fact they've been in accidents, have performed rather well.

ARENDT: Charlie, thank you very much. There may be additional questions, but some of this can be handled tomorrow during our round-table, and so forth.

HAUGHNEY: I'll be around.

ARENDT: Fine.

HAUGHNEY: As will John and Earl.

ARENDT: Our next speaker is Jim McClure. Jim McClure is from Sandia National Laboratories, and I'll let Jim introduce himself.

MC CLURE: My name is Jim McClure, and I'm going to make a presentation to you this morning on some historical information about spent fuel transport accidents. It's my pleasure to be here to speak to the Board, and for those of you that are in the audience, I hope you had a chance to get a copy of my remarks. They always say know your audience. Well, knowing your audience and knowing the size of the room is always a couple different things. So for those of you in the back, you might want to be referring to some of my slides on the hard copy.

I got into this business about 22 or 23 years ago, and I'll tell you right now that the question then and the question now is how good are the regulations. And I have always felt that the regulations were good, quote, unquote, but the thing of it is, it's an enduring question. So I'm looking at the clock, I know where the clock is and where I'm supposed to be, but I'll do the best I can to get us on schedule.

I'm going to tell you that basically what we're doing here is sort of weaving a tapestry, and I'm listening to other remarks that have been made, questions that have been asked, and I'll try to address those in the remarks that I make to see if we can weave this tapestry and give a good presentation as to what this is all about when we're talking about how good the regulations are.

Now, very briefly, I'm going to lead up to a slide that tells you the transportation accidents involving spent fuel that have occurred in the United States. We'll get there eventually, but I'm going to weave my way down through there, and the point of this slide is we receive information from the federal government at Sandia labs in Albuquerque, bought and paid for by the Department of Energy, but strong interaction has been mentioned between the Department of Transportation, NRC and the DOE. It's always been my view that you really have to know where you've been in order to figure out where you're going, and that's the purpose of harboring this information in databases that we can access. And at the end of the slide, I'll tell you that you have access to those databases as well.

Now, the point of this slide; the federal records that come to us on Form 5800s from the Department of Transportation, there isn't a block on there that says was there a transportation accident. That's not the question that's asked. So when we get information into the database from a report from the NRC or from the Department of Transportation, we sit down, we study the report form, we study the attachments to the report form, and we make a judgment. In the case of a transportation accident, we say any accident that involves a vehicle transporting radioactive material. Sweet and simple.

And why is it sweet and simple? Because we don't want to get into a big argument as to what was an accident, what dollar damage did you have to have in order to get counted as an accident. We're going to include anything from a minor fender bender to a major head-on collision as an accident, so they're all in there. It's like Prego; it's in there. Okay?

So at any rate, we have it also compartmentalized into handling accidents. In other words, did the fork lift drive its tie in through the wall of the container in the warehouse? Yes, those events occur, and we're not going to deal with those in this particular case today, but we count those and we compartmentalize them.

And then finally there's the reported incident, what comes to us as a reported incident. We examine that information and decide whether or not it was a transportation accident or handling accident, and then you've got to remember that when people on the outside of the federal government are dealing with the federal government, they probably take the stance that I'm dealing with the IRS. They're a little bit afraid, so they want to cover their backside, and they report things that they don't even think need to be reported just to be safe.

So what happens is if you get those reports, it wasn't a transportation accident, it wasn't a handling accident, but we have the report, we just leave it in the reported incident bin, because maybe a question is going to come up someday and you're going to need to deal with it, and you've got it in the database, you'll find it in the search, perhaps by the year, by a state, or whatever. So we're talking about transportation accidents. That's our area of influence today.

Now, it's been mentioned earlier, I won't dwell on this, but for the Department of Transportation regulations, if a person dies, if you were transporting hazardous material, if a person dies, you've got to make a report to the government. If a person is injured and requires hospitalization, you've got to report to the government. When you finally get down into here, the situation where for radioactive material, it says fire, breakage, spillage or suspected contamination occurs involving radioactive material, you've got to make a report to the government.

Now, what may happen in the situation where things are a little fuzzy at the outset, you've got a deputy sheriff that's encountered this accident, you know, he isn't on the absolute cutting edge of all this information all the time, so he sees a placard and everything goes from there, well, he might suspect that there was a leak, but later it turns out that there wasn't any contamination or release of contents, the report's got to go in anyway, and we'll sort that out later. So this is what happens.

Now, the DOT has this hazardous material incident report system, and our data we call the radioactive material incident report system, so you'll see that play on words in gathering this information.

This is a part that's been discussed earlier. I'm not going to dwell on this, but there is one point that I would like to make. On those Type A packages down there, that limit value, that A1, that A2 magnitude, let's key in on that. We're going to come back to that later in another slide. That's the limit value of what you can have in a Type A package. We're going to use that value with Type B packages later on to tell you something that I think you need to know. So we're going to concentrate on Type B accident resistant packages. They do have the 30 foot drop test, the puncture test, and all of that. And to answer a question that the Board has asked, let me tell you a little story.

A number of years ago, the Department of Energy had a thing called the obsolete cask test program. They did a drop test down at Oak Ridge, and I'm here to tell you that when you read the regulations and you're talking about the drop test, this is sort of ho-hum sounding, because of the it will be dropped on the unyielding target.

Now, our unyielding target weighs about 3 million pounds, has structural steel down into the ground encased in concrete and battle armor on the surface of the thing, to make as well as possible what engineering can do in this day and age to make an unyielding surface, but it's so easy to ride over that statement dropped onto an unyielding target. If you see a drop test 30 feet, 44 feet per second, 30 miles an hour, it's kind of a ho-hum thing. But if you actually are down there watching a 12,000 pound cask drop, it's kind of of a sensational thing in the sense that 12,000 pounds dropped onto an unyielding target is going to shake the ground, you're impressed with that degree. But even then you might say this is a ho-hum deal.

However, what they did in that obsolete cask test program is they took not that same cask, but that same cask design, they brought it up to Albuquerque, hooked it on a helicopter, took it up 2,000 feet, dropped it, and as every gardener in Albuquerque knows, the soil there is like concrete, and if you live in a new development and you haven't had a lot of compost put in there, so this thing fell 2,000 feet, had a velocity of 250 or 260 feet per second, embedded itself in the ground about seven or eight feet. When they dug it out, that cask did not have the deformation on its surface that the cask that was dropped only 30 feet onto the unyielding target had down at Oak Ridge. So this kind of gives you a clue about the importance of the target. That's one little story I'll tell you.

But at any rate, we'll come back to that issue later on because I know it's an important one for you, we're going to deal with the Type B package, and I will tell you that if you witness tests, if the ho-hum nature of the drop test will get ahold of you, the temperature of a 30 minute fire will definitely impress you if you're anywhere in the neighborhood.

Now, you can't read this, don't want you to read this, so read the footnote. NUREG-0725, I regard as the definitive source. I'll give a plug for the NRC here. This is what I regard as the definitive source of information on spent fuel transportation in the United States. I throw this in as a freebie because I figure you just wanted to know about it. Most of them have gone by trucks, most of them have been one element per truck shipment, one cask.

This goes and breaks down something that I think you also needed to know. The DOT has been collecting information that we're using since 1971, and in that period of time, they starting keeping count from '79 through '96 of the number of incidents involving all classes of HAZMAT, and this numbers up to 178,000 or so incidents that have been reported to the DOT. Remember that that's a big number, okay? We'll come back to it later on. And we do get a modal breakdown down here, and what I'm going to show you on another slide, this third bullet down here, I'm going to show you the events that we have from 1971 through 1996 for radioactive material experience, and we'll see that the number of total reports that have come in for radioactive material number about 1 per cent of this 180,000 reports that have come to the DOT.

As a matter of fact, on this slide, we can look at the information that is really just sort of a supplement to it, Mr. Haughney represented earlier, this goes through 1996. The database keeps acquiring the stuff and keeps adding it on, and we generally try to put out a summary every calendar year. But the number of transportation accidents that have taken place involving radioactive material is 388 through 1996. The handling accidents you see, the reported incidents you see, and this total reported incidents, in other words, all of them, the accidents, the handling accidents, the reported incidents, adds up to a little over 1,800. If you divide that 1,800 by 178,000, you're talking about a small fraction of the business that's reported to the DOT that involves radioactive material.

Now, what we're leading up to is this. Here's the key slide. If we go into those transportation accidents, and if we look for spent fuel involved in the shipments, this is what it looks like, and the people in the back are definitely going to have to refer to the table. But the point of it is here we have marched on, we had seven in this thing for a long time. We added the one down at the bottom for 1995, December of '95. There is a point to be made here. First of all, the top line represents the accident that was the first occurrence in 1971, December of 1971, a highway accident, the driver swerved to avoid a collision. The truck rolled over, the cask rolled off. As a matter of fact, I believe the driver was killed. But when that cask was dug out of the side of the road and cleaned off, there was nothing more than superficial damage to the cask. There was no release of content. Definitely a tragedy as far as the driver was concerned, but no consequence from the radiological point of view.

Now, if you go down through this list, this list is there for you to have as your little shopping list of the events that we've identified as having involved spent fuel, with one comment. We have been a little bit liberal here in reporting this to you because you'll see in the second line down, no, there wasn't any release of contents, it was an empty cask. We included that information because sometimes details get a little fuzzy and somebody says, oh, I heard about an accident out in such and such, and so this way, you've got all of the events whether or not there was actual spent fuel in the cask or not. But if that cask was capable of transporting spent fuel, then we've included it. But it really didn't have spent fuel on board. And I believe that the count on those is something like four of them had spent fuel in the cask, and four of them were empty.

So this is the key thing as far as history is concerned. There are about eight events right here, only four of which had the material on board at that time--or at the time of the accident.

Now, let's go back to the limit value again. One of the things that Mr. Haughney talked about was the release nature of the cask. And I've done a little example here using the Defense High level Waste cask, which was intended to be a Type B certified package, so it's identified with these standards, and the question was if the post-regulatory leak rate on the cask is an A2 in a week, then what number can we apply to the contents of that cask and see how well that A2 in a week leak rate performs.

Well, for the vitrified high level waste that was in that cask, there was .34 curies was the A2 magnitude, but the inventory in the cask was 275,600 curies. So what fractional part of the contents of the cask is the A2? Well, an A2 is .34, divided by the inventory, in other words, on the order of one millionth part of the cask contents could come out of that cask and still pass the NRC leak rate requirements for the hypothetical accident condition.

So when the question comes up that you had an accident and it was at 55 miles an hour, and someone says, well, what if it was a 75 mile an hour accident, let's not even consider the unyielding nature of the target, what we're saying here is that after you've gone through all this shake, rattle and roll, thermal testing and whatever, A2 in a week here represents something on the order of one millionth part of the cask contents in this example. And I say that the design reserve that that number tells me says that, yes, that's why we have had no leaks from Type B packages in 25 or 30 years experience. It could happen in the future, I suppose, but it's not likely to. At least that's the measure of the design reserve in the cask.

Now, to conclude, what I'd like to say is that we've had about eight spent fuel transport accidents from the period of '71 to the present time. Four of those eight accidents involved empty casks, but we've included them in the list so you could look at them. The fact of the matter is when you have access to that information, if you want it, you can read the reports and all the details.

Radioactive material incident reports occupy a small fraction of the total of all incidents that have been reported to the DOT. In other words 1,828 events were reported involving radioactive material, and there's 178,000 or so that involve all forms of Hazmat.

Type B casks have not released their contents due to experiencing the transportation accident environment. And the post-accident leak rate gives us a way of assessing the design reserve in the cask, because the cask may be prolonged to the future, but you can't make any guarantees. This study will figure that accidents do happen, there is a release of contents, and that's the subject for another discussion.

If you want this information, since it was bought and paid for by the government anyway, all you have to do is give us a call. We'll make you a TRANSNET user who will have access to the database. The database is called RMIR, meaning the Radioactive Material Incident Report database. And you can call me, but I will turn you over to our system administrator, Fran Kanipe. She will make you a user. You can operate queries from your desk, and see that information.

Presently, we're loading into a new operating system, which means that everything that we have from '71 through 1997 will be available under the new system in about three weeks. But it's available to you now through about mid 1995, and I have it on spread sheets for the interval from '95 through the present. 1996, we had about 114 events. 1997, we have about 68 events right at the moment.

That's really all that I can tell you. I hope it gives you some idea as to what the experience is. I appreciate having the opportunity to speak to you, and I'll be glad to answer any questions that you have.

ARENDT: Norm? Thank you very much, Jim.

CHRISTENSEN: This is just a parallel of the question that I asked earlier. If the 1,800 represents roughly 1 per cent of the total number of Hazmat accidents, do we know what the total number of transportation events is? Is it the same? Is it roughly 100 to 1?

MC CLURE: Well, let me say it this way. The 178,000 represents not accidents, but incident reports that were made to DOT involving all forms of hazardous material. The 1828 represents the incident reports to DOT and NRC. We get information from NRC as well. And that's all classes, in other words, transportation accidents, handling accidents and the reported incidents. We analyze it then and break it down. So that 1800 divided by the 178,000 is where I got that 1 per cent value from.

CHRISTENSEN: I guess the question I was asking is if we--again, I'm sort of thinking at the large scale, that those 178,000 and the 1800 represent accidents that occurred in connection with transportation events, many of which involved no accident. And the question I have then is the number of transportation events for each of those two classes, radioactive versus non-radioactive hazardous materials, roughly in the same order of magnitude, 100 to 1?

MC CLURE: Well, I don't in fact know the number of transportation events in the other hazardous materials. I know their modal breakdown, but I don't know the accident breakdown for those other ones.

Now, a point that I would like to make to your earlier question, though, is I think Mr. Haughney showed that we had something like 2200 Type A packages that had been transported, and 73 of them, or something like that, released their contents. This gives us a physical measure of how good a Type B package is. Remember the Type B package is in normal commerce. It can be subjected to accident conditions, and it has been. I forget the number of accidents involving

Type As, but the point is is that there were 2200 packages of the Type B classification that were in accident conditions, and only 72 of them released their contents and broke open. that's pretty good for a system that wasn't designed to resist accident conditions. It tells you something about the spectrum of severity for accident conditions involving Type A packages.

CHRISTENSEN: Let me just say that the only reason I'm raising it, I have no problem with that, is that I'm not quite sure how to put into comparison the accident rate for non-radioactive events or non-Type B events relative to the Type B events, and it strikes me that the--we may have some differences in terms of how we define a transportation event or a shipping event, and how we define an accident for these different classes. At some point, it's important to understand those if we're going to make comparisons between the chance of something untoward happening with high level nuclear waste versus the chance of something untoward happening with some other kind of waste. And I feel a little bit like we're comparing apples and oranges.

MC CLURE: Let me say to you that just in the interest of time, the door is open, the questions have and can be asked, as you are doing, and this is a dialogue that can go on for as long as necessary in order to answer the questions.

HANNON: If I might supplement that? This is Dick

Hannon with DOT.

I'd like to suggest that we could prepare some analyses that would show those differences. The 178,000 number is a large number. In a recent year, even '94 and '95, there's something on the order of 13,000 reported incidents. The majority of those incidents can be characterized as just minor leaks. They're not accidents; they're leaks. For the last ten years, there's an average of about 400 that we're internally characterizing as serious accidents, and they are those involving a death, an injury requiring overnight, three day hospitalization, an evacuation of people, closures of major arteries, and things like that. That's 400 out of, say, 12,000, 14,000, but by and large, they're leads.

In the nuclear arena, there's much better reporting than there is in many of the other segments. And an incident, DOT's definition, the regulatory one, is any unintentional release. So you could lose a matter of a few ounces, we have incidents of four ounces of formaldehyde delivered to, you know, the high school science lab, that is an incident. That is an incident in that case that requires a response. You know, you say something is leaking with a placard on it at a school, you get a major response by the response community.

But I think we can prepare something that will put these numbers in a different perspective. I agree with Jim's characterization of them, but I think, you know, we can answer what's an accident, what's an incident, when is there release, what is a significant release.

ARENDT: All right, thank you very much, Jim.

We're ready for a break, and why don't we be back at five minutes after 11:00.

(Whereupon, a recess was taken.)

ARENDT; Our next speaker is Larry Fischer. Larry is with Lawrence Livermore National Laboratory, the deputy division leader, Applied Research Engineering Division. Go ahead.

FISCHER: Okay. About 15 years ago, we did the Modal study, and I was the project leader of the Modal study. That was authorized and funded by the USNRC, and they did the study to update the EIS, or Environmental Impact Statement, NUREG-0170, because there were quite a few questions on it with respect to the spent fuel, because at that time, we were going to supposedly start shipping spent fuel to some repositories or to interim storage, and so Congress wanted to know if the regulations were adequate, if the people were adequately protected with the 10 CFR 71 regulations. And so that's why we started the Modal study.

I'm going to go over it briefly. Of course we could spend a whole day talking about the Modal study, but

I'll try to get through it in about 45 minutes, or a half hour, actually, just go over the objectives and describe the study and the results and conclusions. But I want to talk a little bit about some post-Modal study calculations that we did, because of course it's been over ten years ago since the study was performed, and then I want to talk a little bit about the improved structural and thermal code capabilities, because as was already brought up this morning, well, how good are these computer codes, because most of the study was done by analysis with the DYNA and TOPAZ codes, DYNA being the structural and TOPAZ being the thermal code.

The overall objective of the study is put down here. It's right out of the report itself, and basically what we are doing is looking at the protection provided by regulations for the public to see if they are adequately protected, and we were doing this by looking at estimating the protection by using data from real accident histories of similar type vehicles, and models of cask designs that could probably be licensed. And of course we don't have a large database on spent fuel cask accidents. As you just saw this morning, there was only about seven or eight, and so we had to resort to using similar type data for similar type accidents.

And what we did in the Modal study is first of all, we defined the accident scenarios and loading conditions.

Then we estimated the cask response to the loading conditions--not the lading conditions--and then we did a first screening process. This was very important because we keep talking about this 30 foot drop onto an unyielding surface, and the 30 minute fire, and so forth. That's what is put in the regulations as the hypothetical accident conditions, along with the puncture and emersion, and so forth.

We wanted to see how many accidents actually fell within those loading conditions, and we found out about 99 per cent of all accidents, real accident, would fall within the regulatory hypothetical accident conditions. I'll show you a little more detail on that and why that is true.

But more importantly, we were interested in the 1 per cent remaining accidents, or about 1 per cent, and tried to find out or estimate the risks of that one additional per cent of accidents that would occur outside--or could occur outside of the regulatory hypothetical accident conditions, loading conditions. And so what we did was evaluated those risks and the releases, and so forth, and then we compared it with NUREG-0170 risks, because the Commission had already deemed that those risks were acceptable, that they were not significant, especially compared to shipment of other radioactive materials, is was actually only 1 or 2 per cent of the total radiological risk. Then of course we then put out the report.

We looked at a variety of loading conditions when we did the study, and tried to find out which ones we thought were the more important ones and put most of the emphasis into those areas. And so we looked at impact type loads, punch loads, crush loads, and then in the thermal area, we looked at fire, torch and decay heat, and we looked at all the various types of loading parameters that were involved with those types of loadings, and we came to the conclusion that the most damaging, potentially damaging ones would be ones where a cask would actually be impacting onto hard rigid surfaces, like sides of a mountain or abutments, and big strong objects, because and you'll see, if they're smaller objects, the cask just kind of pushes them away and it doesn't even know that they're there. That was one important parameter.

And then of course big long engulfing fires like the Caldecott tunnel or other fires which can last for long periods of time, like in train wrecks. There was one fire we looked at that lasted actually eleven days. As most people know, when there's a train wreck, usually they just let them burn. They don't try to put them out because it's too dangerous.

For doing the impact analysis, we looked at the velocity of the cask as it hit the object surface, and I'll point out that we did use flat surfaces when we did this study. Later on, we did look at surfaces that were irregular, and I'll talk about that afterwards. We looked at the orientation of the cask and also the direction of the cask when it hit the surface. So we looked at all the different angles the cask could be at and the velocity as it impacted the surface. That was for a flat surface.

We also looked at for being hit by, say, a rail, a train sill or like a column, so that the impact limiters would be bypassed and the impact could occur somewhere near the middle, or anywhere along the cask, and so we looked at how that would damage the cask. And we looked at it hitting either directly or around the surface of the cask or where it just barely misses. So we looked at a variety of impact angles and velocities.

We defined our accident scenarios. These were based on national statistics, and also statistics that we gathered from California, Florida and also North Carolina, and also--yeah, North Carolina. I think we looked a little bit at also Colorado. At this time, there wasn't that much data available, but of course these databases are always being updated. But basically, these were the way things were looked at as things that could be crashed into.

This is for the truck, and obviously they're nice soft objects like cones, animals, pedestrians, and when it comes to a cask, of course, those things wouldn't do any damage to a cask, or even motorcycles, automobiles, trucks, buses. A train can do some damages, so we put an asterisk after that and said trains can potentially exceed the hypothetical accident conditions spelled out in the regulations. Others were just signs and that kind of stuff.

