U.S. DEPARTMENT OF TRANSPORTATION

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OFFICE OF HAZARDOUS MATERIALS SAFETY

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RESEARCH & DEVELOPMENT FORUM

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WEDNESDAY,

MARCH 23, 2016

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The forum occurred in the Conference Center, 1200 New Jersey Avenue, S.E., Washington, D.C., at 9:00 a.m., Rick Boyle, Acting Chief of Engineering and Research, presiding.

PRESENT:

RICK BOYLE, Chief of Research and Development, OHMS
BILL SCHOONOVER, Deputy Associate Administrator of Field Operations, PHH-3
LAD FALAT, Director of Engineering and Research, OHMS
VEDA BHARATH, R&D Branch
MARK RANEY, Volpe
SAM ELKIND, UPS
DAPHNE FUENTEVILLA, PhD, Naval Surface Warfare Center, Carderock
COREY LOVE, PhD, Naval Research Laboratory
GEORGE KERCHNER, PRBA
DAWN JOHNSON, Volpe
FRANCISCO GONZALEZ, FRA
LEONARD MAJORS, Engineering Branch
BRIAN MOORE, Engineering Branch
REFAAT SHAFKEY, Engineering Branch
JACK WERT, CGA
DAVID LORD, Sandia National Laboratory
MICHAEL KLEM, Sciences Branch
RICHARD TARR, Sciences Branch
ANDREA DUNHAM, Sciences Branch
DAVE BROWN, Argonne National Laboratory
CYNTHIA HILTON, IME

SHANNON FOX, Sciences Branch

BRITAIN BRUNER, Sciences Branch

ALSO PRESENT:

JOANNA LU

CONTENTS

CONTENTS (CONT.)

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

9:07 a.m.

MR. FALAT: Good morning everyone. Can everyone hear me just fine? All right. On behalf of Pipeline and Hazmat Safety Administration Administrator Dominguez and Associate Administrator for Hazmat Safety Dr. Magdy El-Sibaie, I'd like to welcome you to Office of Hazmat Material Safety Third Annual R&D Forum.

My name is Lad Falat and I'm the Director of Engineering, Sciences and R&D for the Office of Hazmat Safety. Rick Boyle, our Chief of R&D and Radioactive Materials, will host you for the next day and a half, and he will soon walk you through the mandatory safety and security briefings for this location. Also joining us up here is Bill Schoonover, our associate administrator on the Hazmat side.

I want to thank you for taking the time from your schedules to allow us to inform you about our R&D program. The meeting is intended to give you an opportunity for feedback on PHMSA's existing projects and on the program in general, but also to serve as an outreach for proposals on new initiatives.

I will also thank in advance our presenters and their supporting organizations, for taking the time to enrich the forum. Believe me, I know how much work it is to get presentations together, and of course I want to acknowledge and thank Rick and his R&D staff whom he will introduce for pulling all this together.

The core mission of Pipeline and Hazmat Safety Administration is of course safety in the transportation of hazardous materials. As such, we analyze our causes of past incidents and close calls, and address them through risk-based research, which may inform future regulatory policy.

Another critical aspect of the R&D program, however, is forward-looking, to anticipate emerging hazmat transportation risks. This effort takes varied subject matter expertise from the technical folks such as our chemists and engineers you see in the room, but also economists and the like to analyze market conditions and developing trends.

As crude oil was an emerging risk of hazmat transportation by rail several years ago, and by the way it remains in the center of our radar screen today, we must identify and address tomorrow's risk starting -- well, starting yesterday actually.

Will the next focus be LNG, liquefied natural gas as a transportation fuel for highway, rail and marine, and a growing export opportunity, or will the next emerging risk be the increasing transportation of ethane and ethylene as a valuable chemical raw material extracted from natural gas or separated from natural gas.

So engagement of the regulated industry, you folks, and other interested parties, academia, other federal agencies and as well as old partners within DOT, engagement of all of those is vital to our ability to identify these emerging risks.

I see a number of familiar faces in the room. For those who have attended our previous R&D forum, I hope that after the next day and a half you will agree with me that our R&D program has substantially evolved from two years ago and maybe even from last year.

We now have resources on board, and as you will see we're implementing a structured framework. We still have a long way to go, but we are keenly aware of the urgency of developing, prioritizing and executing research projects. So without eating up more of the clock, I'll hand it off to Rick Boyle, Office of Hazmat Safety, Chief of R&D, to host this year's meeting and to walk you through our program. Enjoy.

MR. BOYLE: Thank you, Lad. But the first thing I'm going to do is introduce Bill Schoonover, our associate administrator for Hazmat Safety and let him give a few welcoming comments. Then you'll be stuck with me for a straight hour, so get your coffee in now. Thank you.

MR. SCHOONOVER: So without warning, I think I'm supposed to give you enough time to regroup and prepare for an hour's discussion. Good morning. It's exciting to be here. I'm looking forward to this forum.

I do want to thank the group that's put this together. They've spent a lot of time trying to put this together and develop a forum that we could have a lot of dialogue on how we develop and conduct our research program within PHMSA.

Our Administrator, Marie Therese Dominguez has -- puts forth three values that we try to espouse, and that is safety, trust and innovation. And you know, I think with this, with this forum is a means of carrying that forward so that we are looking at safety, safety of the industry.

We are developing trust that we have, the public trust that has been put into us by yourselves, by our other stakeholders, by Congress who has given us quite a good bit of research dollars to invest, and we're also looking at innovation.

You know, our mission and our vision is really to be the most innovative transportation safety organization in the world, and we can only get there by using research and finding solutions, and finding solutions that are not only applicable, but easily put into place everyday and help us move the industry forward.

So I'm sure over the next two days you're going to have a chance to have some really good discussion. I've seen the agenda and I think there's a lot of intriguing topics, topic areas that we're looking at, and we look forward to your help in guiding our process. So with that, I'm going to turn it back over to Rick. Thank you.

MR. BOYLE: Thank you, Bill. Again, I'm Rick Boyle and I'm in charge of the Research and Development program which is under Lad. So if you start, you start at PHMSA, then you go to Hazmat and then you come down to Engineering and Research and I'm in that group. I'll give thanks to them later, as we go through the presentations, but I think right off the bat we have to talk to our pipeline people.

I think Jim Merritt and Bob Smith are probably both online or streaming in, and they've given us a lot of help with their program. They said you know you're about 10 or 15 years behind where we were, that they got hired in and their budgets have been starting to creep up, and they said this is how we got started.

So they've really been giving us a lot of help. So it truly is one PHMSA, as they've been helping us walk through. The other thing, I think if you attended last year or the year before, you pretty much, at least last year, you saw me standing up here for almost the whole day just talking, because I was pretty much the program. They really hadn't staffed it up.

Tiffany Fossett is outside. She did

the admin for me last year, but it was just the two of us running around. Well, this year you're seeing we have more people here. We've arranged video. We have a better agenda, and I think you can thank Joanna Lu came in around Thanksgiving. She came in and my next briefing's going to be on how we're enhancing the program.

She was brought in to kind of put that program together, put the strategy in, document the whole process and as we like to say get us ready for an audit, because they seem to be auditing programs all the time. So get our program in line for the audit.

I was looking over at Bill because Veda was right over there. Veda also came in -- here he is. Veda came in around Christmas and he's the technical side. He'll introduce himself later as he gives a presentation.

But he's doing the technical side, so when you come in and when you want to talk about lithium batteries or you want to talk about crude oil or whatever you want to talk about, Veda's going to understand it. If you want to talk about radioactive material, I'll understand it. But you know the other -- the other eight hazard classes are really going to Veda, so that's where he's come in to put that together.

So at this point you're seeing us be a little bit more of the whole team. As I go through the program, you'll see we're doing the evaluation. Now I get to -- we say this goes into the stewardess mode. I have to do the administrative details.

For emergency and evacuation, if it comes to that, we'll have speakers that will tell you it's time to evacuate. Basically, all I need to tell you is go out either door when you go out right through here through the main. You can go left or right. Both of those will take you outside and just go toward the river.

The rally point is to the river. If you go towards the street, you get in trouble with the fire trucks and everything. They can't bring the fire trucks in if thousands of people go that way. So us old timers, our initial rally point was to go the other way, and the fire trucks couldn't get in. So now we go to the river.

So if we do have to evacuate, just go out, go to the river. It will be a nightmare to scan everybody back in. I haven't seen how that works, but we're going to hope for the best and I don't think we'll have an evacuation. But it would be go to the river and we'll all rally out there. You'll see people and you'll probably be with people.

But just remember to go to the river. Restrooms are come out here, basically right behind me. If you go over here, that's where the restrooms are. You can also go back to the main hallway, turn left and they're down to the hallway. Don't walk so far that you go out through screening, so then you'll have to screen yourself back in.

They're out towards -- you'll probably see signs for the credit union or anything if you want to go that way, or they're right back here. Coffee, snacks, lunch, typical government YOYO program. You're on your own for those. You probably saw the small coffee bar as you came in.

If you go down the stairs through the elevator bay as you take a right and go down there, there's a snack bar down there. If you come back up the stairs that's where our cafeteria is and you can get more coffee. So you'll be -- I don't know some. If you have government badges, you're completely clear to walk around. The rest of them, you probably want to stay by this coffee bar and then we'll have people over there, over in the cafeteria at lunch.

But I think checking in you realize you're pretty much here for the day. So when we have our lunch break, unless you have a badge to get in and out easily, you'll probably want to just eat in the cafeteria and we'll have escorts over there.

Cell phones, it's the standard. Just

put it on mute, put it on silence, whatever. It's a small room, so it's going to be a little bit warm. Let's not try to bug each other. I'll try not to drink too much coffee and get jittery, and I won't have my cell phone going off.

The last thing, anybody -- this is a little bit more for the people that are listening in. If you're having connectivity problems, I know we put out a Skype link, and then we came and had a pre-production meeting here. We said wow, the streaming is so much better and the Skype you have to be flipping through the -- you have to be looking at your screen to see the slides and be holding the phone.

So we kind of shut down the Skype. So we want you to go to our streaming side. We figured if you have a Skype access you'd have Internet so you can look at the streaming site. So if you'd go to the streaming site and kind of we shut down Skype.

WiFi, as you can probably guess, is pretty limited here. So it's not going to work too well. So you're probably not going to stream yourself. If you have an important question and you want to say what do I look like on the camera, it's probably not going to work. You're going to have to wait.

I do want to tell everybody that's here and everybody on the phone, we do have a transcriber here. It's a court reporter, so it's all being typed in. So if all goes well, in about a month you'll see the videos come up. We hope the videos will be cut by topic, by presentation topic so you won't have to watch eight hours of video or try to find out where you are.

We'll also have a written transcript so you'll be able to go each way. If you want to combine the two, the video will have closed captioning on the bottom so you can read instead of listen, whatever you'd like to do. It will all be there.

All said, administration we've been pretty much warned and everything that our video people have told us have come true. Pick a technology and stick with it. I know when we were looking at Skype, if you left it and tried to come back, you had to make a comment or it was kicking you off.

If the phone kicks out, the phone is routed through the meeting room. If you're having any problems, really the streaming side is best, stick with that. If you want to, if you want to make a comment you'll send your comment.

There should be a bar. If you're watching in video there should be a comment bar at the bottom that says if you have a question or if you have a comment, send it to the Hazmat Research mailbox, the email system.

Joanna is sitting there. She's monitoring that. So anybody that's participating not in this room will send emails in and their questions will come up and we'll monitor. Everybody else here, you can just stand up and ask your question at the microphone. We do have a second camera so that they can -- you can show up on video. We didn't want to just have strange voices in the middle of the video, so we put in a second camera.

Again, if you have connectivity problems, if anything's going wrong, we can't tell from here. Send an email and that's hazmatresearch@dot.gov.

Quickly to go through the outline or the agenda, I'll be quick. We kept changing it as we wanted to confirm speakers and confirm topics and who was coming in. So we're going to start out -- what I'm going to do is give you an update.

Last year I told you it was a big wish list, how we're going to fix our program, what direction we're going to go in. So I'm going to give you an update on what our enhanced program is, what it looks like now, what are our plans as we go forward.

Then we'll go to electronic communication. For us it's HM Access is the program. That's the acronym we've been using.

But it's really electronic shipping papers and electronic communication. We have Mark Raney from Volpe and we also have Sam Elkind from UPS here to speak on that.

We'll go into lithium batteries next, and we have Daphne Fuentevilla from Carderock, Naval Surface Weapons Center. We shouldn't just say Carderock. It's easier for us to type, and then we have Corey Love from the Naval Research Laboratory to discuss two new programs that we're thinking about or we've gotten started, we've invested in.

So we're going to talk about those and how we're moving forward, and if he feels better -- I know I saw the email from George this morning, bad head cold, seeing the doctor at eight.

If the doctor lets him come here and he won't infect us all, he'll be here to give a lithium battery presentation. If not, we'll have a longer question and answer period and we can grill Carderock and Veda and Naval Research Lab.

You can ask them very tough questions.

We'll move in LNG next, and we have Dawn Johnson from Volpe here to speak on some of the work we've been doing up at Volpe. Then we have our partner, Francisco, from the Federal Railroad Administration who will talk, as well as Leonard Majors from the Engineering side of our office will speak on what we're doing, and then Veda will get up and he'll give you the summary on what direction our program is going.

We'll have compressed gas research, and, again, our Engineering Group will take over with that, with Brian Moore and Refaat Shafkey giving presentations on the work we're doing, and we'll bring Jack Wert from the CGA, the Compressed Gas Association.

Crude oil. We have David Lord here to tell you. That's our biggest project. I think everybody has heard a lot about it. It's a lot of money. Joe Nicholas from our Sciences Group has been heading it up as our subject matter expert. But David's here from Sandia, who's actually doing the work and doing the research, so he'll give us an overview of that.

Then another program that we're working through -- Francisco at FRA but through Harvard, Michael Klem will talk to us about the W Inc. Oil Classification Program.

We'll go through energetic materials. Dr. Richard Tarr will be giving a presentation on our chained and unchained work, as well as our black powder equivalency, and then Andrea Dunham will come up and they're all with the Sciences Group. So that's an internal section, internal meaning that whole section will be speakers from PHMSA. They'll give us an overview on enhancing the classification and testing of energetic material.

Emergency Response will be next. I'll ruin the own surprise of my own presentation, we're printing the 2016 book right now. That's why I'm giving that presentation instead of Tom Kiddy who does the ERG. It's being printed right now. It will start delivering next month.

So I'll basically be telling you what enhancement we've made, and then we also have -- we're happy to have Dave Brown here from Argonne who I always call him the guru of the green section. If you have any questions on how that green section is put together, what protective action distance is, what happens when it's Table 1 and Table 2, ask your questions when Dave comes up.

And then Emerging Risks. We kind of put that in as a placeholder. We knew people wanted to speak. I know Cynthia Hilton from the IME wanted to give a presentation or short presentation, so we're looking at smaller, more informal presentations to close out the day as a lead into Thursday morning is discussion groups the whole day and what we're trying to do is we'll give research needs statements.

We stole the idea from the TRB, that they have research needs statements. We're trying to put as many topics together so we can gather them together. And that would close out what the agenda's going to look like.

Finally, success depends on you. If you're here or in the audience, please step up the microphone, ask questions, tell us what you want. Again, the more topics we have, the more research we can do, the more directions we want to go in. A lot of us have more time sitting upstairs at our desk than out experiencing the regulations and experiencing the hazards and seeing where the gaps are and the risks are, seeing what the capabilities of researchers are.

So please, just comment if you're here. If you're streaming, please comment through the email system, and as I said before, the Skype participants, you're probably getting either a blank screen or a screen that says we cancelled the Skype presentation. Go to the streaming side, and that's the link if you go to our Engineering and Research home page is where you'll get.

Teleconference participation -- whenever we ask for questions, we'll ask our audiovisual people. They'll open up the mics so we'll be able to hear the phone people right through here. So they'll be coming in.

And again, if you go home and you're watching the video later or you just think of something or it's something in your everyday work, you can always email the Hazmat Research group.

That's our email address. You can send us your research needs statements, your ideas, your thoughts, your comments, anything you'd like to. No spam or junk mail. We get enough of that. But I threw that in at the end so you can give us that at any time, and I will see how it works.

We're switching to the next presentation or the first presentation. That concludes the administrative side. Is it on me to go forward or -- get to take a breath. My Marco Rubio moment, have a little coffee. Well he had water, sorry. Cheating.

MR. FALAT: What Rick didn't mention

is that there's also coffee in the back of the room. But a word of warning. It's only for the break, because I made it. I typically don't make percolator coffee, so I used a half a can, and I'm not sure if that was the right thing to do.

(Laughter.)

MR. FALAT: On Monday I made a test batch, and it was so strong that when I diluted it 50-50 with water, it was still almost undrinkably strong. So it's only for the brave, it's in the back.

MR. BOYLE: Lad's first batch of coffee was the second worst coffee I ever had, because the worst coffee I ever had, the woman that was making it she had never made coffee before. I couldn't imagine that. So she looked -- if you look at the little box, the filters come in, they show that the coffee's all the way to the top. So she took ten cups of coffee all the way to the top. I wonder.

It takes a long time for the water get there, so we're like what's taking so long? That was the worst cup of coffee I ever had. But Lad's is about half strength of that and good luck if you can get that down. Oh, it certainly will Bobby, no question of that. Full strength.

I don't have to reintroduce myself. I'm still Rick Boyle and I still head up the R&D Program. What I'd like to do now is just give you an overview of our program.

At first, we wanted to just give you the strategic side of the program, and then it was requested why don't you put in some of the money at the end, because people come here saying where can I be part of the program, and we always said that's a nice way of saying how much money do you have? So you know, I know how to gear my programs.

So we do want to include that. I will tell you, I put in total numbers, our yearly budget, but I didn't give you every number for every project, because what happened is last year all the slides go up and they're searchable on the Internet, and somebody said, where's my money? Right there in your slide last year it said I was getting X amount of money, and I don't have my money yet.

So we said we don't want to be putting them up online and have anybody think that they're promised any amount of money. So I took the specific money columns out, but you'll see the programs we're looking at. So I'll give you the overall framework of the program, the strategic system we're working on and then go through a little bit of the programming, all in 45 minutes or less and a giant slide deck.

So what we wanted to do is again, I've been on the program for about 14 months and everyone else less than six months. So we said where do we even start with the defining of the program? So we went back to the strategic plan that our predecessors put together, and it's about three years old now so we'll be refining it.

We said well what did we say was our mission, and basically it was to provide the research and analysis to support the program, which would support safety because we were looking at incidents that had occurred, but we'd also be supporting the regulatory program.

So that was where we were looking at, and then as the new administrator came in within the last six months or so, they took a new look, they being all the executives put together a new -- I want to say I don't think it was a strategic plan because they're not here that long. It's not a three to five year plan.

So they took a look at strategy and that's the small house or Parthenon-looking structure, that they put it together and put their mission and their goals, and then I knew, boy, those columns are so small there's no way we're going to be able to read those.

So I said let's look, and what we wanted to do was compare what our mission was with what the PHMSA goals were and what PHMSA wanted us to do. PHMSA's goals were to promote continuous improvement and I'm going to read through them fast, and when you see the next slide, you'll see why.

Promote the continuous improvement and safety performance of the regulated community, invest in safety innovation in the pipeline and hazardous materials sectors, build greater public and stakeholder trust, cultivate organizational excellence and safety culture for our people, pursue operational excellence in our data processes and systems.

We said wow, that was a mouthful. So the first day we sat down and said how does any of that apply to us, because the first one when we look at their objectives and what they wanted, it looked like it was an enforcement program. So what we did was sit down and said where does this apply to us.

So we took the goals and lined them up in the next column and said what are we doing to achieve PHMSA's goals? How are we going to line ourselves up with the entire organization? What we said is rather than promoting it and going out in the regulated community, how are we promoting safety improvements?

What we're looking at is the risk reduction program, doing more root cause analysis and then the prevention side. I think the first thing when the Administrator sat down with me, she said I want to stop studying the old incident; I want to start preventing the one that hasn't happened yet.

I want you to start looking forward more, because she felt our research was too based -- too much based on what had already happened, and then stopping that from happening again. She goes I don't want these things to happen anymore.

So that was exactly what we wanted to do, and I want to say this. When we go through the rest of the program, we've somewhat split our program in half. We're not going completely away from investigating incidents and accidents and projects that we want to run, but we have added risk reduction and we're calling it, as you see them, either as risk reduction, RR.

What we're looking at is picking up ideas from here, looking for gaps and saying how are we going to prevent the next accident by putting broader-based research proposals out there, where we say we're looking for help in this particular risk category and put a few themes out there and let people respond to those.

So you're seeing two types of programs being run, but I'm not going to give you two parallel slide paths to say this is how we're doing the prevention, and this is how we're looking back at the incidents. We're generally doing them in the same way.

Investing in safety innovations. Again, risk reduction, preventing accidents and looking at emerging risks. That's why we put the second day on this conference. We want to discuss.

We want to see where the gaps are. We want to prevent the next incident. Not to say we're not going to look backwards at what's already happened, but want to prevent the next incident.

Building greater public and stakeholder trust was probably the easiest one. We sat down right away and said we need a system like Pipeline has, that somebody can go online. They can see what proposals we've put in the system. They can see where their proposal was put in the system. They can see oh, it was evaluated by this panel, these were the results. You either got comments back to say this is how you need to modify your proposal, or you track your program all the way through.

If you were funded, you'd see all the way at the end with a report or a piece of equipment or whatever came of that. You'd track it all the way through the system.

We're using the pipeline. If you're familiar or you want to go back, the Pipeline Management Information System is our model. They're putting everything together.

I do want to tell you, right now, we're working the system or the piece we've put together is the behind the closed doors side, where we're doing all our budget and all the money shows up and we're tracking our statements of work and we're tracking everything.

We're doing that internally. We really wouldn't be sharing that with you at all. That would be ours. What we want to do is start putting together where you'll see your proposals, you'll see anything that our contracts office has issued, statements of work. You'll see the public documents, but our budget system will stay behind closed doors.

So that's what we're looking on. This is our third forum. We've also started talking about we need, we're calling them mini forums right now. Once a year is probably not going to be enough. We're going to need your help doing more of the evaluation prioritization. So we want to pick up on that as well.

And then cultivating organizational excellence and safety. What we're looking for is a broader participation in the program.

Previously, you saw the R&D Group, two or three people and then you'd have half a dozen or so engineers and scientists that were interested in R&D in the Engineering Group.

Since Lad came in, he kind of rewrote a lot of personnel descriptions and said everyone's going to participate in R&D. So we've been able to expand our subject matter expertise to everyone in the Engineering and Research Division. The best part, too, is Todd Steiner's group and our Analysis Group, which is PHH-60 has also come on board and said we'd like to do some work, some R&D.

So they're coming in. So as the word is spreading, we're getting more subject matter experts within PHMSA. The next aspect is we said we want to go outside and through our LNG congressional demand, they said work more with FRA. So you'll see Phani and Francisco are here, and they'll give presentations. We're partnering with our fellow agencies more.

Motor Carriers, we met with them

yesterday to look at human factor work. So we're reaching out to our modal organizations. Rick Bornhorst is here from FAA. I wouldn't want them to be left out, and the Coast Guard is also here because I love to talk to them about the fracking water and if you barge it all down and when does it become radioactive. That's one of my interests, side interests.

So we're trying to get all our modal partners together. You'll see, soon, Joanna said, we're going to have a more public process. So we're going to need experts from the field to participate in our evaluation and prioritization efforts. So we're looking to broaden the entire base of the program, and again to summarize it all, pursue excellence in all of it.

Let's not do research for research sake and we'll have the money. We might as well spend it. We want to do things that actually help the program, prevent incidents and keep people safer.

So that's the first thing we're

looking at is when we do an evaluation of the statement of work is does this matter? Does anybody really care about this or what could possibly go with this?

Program enhancement. We got a big promise last year from me that said oh, we're going to do things better. We're going to think strategically and, well, I was thinking a lot of these things but they never got to paper. So you'll probably see this better when you get your slides at home.

What we did, Joanna came in and in -- I think you spent probably the first 30 days she was here explaining to me what a maturity model is and how we would evaluate our program, and how we could take a current assessment and grow it to a longer-term ever-improving session.

So what we did is we said for me primarily, but it also worked in with the model selection, is let's take bite-sized chunks. Let's not write up the biggest plan in the world, where we have thousands of things we have to do.

So we wanted to look at three domains, and that would be listed on the far left-hand column.

We wanted to look at our organization, how were we put together, how were we running the program. The second domain we wanted to look at is our methods and processes. How are we doing things? How are we collecting ideas? How are we evaluating them? How are we processing them through.

The last is the program operations. I always dump that into the program documentation. That's what I have in my mind. How are we putting a management information system together? How are we reporting it back through our budget? How is it supporting? What is what we're doing now supporting the budget request we're making for two years from now? How is what we're doing documenting what we spent and said we were going to spend from two years ago?

So we want that whole program operations. So what we did is we have the model and from there you'd want to say well what are you talking about? It's fine if you're with organization, methods and operations. What do you really want to do?

So what we developed, and I'm sorry it's so small. We thought we were going to have extra screens. What we did was broke down and we said we made three statements for each domain, and each statement is what are we really talking about? When we say organization, what are you talking about, and I'll read them to you.

Organizational -- for the organization. We want the framework of the organization. We wanted to define who we are and what we're doing, what's our culture, basically our safety culture, and then finally, the people and resources. We said how many people do we need, what should they be doing, how should they be operating.

A little look into their position descriptions and things like that. What do we want them doing? With the second domain, the methods and process is our business process, is how we are doing things, our collaboration. We said we really thought that the first thing we needed to do was collaborate internally, that we needed to reach out within all of hazmat, and Pipeline was so helpful right off the bat.

We said we need to make better use of everybody in PHMSA. Then that started growing to interested parties and industry, and then it just kept growing to FRA and our modal partners. So that's the collaboration we're looking at, and then our actual programming activities, how are we running the program.