And then we got into bridge railing where you have to get off the road and hit a bridge railing, and then you can fall off the bridge, and obviously if you hit things like hard rock, or even soft rock, and so forth, all of these were potentially damaging to the cask, depending on the speed of impact against these different objects, like water or road bed, and so forth.

And then it goes into a column, we looked at small through large, and abutment, and we looked at all of them, even though it was pretty clear that the smaller ones could not withstand an impact for a cask.

And then finally we looked at crashing into concrete barriers like you see on the side of the road, and signs and cushions and that kind of stuff, and those are things that basically would fail when a cash would run into it.

We did a similar type assessment for--oh, these are non-collision, this is pretty important, too. Those were just the collision ones. This got split up a little differently than what's in the study. That's why I got a little bit confused. The truck could also go off the road and hit into slopes or over embankments, over cliffs, and that sort of thing, into trees, just overturn, jackknife, and so forth, and also just fire can occur to it.

So we looked at all the different types of accidents a truck can get into, and said that the cask could also experience that environment.

We did a similar type thing for the train accidents. Again, the ones with asterisks are the ones that could potentially damage the cask, or exceed the regulatory hypothetical accident conditions, a very similar type of thing, but we're looking at derailments, rollovers, and so forth, for the train.

The cask we looked at that we actually evaluated, this is a representative truck cask that was designed up where we thought it could meet the regulations, but just like kind of barely squeak through because obviously you wanted the weaker candidate--the weakest candidate to look at. And basically it had an inch and a quarter of steel on the outside, half inch on the outside of lead filled in here, also had large heavy closures on each end. Notice that it's recessed, but this is typically what you would expect. The cask with its contents weighed 39,000 pounds. And I want to point out that these casks are built to the highest requirement, built to the ASME code, Section 3, Subsection MB. There's a new one coming out, NUPAC requirements, which I think will probably later on be accepted by the NRC. But the cask studies that we did were ASME, Section 3, Subsection MB.

And what this means is that you're welding essentially two reactor, nuclear reactor requirements, containment requirements. They're the highest requirements. They have a safety factor of three, so actually when these casks meet all the requirements, they respond in an elastic manner. And so there's a lot of energy that can be absorbed in a plastic mode and still not have it fail. In fact, when we did the study, we could not predict failure of cask under any condition, and I think that's important, and I'll talk about that a little bit more in detail.

So for the regulatory response, basically this cask did not even get a dent in it as far as containment is concerned. There may be superficial damage, but there is no damage to the containment system or to the basket inside that's holding the spent fuel. There could be a little bit of lead sluff that occurs for an end-on type collision for regulatory conditions.

Rail cask is quite a bit more massive. It's about 200,000 pounds, this particular one, and note that it has two and a half inch thick steel on the outside. Of course this is a much bigger cask, and that thickness does provide protection against any type of a puncture by a train sill, or a coupler, as I'll show a little bit later.

Now, when we did our evaluation, we could actually look at a cask being exposed to different G forces and see what the loading conditions are, but they can vary significantly with what the cask runs into or impacts, and what we chose to do is express this in terms of maximum effective strain the cask can see. And the reason why is that two-tenths of a per cent strain, this is basically where the cask will be in elastic mode, and this is where the regulatory condition is, is at this response level, S1, that if it does not reach that level for impacting onto that surface, then it will be within the regulatory hypothetical impact condition. And you can kind of see that here that we show for an unyielding surface at 30 miles per hour, the response level is .2 per cent, or .002. And you can see that what happens when you look at medium surfaces like soft rock or concrete, it goes out much more, out to about 60 miles an hour, and then for very soft conditions, or soft conditions like soil, and so forth, we're talking about 90, and very soft, it won't even be able to cause any kind of elastic response that's of any significance. These are kind of results type numbers. These are fairly real and realistic that were calculated.

We did a similar type thing for--I should point out that this was for endwise. We did the same thing for sidewise, too.

Then for the fire, we selected a temperature at the lead mid thickness in order to determine the level of damage to the cask due to thermal loads. Actually, it turns out that thermally, usually the seals fail, but we were also interested, since this was a lead cask, on the temperature of the lead and when it would melt, and so forth, because that was a more serious condition than the failing of seals. But the seal failure is correlated to these temperatures, as shown here as the lead mid thickness temperature.

And then we showed the fire duration basically as an engulfing fire. So as you can see, as you get further and further away, the temperature is much lower, and a fully engulfing fire, the temperature can go up much faster than say a five hour period of time.

And then what we did is we looked at the damage done to the cask for both mechanical and thermal loads, and defined a matrix. And in this lower corner, basically this is the corner that the regulations cover, right over here, and that covers about 99 per cent of the accidents fall into that region, that the conditions that casks will see will be less than two-tenths a per cent strain, and less than 500 degree temperature on the mid line temperature, and much lower on the seals.

So from this viewpoint, we could then start assessing what happens if it goes to 2 per cent strain on the cask, where it starts to distort, it starts bending, and then we could also look up to 30 per cent where we say, gee, this thing is really getting distorted quite a bit, plus we might start getting concerned about weld maybe cracking. As it turns out, these casks were basically made out of materials like stainless steel, 304 stainless steel. In fact, that's what all of them are at this point in time basically. And the ASME code requires a minimum elongation, uniform elongation of 40 per cent, so you can see where it's quite conservative. We said after 30 per cent, we'd stop guessing, because the welds and so forth are--or calculating, not guess, estimating, calculating, that we'd say we're getting into a region of uncertainty, and that's this outer region here.

And the same thing for temperature, as we calculated on up, or estimated once we got beyond 1050, we said now it's very uncertain what's out here, and it's kind of like residual uncertainty in the study, so we did not say that we could bound everything definitely, because there is uncertainty involved in all these studies.

Now, when we estimated damage to the cask, we looked at both the structural or mechanical damage and the thermal damage, and we evaluated all the accident scenarios, the significant ones that were shown by the asterisks, for all of those different loading conditions where impact velocities up to 150 miles per hour, a lot of people say, well, that's way too high, but we didn't want to get into arguments, many say 120 should be it, but we looked up to 150 miles an hour impact into concrete, soils, unyielding surfaces and water. And then we looked at the inner strain, the strain on the inner wall versus the impact velocity. We also calculated "g" loads, and this was important for trying to determine when the spent fuel could actually fail. And I'll get into that, what damage was done to the cask or to the fuel inside. And then we also estimated probability of occurrence for exceeding those strain levels, and that will be presented.

The same sort of thing we did for the thermal damage; we looked at all the different fire scenarios, where it could be an engulfing fire or away from a fire. We looked at a variety of conditions there, and we used the lead mid thickness temperature versus engulfing fire duration, so this was very severe. This is totally emersed, so we expressed it that way in order to get all the information into one chart.

And then we also looked at combined damage, where you have both structural and thermal damage occurring to the cask, and we looked at the joint probability of occurrence also.

These are the fraction of truck accidents that could result in responses within each response region, assuming that an accident occurs. As I pointed out, we had at least 99 per cent for the truck, was .994, that's a fraction, or 99.4, and the train was 99.3 per cent of the accidents fall within the regulatory conditions. And then we can see as we go to higher strains and deformation, the number drops off. And in fact once you get beyond 30 per cent, you can see one out of a million chance given that an accident occurs would fall outside.

And looking at that same sort of thing, the temperatures here, decreases as it goes to higher and higher temperatures, the probability drops off, although since this is a little bit smaller interval here, it actually increased a little bit for this region, but that's because of the size of the bin that we chose here. And by the time we get out to temperatures beyond 1000 degrees, we're talking about something like one chance in 100,000 given that an accident has occurred.

Now, associated with each one of those regions is a source term, and that had to be estimated. And the way that we looked at it is first of all, we were primarily concerned about the radioactive material due to the failure of the rods inside of the cask. And so what we did is we calculated the failure of rods related to "g" level and temperature in order to determine how many rods failed, and basically we said that 3 per cent of the rods when they're loaded in the cask might be failed, might be leakers, have small cracks or pin holes in them and could perhaps leak some material out. Even though that's unlikely, it was a bounding conservative estimate. Right now, leakers are running much less than 1 per cent, more like a tenth of a per cent, because obviously they don't want rods leaking inside of reactors when they're operating, but there were some bad years where they did get leakers up to about 1 per cent.

And then we get up to, say, a 90 "g" level--I mean, 40 "g" level, we were estimating that 10 per cent of the rods could fail. It's hard to estimate because we don't know the condition of these rods, and so it's a very rough estimate based on virgin material, unexposed, and so forth. And then finally at 90 "g," we just say everything failed, all the rods failed, that we did not know their condition. And I think that this is a conservative estimate. It's something that might be looked at more if we start looking at fuel claddings, and so forth, but it's very hard because we do not know what the actual condition of the fuel cladding is.

The release from the fuel rod cavity was estimated from Oak Ridge test data give than a pin hole has occurred either through mechanical rupture or temperature type of rupture, thermal type rupture, a certain percentage of material will leak out of the rod and into the cavity. And we were able to then relate this to the inner wall strain and mid thickness temperature because, as I told you, we calculated in terms of "g" level, and we related the temperature of the fuel rods to the temperature of the lead mid thickness temperature. So we were able to put them in the proper box, is the main thing, or proper bin or region.

And then release from the cask cavity related to damage in terms of the inner wall strain, distortion, and so forth, as I said here, that we then could put them into the appropriate boxes.

For radiation levels due to lead slump, again we calculated that, what it would be due to impact and related to the inner wall strain, and we also looked at lead melting due to the fire and related that to the mid lead temperature. And then we--the resultant radiation level was expressed in terms of equivalent release to compare with NUREG-0170. That is, we said instead of just saying this is the radiation from the cask, the radiation from the cask is equivalent to this amount of material being released. That's the way it was done in NUREG-0170, although that is not exactly right, but it is a bounding way.

And then as for criticality, the conclusion was just physically unreasonable because as this closes up, the configuration will be lost and it would not be able to moderate to bring about criticality. Also, we assumed there was no burnup credit.

These are the radiological hazards that are radiological hazards estimated for the response regions for the representative truck casks. We looked at Noble gas releases, vapors, release like cesium and ruthenium. We looked at particle release, primarily plutonium, and then exposure was for the lead slump. And so we looked at all these hazards that could occur due to these type of releases. Again, the actual fuel rod releases were estimated from the Oak Ridge data for the given temperature conditions, and we did assume that the fuel oxidized, so we looked at the worst condition for the release.

And you can see here for the regulatory conditions, there's essentially zero release because of some elastic response by the cask.

It should be pointed out that for this condition, this is what is put into the safety analysis report, and the NRC reviews that and indeed confirms that essentially there's no release from the cask for their fire conditions for the impact conditions that are specified in the hypothetical accident conditions.

Then we calculated the probability hazard estimates. Again, this is for the truck cask. This basically takes the probability times the hazard, and this way we can estimate the potential hazard in terms of probability. And then what we did is we basically summed this all up and compared it with NUREG-0170, and it's summed up probability hazard estimate.

Then when we compared it, we found that for our study, we were at least a factor of three less than that that was stated in NUREG-0170. I should point out human factors and uncertainties were not explicitly evaluated, although we did not do any truncations, and as I said, we did have that outer region, which took care of those low probability accidents, and assumed that the cask meets all regulatory requirements, including certification, proper maintenance, proper operation, that it's fully certified and properly evaluated, went through the SARR review process, built to the ASME code, has the correct margins of safety, and so forth. And of course the study concluded that the regulations are adequate.

I want to talk about some of the additional calculations that were used after the Modal study. There were questions on cask side drop onto an uneven surface, coupler impact on a rail cask wall, and then what about closure impact of rail cask on an unyielding surface, or what can you get the closure to fail, what does it take to make it fail.

What we did now is a nice 3-D model, nice colors, contents in cask, everything. We can do anything now, believe me, with upgraded hardware--or software. Basically, our engineers have equivalent to like a Cray 2 computer at his command on his desk top basically, and so we can do these nice things in a lot more detail. But it's interesting we went back and looked at some of the previous calculations we did because of a lot of questions, and it turns out that essentially none of the answers changed even though we could do it much more accurately, a lot faster, and so forth, it really didn't change the results.

But basically here's a cask hitting onto an uneven surface basically here where we have a piece of concrete protruding out. This could be like an outcrop of rock simulated, and we dropped the cask onto it, and we found that as might be expected, the damage to the cask, or the deformation to the cask, was about midway between hitting a flat surface and getting hit by a train sill. And so this was actually bounded by the train sill simulation for this particular incident. So the question would be then, well, maybe we should include a certain percentage of the hits onto surfaces as being of this configuration and, yes, that could be done, but I doubt if it would change the total result of the study, but certainly will not breach the cask. There's no question about that.

We then looked at a coupler hitting a train--a train coupler hitting the cask. We didn't show this explicitly in the study. We said the coupler would fail. We went back and did the detailed study and, indeed, it turns out that the coupler has about an 18 inch square section here that has to try to shear into the cask wall, and it takes 8 million pounds of force to shear this, and the coupler fails at 4 million pounds. And so it's gone basically.

And by the way, the coupler, the drop onto a six inch spike, it actually took more--the damage due to the 40 inch drop on the six inch spike was actually a little bit higher than due to the coupler, so that's a good hypothetical accident condition on the six inch pin, that it actually caused more force, that's like we said, a lot more force on an unyielding surface, the same sort of thing that you see.

This is where we brought the cask down and hit it on the corner, and you'll notice that it has to be within a certain angle here. It has to be within about 15 or 20 degrees, I've forgotten what it was, it has to hit right on the corner. You have to try to pop all these bolts, and of course we assumed that none of this deforms--of course if it deforms and starts getting distorted, it's going to really jam even more so. But what happens is you have to shear the lip of this thing because of the small clearances here, and also this tends to jam over against the side here, and what it takes is about 100 million pounds of force onto an unyielding surface. There aren't too many things out there that won't yield under 100 million pounds of force. And that's equivalent to hitting an unyielding surface at over 80 miles an hour.

As for changes, I want to talk a little bit about benchmark and the DYNA. At that time, we talked about DYNA and it's use in the weapons program. It was extensively benchmarked at the time we did the study, but unfortunately, it was with weapons type applications, and so we couldn't talk about it. That was one problem. The other problem was that a lot of people said, well, that doesn't relate to cask. How does it relate to cask?

Since then, we've had some benchmarking going on, and we've kept up with that, and in fact we were involved in the shippingport transport. We performed the stress and failure analysis of the shippingport reactor pressure vessel and the Neutron Shield tank. The pressure vessel is shown here and the tank is out here, and the inside of the pressure vessel was filled up with grout and the outside of the-- between the pressure vessel and the shield tank was also filled up with grout to hold things in place. And of course we couldn't go out and drop this thousand ton assembly, so we had to simulate its drop, and what we did is we went out and ran a one-tenth scale test that essentially mocked up the important features of the pressure vessel and the Neutron Shield, and we dropped it on the ends and sides and so forth, and this is the one where we dropped it on the end and you can see there's about a 10 inch diameter flattened spot here occurred on the test specimen.

And then this was the calculated result, and you can see again it's about a 10 inch diameter, or 5 inch radius is what was predicted. Now, this was not matched up. A lot of people say, oh, you just fiddled with the parameters until it matches up. This concrete was modelled using laboratory test data and doing the appropriate measurements and blindly putting it in, and then went out and did the test, and we were right on as far as deformation was concerned. The "g" levels were within about 10, 15 per cent agreement.

We also went out and did some tests on a potential plutonium air package. We were also doing this work for the NRC when we're looking at the potential of having air transport from France or England to Japan. And so what we did was determine what the requirements would be on the package, and one of them was to survive going about 1000 feet per second into a concrete block or into soft rock, and one of the questions was, well, can we come up with an equivalent against an unyielding surface, because there's always problems with trying to come up with a real surface and duplicating it. There's a lot of engineering problems in making sure that you have equivalent yielding surfaces or real surface, where the unyielding surface is well defined.

So we did some tests against unyielding and yielding surfaces. Both are grout block, and this is the one-sixth scale model of a plutonium package. We put grout in here to use for providing energy absorption, and then inside we had the simulated plutonium package, and we used an 1100 series aluminum ball to measure the "g" level by the indentation on that little ball. And then we went and shot this out of a six inch Howitzer onto an unyielding surface, and you can see this was the original configuration, and it flattened out when it hit the unyielding surface, and you can see the superimposed computer simulation grid here, very good agreement. And, again, we got, with the same grout model, by the same, same grout numbers, no changes, we got within about the 15 per cent, 20 per cent of the "g" loads, as measured by that little aluminum ball.

By the way, the 1000 feet per second into the essentially concrete block blew the block apart, unfortunately, but it did survive it without ripping through. This is a test of the toughness of stainless steel. It's very, very tough material, very tenacious. And by the way, that's what we use for our spent fuel casks. Essentially, most of them are made out of that, and the future ones I see coming up will probably be made of that. We do not propose using nodular cast iron or anything like that.

And then finally, we did a finite model of steel billets tipping over onto a concrete pad and soil. This was for the storage, spent fuel storage, and see how it inter-reacts. And here again, we saw very good agreement between the tests data and then the actual calculated data, again, same concrete model was used for this. And so we have gained a lot of confidence in that modelling, and we think that it would be more than adequate for any studies that would be done in the future, and it also tended to support the previous work that we've done in the original Modal study.

Questions?

BULLEN: Bullen, Board. Just a quick question on a definition. You talked about the maximum effect of strain as you impacted these containers. Is that a total dimensional change of the length, or do you look at strain in each finite element?

FISCHER: The strain in each finite element. It's very conservative because it gets down to element size.

BULLEN: Okay. And I guess the followup question is you talked about the calculation being conservative on your absolute last slide here where you talked about measured versus calculated, but it looks like your calculations are slightly under in the "g" calculations, even though they're within 20 per cent. Would you want to remodify your model to try and say that you'd better predict or over predict?

FISCHER: I wanted to say that this was done with the original model. Okay?

BULLEN: Right.

FISCHER: I understand your comment, and so sure enough, our people went back and looked at, and sure enough, the concrete was a little bit stronger, and so forth, and it has not been adjusted upwards, but this was the original data, the original model. But taking other things into effect, yes, they came back up and over in most cases, yeah.

CRAIG: Paul Craig, Board. First of all, I want to thank you for a really good visit down at Livermore. You gave me reading that kept me going for days.

FISCHER: Yeah. Well, you're welcome.

CRAIG: Anyway, what I wanted to ask you about is defects, because defects are emerging as a major problem. We've heard about that this morning. Have you done any analyses in which you look at the consequences of particular types of defects and what this might do to the behavior in accidents?

FISCHER; I can talk about my experience. The kind of problems that Charlie Haughney was talking about have to do with storage cask, and they are not built to ASME code, Section 3, Subsection MB, and that's all I need to say. There's a world of difference between storage casks and transport casks, and that's why they're looking at dual storage and transport casks. Not all storage casks would ever be put on the road, believe me.

CRAIG: Yeah, I understand.

FISCHER: There's a tremendous difference.

CRAIG: No, I understand that. The point at issue is that if there are quality control problems for the transport casks, and the experience with other manufacturing in the nuclear industry apparently suggests that there might be unless people get their act together, the question is will failures in quality control of the sort that might be expected lead to significant degradation of the performance in the event of accidents? And that's the kind of question that one could resolve, could get some insight into with the kind of modelling that you're doing.

FISCHER: Yes, I think that can be done. But my gut feeling is that if you're working with stainless steel, it's very forgiving for flaws and defects, that it will tend to turn a localized problem and just smear it out and it won't tear in a catastrophic manner. But certainly it could be something that could be looked at with the computer modelling, but there's a lot of plasticity that occurs with the 304 stainless versus the other types of materials that they're using for storage. And in fact, the primary problems were with the carbon steel. It's just a different animal, different type of cask and situation, yes.

ARENDT: Are there other questions?

FISCHER: Is that permitted, people from the audience, or just Board? I think the audience is later.

Anyone else?

(No response.)

FISCHER: Okay, thank you.

ARENDT: That finishes this morning, and we'll adjourn for lunch, and why don't we be back at 1 o'clock.

(Whereupon, the lunch break was taken.)

AFTERNOON SESSION

ARENDT: Good afternoon. The first thing I'd like to do is to introduce Dan Metlay to you. Dan is on staff, but he wasn't here earlier when I introduced staff.

I'd also like to make a couple other comments I failed to make earlier, and one is that the Board has had significant changes in membership this year. And since 1989, the Board has held about a dozen meetings on transportation and related issues, and this is really the first substantial meeting on transportation for most of the members that are here.

The other comment I'd like to reiterate again is that the focus of this meeting is safety of transportation of spent fuel, and we are treating this subject on a broad sense. We're not concentrating on any specific program, but on safety as it applies generally to spent fuel transportation.

This is one of the reasons that we did not have DOE on the program on today's agenda. They have briefed us previously on the DOE's market-driven approach to acquiring transportation services, and we will be looking forward to additional updates as they're warranted.