For program operations, again I look at that as management information system. It doesn't cover all, but it's a good start. We're looking at our business architecture, we're looking at our information systems and architecture, and we're looking at the technology that we're using.

Basically, we want to know what we're doing, tracking it internally and then making it transparent and communicate it all to you, so when we come here you'll know exactly what projects we're running. You'll know exactly where your proposals went from last year, and it moves on.

This is a little bit of a misnomer. I wanted to show you what we're doing. So if we had a -- if you think these are hard to read, you should see the next one that I wanted to put up and they said you can't put that up. We were growing it like a tree.

We started with three domains; then we had three statements or three subject areas in each one of those domains, and then we have five rating factors for each one of those. So you can see as that tree grows out, you're never going to see it on this screen. So they said just talk people through that.

So what we've done is we've created, we evaluated ourselves, where are we right now and we said organizationally, these are our three important areas. We have five criteria for each one of those areas. Where do we stand right now?

What we came up with, this is an overview of it.

You come up -- I don't think it's any secret. We're not proud of it, we're not ashamed of it. We really came up with a Level 1. We're in a developing program status. But what we felt was the good part about doing it so far tiered out is we could really sit down with Lad and with Bill and with Magdy and our supervisors and say this is where we want to take the program. This is where we think we're weakest, and we had 15 or 20 choices, rather than saying we think it's going to be organizational and they'd go, well what are you talking about?

So we could lay it all out and then this, our Thanksgiving/Christmas effort will be we'll do a new current status. We'll evaluate ourselves every year and hopefully next year I'll be coming in and saying we're a Level 2 or in organization we're a Level 3 that will do these things continually.

We're hoping, or our plan is in about three or four years we'll be telling you we're a

Level 4 developed, mature program that's operating efficiently, and then Joanna will have to give us new organizational, new domains and new statements as to how can we get even better.

So that's the strategic side. I think a little more, probably a little more interesting for you guys to say where do I really fit in the process and what am I doing. This is how our workflow is coming and how are we getting projects, how are we getting ideas and how are we taking them through, if you want to say, a contract award or an actual research contract?

Probably not too much different than you think, but I do want to say some of it is still evolving, that we're trying to get more people involved. But we're also under a time crunch that money needs to be spent within the fiscal year constraint.

So it's -- you know, that's why I said in three or four years, we'll be the fully perfect program. It doesn't happen in six months. What you're looking at, as we come into the top you'll see we label them the TRB. IP could be international programs. It could be interested parties.

The acronym's don't really matter that much, because what we're doing is over time collecting ideas and the ideas are represented as this evolves, the ideas, the research needs statements. If we go to TRB and we see they have a needs statement or something we want to do, if somebody's identified a gap, we're kind of putting those in the hopper.

It goes through. We present many of them here at the Research Forum. We collect even more at the Research Forum, and what they do is come across as the first box on your left, it's reviewing the information and risk. What we want to do is take all these ideas and that's a dark blue box, and dark blue means we wanted outsider participation and outsider meaning outside the Office of Hazardous Material Safety.

When I say outside, we want more than just our subject matter experts looking at these.

So we want to review everything we've had and do a really rough screen, you know, maybe 50 percent are good, 60 percent are good. Just screen out the ones that really just don't make sense, are really not hazmat oriented.

If they're too multi-modal in nature, we'll send them over to TRB and say this is too big for us. If they are more for Coast Guard or FRA, we'll send them out to them. So we'll screen through with them and establish our own priorities, and that's the next box as we're coming across.

It will be establish priorities. Then what we want to do, the next two are lighter-color boxes. They'll be internal. We'll take our subject matter experts and that will be in our Sciences and Engineering Group, and what we want to do is make sure we haven't done that research before.

I don't want to call it a literature search, but it's a little bit of a literature search or your expertise search. Reach out to your experts. Let's make sure we're not reinventing the wheel. Let's make sure, you know. It's always -- I always kid around with contractors that say the best contractor sells the same thing two or three times.

We want to make sure we're not going down that road, that we're like I think we saw that before. So just do a little screening from our own expertise, a little literature search and make sure it's clean.

I think the next two boxes, Joanna and I have a constant battle, which one comes first. Right now we have a lighter box, which means we take it to our management and say these are our priorities and this is what we want to do, and we present it and say that's what we want to do, and that would be the Magdy El-Sibaie level at the associate administrator or maybe even the administrator.

We'd have a briefing and say this is what we want to do over the coming year. Then it would go, as it stays now, then we'd take that out and somewhat publish it, maybe have another meeting here and get the public input to it and say what do you want to do.

For me, I say I think that's reversed. We should get the public buy-in and then we can go to our management and say we've briefed this. Everybody's in line with it, it's all good. You can make a decision and we're struggling over which group we should do first.

So at this point, we're going to take it to our management first. We're going to get a list and that lines up with our communications goals that say before you release a large plan to the public, get management buy-in on it.

So I think this reflects our communication standards now, and then what you'll see, what we put in in project development, which is somewhat new for us.

It's not only new concepts, but there will be acquisition planning, how we'd source an award, how we're going to evaluate those, how we're managing the contract, how we're evaluating the results. And then how are we promoting the results because for us, the worse research program in the world is to have a book shelf full of reports, and say here's the FY '16 bookshelf because we've got all these reports.

It might be good, but we're looking for more than that and that we'd have more output and we'd have devices or equipment we're putting out. We'd have suggestions. We'd commercialize some of our work.

Now this, Joanna said you know, you're pitching the same slide twice. I just took that column and made it a circle. So you're telling the same story twice, and I said oh, not so fast. I see it completely different. What the circle reminds me of is we're going to do this year after year after year.

So if you say every year we're going to come across the top and generate new research ideas, they're going to go down in that circle of evaluation. Now what's in that circle already is last year's projects. If you're given a three year funding, well you're going to be reevaluated, that if I haven't seen anything from you or I said that was kind of a dry hole. That didn't turn out to be the problem we thought it was going to be, what we'd be able to do is evaluate and I'll be blunt.

We'll cut your funding off. We'll say that one's just not achieving the results we want. It's not where we want to go. So what this means to me is it's not individual years where you get your money and we say you're good to go for three years. Let us know when you're done. We're going to reevaluate you year by year and if you're not producing or we're not seeing the results we want, we're going to shut that program down in favor of a new idea.

And again, I don't know. We haven't had in our mind how many will be multi-year projects, how many will be single year projects. But that's what we're looking to do, is it will be a continuing process we're evaluating.

Now for the interesting part for some

of us is to where do we spend our money, what do we have, and since I have I think about ten minutes left, we don't want to -- we don't want to drill down too deep in all these and luckily it's hard for you guys to see. So I'll read some of this off.

With our FY '14 to '16 money, just to be clear, we get three year money. Our goal, long term, is to spend about 60 to 75 percent of the money in the first year, and then the extra, if you want to say the remaining money would be for the contracts that we say are multi-year or follow-on.

But our goal is to spend it 75 percent in the first year. That's quite a change from what we normally have. We've normally been spending in the second and third year, so it's a big shift. So what you're seeing, I've color-coded it. Some of the PRs, purchase requests that we've submitted that we've just submitted this winter, you'll see we're supporting the ERG. Dave Brown will brief on the green section. He has a whole model to do the toxic by inhalation modeling, and we pay Argonne annually to maintain that.

He's also doing reactivity studies, which I could tell you loads about but he's going to tell you later this afternoon. So he's much smarter than I am. We're doing some black powder equivalency work. We have two lithium battery projects and then currently through the FAST Act we were required to do an insurance and liability study for rail transport. So we're funding that as well.

So that's what -- those are the, if you want to say new projects that we've really got going. I've put submission by March using, you know, we were going to say we're going to submit them before the Forum starts.

If you look at the blue section, those are projects that we've submitted a long time ago. IDIQ, I'm going to have a slide on that. It's Indefinite Delivery, Indefinite Quantity, and what we did was split that in half. We wanted to set up a commercial entity where we could send task orders and it would be --

I don't want to say it's all for enforcement; it's more of a rapid response where if we see a problem, we can say please analyze this right away and send a task order. If it was a deterministic, if it was testing we'd say, here, test this material and we could send task orders out and we'd have a contractor already set up.

So we put those two out there, and what I want to do is I promised our budget people those announcements are on the street now, I said, so I'm not supposed to talk about them. They said no, you can talk about them. It's fine. The solicitations are out. I've provided the solicitation numbers, and then you just have to go to the website below and you'll be able to pick up and you'll be able to bid.

If my memory serves me, I think we're still in the question and answer period. If you have questions, comments, don't understand anything, I believe you have about another week to make sure you're clear on what we're doing, and then you probably have two or three weeks from today before bids close.

So what we did was divided that. Initially when we put our first request out, we want a company to do it all. The comments we got back is, you know, you really don't have a company that can do all the analytical work and all the testing. Break it in two.

So that's what we've done, and I do think some of the comments were down in testing is you don't have testing companies that can test all nine hazard classes, anything you want. So we're seeing what kind of bids come in. But we do want to tell you that indefinite delivery, indefinite quantity, what we're looking for is setting up a contract for testing and then setting up a different contract to be analytical.

At this point we're looking at one company at a time. If it's successful, we may put it out again and look for multiple companies.

So we'd have multiple test labs or multiple test facilities, multiple analytical. Right now we're going to bite, take a small bite off the apple and set it up once and see how that works.

So we also have money. We got money in FY '15 to '17, and that was $7 million. So the easy pie steps were the safe transport of energy products. It looks broad like we could spend it on any energy product, but as we read the language and our projects came in, it was really crude oil.

Step was almost synonymous with crude oil and David Lord will come in and talk to you about the project we're working with, we being the Department of Transportation. Department of Energy have funded Sandia National Lab to do crude oil classification work.

Rather than me butcher the topic, David gave the best presentation I've seen on it. I've seen about a half a dozen presentations. This really made sense with me and brought it all to light with me. So if you love David, you think like I do. If you said David didn't make any sense, you're thinking like other people, other scientists in the room that liked other presentations.

But that money was generally spent. That money has been put on contract and is out. Our LNG money, liquefied natural gas, we're partnering most of that money with Federal Rail. We're looking at doing tests on intermodal containers and we're going to have Leonard Majors and Francisco get up and talk about those programs and tell you what's going on in a later section.

So again, I won't butcher that. But what I want to talk, because when we met with some of the interested parties, they say, tell us, you know, what they consider as a gap is where you have money left. What could we propose and there would be money left.

I'll tell you in that LNG section you're looking, we could have half a million dollars left and say to do LNG work. Right now we're working. We're doing some thermal work. We don't know how far that's comes along right now. But if you want to say what has a statement of work or what has a problem statement attached to it, you'd be saying about a generous half a million dollars is left there.

From the discretionary side, what we're looking to do, it's open but it's not open. What we're looking at is we have about a million and a half left, but we want we want to do is use the topics that we generate, that we've already generated.

Remember all the balls going into the funnel to feed into the research forum. What we want to do is take those out and say those are the research contracts we're going to issue for the risk areas that were identified by management, by our interested parties, by our modal authorities, by our research forum.

These are the hazards and gaps that are coming through, and then what we do is put out a request for proposals or request for bids, if you will, to say who can help us do this research. So right now, the discretionary pot would show about a million and a half open, but that's what we want to do with it.

We want to put it out to say who can help us with emerging risks such as who can help us with safety improvements such as. So we'd be looking to put those out. I think our initial goals is to get those to our contract office by the 4th of July, and then so you'd see those go out on the street late summer or early fall to say who can help us with this research.

So if you're talking at the microphone or asking questions or bringing up gaps and issues, what you'll see is those be put into these general research proposals and announced in the summer, if all goes well. That's the plan with that. So there is money there. If you recognize and say here's a specific problem, here's a specific project, we could pull the money out of there.

'16 to '18 funding, seven and a half

million. I think what I'd want to say is, again, we see the risk assessment or the risk reduction being an annual effort to the million and a half, million and three quarter level. So you'd see that be pulling it up. That's the green section down at the bottom.

What you're looking at, where you're most interested is new starts. Two and a half million dollars is we have projects. In a sense we have a list of projects. We're always looking to have that project grow. If you remember the chart as you're coming across the board, we're going to evaluate and prioritize. We're going to start evaluating and prioritizing everything we have in the loop and start funding those.

So if you propose new starts, if you propose new ideas, you'll either be put in a general research topic with a Broad Agency Announcement, or we'll look specifically to your project and we have about two million dollars for you in the purple section that's showing up on this chart.

And again, all these will come to you online. I don't know how fast they'll be available, but I'm pretty certain you'll have all the slides by the end of the week, because we have them now. Veda has them and it's a simple case. We go to our IT team and they post them on the website within 48 hours.

So you should see all these slides by the end of the week. So these -- you'll see the dollar figures and you'll see what I'm talking about. Looking forward and just to close out before Veda cuts me off, he's getting ready. He's the meanest guy we've hired next to me.

Challenges on future actions. I hope it's big enough. You can see what day I was putting the challenges slide together. Metro, it was the day last Wednesday when they closed everything down. So we said project improvement and program management is something we really need. That's the biggest challenge.

We're really starting from scratch. Again, I've done radioactive material for 20 years. So when Lad said guess what, you're going to do R&D. You're doing real well at it. I said well okay. So there's the challenge of program definition, improvement, documentation, management information systems. You can put all of that in there.

I think the next is -- I used a few traffic signs. You say no U-turn. Well we're saying there's no going back. When they said you're hired in to do this job, we want it done, they didn't say -- unless it turns out later on you don't really want to do it.

So there's no going back. We're committed to this process. We think we've got the right pieces in place. We've got the right model in place. We've got the right documentation in place. We have the pipeline people that have helped us and moved us forward.

So we don't think there's any going back and we don't think we're going around in circles and never going to accomplish anything. Lastly, our long term challenge is we want this to feed into our budget request. We want to say here's all our thoughts, here's all our efforts, here are all our programs, here are our priorities and we want to be feeding those into the budget process for a year or two from now, rather than having more the budget process feeding back to us saying you've got a pot of money, now spend it. So we're looking at rotating the program around.

What are our future actions? I like the electric car. That's a little Duracell battery if you can't see it. Our problem is to get the whole program defined, that I started writing it a year ago when it was just me. I started writing, I said this is a hopeless cause and I just stopped.

I said I couldn't write the whole standard operating procedure and define the whole program. So I said get me some help. Get me somebody that knows what they're talking about. So Lad said Joanna can come in. So we hired Joanna. So her whole job next year if you're lucky, she'll stand up here and she'll have a giant document and say here's our standard operating procedure. Here's the whole plan. I'm going to give you a briefing of this book that defines our program.

That's where we're looking to, and then maybe next year or the year after, you'll say I really don't need Joanna's brief anymore because your management system is all online, and I can see everything online. I can see where my projects are, I can see everything in the hopper. I can see everything you're doing.

Training. Who knew? Our budget office came down and said you need contractual training. You need to be a contracting officer's representatives, and Veda and I said we don't even know how to spell that. So there are training requirements. We need to bring ourselves up in line.

The other thing we looked at is we said if we're looking to, you know, award a million or two million dollar projects to Sandia to look at oil, shouldn't those subject matter experts have some sort of contractual awareness? If we want to start co-funding with TRB, shouldn't we have a higher level of training than we have now?

So we put together training plans, and then the last challenge is to keep our partnering going, that it's easy to sit in our own office and never go upstairs to FRA. It's easy to say Coast Guard isn't part of DOT anymore, so we don't have to talk to them, and FAA has their own buildings over there at L'Enfant Plaza. We never have to go over there.

It's real easy to ignore them. We don't want to do that. We want to rely on their expertise as well as industry. We want to keep you involved. You know what's going on out there. You know what we're not doing well. You know what we are doing well, so we want to have you guys involved.

And with Veda's permission, I get to say thank you and ask if there are any questions.

If you have any -- through the whole day and tomorrow you can ask Veda anything. You can give him your card. We're going to have comment cards out front if you just want to submit a question because you don't want to stand up at the mic.

Joanna's available, Veda's available, I'm available. Even Lad's available. Lad might tell you to go see one of the three of us, but he's available to take questions and comments. We deem him quasi-core, quasi-subject matter expert. He gets to wear two hats.

So -- and if you have any questions I can take them now, or we'll just move into the next piece. Frank, how are you? In the back of the room please. Please come to the microphone and introduce yourself, the microphone in the center of the room. That would be true not just with Frank but everybody, because you'll be on the camera. So you need to tell us who you are so the court reporter can comment on that.

MR. LISAK: I'm Frank Lisak. I'm with PHH-60, and I wanted to ask Rick, will you be putting these slides online for us to review later on?

MR. BOYLE: Yes. What we were doing is we were in panic mode earlier this week just to get them ready, because we had to put them on a thumb drive so they'd be on the IT section. So what we're doing is we said just as we kind of locked down the agenda on Monday and posted that online, all the slides and presentations are locked down as they're given today, and Veda will take the same thumb drive that he gave to the IT people today or roughly the same, maybe not the exact same one.

But then they'll be posted. We'll put them online. I would expect they'll be there by Friday.

MR. LISAK: Thank you very much, Rick.

MR. MILLER: Thank you. David Miller, American Petroleum Institute. Great overview. A question early on in the presentation. You talked a bit about mini-forums. Can you describe those a bit more? Are they going to be thematic or on a specific project?

MR. BOYLE: Yes. Yes I can talk about them and they're in the planning phase. I think what we're looking at is here we're looking at a big meeting wherever -- I'll say all nine hazard classes are open. As we get proposals in, let's say for the sake of argument only people want to talk about crude oil.

We have crude oil and LNG are the only products or the only ones that are high priority. What we'd do is call subject experts on those two topics and maybe have two meetings and do it topic by topic. There will be at some point we're planning an overview.

I don't think we're at the point yet, so I'd say maybe we're a year away from almost saying there's an executive panel, if you will, that meets, that will have some of the more senior people and will have an overview, and they'll be cross-cutting, I'll say against all nine hazard classes.

But I think at this point we'd be

looking at thematic or topic areas, small meetings. Thank you, David.

MR. WILLAUER: David Willauer, Cambridge Systematics. I was just curious. The TRB is doing a study on flammable liquids, crude oil, ethanol and natural gas.

I was curious why ethanol was left out of the mix today as a high volume flammable liquid, whether that was already being covered in another topic and if you guys have given that some thought. Thank you.

MR. BOYLE: We have given it thought. I think what we were -- why it's not on today is we were trying to give projects we had defined and we had statements of work, so if people had questions we could say this is what we're working on.

We are looking -- we did expand in our own mind to energy products, of staying STEP would be more than just crude oil and we'd start taking some of the money that we said was discretionary and start feeding that back into the energy product line.

I think we're going to have a presentation or Brian Moore may touch on compressed natural gas and then in the Emerging Technologies Britain Bruner's going to present some of the new natural gas and that would be the time that comes forward.

The other aspect we'd look for, we hope you're going to stay on Thursday, or at least submit a comment to say you should be looking into this area, because that's the type of topic if it's growing. And I know Chris Biggers (phonetic) was here.

PHH-60 hired or assigned an emerging energy subject matter expert, and we asked him if he'd look at ethane and looking at the emerging market and should we be doing anything about it. So if Chris shows up again, Rob Benedict is standing right there by the door. He works or he's Chris' boss or I'm going to claim he's Chris' boss.

So the ethane work would be talk to

Rob and see what Chris is doing, because that's the problem definition leading to the statement of work that's going to come from Chris. You've handled the worse part of the day, me for an hour. Now you get the quality presentations.

We have about five minutes to stretch. Just a little bit more administration. For presentations, we're going to ask that people giving presentations, we've saved the front three chairs if you'd come up and sit here. It looks -- it's a little annoying if you sit at the table all the time, probably annoying for you because you can't see the screen as well as with the video. It may pick you up.

So we're going to ask the presenters to sit in these chairs and then I'll come back. I'm going to host the morning, Veda's going to host the afternoon. We'll introduce you, and then at the end of the session if we have question and answers, we'll bring you up and we'll sit at the table at that time and they'll turn the camera to the table.

So if you're giving a presentation in that section, please come up and sit in the front, and then I'll kind of introduce you. You'll speak and then you'll sit back down and come to the table.

We've got a couple of minutes. If you want to stand up and stretch as we reshift, and then the next thing we'll is Mark Raney with Volpe on the HM Access program, past, present and future. Sam from UPS will also be here.

(Whereupon, the above-entitled matter went off the record at 10:00 a.m. and resumed at 10:15 a.m.)

MR. BOYLE: If I can get you to take your seats. I think I'm going to have to owe Lad some lunch, because I said nobody will want your coffee. That's awful. So I think we had a lunch riding on it or anything. So I think I'm buying the next lunch, Lad. Can you take your seats please, so we can stay on schedule?

(Pause.)

MR. BOYLE: Thank you. The first

section or the first topic we're going to cover is the electronic communication and there will also be, in addition to questions and comments at this presentation this morning, there will be a whole session, they'll be a half an hour session that's talking on electronic communication.

So if you don't get your question in today or we run out of time, come in tomorrow or send your question in tomorrow, because we're going to have a whole session on electronic communication and the globalized harmonized system. So without wasting any more of Mark's time, I'd like to introduce Mark Raney from Volpe, who's been working on the HM Access program for longer than I've been here. So much longer than the year and a half that I've been here.

What he'll do is touch on where are we -- what we've finished and he'll also give you where we're headed in the future. So Mark, please --

MR. RANEY: Thank you, Rick. So as

Rick mentioned, this has actually been going on for a while. It's a large program, so it's an awful lot to cover in a short period of time. So what I'm going to be doing is hitting some of the high points, discussing the activities that have been conducted, what the findings were, recommendations and what our next steps will be.

But it is going to be at the high level and if you have additional questions, I'll be happy to answer those during the Q and A period or during one of our scheduled breaks as we move forward.

So for those unfamiliar with HM Access, it's actually a pilot program under Map 21. The purpose of the program is to look at the -- evaluating the feasibility and effectiveness of paperless hazardous communications systems, really e-Systems, and their ability to provide an equivalent level of safety as compared to the current paper-based requirements.

The intent of the program is to look for all transportation modes, to evaluate the performance and impacts associated with using e-Systems. I just want to clarify. HM Access itself is not the system. It's a study of the performance of systems. Sometimes that's how people get that confused.

So I'm sure everyone in this room in this room is aware that current regulations require the use of a paper copy to accompany every hazardous materials during transport. The rationale behind the paper system is that it's a consistent manner to -- that is widely understood amongst all stakeholder groups that need to have access to the information.

But for a while now, a number of stakeholders have been asking to be able to use electronic systems to communicate the information, and that is really the next step in the evolution of hazardous communication, and it does -- and E-Systems do offer the potential not only to industry but offer potential benefits to inspectors and responders.

So in terms of the activities that

have been conducted, so in accordance with Map 21, because it is a Map 21 program, we consulted with various hazardous material stakeholders, both within state and federal inspectors and responders as well as industry, primarily with shippers and carriers.

We conducted pilot tests that test the performance of these systems, and we collected additional data to support an impact analysis or qualitative impact analysis. All of these activities, the pilot test, data collection, required development of a data collection plan and development questions to collect the information and that all had to be conducted in accordance with the Paper Reduction Act.

At the end of the pilot test, we prepared a feasibility and assessment report for the Secretary to provide to Congress. Like I said, I'll be going through these fairly quickly, but I'll be happy to answer additional questions on details after the presentation.

So as I mentioned, we did talk with

various -- various hazard material stakeholder groups, and the purpose of those consultation aspects was to obtain feedback on the priorities, gaps, concerns, operational requirements associated with using e-Systems.

We gathered information from approximately 90 plus individual groups. We also conducted public workshops and a lot of that information is also available on separate information papers that are available at PHMSA's website.

So in terms of the pilot tests, they were conducted between February and May 2015, within five U.S. regions that align with PHMSA's service areas. They included one rural areas, which was a requirement under Map 21, and as I mentioned the purpose was to actually test the use of these systems.

So all of the participants involved were volunteers. The representing shippers and carriers, emergency responders and law enforcement. We actually had, what was that, 35 entities that had volunteered, met the requirements and were eligible to participate.

Unfortunately, only about 20 were able to participate just because of the availability of hazardous materials shipments that occurred within -- with those participants within the pilot test period, because we were actually utilizing real life shipments during the occurrence of these tests.

Emergency responders and law enforcement actually conducted the simulations with the participating shippers and carriers. They collected the information and reported the results of those tests using online questionnaires. What was really the intent of the pilot tests were to mimic real life to the extent possible.

So the simulations were unscripted, following participants' own policies and procedures, using their own existing equipment and resources, and during the test we still had to use -- every shipment still had to have a company shipping paper accompanying the shipment as a requirement under Map 21. It had to still stay within those current regulations. We couldn't exempt from those. We were looking to test our modes.

We actually conducted 21 simulations, five emergency response simulations which cut across all modes, an additional 16 inspection simulations that were associated with roadway and maritime. Unfortunately, we weren't able to conduct any inspections with air and rail modes, just to the availability or unavailability of hazard material shipments within those modes with our pilot test participants during the pilot test period.

In terms of the time associated with receiving electronic information during these simulations, during the emergency response simulations 60 percent of the time they received the information in less than five minutes. In all cases it was received within less than 30 minutes.

For inspections, it took a little bit longer. Eighty percent of the time it was less than 30 minutes. About half the time it was less than 15 minutes. Part of the reason for this was all the -- the majority of all the transfers was actually provided not directly from the driver to the inspector or responder but was actually provided from an offsite office location.

So that created some additional time lags and we expect if the driver had the capability to provide the information directly, that would have significantly reduced the time. I should point out in all cases the electronic information received did match that of the hard copy shipping paper, and was representative of the hazmat being transported.

Concurrent with the pilot test, we collected data for the qualitative impact analysis. We collected information not only from pilot test participants but from a larger stakeholder group, and we -- the information was provided using online questionnaires.

So it was done at the same time as the pilot test, so that's between February-May 2015. We actually received 92 responders and responses. Forty-one percent was from emergency response and law enforcement, primarily from emergency response, and 59 percent from across the hazardous material industry, shippers, carriers as well as also hazardous material trainers, equipment vendors and a variety of others.