Earlier, you may recall that we started talking about emergency preparedness and routing, and a few things like that, and I just want to say again that we did not intend today to get into those areas in detail. I think the NRC and DOT did a good job in indicating where these activities lie, and at some future date, we will again be taking all of those up when there's a little more to say about that.

The first speaker this afternoon is Dr. Chen from Argonne National Laboratory. Dr. Chen is Strategic Area Manager for Risk Assessment. I can't read your writing, Woody. We'll let Dr. Chen explain, but there's a word here that looks like it's management. I'm sorry. He's at Argonne National Laboratory in the Environmental Assessment Division.

Dr. Chen?

CHEN: Thank you very much. Actually, it's risk assessment and management. I'm glad to be here and appreciate the invitation from the Board.

This morning, we heard the regulators talk about their regulations. We heard about the analyses of casks in terms of safety, and actually the one I'm going to present is kind of a quick overview of how those practices are implemented, and a rather quick summary of the Department of Energy's Environmental-Statement-Related Risk Studies.

I actually will give a quick introduction, and also the risk assessment process, followed by review of commonly used analytical methods, and provide some typical examples and also conclusions.

We all know that the NEPA, National Environmental Policy Act, was promulgated in 1969 during the Nixon administration. So it's over 20 years that the DOE has gone through the process, and basically all this compliance has shown up in the Environmental Assessment and Environmental Impact Statements, and I'll focus on these two particular documents. Certainly there are other NEPA documents, like Finding of No Significant Impact, the FONSI, and also the lower one being the categorical exclusions, which I'm not focusing on. But keep in mind that they're also part of NEPA documents.

In that kind of vein, the NEPA evaluates impacts of federal actions. What's important is that there are going to be alternatives scoped out, and the risks will be analyzed according to the alternatives, so in the very end, there will be records of decisions which will be reached, and the risk impact is certainly one of the important points there to be fed into the decision activities.

DOE/NEPA activities mainly focus on spent nuclear fuel and radioactive waste materials, and certainly there are others, but these are the major activities here. And in the past, transportation risk has been singled out as one of the important risk components, and in this decision process, transportation has been weighed against other conditions, such as risk, all facility risks, all costs in those kind of terms there.

And to show you the magnitude of DOE's inventory of this material here, we first have the spent nuclear fuel, both on the DOE side of spent nuclear fuel, and the commercial side. We know that the DOE side of the fuel in terms of inventory really pales the commercial side of total inventory here, and much of the activity on spent nuclear fuel actually is circling around shipping these materials across the country, and perhaps to the storage, and also eventually to the repository. And, thirdly, we have two major programmatic EISs that have been done. One is the INEL programmatic spent nuclear fuel of the DOE fuel itself, and also the foreign research fuel reactors. Both have been completed up to this point. Certainly there are EISs, such as the Naval reactor shipment systems EIS that recently was completed.

But the other major component is the commercial side of the fuel, which we know that under the Nuclear Waste Policy Act, the date is next year, and I'm not sure how it's going to be done, but currently the ongoing repository EIS has been conducted up to the MRS, we don't know yet whether the Congress will make a decision or not. It's up in the air. What I did not mention here is also the high-level waste of the DOE side will also eventually go to the repository.

The other component, major component, perhaps a bigger one, on transportation and waste management operations, and this one, we know that recently, just early this year, that WM, Waste Management Programmatic EIS was completed, and this is kind of a quick summary of the order of magnitude of the inventory. We have low-level waste, high-level waste, low-level mixed waste, transuranic waste, true waste, and certainly these are hazardous wastes, which were a lesser extent here.

We can see with this that large amounts of waste are going to be transported. The quick estimate is that the total mileage of shipment is probably approaching one billion miles, total shipment over 20 years. That's the kind of magnitude we're talking about, and this has been documented recently in the Waste Management Programmatic EIS.

One thing I wanted to bring to light is that certainly, as you see, the volume is large. What's not included is environmental restoration activities, or site cleanup. Much of that could be soil, and the magnitude or the volume is probably ten times any of these in order of magnitude.

Speaking about the transportation risk, we know starting in a very quick way, waste of spent nuclear fuel started from here. Either that will come into the storage or treatment, and then eventually to the disposal here, usually has to engage some sort of shipment of the material or waste. So whether you transport through the facility there, then you have a facility risk, health risk, environmental impact when you want to construct the particular facility for storage of waste. And then you have a complex wide shipment across to the disposal site, or from the facility to the disposal. All this activity has to be connected by some sort of transportation campaign, so all the transportation impacts will incur as you conduct all these activities.

Basically, you can say, well, what will be the basis for this transportation risk assessment. Basically, we are talking about a DOE guidance, the NEPA "Green Book," which stipulates that in transportation links, risks should be analyzed in those links. The other thing is that, well, don't just cite the regulation and say we'll meet the regulation. Full-blown analyses will need to be performed. Also, in that case when you do the analyses, both routine when no incident has occurred, as opposed to when an accident happens, both should be analyzed. And some of this I've already mentioned about RADTRAN, and certainly I don't want to get into RADTRAN. I think that Sandia will present RADTRAN later.

In a short summary, you know, what kind of risk do we expect from transportation, basically we define risk as frequency times the consequence. Frequency could involve the probability of occurrence. It will be a proportion of the total mileage shipped to what kind of transportation mode, and also how severe the accident might be, and those are the kinds of considerations, consequence being what the severity in terms of the risk end point is going to be. So these two terms form the basis for the risk estimate, and the end point we're talking about here is mainly the human health impact in terms of cancer risk.

Again, we talk about a routine and accident conditions. In the routine conditions, since it's going to happen, so frequency is always the one here; exposure to exhaust, which is non-radiological, exposure to ionizing radiation, which is radiological. Similarly, in the accident conditions, we talked about this morning the Modal study. When an accident happens, it does not usually or most likely not lead to release, most of the time it will not; only for the rare occasions when you go beyond the design basis accident, some sort of release might happen. So risk also includes physical trauma from accidents. That means that the truck will run people over, some people will die from injuries. That's a risk. And, thirdly, the frequency from the accident is always a statistic and usually very rare.

Risk also depends on transport mode, material, package, route characteristics, as I mentioned earlier.

In terms of analyses of risk, basically DOE's analyses also evolve with time. It didn't happen just one time, overnight. I know that since the promulgation of NEPA, there's also in the earlier AEC times, there were also some documents being prepared. But the most significant one that we heard this morning is NRC's NUREG-0170, EIS on the Transportation of Radioactive Material by Air and Other Modes, published in 1977. And then the later part of the approach has been improved in particular to the spent nuclear fuel. We heard this morning about the Modal Study, a more detailed analysis that tries to characterize the accident modes there. And also they improved the statistics and parameters. For example, the accident statistics over time have been improved.

I know that some of the, especially the Waste Management EIS, has been used at state level, an excellent statistic, as opposed to earlier times, the nationwide level. So gradually, this parameter also gets improved, and also it's driven by the legal precedents. There are some legal actions taken upon the different groups, you know, ways of forcing DOE to take more activities. So there's also the legal precedents, and in particular related to spent nuclear fuel.

This approach in analyses has evolved in response to stakeholder concerns. There will be increasing route-specificity there, the push to do that, also scenario-specific analysis, all talk about the RISKIND code that Argonne developed for RW, in large part, responding to the stakeholders' call for consequence only type of analyses.

Also, there are emerging issues to include environmental justice that try to capture the cumulative impact in these NEPA documents.

I'll not try to talk too much about the Modal study. I think Larry Fischer has articulated it very well. But in the NEPA analyses, there's a quick glimpse of how to make sense out of these Modal studies response regions, and I don't want you to hold this number hard and fast, because all this is subject to uncertainties. We tried to make sense of that, so these are some sort of examples that we tried to utilize, some of the formulas, you know, written in the particular document and tried to, in the NEPA analyses, see if we can have a better interpretation for the stakeholders, and this is one we tried to interpret. But, again, I will caution you not to hold this number hard and fast. It's a quick way to try to summarize or interpret how each region might be interpreted. So that's kind of a quick glimpse of each region, or some of the typical representative scenarios might look like.

Basically, there are four models that are commonly used, in particular in the last five years to ten years. We talk about RADTRAN here, and certainly I don't delve into that. Again, Sandia will follow me and is going to talk about RADTRAN in more depth.

RISKIND, on the other hand, has been designed, as I mentioned, in response to the stakeholders' concerns in the past. There's a question about the risk probability masking the consequence, type of argument there, so in RISKIND we take the particular scenario and just do the consequence to see what's going to happen to the community in scenario-specific type of analyses, and show to the stakeholder if you take the probability away, what's going to be the consequence alone. That has been very useful in communicating with the stakeholders.

RADTRAN was developed by Sandia; RISKIND by Argonne. We have two other codes, HIGHWAY and INTERLINE developed by Oak Creek National Lab. HIGHWAY has been doing the highway routing model, and INTERLINE being used for rail routing models.

This one just kind of summarizes what the risk analysis has been, and I basically factor those four models into this particular figure here. Basically, when you do the analysis, you're going to do both routine and then accidents, but before you do that, you need to find out the routing, linking, the origin, destination. You have to characterize the waste material itself. And in that, you branch into the risk probability times consequence, or you blow up some of the maximally exposed individuals, just look at the consequence alone. That happens the same way on the accidents. That's related to a radiological impact. In the vehicle-related risk that we talk about, accidents, the trauma alone, and also some of the emission from the exhaust here, so all this captures the risk and also is some complementing consequence presentation here.

The following two, actually you can read through that, but I don't want to go into that. This is a summary of very recent EISs, just to support my statement earlier, how they did the analyses in this past EIS, some of them spent nuclear fuel. But if you look at the type of NEPA documents here, what they are focusing on, what is the transportation mode, what kind of model they use for routing, the risk model they use, what kind of input they analyzed, so you can pretty much see that basically it's generally a consistent approach that's been developed. The same with the next slide, about a couple thousand of them, you know. There are actually more. Hundreds we review, but these are just kind of typical and show the past few EISs.

In giving you pretty much a quick summary of what the risks look like, in these two figures, we kind of took the spent nuclear fuel, high-level waste as an example here. On this, we have the radiological related dose. Dose, I use a surrogate of risk because they have a more direct relation. Over here are all the kinds of different EISs here. The first figure here shows the rail shipments. The second one shows the truck shipments. And as you can see, in this particular dose here, we kind of normalize by the so-called transport index. We don't want to have that influence it. So if you take that away, most of the people, you can see that the trucks would have a higher per unit risk here compared to rail, because the rail usually goes faster, it runs through a lot of remote areas, whereas, the truck would go through a lot more populated areas, and generally the speed is slower. So mostly what you can see here is a fairly consistent result in the recent EISs that you can observe, really not a drastic departure among all these different documents and analyses.

And I would add, coming back to the earlier slide here, there was one question earlier this morning about the statistics, some people ask, well, what happened to the total mileage here, and I want to talk about the statistics here. What we use, basically the rule of thumb here for the truck, our estimate--actually the compilation of DOT data over the five years has been almost one accident case in about 10 million miles, in that order of magnitude. Rail is probably in the order of five times ten to the minus eight, you know, that means five in about 100 million miles, that kind of accident statistic. So in terms of order of magnitude, it's been done that way.

And if you talk about how exactly you verify that, it's kind of hard because the carriers don't usually give you that information. And if they do, they'll tell you there's no accidents. But if you talk about statistics, one in 10 million miles is a lot of mileage to log. So some of the carriers may not even reach that kind of distance, so even though they don't have any accident happen, does not necessarily mean that they are as safe as they claim to be.

And to just give you a feeling of what risk would look like, basically for the truck, we can say that transportation risk is basically proportional risk for the shipment mileage, and the more mileage you have, the more risk you involve. And accidents, physical trauma is actually dominate non-radiological risk. You can see the orange part represents truck and rail here. Radiological risk is dominated by routine exposure, and most likely in stops, and also radiological accident risk tends to be low due to low frequency of accidents involving releases. And that confirms NRC's and also Larry Fischer's analyses this morning that when you certify the cask, actually most of the accidents that happen are actually within the design basis accidents.

So in order to get to the release, you have to go beyond the design basis accident, which is extremely rare.

In conclusion, I would like to say that by looking at DOE's NEPA analyses, transportation risk assessment has become increasingly comprehensive. That means evolving over time, and we can see that some of the analyses, like Modal study, are also evolving. A consistent approach has been applied in recent DOE transportation assessments, many using pretty much the same model here, and conducting the analyses.

And also, I wanted to point out also that environmental justice and cumulative impacts are also being addressed in past EISs. One important thing to bring up is that despite all the improvements here, actually observation is that the risk numbers really do not change a whole lot, but one aspect is that those improvements are extremely variable in making the NEPA process more transparent. I think it's a very important point here, because much of that is in response to stakeholder concerns, and that improves the communication, for example, the Modal study makes it easier for interpreting the risk and characterizing the accident analyses. And there's also an emerging trend there, trying to use the GIS to offer up recent information and make the communication better. And I'll conclude my presentation here at this time.

ARENDT: Thank you. Are there questions? Debra?

KNOPMAN: Knopman, Board.

On your flow chart of the risk assessment approach, and also in your conclusions, you talk about comprehensiveness. To what extent can you--or can you tell us a little bit about sensitivity of the assessment to a couple of key parameters or issues? And we've heard that the most important issue here really is not mode, but packaging, and packaging comes up in the waste characteristics. What I wonder is do you need all this--what do you add in terms of your understanding of risk assessment once you get beyond packaging? I mean, do you really get any kind of differentiation there from introducing other variables?

CHEN: Well, I will leave the sensitivity to Sieglinde to talk about RADTRAN sensitivity capability. But to address your question up front here, if you're talking about routine exposure, basically it's external dose strengths. That's what dictates what the risk is. That means if you allow more leakage of radiation, which is certainly within the regulatory limits there, then you have more risk there in the routine operation.

The other point I want to point out, most of the routine operations here, the biggest dose comes at a stop. Every time you stop for inspection, people get very close to that and, therefore, you can potentially expose people, and we know radiation's one over r squared rule, the closer you get, the more exposure you have. So that's one of the reasons that the stop dose has a high radiation level.

On the other hand, for accident analyses, as I mentioned, there's no leakage there, no risk. So from the accident point of view, release fraction becomes extremely important. That's the reason why the presentation this morning by Lawrence Livermore focused so much on the design basis accident, because that's where the release is going to happen potentially. So that's where the sensitivity is.

So when you get the accident analysis, you really have to know how much has been released and what probability and what response regime that particular release may occur. And that's the focus of the data collection here, and that's the reason why NRC spends so much time and energy in characterizing the release conditions.

ARENDT: Dan?

BULLEN: Bullen, Board.

In your comparison of risk results for the two transportation modes, rail and truck, do you want to go to that bar graph, if you would, which is a couple past where you were? If you normalized it over the population, you mentioned that there's a low population exposure for the rail and a high population exposure for the truck, do those numbers get closer together? I mean, this looks like a little bit of a skewed, and what I'm looking at is the dose to the maximally exposed individual, which is what I'm trying to find.

CHEN: That part may not be that much of a departure there, depending on the scenario. If you focus on this, say for example, I mentioned the RISKIND thing, but if you take the probability away and focus on the scenario-specific, then that will be heavily dependent upon what scenario you have.

Say, for example, you have inspectors who check the trucks and rails, in that case, the distance is about the same, the timing is about the same, then those should be comparable.

ARENDT: Woody?

CHU: This is Woody Chu of the Staff.

I'd like to follow up on that question, please. The number of shipments will be higher for the truck shipments; right? Does that answer, in part, as to why the truck numbers are higher, because you have many more shipments, when the same amount of material is carried by truck?

CHEN: Is the same material carried by the trucks? Fred, can you answer that question?

MONETTE: Yeah. In these two bar graphs, I believe the biggest driver, and the difference between the truck and the rail, are very conservative assumptions in terms of the truck stop model, in terms of how often a truck stops and how many people are exposed at each stop. If you reduce the conservatism in that part of the model, those numbers will be much closer together, because the rail doesn't stop as frequently, and there's not as many members of the public exposed each time the train stops.

CHU: My question was of a somewhat different sort. In other words, if you take, let's say, the fuel associated, or the material associated with Yucca Mountain, as an example, you have so many thousands of metric tons to move, so under truck shipments, you would need so many numbers, and under rail, you have so many numbers. Is part of the reason why the truck numbers are higher because there will be more shipments by truck; is that part of the drive?

MONETTE: That's a true statement, but that's not what is reflected on these graphs, because these are simply normalized per mile.

CHU: Oh, normalized.

ARENDT: Okay, thank you very much.

CHEN: Thank you.

ARENDT: Our next speaker is Dr. Sieglinde Neuhauser from Sandia National Laboratories, and Dr. Neuhauser will be joined by Doug Ammerman.

NEUHAUSER: Thank you for the opportunity to address the Board today. This quickly is the group doing risk assessment at Sandia. Doug is with a sister organization that does package testing, and we work very closely together. This is simply the risk group.

As you've heard a couple of times already today, RADTRAN and NUREG-0170 are co-evil. RADTRAN 1 was basically developed in order to do the analysis in NUREG-0170, and it was later, a few years later, decided to generalize it. Originally, the first version of the code literally could only do the standard shipment model in NUREG-0170. RADTRAN II was changed simply to allow the same calculations to be done on any user entered data, and it was also the basis for the IAEA code INTERTRAN, which was an internationalized version of RADTRAN.

RADTRAN III represented some model updates, and just like S.Y. said, we continually try and update our models and our codes to take account of new data, new computational techniques, and so on.

RADTRAN 4 included our first cut at being able to do more route-specific analysis, and RADTRAN 5, which is just out this year, extends that attempt to allow the user to do highly route-specific analysis, and it removes essentially all embedded values that were in previous versions of the code.

RADTRAN 5 allows you to look at radioactive material transport by all commercial modes, any type of material, although we certainly do a lot of spent nuclear fuel analyses. As I mentioned before, it contains no embedded data, and like any risk assessment code, as a matter of fact, in order to do risks, you must calculate consequences and probabilities, and those are also part of what's put into RADTRAN and part of what comes out of RADTRAN.

The flow chart shows you how all the models fit together. I think it's attached at the back of the packet because we didn't reduce it. But in addition to incident-free population doses, we call them doses instead of dose risks because like Dr. Chen pointed out, the probability of occurrence of those doses, given that the transportation occurs at all, is essentially one. The dose risks are usually the subject of most interest. Quite a few different kinds of individual doses, and I put in here specifically that consequences are printed in the output and probabilities are printed in the output, along with risk, so that you can separate out those contributions to risk and do CCDFs, complementary cumulative dose functions, and so on. It's all available in the output.

On the incident-free dose calculations, the code uses very simple basic point source and line source models. The line source models are only invoked on large packages for people who are close, if you become for occupational reasons close to the package. We do integrations over uniform population densities, distributions within each route segment. However, the user can pretty much define how small those group segments become, and of course we look at stops separately.

The kinds of subgroups we look at, we use the shorthand terms off-link and on-link. That means people adjacent to the road, members of the general public living beside the road. On-link is people sharing a transportation link, people in other vehicles and so on, crew members, escorts, persons at stops, handlers, inspectors and storage, and I don't mean storage like on-site storage of spent fuel at a reactor, I mean interim storage.

For example, a kind of interim storage that occurred was during the Taiwan research reactor spent fuel transport program, because of an MOU between the states of Virginia and North Carolina, only three spent fuel casks at a time in any 24 hour period were permitted to go pass through North Carolina, and they were going to Savannah River. They arrived at Hampton Road. Therefore, when six or more casks--when more than three casks came in, the remainder had to be held at least 24 hours and shipped the next day, and they were held in a warehouse at the port. That's the kind of interim storage I'm talking about.

And of course we look at individual doses, including maximum in transit individual, and a number of other individual crew member doses, and so on, can be calculated, but the user has to know what they're doing. You have to select your input values. They're not automatically output for you.

In dose-risk calculations for accidents, we look at six different dispersion related exposure pathways, and the loss of shielding type of accident where, for example, Larry Fischer this morning mentioned lead slump. If you had a thinning in your shield, there would be a partial loss of shielding. That's the kind of thing you could analyze in that module of the code.

Some changes that we've made in this version that are different from older versions, give you more flexibility, is that the clean-up and interdiction levels are now independent. The interdiction levels used to simply be a multiple of the clean-up level and you couldn't change it.

We've added a new ingestion model, replaced the old ingestion model with the COMIDA2 code, which is also used in the MAX code, which is the Melfor (phonetic) Accident Consequences Calculation System, which is used by NRC for reactor safety, and we try and stay somewhat parallel to them wherever we can so that on-site risks and then transportation risks can be more or less reading off the same sheet of music.

All of these risks are calculated separately for each route segment. These are all user definable. You can do up to 60 individual route segments per run of the code. You can run the code many times if you want to do more than that. They don't have to be sequential route segments. They can be the same route segment, different times of the day, for example, that kind of thing. It's very flexible that way.