Because it was a smaller sample size, we can't necessarily generalize to the broad HM community. But it was indicative of potential benefits in a number of areas. The majority of respondents that had experience with these systems, they believe that these systems offer benefits in terms of safety-related benefits, as well as associated operational and cost benefits.

So some of the additional pilot test findings. In all 21 cases, the participants in this was using their own equipment and was their own choice. They all chose to communicate the electronic shipment papers via a PDF format.

It was something that was easily transmitted and received from all -- between carriers or shippers and with the corresponding inspector and responder, and it was easily -- it could be read by those groups.

In some cases, the inspector responder did indicate though that they had some difficulty reading the shipping paper information on their Smartphones, mainly due to the screen size and try to move around and see all the information, but in some cases also because the PDF that was provided was a scanned copy of the hard copy shipping paper, and it was in some areas a little bit more illegible.

There was mixed feedback in regards to potential benefits from our inspectors and responders that participated in the pilot test. Most responders, 80 percent actually felt that e-Systems could positively affect the time needed to respond to an incident, assuming that connectivity was available.

Inspectors, 88 percent, felt that it

didn't provide any additional benefits over the current paper-based system. I saw some mention that some of the delays, and as I alluded to earlier, some of the delays that we did encounter in terms of receiving information was more due to the information we provided offsite versus directly from the driver, and in some cases the person that was contacted to provide the information may not have been aware of our pilot tests that were --

They had to go through another step to get permission to send us the information, and in one cases it actually occurred during their off hours due to different time zones.

Some findings related to the availability of the electronic devices needed. This is from the inspectors and responders' point of view. Air and rail inspectors generally already possess electronic devices capable of receiving electronic shipment papers. Field maritime inspectors, meaning Coast Guard recently purchased tablets for their personnel.

However, those tablets were purchased for other purposes and are currently not authorized to use them for this, but they could be modified for such. Roadway inspectors is a little bit different. It's a more complex mode than the other modes, and it varied in terms of their ability.

But most roadway inspectors did have laptops and access to HM information. Most responders, those located within urban areas did you have -- generally have the equipment in place to be able to work with electronic shipping papers. However, those that are in more rural areas, areas of less connectivity or volunteers need to rely more on their existing layered redundant systems for ways of getting that information electronically.

Whether that's through relay from a -- radios or what have you. I mean they have systems in place, but they have to rely on those more.

In terms of shippers and carriers,

many of the shippers in all modes already have e-Systems in place that contain the hazardous material shipping information. Air, maritime and rail generally have that in place. Carriers are roadway carriers, although it's a little bit more different and more complex.

Many of the larger carriers actually do have established e-Systems that can be easily modified to communicate the information. However, some of the others that either because they require the paper for other purposes, other business practices or their smaller operation where it's not as beneficial for them from a business perspective to have what they've converted to an e-System.

For some of those, it may be more problematic or less desirable for them to go, to use e-Systems. The impact analysis findings, you know, the use of e-Systems includes both safety and security benefits as well as some vulnerabilities associated with e-Systems. To really understand the full magnitude of those safety and security impacts, it's kind of -- it's difficult to kind of quantify that at this point until you have more operational experience with e-Systems.

However, if e-Systems have been verified and tested as being protected from unauthorized access, they have the potential to provide a more secure means for the transmitting and storing of the information.

Cost-benefits and impacts for shippers and carriers across all modes are expected to be more common within the administrative areas than the operational areas, and transition costs to go to an e-System. It's expected to vary across all modes, due to differences with respect to their existing use of e-Systems or nature of their operations, whether it be business type or what have you.

Overall, the conclusion of the study was that e-Systems can be a flexible and effective alternative to the current hard copy shipping requirements if certain performance-based standards are met. That's kind of the key part of that.

The report does recommend that a rulemaking be considered to amend the current regulations to permit the use, not mandate the use of e-Systems and to set -- and to establish a set of performance requirements or criteria to allow for the use of these systems.

So in terms of the recommendations, some of the specific recommendations related to those performance requirements are that a point of contact be available 24 hours a day, seven days a week to obtain the information; information provided electronically on demand within a defined time interval; and that it is also training requirements established for those that are using those e-Systems and how to communicate the information; that it includes a performance definition in terms of what a paperless hazard communication entails; and that it be defined as being flexible in terms of the use of different technologies; and that it provides that the electronic information is provided in an open, easily transferrable or readable data format. An example is PDF but there's others.

Some additional requirements or criteria would include that for all carrier modes they use a standard defined visual aid that would be adhered to the exterior of the conveyance, to indicate that electronic shipping papers are being used for the transport of that material, that communicates not only that electronic papers are being used but how that information would be obtained.

And in areas where there's known problem areas of Internet connectivity, that they have -- that the carrier has a backup means of providing the information, and ideally the driver actually can directly provide the information to the inspector/responder.

We also recommend that additional pilots tests be performed to (1) test the performance standard that would be developed during that rulemaking process, and (2) to expand upon the pilot tests that have already been conducted, so that looking at all modes, utilizing a larger, diverse set of participants over a larger -- along the pilot test period, looking at other areas of known problems with connectivity in terms of rural areas, geographic areas.

Maybe doing -- by extending the pilot test period, you could also look at weather, areas where in terms of weather may have impacted that connectivity, and possibly even looking at intermodal transfers and a variety of other technologies. One of the limitations of the pilot test we had is with the -- we were asking participants to use their existing equipment, existing resources.

The ones that volunteered and participated, they didn't have the means to work, to communicate directly from the driver. They didn't have tablets on board. They didn't have an onboard system, so that they were providing all the information for an office location. We'll be looking at tests, additional technology.

So in terms of anticipating next steps for the program, it's really those next steps are slated to occur across three phases. The first phase being developed that on a draft performance standard, including the visual aids that would be needed and they expect -- they're likely to vary based on the mode, so there'd be a defined visual aid for each one of the modes.

Obtain comments on that performance standard and those visual aids, determine the scope and approach for the pilot test and then actually to incorporate those comments, conduct those pilot tests, test that performance standard, expand on the previous pilots and then to the third phase being to actually finalize that performance requirement and rulemaking to allow for the use of electronic systems.

For FY '16, the focus will be on putting together that draft performance standard and visual aid and obtaining comments associated with that. And there's a lot of information. I'll go through that pretty quick. I'm sure there's probably some questions. I'll be happy to entertain those at this time.

(No response.)

MR. RANEY: Okay. If there's no questions, if there's something you don't want to ask at this point, I'll be available during one of our scheduled breaks if you have -- oh sorry. Yes.

MR. FRONCZAK: Hi, Bob Fronczak with the Association of American Railroads. Did you have a chance to look at our AskRail system that we implemented back in 2014, late 2014 to provide, you know, emergency responders information?

MR. RANEY: We were present during some presentations that were done associated with that system that we got here, that were provided here a PHMSA and we did talk with some of the groups on that. Yes, so we were aware of that and if I understand correctly, that's more for the

Class 1 railroads. Is that right?

MR. FRONCZAK: Well, right now the Class 1 railroads are reporting single car and full train contents to AskRail. The short lines are reporting, you know, single car if possible. The problem is with the short lines is they have to actually feed the train information into our rail line system in order to access that information.

Class 1's have agreed to do that, but the short lines get -- they don't have the resources. Is this on?

MR. RANEY: Yes. As I mentioned, we unfortunately weren't able to test, do a simulation with the rail as an inspection. But we did do a simulation on emergency response and actually it was -- that worked well and it was actually working internally to that railroad, and they had their own emergency responders involved with that.

MR. FRONCZAK: Yes, and AskRail doesn't do -- doesn't reproduce the shipping paper, and we worked with the International Association of Fire Chiefs on this, you know, to try to get the information that somebody needs right within the first 60 minutes of an accident, to get that type of information. Of course, the other information's already on all locomotives.

MR. RANEY: Thank you. Any other questions?

MS. HILTON: Hi, Cynthia Hilton with IME. So if I understand what you're saying -- well, what I understood what you were saying was that you were -- this project was about, you know, like whether or not it would work, right? Did I get that? Okay.

And so that involved you working with all the parties that would be interested, including the emergency responders. However, or maybe the other speakers will address this.

I am interested to know whether or not any of the emergency response organizations maybe that are here today, you know, have embraced this and are looking forward to this and see advantages in this?

MR. RANEY: Yes. As I mentioned, I mean there's always going to be variations in that feedback and we collected feedback during the consultation stage prior to the pilot test as well as during the pilot test, and a number did have reservations or concerns, because it was -- with the change.

But a lot of them also so benefits associated with it. One of the things we heard was that although they want to get the information as quickly as they can, it's more important that it's correct, and that if they could live with a slight delay if it means that the information that they're receiving is better quality than what they're currently getting.

Another -- and they saw benefits in terms of the quality of the data. As I mentioned, all the emergency responders that participated in the pilot test themselves, about 80 percent of them, they actually saw that there would be benefits in the -- in the time of receiving the information and responding to an incident.

They also saw benefits in regards to if there's a serious incident, it enabled them to get the information without approaching the vehicle because -- and that would help protect them from dangers in terms of responding to that incident.

So the one set had the largest reservations were those in those rural areas or those that for more of a volunteer responder, and they may not have as much equipment, although they are gaining equipment at this point in those areas of low connectivity are also getting smaller, and they already have existing systems in place, backup systems in place to get that information when they can't even -- when they can't get it currently on the paper.

MR. BOYLE: One more quick question and just to let Sam know, we're not going to cut into your time. It looks like we'll be taking like five minute setup breaks rather than a long

15 minute break.

So Bob says -- Bob Richard is our next speaker used to work at PHMSA. That's how I know who he is. So he says it will be quick, and Mark, give him a quick answer too because we need to get on.

MR. RICHARD: So I'll get to the question eventually, but a little bit of comment. Back in 2009, 2010 time frame, the agency was funding the IAFC to do certain work, create a fusion center where they were collecting data about the efficiency of responding to incidents.

Part of that was there were trained fire chiefs, retired fire chiefs that would go out and actually investigate how some of the emergency response worked in different incidents that occurred around the nation. I would suggest you go back to those reports and look at some of that.

I agree with you that the criteria is the most important aspect of this, because some people are more advanced than others, and there has to be redundant ways to share the information. Initially, the emergency responders and inspectors are very resistant to all of this.

But I mean there are so many benefits of it. When you pull up to a truck that's on the side of a road and, you know, there's been an incident, a small release for instance, there's plenty -- there's a number of different hazardous materials covered by a number of different shipping papers.

If someone has to rifle through all those physical hard copies of shipping papers, that's just very inefficient, and what we really should be looking for is a manifest with everything that's on that vehicle and be able to communicate with the companies who are responsible for those immediately. There's so many beneficial ways to do that nowadays.

I mean if you look at how we do this today, it's like we're living in the dark ages. So hopefully a rulemaking will be expedited. The performance criteria is very important, and having that in there I don't see any way that we're really compromising safety.

So it would be beneficial and I think we could, you know, it would be a positive way to get the information to the people at the scene, protect them from, you know, inherent hazards associated with leaks.

So you know, I think this is a great effort and I just hope it can be expedited as quickly as possible.

MR. RANEY: Thank you, Bob. Yes, I mean that was our conclusion and again it's making, as you mentioned, it's having that performance criteria established that will enable the use of it while maintaining the safety of it. One of the -- the reason we talked about that visual aid, that was one of the concerns that inspectors and responders had, was that when they arrive on an incident, how did they know to get that information since now you kind of have two ways of getting it out there.

They want to know immediately upon

arriving are they supposed to be looking for that shipment paper in the door of the vehicle, or are they supposed to be trying to contact someone on scene or off scene to get that information, however they got about doing that.

And I guess we've got to move along, so I'll give it to Rick to give to Sam. But if you have any other questions, I'll be available during break. Thank you.

(Applause.)

MR. BOYLE: Thank you. Again, looks like we're going on shorter breaks. We won't be taking a 15 or 20 minute break. George is here so we can get into the lithium battery presentation. So without ado, we wanted to invite somebody rather than -- who's thinking about and designing systems at Volpe, somebody that's actually using an electronic system. So we've asked Sam to come in from UPS and they have a special permit.

I don't want to cut into his presentation, but they have a special permit where we actually allow them on a limited basis to use electronic communication. So we asked Sam to come in and give an overview of that program and his thoughts and the direction we should take the program. Thank you.

MR. ELKIND: Thank you very much for the opportunity to come and speak about this. Our special permit that covers the use of electronic communications is 15747. It was granted to us in 2013 and we began using it in June of 2014 as an active part of our business.

So in most situations, we are using a -- we are not carrying a hazardous material shipping paper in our small package feeder network. So I want to help you understand the boundaries of what I'm talking about.

We're using this in our tractor-trailer internal distributions parts of the company, and not in our pickup and delivery operations. It is not part of the UPS freight or the former overnight operation. It is not part of our air freight operation. It's specifically the small package distribution/internal distribution process.

The success of the program relies on the inspector or the emergency responder identifying the trailer number that is being queried and requesting information from a central UPS telephone center that provides information. The telephone number is shown here on the screen. It's a dedicated number for this emergency purpose and with that request a caller can receive the information by email, by telefax or verbally read over the telephone.

The special permit, by the way, has been renewed and it will be in effect at least through the end of June of 2019.

So our goals, UPS Small Package Operations pick up and deliver 18 million packages everyday. Our goals of using electronic communications for hazardous materials are part of larger framework to increase our efficiency and use electronic processes where possible.

So as we approach the hazardous

materials program, we've built on technology that we had already deployed for the UPS airline, and we have been able to improve, this is one of our goals, the resilience of links between our scanning functions and the hazardous materials data.

It also has demonstrated that we can use electronic information for inspections and emergency response, and the feedback we have received has been positive.

I'm going to quickly go through some process diagrams, and I'll start with -- well, spend a little time on this one and then go more quickly. But our process depends on electronic information and paper both.

If you imagine that the customer depicted in the upper left corner is a hazardous material shipper, that customer uses a shipping system to create documents that UPS will use at pickup and delivery for the hazardous materials shipment.

At the same time, that shipping system

makes an upload of an electronic record for the hazardous material linked to the tracking number for the package. The driver makes the normal pickup using hazardous materials paper work in the cab of the vehicle, brings it back to what we call our origin center, the first building, and there we have personnel who we refer to as acceptance auditors who perform a check of the package.

In doing that, they're using both paper methods and also electronic methods and you'll see on the screen here that we divide the processes with that handy dotted line. But the HMMS is our tool. We call it the Hazardous Materials Management System. That is our tool for managing the electronic information associated with the hazardous materials shipment.

We follow normal document retention processes and then advance the package. In the airline, we have a loader who scans the package into an air container and many years ago we had a requirement created to be able to identify hazardous materials on an aircraft remotely. That process is really the backbone of what we're doing here.

The loader scans the package into a container, creates a container summary and builds a no TOC (phonetic) for the aircraft operations. So each flight has a record which is delivered to the captain, that shows the identity and presence of the hazardous materials.

So we mimicked that. That process goes through to completion. As I said, I was going to rush this for interest of time. We mimic that on the ground side for our loading of what we call our feeders. You would think of them as our tractor-trailer operations.

There again, the loader scans the package into the trailer that links the hazardous material record to the trailer. We have a manifest capability for the trailer. But we do not provide paper.

At the moment when we -- at this moment when we dispatch that trailer, it can go either let's say to a rail yard for a topsy move or it can go over the road, and in either case an electronic record is used for that process.

So just to be clear on where in our business model this kind of record is active, these are the feeders connecting our buildings, the tractor-trailers that we use for taking the volume that we pick up during the day and putting them into sorting facilities. Those tractor-trailers are ones which are relying on electronic records.

So if you look on the screen, the package car that makes the pickup uses shipping papers. The package cars that make the delivery use shipping papers. At this time, we have not done the engineering to make the electronic process for pickup and delivery, although there's lots of talk about how we might.

In the cab of the vehicle, the driver carries to recognizable card, which is used to supply the information to an inspector or an emergency responder. You can see that the telephone number for the inquiry is very prominent on the card.

Now we've heard the comments from Volpe that perhaps there's a need for an identifier outside the vehicle. We're not too sure that's practical. In the motor carrier business there's an enormous amount of interchange of rental and other equipment, so that idea of the placarding may not be practical in the long run.

Drivers also of course carry the special permit that authorizes the use of electronic information and they will have the emergency response guide book as well. I want to spend a little bit of time talking about the way the information has been used.

Then I'm going to show you some examples of the documents and then I want to talk about some limitations, because it's not -- there are some caveats. It's not used in every application in our motor carrier operations.

So we have stars on the map that show

the states where calls have been originated in the 21 months that we've been operating with this special permit. There's a pie chart on the left side of the screen that shows you the methods that we have used to deliver information on request.

So 55 percent of the time, the information has been delivered verbally, and 32 percent of the time the information has been delivered by email, 19 percent of the time by fax. We have a performance requirement. The information has to be delivered within five minutes of the call being initiated and we track that very closely.

DOT has put on us an obligation to create a corrective action plan should we ever go outside that five minute window, and twice in the life of the permit we have had moments where we've gone beyond the five minutes and corrected accordingly.

If you look here, this is a hard graph to read in the room, but the bar charts will give you a sense of perspective. The bars are calls that are either inquiries during on road inspections or emergencies. The green -- I'm color blind, I understand that it's green. The green is said to be the inspections and the red, again I understand it's red, are the emergencies.

So the very tallest bar in September of 2014 was 22 calls. In that same month, we had two emergency calls. The large -- this chart, this bar here, August of 2015 for those of you in the back of the room to give you a sense of dimension, that's 12 calls for inspections and seven calls for emergencies.

The continuous line across the top of this chart is measured against the scale on the right side of the graph, and that's the time, average time each month to answer calls, and as you'll see we average well below our five minute performance requirement.

I can take this apart more if people in the room are interested in particular months and results. But I think what you see here is we had a period of testing, where I think perhaps inspectors were a little uncomfortable with the idea. They did test and I think the results have been satisfactory to them. At least that's the feedback I've been getting through CVSA.

This is a sample manifest for a hazardous materials load in a trailer. Again, you probably have difficulty reading it, certainly in the back of the room. But if you look in the lower portion, read horizontally across from left to right are the elements of a required shipping description, ending on the right with the emergency response telephone number and the information provider.

This is a sample of a manifest for a trailer that contains no hazardous materials, so we can provide either one depending on what the circumstances are. Then I want to end with a couple of comments about tractor-trailer operations, where our reliance will not be on electronic shipping papers.

So first of all we have large-scale

customers from whom we pick up volume in trailers or to whom we deliver volume in trailers, and those tractor-trailer pickup and delivery operations are not covered by a special permit. It's a simple reason. Our process has not yet accepted those records into our system, and we have not validated those records so we don't rely on them.

We also move trailers to Canada, and because this is a U.S. DOT permit, not a Canadian permit, we are going to issue papers to those drivers who move those trailers. Then finally we have air trailers that move loaded aircraft containers from our buildings to the airport and back, and for those legs, again it's an engineering question. We haven't completed the engineering to do that, so we rely on our container manifests for those moves.

So looking at this in terms of our goals, we definitely feel that the results are favorable. We're moving in a direction that we think is productive. We see that we have simplified our hub processes.

We have allowed ourselves improvements in our loading processes. In fact, we feel now we have a whole lot higher confidence in what is on a trailer being reported correctly than when we were relying on people to move paper.

In addition to those benefits, I want to make a point which is something that we as a sustainable organization have to point out, and that is that if you think of the paper that is associated with each hazardous material and think of the scale of commerce in the United States, reducing the paper for those shipments is not significant.

Let's just say hypothetically you look at 10,000 hazardous material shipments in a day. Multiply that across the year. That's an enormous amount of paper that has to be made, produced, printed and then thrown away.

So we believe that there are many multiple reasons, those on the screen and others, to link electronic records with hazardous materials transportation, and we certainly are appreciative to PHMSA for responding in this many years of development that we've engaged in, to open this special permit up.

We're very appreciative of the emergency responders and the roadside inspectors who are meeting our tractor-trailer drivers and using this telephone information in place of shipping papers. I, like Mark, am happy to take questions if there are any. Cynthia Hilton.

MR. BOYLE: You can ask questions. We have about five minutes. You can ask questions of Sam or Mark at this point.

MS. HILTON: Hi, Cynthia Hilton with IME. Thank you very much Sam. So I kind of have two questions. The first one is I understood that you mimicked this system based on your air operations. So I don't know exactly why your trailers that go from your hub to your airports, you know, why that , because it's not allowed by the special permit one, and two, we have number two out.

So you can't take your trailers into Canada. This is kind of also a two-part question. Is that because -- is Canada interested? You know, we have this RCC process where we're supposed to be eliminating barriers.

Is this something that could be advanced in that forum, and then just generally worldwide, is there any other place in the world that is exploring this kind of thing, or is the rest of the world all on paper?

MR. KERCHNER: So question one about our air trailers. Certainly, the information links to the trailers. But we had focused our engineering dollars elsewhere and haven't engineered the combination.

MS. HILTON: Because you said those were electronic --

MR. KERCHNER: Our process links all the records to the containers, and it's simply an engineering question. The engineering budget is not infinite. The second question, we do take our trailers into Canada but not with electronic information.

We have not had dialogue with the Canadian authorities about electronic records. So I don't know what their openness is to that. Your third question was about the other places that may be looking at electronic records. We are aware of some efforts in Europe.

They use the term "telematics" and it seems, from what we have learned about that, that there's an interest in augmenting communications with electronic capability, not replacing. At least that's our reading of it at the moment. I could be inaccurate in saying that.

MS. HILTON: Okay, but the rest of the world they have paper, right, where you operate?

MR. KERCHNER: At the moment.

MS. HILTON: Yes.

MR. KERCHNER: At the moment, we have the greatest concentration of hazardous materials businesses in the United States for us. Other people will have a different experience. Bob.

MR. ELKIND: Yes Sam. Our system is

a little different, in that it's in the hands of the emergency responder, and they can just use it any time. Yours is a little different, where they have to go get, you know, talk to the driver it seems like. So security wasn't a big deal it sounds like in what you set up.

MR. KERCHNER: That's a good point. Well let me -- that gives me an opportunity to say a couple of things, Bob. First of all it's, you know, working with your industry that helped us to move this technology into the ground operations, so thank you for that.

The second thing is that we don't view this as the end state for our electronic process. We view this as a transitional process. The end state we anticipate will have drivers equipped with the information about hazardous materials. I neglected to say that the driver's device in the cab, which is used for dispatch and for a number of other processes, does identify the presence of hazardous materials by trailer.

Then your question about the security

aspect we, because it's somewhat enclosed, don't view this as a security risk. But we do think a future time where maybe, and I don't know where this would go, devices of some standard read remotely, we do think security will be an issue there and I'm sure that our successors will want to work that very carefully. No other questions? Thanks.

(Applause.)

MR. BOYLE: My apologies. Instead of a 15 minute break we'll take kind of a five minute stretching, shuffling speakers and everything presentation, get the next one ready to go in about five minutes. Thank you.

(Whereupon, the above-entitled matter went off the record at 11:01 a.m. and resumed at 11:06 a.m.)

MR. BOYLE: Sorry to be such a task master, but I need you to take your seats again please. I hope you enjoyed that long break that I gave you of three minutes.

PARTICIPANT: Twenty four hours.

MR. BOYLE: What did you do with all that free time? Since we're a little short of time, what we're going to look for in this -- in the next two sessions at least, until lunch gets us hopefully back on schedule, we're going to hold the questions until all three presenters are done.

Then I'll have them either just stand up in the front with a -- we'll have a hand held mic and they can either stand up front or they can sit down and we'll use a table mic. But what we're going to do is hold the questions until all the presentations are done, and then we'll not only open up the phone, but we'll also open up the microphone for anybody that wants to speak.

So I apologize if you have a question and you have to hold it for two more presentations. The next session we'll have is on lithium batteries, and we've done some long-term research with Carderock or large format batteries. So if my notes are correct, we'll get a little bit of summary on that, but we'll also get the direction that we're headed in next.

Then we're also looking at thermal runaway on lithium batteries. So we've got some work going on with the Naval Research Lab. So we're going to get a briefing on that, and then although it's a little bit in the emerging trends, we asked industry rep George Kerchner to come in and give us his thoughts on not only lithium batteries but batteries as a whole, and some of the emerging risks or emerging trends or some directions that we should go in.

So those will be our next three presentations, and I'll turn it over to Daphne from Carderock right now.

DR. FUENTEVILLA: Hello everyone. Good afternoon. My name is Dr. Daphne Fuentevilla, and I work for the U.S. Navy, actually for the Naval Surface Warfare Center Carderock Division, which is just a few minutes outside of Washington, D.C., and I work in lithium battery safety, and that is what my presentation today is on.

I'd like to start out by having everyone either take out your cell phones or just think about where they are in your bags for a second here while we watch this video. This is a test. I actually ran this for you -- ran this for you yesterday. You can actually see it start to go on the left here.

You're looking at a commercial cell phone that is strapped down to a heater plate. We are abusing this battery with high temperature, this cell phone with high temperature, and we're going to watch and see what happens.

[VIDEO PLAYING.]

DR. FUENTEVILLA: I ran this for you because I wanted something that was pretty relatable, that you could all see exactly what was in your pockets. On the right, you're looking at the thermal image of the same abuse.

This is an old cell phone. It belonged to a colleague of mine. It was -- he'd already fixed it, recharged it up and he sacrificed it for a good cause. This particular one did not catch fire, but those -- that smoke is flammable. So if I had have put a sparker right next to it, it would have caught fire.

So it smokes a little bit more. On the right, you can see that the temperatures were in excess of -- the white is 260 degrees, 260 degrees. So you can see that we are well above that. We are actually -- we had thermocouples on it. We were well in excess of 380 degrees Celsius.

So the thermal runaway occurred with the battery. This is a single cell in a cell phone. The battery vented and it released this flammable solvent. So the Navy -- so that's -- you can think about how many cell phones are probably out there, and how many cell phones are probably in transport.