We do include a library of radionuclide data, plus a DEFINE function that allows you to redefine those radionuclide-related values in case you choose to. And there's some inherent conservatism there. For example, in the inhalation dose conversion factors, we use an average AMAD particle size of .3 microns, and this may sound extreme, but that way, that average diameter gives you 100 per cent of the population below 10 microns, which is the respirable diameter. That is extremely conservative, extremely unrealistic, but very few measurements have been made of actual particle diameter distributions. And where good data are absent, we tend to get very conservative. But if you do happen to have particle diameter distributions for your problem, you can use the DEFINE function to alter that.

This is in partial response to your question about what's most important. We have done quite a bit of sensitivity analysis and uncertainty analysis over the years and package response. The uncertainty in extra-regulatory package response tends to dominate the accident risk, not necessarily because it would if we knew what it was; it's just that there's been very little extra-regulatory testing. So we have to assign it a high uncertainty when we do these analyses.

Of course accident probability, as well as package response data, are all obtained from event trees of the type that you saw Larry Fischer showed you this morning, and these are almost essential to doing a risk analysis. There are other ways, but this is the best way, and event tree development is one of your first steps in a new area if you're analyzing a risk for nuclide transportation.

You can use, as far as dispersion parameters go, you can use pre-calculated values for an average, a conservative average cloud, which means a small diameter initial cloud, ground level dispersion, these always give you fairly high downwind values as compared to something that goes higher in the atmosphere or has thermal loft or whatever.

However, if you don't care to use those, you can define your own output from any dispersion code, so you can always do your own. In addition to population doses, we also calculate individual downwind doses at each isopleth distance, and this is essentially incorporating into RADTRAN a code that we had separately before called TICLD, which stood for Transportation Individual Centerline Dose, and so now you can get the individual doses associated with your population doses downwind at all distances, and you can even independently define the population densities in each downwind isopleth, although you can't do that separately for each route segment. That's a restriction. It's intended to be used more for a case specific purpose.

Other features; the economic model that was previously in RADTRAN 4 has been replaced by a new model, based on a report by Dave Shannon, Walt Merson (phonetic), sponsored by DP program at DOE DP, and it's now a separate code and it's available, the documentation for it is available, like all the code documentation for all of our codes, at our Web site, and if you need to get a password to actually get onto the--to use the code itself and not just look at the documentation on the Internet, contact Fran Kanipe. That number was already given this morning by Jim McClure. She's our web master and our assistant manager for TRANSNET. And TRANSNET is simply an Internet accessible and modem accessible system of codes with a user friendly GUI, graphic user interface, for RADTRAN. It's available at no charge, thanks to our DOE sponsors, and is intended to provide all interested members of the public with access to state of the art tools like RADTRAN 5.

Before I get to the last bullet here, I should also mention a couple of additional features that aren't on here. We do calculate--we do account for residence time in the off-link population based on 1990 census data. That addresses how long people reside at the same spot, and the average time of residence in a single location in the United States is only three and a half years. For a 20 year program or 40 year program like the Yucca Mountain repository is projected to be, that means that a lot more people will actually be living in the off-link band width than just the resident population at any one point in time. And we automatically calculate that. There's an algorithm in the code that calculates the total exposed population on that basis.

And then there are also non-radiological impacts like fatalities and pollution are also calculated based on the route data you put in. You don't need to put any extra information in. It just simply calculates for free, print it in the output, and it's based on a simple, common editorial code that just puts fatalities for kilometer traveled.

We also have a software QA plan. We follow ASME software guidelines. We have--our code verification methodology is written, followed, was recently published in a peer review journal, RADTRAN journal, and we also had independent validation by SAIC for RADTRAN 4, still very applicable because many of the models are the same, although we do need to repeat that for RADTRAN 5.

In addition to RADTRAN itself, we use a Latin Hypercube Sampling code developed at Sandia as a shell around RADTRAN. This card was developed with the intention of being able to be used as a shell around other risk codes. It was developed in the Reactor Safety Group, and Ron Eiman (phonetic) and John Hilton are sort of the fathers of Latin Hypercube Sampling, world recognized experts in probabilistic analysis, and they did this work at Sandia, and we're using this shell.

This is a modified Monte Carlo. You sample from distributions rather than using fixed point estimates. It's the same exact technique that's been used in repository performance assessments, like the recent WIPP performance assessment, the Waste Isolation Pilot Plan for the EPA. It allows you to do not only fully probabilistic risk analysis, but sensitivity analysis and uncertainty analysis.

To summarize up to now, the RADTRAN code is a highly flexible, very powerful tool, capable of performing high accuracy and high resolution risk and consequence assessments. And as realism increases, your conservatism necessarily decreases. There's good things and bad things about this. One of the good things about it is that the central risk estimate typically goes down quite a bit. The bad thing about it is you must make sure that your event trees are right. You can't leave things out of your event tree. You have to really have those down. And the accuracy of course depends, if anything, more than ever on the quality of the input data. We don't predigest anything for people any more. We do have additional databases that you can take data out of if you don't have any of your own, but we don't have anything embedded in the codes.

So the question of input data, just like Dr. Chen said, keeps becoming central. And we have some current initiatives in that direction to obtain distributions for LHS applications and simply to gather data of the higher quality necessary for modern risk analysis. These include we obtained a site license to the last 15 years of Lloyd's of London data. This is the individual written out accident descriptions. It's really painful to plow through, but it's useful. And of course event tree construction, I've hit that hard enough. The DOE has sponsored a SeaRAM program, which is to look at radioactive material transported by sea, and the purpose of this was to improve the analysis of the Maritime mode, of course, and the NRC is currently sponsoring a revalidation of NUREG-0170, which we are redoing the event trees on for that.

Of course, GIS, like Dr. Chen also--believe it or not, we did not talk about this ahead of time. GIS based systems are simply the way to look at route data, and we have recently acquired a site license to an ArcView compatible census block database, and that's a census block, not block group. These are the little tiny blocks of 50 people, approximately, per block. And we also obtained two very detailed databases developed for 911 emergency response purposes by local entities for two separate locations in the U. S. to do some reality checks with.

We have used data elicitation methods. This isn't a full-blown formal data elicitation because we did it by phone instead of talking to them in person, but in every other way, it was a data elicitation. These were first responders. They were contacted regarding questions such as evacuation time, response time, decision time. And we do time and motion studies. We've been to and filed and recorded and measured and stop watched and everything else vehicle inspections, vehicle stops, intermodal transfers. We have a little bit of film on some of this that I'll show you at the very end and a couple of still shots we'll get around to in a minute, and then the whole subject of how packages respond to various types of accident insults, which is Doug Ammerman's area, he's the structural guru, and Joe Koski is his counterpart in thermal. All of these initiatives are intended to produce data for use in our risk analyses.

And before I go on to the very last part, let me show you a couple of--this is a distribution. I don't think that's in your slides. This is the result of the data elicitation that I described with first responders. These were first responders to actual Hazmat accidents in the past, I believe it was the past ten years, who actually evacuated real people, and we asked them how long did it take. And we could not believe how close this approximated lognormals as shown as a cumulative lognormal distribution.

We had been using--like I say, we need to get more realistic. We had been using 24 hours as a default value for evacuation. Well, the mean, or actually the mode, as it's called for lognormal distribution here is in the vicinity of less than two hours. This is preliminary data. We have to add on things like how long does it take to get there and how long does it take to make the decision to evacuate. This is simply a piece of an initiative. This is what data we already have, so I thought you would be interested in that.

The next slide shows even at the census block level, this shows what kind of problems you can run into. This is a very rural area of New Mexico. The blank in the middle is a city, Gallop, New Mexico. We're looking at the rural areas. Those are census blocks. The little squares are an 800 meter--1600 meter total band width, one kilometer pieces of the route. It's a custom made cursor for our system. We marked it down the route. And that shows you how much bigger rural census blocks are compared to our cursor to the area that we're normally interested in for incident-free analysis. And the question of course becomes how do you distribute population out of this huge census block into these relatively small pieces of that census block, and that's an area where we've been doing some work.

The next slide, this is a 911 database. These are actual houses for the same area, McKinley County, New Mexico for emergency response, and what's interesting is that you can see where some of the roads are even though the roads aren't on there. There is clustering, especially along secondary roads, although it's much--little or no clustering along the interstates, a very interesting result from the point of view of state alternative routes.

Does anybody need to have this--those are roads. Those are houses along roads. You can really see where the roads are.

This is an example of--this is some time and motion studies we did. This is in a section of a rehearsal of a waste isolation pilot plan shipment at the inspection at the state border. We sat there and watched this whole thing. We were absolutely appalled to find out it takes 45 minutes, that at least one poor soul is next to every single one of these shipments for 45 minutes within one meter. This is anti-ALARA, and there's no demonstrable safety increase to justify this. We think this is a real problem for future looks, although we certainly don't have any control over the regulations.

And let me go on to the next slide, and I'm going to ask Doug to take over pretty quick here, because these are package response questions and I think--Doug, would you like to--

AMMERMAN: As Sieglinde said early, a major driver in the accident risk, and that's why I also brought is out, is what is the release fraction. In order to get the release fractions, we have to look at package response to these individual events.

For the risk assessment that we're doing for safety of shipped transport, we're looking at both structural response and thermal response. The structural responses show a little clip in the video that shows what happens to a radioactive material package when it's on board a ship that's struck by another ship. You can see in the top picture just before the collision occurs. The middle picture is part-way into the collision, and the bottom picture, what happens to the package, and you can see that it's being pushed out the back side of the ship. That's a very typical response; a package is stronger than a ship, at least bulkily, and so instead of the package failing, the ship fails.

We also look at, for terrestrial transportation, what happens in extra-regulatory events. We tested a minimally designed test unit, in other words, it had low margin of safety against the regulations. In a 30 foot drop, the regulatory impact, the stresses in the test unit were at the regulatory limits. We subjected this to increasingly severe impacts. This picture here shows the result after a 60 mile per hour impact onto an unyielding target. You can see that there's significant plastic deformation at the bottom of the package there near the impact point. The impact member is completely crushed up, is gone material solid, but this package is still leak-tight.

We also have looked at fires aboard ships. This shows what could happen if you had a radioactive material package in the same hold as, not flammable material, because the IMO regulations prohibit transportation of radioactive material and flammable material in the same hold, but you may have combustible material, for example, wood pallets or other wood material, and that's what this is showing. We had a wood crib, which is a standard test unit, if you will, for looking at fire extinguishing capabilities, so the heat supplied by that wood crib is very well characterized when it's constructed to this specification.

We had a calorimeter that simulates a radioactive material package immediately adjacent to the location of this crib fire, and we're measuring what is the heat input to this calorimeter during this test, and it was found that it's less than the regulatory fire, as you would probably expect, since it's not totally engulfing. We also used that test to benchmark analysis of that same event, and you can see in this picture the wood crib at about the same location as it was in the photo, and the calorimeter at the same location, and that the heat rises--essentially, most of the heat from that fire goes up, as you would expect, and convection is making--you can see the convective arrows on that slide showing how the heat is transferred over to the sides of that hold, and the calorimeter is actually in a region of relatively low temperature.

This is another comparison of the calculated result versus experimental. The heat flux that we typically see in engulfing fuel fire is about 100 kilowatts per meter squared. The regulatory 30 minute fire, how it's specified in the regulations, is really a heat flux specification, and I believe that's about 60 kilowatts per meter squared, is what that specification turns out to be.

NEUHAUSER: Just to wind up, one last subject here, we also get asked to do special analyses like contents response analysis for--VHLW is the example I used. This is in response to some rather inflammatory and unfortunately highly erroneous statements made in a report put out by Nuclear Control Institute. I have copies of our response, enough at least for the Board, and a few extra which I will give you when this is over. And that concludes our presentation. Ready for questions?

ARENDT: Questions?

NEUHAUSER: Oh, wait a minute. Oh, that doesn't conclude; I forgot our videotape.

(Whereupon, a videotape was shown, and the following is the explanation of the video by Sieglinde Neuhauser.)

NEUHAUSER: This is a spent fuel cask in the hold of a ship being put--a spreader crane is being put into place by the support workers. This was a ship very much like the one that the tests we did were conducted on, the Coast Guard facility in Mobile.

And one of the first things they did, for example, is inspect the crane cables an hour before this was started. The Port Authority is very, very thorough about these things. This was Newport News.

We had hours and hours of this kind of tape. I just picked out one little piece of it to show you. I was sitting there with a stop watch through most of this. We measured all kinds of parameters. We did not have an expert camera man. Very professional way this was run by the Port Authority. This is coming down, as you'll see, it's on a, when it gets down here, a waiting chassis, low boy trailer. And the tie-down here, the port workers are coming over and guiding them on.

Okay, this is the animation of the finite element analysis. This is the packaging, set of packages together treated as a rigid body. You can see it's punching into the back of the ship, and like Doug said, this ship is failing, the package is not. There's a lot of this. We just took a small clip to show. And this is the--see how it bulged out? That's the minimum test unit, a larger, closer shot, but did not fail 60 miles per hour, unyielding surface. And I think that's it.

Okay, now questions.

BULLEN: Just a couple of quick questions. You mentioned in your route survey, you picked the average time span that somebody lived along the route is three and a half years?

NEUHAUSER: Right. Well, no, we don't; that was just another piece of data that came out of this Census Bureau--

BULLEN: Okay. So you leave them there for 40 years while this is all going by?

NEUHAUSER: No, we move them at a national--at a rate of replacement. There's an algorithm for how many people move and how often they--how long they lived there.

BULLEN: Is this also based on the economics? Because usually the people that are living near the railroad tracks don't have quite as good of economics as--

NEUHAUSER: No, actually the Census Bureau didn't find a particular relationship between economics. They did find a relationship between region of the country, and you could regionalize this if you wanted to.

BULLEN: Okay. I guess the last question I had was you said that you had user input parameters, but if you're looking at the plume exposure, you had sort of set parameters you could also use. Are these like regional, you know, kind of--

NEUHAUSER: Yes, based on national average weather and a small diameter ground level plume.

BULLEN: Okay. So these are--

NEUHAUSER: It's a fall-back if you have nothing else.

BULLEN: But it's national averages. Do you have seasonal data and like daily data and all this?

NEUHAUSER: No, no, it's national average as far as the frequencies of occurrence to the six pascal dispersion categories; that's what I meant.

BULLEN: Okay, thank you.

KNOPMAN: Knopman, Board. This is a risk assessment tool. What have you learned from it that would bear on risk management?

NEUHAUSER: Very good question. It doesn't work the way we're looking at route analysis, because even with the minimal test unit, it's becoming apparent that only an impact with a really hard object is really going to do anything for you, even potentially release material. So the incidence of hard objects along a route are starting to become extremely important, and that's one of the things we will be looking at very closely in the next year, trying to hopefully GIS map that and get a better picture of the route on that. And that's not a view we had before.

KNOPMAN: Any other things like that?

NEUHAUSER: No, other than that in general what everybody's been saying today, it's very hard to fail these packages, and we're just zeroing in on the one thing we have found so far that might do it.

ARENDT: Any other questions? Staff?

(No response.)

NEUHAUSER: Thank you.

ARENDT: Thank you very much.

Our next speaker is Dr. Marvin Resnikoff. Dr. Resnikoff is with Radioactive Waste Management Associates.

RESNIKOFF: Thank you for inviting me, Mr. Chairman. I'm usually brought on at this hour of the day to liven things up. I know you're all a little tired, so I hope I do my job right.

I've worked on transportation issues for a long time, since 1975 when I first started working for the New York State Attorney General, when he was concerned about transportation of plutonium out of Kennedy Airport, since the casks were designed to withstand a 30 foot drop, and most planes out of Kennedy fly higher than 30 feet, he brought the issue to court and that was my first encounter with the NRC and I've since been working on transportation. And I'm now working for the State of Utah, I should mention, on this proposed storage facility at Skull Valley.

The public is very concerned about transportation because there are many more people on transportation routes obviously than at reactors or at the proposed repository. This is a cartoon that I clipped out of a newspaper in Hudspeth County. I'm going to read it to you if you can't read it. I'm pretty sure you can't read it. But one person is saying, "The public is worried about our plan to haul nuclear waste to far away dumps along routes running down major highways and passing through hundreds and hundreds of cities and towns. How can we calm them down?" And it shows all these various trucks, a Piece Brothers Toy Company trust us with your children, Moo Milk. This I clipped out of last week's newspaper. I just wanted to do that to show you that the public has some concern about transportation issues.

I want to emphasize four points today, and they are there's a need to coordinate what is happening at DOE repository, the DOE repository requirements, with what is happening in the private sector in radioactive waste management. There's a need for training and equipping local personnel along transportation routes. There's a need for a new environmental impact statement on transportation. I want to talk about that at some length. The last one was produced in 1977 by the Nuclear Regulatory Commission. There is a need for additional physical testing of transportation casks, that's transportation and storage casks. This is a whole new generation of casks that will require testing. Those are the four points that I want to emphasize.

As has been pointed out by other speakers, the number of shipments that have taken place in the past is nothing compared to the number that will take place in the future. I think it was mentioned that approximately 80 shipments per year have taken place since 1979, and approximately 2,000 shipments will take place when a repository or a dry storage facility, an MRS facility or an independent storage facility privately licensed. Most of the reactors are in the East, I don't know if I have to show this to you, and this material will be transported to Utah or--to Utah, then Nevada or directly to Nevada.

These are the reasons why I believe a new EIS on transportation is required by the NRC. I don't know what happened to cask burial. It seems to be degrading. Several years ago, I suggested to the NRC that the commission do a new EIS on transportation, that the previous EIS was inadequate, and I said that some state is going to eventually take the NRC to court on this issue. And then I said this again in Atlanta where Charlie Haughney was on the program this past spring, and Charlie Haughney says, "Stop beating us with this. We're going to do it. You know, you don't have to talk about it any more." Well, I felt great.

But then I talked to Charlie in August and he backed off a little bit when I talked to him personally. He said the NRC was considering doing an EIS now, that I should send them a letter saying why an EIS is required. This is a crucial time, he said. So now it's not certain any more that the NRC is doing an EIS, so I want to underline the issue, and I want to suggest to the Board that it recommend to Congress that the NRC do an EIS in transportation, that Congress fund the NRC to do this EIS.

These are my reasons for it. When NUREG-170 was initially written, it was premised on the fact that there would be reprocessing. Fuel would sit in reactor pools and then it would be transported to a reprocessing facility. It wasn't premised on the fact that fuel is going to sit in dry storage for years and then be shipped on the highway or rail. This makes a big difference, as I want to explain to you.

The storage systems that are presently in use, not the ones that are being proposed now, that's another issue, are primarily the NUHOMS and the VSC-24 containers. TN-40 has, you know, been suggested at Point Beach. Now, these containers are built in the following way. This is a NUHOMS container. Essentially, the cask is--the canister of fuel is sitting horizontal within a concrete box. This is what I call the mausoleum concept, or the stone hinge concept is the VSC-24 which stands upright on the platform.

Now, the two of these have a similar characteristic, in that you have a storage canister which is welded shut with helium inside, sitting within a large amount of concrete, almost three feet of concrete. The effect of that concrete is to insulate the canister inside. Even though there are air ducts, the temperatures can get very hot.

This is an overhead which shows some of the temperatures. You see that for the maximum cladding temperature, temperatures can be almost 700 degrees Fahrenheit inside the container. In fact, I compared these temperatures to the maximum cladding temperature while a reactor operates, and those are comparable. In other words, in dry storage containers, the temperature, the maximum cladding temperature is comparable to while the reactor operates. These are classified as very benign systems, but the temperatures are in fact very hot. These are the temperatures in the reactor and the temperatures in dry storage. The cladding temperatures in the reactor; cladding temperatures in dry storage.

What is the meaning of that? Well, first of all, as I tried to say, the impact hasn't been anticipated in NUREG-170, and the possibilities are for cladding degradation. Extended storage at high temperature increases the likelihood of corrosion cracking, creep corrosion, and increases the likelihood that in an accident, there will be rupture of the cladding.

The next point I want to make is the location of severe accidents was never correctly stated when NUREG-170 came out. There never really was an analysis. It was engineering judgment. The judgment was severe accidents take place in rural areas, are more likely to take place in rural areas, and less likely in urban areas.

On behalf of the State of Nevada, I looked into 40 real accidents which have taken place, not nuclear accidents, but 40 that could be easily analyzed, that had been already analyzed by the National Transportation Safety Board, and looked at where those accidents actually took place.

So in NUREG-170, you probably can't read this, but the accident severity categories are listed in this column, and one is the least severe and eight is the most severe. And you see that in rural areas, the least severe accident is least likely. The more severe accident is most likely in comparison to cities where the reverse is true. And these numbers are essentially made up. There's no basis, no statistical basis for them as it appears in NUREG-170.