The Navy deals with this problem too. We sometimes deal with this problem on more energy vent systems, because we're really looking to, for our particular systems, to have really energy dense power sources, and we deal with this problem with -- I've got another video from one of our battery tests.

This is from a few years ago. Can you guys run the video there? This is actually at test that we ran at one of our facilities, where we're trying to simulate what this would look like inside of a ship. This battery in particular is going to be carried on board some of our ships. We need to be concerned about the storage of those batteries on the ship and then what happens if there's an actual event.

How's it going? Two minutes ago this worked perfectly. All right. I think we're going to try to skip past it and see if we can come back to it. It's not clicking forward.

(Off mic comments.)

DR. FUENTEVILLA: So really what I want to convey here is that -- is that these are -- these batteries are significant problems for us. They're certainly problems for the Navy and they're certainly problems for commercial industry as well.

The Navy deals with these problems through a -- we've been dealing with them for decades since the 70's, through the Navy's Lithium Battery Safety Program. Carderock is one of the technical agents for the Navy's Lithium Battery Safety Program. We are tasked with evaluating the safety of every single battery, lithium battery that's used by the Navy or the Marine Corps.

My group has been doing this since that program's inception. So we have to evaluate the safety of each battery in its use scenario. Now that's not something that that's a luxury that I had within DoD. That's not something that is quite as economically or politically feasible from a transportation scenario.

However, there are lessons to be learned from that same -- oh, here we go. Can we advance the slides a couple?

(Off mic comment.)

DR. FUENTEVILLA: Okay, all right. So

there's certainly lessons, same lessons to be learned from DoD that can be transferred to the Department of Transportation. So what I would -- was going to do -- oh, here we go. We can just skip past that to the next slide. Fantastic.

So what I was going to explain was that batteries are stored chemical energy, which I hope that everybody's aware of. If you think about how many -- you know, really think about how many of these things are out there, they enable our use of technology.

When they're used appropriately and designed well, the controlled release of this energy provides us with electrical power in the form of current and voltage.

When you are -- when they're not -- when they're abused, when they're not designed well, then you can have the uncontrollable release of this energy, which can result in venting, fire, a release of toxic materials, shrapnel.

You have high pressure events,

deflagration which if we ever get to show the video, I'll be able to show you a nice shot of. But those are the types of hazards that we're talking about.

I already mentioned a little bit about the Navy's Lithium Battery Safety Program, but we've been using these batteries because they provide a substantial increase in both the gravimetric and the volumetric energy density over other commercial battery types.

The Navy had had personal injuries as a result of this use, and that was the reason why the DoD had initiated the start of the Navy's lithium battery safety program. Again, I had already mentioned that Carderock is the technical agent for this program, so I'll move right ahead.

So DOT/PHMSA's mission is to protect people in the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. And these batteries, while they're incredibly useful, that uncontrolled release in the cases when they are abused or if they're not designed properly, poses a problem for this mission.

These are just some pictures from recent events that have happened. I'm sure everybody is familiar with hoverboards, cell phone. This is actually from this past weekend, you know. If you think about what's held by the person, by the person sitting next to you on the plane, the electric vehicle fires and 787 incidents. Carderock had been involved with NTSB and the investigation into the 787 battery.

So in terms of the collaboration between Department of Defense and Department of Transportation in this -- in trying to deal with these types of hazards, there are areas in which our missions overlap. We have to identify the hazard, we have to deal with hazard prevention and we have to deal with hazard mitigation.

When we talk about hazard mitigation, that hazard identification, what that means is classifying the batteries and then certifying that they're safe. When we talk about hazard prevention, we're talking about characterizing battery failure mechanisms.

And then when we talk about hazard mitigation, what we're talking about his how you detect failure before you have -- before it's too late, and then how you contain it if you can't stop it. So we have four, which I'm going to touch on briefly, four different efforts going on within the -- that cover all of these topics.

My colleague, Dr. Corey Love from NRL, we're working with him on several of these. He's going to follow up on my presentation with some more detail about a couple of them. I'm going to start out with just a real quick introduction to each one of these, and then we'll move on to Corey's presentation.

So first, hazard identification and classification. We are looking at shock testing criteria for large lithium batteries. The idea here is that the design type tests as specified in the U.N. Manual of Testing Criteria, require large format batteries to be subjected to half sine shock, a peak acceleration of 50 g and a pulse duration of 11 milliseconds.

So large format batteries, some of which can be quite heavy, see a large force -- a larger force for the same acceleration as with smaller batteries.

So we conducted a study where we were looking at dynamic loads that were experienced by these large format batteries during transportation, and evaluating whether the current shock testing was representative of what it would see in a transportation environment.

We were also identifying when the criteria for conducting shock testing on large format batteries became unrealistic in terms of the transportation environment. So this is just a quick summary of what our results were. We have a report which we can -- so if anybody has any questions about this, we can talk more about it during the question and answer session.

But our testing indicated that the fixed acceleration and pulse duration parameters could induce responses in some of these test items that were not representative of abuse conditions that were seen specifically during transportation.

We correlated drop heights with the 50 g 11 millisecond half sine input accelerations by weight, and we also looked at other different heights and what those acceleration and input accelerations would look like for different heights, as well as for different impact surfaces.

So we have three projects that I want to talk about next, which are the upcoming projects which we have just started on. These are quantity, weight limitations for air transport.

The issue is that current air transport regulations limit lithium ion battery quantities to 35 kilograms per package for a cargo aircraft, and the severity of the hazards are posed by these lithium ion batteries may not correlate directly with weight.

So the objectives of this study are to provide a hazard which encompasses electrical, thermal, environmental hazards, thresholds that are posed by these existing limits, evaluate the hazard variability by cell size and by state of charge on the weight basis, and then identify other criteria that are associated with these types of hazards.

The third effort that we're talking about, this is more in line with hazard prevention. We're looking at lithium battery failure mechanisms in order to understand better exactly what it is that's occurring, so that we can have some better ability to either provide standards for how to design batteries, or to certify batteries properly.

So the transportation industry remains vulnerable to these occurrences of low probability high impact delayed cell defects that can trigger internal shorts at some point in a battery's life cycle, and understanding delayed cell failure mechanisms will inform future protections against battery failure.

So the objectives of that study are to examine onset of lithium plating, the condition of a solid electrolyte interface which helps keep batteries safe, and copper dissolution thresholds on lithium ion batteries.

It also is intended to provide a mechanism for -- on mechanism-specific indicators that are relevant to the sequence of events and root cause failure for lithium battery-related transportation issues. Then finally, I'd like to talk about hazard mitigation containment and basically looking at diagnostic technologies for battery failures.

This is a big one. The energy density of bulk packages of lithium batteries presents challenges for containment of failure events. These detection technologies will be able to hopefully detect failures earlier, which can inform choices about mitigation technologies and activate mitigation earlier in order to improve their effectiveness.

The objectives of that study are to assess the effectiveness of emerging technologies for detecting internal short conditions in cells prior to thermal runaway events, and evaluate which ones are practical for the transportation industry.

There are several of these types of approaches that are currently coming into the prototype stage, and it's worth taking a look and seeing what's available for transportation.

So, pretty quick presentation, especially without the video. I'd like to summarize by just giving my contact information here. Our research team at Carderock includes myself, Dr. Azzan Mansour, Jonathan Ko, Chris Hendricks. I actually left two people off there. We've got Mr. Paul Jalics and Mr. Thom Zhang here in the room with us. And we have collaborators. Dr. Corey Love is going to be talking next from the Naval Research Laboratory.

We are also working and will be leveraging some of this work. As I said, these are of interest to DoD as well, leveraging work that's going on with the Expeditionary Energy Office at the U.S. Marine Corps, with our colleagues at the Naval Surface Warfare Center in Indian Head, and some of our industry collaborators. Thank you very much.

(Applause.)

DR. LOVE: All right, thank you. I have the privilege of going after Daphne. She's sort of set the stage for you and attempted to show some videos, but I have a DoD laptop so maybe during the break we can show those videos for anyone that's interested.

So, PHMSA's mission -- or let me first start by saying, you know, my name is Corey Love. I'm a materials research engineer in the chemistry division at the Naval Research Laboratory, and we're located in Southwest D.C. along the banks of the Potomac River. So, close by.

So, following along, you know, Daphne's presentation, PHMSA's mission is safe transportation of hazardous materials, right? So what are sort of the objectives they use to roll out that mission? Well, it's establishing policy, setting and enforcing standards, reducing the consequences if incidents occur, and conducting research to prevent incidents, right?

So, what Daphne has just sort of mentioned to you is, sort of from a large format standpoint, what are some of those metrics, okay, for shipping? What are some of those enforcements, the standards that DoD needs to set, okay?

And where I reside is a little bit more on a basic research side of things. We're sort of -- you see there's a little bit of overlap between NRL and Carderock, and that's because there's a lot of information-sharing between our two organizations.

So, NRL, I would consider it more of an incubator, more of a technology incubator where we're focusing more on the fundamental chemistry and materials processes. What's happening inside of that can? What's happening inside of the battery? And then based upon what we learned, we sort of get it to sort of a fundamental, more general standpoint, where we can hand it off to Carderock and they can actually do something very useful with that information, okay?

So I'm going to talk about today lithium battery research safety programs and what they should encompass. So, a comprehensive strategy for lithium ion battery safety would include prevention, mitigation and containment, okay?

They all sound about the same, so I'll give you my definition. So, prevention is that early on, real basic chemistry materials processes, what's happening inside the can, okay? Mitigation is more screening tools and diagnostics, and what can we look for? What are the signatures of an impending failure? What are sort of small devices that we can employ to identify those hazards before they become a thermal runaway situation?

Lastly is containment. And so that's more of an engineering approach, saying, okay, if we incur one failure how can we contain that failure to one individual package so it doesn't propagate throughout the shipment? So those are the three areas that I'm really going to focus on.

Okay. So, from the military perspective, you know, lithium ion batteries are the ubiquitous power source for rechargeable electronics. We talk about man-wearable, portable electronics, small vehicles, robots, unmanned systems and even larger propulsion systems. So, that big yellow thing you see there, that's LDUUV. That's large diameter unmanned underwater vehicle. Essentially it's a submarine packed with an energy section, okay, for very long endurance missions.

Well, on the civilian side of things you have this pretty much the same thing. You've got portable electronics, e-cigarettes and hoverboards, and now getting more traction into electric vehicles and propulsion systems. So, really large format batteries on the roadways.

So, why do lithium batteries present such a serious threat? Well, you saw from Daphne's cell phone video there's a lot of heat and smoke and fire, in some instances, released with a battery failure. One of the key things to keep in mind is there are often no outward signs of an impending failure.

So, from the outside, a battery pack may look good, okay? So where I reside is sort of inside the can. I want to try and find out what's happening inside, when they are no outward signs of an impending failure. And then oftentimes only one cell failure is needed to propagate through a shipment, okay? So all it takes is one cell to go into thermal runaway to produce enough heat to cause the neighboring cell to then go into thermal runaway, and you propagate down the line. So one cell can create an enormous, enormous failure, okay?

So, as I mentioned, I reside inside of the can. The chemistry and the materials processes. This is just a cutaway of 18650, a cylindrical lithium ion battery cell. I like to put a schematic there, or put the icon for the fire triangle, because you have all those components inside of the can already, okay? And if you were to go through the individual components, the positive electrode, negative electrode, there are oxidizing agents, there are components which will release oxygen at high temperatures. You have flammable organic solvents that are present inside of the can, okay?

So, what is the heat source? Well, the heat can come from a variety of different places. Internal short circuit, external short circuit. An external short would be, you could imagine, you know, a screwdriver bridging the terminals between a battery.

Overcharging or rapid charging. That's often the result of faulty electronics or tampering with electronics. This is big for the RC community. There are, you know, radio control guys that are doing things in their garage and sort of overriding the fail-safes that are in place to get more energy into their batteries.

External heating. So, that would be Daphne's example that she showed with the cell phone previously.

Internal shorts are a little bit different. So, there's a recent report that said that battery failures, about 68 percent of battery failures are a result of internal shorting, okay? When we talk about internal shorts, it's usually the result of the lithium dendrite. So, lithium dendrite, it's a metallic lithium component that's formed in the battery. It bridges the gap between the anode and the cathode, the negative and the positive electrodes inside of the battery.

It causes an enormous amount of heat generated. So you've got a large rush of current through a very, very small surface area, and it creates an enormous amount of heat. So that's a really significant heat source, okay?

And just to show you, the picture on the top left there is one morphology of lithium dendrite. So it's metallic lithium. The bottom image there is an example of a counterfeit cell, and those can happen, as well. So, in this case, an inferior battery has been stuffed inside a superior can, okay, and mislabeled.

And on the right-hand side, those images that are gold, those are taken from the NTSB's report on 787. And NRL provided some level of support into identifying the dendrites and sort of the parameters necessary to form a specific morphology of lithium dendrite.

Okay. So I'll just point out quickly two documents that have sort of the foresight to identify lithium batteries as a potential hazard. And I don't know if anyone, walking into the screening this morning through security, if you were asked if you were carrying spare lithium batteries.

I was. I thought it was a joke. I thought Veda was going to jump out from behind the bushes and say, "Got ya," you know. But it's the threat is here, okay, and that's been outlined in this R&D strategic plan from 2012 to '17. It says there's an immediate hazard associated with lithium ion and lithium metal batteries.

In another document, Strategic Plan 2013 to 2016, calls out lithium batteries and suggests to foster robust research and development and innovation for risk management, okay?

And so going back to my previous statement, well, when you put together this comprehensive safety program, you have to take into account prevention. So, at the early stages, try and prevent everything from happening. If that doesn't work, mitigation for identifying the sources of instability, and then containment if a failure does occur.

So, failures in the laboratory are

very easily to induce, okay? We can strap a cartridge heater to a battery and elevate the temperature and get a thermal runaway event to occur. Mimicking the real world failures, or the failures that we see in the field, are very difficult to do.

And so I identify sort of a research need, is that, you know, we want to prevent future incidents through approved testing and validation methods which more closely replicate failures that we see in the field. And so that creates a technology gap.

Well, we really don't have the method now to trigger those sort of real world failures, and what I'm proposing here is things we could do to the chemistry, some funny things that we can do to initiate those failures in a much more reproducible manner. And this eliminates a lot of the testing time that's necessary, and also gives us a sense of more of the realistic, as I mentioned, field failures that we see in the field.

And I'm not just speaking alone here. This technology gap is also identified in the U.N. Manual 38-8 which DOT relies on pretty heavily for testing and evaluation.

So, I have a short little video. It's not as exciting as Daphne's. So if we can get that rolling, please.

And again, this was working earlier. So what we're looking at, in a static mode here, is a commercial graphite anode. So this is the negative electrode in a commercial battery. What we have is an in situ optical cell. It's basically a battery that we can look at under the microscope, so we have a window inside to get a sense of what's happening inside of the can.

And if it were playing, what you would see is lithiation of the graphite. So it replicates a recharged cycle in your cell phone battery. And as that happens, there's a color change associated with that as lithium ions go into the negative electrode.

You get to a certain point. The anode

can't accommodate any more lithium ions, and those lithium ions now become lithium dendrites. So, metallic structures start to form on the edges of this electrode. And those are the things we really want to understand, where they're forming, when they're forming, what are the conditions present to form and to grow these catastrophic lithium dendrites? Because, ultimately, it's the dendrites that cause the internal short circuit.

So, again, if anyone's interested in that video, we can get that rolling during the break as well. I will say this is great, very fundamental stuff, but we're actually implementing what we're learning from this experimental cell to drive standards for the Navy and Marine Corps as far as low temperature operation and what are the hard and fast conditions that we need to stay within when we're recharging in the field environment.

That was prevention. So, mitigation, more along the lines of screening tools and diagnostics to identify a potentially hazardous cell before a thermal runaway event. So, the research need is to prevent future incidents through earning warning, screening, fault detection methods.

We have a way of doing that. We rely on electrochemical impedance spectroscopy. You could think of it as just doing some resistance measurements, and we focus in on a very specific area where we know it's tied to the state of health of batteries. We sort of continually probe that area and get information back.

And what we can do with that is we could develop these state-of-health maps. So that information that we're receiving now, we can see where we are on this map. Okay, are we still in the healthy regime? Have we deviated outside of the health regime? Are we possibly damaged or is there an internal fault?

And then as we go further off the map, we know we're in an unsafe condition. The chemistry has changed irreversibly, so much that we have a potential hazard on our hands. So we have been working at NRL developing this technology for several years now. And it's at a great place where now we can sort of roll it out to a variety of chemistries, and really put this methodology to its paces.

Okay. So, lastly, we talked about prevention, mitigation, and last is containment. As I previously said, it's more of an engineering approach. So, the engineering solution right now is to go in with the understanding that you'll have one cell failure. How can you contain that failure without it propagating throughout the cargo shipment?

So, that's the research need. The technology gap is really packaging materials that can give you that non-propagating effect, okay? You need things like fire prevention, you need things like phase change materials that will remove a lot of heat away from the situation, okay? When you draw out that thermal signature, you can greatly reduce the effect of a thermal runaway situation.

And so the research opportunity here would be, well, can you contain, you know, all those things, all of those nice properties in one packaging material?

And there's a strategy. On the left-hand side here you see it's a polymer coating that's been developed at NRL, and it's actually for ballistics. It's a very thin polymer, and so it's known for its impact resistance. So, you probably don't need this level of impact resistance for, you know, a pallet of lithium ion batteries.

But what you could do is you can tune the chemistry of that polymer and you can tune it to the desired impact or the specific threat that you may have. So it may be more of an automotive impact or sort of a rail car impact. You can tune the chemistry specific to the frequency of that sort of impact event.

And as I mentioned, internal to a multi-layered laminate, you'd have something with fire prevention capabilities, really high temperature materials. And there's a commercial aerogel, it's the first application of aerogel materials for insulation, that is used in DoD right now for similar applications.

And so that was kind of quick, but I'll thank you for the opportunity to present, and I think we're going to move ahead and I'll be happy to take questions during the break.

(Applause.)

MR. BOYLE: Our next speaker and then we'll take questions at the end is George Kerchner. He's from the PRBA. I always invert the letters. I must be partially dyslexic. So I'll just introduce George and we'll just keep moving, and then we'll take questions for all three of them at the end, and thank you two for scaring me. Every time my phone buzzes now my heart starts shaking. Thank you George for coming.

MR. KERCHNER: So everybody knows I'm sick, right? But thank you for -- thanks for

PHMSA for letting me come here. What I'm going to present here is just where things stand right now for the industry as far as packaging performance standards, lithium battery performance standards mostly at the international level through IKO and SAE.

I think it's a good segue into what Corey and Daphne just talked about, because I think there's an opportunity here for the Navy, NRL and for PHMSA and the industry to work together on some of these issues, which I'll explain in more detail as we go through here.

For those of you who don't know who PRBA is, we're based here in Washington, D.C. We've been here since 1991. We are an association of battery and cell manufacturers. But in addition, our members include product manufacturers, medical device manufacturers, airlines, packaging consultants, packaging manufacturers in testing labs.

So it's a very diverse association and I always say this when I give a presentation.

But when you think of PRBA, again just don't think about batteries. We have a very diverse membership and that really is a huge benefit to me to reach out to our members, who have a lot of expertise in a lot of different areas.

And particularly this particular issue when it comes to safety, packaging, you know. We have a lot of great expertise from those different companies that I can tap into that have a variety of interests in this issue, and we can benefit from that as an association.

We obviously are very -- we are very active on the international and state level on regulatory policy and legislative issues. We are members or observers at the U.N. Subcommittee as well as the IKO Dangerous Goods Panel, and occasionally participate in the IMO meetings on Dangerous Goods.

So IKO, as most of you know, has been very busy on lithium battery issues. They have recently adopted very stringent regulations for shipping lithium ion batteries on aircraft.

Starting April 1st, you'll be prohibited from shipping lithium ion batteries on passenger aircraft.

In addition, your lithium battery cannot exceed 30 percent stated charge starting April 1st. So those are two big changes coming into effect April 1st. The other thing that's going to happen is that IKO has partnered with the SAE, Society of Aerospace Engineers, to develop a lithium battery performance-based standard.

They describe it as a packaging standard. I don't view it that way. I view it as a general performance-based standard, and I'll explain why that is. As I noted, IKO has been very busy on tightening the regulation for lithium batteries. This particular performance-based standard is just one of those issues they've been working on that will proceed to 2016-2017.

And again, the standard rule generally focuses on packaging. I do it as a performance-based standard with a packaging component associated with it, okay. So that's a very important point there. The SAE and IKO had a meeting the week of March 7th in Montreal where they met for a week, talked about lithium batteries and packaging.

It's hard to imagine to do that, but that's how long they worked on this. So this is a brand new standard that SAE is developing, that will eventually be incorporated into the IKO technical instructions. I'm assuming it will eventually be adopted into 49 C.F.R.

So the intent here, the broad goal here really as far as this particular standard goes is to limit the thermal event within the battery and/or the packaging.

That is, if you have a thermal event, one cell goes in thermal runaway and maybe it propagates to the next cells, the idea here is with this particular standard is to limit that within the packaging, and I know Daphne referred to this a little bit in her presentation.

Some of the criteria, very broad criteria that they're talking about with developing this standard are listed there. Limitations on external surface temperatures. No hazard fragments can leave the package. The package must maintain structural integrity. Limits on flammable vapors and the pressure pulse coming off the package.

Very, very broad criteria that again, that meeting they held in Montreal the week of March 7th, they were fine-tuning the standard. This is going to have a very significant impact on the industry once it is developed and once it goes into effect.

So leading up to this standard, over the last couple of years there's been a lot of information in the press, a lot of information from companies releasing press releases about their secrets to meeting this potential standard. The standard has been talked about for quite sometime, but there are companies that have come out with various solutions for meeting the standard.

The Omega Box, for example, is a company that we recently ran into, that has this very large metal box that would theoretically meet the standard that SAE is developing. Pyrophobic (phonetic) is another company.

The one on the bottom left has this box that has some -- has some interesting properties to it that apparently can withstand a thermal event involving a battery.

FedEx has their gel pack, a gel pack where you would put this inside your packaging. In the event there was a thermal event involving one of the cells or batteries, the gel pack would open up, cool the cells and prevent further propagation to the next package.

So again, the packaging ideas do abound. There's a lot of interest in the packaging community in developing, you know, the packaging that could meet the standard. It's a very -- it's a very fluid process right now.

We don't know exactly what the

standard will require, but it's -- the good news here at least is there's a lot of alternatives out there to meet this standard, and that's a good thing for the industry.

Americase has done a lot of work in this area. I know many of you are familiar with Americase's packaging. They also have a special permit from DOT that authorizes the use of their packaging for shipping damaged defective batteries by air.

So I would have to say they're probably head and shoulders above the rest of the packaging manufacturers and designers out there with regard to the type of packaging they have available to potentially meet this standard.

They are a member of our association. We're happy to have them on board, and have worked with them on these issues for the last six or seven months or so.

So again, I think again reaching out to our members to participate in developing this type of packaging and developing this standard is really where I think it's going to be key, and again Americase is going to I'm sure play a big role in that.

I throw this out there because everybody talks about hoverboards, you know. The good news is if you've got a hoverboard -- does anybody have a hoverboard in their house? Come on, admit it. No? Nobody, come on. You know, I go to make these presentations. I say who's got a hoverboard and nobody raises their hand. I swear.

But the good news is if you've got a hoverboard, there is a Hovercover fire resistant hoverboard bag you can buy from Amazon, and if you're a Prime, Amazon Prime member, you get next day air. So I throw that -- there's always -- I always try to throw a little bit of humor in lithium batteries, and that one usually gets a good laugh.

But I find that just amazing, that if you're a parent and you're buying Little Jimmy a hoverboard, you also are going to buy a

Hovercover fireboard or a bag. But anyway.

So for the industry, the next steps for us at least, and this is really important. SAE, IKO they had this meeting in Montreal the week of March 7th and there were probably 20 or 25 people in that room, and they should have had 50.

There were a lot of people that were shut out of that meeting because they wanted to keep it at a relatively small writing group. But unfortunately they left a lot of people out of that meeting that I felt could have contributed a lot to that writing that standard.

So this meeting in Montreal a couple of weeks ago, they did apparently draft a standard. We haven't seen it. It's a draft. I expect it will be circulated some time soon.

But they sent an email out yesterday or last night that they're going to have a conference call for April 11th, where they'll present the standard, talk about it, give everybody an opportunity to submit their comments in writing.

Eventually I'm assuming they're going to come up with a second draft, and then they'll have another writing meeting. Then some time maybe they'll develop the final standard by the end of this year maybe. It's on the fast track, there's no question about it.

And the standard, just to make sure everybody's aware, this is all about air transport. This is not about ground or sea. This is all about air and the concerns with lithium batteries in the cargo hold.

So again, this was IKO's idea for developing the standard, and as I said before, it's going to have a very significant impact on the industry.

So what I'm suggesting here is with PHMSA's interest in this issue, NRL and with the Naval Surface Warfare Center, I think there's a great opportunity for all of us to work together in testing out this standard. Once this standard comes out in draft form, it's going to have criteria in there for forcing, you know, to explain how to force your cell into thermal runaway, okay. How hot does that thermal, that temperature have to get to force that cell into thermal runaway? What does the packaging need to look like? What's the pass/fail criteria?

I think with our members, and again because of the diversity of our members who do manufacture billions of cells and safely ship billions of cells and batteries every year, there's an opportunity I think for us to work together to test out the standard, test some of the packaging that's in the marketplace and see what works based on what SAE and IKO is developing.

So that's my proposal or my idea, at least for the folks in this room to think about, because I think we have the resources in the sense that we can get the cells and batteries. We have the expertise and some of our members who have the packaging we could test that out.

We have labs, members -- we have about

half a dozen members who are labs who can do some testing as well, and are willing to donate their resources for that. So again, I view this as an extra opportunity for an industry-government joint effort to work on this. I think it will help SAE and IKO as they develop this standard, to find out where the holes are in the standard and maybe how to improve it.

So I have a video as well, and mine, I know mine's going to work. Let's see. Nope, it's not going to work. So it's weird. It does, like everybody else. It seems it worked. I just had it on my laptop a second ago. So there's no way to -- yeah, it's weird.

So what this is -- I'll explain what this is. There's no fire, okay. These are packages of 18650 cells at 30 percent stated charge, which is exactly how they're going to need to be packaged for air transport in about a week and a half, and they forced these cells into thermal runaway.

They put a heating cartridge in the

middle of the box. The cells were shoulder to shoulder and there's about 200 cells in the box, and what this video shows is virtually nothing. You get a little bit of smoke coming out of the package. There's no fire, there's no explosion, there's no, you know, what would be called rapid disassembly, 30 percent stated charge.

And again, I think what you're going to find, as SAE and IKO developed the standard and we go out and do test some of this packaging, at 30 percent staged charge, and again that's the limit for your cells and batteries starting April 1st, there's going to be a lot of non-events, and that's what this video is intended to show.

At 30 percent stated charge, you're not going to get that propagation. You're not going to get all the fire and everything everybody's been talking about.

So I think that's very key for everybody to understand, is while the packaging standard or the standard SAE and IKO is putting together while it's very important, those limitations on stated charge are going to have a very significant impact from a safety standpoint.

So that's all I've got for now. I know we're tight for time and such, and I'll be glad to take questions of the panel as well.

(Applause.)

MR. BOYLE: You want to turn this one on as well, and then if we have any questions, I'll just have you guys stand in front.

(Off mic comments.)

MR. BOYLE: Are there any questions? We'll for about five minutes or so. Sam.

MR. ELKIND: Yes, Sam Elkind with UPS. I have a question for Daphne. You made a comment about working on a quantity measurement other than mass for batteries for transport purposes. There's a company that accepts some packages that is interested in that, and then I have a question for Corey after that.

DR. FUENTEVILLA: All right. So what we're planning on doing with respect to that is to take a look at what hazards are encompassed with a mass limit of under and a mass limit of over, and we're specifically focused on what are you limiting when you say this mass indicator.

Mass is not directly tied to electrochemical energy or the abusive energy that's coming out of that potential hazard that you're directly concerned about.

So we're going to take a look at how those two tie together, and what other factors can be used or controlled or are reasonable in terms of a regulatory, from a regulatory perspective, for defining how to limit the hazard.

MR. ELKIND: Thank you. I appreciate that. The comments you made at the end were very interesting, because we have heard discussions about there ought to be some limits of X or Y type, and we just -- we don't know whether you're talking about battery count or package count or weight count or what. And so I think an exploration along those lines would be very interesting.

Corey, I have a question about the dendrites you were talking about. It's unfortunate. We've had experiences with lithium battery incidents, fires, and for us they're apparently new packages, packages of new products going out into distribution.

So you're talking about dendrites forming. I thought I understood it to be through a charge/discharge cycle. Do they form early in the process early enough that product that is, so to speak new, going out the door has a dendrite that poses a risk of short circuit.

DR. LOVE: Yes. So I would say under certain conditions, it's possible yes. Thermal cycling or thermal stress, especially on the low temperature side of things. I think more directly, if you're talking straight from the manufacturer, it could be a manufacturing defect or FOD or something that's inside of the can, that can then propagate itself into a dendrite, you know.

Typically, I'm focused more on the

recharging side of things and understanding what are the exact -- what's that low temperature boundary which we cannot go below for recharging purposes to recharge safely. So I would say, you know, and open it up to the floor, but it could be, you know, a manufacturing defect or FOD or something inside of the can that can get that similar internal short circuit.

DR. FUENTEVILLA: I would just like to follow that up. I agree with everything that Corey said about that. It's been a challenge for us on the DoD side to actually identify these latent cell defects and when they're going to show up.

We've seen battery failures that occurred in the field with some of our systems, where the battery's been in storage and it's got a sign-out sheet, you know, for who opens the door and it's been -- nobody's in there for two weeks and then all of the sudden there's smoke detection, which is -- that's not typical.

However, we've seen it. And trying to

understand why that's occurring and what is changing to make that occur is difficult. That's actually something that we're trying to take a look at some of these basic failure mechanisms, and look at dendrite growth, because we want to understand that better.

We want to see where this is coming from, why it's happening, whether it's a temperature change, whether it's something inside the cell and then vibration. You know, we want to understand better why that's occurring and how it's happening.

MR. ELKIND: We would imagine you're dealing with first rated batteries and cells --

DR. FUENTEVILLA: We would hope.

MR. ELKIND: --and our concerns are often focused on the possibility that we're handling --

DR. LOVE: Yeah. We have the benefit of identifying the vendor early on that we want to work with and working with them through all the R&D, and selecting the cells that meet our criteria and standards. So we have the best of the best cells and, as Daphne just mentioned, we encounter some of the same problems, even with those really top notch vendors.

MR. ELKIND: That's very interesting. Thank you.

MR. RAJ: Just a couple of comments. I think I was intrigued by what you said about making connections between what we're doing in DoD and PHMSA.

But I would also suggest that we should make connections with what is being in DOE. For example, for the last four years we have an ARPA-E project, looking at how to predict runaway events and developing sensors to detect events before a fire occurs, and so those technologies would be considered.

The second aspect of that is also risk management. I was very intrigued by the slide. We are looking at, for example, we are testing hybrid power ship off the Norwegian coast called Viking Lady, and what we look at in terms of battery safety issues on board ship is use of system-wide risk assessment method, similar to what we've been using for pipeline.

So probably PHMSA should reach out to PHMSA. But the idea was really to treat battery as a system. Just like pipeline, you have a, you know, fuel that's flowing inside the pipeline and then you have all these environmental conditions outside.

The battery could be regarded just like that, and so we can look at it as a, you know, barrier, number of barriers have to be breached simultaneously before an event occurs, those kind of things. Just a suggestion for consideration in terms of risk management approaches.

DR. FUENTEVILLA: Thank you. We're actually very interested in working more closely with ARPA-E on some of their technologies, because there are similarities between what's happening, what's being developed within DOE and what's being worked on within DoD, and we do very much take a look from a system safety perspective is how we evaluate battery safety within the Navy especially.

We're always concerned about not just what the battery does but how any residual risk impacts our platforms or our mitigation system capabilities, and looking at each barrier and what it takes to breach it, and then what's needed to contain it.

MR. BOYLE: Okay. Thank you all. Thank you George.

(Applause.)

MR. BOYLE: We're going to take about two minutes so I can ask the LNG presenters to come forward.

(Whereupon, the above-entitled matter went off the record at 11:58 a.m. and resumed at 12:00 p.m.)

MR. BOYLE: I know we're taking some of your lunch, so I won't take all of your lunch, and I'll begin the LNG session by introducing Dawn Johnson from Volpe, who's been doing some of our work on small scale LNG work, as well as a literature review on some of the testing that's been done.

Then we'll turn it over to our partners at FRA and our Engineering Group at PHMSA, and then we'll close out with our R&D, my colleague Veda, and he'll tell us a little bit about where we're headed forward.

Hopefully this session, we're going to keep it at about 45 minutes and we'll probably have a little bit shorter lunch. So I apologize for that. But without taking up any more time, I'll introduce Dawn. Thank you.

MS. JOHNSON: Good afternoon everyone. I'm going to be talking about two research efforts that Volpe is doing in conjunction with PHMSA on LNG work.

LNG stands for Liquefied Natural Gas. The bulk of this presentation is going to be on new and emerging LNG facilities, and then I have a slide towards the end on some of our initial research findings on fire testing and thermal modeling associated with portable LNG containers.

Do I have to point this at any particular -- it is the arrow button, correct?

PARTICIPANT: Yeah. Try the other one.

(Pause.)

MS. JOHNSON: This is not a video.

(Laughter.)

MS. JOHNSON: Okay. Just an overview on LNG. The abundant supply of natural gas in the U.S. coupled with this lower cost when you compare it to crude oil has increased the domestic gas production in recent years. This growth has also driven the development and new LNG facilities and new uses for LNG that aren't currently regulated under 49 C.F.R. Part 192, which regulates gases that are transported via pipelines, and also 49 C.F.R. Part 193 which regulates LNG facilities specifically.

So just to get everybody kind of on the same page, some properties of LNG, and this is really -- these properties are common to all of the new emerging facility categories that I'll talk about in the later slides.

LNG is considered Class Division 2.1, which is a flammable gas. It has a high methane content and it's also considered a cryogenic liquid. LNG is basically natural gas in a liquid form, and it's in liquid form when it's at or below minus 259 degrees Fahrenheit, which is very cold. Hence, its cryogenic properties.

LNG is the cleanest burning fossil fuel and when it's regasified, LNG has 50 percent lower emissions than coal. It has negligible oxides and it can be used by most energy sectors. So it's definitely looked at in transportation as a possible via alternative to traditional coal or other types of fuel.

And when it's liquefied, LNG takes up 1/600th of the volume that natural gas does. So when you liquefy it, you shrink the volume of it exponentially. LNG is odorless, non-toxic and non-corrosive and it rapidly evaporates when it's exposed to the environment. When it's exposed to the environment, what's going to happen is it's going to change to gas, hence the evaporation properties.

Some of the main risks associated with an accidental LNG release, again this is when the liquid would turn to gas. It includes fires, explosions and exposure to the cryogenic effects of LNG. Just so that everybody is aware, LNG is forbidden to be transported by air and on passenger rail.

Non-bulk transport is permitted on roadways and waterways and UNT 75 portable tanks, and bulk packaging is permitted on vessels. Bulk packaging of LNG on rail has to be approved by the FRA's Associate Administrator of Rail Safety.

So the problem statement that we're looking at for PHMSA is PHMSA's Pipeline side identified 12 and emerging LNG facility categories that aren't currently regulated under Parts 192 or 193 of 49 C.F.R. So what we were charged to do is to do some research on these new 12 categories.

So the next two slides have the 12 categories identified in bullet form. I'm not going to read these all to you, but I'll just use some summary. So we're talking about LNG, marine, export and import terminals that aren't supplied by or connected to pipelines.

Some of the cargo transfer system components associated with marine vessels and the last valve on the storage tanks are when LNG is transferred between those pieces of equipment; various vehicles and tankers that consume LNG as fuel or transport LNG; natural gas processing plants that don't store LNG at the plant; some distributed production facilities that use LNG but don't store LNG; and also LNG facilities that store or vaporize LNG that is produced on site, as long as that facility is the sole consumer of that LNG.

The additional five of the 12 categories include LNG refueling stations for vehicles that use LNG as fuel; some LNG marine and land depots where LNG is loaded onto transport vehicles; floating LNG liquefaction and gasification facilities not supplied by pipelines; some LNG at satellite plants that is consumed by power drill equipment.

This is known as the ultimate consumer exemption, and finally LNG-based distributed power plants that are supplied by pipelines that serve only the pipeline operator, and also LNG plants where LNG is supplied by means other than pipeline.

So a lot of these are -- it's a lot of verbiage here, but basically these are 12 categories were identified by PHMSA. In our research, we did not find any additional categories, so this presentation is focused on these 12 categories.

So in our initial research findings, we found for nine of those 12 new categories some descriptive characterizing information. This information included U.S. locations where those types of facilities or operations are located; some detailed process and equipment explanations;

as well as some safety, security and risk information.

Out of those nine categories, we also found specific risk and hazard information associated with an accidental release for three of those four categories. So that particular risk and hazard information was specific to those types of categories. They weren't following the general properties of LNG. It was in addition to the properties that I described on the previous slide.

For three of the new emerging LNG facilities, we didn't find any specific information and no U.S. locations and no descriptive process information. So again, this is our initial research results here.

So some safety and security information that is common to all LNG facilities. We talk about basically four layers of protection. The first is primary, which is using appropriate materials and proper engineering design when you're building the facilities, when you are establishing these new uses for LNG.

You design these areas and opportunities such that, you know, you remove any hazards as much as you can. Secondary level is if you do have a spill or a leak of LNG, to have the appropriate means to contain it, such that it doesn't spread and it can be quickly mitigated. The third level would be Safeguard systems. These include high level alarms, backup systems and also shutoff operations, where if you were to have a piece of equipment that failed or you had a problem with it, operators would be notified of the problem and then be able to stop it at the source so the problem wouldn't get worse.

Then the fourth level is regulatory mandated separation distances from communities and public areas. So when a new LNG facility is built, it has to be certain distances from the public and from, you know, schools and other types of vulnerable businesses, and also there are required safety zones around LNG's ships.

So more specific safety and security

information that primarily deals with LNG transport ships and also LNG transport trailers and tanks. They have to be double-hulled and this is a safety preventative measure, such that if there is a leak you have another barrier of containment that can contain the LNG.

And also with ships, they're required to be inspected annually by the Coast Guard and also by the Captain of the Port within 96 hours of entry into a port. So all of the compartments have to be inspected by the Captain of the Port before it's allowed into the U.S. port.

DOT also has requirements for LNG transport by highway, and also some specific requirements for cryogenic liquids in cargo tanks. So there are some regulations that do deal with LNG that's transported in these capacities, but they don't fully cover all of these 12 new and emerging types of LNG facilities and operations.

Some risks and hazard information. These vary between public perception being that sometimes, you know, people don't really understand LNG and they've heard about previous events where LNG explosions or fires happen. Also, there has been some public perception in recent years about LNG facilities being potential terrorist targets.

You know, this is an area, you know, if it were to be exploited could be a problem for the general public. Some other emergencies associated with marine cargo transfer system components can include if the LNG's tanks pressure valve go, that could compromise the tank's structural integrity. Natural gas releases if they're near a source of ignition and oxygen could have the potential to ignite.

Extreme weather conditions, which could promulgate an accident that, you know, results in an emergency, and also when we talk about vessels that are moving LNG, there's congestion at berthing and mooring areas, where you could have, you know, a vessel that strikes another vessel, which could cause a rupture of a tank, which would then result in an emergency.

Also shallow water areas where these vessels are coming into if they were to, you know, hit some type of rock or a reef underneath, which could compromise the tank's structural integrity. Also transfer operations.

When you transfer -- when you reduce natural gas to LNG by cooling it, there's risks associated with that because you're taking, you know, a gas and you're cooling it very rapidly at a very, you know, a very cold temperature.

You can crack a ship's deck, any type of leak that results in that type of, you know, operation if you have it as a liquid, and the liquid then goes past the crack and it can go to other areas of the ship, and if it's cold enough that can result in its cryogenic features hitting other components of the ship, compromising the ship's structural integrity.

There's also -- the last bullet talks about some fire test analyses that was conducted by Sandia on bulk LNG transport carrier ships, and these talk about LNG dispersion distance is limited by the closest ignition source.

So basically if you have an ignition source near where LNG is dispersed, that's where the fire's going to happen and it's, you know, it may spread a little bit but it's unlikely to jump and jump and jump unless there are, you know, additional volatiles and additional sources of ignition.

LNG fires produce temperatures of 700 to 1,200 degrees Celsius, they're very hot, and the flames can anchor to the ship structure.

So when you get something like this, it's going to be limited to the ship, but you're going to have probably a lot of damage on that ship because the fire is so hot and it does -- the cryogenic nature of LNG will affect other ship components.

If you have cross-winds, that also promulgates the possibility that the fire will be -- move around the ship also. One other finding that was interesting that the LNG cargo tank pressure increases minimally during a nominal spill or fire. So you're unlikely, unless you have other structural integrity issues, you're unlikely to see one tank go up in flames and then another one go up in flames unless that other tank has been compromised structurally as well.

Some additional risk and hazard information is that land-based LNG fueling stations can be sensitive to heat entries. So the LNG can boil off rapidly, again turning into a gas. If you have an ignition source, that could be a potential explosion or a fire.

LNG being a very cold fuel, handlers need to be wary and wear appropriate protective equipment, and they also have to have the required training in order to know how to safely handle those types of transfer operations. Vessel to vessel LNG transfers are very complex. There's multiple pieces of equipment on both the vessel where the LNG is stored as well as the one that it's going to be transferred to, and all of those components have to match up.

And so each vessel that carries LNG or it's being moved to has standard operating procedures. Their crew has been trained on how to properly transfer the LNG so that the possibilities of an emergency are minimized.

So in addition to those procedures, you also have vessel compatibility assessments that are required to be done, such that it reduces the chance of an emergency happening during those transfer operations.

So some potential next steps for this research effort is to work with industry to further characterize and what was characterized and determine any types of transportation impacts for the three LNG new and emerging categories for which we found no information.

Additionally, we'd like to conduct site investigations for all 12 categories to be able to further characterize and understand where they are in the U.S., and understand some of the operational procedures, as well as some of the safety and security information that has been gleaned by those new facilities in ways that LNG is being used.

Also to conduct applicability and gap reviews of the current federal regulations, based on what these new and emerging facilities, how they're using LNG and what components are at these facilities, and also to identify new opportunities with industry and other government partners for additional research related to the transportation risks associated with these new and emerging LNG facilities.

The second research effort that we're doing is a literature review, and it was trying to determine whether any fire testing and thermal modeling has been done on UNT 75 portable tanks. What we did was we searched on LNG as well as similar materials being compressed natural gas, petroleum and diesel that have some similar properties.

What we found was a literature research of universities, all of the federal labs as well as just a general research effort, you know, looking on the web. We found no evidence of fire testing and thermal modeling information for UN T75 portable tanks, tank cars, iso-containers and packages.

Now this information may exist at the manufacturer level, but we didn't go to that level, nor would we be able to based on manufacturer's proprietary data. So that may be something that would be a potential future effort, if we were to make, you know, the appropriate connections with industry and they were to allow us to review those tests.

I guess I'll wait until questions, until we have the next two presenters.

MR. BOYLE: Thank you Dawn.

(Applause.)

MR. BOYLE: We are going to hold questions until the end, and now to discuss some of the research on containment and transport of LNG from the FRA, Federal Railroad Administration side, bring Francisco Gonzalez up please.

MR. GONZALEZ: Good afternoon. Does

this work? Oh yeah, good, and I knew that the videos were not going to work, so I didn't bring any.

(Laughter.)

MR. GONZALEZ: In FRA hazardous materials and tank car research, our mission is to reduce the incidence of hazardous materials releasing from rail tank cars and other containers. Our goal is to provide support for the Office of Railroad Safety in PHMSA, to develop new regulations and standards and best practices.

So we do a lot of this research, provide this information to the community and also the industry, and they can develop also some of the best practices like in the AR for example. This is a list of all the hazardous materials and tank car projects that I manage.

Right now we're not going to talk about all of them, because we don't have all day, but we want to talk about the last three, which is only for LNG commodity, LNG as a fuel and also some of the tank car and iso-tank car -- ISO tank fire testing.

At the LNG commodity rail transport in commerce, it can be transported by tank car or an ISO tanks. Also, we're going to talk a little bit about the regulations related to tenders and also as a commodity. LNG is used as a fuel for powering locomotives and also we're talk about LNG tanker design issues and crashworthiness.

Right now as in the LNG commodity and rail transport, right now we have special permits if some people want to transport LNG in ISO tanks. What we do -- what we've done is to contract with Volpe and do a crashworthiness assessment on the transportation of ISO tanks on rail.

Some of the concerns that we have is the potential consequences of an accident on -- when it's transported into, in rail. Some of the consequences may be significant, and also some of the hazmat train accidents or some of this transportation is going to be under are -- can occur in dense population areas or when there is no access to that train.

So it could be hard to reach with emergency equipment, either because of the population or because it's hard to get there. So right now what we do is in the approach that we're taking is to develop equipment information, gather all the information and equipment, on the ISO tank and also on the rail car or the flat car or the well car that it's going to be transported, define some of the accident scenarios and do a crashworthiness analysis of equipment in those accident scenarios.

So some of the accident scenarios that we're looking into is there are three general categories of train accidents, train to train collisions or head-on collisions, grade crossing collisions and derailments. Some of these sources for these accidents we're using are FRA railroad accident investigations, PHMSA hazardous release investigations and also NTSB investigations.

There have been several developed scenarios before in tank car crashworthiness that we have done, and also under the TAG, which is the Tank Car Advisory Committee or Group with AR, FRA and PHMSA and the industry, and to see what are those scenarios of concern or general scenarios on derailments.

So we have five LNG tanker scenarios. For example, we have train-train like I just mentioned, grade crossing scenarios, rollover accidents, head impact or shell impact.

On the three tank car scenarios that we have done on my program, we have done several testing on head impact, center seal impact and offset shell impact. So we have done those kind of scenarios on either modeling or the actual testing.

So Step No. 2 will be the crashworthiness analysis approach. The container performance in scenarios is to be evaluated in three phases. First, they interpolate, extrapolate from existing LNG tender and hazmat tanker analyses and tests. That has been done on the tank, on the LNG tender, on the tank car tender, not on the ISO tanks. So we're going to take some of those scenarios and some analyses to feed into this program.

The Phase 2 will be a simple fire engineering analysis, to see what -- how can they survive or how, what would be the survivability of the ISO tank in transportation. Also after that, we will do a detailed computer simulation, to see are there more detail in some of those scenarios and then how can we learn.

Throwing out the status and next steps on this task is equipment description. We've gathered the information in sufficient detail for the initial evaluation. We're getting some of the information on the ISO tank, how is this contracted with the material and all that, and also what are the rail cars that are going to be used to transport these.

It could be a flat car or it could be also a well car, and see what other safety features they're going to put in this, to make sure that these ISO tanks are in place. The accident scenarios, we drafted discussions and they're used from accidents information in previously developed scenarios like I mentioned.

An assessment of crashworthiness performance in scenarios. Like I mentioned, interpolate from existing assessments, perform some survive engineer analysis and do a more detailed computer analysis. Now all these -- those two information, this information will be used in a risk analysis or crashworthiness assessment by FRA, PHMSA or maybe some other people who are going to transport this material.

We know the risk frequency but there's consequences. So the accident scenarios may be used as a part of the analysis on the frequency term. The crashworthiness analysis, the resource may be used as a part of the risk analysis consequence term. In other words, but the details of how crashworthiness information is used depends on particulars of the risk analysis approach.

So Leonard is going to talk about a little more of the analysis or the risk analysis that they do, and Volpe's doing some risk analysis and also the companies or the railroads that are going to transport these, they're also doing a risk analysis. So some of the information that we're going to obtain here will be feeding to that risk analysis.

Some of the regulations that are in place in commerce for LNG shipments by rails is the LNG shipments in commerce in rail tanker is not authorized. So there has to be a special permit under 49 C.F.R., and it will be issued by PHMSA. In other words, the tank cars that are being used are like DOT-113, cryogenic liquid or cryogenic tanks for cryogenic liquids.

So that can be transported in that, but it's not authorized. LNG is not authorized for transport. It has to be a special permit. LNG shipments in portable tanks on rails are authorized, but it has -- need a special approval needed from FRA if it's going to be transported by rail. So in commerce and vessels, and also in road, they are -- they are authorized to transport it.

Now the regulations of LNG tenders, that means when this -- either a tank or ISO tank is fueling or is used to fuel the locomotive, there is no coordination in the use of LNG in a tender to carry and feed fuel to a locomotive provided that it's proper condition and is to safe to operate without unnecessary danger or personal injury.

LNG tender is subject to FRA's statutory authority under Chapter 207 in the locomotives, because it will be treated like a fuel tank. LNG tender is not subject to HMR requirements because it will be part of the locomotive, as long as it complies with the locomotive act or chapter.

Associate Administrator letter to industry on safety rationale in HMR is applicable to the assigned operation of LNG CNG tender. So the FRA has been working a lot with the industry, to make sure that this tender in some of the pilot programs they have done, to make sure that it's safe to be transported and used as a fuel.

Applicant to obtain an FRA concurrence letter before using LNG tender to fuel as locomotive, fuel a locomotive. Here's an example of a LNG tender feeding a locomotive. This is one of the pilot projects that CNG analysts have used, and you can see the tender is in the middle between the locomotives, and that tender is fueling the two locomotives to transport it. Not to transport it, I mean to fuel the locomotive assembly.

Right here is the iso LNG tender constant. This is pretty much the same principle. The only thing is this is an isocontainer. This one it could be -- I think this one they only use is to fuel just one locomotive. Is that right Leonard?

MR. MAJORS: To both of them.

MR. GONZALEZ: To both of them, okay.

So it's the same principle; it's just a smaller container.

Now FRA is participating in the LNG tender cars. Melissa Sherman, Michael Rush and also Steve Clay. They participate on the AAR TAG, which is the technical advisory group, the AAR, the industry and also the FRA and PHMSA participates.

So they've been doing that for a while and FRA participates and induces the industry to develop a specifications for future LNG tender.

The crashworthiness analysis research is being conducted by ARA in support of AAR, and by Volpe in support with FRA. Research is being conducted cooperatively. Like I mentioned, those scenarios that we've -- that I described for the ISO tank, David Terrell from Volpe, he has done this work for LNG tender on tank car. So that's why we're using kind of the same scenarios.

AAR LNG TAG is charged with assuring the functionality as well as the safety of product on the LNG tenders. Real quick right now we're going to -- before, so we can go to lunch, this is dynamic crashworthiness scenarios. These are the scenarios that we're considering.

For example, if a locomotive or parts of a locomotive tender locomotive hits a wall that is a highway grade crossing and something hits the tender in transportation, and also if it's a rollover in case of a derailment.

This is something that we have done before on tank car research, that we put them on the well in TTC, and then we hit on the middle on the shell, and also during head testing.

So we can do these kind of scenarios also for a tender -- LNG tender in a tank car. This is another one, kind of a quasi-static crashworthiness scenario that we're proposing that we can do. Real quick on these scenarios.

So what is FRA doing to promote the safe use of LNG? Like I mentioned, participate in the AAR's TAG and develop on the standards. We do a lot of modeling and study on the licensed tender crashworthiness on different accident scenarios along with the industry; evaluate special petitions of permits to transport it; and review petitions in commerce for the LNG in portable tanks.

So some of the nearer terms -- the longer term plans is monitor and collaborate with the industry in its development of tank car tender standards, and that will be for the tank car not the ISO tank, because the ISO tank is already done. But the safety on going in between -- you know, when the material or the LNG, the natural gas is moved from the ISO tank to the locomotive.