We looked at real accidents which have taken place, and let me list them. Here are train accidents. We looked at 21 of those. Six of them took place in rural areas, ten in suburban and five in urban areas. We looked at truck accidents, severe truck accidents. Two took place in rural areas, ten in suburban and seven in urban areas. It seems to be the reverse of what the NRC has said. So that's another reason why we believe that a new accident analysis should be done.

Most major rail accidents occur near upgrade and downgrade areas. It doesn't correlate with urban or suburban or rural; it's where the upgrades and downgrades occur. Accidents in Helena, Montana or Bakersfield, California are two examples.

We are also concerned about fire temperature in impact, and this has been mentioned at great length today. The original analysis that was done by Sandia for NUREG-170 assumes that accidents are elastic, they use elasticity theory, which is entirely inappropriate for severe accidents, because a cask smashing into a concrete bridge abutment is not like two billiard balls colliding.

We also looked at fire temperature, and we looked at real fires which have occurred in real accidents on the highway and rail, and many of those are not diesel fuel; there are other substances which can burn much hotter. And it's our contention that real materials need to be considered. Real accidents need to be looked at to see what the real fire temperatures are, and to compare those with the regulatory standards.

Accident rates were another concern that we had, and I was glad to see that Mr. Fischer has been looking into accident rates, and also Sandia Laboratory is looking into accident rates. The accident database that was used for NUREG-170 is very thin, and a new database should be used in estimating where accidents take place, the likelihood of accidents.

Earlier today, there was a listing of the number of accidents which have taken place, breaking those down into Type B, Type A, and strong containers, and I just wanted to say a word about that. We have some concern about that database, and this underlines the points that were raised earlier by one of the panelists, in the fact that the accidents are not looked at in a consistent manner, and I will give you a couple examples of that.

There have been Type B accidents which have taken place, which have released their contents. You saw a number zero that appeared on the overhead. That assumes your Type B containers are only spent fuel containers. But as Charlie

Haughney mentioned to you, there are other types of Type B containers, namely radiography containers, which they analyzed and some of those have broken open in accidents and released their contents on the highway.

In addition, there have been some high level waste transportation accidents which were not included which should have been included, if you want to include them in a consistent way with the way you look at low level waste accidents which have happened, and I'll give one example of that. A shipment of fuel from Haddam Neck reactor to Battelle Columbus took place in 1980, and the fuel rod was too hot for the container. As a result, the uranium oxidized and when the cask was opened and put in the fuel pool, a lot of the fuel just emptied out into the pool.

Now, you may not consider that a high level waste accident. Okay? But then let me give you another accident which took place at Barnwell, South Carolina. At Barnwell, they had a Type B cask which they opened up, which was supposed to have been shipped completely dry. When they opened it up, 75 gallons of contaminated liquid came rushing out. They had unfortunately left some water in the cask. That is in the database. So the high level waste accident at Battelle Columbus is not in the data base, but the one at Barnwell is in the database. So there is a point in the fact that these accidents are not looked at consistently.

Other kinds of accidents were not included in the Sandia database and should be, namely drops off bridges or--well, let me give some examples of that, a bridge collapse on I-95, Mianus River Bridge collapse, or the Schohari Bridge collapse on the New York State throughway. Those kinds of accidents are not included in the database and should be, because the velocities can be high and there's not any evasive action that a driver can take if you're, you know, flying off into the abyss, as happened in the Mianus accident, where vehicles dropped 80 feet.

Another point concerns human error. I wanted to discuss that briefly, and that was also raised today. NUREG-170 assumes a perfect container and an imperfect world, and as Mr. Fischer said when he was asked the question as to whether they actually look at design defects, he said no, no, they don't look at--they assume that the cask is constructed perfectly, and there have been several instances where that has not occurred, where casks have been constructed incorrectly.

Let me point out a few of them. The NAC-4 transportation cask was not constructed correctly. Four of those out of seven were removed from service after being used for several years. The VSC-24 storage cask at Palisades was incorrectly welded and has still not been removed from service. It's still sitting there.

Workers sometimes make mistakes. A cask, the NLI 1/2 at Duke Power was supposed to have been filled with air, and instead was completely filled with water, because a worker put the wrong hose on the wrong connect. And as I mentioned, this high heat fuel assembly that was shipped from Haddam Neck was a human error. Human error is not factored into any of these calculations, and it should be.

The cask capacity has changed. The newer casks hold much more fuel than is assumed in the old EIS. They can hold up to 24 BWR fuel assemblies. The new casks that are being considered by Holtec International and by Sierra Nuclear, the transportation storage combined use cask, can hold up to 24 fuel assemblies, BWR fuel assemblies. And an accident with this huge inventory of the radiated fuel has not been analyzed for an urban area.

These casks will hold more than a critical mass of fuel. If they are BWRs, they will hold more than 17 BWR fuel assemblies; therefore, more than a critical mass. And if the nuclear industry is successful in lobbying for burnup credit, that is another element of human error that is possible, if a worker puts the wrong fuel in the cask.

A criticality event where fuel is rearranged, the consequences of that are far outside the envelope of consequences that were assumed in NUREG 170.

There's been some discussion earlier of sabotage, and I want to say a few words about that. The NRC arguments about sabotage I don't believe are persuasive. Let me give you a for instance. Imagine the Olympics taking place at Salt Lake City. They are going to take place at Salt Lake City. Imagine rail casks going through downtown Salt Lake City on the way to Squaw Valley. I think that's a highly visible target. It's a type of scenario that needs to be considered.

There are many enemies of the United States. There are domestic militant groups. It is within their power to actually successfully attack these containers.

There are hand-held anti-tank weapons that can penetrate more than a meter of steel and can shoot the distance of two kilometers with accuracy. So I believe it's an issue that needs to be investigated carefully. A few guards holding, you know, handguns is not going to stop this kind of activity.

Finally, the issue of cask burial is important. It's an issue that we looked at in a study we did for Greenpeace concerning what happens if a cask holding vitrified high-level waste lands in the ocean, and there are calculations which show, at least for the TN-40 cask, that the cask could rapidly overheat. In the matter of tens of hours the cask could overheat, and, therefore, a successful salvage operation is needed. And that's not that easy to, you know, successfully move a 125-ton object that's landed in the water.

I wanted to bring up some policy issues that have come out of the work for the State of Utah to pose to the panel for you to consider.

The first policy issue is whether the casks that are being proposed that Charlie Haughney has mentioned, such as the HI-STORM and TRANSTOR cask, whether they are actually going to be compatible with DOE requirements. This is an important issue. If they're not compatible, then the canisters will have to be open and the fuel is going to have to be transferred.

So it's an important consideration if you want to minimize the amount of handling to make sure that these systems are compatible. And the NRC regulations actually require that these casks be compatible, but in the questions that the NRC has asked these cask manufacturers, they have not broached this particular question, to my knowledge, and I've looked over all the questions the NRC has posed to Sierra Nuclear and to Holtec. Obviously, the best is, you know, if these casks are completely compatible and so DOE can use them in their disposal overpack.

This may seem like a strange issue, but let me bring this up as well. The definition of storage and storage facility is not clear. You think that storage--you know, what is storage? You put casks out on a pad and they're you're storing it.

But let me give you another example. What if you have rail casks that are sitting on a rail siding, say they're sitting on a rail siding for a few days next to Interstate 80? Is that storage, temporary storage, or is that transportation? If there's a building with a crane that lifts casks off rail guards and puts it onto a heavy-haul truck, is that a facility? That requires licensing by the NRC? And does such a facility have to have certain physical protection as it sits next to I-80? These are questions that, you know, the state is considering and that I consider important.

There's an issue about private storage facilities versus the MRS, versus the Department of Energy facility. The Nuclear Waste Policy Act provides protection for states. That's built into the Act if it's a federal MRS facility. But these protections are completely bypassed if the facility is private. So there needs to be a consistency, I believe, between these regulations, and there needs to be a consistency in federal law as well.

We would question whether the NRC actually has the authority under the federal law to regulate private storage facilities. And don't ask me questions about that until after November 24th because that's when the State files their petition.

Those are the primary issues that I wanted to address, and thank you for your attention, and I'll answer any questions you might have.

ARENDT: Thank you.

Are there any questions? Dan?

BULLEN: Bullen, Board.

Just a point of clarification on your cask burial scenario. You were dropping it into the river, but you were burying it in the mud? I mean, were you going deep enough?

RESNIKOFF: Yeah.

BULLEN: So there wasn't water cooled? It was buried in the soil, and that was where the heat transfer problem came?

RESNIKOFF: Yes, that's right.

BULLEN: And the river was just an impediment to getting it out because you had to do it under water?

RESNIKOFF: That's right.

ARENDT: Other questions? Staff?

Thank you very much.

RESNIKOFF: Okay. And I'll write this up for you. I'm sorry I didn't get--

ARENDT: We would appreciate that.

CRAIG: Yeah, can I make a comment as he's finishing? Craig, Board.

As you write them up, I wonder if you'd take special pains to highlight the areas where you think the Board might take action. You identified several of those in your presentation.

RESNIKOFF: Yes, I'll be glad to do that.

CRAIG: Thank you.

ARENDT: We're slightly early, so we'll still have a break, and let's get together at 3 o'clock.

(Whereupon, a break was taken.)

ARENDT: Well, I guess we'll start without them, but we've got to have our speaker, though.

Our next speaker will be Robert Jones, and Robert will be discussing the transportation of commercial spent fuel.

JONES: We have a few stragglers back there.

As tempted as I am to discussing a few of the points that Dr. Resnikoff addressed just before the break, I won't. Perhaps there will be some opportunity tomorrow in a panel discussion to address those.

I guess this is also part of the twilight zone when lunch kind of kicks in. I hope everyone had some coffee before coming back. I don't know that I'll be nearly as entertaining as the prior speaker, but I'll see what I can do. Also, I apologize, I don't have any elegant visual aids either, but hopefully they're to the point.

As you can see, I'm going to talk about

transportation planning and execution, commercial spent nuclear fuel movement. This is sort of--although you've heard an awful lot of talks about probabilistic risk assessment and modal studies and structural analyses, this is kind of where the rubber meets the road, and I thought I'd give equal opportunity to the other modes of transportation. So this is sort of where the hoe meets the harbor or where the wheel meets the steel. Use them as you like.

So I'm going to talk about, first of all, the definition of shipping campaign. You've heard that word used a lot, and I'm going to tell you what that really constitutes. I'm going to discuss pre-shipping planning, pre-shipping mobilization. Then we'll talk about shipping activities, post-shipping activities, and then I'll wrap it up with a little show and tell.

So you can see from the slide that my name is Robert Jones, and I've been in the nuclear field for 31 years; 28 of those have been involved with spent fuel packaging, transportation, some storage as well in more recent times. I have designed, licensed, constructed and tested transportation systems, casks if you will. I have directly participated in the shipping of spent nuclear fuel, and I have performed studies and assessments of practically every aspect of the movement and storage of spent fuel. And I'm also acting as my own slide turner here.

Jim McClure this morning has presented some--oh, gee, thank you, Woody.

Jim McClure presented statistics on spent fuel transportation in the U.S., and, you know, I really find this to be an enviable record, and it really didn't happen just by accident; no pun intended. It really happened because those people in the business, those entities and those individuals are very much aware of the responsibility that they have to the general public. And one of the sources of that responsibility, of course, is that we all, ourselves, our families and our friends, are all members of the general public. So, clearly, we take our business very seriously.

Now, there have been--this number, this 2,600 shipments, it seems to vary, and it kind of depends on whether you're talking about since 1979 or whether you go back into the '60s. But let's just take that number, that there have been roughly 2,600 shipments of commercial spent fuel in the country over the past three decades or so, and although this really isn't an enormous volume by European or worldwide standard, nonetheless it's significant. You can't pawn this off as being just a trivial amount. These shipments fall into two general categories; they are sort of individual shipments, and then there are "campaigns," and I'll use that in quotations.

Individual shipments have tended to be sort of the onsies, twosies (sic) used to ship lead test assemblies from reactors back to hot cells for examination, a very important part of the nuclear fuel development programs, but the bulk of the fuel have been shipped in campaigns where multiple shipments, usually with several casks in service, are scheduled and conducted from one facility to another. Campaigns are conducted to minimize the impact of spent fuel shipping on the shipping and the receiving facilities. By blocking out specific periods and maximizing the shipping activity, these facilities are better able to mobilize their resources, equipment, personnel and infrastructure. In other words, spent fuel shipping at a reactor site is not something that they do routinely. They have to change a lot in order to gear up for that, and, therefore, the campaign kind of puts that all in a block, if you will.

So let me illustrate a campaign by describing the Shoreham Fuel Project in the next slide.

Now, the Shoreham Fuel Transfer Project was a shipment of 560 radiated BWR fuel assemblies from the Shoreham Nuclear Station in New York to the Limerick Nuclear Station in Pennsylvania. The Shoreham plant was being decommissioned, and the 560 assemblies represented the first and only fuel core. Remember, that was a very prematurely decommissioned plant.

Due to the low burnup, the fuel had had energy value and was being shipped to another BWR, that is Limerick, for continued use. Because the fuel had produced power during Shoreham testing, it had to be shipped in spent fuel shipping casks due to the fission product inventory. The fuel actually had like a two effect at full power days, but that was enough to make it relatively high. Contact doses were in the order of 100-R per hour.

Two Model IF-300 railroad shipping casks were used. The transportation was via heavy haul, barge and railroad. So it was truly an intermodal. Total one-way distance was about 400 miles, and it went from the north shore of Long Island, you know, where the Shoreham is--north shore of Long Island, out around the tip of Long Island, down along the New York and New Jersey shore, and up the Delaware River, eventually going over land to the Limerick Station, which is about 50 miles west of Philadelphia.

Now, the project planning began in 1990 before the selection of Limerick as its destination. Several other facilities were considered before Limerick. In one case, significant planning was performed for that site before it was dismissed in favor of Limerick. Once the final destination was identified, the campaign planning took roughly six months, although much of the preliminary work had been done looking at the prior location.

The final closeout of this, we estimated it would take something in the order of a year. If we took the prior work and we took the actual work when Limerick was selected, kind of compress those, we think that it would take about a year to do the preliminary work before shipping and one month more for the final closeout.

So the Limerick campaign, then, kind of consists of this list here, all the pre-shipping and preparatory activities, a couple of casks, packaged to prevent in-transit damage. That's an artifact of that particular shipping campaign because we're going to reuse the fuel. You don't generally do that for spent fuel that's going for disposal. But the significant thing is two casks, 17 assembly per cask.

The plan is to ship by barge from the Shoreham Station to the fossil fired plant, Eddystone Generating Station, which is on the Delaware River. From there, it would go by railroad, from Eddystone to Limerick Station. So it is like a 350-mile trip on the water and about a 50-mile trip on the railroad.

The plan was that one barge and one rail cask were assigned as a pair, and the two casks sort of move in opposition to one another, sort of the loaded passing the empty at sea. The total turnaround time, that is the time from the loaded outgoing one until that one came back and was going out again loaded was projected at about 11 days, and there was three-day headway between the two casks. So this would yield roughly two shipments every couple of weeks. A total of 33 shipments were required to move 560 assemblies.

We needed two intermodal transfers. The first one was a roll-on/roll-off operation at the Shoreham on-site barge facility, where the heavy hauler, a heavy haul transporter would move the cask from the Shoreham reactor onto the barge. And then there was a second intermodal transfer, which was the lift-on/lift-off operation at the Eddystone coal plant where a semi-permanent crane installation was installed specifically for that operation in order to move the cask between the--actually a cask and skid combination between the barge and the railcar.

So we expected the total campaign to take something like a year, and then we had a two month time-out while one of the Limerick units went down for refueling. And in the month or so prior to the refueling outage, we had to kind of break ranks a little bit and sort of change the way that we scheduled shipments in there because there's an awful lot of site preparation for a refueling outage.

We also committed to make an attempt to try to see if we could move fuel into the plant during the refueling outage. We didn't think that was going to happen, and we were certainly correct in that.

And finally, the campaign concluded with all the post-shipping demobilization and documentation activities.

So as you can see, a campaign is a very complex undertaking. It requires significant planning and ample time for execution.

So let's get into the planning part. Throughout this I intend to kind of cite examples of issues that pertain to more of the generic discussion of shipping. I'll cite examples from Shoreham.

Now, Shoreham, obviously, is not the only shipment that's--a campaign that's gone on, but it's fairly current, and I think that it is quite representative of what a major campaign would entail, so that's why I use it as a set of examples.

No planning activity can begin without marshalling the team. The ideal initial planning team, certainly the cadre of people who have short of been there and done that--maybe I'm being a little parochial, we old-timers who have been there and done that, but I really believe that there's no substitute for experience. This isn't to say that you can't start from scratch and build a team, and I'm certain that that will have to happen at sometime in the future. But recognize that the learning curve is fairly long, and again, I want to emphasize the need for starting things further in advance than maybe seems logical, but, you know, time invariably seems to get away from you in these sorts of things.

Next, routing, modes and equipment. A great deal of planning goes into the assessment of the logistics of the campaign. The early work involves the matching of the reactor site with the appropriate transportation system. Items of concern are type, characteristics and quantity of fuel, reactor facility characteristics for cask handling, local transportation infrastructure, cask system characteristics and availability, routing, and proposed campaign schedule. These form the skeleton of the campaign. And generally early on, options for fulfilling the transportation mission are developed in the process. Some sites there are no options, you can only go one way. But a lot of sites you find that there's rail versus truck versus intermodal, and early planning generally keeps all options open.

As the planning proceeds, more details are developed about the route and modal alternatives. The process is a carefully balanced one, which through the development of additional data actually reduces that options list. Cost is one of the factors considered in the planning, obviously. Safety is the underlying consideration, but the rules, regulations, equipment and personnel requirements really makes each shipping mode and type of equal safety.

A cross consideration example would be truck versus rail. Truck shipping is typically at lower cost than rail, but it requires a lot more shipments. Rail, few shipments, higher cost. So it's a balancing act between--that's just an example of one of the cost tradeoffs that one has to do in early planning.

Route selection, of course, is mode-dependent. DOT regulations, as you heard earlier, prescribes the route for highway shipping under the so-called HM-164 protocols. To date, rail and water routes remain at the discretion of the shipper consistent with other applicable regulations. As the planning converges on the selected route, there are other touch points. One of the most important ones of these, of course, is the NRC route approval, and again, earlier this morning you heard what that entails. I'm sure that Charlie Haughney will be glad to discuss that more tomorrow if there are questions on what the NRC goes through. And, of course, that approval is independent of shipping mode. Really, it's not just the highway in that instance.

Now, federal regulations are not the only route selection considerations. Various states have HAZMAT or radioactive material specific regulations which are supplementary to those of the Federal Government. In some cases, the state regulations may be contrary to or more restrictive than those of the federal regulations. And, of course, in this latter case, federal regulations may pre-empt them.

However, as a practical matter, the commercial shipper, at least, may choose to obey them and bear the added inconvenience, rather than engage in challenging their legality, since such a challenge could be costly and very time consuming, and their schedule is generally breathing down your neck throughout all of these things.

There are instances, however, when a shipper is forced--either the legal aspects are so daunting that they must be challenged, or sometimes the shipper is forced to defend itself. An example in the Shoreham case was that the State of New Jersey attempted to invoke the Coastal Zone Management Act in order to stop shipping along the New Jersey coast. Now, we weren't shipping through New Jersey, and I think we entered New Jersey territorial waters when rounding Cape May and coming up the Delaware River, where had we been 100 yards on the other side of the center line of the river, we would have been okay, but that's not the way the traffic moves on the Delaware River.

The State sued in Federal Court, and the case eventually went to the Supreme Court. In fact, it went twice because there were two arguments that were forwarded by the State of New Jersey. The Supreme Court declined to hear the case. The lower Court's ruling in favor of the shipper stood. No injunctions were issued. The shipments went on while this was going, but it was felt important to fight that in the courts.

By contrast, we actually changed plans from a heavy haul to--we were going to heavy haul from Shoreham Station to Brookhaven. We were going to load the casks onto the railroad at Brookhaven, and then we were going all the way to Limerick by rail. There was such an outcry in the city of New York over these. Even though we probably could have prevailed in some kind of a pre-emption case, it was decided for optical, political reasons to simply use barge and run the city of New York and get on with our program.

So there are two examples of where we stayed to fight and other examples where we chose to pick the more time consuming, costlier route and avoid the delays that might be associated with litigation.

Facility requirements. The ability of the reactor facility to support the shipping campaign, of course, is an important consideration. This includes both the physical plant as well as the personnel. One of the key items in any investigation is the heavy lifting capability of the reactor facility. The NRC guidelines on heavy lifting are contained in NUREG-0612, and in some plants structural or equipment modifications are needed in order to comply with 0612. The cost and feasibility of this compliance are certainly considered in the cask size selection, since the selection of a lighter weight cask, let's say a legal weight truck cask, might yield some benefits in 0612 compliance than the selection of a rail cask being significantly heavier.

Again, this illustrates the need for early planning since modifications to plant structures or safety systems are very time consuming, and quite frequently they involve NRC licensing.

There are many facility requirements for fuel shipping, such as air and water service, decontamination equipment and chemicals, fuel-handling equipment, cask-processing equipment, such as vacuum drying, compressed inerting gases, scaffolding, special tools. The list goes on. Of course, every cask type kind of has its own unique requirements, but the fact is there is an enormous amount of stuff that you have to get ready for.

Generally, a nuclear station has the staffing capability to perform cask preparation, loading and shipping. There are unique requirements, such as heavy hauling to a railhead or a barge slip. And, of course, then those specialists are included in the planning.

Next, emergency response and public outreach. Another route selection aspect is emergency response planning. Somewhat related to this is public outreach. Shippers typically rely on the existing infrastructure for emergency response; that is, the first responders. You heard Earl Easton talk about that this morning.

Experience shows that the states are generally well equipped through their emergency management organizations to deal with accidents involving hazardous materials, including nuclear materials. Of course, all of the states' preparedness is supplemented by federal or even utility resources. Utilities are clearly not unaware of the shipping needs, especially under accident conditions.

The key to success in certainly emergency planning, or one of the keys to success is the Transportation Plan and its implementation. The Transportation Plan is a blueprint of the entire campaign, including emergencies. Emergencies are dealt with through contingency plans, equipment tracking and communications with resources.

As an aside, emergencies are indirectly dealt with in the Transportation Plan by insisting on those steps that are necessary to keep accidents from happening. It sounds a little odd, but really, you know, we go through a great deal of effort to assure that there will be no accidents, but we'd be unrealistic if we didn't think that the unplanned might occur. It's important to note that emergencies are not necessarily accidents. Indeed, most of the items where the shipment is delayed are due to malfunction, such as radiator hose failure or flat tire or some other non-threatening event. Even these are infrequent due to the high level of maintenance inspection to the equipment.

As we know, Part 73 calls for notification of the governor or designee of each state traversed at the time of shipment. However, contact is made in the planning stage with the state emergency management organization long before shipping. Information on routes and the nature of the shipments is shared, and arrangements are made for cooperation, and the states are eager to do this. Usually the governor's designee for specific shipping notification is either the state police or the emergency management organization.

I can tell you that the states are not surprised by shipments. They know well in advance just exactly what's coming through.

It is currently not required to perform emergency response training for all responders along the route of travel. Certainly, in the future, the provisions of 180(c) of the Nuclear Waste Policy Act calls for additional training and equipment for responders along the routes of travel. This is something that DOE certainly has plans for.

In the past, shippers have been willing to voluntarily provide emergency response information to those agencies that desire it. Often this comes as a request during any public outreach activity. Outreach programs have been selectively used in the past where there may be some local interest.

In the Shoreham Project, for example, an information center was set up at a local hotel within Philadelphia. The reason for that is that the train from the Eddystone Station to the Limerick Station passed through downtown Philadelphia, very close to downtown Philadelphia. Philadelphia Electric, or PECO Energy, set up an information day, rented the ballroom at a local hotel, opened it up to the public, announced it well in advance in order to give the public an opportunity to become familiar with what was going on.

Now, I know of no time when a shipper has been unwilling to provide the public with the information on transportation safety, but as a rule, massive outreach programs have not been conducted.

Point of fact is that outreach is performed to provide the public with information, but it doesn't contribute to safety. I mean, safety really is inherent in the equipment, personnel, rules, regulations and organization of the campaign. And I'm not suggesting by this that the public doesn't have a need to know, but the safety is not from a public outreach program.

The best information comes from generic programs, I believe, that generally enlighten the public on the shipment of radioactive materials rather than key into a particular shipment.

However, PR planning with the campaign was necessary, we did it at Shoreham, in order to provide facts to those who are interested, such as the media or representatives of the public. An awful lot of politicians were very much interested in these shipments, and we made a particular effort to make sure that they were comfortable with what we were doing.

Now, industry does not try to hide the shipments, but I think it feels that little is gained by massive advertising them. Ask yourself when the last time was that a chemical company told you about a chlorine shipment that was coming through your neighborhood. You know, never has. In fact, I think that the nuclear industry probably does more than any other hazardous material shipper to provide information to the public.

Planning integration. So I kind of hit a bunch of individual items here that are aspects of campaign planning. These become integrated into a comprehensive plan, which all parties contribute to, and they buy into really. The Transportation Plan is essentially the campaign bible. In the case of a campaign where there are multiple modes of shipping, a separate plan may be written for one particular aspect. In the Shoreham Project, there was a separate Marine Transportation Plan which reflected the unique requirements of the waterborne shipping environment. And this, of course, was integrated into under the subset of the master Transportation Plan.

So getting into mobilization. Using the Transportation Plan as a basis, the next phase is mobilization. Mobilization has many dimensions, from equipment and personnel acquisition to procedures and permits. It expands a great deal. This is where our planning is now put into action.

The transition from planning to implementation really is pretty seamless. Generally, the same core team that performed the planning also does the mobilization. The team is augmented by disciplines such as quality assurance, procurement, reactor operations, maintenance and human resources. The skeleton that was created by the planning is filled in with the necessary equipment and personnel in this mobilization phase. This is a gradual effort as stages of mobilization are reached.

For example, when the cask selection is complete, a cask specialist or field engineer is assigned to the team. In the Shoreham Project when we finally settled down on barge shipping, we added a marine engineer to the team because of his unique experiences.

When the team is essentially complete, I believe it's a good idea to engage in a team-building activity. Now, team building was done very successfully on the Shoreham

Project. This is actually a formalized process whereby all of the members of the team are brought together. They get to know one another. They are thrown problems that require cooperative problem solving, a very healthy kind of thing. The reason that that is done is because you have team members that are on the shipping members, you have team members on the receiving end, and you have team members in the middle. And working together in a coordinated fashion with a common objective, even though in reality distributed, this makes the whole operation go well. It's really the heart of team building. I would recommend wholeheartedly for future shipments.

Now, as I said earlier, mobilization can be a fairly time-consuming process. It's not uncommon that equipment and facilities require modification and possibly even licensing. In the Shoreham effort we had to build two new cask baskets. The BWR baskets for the IF-300 cask originally were 18 element ones, but because of the fuel protection devices that we had to build, we had to reduce the capacity by one assembly, so we had to build, design, analyze, license, construct two new baskets for that. We also had to qualify the fuel cushioning system as well.

Often reactor facility or sites require modification. Rail service may have to be extended or perhaps track upgrading performed. We had to put in the intermodal transfer facility at the Eddystone Station, which meant putting in several hundred feet of new track and mounting a semi-permanent mobile crane.

A barge slip might be required. Building equipment may require relocation to provide clearance for the cask. There are usually, you know, a whole slew of site specific changes that must be completed prior to actually beginning the shipping.

In anticipation of having to repair or debug equipment or systems, specialists are brought on site or identified for rapid mobilization. A cask field engineer is usually on site for training and overseeing. Sometimes that individual is on site for the entire shipping campaign. Sometimes that person is there for the first number of shipments and then is on call for the balance. And, of course, an inventory of cask and ancillary equipment spare parts must be secured and must be ready.

Another part of mobilization is organizing for the control of the actual shipping operation; that is, a traffic management function and the facilities and equipment for its implementation.

Traffic management revolves around a focal point, a command or a control center. This is usually located at the shipper's facility, and it must be staffed around the clock by regulation. It could be incorporated into the reactor control room activities; not necessary, but that makes a lot of sense. This control center integrates the transportation activity, serves as a master location for tracking and communications and dispatches resources as required to keep the operations moving.

Now, cask loading and preparation for the shipment is usually under the control of plant maintenance or plant operations. It may be a combination of those two. Once prepared for shipment, the traffic management takes control and carries it forward to the destination. Even the empty cask being returned falls under the control of traffic management.

Next is training. Prior to the beginning of shipment, of course, we go through what are called dry runs. This generally involves the cask itself, and it's used for personnel training purposes.

Other tests include putting the traffic management function through its bases, particularly its bases when confronted with off-normal conditions. You can call these tabletop exercises, or sometimes they're structured actually using the resources out in the field.

Communications systems and equipment are all tested for effectiveness, and, also, all of those who were involved in the spent fuel handling, and I'm talking about tugboat captains, deck hands, railroad personnel, you name it, are all trained per DOT regulations for hazardous material handling. And, of course, all the training follows written procedures, usually the reactor facility requirements, which means lots of documentation, tests, et cetera.

Next are permits and approval. Permits and other regulatory items are secured in the mobilization phase. Route approval is included in this list; for example, the DOT route approval part. The Coast Guard reviewed the Marine Transportation Plan for Shoreham, and this included not only equipment, but also the route. In the course of that, they established a barge tie-down inspection protocol prior to each shipment where several Coast Guard members would come out and actually do a walk-down of the barge and the tie-down prior to each shipment.

When we were considering the Shoreham alternative transportation where we went on public streets, where we were going to Brookhaven and didn't, one of the early alternatives, we were prepared to look at overweight permits at the state of New York and requirements of the local community for police escort.

Of course, we also have to arrange for the escorts to comply with Part 73, and, of course, the project team gets really crazy about this time. They're very schedule conscious, and mobilization is something that has an awful lot of things in it. And quite frankly, the permits and approvals are generally on the critical path, and they generally are the ones associated with the most uncertainty. Sometimes it's difficult to get approval--those who are in the position of giving approval to move. So times get a little tight usually at the tail end of the mobilization phase.

Procedures is the next item. Since these shipments are initiated at a nuclear facility, of course, all associated activities are under the rule of the plant, which are typically dictated by NRC regulations. This means procedures and safety committee reviews. Of course, the NRC resident inspector gets involved in all of these things, not only looking at the procedure writing, but also looking at the physical handling of the cask.

Procedure writing and approval follows all of these strict rules. Input to these comes from sources such as the cask vendor, the carrier and any other knowledgeable resource. Most cask and fuel-handling activities are safety-related and require such controls as sign-offs, independent verifications, the use of SROs for fuel handling, et cetera.

Next are carrier arrangements. Carrier arrangements are in this final phase. There's sort of the good news/bad news in this aspect.

We'll start with the easiest one, highway. For highway shipments, there are several specialized carriers that have the properly equipped trailers and qualified drivers. Truck casks generally have a custom built trailer to integrate with the cask, so the carrier only supplies the driver, the motive power and associated services. And these companies have contacts with the resources for complying with Part 73, including escorts, communications and sometimes even satellite tracking systems.

So arrangement with the highway carriers is relative straightforward. There are certainly people in this room who deal with them every day and I think would find them to be pretty easy to deal with.

More difficult to arrange are railroad barge and the sometimes associated intermodal services. Railroad arrangements may involve several rail lines, each of which may require contracts and operating rule agreements. These are generally negotiated tariffs. Railroad shipping casks, like their highway counterparts, are designed with their own dedicated railcars. Thus, the railroad only provides motive power and buffer cars, which are generally empty cars, flatcars for example, that separate the locomotive and caboose from the cask or casks, plural, because you can fit more than one spent fuel rail cask in a train.

Some form of escort transportation, either a caboose or similar car, must be included in the train. Obviously, the Part 73 escort requirement pertain to rail, as they do for any other mode.

The rail cask can move in regular freight or dedicated freight. The latter, dedicated freight, of course, is where only the cask car or multiple cask cars are in the train with their associated buffer cars, and, of course, with this escort car, whether that be a caboose or something more luxurious than that.

All commercial fuel rail shipments in the last two decades, about, have been made by dedicated trains. My understanding is that DOE hasn't made up its mind with respect to how it would intend to ship by rail in the future, whether it be regular freight or dedicated train. Dedicated train offers greater flexibility and control over the shipment, but quite frankly, the cost is high compared to regular freight service. A dedicated train would typically run $50 a train mile, independent of the number of rail casks that might be in it. And this $50 is in addition to the regular tariff on that particular commodity, and that would be based on the number of casks in the train. So it can be expensive.

Some plans that I've heard suggest the possibility of dedicated train on the loaded and regular freight service on the empty.

Just sort as an aside from what I've written, there was some talk by the gentleman from DOT about rail routing.

And I've dealt with railroads a fair amount, and there are some things where--some things that are in short contrast in the rail arena as compared to the highway arena, and they kind of go like this: A lot of it is keyed into the fact that the railroad owns the rail, but the railroad has a vast amount of material that it has to ship, and there really are no opportunities in this day and age of railroads just adding more rail lines. You know, the rail lines that we see now are almost going to be the rail lines that are going to be around for an awful long time to come.

So the juggling act, if you will, of trying to move cabbages and, you know, lettuce from my state of California and all of that, that juggling act is particularly difficult for the railroads. And the railroads find--you know, we've made rail shipments where the railroads will say, we're going to go from here to there to there to there, but they find that due to some delay in the shipment of coal from X to Y, that they would prefer to route our shipment from here to there rather than from there to there.

So, you know, they really need a lot more flexibility because there are just a finite number of rail lines that exist, and under at least current thinking about restricted train speeds, 35 miles an hour, and passing restrictions and all of that, a lot of railroads find themselves in the position where the presence of a special train moving at slow speeds almost backs them up to the point of being unable to move on certain main lines. So there's a great deal to be looked into on the matter of rail routing.

So let me jump--sorry about that little dialogue.

Let me jump to barge now. Now, barge shipping involves carriers and equipment which must meet--there's an ANSI Standard N14.24, that is a very good standard, defining just what the requirements are for barge shipping. And, of course, the Coast Guard then has an awful lot of requirements as well. So, you know, the ANSI Standard and Coast Guard pretty much define what you have to do in order to ship by barge.

The number of qualified carriers, principally due to the requirements for the barge in terms of its damage stability and compartmentization and things like that, there are really not very many carriers that have barge capabilities that meet those standards. Obviously, negotiations are required to get some agreement on service, personnel, equipment, insurance, et cetera. Every barge shipment--every barge shipment, of course, and some rail shipments are intermodal. I mean, barges don't go up to a repository or don't go up into a fuel building. So there's always some transfer from barge to some other mode of transportation.

So invariably, if you select barge, you have to deal with some kind of a rig or a heavy hauler, and there are a number of very qualified vendors in this country, many of whom team bid, one that I know of on the East Coast that actually is a rigger heavy hauler and also is a barge line, so it is a vertically integrated company.

Let me turn to outreach as the last item in this slide, only to say that in this mobilization phase is where your planning for outreach gets put out there. You know, it doesn't do any good to perform outreach too far in advance of when you're really going to ship.

So after sweating out all of this planning and all of this mobilization, the shipping actually, although it's very exciting to do that first shipment, it's a little bit anticlimactic because if you've done your job right in the planning and mobilization phase, this is all going to go pretty easy. Of course, the cask and its ancillary equipment are on site before shipping occurs, before the dry run and familiarization training.

So the very first activity for shipping is loading and preparation of the cask, and I'm not going to go into any great detail on this. Cask loading occurs in the fuel pool of the reactor. It's either in containment or in the fuel building. Cask sealing, testing and decontamination occur also within those particular buildings. The cask is moved to its transporter using the main building crane and is secured to the transporter. Radiation monitoring occurs throughout the handling process. Preparation for shipment involves final inspections, placement of shipping seals, final radiation surveys, instructions to the carrier, shipping papers in accordance with DOT regulations and notification of the control center to institute the traffic management function.

Remember, I said there was this handoff that kind of went from plant operations to plant maintenance to the control center when the cask was ready to go.

Carrier arrangements in this context differs a little bit from the prior carrier arrangements. You know, you don't want to have the cask languishing around the site for a long time. On the other hand, you don't want to have truck drivers hanging around the site for weeks either. So there's a need to try to stage the arrival of the locomotive or the barge or the truck or the tractor such that it can, with little delay, can hook up and move out into the public domain.

The whole campaign is scheduled such that near continuity is maintained. The cask loading and preparation time is reasonably predictable, but there certainly is a learning curve. And sometimes things occur. Sometimes decontamination takes a little bit longer than you anticipated, so you've got to have sort of a flexible arrangement with the carrier.

The Shoreham Project, because we had heavy hauling, we had barge, we had rail carriers, we had two intermodal transfers that had lots of personnel around it, it was a challenge. It was a real juggling act. However, the strong traffic management function and team work made that operation go very smoothly, I thought.

I struggled with this next one. I didn't know what else to call it, so I called it notoriety, which I thought was a pretty benign term.

As you know, the times and dates of all shipments can't be divulged by Part 73 except on a need-to-know basis. However, if there's going to be some notoriety from the press or from any protest organizations, then this is when it occurs. I mean, it's the first shot out of the blocks where any kind of a protest is going to happen.

And although this is an infrequent occurrence and is relatively benign in those instances when it has happened, the shipper really has to be prepared to deal with it.

In the Shoreham Project, procedures were written to cover actions to be taken in the event of such an event. We actually had expected an attempted boarding of the barge by a nameless, in this forum, protest group, and although there were some--you know, the folks, the deck hands and all of that sometimes are a little rough, we had a procedure in place that called for, you know, passive resistance and notification of the law enforcement authorities. We would take no actions to stop that, and everyone bought into that.

And as an aside, nothing ever happened in all of the 33 shipments, and we were glad that nothing happened. But one would be foolish to think that it couldn't happen, and one needs to be prepared for it.

In-transit activities. You know, once underway, the shipping proceeds per the procedures. I mean, this is why you did the training, this is why you created the plan.

And, of course, the routes are predetermined. Notifications inform the governors or their designees of the shipment. The in-transit security measures are implemented. Communications occurs apart from just that required under Part 73. Sometimes satellite tracking is used, although it isn't required. The technology, and I think that the DOE is looking at this TRANSCOM, which is likely to be--it's likely that all of the shipments made by DOE of commercial fuel will be satellite track.

Of course, the carriers have multiple ways of communicating and tracking, so it isn't just those that are there for Part 73, but it's there for those--just because the barge company and the tugboat company want to know where these people are, what their needs are, what's happening. So lots of communication that goes on during these.

Shipments may or may not have some form of radiological monitoring while underway. Of course, the specialized highway carriers are trained and have with them radiation monitoring equipment.

For the Shoreham shipments, we actually had a radiation technician accompany the loaded shipments for both the barge and the railroad segments. To be candid, this was regarded as more of a public relations requirement. We were confident that his presence was not needed for any shipping safety, and I'm pleased to say that his services weren't required in any of the 33 shipments. He just got probably more tugboat time and tugboat food than he ever bargained for. And that means it's worse than airlines' food, and what does that tell you?

Off-normal events. You know, sometimes something happens or occurs in-transit that's not in the baseline plan; weather, road repairs, breakdowns, illnesses, et cetera. There's a number of things that certainly can happen.

The Transportation Plan, and that's with a capital T and a capital P, covers these through contingency planning. In the Shoreham Project, for example, a hydraulic winch in the towboat blew a line, and the boat was unable to reel in the barge for its movement up the Delaware River. Usually you tow, you know, like 1,200 feet of cable out behind in open ocean. You reel it in close couple when you're moving in inland waterways or areas like the Delaware River.

Advanced planning had towboats on standby, and when the winch problem arose, the control center was notified, and a replacement tug was immediately dispatched. The Coast Guard was notified by the control center, and it immediately responded, and within a few hours, the cable had been transferred to the new towboat, and the barge proceeded to its destination.

And in a true lessons learned sense, for all future shipments, new hydraulic lines were installed on all the towboats, and the winch inspection program was intensified. So, you know, we learn these things. It only makes sense.

Finally, the receiving facility. I mean, we've kind of marched through this whole thing, but let's not forget the receiving facility.

The receiving of the cask and transporter at the end point pretty much terminates the control center's responsibility for the shipment once it gets on site there. The receiving facility unloads and processes the cask and returns the empty to the originating shipper. The control center monitors the empty's progress, since the campaign depends on turnaround time. You know, we're still talking about this block of time that we want to maximize for the movement of a certain amount of fuel.

The shipment phase is really a very well orchestrated effort. It involves personnel at the end points, as well as along the shipping route. My experience shows this to be very doable. It's complicated, but it is very doable, and it's been demonstrated time and time again in lots of campaigns conducted in this country, and, in fact, conducted around the world. And despite this complexity, it shows you that the training and the planning clearly pays off.

Getting close here.

Post-shipment demobilization. This is sort of the old expression about the job not being over until the paperwork is done, and spent fuel shipping is certainly not immune from that old adage.

NRC regulations have records and record retention requirements for all of the shipping and fuel transfer activities. In addition, any temporary facility modifications, of course, must be reversed. The cask and equipment must be returned to its owner or perhaps moved to the next location or where it's to be used. Oftentimes, this equipment handling involves decontamination in the case of ancillary equipment. Lifting devices, for example, have to be packaged, decontaminated and packaged in special packaging, and carrier arrangements made to move that on to its destination.

And finally, contract items must be reconciled, payments made and all of that kind of stuff.

So let me wrap this up by, again, just sort of giving you this snapshot of what was accomplished in the Shoreham Project.