Continued computer modeling of accident scenarios, perform physical tests on tank cars and ISO tanks in Pueblo, Colorado in the test centers. So about one or two years, in the next three years. Perform fire testing on tank cars and ISO tanks; use industry standards and their results to amend current regulations.

We're talking about the cooperation between PHMSA and FRA. What we're doing is we're going to fire test and also crashworthiness testing on tank cars in my side. In the side with PHMSA, they're more interested also in the ISO tanks.

So what we're trying to do is to cooperate and provide some information or do a contract, for example, when we do these kind of tests, do it on both. Do a tank car and ISO tank in a crashworthiness scenario, whatever the scenario will decide that is more important and we can get more information, and also a fire test.

Dawn mentioned that what we did is to try to find out, see if this kind of fire testing they have done in other parts of the world in the country, and we find out that it's not many they have done. So we have to come out with the information. I think Sandia has been doing some of the testing and also Melissa Sherman has been doing some research and literary research on that. So we -- we're waiting for that result. So before we put the contract, we need to find out what has been done, what would need to be done before we start doing the testing.

Just to finish it up, the Broad Agency Announcement, we have done this for -- you know, every year. So this year we have three different topics. So anybody who is interested, go to these websites and you can read what is the criteria or the in other words request for information or proposals or concept papers, to see -- for example, on the first one is protecting hazardous materials tank cars from punctures and heat.

The second one will be quantity of lading laws under bridge condition. In other words, if the tank car is breached and some of the material comes out, how much of that material comes out?

Sandia is doing a lot of -- DOE and Sandia are doing a lot of the other studies. So we kind of want to try to complement some of the other research ideas that we need to know, and especially in the transportation of these materials, crude oil for example.

And also fire performance of alternate fuel tenders. In other words, we know that it's not a lot of fire testing done on these materials -- on these containers. So we want to have ideas and other papers, did anybody have ideas how to do it or how to perform these tests. Thank you very much.

(Applause.)

MR. BOYLE: We're going to your questions at the end as we have time. Our next presentation from our engineering shop -- from the PHMSA engineering shop, and it will be Mr. Leonard Majors. Thank you Leonard.

MR. MAJORS: Good afternoon. I'm here to kind of highlight a project. It's more of a proposed research project that we want to do like a safety assessment of LNG transportation overall as a commodity.

So as an overview, LNG is an emerging clean energy technology and it's beginning to be used as Francisco highlighted, as Dawn highlighted, as an alternative fuel for locomotives and ships. As this -- as these modes develop and these opportunities come about, there are going to be new opportunities for exporting and also transportation domestically. These shipments are going to go through some high -- you know, high population areas, some may go through low population areas as well.

So the proffer statement; as the previous presenters highlighted, you can only transport LNG currently in UNT 75 portable tanks, MC-338 cargo tank motor vehicles, and rail shipments require approval by the FRA.

As Francisco highlighted, the DOT-113 tank car is being considered for cryogenic shipment by rail, but it is not authorized. So there could also be a potential way you could have rail cars that could enter the commercial market as well.

As I said earlier, expanded use creates more opportunity, and more opportunity creates, you know, a safety -- the need for a safety assessment and that's what PHMSA's going to do with our safety assessment.

So what type of work do we want to do? So we want to do something that is, you know, kind of like a commodity flow study or an estimate on commodities flow, because currently nobody knows how much is being shipped and no one has identified where this shipping will go, which mode is more effective.

Everyone's gearing up for rail, but currently you can go by highway, you can go by vessel. Most of these ISO tanks are being -- I've heard of a couple of ISO tanks being used for specifically by a company to fuel a commercial ship. So highway transport is being utilized right now, but as it expands, you could see more shipment by rail.

Also we want to do a modal risk assessment, a risk by mode, you know. One highway truck versus 20 rail tank cars or how many rail tank cars could be shipped is also something we want to look at. Packaging. As I mentioned, right now you can only have a UNT 75, but that could expand into a tank car.

So a tank car could obviously cut -- lower your risk because you have one tank car compared to maybe, I don't know, two or three portable tanks. So that could create a risk reduction.

Overall, we want to do a safety assessment so we can kind of get away from having to do all these approvals, and that way we can go undertake a rulemaking and have the information and analysis to back up the rulemaking in the future. That way, you know, we can kind of, you know, cut out the government in the process of trying to transport this material.

So I kept my presentation short because I'm kind of hungry too; so any questions?

(Applause.)

MR. BOYLE: Leonard is my favorite speaker. Now before lunch, a little questions too. We'll have Veda. He's going to give a little bit of a look forward as to what PHMSA's plans are, then we'll have a few minutes for questions and then you get a shorter lunch, because I'm not one to miss lunch very often either. So turn it over to Veda, then we'll do a few questions.

MR. BHARATH: Hello everybody. So I'm the lunch gatekeeper, so I'll go as slow as possible, and I have several videos.

(Laughter.)

MR. BHARATH: I'm kidding. So yeah, just to summarize what everybody did, Dawn, Francisco and Leonard, you know, Volpe looking at the small scale stuff and FRA looking at tender cars and other issues associated with transporting LNG by rail.

The thing is, as Rick and Lad mentioned earlier today, the need for LNG and the demand for LNG use is going to increase significantly over the next few years. So we need to be pretty proactive, as Sam just mentioned, on lines in addressing those needs.

So as stuff associated with that, not

even associated with DOT, there's a lot of issues going on non-transport related, for instance, one highlighted here -- maybe not. Where they were looking at LNG spills in a static sort of situation. This is really good information for if mitigation of circumstances associated with like for instance rail transport.

There's some way you could sort of anticipate how this LNG dispersion might happen if there's a breach in the cars, because LNG is sort of twofold as people were saying. It's a cryogenic liquid as well as flammable. LNG furthermore, like when it gets breached into the air, it's denser than air so the gas tends to stay at the bottom. So you have a high flammability risk for a longer period of time.

I won't go through -- so we don't really want to get to the point of where issues happen, and then we want to like address the issues after they happen. Again, going to emphasize that we want to be proactive when it comes to LNG work, and this is the obligatory

Lac-Megantic highlights here. This was an accident that happened in Canada. Maybe two people will know what I'm talking about here in the room.

Yes, but we do want to get the point where we have an open collaboration between industry and PHMSA and FRA, to get to the point like they have in this highlight here, where crude, you know, put on a good rail car, safety precautions in place, but we want to have it proactively before any issues arise.

So I wouldn't go through this. You guys can look at it, but this is just some of the possible directions that the research for LNG wants to go into. Again, this is not going to be really effective and possible if we don't partner actively with for instance our modal partners like FRA, as well as other agencies like DHS, and I know we have a few here in the audience so -- and as well as industry.

And that's it. Is that quick enough? All right. Questions.

MR. BOYLE: So does anybody -- Bob, I knew Bob would have some. I'll turn on the mic so that you can ask them. If you can introduce yourself before you make -- ask your question we'd appreciate it, because the court reporter doesn't know who everybody is.

MR. FRONCZAK: Yeah. Bob Fronczak with the Association of American Railroads. We are working with FRA on the tender, right? And Francisco talked about that, and we have looked at different crash scenarios, that sort of thing. That's a different, you know, application in our opinion.

In other words, it is -- you've got a tender next to a locomotive that's going to be occupied. So we believe that extra regulatory, you know, considerations ought to be considered. For LNG transportation in tank cars, we don't think there's additional research necessary.

In other words, Transport Canada has already authorized LNG in tank cars. So we've got tank -- you know, potentially tank cars running around in Canada already. We transport a lot of other cryogenic liquids in tank cars. In our opinion, the only reason that we haven't authorized LNG -- and unless you can find evidence otherwise -- is that there hasn't been a need, you know, other than the tender application.

So you know, we think you're kind of setting up an extra regulatory requirement for LNG in tank cars, and if you do it for LNG, why don't you have to do it for every other hazardous materials that -- you know, material that is transported in tank cars? So just a comment, not really a question.

MR. GONZALEZ: Yeah, thank you, and you're right. I mean on the tender side, we're doing a lot of work and you're like we need to do a lot of regulatory on the transport -- not transportation but on the tender issue, make sure that it's safe and I know Phani has done a lot of that work.

On the person on the tank car -- I

defer that to them. But you're right. I mean the DOT-113 we know is a cryogenic, and it was not -- it was not authorized or it was not set in the regulations. So I don't know what the future on that is.

MR. MAJORS: Well Bob, just to speak on that, we would like the railroads' participation in developing our safety assessment. If you guys could, you know, meet us at the table and kind of identify some areas that we, you know, kind of need to explore and research, we'd be open to look into it, you know.

I think, you know, not to compare crude oil to LNG, but some of the concern is that if you get an incident with crude oil -- I mean with LNG, you might not have the same results. Well, you won't have the same results as crude oil. It could be -- I don't want to speculate worse or whatever.

But I mean, you know, we need to really get a handle on it before we end up being back in in the rulemaking, like we have been in the past.

MR. SRIDHAR: I'm Narasi Sridhar from DNVGL. I had a question. On the last slide, you talked about the future. You mentioned a lot of risk factors and so on. I didn't see something about interactive threats, about how a couple of different events could interact and increase. Is this something you guys thinking about or --

MR. BHARATH: Yeah, yeah, and like for instance I think Francisco might have slightly touched on that before. We're looking at some intermodal events, you know, for railway crossings and so on like that, where we have like some type of intermodal incident, and also kind of over -- to some degree with that, we have some interest in like human factors and how this could influence them --- possible risk involvement.

MR. RAJ: This is Phani Raj from the FRA. I just want to address Bob's concerns. While I know that DOT-113 is actually -- is authorized to carry even liquid hydrogen, which is much, much colder than the LNGs.

The concerns that we have is not so much as there are single shipments of LNG, but it is really unit trains. So we have no idea what happens if an LNG -- let's say in a unit train, one LNG car breaches and it exposes the other LNG cars to a fire. Nobody has done those experiments. We don't know what -- LNG -- by the way, those people who may not know, LNG tank cars and the UNT 75 ISO tanks are double-walled, because you have to have that in between the inner tank and the outer tank to prevent the heat leak going into the LNG side.

So we have no idea what kind of puncture resistance these have, what kind of fire resistance these have and certainly when we are talking about their using -- authorizing DOT-113 for LNG, we can simply authorize it and somebody transports, you know, 10,000 cars a year from a single shipment -- single shipper rather, the risk goes up by the volume of transportation, not by just a single car.

So that is a concern. We want to be able to understand really how the survivability of these tank cars will be -- or ISO tanks carrying LNG will be. So that's the reason for proposing some of these tests that we are proposing.

The second issue that I want to make a comment on Dawn's presentation. I have been working the LNG issue, the industry and the hazards for 35 years. The word explosion and LNG do not go together. If that were the case, part 193, which was instituted in 1978, would have included a requirement to assess the damage of an explosion.

It is not there, and I have done myself experiments, fairly large experiments in China late in the 1970s, where we actually really tried to explode a LNG vapor stoichiometric mixture; it is an absolutely perfect mixture of air and LNG, with dynamite. It wouldn't explode.

The word explosion really means a detonation. So we should be -- as a regulatory agency we should be very careful what words we use, because the public is going to latch onto that and then it will come back to us to haunt. So we should be very careful about what words we use, especially the words explosion, which is now associated with Lac-Megantic and other things. So we should be very careful. Thank you.

MS. JOHNSON: I agree with you sir, and that comment came up in the presentation relative to a public perception. So whether it's real or not, that perception is out there in the public. I found a number of newspaper articles that talked about people being concerned about having a new LNG facility near their homes and in their residences because of -- they were concerned about explosions.

So I agree with you, and you know, there's an awareness piece that's coupled with training and operations, and understanding how this is used, but thank you.

MR. RAJ: My concern was use this property criteria --

MS. JOHNSON: Oh okay. I apologize.

(Simultaneous speaking.)

MR. BOYLE: We'll allow -- because I know I'm getting weak from not eating. So Bob will be our last commenter, and then I'll tell you what our plans are for lunch. Thank you Bob.

MR. FRONCZAK: Yeah. Bob Fronczak, AAR again. I would say that if the concern is unit trains of LNG, we have no, you know, no idea at all whether that is really, you know, what people are considering. I mean I think people are considering small volumes at this point in time and it's going to take a while to get there.

Authorize it in tank car in, you know, single shipments or something until you get -- do the research. That's my last comment.

MR. RAJ: Just to the matter of --

MR. BOYLE: One more. Bob, you have a lunch partner now.

(Laughter.)

MR. BOYLE: What we're going to do is Phani.

MR. RAJ: One sentence, one sentence.

MR. BOYLE: It's never been one sentence, Phani.

MR. RAJ: There is always the special permit rule for specifically asking for shipments of LNG in tank cars.

(Simultaneous speaking.)

MR. BOYLE: See what respect I'm getting to have lunch. Bob and Phani, you may take this to the cafeteria. What I'd like to look at -- we're going to say 1:30, but it will probably be 1:35. Let's try to take about 40 minutes for lunch.

If you don't know where lunch is, go out to the main atrium when you came in, turn right, go through the elevator, down the stairs and back up the stairs. Please, if you do not have any government badge at all, eat lunch with somebody that does. You'll need an escort over to the cafeteria.

(Whereupon, the above-entitled matter went off the record at 12:35 p.m. and resumed at

1:40 p.m.)

MR. BHARATH: Afternoon everybody. We might just want to start the program immediately in the interests of time.

All right, so we're going to go right into cylinder compressed gas research; and first up we have from PHMSA, our Engineering Branch Brian Moore, and he's going to talk a little bit about cylinder failure. Yeah, so without any further introduction, Brian.

MR. MOORE: Good afternoon. My name is Brian Moore. I'm an engineer in the Engineering Research Division at PHMSA. I'm glad to be able to talk to you today.

First off, to correct what David just said, I won't be talking about cylinder failure. Actually what I'd like to speak to you about briefly is the ultra-large composite cylinders. So that was just a small thing.

In any case, PHMSA first became -- or I'd say Office of Hazardous Materials Safety first became aware of and involved with ultra-large composite cylinders through Hexagon Lincoln's special permit request, which was filed -- I want to say approximately 2008, to manufacture, mark and sell a hazardous material transport system which is a steel frame ISO frame, which contains multiple large composite cylinders, each of which is a maximum of 40 feet in length, four feet in diameter approximately and a working pressure of about 3,600 psi, and each of which has a water capacity of approximately 8,500 liters.

So this permit took from -- I want to say maybe 2008. It was authorized finally in 2012. Its service is for 2.1 to 2.2 gases, and particular CNG. What we're noticing from the industry is that there is interest in the energy applications for being able to transport natural gas CNG on the roadway and by vessel.

So that was our first introduction to that particular type of technology, and from where we stand right now, we're starting to see a couple of other companies come in to request similar special permits.

Currently, the regulations that support these types of composite cylinders are the ISO 11119-3 and the 11515. Now the 11119-3 as you can see only authorizes up to a 450 liter water capacity, whereas the 11515 allows you to go from 450 to 3,000. These are for composite cylinders with non-load sharing plastic liners, which is another key part of this technology.

We're not dealing with metal, so we definitely have a -- in addition to the high stake -- high strength to weight ratio that you get from having the lightness of that composite and its strength. We're also reducing the weight by not having a metallic liner.

So that was something that was -- you know, in terms of the size of these cylinders, a very key risk that had to be analyzed and looked at very carefully in authorizing this particular special permit. However, as you can see from what's said above on the slide, each one of the hexagon tubes has a maximum water capacity of

8,500 liters.

So the standards fall short in that, you know, we're already authorizing the manufacturers to go beyond what the strict requirements are for the two ISO standards. So with that said, in terms of trying to understand where, you know, this technology might go and what we might need to anticipate in terms of providing for adequate safety in transportation of these commodities with this particular type of technology, some of the key questions that we think of are possibly, you know, what are the risks?

What do we have to think about, you know, in terms of the design, manufacture, transportation of these systems? What risks are we encountering and at what point do we say the risk is too great for, you know, what we like to have in place?

Secondly, a very unique manufacturing design, or even transportation issues associated with these systems. We've gotten an analysis from -- for instance, from Lincoln Hexagon, but in terms of having a more comprehensive understanding of what's going on, what we might need to look at as this technology continues to develop, we don't know.

Also for very long tubes now, as I showed you on the previous page, the current technology only allows up to 40 feet in length. However, there is indication that industry wants to go even higher on service pressure -- or excuse me, working pressure, and also higher on length.

So does that introduce any type of physical phenomena in terms of the design and manufacture of these tubes by going, you know, so high in length, whether or not there might be particular bending, stress-related issues, whether or not there's any type of modal type of behavior that might need to be analyzed? Who knows.

Then lastly, what are the practical limits of this technology? These are just some of the questions that can potentially be asked with regard to this technology given its newness. So currently, there are no research efforts underway for this technology. Currently, I'm working on one new special permit application by a company named LightSail Energy, that's in its final stages of the evaluation process.

There may be other special permit applications that are soon to come down the pipe towards one of our offices for evaluation. So given that, there is a need I think to get a more comprehensive understanding of what's going on with this technology and where it may lead.

Some of the existing gaps, to reiterate, are the risks. We don't necessarily know what all the risks are, and we don't know, based on having an introductory understanding of this technology, where we might want to draw the line on the risks at the end of the whole analysis, as this technology comes to even greater fruition than it is at this current state.

Rollover, you know. How these systems will behave under rollover conditions is also something I think is very important to look at. The Lincoln Hexagon system, one of the key components that allowed it to be authorized was the fact that it had a fire protection system. For cylinders that are this massive, in terms of using a standard type of pressure relief device, it just wasn't feasible.

So Lincoln Hexagon actually developed a system which allowed it to -- the cylinder -- each cylinder to sense a heightening of the temperature at any length along the tube. But you know, this was the -- of course this was one of the key technologies that allowed this special permit to be granted.

But there may be a need for additional research in terms of fire protection and/or fire suppression. That was one thing we haven't seen and we may want to look at. Is there any avenue out there for a fire suppression system as opposed to just protecting it?

The current Lincoln Hexagon system and the way I think that it is currently going, industry is -- for this fire protection system, it acts just like a regular PRD. Once the system is initiated because of a pool fire or some sort of a fire scenario, it just vents the entire product.

So you have, you know, 8500-plus liters, you know, going out of this entire system until it's reached, you know, its empty state. Of course it will be safe, but then you've lost your entire load of product. Is there any way for you to prevent having to prevent the fire or stop this fire while also retaining your whole lading?

So that basically in a nutshell gives you an idea of what we might be looking to do with regard to this technology, and with that said I can take any questions for a few minutes, if there are any out there in the audience.

MR. SELK: Steve Selk, Homeland Security. Is there any other corresponding technology that's in service today at that size and pressure in steel construction?

MR. MOORE: I can say no. In terms of the dimensions and size, absolutely not, you know. When I'm thinking of ASME vessels or any ISO vessel, you know. You won't find any there maybe over a foot or two in diameter. Maybe comparable in length but definitely not in terms of the cross-sectional area.

I think that's a -- I think it would be actually weight-prohibitive to do something like that in steel, although it will probably be safer if you did do it in steel.

MR. SELK: So that might figure predominantly in your risk calculations, is the quantity of material and pressure?

MR. MOORE: Right, absolutely, yes.

MR. RAJ: Phani Raj from the FRA. A question I have is in the risk assessment that you plan to undertake. Are you also looking at the vulnerabilities of the boss and the fittings on the thing, because that to me represents probably a more severe, you know, possible failure.

MR. MOORE: Yes, absolutely. You know, those are two critical points at which the cylinder is mounted. In addition to that, maintaining the interface between that metal boss and the rest of the composite material and the liner, keeping that -- those surfaces sealed is something that's very critical.

I can only -- although I've spent a lot of time over the past months getting familiar with this technology, I can only still grasp at some of the basics of what all of that means. So I would definitely say that would be part of a risk analysis that we would need to know more about.

MS. LU: So this is a question from online. Are these large composite cylinders only approved for highway use, and if so, are other modes anticipated?

MR. MOORE: Currently, it is authorized both for highway and for sea vessel.

I don't anticipate this will ever make it out of those two. I can't see any type of application where -- you know like for instance cargo aircraft even. I don't how that will work.

I just -- at this point in time, I don't see aircraft as being something that would be feasible for that type of technology. But I mean who knows? But at the moment, I think it will restricted to roadway and vessel.

MR. RAJ: Again, this is Phani Raj from the FRA. Actually, we have a proposal from an organization that wants to use these kinds of CNG, compressed natural gas at 4600 psi to be used as a tender for a locomotive, but not the gas transportation across the coupler, but use the natural gas in the tender to develop -- to have a gas turbine and then generate electricity and pass the electricity across the coupler. So yeah, rail application is also coming.

MR. MOORE: You know, actually I did misspeak. I didn't think of rail. Most of the stuff I do is with cylinders, so I very rarely look at rail. So I never think about rail. But yeah, I think that that might be a possibility. So yeah, thank you very much for correcting me.

Anyone else? Thank you very much for your time.

(Applause.)

MR. BHARATH: All right, that was good. Keep it moving, probably catch up on some time. The next speaker is Refaat Shafkey from the Engineering Branch as well, and he's going to talk to you guys about PRDs, pressure relief devices.

MR. SHAFKEY: Thank you Veda, and as introduced, I am Refaat Shafkey and I'm also part of the Engineering group here. My presentation -- my research presentation topic, as you can see is there. It's evaluation of the safety effectiveness on the use of pressure relief devices on cylinders containing compressed or liquefied gases and mixtures.

It's kind of a mouthful, but essentially what we are saying is that we want to look at the safety effectiveness of PRDs, pressure relief devices. As you know, these are required for compressed gas containment here. According to the U.S. regulations, Title 49 C.F.R. 173.301(f), requires them for use on division 2.1, which are non-flammable gases, 2.2 division, non-flammable gases and even for toxic gases, division 2.3 gases.

For the low toxicity gases, the PRDs are required. So why do we require them? The logic behind this requirement for pressure relief devices is that to prevent overpressurization-type, catastrophic failure of cylinders. So if for some reason the pressure were to develop and go reach the cylinder's burst pressure, instead having a catastrophic rupture you will have a more benign leak before break type failure.

That's the logic. That's kind of accepted here in North America, but this logic is not shared universally because the practice in Europe is very different. They usually don't use PRDs on most of their, you know, compressed gas containers, with the exception of maybe carbon dioxide, nitrous oxides, storage which has very high developed pressures. Usually they are not used.

Their logic on that side is that actually having PRDs actually creates more problems, because they often end up developing unintended leaks. If you have a flammable gas, the leak will lead to -- can lead to fire, and a smaller problem which either would not have existed now can spread to other surrounding cylinders and you can, you know, have a bigger problem if all the surrounding cylinders also have flammable gases. You will have a proverbial situation of adding fuel to the fire.

So you know, we have different perspectives, and some additional background on the use of PRDs, where did they actually originate? The original use of the PRDs was actually in what are known as active pressure systems like ASME steam boiler would be an example of an active pressure system in which the pressure is continuously building up.

So you need a PRD there, and that concept was borrowed from there and got into the -- you know, our compressed gas containments are not active pressure systems. They're static or passive pressure systems. So the pressure is not continuously being built up.

It raises a little bit because the temperature radiations will result in some fluctuations in the actual developed pressure in the cylinder, but the pressures are way, way below the cylinder's rupture pressure. Typically, the rupture pressure of a cylinder is like for DOT 3, a break-type vessel.

The ISO 809 type vessels is 2.5 times their service pressure. So that sum of pressure is never, ever going to be achieved in any of these applications. So we have to really rethink the basis for using PRDs, and I will give you a little example as we move along to -- hopefully I can use that.

Okay. So this is an example to give

a little background perspective. So the question to ask is how many PRDs are used on each cylinder? So typically for small cylinders we will only need -- say just one would be sufficient.

But the requirement for sizing and venting capacity for -- is actually determined in accordance with CGA, Compressed Gas Association standard S-1.1, which is incidentally also incorporated in our regulations by reference. So that determines how many PRDs, how much venting capacity you need to have and what would be the number of PRDs and how many PRDs could go on a particular containment.

So as an example, you know, I think for one PRD usually is a part of the valve. But if you have multiple PRDs that are required, then for large cylinders they normally have sort of a hexagonal-type nut which allows multiple PRDs to be put at each end, and that thing is called a bull plug.

So for large tubes they have to use

bull plugs at each end to accommodate multiple PRDs, and I have an example here. Well, it doesn't show up on the screen, so only on the wall. Anyway -- yeah, but it doesn't show up on the screen, only on the wall. Okay.

So the example is a hydrogen chloride trailer with seven tubes, and what it requires is it requires two bull plugs at each end. So each bull plug has six PRDs. So 12 in a cylinder and on seven cylinders you will have 84 PRDs.

So that's a whole lot of points where you can develop leaks and failures, and potentially consequences of any one of them leaking would be, if it's hydrogen chloride, you know, it's doing in 2.3 gas you can have health issues, you can have fatalities, you can have evacuation requirements for a large area.

So I think that kind of puts things in perspective, that if we're going to have the PRDs, we should know whether they are really doing any good or are they increasing the risk, or we can continue to believe that they actually prevent catastrophic failure by having a benign leak before the actual eruption.

So I just -- we need to get a little -- technically some perspective on the benefits of using PRD. I guess it's based on the previous example it should be -- it should not be hard to come to that conclusion, and the goal of our research here is to minimize the risk obviously and to enhance safety and handling the transportation of compressed and liquefied gases.

Now this project that we are working on is a little, you know, unusual research project because normally in a typical research project you say, okay, we have a little hypothesis. We do some tests and either prove or disprove hypothesis.

Well here, we're not going to be doing any tests. We have to look at a slew of information that is all over the place in the forms of accident reports, incident reports and different agencies have done those reports, different -- and they have been kind of formatted differently. So it's difficult to bring all this information to a common baseline denomination and be able to do any technical evaluation on those.