It was approximately four years in duration, having been completed in July of 1994. Realistically, if you backed out all of the search for alternative sites before the selection of Limerick and all of that, I'm still going to put this as probably, as a minimum, a two-year window for conducting this shipment.

We moved 560 BWR--radiated BWR fuel assemblies, which is roughly 100 metric tons between two reactors that were about 400 miles apart.

We moved by heavy haul, barge and railroad, and we had two intermodal transfers per direction.

We used two IF-300 shipping casks, shipped them separately, for 33 shipments total.

Then we completed our campaign in nine months, which included the two months for the Limerick refueling adage.

We had no accidents. And we completed the effort 94 days ahead of the contracted scheduled, miraculously six days ahead of the theoretical schedule, and within budget. So I thought it was a damn good campaign.

Now for the promised show and tell, here's some photographs. We won't dwell on these unless there's a reason.

IF-300 cask at Shoreham Station up on the refueling floor. You can kind of get the relative size. There's a person down here in the lower right-hand corner.

Remember, this cask was designed in the '70s for 120-day out of core fuel, so it has some design characteristics; for example, the corrugated surface for heat removal that you wouldn't see on a cask designed for five or ten-year out of core fuel as you might see now.

Well, I guess it doesn't matter. This is a shot down--kind of down the equipment hatch with the cask on its transporter, horizontally. These are workers preparing it. I don't know if they're preparing it for shipment or receiving it. They may be surveying.

These are the small--there's a liquid neutron shield in this cask, and they're expansion tanks for the liquid neutron shield.

Valve boxes. These are valve boxes on either end for the drain and vent valves.

This is a tipping cradle with the guy who's standing on the blue item, which pivots, and the cask sort of sits in it, so it can go horizontally--horizontally to vertically. That's the tipping cradle right there.

Okay. For the shipments, we put--this is not to hide it, but rather there's a personnel barrier that covers the cask that's made of aluminum. And, of course, we're going into a marine environment with salt water, and so we put kind of a canvas cover over the shipment in order to keep salt water spray from corroding the aluminum. Of course, the cask is a stainless steel structure and doesn't have a problem.

This is the heavy hauling unit, and it's backing out onto the barge here. This is, again, at the Shoreham site. So it's backing us out onto the barge.

Okay. This is now--you can see there's a shipping skid that the cask is mounted on. So we basically backed out onto the barge and then set the cask skid down onto these stands, bolted it to the stands, which are welded to the deck of the barge. And this, obviously, is on the Delaware River where the tug is closely coupled to the barge for moving up the river.

This is the lift-on/lift-off facility at the Eddystone power plant. Over here is like a 250-ton crane that picks the barge--picks the skid up off of the deck of the barge, there are the stands that support it, and then simply pivots around, and the railcar is sitting over to the left-hand side of the screen.

The next picture I think shows it--there's the crane, and here it's placing the cask skid onto its railcar.

This railcar is dedicated. It's part of the transportation system for the IF-300. It has tie-downs here. It has a restraint block in the middle welded to the deck; another tie-down system out here. You can see the cask outline inside the personnel barrier if you look carefully enough, and they're just setting it down.

I think we have one remaining.

This is now how the shipment proceeded. Actually, this is the caboose. They do put a buffer car. This was on site at Eddystone. When they got this out, they actually inserted a flatcar in between the caboose, which held our fearless technician. He was probably getting pretty tired by the 33rd shipment, and the railcar itself.

That's the last slide and the end of my presentation. So if you have questions, I'll try to answer them.

ARENDT: Yeah, who determined the adequacy of the railcar?

JONES: The adequacy of the railcar?

ARENDT: Yeah, I saw the railcar there. Was there a special specification that had to be followed?

JONES: Well, actually the railcar was--there's kind of two parts, maybe three parts to that. First of all, we got a railcar that was a design--it was a previously used design. There's a standard railcar for that particular capacity.

It's like a, you know, 100-ton railcar. There are lots of ways you can buy them. This one happened to have a cast steel underframe, which was sort of the Rolls Royce of railcars.

But we didn't have to do any particular testing. In other words, if you had a custom-built railcar--if you recall the NL-1024 cask, which dates back down to the same era, it had a railcar that was unique, and it had to undergo a bunch of tests that the AAR specifies in order to qualify it. So there are design criteria within the AAR. But if you use a railcar design that is previously qualified for some other service, then you don't necessarily need that.

Now, another aspect that we wanted was, we had to be able to carry the loads that are--remember, there are tie-down loads that need to be carried into the deck of the railcar specified. There's some AAR regulations on "g" loadings, and, of course, there's the famous 10, 5 and 2 "g" loadings that are under--in our regulations.

We also wanted a railcar deck that you could work on, so it's all steel, rather than--a lot of flatcars, you know, don't have steel decks. We wanted to have some space in order to put additional equipment on the end of the railcar.

So there are a number of needs that were fulfilled in the railcar design of selection process.

ARENDT: Other questions? Debra?

KNOPMAN: Knopman, Board.

Since you've had so much to do with the whole transportation stream on spent fuel, perhaps you could tell us a little bit about how various shippers and others that participate in this system insure themselves, what the insurance structure is, which is essentially an indicator of somebody's perception of risk management here, what that looks like. Or is this covered by Price-Anderson to some extent?

JONES: Well, first of all, you know, I do not hold myself out as an expert in the insurance arena. So, you know, my understanding from what I read is that Price-Anderson does, indeed, cover these kinds of shipments.

There are some who sort of dissect Price-Anderson--I've heard these arguments--who dissect Price-Anderson and say, well, yeah, but, you know, if you interrupted a shipment and diverted it by virtue of, you know, whatever, Price-Anderson language doesn't specifically cover that. And I guess like my homeowner's policy, there are, no doubt, exceptions to everything.

But my general understanding is that Price-Anderson is sort of an omnibus policy that covers all of these activities. And I would, you know, defer to anyone who knows, and there are probably lots, I'm sure there are lots, who know more about Price-Anderson coverage vis-a-vis transportation than I do.

KNOPMAN: If there is someone here who does know, I'd be interested in talking to you at some point and would also be interested in knowing about, you know, any claims that had been filed.

ARENDT: Okay. Dan?

BULLEN: Bullen, Board.

Just doing a little simple math, you shipped about 100 metric tons, and you said the campaign would have really taken about two years with the planning and nine months to execute. And if you do a little math, that means 50 tons a year. And if we're going to get to 3,000 metric tons a year, you've got to extrapolate that by a factor of 60, right? And if you extrapolate that by a factor of 60 and you have limitations like the 35-mile an hour max speed limit of the trains, is there the potential for a shipping campaign at 3,000 metric tons a year to be a significant constriction on the rail industry in the country?

JONES: I believe the following: I believe that if I use the Shoreham Project as a model, and I say, gee, here we had an expert team with two known end points and two qualified casks and 400 miles apart, and if it took us two years--if it would have taken us two years to do the planning at best, to do the planning--to ship 100 metric tons, I think that the DOE needs to really consider the real world in terms of planning. I get bothered when I see 400 metric tons the first year, stepped up to 600 metric tons, stepped up to--you know. I was kind of upset when I saw transportation and waste exception sort of put on the back burner. And please take this in the right vein, but, you know, much of that flowed from recommendations of this Board.

I think that there's a significant misunderstanding about how long it really takes to get the infrastructure and the equipment and the people in place to make it happen--significant.

And I think that if we're talking about if we think that Congress is going to act in a timely fashion and we think that shipping to even a centralized storage facility might happen soon after the turn of the century, we could well be behind schedule significantly right now. And, yes, it's going to be put a strain on the rail transportation, since that's really the base transportation mode for the plants, in order to get stuff going.

CRAIG: Craig, Board.

First of all, I want to thank you for a wonderful presentation. It really enhances my comfort level on this whole business of actually doing it a great deal, to hear about this campaign. So that was really quite fine.

I'd like to ask you to explore the lessons learned aspect a bit, and particularly in the context of what the government might be doing. And I was struck by one comment in your remarks where you said something like permits and approvals are often on the critical path, have had the highest uncertainty. That sounds, to me, not the way things ought to be. By the time you get ready to actually do it, one would rather--in a well-run world, all of the permitting would be totally under control, and then you could get on with the task. What can we learn?

JONES: What I meant by that was that there are unique approval and permits required almost per every shipment. It seems to me that if one wants to get those things off the critical path, whoever is running the system--you know, I mean, I see the DOE kind of handing off to RSAs. I'm assuming that the privatization efforts will go forward. And if that happens, that kind of delegates to another level an awful lot of the arrangements on a regional basis or, you know, however it might eventually emerge.

To me, you can't wait until you are going to ship from XYZ facility and start making plans. I mean, once one has established the mission, and we're talking now a national mission, that's the time to start sitting down with all of those entities that have to be dealt with. And whether that's, you know, the local fire chief--I don't want to keep bringing up Shoreham examples, but the fire chief of

Eddystone, Pennsylvania. I mean, this was just, you know, Fred in his office with a half a dozen guys who wanted to know. And, in fact, he had--under their law, he had the ability to stop shipments, and he wanted a decal put onto the transporter that said that he was aware of what was going on.

Again, we weren't going to fight that. There was not a reason to do that. It was important that he be happy about it.

Well, there may not be a counterpart to Fred in some other county, but, you know, one needs to go and really sort of sort those out. I mean, it's a whole lot better to solve the problems when you don't have the schedule breathing down your neck. I mean, if I look at 400 tons followed by 600 tons followed by 800 tons, all I have to do is miss by 100 tons on the first year, and now I've added--you know, I mean, I can get accumulative effect that can overwhelm me. You know, I can perhaps never catch up because there's clearly some finite limit to what my shipping capabilities are.

So solving the problems in advance when they're not on the critical path, to me, is the thing that you've got to do.

ARENDT: Dan?

BULLEN: Bullen, Board.

Just one quick follow-up. You actually had a very benign waste form or product to ship. Do you expect it to be more difficult when you have the 120-day out of core fuel or the 10-year out of core fuel, or whatever, or do you think that lessons learned, to follow up on what Paul said, are well enough advanced that it doesn't matter what you're putting in the cask because you've got the mechanisms all laid out?

JONES: We found that other than the Part 73--remember, we shipped this as special nuclear material of low strategic significance, so we didn't have to go through all of the Part 73 stuff. But the fact is that whether it was low burnup fuel or high burnup fuel, the public has a hard time differentiating between those two, and so that was kind of a wash.

Now, I suppose that maybe the benign nature of the Shoreham shipment, the Shoreham fuel, caused those who would oppose this to back off because they felt they didn't have a really strong safety argument. But I think that the public in general was unaware of really the differences between high-exposure fuel and the fuel that we were shipping.

ARENDT: And technically, there's no difference; is that correct? From a technical point of view, it doesn't make any difference?

JONES: Well, I don't know what you mean by it. The fission product inventory clearly is different, a lot.

ARENDT: But once it's loaded up, there's a certain number of R per hour at a certain distance?

JONES: Well, I mean, when we loaded this fuel, you know, we couldn't even--the dose rate on the outside of the cask was about the same, whether it was loaded or empty, because this fuel had such low burnup on it. That wouldn't be the case with high burnup fuel.

What I'm saying is, is that the general perspective of the public was that spent fuel was going to come through our community, and, gee, maybe we ought to know a little bit more about it. And I don't think that the difference between Shoreham fuel at low exposure versus something that was at high exposure, I don't think that difference would have caused the general public to say, oh, well, I'm not worried there and I am worried here.

ARENDT: You had mentioned cost on dedicated trains and other things. It's my understanding that the latest technology that the railroads have are only advantageous or useful if you use them in dedicated trains; in other words, you can't mix cars. Do you know anything about that?

For example, they have a new coupling arrangement that would prevent derailment, and there's some other things. And so I'm just curious that I think there's more than just cost. I think that if, for example, the railroads have technology that would make the transportation safer, then maybe the use of dedicated trains might be worthwhile, just that itself. And I'm wondering what you know about the latest railroad technology.

JONES: Well, let me--I don't follow the latest railroad technology that closely, but let me make some personal comments about dedicated trains.

Back in the '70s, as you know, there were landmark hearings before the Interstate Commerce Commission because the railroads chose to flag out; that is, they refused to carry spent fuel, or they would carry spent fuel, but only on a special train, and their definition of a special train was like the circus train, that is a train operated at the railroad's convenience, not at the shipper's convenience and moved under rules that were dictated by the railroad. And the railroad's argument was that this was the only way that spent fuel could be moved safely.

I was with General Electric at the time, and we and the rest of the industry, plus it was ERDA at that time, essentially went to the ICC and protested the railroads, the argument saying--or our argument was that dedicated train or special train ought to be something that's an option to the shipper, but we certainly were not going to concede anything on the safety question because we were confident, as we are today, that these casks are designed to survive accidents without problems.

Now, we can skip forward from the '70s to now, and I still maintain the safety issue, but I can tell you that--and cost is a consideration, I understand. But I can tell you from experience that dedicated train brings a great deal of flexibility. I mean, when you can say, I want a locomotive to show up at 2 o'clock in the morning on Thursday, Christmas Day, or whatever it might be, you can guarantee that. If you try to meet the scheduled regular freight that switches that plant every three days, you may find yourself able--you know, you miss it by one hour, and now you have to wait three days in order to catch the next one.

So in other words, there's a tremendous convenience factor that dedicated train brings that regular freight doesn't. And I'm not dismissing the cost, and one has to kind of go through a process of deciding whether the cost of that is worth--a convenience is worth it all.

But certainly from an operational perspective, dedicated train makes a lot of sense. Others have also commented that being able to provide the kind of in-transit security, as dictated by Part 73, is significantly easier to do when there's a dedicated train and you can keep the car in observation at all times.

Way back when, when we built the IF-300 cask, I actually accompanied it from Denver, where--well, there's four of these. But the first one, when it was constructed, I accompanied it from Denver to Morris, Illinois, the facility, riding right across, the 4th of July, right across the middle of the country, riding in regular freight service. And sometimes we were at the front of the train, and sometimes we were in the middle, and sometimes we were in the back. And, you know, it's not very good duty, and it's slow, and, you know, there's lots of stuff. And it's hard to keep the observation and the car itself always going as a unit when you're in regular freight service because you get switched, and they take cars off, and you know how railroads work.

So, you know, I can come up with an awful lot of pluses from an operational convenience perspective for dedicated train. But as I say, I don't believe that it buys any more safety than running regular freight service.

ARENDT: Okay. Are there further questions? Staff?

All right. Thank you very much, Robert.

JONES: Thank you.

ARENDT: Our last speaker this afternoon is Richard Guida with the Naval Propulsion Program.

And, Richard, you may have some answers to some of the questions--the question or two that was asked previously. For example, I noticed you were nodding your head with Price-Anderson. Thank you.

GUIDA: Okay. Thank you. Can you hear all right?

Well, thank you very much, sir. It's a pleasure to be here before the Board and the staff to discuss the Navy's practices and efforts in managing spent nuclear fuel and transportation.

By way of quick background, let me just explain, my history is 25 years of experience within the Naval Nuclear Propulsion Program, right out of college. I've spent initially eight years working on reactor design, reactor plant design and fuel design and manufacture, and the remaining 17 years spent working on environmental issues. I'm responsible basically for all aspects of the Naval Nuclear Propulsion Programs, environmental efforts, some foreign affairs, and litigation, fortunately or unfortunately.

The program is a joint Department of Energy/Department of the Navy effort. By law, we exist in both organizations.

Our scope is as follows: Basically, we are 40 per cent of the Navy's principal combatants. I just give this to you by way of background so that you have a perspective, once I start talking about spent fuel in particular, why spent fuel is of such great importance to us, the proper management of it, the proper disposal, transportation and so on.

Basically, the Navy's aircraft carrier fleet is more than half nuclear powered, heading towards all nuclear powered fleet. All of our submarines are nuclear powered. We have steamed 112 million miles safety, 4,800 reactor years without a reactor accident. Reactor accident in our terminology means no damage to fuel, no release of fission products. So it's a very conservative definition of what constitutes a reactor accident.

Another important element of our business is we have to go into foreign ports, 150 foreign ports in 50 foreign countries. We have to be accepted by foreign governments as safe. Our record is scrutinized very closely with respect to that, but we do not give them any of our detailed technical information because we are not interested in having them design their own nuclear-powered warships.

Now, let me briefly describe the naval fuel cycle, okay? We have a requirement that once we refuel or defuel a nuclear-powered warship, the fuel is transferred to the Idaho National Engineering and Environmental Laboratory where it is examined. Refuelings, defuelings occur at four naval shipyards and one private shipyard. The four naval shipyards--the standard ones you're probably aware of, Pearl Harbor Naval Shipyard, Puget Sound Naval Shipyard in Bremmerton, Portsneck (phonetic) Naval Shipyard in Kittery, Maine, and Norfolk Naval Shipyard in Portsmouth, Virginia. We did it that way so as to confuse the Soviet Union, and obviously it was successful.

We have a goal here of designing fuel with longer lifetime. Okay, our intent is to ensure that we can get every bit of energy possible out of fuel before we have to refuel the ships.

Now, for comparison, just to give you a quick picture here, when Nautilus went to sea in 1955, she operated two years on her first reactor fuel load of core--or load of fuel her first core.

Our current fuel operates in excess of 20 years. USS Nimitz went to sea, for example, in 1975. She's currently giving sleepless nights, we hope, to Saddam Hussein in the Persian Gulf. She comes in next year for her one and only refueling, first and only refueling in the 50-year life of the ship.

Our next generation submarine will operate to the end of the ship's life with one load of fuel.

Now, we have been able to achieve this because of the examination that we do on the fuel after service, but that examination serves, as it turns out, multiple purposes. Not only does it give us this ability to ensure we get the longer lifetimes, it also gives us confidence that we know the condition of our fuel very, very well before it is containerized ultimately for dry storage and then ultimately disposed of. So we have an additional piece here that is an artifact of the way we do business.

Now, before 1992, our spent fuel was reprocessed. It turns out--and it was reprocessed to recover uranium because we used high and rich uranium for nuclear weapons applications, not nuclear propulsion applications. Basically all of our fuel is virgin material.

In 1992, DOE decided to cease reprocessing, and now we store it at INEEL, the Idaho National Engineering and Environmental Laboratory, stored pending its ultimate disposition in a repository or storage--or shipment, I should say, to a centralized storage facility outside of Idaho.

Now, let me talk about the amounts. We have very small amounts of naval spent fuel as measured by the Nuclear Waste Policy Act metric, which is metric tons of heavy metal. That is the metric prescribed in the Nuclear Waste Policy Act, which you're well familiar with. Our current inventory is 14 metric tons of heavy metal of naval spent fuel at INEEL. Before reprocessing, a total of five metric tons were reprocessed. So the grand sum generated since 1955 to present is 19 metric tons, of which 14 metric tons remain extant.

You know the numbers, obviously, for DOE and for a commercial industry. By 2035, the projected number is 65 metric tons of heavy metal.

Now, these numbers are a bit misleading, and I wanted to, in the interest of intellectual honesty, give you some additional picture on this. If you were to look at metric tons of total metal--okay, so this would not just count the heavy metal, which is the uranium, plutonium, thorium, but the total metal, our metric tons of total metal by 2035 would be 4,400 metric tons total metal. The reason it is so much is because our fuel, unlike commercial fuel or DOE fuel, basically has a little bit of uranium with a car load of zirconium, of zircaloy. We have a lot of zircaloy structural metal in order to achieve a kind of shock hardness, which I'll describe in a minute, necessary for a maritime military application. What that translates into, then, is a lot of total mass, albeit very little, uranium. And the uranium we have is U235 versus U238.

By comparison, as I understand it, the commercial industry, 80,000 metric tons heavy metal number would equate to about 120,000 metric tons total metal, if you add in theirs. They don't need as much zirc because they don't have to meet battle shock conditions.

Okay. What is the form of our fuel? Well, the specific form is classified. Certainly, we are more than happy, have already provided it to Mr. Arendt and to Carl Di Bella, Dr. Di Bella on the staff. As other staff members get cleared, we are more than happy to provide all the details of our classified technology to the Board and to the Board staff.

But even though the specific form is classified, I can describe certain features of it, which are, in our view, the most important element.

First, it is, obviously, solid metallic form. It is not flammable, not explosive. That is true of commercial fuel as well.

It is good for combat, battle shock. The battle shock requirement is classified, but the number that we've seen in unclassified studies is well in excess of 50 g's, 50 tons of force of gravity. And that is a limit that is premised on the design requirement of no yield in the clad. We do not reach yield in the cladding, okay?

We fully contain all fission products. Now, this is a distinction between us and other forms of fuel. All fission products remain in the fuel. Now, that may seem to be a pretty robust statement, and I can assure you it is accurate for a couple of reasons; not only because of our inspections after life will we know exactly what the condition of the fuel is at the end of lifetime, but also because every day on every warship, every reactor plant, we take reactical samples, we analyze those reactical samples on an on-board laboratory in the submarine or the aircraft carrier. We look for any evidence of fission product increase above a very low level that's present from fission products created from a few fission that occur in the cladding. Okay, you tramp your U238 that's present in the cladding.

We have the ability to detect down to, you know, literally less than pico curie per liter kind of numbers, and if we see any evidence of an increase, which we have never seen, above this very, very low level of fission products in the coolant, that would indicate a fuel element failure. Never seen it.

So we have that kind of very robust data to demonstrate our fuel is, indeed--has the integrity that we are describing.

I've already described it operates over 20 years, which means it's safe to store for much longer periods of time. The way we capture this in a qualitative way is we have a statement that says if our fuel is safe, and we believe it is safe, to operate in close proximity to the crew, and I'm talking now within 100 feet of the crew who are living, working, eating, sleeping on a submarine, within a couple hundred feet of the crew on an aircraft carrier, where there are 6,000 people living, working, eating and sleeping on that aircraft carrier, if it's safe in that context in combat, which it is safe in that context in combat, then it is certainly safe to transport shutdown in peace time. So that's the simple sound bite that we try to use.

Now, this is a slide that I wanted to spend a minute on because it tells a lot of--it has a lot of information. It's information rich; okay, a picture telling a thousand words, and I'll try to keep this to just 100 words.

But basically what you see here is the USS Theodore Roosevelt in 1986 receiving a shock test. The shock test that she experienced here was the equivalent of 40,000 pounds of explosives, less than a thousand--fewer than a thousand feet off the Starbird Beam. This caused the ship to experience a shock load that was less than one-third of the ship's design shock. The ship's design shock is a very small fraction of the fuel's design shock. Okay, so this was actually not very severe relative to the fuel, but it was quite a move on the ship.

And I was not aboard this particular ship when this shock test happened, but I've been aboard other ships when shock tests have occurred, and unless you brace yourself, I mean truly brace yourself, you will kiss the deck. So you have to be very careful when you run these shocks, you are aiming to try to ensure that you get a full rendering of the test, you get a full--how best to put it--a representative test, albeit not at the full design shock load for the ship, a representative test that will give you useful information.

Now, in this particular instance, the reactors were operating when this test went down. There were a number of things on the ship that broke; okay, broke as in the hangar. The hangar bay door suddenly couldn't close. I mean, the ship--this was part of the shakedown for the ship, for this kind of ship. You want to check and see what doesn't work afterwards.

The reactors did not scram. The reactors operated normally throughout the test. The propulsion plant performed superbly. So there was no problem with any of the nuclear propulsion aspects as a result of this test.

Okay. What is our shipment story? We have made a total of 684 container shipments since 1957, which is when we did the first refueling of the USS Nautilus. All of our shipments are made in Type B containers. Now, they are certified not only to our standards, because as part of the Department of Energy, we have the authority to regulate, to grant the certificate of compliance for purposes of shipment, but they are also certified to NRC standards. Admiral Rickover insisted early in the program--excuse me, in the 1950s, that he would ensure that at the time the AEC, Atomic Energy Commission licensing branch, and subsequently the NRC, would give us certificates of compliance for these containers. We were not going to simply do it on our own behalves.

So we have always gotten NRC certificates of compliance, and our latest containers are no exceptions to that.

The only thing I would point out here is, obviously, there's been a great deal of discussion about what is a drop onto a 30-foot unyielding surface--a 30-foot drop onto an unyielding surface, what is that equivalent to in terms of real impact? What we usually try to do is give people a reference that is more useful for them to appreciate when I give presentations in public. Obviously, this is a very technical group, so you understand this without any trouble. We try to make the argument that this is equivalent to about a 60-foot drop onto a reinforced concrete surface. That's about the same amount of energy absorption within the container to a 30-foot drop onto an unyielding surface.

This is the design that--the newest design of our containers that we use. It's called an M-140. I want to give you a couple of facts about the M-140.

The shell that you see here, this is a reusable container. Let me emphasize. This is a reusable container. You load the fuel in this at the shipyard. You ship to Idaho, unload it from Idaho to be examined, ultimately stored, the water pit there pending containerization. Then you send this back to the shipyard, and you do it over and over again.

We have 24 of these containers. The containers and the railcar on which the containers are loaded--the railcars

--come as a matched set. They are four million dollars each. They were designed specifically for naval spent fuel applications.

You'll notice this is DODX railcar. That means we own it. We do not rely upon the rolling stock of the railroads. I'll get to this in a minute, but this is a very important feature, which I think contributes greatly to the safety of our shipments.

The container itself has a shell 14 inches thick, stainless steel. No lead used in the container. So this container shell is thicker than the battleship--now, that's a lot of steel, but I am not contending it can't be opened by malicious intent. In fact, we will discuss that in just a minute.

You will also notice that there are four trucks here, a total of eight axles; a very important point because we have had more than one instance where people have complained to the railroads that we exceed the weight, the allowable weight for railcars. Well, if you took the weight of this container loaded, which is 190 tons, on the railcar, and you divide it by four axles, that's true, we do exceed the loading, specific loading. You divide it by eight axles, which is what we've got, you don't.

So it's just one of those little pieces that it's easy for people to misapprehend.

Okay. What are our practices? Well, first of all, we escort all of our shipments, have always escorted our shipments since day one. We have more than one escort per shipment. We have 24-hour surveillance of the shipment, of the containers as they are en route. Typically, we have anywhere from a couple of containers to up to six containers per train when we make these shipments.

We do limit the speed to 35 miles an hour. Now, I realize that there's a lot of debate that we've already had on discussion on what does that really constitute in the way of an impact on the railroads. Well, let me say that our view of this, which I'll skip down here, we do not require special trains, okay? We do not use special trains normally. There are some exceptions to that, like if we've got some urgent need to get a shipment from Point A to Point B, we might use a special train. Normally, we go in regular commerce.

And now I will tell you also that Union Pacific, even though we pay the regular commerce rates, it turns out their practice is to give us a special train because it's easier for them. But we don't pay. We try to do our best to protect the taxpayers' pocketbook here. And the bottom line is we do not require special trains.

Now, what does that mean in terms of duration of transit? It does mean the transit is a little bit longer until we get to Union Pacific. Then they take over, and they go faster. It means a little bit longer. Is that a problem for us? Not at all. We've got more than one escort and 24-hour surveillance. They're in a caboose doing this. They have 100 per cent communications capability. It's closely tracked. We track and keep a close tab on the location of the shipment throughout its duration.

We do this through the Transportation Safeguards Division out in Albuquerque, the DOE Albuquerque office, because even though the shipment itself is not a classified shipment, it is a shipment of classified material. The fuel form is classified, and it's also high in rich uranium. So what that translates into is safeguards considerations, as well as a need to make sure that we treat it as what's called a national security shipment.

Okay. We do not specify our own routes. Whatever the routes the railroads pick, they pick. We pick the railroads, but they pick the routes.

Now, the use of government-owned railcars, this is very--this is the thing I alluded to earlier. This is very important because one of the things that we do is we inspect before and after every use. We look for any evidence of wheel bearing deterioration, the brakes are not working or the brakes are deteriorating, and we refurbish. We have the ability to refurbish these railcars, bring them back up to spec, if there is a need to do so.

What that means is, in the 684 shipments that we've had, not only have we never had an accident, we've never had a derailment. We've never even had an event or a concern or a problem occur which really imperiled the shipment. And I like to think, I'm not trying to prescribe this as the way that the world should work for, you know, everywhere because clearly this may very well be a bit of overkill, but that's normally what we do for a living is overkill these things.

I think that the issue here is that if you know your own railcar--it's like getting your own car, using your own car versus getting a rental. You get the rental, who knows whether they maintained it right, who knows what the last driver did and all that. If you have your own car, you know that it's either you or your spouse, okay, that has dealt with that car, okay?

Okay. Now, let me discuss the analyses that have been done here, and there a couple of very important pieces of this; first of all, with respect to the Environmental Impact Statements that the Navy and the Department of Energy have done either together or separately. I have lived through those EISs. I have worked on those EISs and lived them. And what I would commend to the Board's attention is the fact that there is an immense amount of information out there already, some of which was already discussed by Dr.

Chen and by Dr. Neuhauser, but let me just say, they lived it with me as we went through this process. There is an immense amount of information already present, and what I would commend to your attention is that that information really warrants its full due.

Just to give you a picture, the programmatic spent fuel EIS the DOE and Navy did collectively in 1993, it took two years to get it done, was $50 million worth of analysis, 44 million by DOE, about 6 million--a little over 6 million by us.

So that instrument, before one concludes that, gee, there's more paper that needs to be generated here, a new EIS by this organization or that organization, I would earnestly suggest that the full value of those documents needs to be taken into account. I would further suggest that in the case of that document and the subsequent EIS which we performed looking at naval spent fuel shipments from INEEL to a notional repository, none of those EISs has yet been determined by a court to be inadequate.

Now, there was one court challenge by the State of Idaho, which in all honesty caused the first EIS to be generated. Okay, give them their due. They caused that first EIS to be generated, but then they settled that case after that EIS was complete, after about a four-month interregnum.

A separate lawsuit was filed by an environmental group in Snake River in late 1995, challenging the adequacy of that EIS, has basically not gone anywhere, not gone anywhere in the sense that the plaintiffs have not prosecuted, have not taken it to closure. The courts show no interest in working on it.

So, and there's been now lawsuit filed on the Navy EIS that was prepared and published last year.

So my point is that if you ask yourself the question in a legal setting, where have the documents that we're talking about here found--where have they been found to be inadequate, to either be inadequate because they were based on the NRC modal study, which is allegedly out of date, or because they contained mathematical errors, or they didn't adequately address the multitude of comments that were received, the answer is nowhere. It hasn't happened.

So I think that that's something that, you know, being a government employee, I know how easy it is to simply produce more paper. Heaven knows, you know, swathe, whatever the right word is, in paper. I just want to make sure we use the paper that exists before we create more paper unnecessarily.

Now, with respect to these analyses, we looked not only at incident pre-shipments, we looked at potential accidents, as well as terrorist attack. And I just want to take, if I could, a one-minute interregnum and discuss the terrorist piece here because it has been raised in earlier discussions.

One of the things that we have the benefit of being able to do that others do not have, sometimes others do not have, is we can go to our sister agency, sister service, the Army, and talk to them on a classified and unclassified level about what does it take to penetrate armor. They are obviously the experts in this matter. They build the tanks, and they want to destroy tanks.

Elmer Naples, who is my senior program manager here on this issue, and I visited the Piccatin Arsenal last year and had a detailed discussion on a classified level with the Army experts who are designing the next generation of anti-tank weapons, who are intimately knowledgeable of the existing generation of Army anti-tank weapons and could speak knowledgeably on how anti-tank weapons work.

Well, let me say, first of all, that there are a couple of types of weapons. One is the kinetic projectile, you know, which is like the depleted uranium shell. You can't use that unless you have a tank canon to shoot it. So, obviously, that's not very attractive for a terrorist.

The more likely used weapon that a terrorist would use is what's called a high explicit anti-tank weapon or a shaped charge. This is the business end of a three-inch diameter, about three or four inches--I guess three-inch diameter shaped charge, minus the explosive, minus the propellant, a few other things, okay? But this is basically the business end. And if you put the explosive here, what you've got here is like a copper cone. The explosive blows up, causes shock waves in the copper cone, and shoots that copper out like a jet at about 10,000 degrees kelvin and your target.

Now, you look at that and say, okay, that's three-inch diameter, so it must punch a three-inch diameter hole in the target, right? Not even close. If you look at this here, this shows the penetration--and I invite you at some later time to come up and take a look--this shows the penetration of many, many--about two feet I guess here of armor plate of this shaped charge weapon. And what you find out is that at the very end, at the depth basically where you would be looking at it, if you had a 14-inch container like we've got, that's the diameter of the hole that is created. It's basically 1/10th the diameter of the weapon or 1/100th the surface area. That's point one.

Point two is, if you look at this further, you will notice that on the entrance part of the hole, there is a copper afterbirth. Part of the copper that is shown there ablates. It does not fully penetrate. What happens is, the copper plugs the hole, okay? This is what you expect. This is exactly what you would expect. So if a terrorist were to fire one of these weapons at a container loaded with spent fuel that is just a bunch of metal, it's not full of explosive itself, you would get a hole that would either seal itself or at worst, would be very small in diameter.

Now, the final point that I would make on this is that you all, obviously, have seen pictures of Iraqi tanks blowing up when these types of weapons are shot at them. The distinction there--at the risk of stating the obvious, let me just state it. The distinction there is that if you fire one of these weapons at an Iraqi tank, or at a tank, and you hit the turret, and you inject the molten metal into where the munitions are, where the explosives are in the turret, then yes, indeed, the thing is going to blow up. But you don't have--you know, I don't think we ship spent fuel, I know we certainly don't, I'm sure the commercial industry doesn't, with explosive charges inside the container. That would not be too smart.

Okay. Now, what kind of analyses did we do here for routine transportation, as well as for accident conditions? We used basically the technology, or the techniques I should say, that Dr. Chen and Dr. Neuhauser so well described, RADTRAN, RISKIND and all. We analyzed a couple of different things. We looked at the container shipments that were made prior to 1995 and then the container shipments projected from 1995 forward in two categories, those that are coming from the shipyards to INEEL, those that would ultimately go from INEEL to a repository.

Now, these are the results, and I want to just spend just a minute talking about these results because they really are, in our view, very robust results.

For incident-free shipment, for shipments to INEEL over a 40-year period of time, the total person rem exposure was about 2 rem. So that means that there is one chance in a thousand of a single latent cancer fatality among eight million people along the transportation corridors in a 40-year period of time. It's not once chance of a thousand per person, it's one chance in a thousand of one latent cancer fatality among eight million people in 40 years, okay?

Now, if you ask yourself what is the risk of somebody being killed as a consequence of being run over, that risk is several orders of magnitude, three to four orders of magnitude higher than this risk. In other words, there is a fair likelihood that somebody is going to get run over by those trains in that period of time, around three to four orders of magnitude higher.

Now, for a severe accident, the risks are even lower, and the reason the risks are lower is because even though the accident event will have a higher consequence, the probability of the accident, obviously, is lower.

And what we looked at here were several things. We looked at accidents involving penetration of the container, not just by a terrorist weapon like this, but penetration of the container by some other kind of a missile, some type of an airplane crashing, whatever. We looked at accident scenarios where the container was penetrated, and 10 per cent of the fuel inside the container was made available for release. You can see the risks are extraordinarily small even in that circumstance.

Now, there lies an important point. Let me say that I'm wrong. Let's say that at the risk of conceding a point to our critics, which I'm not willing to concede, but let's just say that, hey, 100 per cent of the contents are eligible for release. Everything comes out. Say I'm off by a factor of a thousand. Well, then I have a number of say 1 chance in 25 instead of 1 chance in 25,000 of a single latent cancer fatality among eight million people in 40 years.

My point is that the risks remain negligible, even if I assume situations that my critics will never be able to prove are realistic.

Finally, the final slide. This is a summary of the transportation discussion for shipments from INEEL to a repository. Now, I would point something out. You notice that, gee, we're down now--now down to a chance of 1 in a 100 of a latent cancer fatality, whereas it was a chance of 1 in a 1,000 at a population smaller here than it was in the other case. Does that mean that for some reason, these shipments are riskier than the shipments that we made to INEEL? The answer is no. This is an artifact of the calculation. Let me explain what I mean.

The shipments to INEEL, we use our M-140 containers. We know exactly what the radiation field is. The dose rate is external to the container. The requirement, as you know, under DOT regulations is 10 millirem per hour at 2 meters, okay? We meet that standard, that requirement, by factor of 100. Typically, our radiation doses are 1/10 of a millirem per hour at 2 meters. So we actually use real data because we have real date with M-140s loaded with fuel. We have been doing it, you know, for many, many years.

For this analysis, because we do not yet have a container design, we are in the process of designing the container, we assumed that we would be at the regulatory limit; that is, 10 millirem per hour at 2 meters, okay? That explains why this is a higher number. Do I expect we're going to be at 10 millirem per hour at 2 meters? Not on my watch. I guarantee you we will ensure we're down probably around 1 to 10 per cent, like the other containers, which will make those numbers commensurately come down as well.

So in a nutshell, those are the results. I would again emphasize that they have undergone the NEPA scrutiny, the process of scrutiny under NEPA. They have undergone technical scrutiny by federal agencies. And we're willing to stand behind those numbers, and, frankly, I have yet to have anybody point a hole in those numbers, any of our critics say, well, you forgot to divide when you should have multiplied, your conversion factors are hosed up; you know, you assumed that you were shipping by aircraft carrier, or something like that. Nothing, there is no criticism that we're aware of in any of the documentation that has any merit in that respect.

Okay. That's it. I thank you very much for your attention, and I'm happy to answer any questions, or will try to answer any questions you might have.

ARENDT: Questions?

KNOPMAN: Well, since you were nodding your head about--

GUIDA: Yes, ma'am.

KNOPMAN: --the Price-Anderson issue, maybe you could enlighten us a little bit about how it works. Is there a floor, as well as a ceiling, on liability coverage?

GUIDA: Let me describe the way Price-Anderson works as a client. I can not describe it as an attorney, although I have some attorneys with me here who can probably--I'm sure can do justice to it better than I can.

Basically the way it works is that Price-Anderson indemnifies--has the government indemnify a company, whether it's a transport company like a railroad, or whether it is a private company like Westinghouse, whatever, indemnify a company so that if they were to get a third-party claim, somebody who's injured as a consequence of transportation, a reactor accident, whatever, has to be related to the radiological aspects of byproduct material, okay, i.e., radiation from byproduct material. If they are affected by a nuclear incident under the Price-Anderson Act definition, which would be an accident, then that person can file a torte claim against Company X.

And Company X, then, invokes the indemnity provision that they've been given with the government, and the government then--what will usually happen, and I've been through this a few times, not involving transportation accidents, but involving accusations of, for example, shipyard workers who claim they were injured, got cancer as a consequence of radiation exposure. They filed suit against the shipyard, sometimes under workmen's comp, sometimes not. Then the shipyard comes to the government. The government winds up--because of the indemnity extended to the shipyard, the government winds up assuming the defense because since we're ultimately going to pay, we wind up defending the case, even though the suit was not originally against the government per se.

Now, the way it works is that the government usually requires the company to maintain a certain modest amount of insurance themselves to deal with what you might characterize as nuisance suits. That can range anywhere from a couple million dollars of insurance up to, you know, several tens of millions of dollars. If the claim is in excess of that, and usually the claims are in excess of that, then the delta between what the private insurer, you know, is going top pay versus what the government paid kicks in, and the government steps in.

Now, there are a couple of exceptions in the Price-Anderson law. I will have to get you the specifics, but my recollection is war and civil insurrection are examples of exceptions where there would not be payments made in those cases. But war and civil insurrection are not very--they're very difficult things to prove. You know, a terrorist attack is not civil insurrection. Civil insurrection is the loss of the force of law, basically, you know, where you've got the vigilantes doing things and all the rest.

So in the cases I've been involved in, in my last 17 years of working on this, there have probably been about half a dozen Price-Anderson torte claim lawsuits against companies, which then we wound up being the defense on. We have never lost--never lost a case, and that's on the merits.

Now, one of the things about Price-Anderson which is very helpful is, Price-Anderson creates, or employs a doctrine of strict liability, which means that you do not have to demonstrate that what you're dealing with is dangerous. That's taken as a given. What you now have to demonstrate is, however, that your injury was caused by the thing that was dangerous. That is your threshold test. So it's very good in that respect.

Now, in terms of amounts, my recollection is that the government is liable for the same amount in the event of an incident that the commercial industry is liable for, although we don't--it's not paid in the same way. In other words, the commercial industry is liable in the event of an accident by virtue of the money they paid into a fund over the years, and I think it's like seven or eight billion dollars at this point, is the limit of liability. The government is subject to that same limit of liability, but even there, the Price-Anderson law says that once you reach that point, liability isn't really tapped--or capped rather. Instead, then you have to go to Congress, and Congress will decide whether more funding, whether government funds should be made available for purposes of making people whole in the event of an accident.

Does that--

KNOPMAN: Yes, that's excellent. But the bottom line is there's no private insurance here beyond the--you said, a few tens of billions, probably.

GUIDA: That's correct.
KNOPMAN: And then once--
GUIDA: I'd have to--yes, ma'am.
KNOPMAN: --you're above whatever that threshold is--
GUIDA: Price-Anderson kicks in, yes, ma'am.
KNOPMAN: Price-Anderson, okay.
ARENDT: Other questions?
Richard, you've got a flight.
GUIDA: I know. It's my pleasure to be here, sir. Thank you.
ARENDT: We thank you very much.
GUIDA: Thank you. And again, I invite you all, as time permits, please come up and take a look at the hardware, if you would.
ARENDT: This closes our session for this afternoon. There were no registrants to make comments, and so we're dismissed until tomorrow morning at 8:30 a.m. I thank you all for coming.
(Whereupon, the proceedings were adjourned, to reconvene at 8:30 a.m. on Thursday, November 20, 1997.)