But that's the intent, is that we will kind of look at the information that is out there and try to cover the cylinders from 50 -- less than 50 liters to small size cylinders to large cylinders over 500 liters. And then some sort of limited risk based assessment will be performed to determine the PRD's role in the prevention or enhancement of the accident or incident severity.

This gives a little description of what we have been trying to do. What we have done is we have tried to look at all these different reports that exist, you know. Some of them are like DOT's incident reports. For every incident there is a report, but those are not technical reports.

Those are kind of anecdotal reports, you know. The inspector goes there, sees what he sees and listens to what others have said and kind of makes some assessment as to what could have happened. Not really very good for any technical assessment. Then there are some reports from NTSB, some Chemical Safety Board reports. There are also reports from Transport Canada and some European reports from EIGA, European Industrial Gases Association. Also reports from Gas Association.

There are also some reports which the companies have, and they may or may not be willing to share that information, and then there are some sort of experts which have some anecdotal information. They have some views on how certain things could have happened, could have been prevented.

So our project has been to gather all this information and sort of kind of try to filter out what is technically relevant and kind of come up with a little summary of technically relevant things for which we can do a kind of -- a comparative evaluation and come up with some sort of conclusion on what exactly has been happening with the PRDs, whether they have been a source of adding to the risk or actually minimizing the risk of accidents or incidents.

So I guess the end of the day, we want to -- after we have done the evaluation analysis, we want to be able to tell whether the PRDs prevented catastrophic failure, whether the PRDs initiated or aggravated the accident or incident. The use of PRDs have no impact; that could also be the case on the accident or incident.

The segregation or storage of cylinders properly could have had adverse or favorable impact on the accident and incident, and any other facts that have become apparent will be evaluated. So it would be kind of looking at all this database, all the history of accidents and incidents and trying to sort of filter out how these PRDs have contributed to the accidents.

After we're all done, hopefully at the end we would be able to come to some sort of conclusion and say that if the PRDs are indeed required or should be used, then this project should help establish the conditions where the PRDs should be required, and the conditions where the PRDs should not be required, and also the conditions where the PRDs may be permitted but should not be mandatory or required.

So I hope that at least we will be able to get to this at the end of the project, and with that, I come to the end of my presentation. I thank you for your attention, and I guess that takes us to --

(Applause.)

MR. BHARATH: Any questions? Pretty complex subject.

MR. SHAFKEY: So I guess I must have done very well then?

MR. BHARATH: Yeah.

(Laughter.)

MR. BHARATH: Do you have a question?

(Simultaneous speaking.)

MR. SRIDHAR: I'm not going to let you go that easy. Narasi Sridhar from DNVGL. We are faced with the similar kind of things on other areas where we have to assemble a whole bunch of diverse kinds of knowledge and uncertain information and so on. So I'm just curious what methodology are you planning to use to arrive at a risk assessment?

MR. SHAFKEY: Yeah, I guess I will -- that's why I had used the word a limited risk assessment, because I don't know we are in a position or the contractor that we have contracted the work, the research project to, is in a position to do any actuary-type risk analysis.

So it would be more of a qualitative type risk assessment, but what they are doing is trying to put a little summary of different reports and so that it's kind of put on a similar format, so that the information is technically evaluatable. Because if you have different reports, they have been written in different ways. It's difficult to compare one set of information with the other.

So they're trying to write little

summary briefs from which we will be able to do a little comparative evaluation. So that will be the basis on which the incident and accident data from different sources would be evaluated and compared.

MR. RAJ: Phani Raj from FRA. We are actually grappling with the same kind of problem on tank cars, whether we should have pressure relief devices or not. So when -- in the last slide you said you had several different criteria for, you know, having or not having, can you define for me what the accident means?

MR. SHAFKEY: Well --

MR. RAJ: With an improved fire exposures.

MR. SHAFKEY: Of course, and I mean fire explosions, and for us an incident is a leak.

MR. RAJ: Exposures.

MR. SHAFKEY: Exposure?

MR. RAJ: Yeah.

MR. SHAFKEY: Okay, fire exposure as

well. Of course it would be, because in a stricter sense, the rationale quoted for PRDs is that it will prevent the rupture of a cylinder in case of a fire, whether that works or not in many cases.

But I guess the thrust that I had was that the likelihood of cylinders being in fire is far less the risk of that, as opposed to the PRDs leaking and leading to fire if it's a flammable gas, because right now it's a flammable gas.

So if you have a flammable gas and it leaks, and there is some friction or some other source of ignition and you have a fire, then everything else will become irrelevant. Whether the cylinder explodes or not, it's going to happen so fast that the whole thing will actually develop in a big inferno.

MR. RAJ: Actually, the concern is not so much the leak as the real damage and actually sheering off of the PRD itself in a mechanical accident.

MR. SHAFKEY: Right. That can happen

too, and you're right. I mean that's the other way of looking at it as well, because that can happen on road transportation. I saw the physical damage to the PRDs.

MR. BHARATH: Any other questions?

MR. SHAFKEY: Okay. Thank you very much.

(Applause.)

MR. BHARATH: All right. Next up, from the Compressed Gas Association we have Mr. Jack Wert.

MR. WERT: Thank you. Good afternoon everyone. As was just announced, my name is Jack Wert. I'm with the Compressed Gas Association. I'm a technical manager working for the Compressed Gas Association, and just a little bit of background on me before we get going -- and it will be brief.

I've been in the industry, compressed gas industry for 23 years, and I've been with the Compressed Gas Association now for 12 years. And for the CGA, I manage several technical committees and then outside CGA, I participate on numerous ISO committees, TC-58, SE-2, SE-3, SE-4, which are valves, cylinder construction and requalification, and then I also participate at the United Nations on the subcommittee of experts of TDG and GHS.

So I've got a full spectrum of perspective that I'm looking at this with. At the same time, I'm combining that with what the membership has provided me to present to you, feedback on the presentations.

First, I want to thank you for inviting me. My little world revolves primarily around cylinders and those gases and those regulations. And I realize there's a much bigger world out there than just that, and so many of the presentations given today just opened my eyes to the other endeavors that are going on and they're very sincere, very intense and the goals are very noble. It's very pleasant to see something like that.

I think having these forums once a

year, it's a great idea. The many forums even better. Okay. So let's take it from there. You're asking to give feedback. The first thing I would like to talk about -- ah, MAE.

I know that the OHMS R&D has an ongoing project for the development and refinement of mobile acoustic emission, and that they have and others have indicated that this technology may be the best suited for inspecting composite cylinders.

From what I understand in the United States, OHMS R&D has the foremost -- is the foremost in leading this type of methodology forward, and that's handled both by the R&D group at OHMS and that has carried through to the International Standards Organization, the ISO committees, where several of the gas committees from around the world are learning about MAE.

Up until now, composite cylinders have been judged for fitness of service if they pass the -- during manufacture if they pass the performance criteria, and then after that requalification is official, you look for any type of damage done to the fibers, any type of damage done to the external or internal of the cylinder.

Well that's very subjective, and our guidelines are extremely conservative. So we're probably at times taking vessels out of service that are fit for service. However, there are things that could happen down the road with the development of composite cylinders that are going to need a better method of inspection.

MAE shows promise to be that method of inspection. It sees the full body, all the way through the composite layers of the cylinder into the lining, and that can tell us a lot more than discoloration or dent marks or broken fibers on the external surfaces of the cylinder. It tells about delaminations in the volume of the wrapping. It can tell us about deformities in the liners.

Several reasons to move forward with MAE, and it would give us a quantitative or at best -- or at least a semi-quantitative measurement of the fitness for service and so it's moving ahead in ISO. OHMS R&D is taking the spearhead on behalf of North America, and we really would like to see that continue. We support that.

We do support that as members of ISO, and I think it's necessary given that composite cylinders are in almost every conceivable application in the U.S., North America and around the world medical gasses, SCBAs, CNG, aerospace, industrial applications. They can be found just about everywhere, and there are as many variances in sizes and pressure ratings, liner materials as there are applications.

We start from metal liners, move to -- which is now becoming more and more prevalent in North America, the polymeric liners, and then there's even linerless, linerless composite cylinders. It's really important that we get a handle on this going forward.

We're taking cylinders and because of

their exemptions or special permits or specifications, they're limited to a finite service life and perfectly good cylinders are being taken out of service and scrapped because we do not have the technology with a high degree of certainty to say it's fit for continued service.

So I think that is one development project CGA will certainly support. There's a large number of composite cylinders that have been fielded and serviced for quite some time, as you all must know, there's tens of thousands around the world. This is not just a North American effort. This is, as I said, an ISO effort and therefore a global effort.

CGA would encourage the continued research of MAE to develop and refine the capability to inspect and requalify the ever-evolving composite cylinder. In particular, I put polymer liners down there because we're starting to see more and more of them, and I think we need to get a handle on that.

Pressure relief devices. Refaat, thank you very much. Thank you very much. CGA supports continuing research on the use of pressure relief devices. We've been looking at this now for about two years, and it primarily consists of as much literature searching as we can, with the exception of a test done in the Mojave Desert.

The literature searches so far have not given us a beacon to go one way or another with PRDs, either by class or by specification of the cylinder, okay. The Mojave Desert test is briefly there. It shows us some promise.

There are two trailers, some fitted with PRDs, some not with PRDs. Some distant to the end of where a fire was, some on the end where the fire was, and the fire was 200 gallons of fuel oil that was ignited and allowed to burn out, fully charged tubes. None of the tubes ruptured and all of the tubes, after the testing and metallurgy were done, proved to be fit for service.

So that tells us a little bit of something, enough confidence to say that maybe we should consider taking PRDs off of permanent gases for certain specification cylinders, say the 3 series. It still needs to be determined.

Along the lines of the research, I know OHMS R&D has employed Barlen and Smith to do a literature search and formulate next steps, and I would encourage that this research be wrapped up because I think everything is done; isn't it?

MR. SHAFKEY: Right. It still needs to have the conclusive analysis part.

MR. WERT: Okay, okay.

MR. SHAFKEY: So the literature search part and putting them in a summary format is done.

MR. WERT: Okay. I didn't want to cut you short there. But what I want to say is the research itself, the research is coming to a conclusion. But when it's done, analyze the results, Barlen and Smith's research and formulate the next steps. Is the research done?

If so, here is how to assign PRDs as indicated earlier. If not, is further research needed and identify the objectives.

Is a risk assessment approach by itself adequate? I know people, anybody who's performed risk assessments know how risk assessments work. They're tough. We've got plenty of risk assessments submitted by our member companies. They all generally agree, but assumptions made along the way don't necessarily agree. So it has a lot to do with your perception and how you operate. So that's why the question's asked, is the risk assessment approach by itself adequate?

Something that was brought up early on and we just did not have the resources to do, is there a need to model and confirm the model by testing? Should you set up a model and determine what happens to a cylinder in a fire, the heat transfer, the developed pressure, the weakening of the steel?

All of those parameters, the millions

of parameters that go into that, and see what it says. And then take that model and take some cylinders and do some tests and validate the model or adjust the model, okay. So that now you have something maybe you can work with as a model or calculation rather than going around blowing up cylinders.

The research obviously would have to cover all the physical, chemical properties of all the various gases you deal with. Okay, let me move on. Okay, so that's it. Pressure release devices, we support that. And then here's something, it's the last one. Extension of requalification periods.

We note in Europe, they extended the requalification periods to 15 years on what is analogous to our 3A, 3AA cylinders, and I don't how much science was put into that. I've not been privy to that. CGA is looking at that, but not gaining a lot of traction.

However, we would suggest that DOT begin to look at this, not as an immediate -- not in the immediate future but rather over time, specification by specification, after adequate investigation and consideration.

For DOT 3A, 3AA qualifying for ten years, go to 15 years. What requirements and controls would be required, total UE before 15 years' service, UE requalified; qualification every 15 years, dedicated service, positive pressure non-return valves.

For specific specifications only those made after a given date, and this is driven by better utilization of the cylinder fleet and all the things that I have spoken about this morning are driven by global harmonization and safety.

With that, that is the end of my presentation or my comments. I will take questions.

MR. BHARATH: Any questions for Jack?

MR. WERT: Okay. Thank you very much.

(Applause.)

MR. BHARATH: All right. You're going to keep the dial moving here. Next, we're going to move into the Crude Oil Classification subsection of our forum.

First up in our lineup is David Lord from Sandia National Lab and he's going to talk today a bit about crude oil characterization. David.

MR. LORD: Okay. Well first thank you for inviting me to talk about our research project. So my name's David Lord. As you know, there is a team of people working on this project. Can we move to the next slide or do you want me to advance it? Okay, I can advance it.

Okay, and since this is a multi-disciplinary project, we have expertise in a number of areas. I am currently the project technical lead and my area of technical interest is in crude oil properties.

But being that we do a lot of combustion testing in this work scope, we have combustion expertise, Anee Ludeka (phonetic), Tom Blanchard. We also are working on issues related to variations in crude oil quality to the supply chain and crude oil properties.

So we have help from the University of North Dakota EERC. We have also have hydrocarbon sampling and testing specialty embodied with Ray Allen and Allen Energy Services, and also we're doing a substantial amount of data analysis in EOS modeling, with some help from Dave Verdine (phonetic).

So I'm going to go through my outline here, problem statement and objectives. Talk about project governance and work flow, and then once you see the project governance slides you'll understand what Task 2 and Task 3. Task 2 and 3 are really in a project sense are where the major testing is going to occur, and then I'll leave you with the project management contacts and a list of current project publications.

So problem statement and embedded technical objectives. So crude transport by rail poses risks recognized by U.S. and Canadian regulators, and the hazards have been realized in a number of high profile train derailments leading to spills, environmental contamination, fire, property damage and fatalities.

It's an open debate on whether the types of crude, i.e. tight oil per se versus conventional production have a significant bearing on the severity of transportation accidents, and I just took a couple of government report images here that probably most in this crowd are familiar with; the top one being from Casselton, North Dakota and the lower one being from the aftermath of the Lac-Megantic derailment and subsequent fire.

So moving on to the project objectives, and I've color-coded this primarily according to the top two black color-coded have to do with studying oil properties, and the lower bullets relate to studying the combustion properties of fuel once it's in the fire.

So what one of the initial questions is related to what should we be measuring in terms of crude oil properties and how should we capture the sample, and does the sample capture method actually have bearing on what the analytical results say in the end, primarily because many hydrocarbon fluids actually contain dissolved gases, and those dissolved gases have a way of escaping containment unless you actually retain pressure on them and bring that pressurized sample all the way to the lab.

So in the language of the slide here, the first thing we want to do is determine what sample capture and analysis methods are suitable for characterizing select physical properties of crudes, that exhibit some volatility, and then we want to evaluate which of these select physical properties of crude oils, and in particular, tight versus conventional production that are moved within the rail transport environment, that have some bearing on flammability risks.

So that's the crude oil characterization part, and then the second phase of the project, once we settle on what are the best ways to go grab your volatile oil sample and take it to the lab and test it for the physical chemical properties, once we've settled on that, then we're going to go get large scale samples, 3,000 gallon samples, out from the field and bring them over to Sandia and measure their combustion properties.

Those would be things like flame dimensions, surface submissive power, selected oils. Again, this would embody a sample set that would include tight versus conventional oils, but under controlled burn scenarios that have bearing on hazard determination.

We would compare combustion properties to existing published data and other flammable liquids and that would come from the public database as well as what we have at Sandia.

So other flammable liquids would include methanol, ethanol, jet fuel and hexane to name a few. Then we would evaluate if the selected tight oils that we studied exhibit measurably different combustion properties from conventional crudes or other reference fluids tested previously.

So what we're really looking at is trying to figure out if the properties of the crude oil involved in the fire have a bearing on the severity of the combustion event that follows.

But we're not looking at in this phase of the project the probability of ignition. In all of our tests, we assure that the oil is ignited, just as we did for the methanol, ethanol, jet fuel, hexane tests.

What we want to look at is the severity of the fire itself, the combustion event itself and have objective measurements for measuring, valuating that.

So on to project governance, you know, who are the players here. So Sandia National Labs, located there in the middle of this diagram, is the lead technical lab. That's my employer, and we are directly funded by the USDOT and the Department of Energy, and we are supported in kind by Transport Canada.

Those three government agencies are

basically jointly advising Sandia through the crude oil coordination -- Crude Oil Research Coordination Steering Committee. Sandia, while we didn't have a lot of the expertise needed in-house, there are certainly other capabilities like going out and actually capturing the crude oil samples and analyzing some of those samples in commercial facilities. We reach out to other subcontractors to help with some of those services.

So now just a snapshot of the overall project workflow. Okay, so let's just start with Phase 1. We'll move across.

Phase 1, which has been completed, was a literature survey followed by a sampling and analysis plan, a literature survey basically looking at the problem and trying to figure out where the gaps in knowledge that would be useful to try to close with subsequent work.

Once we identified those gaps, we basically put together a sampling and analysis plan to address that. Like I say, Phase 1 was completed, and we do have a literature survey and a sampling analysis plan that were put out in the public domain, and I'll give you references to those at the end of this presentation.

That then transferred to Phase 2, which is the experimental phase of the work, and that's where we are currently. I have this broken down into -- we conceived of six tasks that we wanted to complete in order to evaluate all of the open questions that we at least envisioned in this phase of the study.

Right now we are currently funded for four. So as you as I have them listed there, Tasks 1, 2, 3 and 4 are currently funded. Task 5, which involves rail car performance and Task 6, which is kind of a broad-based sampling around North America, of different types of crudes, that is at the concept phase only. So the rest of today's talk will focus on what's actually been funded and underway.

In the end, after all this work is done and we also have what I've envisioned as an implementation phase, in which all stakeholders hopefully would come together to utilize the knowledge gained during the prior phases, to inform decisions on industry best practices, standards and regulations.

And another important component of this is that we've been using regular public outreach in each of these phases, to let's say make sure that stakeholder interests, at least technical interests are addressed. So we have reached out and gotten participation in terms of say technical peer review of our plans and our reports with the American Petroleum Institute, Crude Oil Quality Association, Canadian Crude Quality Association.

As we go forward, I would like to engage with ASTM and GPA as we move toward, you know, later phases. But that's yet to be determined, and we also have utilized some of the knowledge and data from the U.S. Strategic Petroleum Reserve to do some of our early design work.

Let me just move forward. I'm going to overlay color-coded boxes here just to indicate again, reinforce that we've completed Phase 1. We are currently in the middle of Phase 2 and then possible future work embodied there in red.

So this is a high level project schedule. If you align, this is in the U.S. fiscal year system. If you align Year 1 Q1 with basically the beginning of this fiscal year, October 1st, 2015, this is kind of where we are. You can see we're near the end of the second quarter.

We intend to finish all activity level work, if we -- if everything proceeds as planned. Finishing activity level work, that means actually collecting samples, running tests, burning oils by the end of Q3 in Year 2, summer of 2017 and then the final reporting rollouts, public relations, that type of stuff would be occurring near the end of the second year, basically the end of FY '17. That's our current plan.

So let me just give you some screenshots of some of the tests that we're intending to do. We're looking at crude oil properties and combustion tests.

So as I alluded to before, Task 2 is looking at what are really the best ways to capture an oil sample and to test it for its basic physical properties, understanding that some crude oils exhibit some volatility.

And it is the volatility or potential volatility of tight oils that has been at least publicly implicated in being a factor in the severity of certain accidents. I meant that's really one of the hypotheses we want to test, is volatility, embodied in a crude, responsible for or relatable to the severity of a combustion event.

If you don't adequately capture all the gases from the source material and get them all the way to the lab and all the way to the burn test, well then you actually haven't tested the parent sample. You've tested something that has changed along the way.

So this -- largely this effort around Task 2 is making sure that when you go out and collect the sample, you retain all the gases and the volatility properties that are exhibited at your testing or your sampling point in the field is retained all the way to the lab.

So we're going to compare sample capture and analysis methods for two selected North American crudes. Now one question comes up is well why just two? What we're doing here is -- what we're doing is we're doing a series of sample capture and analysis methods. We want to have a normalized sample and compare the methods, so that your source material is the same but all your methods vary.

And that's -- that's our initial attempt. Again, the experimental variable is the sample capture method and the sample analysis method, not the material itself.

Later in the program, we will then

narrow down to the sample capture analysis methods that we're comfortable with, and then the experimental variable will actually be the source material to see how the source material varies. But that's more Task 4 and Task 6.

So anyway, on to Task 2. So Sandia and Transport Canada will administer parallel tests. When I mean parallel, in that Sandia and Transport Canada will both bring contractors to a site and we will capture a variety of -- we'll capture an oil through a variety of means and analyze them through a variety of means as well.

We'll do a critical review of, in particular, open versus closed capture and applicability for use on minimally stabilized oil. Now some of the properties we're interested in are crude oil vapor pressure, VPCRx at T at selected V over L and temperature. We are looking at pressurized by virtue of gas, pressurized gas chromatography, light ends concentration.

Again, this kind of goes back to many

gas chromatographic methods used in the crude oil industry for analyzing oil quality is run at atmospheric pressure. So you can take a pressurized sample, depressurize it at the bench top and then inject it into a GC.

Well, the problem is is you've just done a separation process right before it goes into the GC. So even if you got your sample all the way to the lab, if you didn't put it into a pressurized GC analysis, you've lost your light ends. So we're going to make sure that we have continuous pressurization of our samples from sample capture all the way to analysis.

But we will also do unpressurized gas chromatography as well to do compare side by side, as well as simulated distillation. We'll do unpressurized physical property measurements for molecular weight-specific gravity and viscosity, and I think we're also actually, and this is kind of a new development, is we've also got access to some pressurized specific gravity methods.

So we'll try to do some pressurized versus unpressurized specific gravity as well, and also, at least it may be familiar to this group, flash point and initial boiling point measurements as well.

I'm going to -- the next slide I'm going to show you is our experimental matrix. Maybe I'll walk through this a little bit. I don't expect you --

I prepared this slide for the Crude Oil Quality Association and the Canadian Crude Quality Association and they, they're both familiar with these particular standards for the sampling techniques and the property measurements. I don't expect this crowd to be necessarily.

But what I want to impress upon you is that for a given sample, and we're going to collect two samples out in the field, we want to compare these various methods, pipeline, closed. These are all pipeline or closed sample acquisition methods versus what they call the

Boston Round, which is basically an open vessel.

We're going to take all these to the lab and compare the pressurized samples to the unpressurized samples as they go through this suite of analyses. The analyses are over here going across the top, to include true vapor pressure, three different means to measure the composition, all of which -- this is a completely pressurized compositional analysis. This is the combination of pressurized and unpressurized.

This ASTM D8003 is a relatively new Canadian method that they believe has some promise, and in particular Transport Canada, who's sponsoring that test. They're very interested in that. Then we'll do these physical property determinations as well.

So we're really trying to get after what is the best combination of sample capture. So in the end, we're going to try to identify which sample capture methods and which sample analysis methods give us a self-consistent set of data that give you a composition and physical properties that are, again, self-consistent, especially for systems that have dissolved gases.

So that's Task 2. Now onto the -- onto the actual combustion tests. Once we have down-selected to methods here that are adequate to the purpose of bringing the whole sample back to the lab to do the property and combustion testing, we will then go out and get large-scale samples and throw them into the fire.

So we're going to select four North American crudes and we're going to do the basic property measurements. So when I say basic property measurements, I'm going to go back a slide. The leading, the leading candidates from this table will then be used to characterize the properties of these four large samples, and these samples will necessarily span a range from tight oil such as Bakken, Eagle Ford, with high visibility to baseline light sweet oils, for instance the West Texas Intermediate, the Louisiana light sweet, which is kind of at the middle range, to then a specialized, a specially stabilized crude from the U.S. Strategic Petroleum Reserves, to try to at least --

We're envisioning that these oils will span some measurable range of parameter space, from volatile, higher volatility to lower volatility, and that's the intent of working with these four samples. This doesn't pretend to get the highest, most volatile material versus the lowest, but it does at least span a measurable range.

We'll compare these results. We'll put these into fires, control burn scenarios, and we'll compare these to the performance of ethanol, methanol, jet fuel, gasoline that we have tested in the past. So let me just go to a few images of burn test configurations.

These were photos that were taken during prior Sandia fire testing. One configuration that we're going to look at is the pool fire. As you see, that's the top image there. That's about a five or six meter pool fire, I believe, in their outdoor facility, with a hydrocarbon liquid fuel.

We'll be looking at things like surface submissive power, how much power potentially is coming to an object outside of that fire. How much would that cede. Heat flux to engulfed objects, flame height and fuel consumption rate.

Regarding fireballs, we're going to set up a fireball configuration as well. We'll be looking at similarly surface submissive power, heat flux to nearby objects, and then we would also be interested in and we'll have some high speed photometric diagnostics out there to look at fireball diameter and fireball duration.

That is it for the kind of scope that I was planning on talking about today. If you are interested in reaching out to the various sponsor contacts for more information, just so you all know, Evan Frye is our U.S. Department of Energy contract officer; Joe Nicklous here at DOT and at Transport Canada Barbara Di Bacco is the primary point of contact.

My information, contact information is given here, and then our program manager at Sandia over this work is Erik Webb, and I'd also like to just identify, since he's here, Carlos Lopez is a new line manager who helps -- who is associated with this project. So Carlos will also be in the next version of these. He will be listed there.

We have several project publications, and you can see those. Those are available. I know the top one's available in the DOE/OSTI website. That's our literature survey we did about a year ago, and then associated sampling and analysis plan is posted on the DOE energy.gov website.

Going forward, we actually have the Crude Oil Coordination Steering Committee, I'm going to back up here, has a public relations subcommittee, and so I'm going to turn Mark Raney here. Mark is actually going to be coordinating our project level public relations.

So he would be a point of contact

going forward as well, if you want to understand what the project level information is. We have a number of reports for every one of these phases of the project, Task 2, Task 3, Task 4.

We're going to have a public sampling test plan that will be posted to the public, and then when all the results are done, we'll have a public release technical report as well, plus periodic presentations at public venues like this and conference-association type presentations. So that's it.

(Applause.)

MR. BHARATH: Questions for Dave? Great.

MR. SELK: Can you just quickly tell us --

MR. BHARATH: Can you say your name, sorry?

MR. SELK: Steve Selk, Homeland Security. Can you quickly tell us what method you use to come up with the fireball?

MR. LORD: Okay. So yes, the fireball

is going to be a -- we're creating a durable, reusable pressure vessel with a -- basically a rupture disk on top, basically a custom designed rupture disk such that we -- add a pneumatic hammer on the top to make sure that it goes under the selecting conditions, and then we'll have burners essentially igniting the fire or the fuel plume as it goes up.

MR. FRONCZAK: Bob Fronczak, Association of American Railroads. To show I can provide constructive feedback, you said you're looking at a Phase 4 and the RSI/AAR Tank Car Safety Research and Test Project has done modeling of the using AFFTAC to look at the different crude oils and the impact on tank cars.

So it's something that we've already provided DOT. I know we've provided it to FRA. I don't see Francisco here, but they've already got it.

MR. LORD: Okay, and that would be -- what we'll do, the relevance at this work Task 5, as I have it rail car combustion testing and modeling, we would be utilizing that. If I understand the scope of what you did, we would be utilizing that as the literature base from which to do our Task 5 experiments and modeling.

MR. FRONCZAK: Yeah. I mean we've already done the modeling, so you might want to do some verification, but you --

MR. LORD: Yes, yes.

MR. BHARATH: All right. Next up for the home team, Michael Klem from the Sciences Branch. He's going to talk about W-Ink Crude Classification.

MR. KLEM: Okay. Thanks Veda. Last year I was up here talking about PHMSA's interest in potentially funding this project, based on some preliminary data that Joanna Aizenberg presented at a meeting to FRA based on a six month seed project that she had on there, looking at a special substrate she had, more or less kind of like a silicon chip that was modified to specifically change colors when wetted with different flammable liquids, and then using that color change as an indicator for what that flammable liquid was.

In her preliminary data she was looking at could we differentiate packing groups 1, 2 and 3 based on this wetting technique. Well, the interest PHMSA had is we were dealing with the crude oil topic that David had just finished. You know, looking at the dramatic rise in crude by rail shipments, about 423 percent just from 2011 to 2012 alone.

Knowing that there are differences in crude oil, depending on where it is in the supply chain, where it is sourced, when it is sourced, what the ambient temperatures are. Is it blended with other crudes and how is it packaged?

The idea was this chip that she was presenting that could differentiate potentially packing groups, couldn't differentiate other physical properties, because to determine those packing groups, it's based on physical property testing.

The idea was this could be a portable

test method that could be used in the field. The idea was this would require little to no training to use. In the ideal sense you'd put the chip in, it's covered with liquid, the color changes. You would have something like an iPhone or some type of image capture device, and then it would spit out.

The idea that we can now test in the field, our field agents could use this to get a rapid indication of physical properties; first responders could use it for maybe identifying chemical spills; industry may be interested in it as a cheap, affordable way of testing at transloading facilities, you know, test the material as it's being loaded.

So today, I would like to give a little bit of information on -- this we decided to go ahead and fund this, and we have now completed the first quarter of this two-year project. To give you kind of an update of where we started, where we are right now and where we're going.

The idea again is a colorimetric assay, and this -- I don't really have it. So what we have right here is kind of a render of the final product we want to get to. We want to take this from being a bench top device, a basic research device and get it to the point where we can have a commercially available product where you have a plunger.

You push it. It extracts a liquid up into the device, syncs wirelessly with, say, your iPhone. The software component is a feature of this. So can we write software that will have a matrix to determine in what we have a case here, is can we identify hazard class? Can we identify what the specific material is? Can we identify packing group?

We can have things like specific chemical or physical properties? Can we tell vapor pressure? Can we tell what initial boiling point is, and do this as a cheap method? So the chip she has can be chemical specific. So here I have a couple of examples. Up top, what she shows was a couple of common cleaning solvents.

I got methanol, ethanol, isopropanol. This is one chip, one set of modifications, different responses depending on what that liquid be put on there. So at least among these cleaning solvents, this one chip can discriminate between what each one is.

Other solvents, water, acetone, isopropanol. Again, unique responses, one chip, one sets of modifications. It could discriminate against that. Over here, just looking at ethanol, it's not just what the specific material is; it can discriminate based on concentration.

Here we're getting, you know, at least in this setup right here, less than 20 percent alcohol. The chip reads out the word drink. Above 20 percent alcohol, it reads out drunk. So material-specific response, concentration-specific response. Now I'm going to keep this at a high level and try to avoid showing reflectivity data and a whole bunch of other things.

But it can discriminate based on carbon chain. One carbon chain up through 12 carbon chains with specificity. So a wide range of indicators, excuse me, a wide range of responses to determine products. She's developed a range of like what she called 15 common solvents, and the first quarter for this work she's been able to get a 96 percent success rate at identifying these common solvents.

The way the chip works is by the way these solvents wet the surface. Now PHMSA's interest again is this crude oil classification. We've talked about dissolved light ends, volatiles. Well if the wetting of the chip to get this response is only one thing, that's the wetting behavior, you have a volatile component, we have a drying behavior.

The chip, more or less, has pores. Liquid goes into the pores in this wetting process, you get a color change. As it dries, and it's going to dry based on its volatility, that pattern's going to change. Looking at the volatility changes, at least this drying change, that 96 percent accuracy goes up to 99 percent accuracy, 99.9 percent accuracy in their tests.

So we've got now ways of looking at volatility. Volatility is tied into a lot of these crude oil properties that we've been talking about with these light ends. You know, we can talk about flammability; we can talk about vapor pressures.

So her work is now going on and looking in there, and who can benefit from this? Again, this is a chip put into something that you just have to coat it and it changes color and then your smartphone, because they're working on the software at the same time, tells you what the properties are.

No training requirement other than how to use the software. It's a push button right now. Now they don't have a commercial device. The current device that they're working on at the bench top right now is more or less a light box. It's got a little plastic box that sits on top of it.

It's more or less a pipe head. It does a suction in there. The liquid gets drawn up, the chip changes color. They had an iPod Touch as their camera source and their software device. In two years they want to have this -- or one year, depending on how things go, they want to have this as a commercial device.

So we're looking at two years of funding, and now this is looking at some of the milestones that we set out in the statement of work that we're looking to hit. The first milestone was to develop a scoring system. This is how does a chip respond to various solvents? How would it respond to various crude oils, and can they write a software product to discriminate?

So looking at this petroleum products, within the first quarter they have completed this. They have the dynamic range of the chip now defined across a variety of different organic components, and they are comfortable going forward looking at being able to discriminate different crude oil samples.

The second milestone was to demonstrate a software that is capable of doing this. So not just getting this in the lab, having a trained student or a Ph.D. or a postdoc looking at this saying okay, this change based on reflectivity data on this research grade instrument, I know what this is. They now have the software able to identify this with a high degree of specificity and accuracy.

Again, this is within three months of the start of this project. You know, other milestones that they were looking to have done within the first year, we're still looking at this first quarter results. Now we begin to look at indicator functionality for looking at flammability criteria, volatility, vapor pressure.

So they have this substrate that they're looking at. They're now looking at using other substrates. More or less if people know what a photonic crystal is, they're looking at photonic crystals which don't respond by wetting, but respond by gas penetration with time, which is going to be correlated to vapor pressure.

So all this light end talk and all this testing, open versus closed, getting things to the lab, making sure, now we have a sampling method that can do it all in one extraction. At least that's in the ideal sense. That is what is ongoing. That is what is going to be looked at in Quarter 2 amongst other criteria.

The wetting criteria they have, that's what completed. The drying criteria is an ongoing feature they're looking at to have in Quarter 2 of this and at the end, develop a physical model of volatility profiles, of flammability mixtures. This is also in progress. They are now taking samples collected by PHMSA field agencies, or crude oil samples from a variety of locations, which are going to have a different amount of light ends dissolved in there.

The idea was is that PHMSA would have these characterized with their -- by our labs that we've contracted out. So we know what's in there. We know what their properties, you know, what their physical characteristics are.

Now she's going to benchmark this chip and going in toward getting a device, and can they get a similar type of response or determination in terms of minutes, rather than us having to ship it out to the labs and have them perform all of these ASTM tests on them.

So kind of the outline that they have agreed to right now, you know, develop this indicator assay based on wetting. Note that was supposed to be a three quarter project. They're calling it done within one. So we're already going to be gaining benefits and looking at other criteria.

Develop criteria based on drying. Four quarter project. They are now going further into this within the first quarter than they thought possible before they started this work.

Phase 2, note these are like second year goals. So this is what you may be looking forward to hear, based on the success of this first year, if we choose to go forward in funding.

Image analysis, composition, response. Again, can we now get the software to tie into the chip getting into these vapor pressure analyses. Can we get this all integrated into one to start to go into device manufacture.

Adapting to diverse test conditions. Again, this is currently on the lab bench right now. It's in a light box, a iPod Touch.

They want to develop a device now that can handle robust conditions, to go from minus 10 centigrade up to, I believe it was 80 Centigrade. So they want to have it be applicable in the field, not just on the bench, and then a user interface for a kind of a rapid spill.

So like one of the cartoon pictures I have there had this little iPod, like iPhone screen up there that said flammable liquid, class and then, you know, kind of an identification.

Can we actually now, instead of talking about this, have a practical application of this? Again, last half second year, but we're already so far ahead on the first year.

Last time I talked with Joanna, she feels with potentially some additional seed money thrown in there, she could have this executed within one year. Develop prototype device. Again, if we choose to go forward with the second year of funding, this would be looked at at the end of the second year, and then submission of quarterly reports and the reporting requirements is a thing in here.

So that's what I have right. If Veda wants to cut me off, so -- questions.

MR. BHARATH: A couple of quick questions?

MR. LORD: Is the chip a MEMS chip?

MR. KLEM: It is not a MEMS chip. I was avoiding getting into any technical detail. It's a reverse, it's a reversal of a chip. So it's a standard depth, but then they have this vapor phase deposition thing in there to modify the poor behavior, and then introduce various chemical moieties in there, which would affect the wetting behavior on different sections like that drink, then, or that drunk.

Different sections of the chip and depth. So you don't just have the surface chemistry in there; you have the depth profile going in there, and they have ways to get in there and modify that. So you're chemically altering the wetability, which also means you're changing the volatility as it dries off.

MR. BHARATH: Anyone else with a quick question?

MR. KRATOCHVIL: Joe Kratochvil, International Association of Fire Chiefs. Just a quick question about the goal for first responders. Was this intended as a first off the truck meter, or was this going to be designed for verification and identification?

MR. KLEM: You know, I don't know what she had in mind when she first proposed it, you know, to set that. But I think the idea was you're coming in, you have an unknown, and before you, you know, you want to get into that, you kind of want to know what that is, what the hazard is associated right there.

So I would say, you know, minutes on the scene. If you could put this in there and get, you know, a common response to what it could be. If you can't say read the placard on the spill or you don't have the shipping paper, or you can't get access to that information. It would get you more of a is this caustic, is this flammable, do I want to have -- is it okay to send my people in there, or do I want to have them withhold until we can have other treatments come forward?

MR. KRATOCHVIL: Okay, yes. Just I see some issues. If you can get it where it reads vapors, that's fine. But I could see some issues if you've literally got to go to a product. Before it identifies you've got to wet it, that you could be putting people into a harmful environment unknowingly without using other stuff. So that's why I asked.

MR. KLEM: Yeah.

MS. LU: -- time for one more question.

MR. BHARATH: Okay. Yeah, let's make it quick, because it's online.

MS. LU: Okay, it's online. Are there considerations on --

MR. BHARATH: Do you mind?

MS. LU: Oh okay.

MR. BHARATH: Just go ahead. Michael, we'll reiterate the questions.

MS. LU: Are there considerations on how to ensure a representative sample is being tested? For example, how does the same sample get drawn into the test device or chip, and is that test open to atmosphere?

MR. KLEM: Okay. So the question was how are we making sure it's a representative sample cell. So in the case of crude oil, how are we going to make sure that the light ends are retained? Well, in their current experimental design, it was in our last quarterly report, they're looking at have, building a closed system in terms of if you're going to look at the photonic crystal that's going to respond to vapor pressure -- it's going to have an enclosed cylinder in it.

I forget what the dimensions are, what the orifices are. But you know, you're going to have a liquid introduction system, so you're going to have a, like, closed pressurized cylinder, kind of an FPC floating piston cylinder type device.

It's going to push the crude oil into there because of course, since these have dissolved gases, these are non-equilibrium conditions, what the vapor to liquid ratio is going to be is going to impact the response of the chip.

So you're going to have a closed system. You're going to -- introduced in there to maintain these closed conditions. You're going to vary how much liquid in there, and then you're going to have more or less the chip up on top, detector coming up through the, you know, impinging down on there.

You fill from the bottom, at least in the gross schematic. So the experiment is designed to maintain all the gases, because the moment you vent to atmosphere or you do, you open it up, you're going to lose. You no longer have a representative sample.

So at least the sample PHMSA is going to provide, they're going to come in floating piston cylinders. They're going to tie those in with metal tubing. They're going to maintain compositional integrity throughout.

MR. BHARATH: Okay, thanks. Thanks, Michael. All right. So right about now we have time for a break. We're going to push the break back a little bit. If you all could be back by 3:15 it will be good, so we could keep on time.

(Whereupon, the above-entitled matter went off the record at 3:08 p.m. and resumed at

3:15 p.m.)

MR. BHARATH: All right, thanks everybody. We're going to go right into it. First up in the Energetic Materials section of the afternoon session, we're going to have Richard Tarr from the Sciences Branch, talking about chained and unchained fireworks and then black powder equivalency. Richard.

MR. TARR: Thank you. Just a little background. I've been with PHMSA previously RSPA for over 23 years now, working most of the time with energetic systems but I did a stint working in cylinders for a few years.

Today I'm going to talk about a topic related to explosives, and it's dealing with chained and unchained fireworks. Basically, display fireworks are the things we all get to see at the 4th of July, and we need to -- we're looking at evaluating the -- is the risk of chained and unchained display shells essentially the same? Should they be regulated the same by DOT?

We want to look at these using a standardized test used for classifying explosives, and those are the tests found in the U.N. recommendations, and it's called the Series 6 test. Just an example here. You see the chain shells on one side. They're also typically put in boxes and unchained shells on the other side.

So the problem, well just to understand, so basically in a chained situation, all those shells are chained so that when I light one, the whole series in that chain is essentially lit instantly. I mean within milliseconds, every shell in the chain will ignite.

And in the display they're all loaded in tubes and they all shoot up in the air and they look gorgeous. But in transportation, what's the risk, and then versus you know when you ship shells unchained, they're all still put in the same shipping boxes.

So, you know, when you light the first shell, it still may be only half a second before the balance of the shells goes off. So we're trying to answer is that time enough to change, potentially change the classification of these two materials?

So do shells react differently from an unchained versus chained, and evaluating that under the U.N. test scheme. So in that scheme, we basically have three tests classifying being able to differentiate explosive risk, and those tests are single packaged tests, Test 6A; stacked tests, 6B; and bonfire. I'll explain a little about how they differentiate in a moment.

History. For years, I mean my whole career here, we've approved display shells under a default classification standard called the 87-1. This standard, and under the standard we reviewed chained and unchained shells the same. Then there was a concern that got raised a few years ago. Is the risk the same?

Since we didn't really have any data to support it, I've gone to the U.N. and asked them. They have done extensive testing on fireworks, fireworks and classification. But one of the things they did not look at is the impact of chaining shells and how it impacted classification.

So we decided we would invest and do this research on this, and this is research that's currently being carried out now. So although the U.N. standard is not currently adopted, it does allow shells up to six inches to be classified as 1.3G fireworks. So that's the target and does chaining impact that classification?

So now I'm just outlining the project that we had proposed and that we're currently funding. We're going to look at overall three different types of shells, some smaller shells so you get a lot of them in a box; generally that's 72 shells in each shipping box, and the most common that we see are assorted colored shells on firework displays, and that's typically how they're shipped.

The ones that are chained are the ones

you see at the end of the fireworks show, your finale. So we're going to compare those to the small shells. Then of course everyone likes to salute. They're chained and they're in many finales.

So we're going to look at the risk of what would be considered probably the highest hazard shell in transportation, which are the salute shells, and we'll see if they differentiate between the chained and unchained configuration.

Then under the U.N. default system, the largest shell that they approve is a six inch shell. So then we'll -- we'll take a look at that as well. That's my biggest fear, this little change in this one or, whatever. Probably not my biggest, but one.

So we use the six inch chain as the highest level, and then of course compare them all to using U.N. as the baseline for the classification of a 1.3, 1.3G firework. So yeah, the project -- so we consisted of selecting those three or three different shells in chained and unchained.

Then we'll do the test. We're going to do all the tests regardless. Normally in classification tests, once something says it's this level of classification you stop. But because of the nature of the research, we want to do and get as much replicate data as we can.

So we'll conduct all the tests. We'll do the single packaging test. That's basically you take one package, you ignite a shell inside and you're looking at propagation from shell to shell within that single package. The stack test is similar, but you put two packages adjacent to it, and then you're looking at propagation not only within but two adjacent packages.

These are -- the first two tests are pretty highly confined tests. You put about a meter of sand or gravel or generally sand on top of the packages. Then the last test is a bonfire test, where you just put it on a rack and see how it reacts in a fire situation.

We're going to collect all the data and see how it -- see what it tells us in terms of is there -- is the classification of these products essentially the same? So that's our research goal for this project as a whole. You want to go into the next? Okay. So I'll move down. So that's chained in a nutshell.

The next project, which is -- has been written up, is ready to be, I hope, submitted for bids, is a project that's called black powder equivalency test. This project's history here is that we have no test to really -- to evaluate the properties of black powder and assess its risk in transportation.

Now you have to put this in context in the whole scheme of how black powder is incorporated in fireworks. So it's a critical, it's a major element in fireworks approved under the APA standard, and about in the third revision, 2001, we changed the standard to allow what we identify as equivalent formulations of black powder.

But we never developed tests that could assess or measure those equivalent formulations. It's been a very highly debated topic in terms of what's equivalent and what's not. So we want to put this to bed. We want an answer to definitively identify the equivalency of black powder.

The formulations of black powder are not what they used to be. Although we identify black powder in our regulations as mixtures of charcoal, as potassium and sodium nitrate, that was a while ago. Things have changed. The world has changed. But you know, the regs may be slow to change.

But anyway, what we know is industry has changed these formulations of black powder, and they've gone to what I would call more energetic oxidizers, sometimes more energetic fuels. So how can we identify this risk and be sure that we maintain the risk and don't exceed, you know, in consumer fireworks, the 1.4G risk of fireworks, and in professional fireworks, of course the 1.3G risk of fireworks?

So in all of this, we're going to look for -- we want to find this test or tests to be able to assess this risk and hazard of black powder. So the project here is first, there's a lot known about black powder. We really need to do an extensive study of what's out there, what's published, what do people use to qualify, do QC work, to ensure that black powder meets or maintains a standard?

So is there something out there that we could use or capitalize on, some information I'm hoping we can use. Then couple that with, you know, look at the U.N. test manuals. Are there tests that might be very useful in terms of incorporating or potentially modifying to assess the properties of black powder?

Then we go on. Once we do the research, then let's, you know, I think -- okay these are my ideas, that the type of testing is going to be to look at the power of these explosive substances, burning rate of the substances, or a very popular test is a time pressure test, where you confine the substance in a very small space and look at its pressure profile as it's burned or as it's ignited.

We want to do this based on what we find out in the literature, based on what the experts out there who know black powder. Take that insight and develop a test scheme.

Then write up a matrix of the powders we can test, look at what the various formulations of black powder are, commercial black powder, you know, the many black powders that are incorporated in fireworks today, and then from that matrix, you know, just do as much testing as we possibly can. We've built a large database to understand and assess the properties of black powder.

I do want to test. I think it's important to test alternative formulations, compositions, use in fireworks to see how the energy or characteristics, explosive characteristics of those comparative black powder.

I mean although black powder is sort of the standard for energetic composition, you know, how do other compositions compare, in terms of looking at the overall risk of the compositions that are used in fireworks today? And with luck, that's it. Thank you.

MR. BHARATH: All right, questions for Mr. Tarr?

MS. HECKMAN: Julie Heckman, American Pyrotechnics Association. Just a couple of quick things. With the chained and the unchained shells, have you selected the contractor, the lab yet to do the test?

MR. TARR: SMS was awarded that, yes.

MS. HECKMAN: Okay. When the testing is done, can industry observe?

MR. TARR: I don't know. I mean --

MS. HECKMAN: I'm just thinking we'd probably like to, if there was a possibility to just observe the tests that are being done, just for --

MR. TARR: I mean it's certainly not being done in secret. It's all going to be recorded. All the data will be released to the public.

MS. HECKMAN: I would just think curiosity on this one.

MR. TARR: Yeah I think --

MS. HECKMAN: I'm sure we'd have a technical consultant that would be there.

MR. TARR: The biggest challenge is really timing, because we're really pressed to get this -- the chained one done. I'm traveling out to SMS next week to witness as much testing as I can in that week. So -- but I know setting up visits out to there, yeah they need advance notice.

I would certainly never object to it. I don't think the department would, but it's making it and coordinating it would be the complication.

MS. HECKMAN: Oh yeah. No, and I wasn't going to ask for that. I was going to say if they said it was next week and we had one person that wanted to go. That's all.

MR. TARR: We're definitely doing testing next week.

MS. HECKMAN: Thank you. I'm glad to know it's going forward. The other thing is with both of these projects, even though right now it's really about the APA and all of our importers and the approvals that we do issue to fireworks, you know, this is a global issues, and the International Symposium on Fireworks, which I am a director of so I'll make the pitch now, the next symposium is April 2017 in Japan, and I think you should present both papers. If you can get both projects --

MR. TARR: Jerry, do you hear that?

MS. HECKMAN: If you can get -- if you can get both papers done, I think this would be really important technical information to put forward in that platform.

MR. TARR: Well certainly the chain research should be done. The black powder one is, you know, I can't speak for that. We did just -- we're just finishing up the research on the waste treatment for fireworks, and we hope that that would be a forum to present that research as well.

MS. HECKMAN: I think any of those would be great topics. Thank you.

MS. HILTON: Are you going to be participating in the roundtables tomorrow?

MR. TARR: I'll be here.

MS. HILTON: Okay. So maybe in the interest of time I'll just hold my question, but I've got --

MR. TARR: Just save it. Okay, I'll be here.

MR. BHARATH: Any other questions? Okay, thank you.

MR. TARR: Thank you, Veda.

(Applause.)

MR. BHARATH: All right. Next up we have Andrea Dunham from the Sciences Branch.

MS. DUNHAM: Thank you Veda. Again,

my name is Andrea Dunham, and I am with PHMSA's Sciences Branch. I'm a chemist. I'm going to talk today about enhancing the classification and testing of energetic materials. Now what exactly do I mean by that?

Well for certain, well-understood items with defined parameters, can we classify these using alternative tests, streamlined classification, fewer tests, no tests even while maintaining -- still maintaining the equivalent level of safety to the regulations?

And of course to do that, to determine new areas that we can do that, we would require research. So keeping that in mind, our goal of why I'm talking here today is to help, get together and help come up with ideas and areas in which different materials or different items can be classified differently.

This would be ideas for future research. If we can do this, we can increase efficiency, not only for industry because perhaps less testing will be required but for PHMSA as well, eliminate unnecessary tests. Again, I want to reiterate that anything that we do if we were going to deviate from what's currently in our regulations need to be supported by research. It needs to be supported by data, and we need to maintain our safety equivalency to our current method.

So we are already doing this in some ways. So I want to start out giving you a few examples of ways that we really, we already do do this. This is just an idea of what is possible. One example are jet perforating guns. Currently, jet perforating guns that are manufactured to certain specifications that are outlined in the AESC/IME standard, and that contain already-approved, DOT-approved explosive components such as shaped charge, detonating cord, and manufacturing according to the standard they can receive an EX from the DOT without classification testing and without review, a technical review.

Small arms ammunition. Small arms or ammunition, if it meets the requirements in our regulations can be self-classified for the manufacturer. Again, this doesn't mean that they don't need to be tested, they don't need to be reviewed by PHMSA.

Fireworks, as we were just talking about, is another example. Fireworks, if the devices meet what's outlined in the APA standard, if the chemicals are on any approved list and if they pass thermostability testing, they can apply for an EX and receive an EX from us, but classification testing isn't required if you meet the standard.

This is an example on the right if you're curious, that is an example of a jet perforating gun -- a supported tube -- you can see it has shaped charges, set detonating cord. The components are approved by DOT. So what kind of research can we do to support any of these ideas? One example would be shaped charges.

Shaped charges are fairly common articles as you saw on the previous slides. They are within jet perforating guns. They tend to have the same common explosives, the same types of liners if they have liners. Here's an example of a conical-shaped charge with a liner.

In the past, we have used weight to differentiate between different classifications, but what we are missing is research to help us determine where these different classification division boundaries are. So just for an example, would net explosive weight, could we see this difference between Class 1-1 behavior and Class 1-4 behavior? Or wouldn't we start seeing effects outside of a package in classification testing?

So this is an example of where we need research, and if we can get research to support this idea, we could perhaps come up with a standard for shaped charges, and a way to have the streamlined classification.

A few other examples, and this of course is not an exhaustive list. It's not an exclusive list. These are things that we came up with to kind of start a conversation. Analytical standards are extremely desensitized explosives. At what concentration would you start -- would you stop seeing an explosive? How dilute does something need to be for it to not be an explosive?

This is something that we don't have a lot of data on. So right now, any explosive content needs to come to us, needs to go to a test lab. But is there a low amount that it would not be considered an explosive?

Electric matches and igniters are kind of like shaped charges, examples of articles that are fairly common, well-defined. So what we would need to do is identify the parameters and supporting test data to possibly incorporate these in some way.

Smokeless powder packagings, another example. Smokeless powders are also classified as a 1-1 or a 1-3 and can be packaged down to, you know, 1-4 classification.

MR. BHARATH: That's the video.

MS. DUNHAM: Okay. So for example, is

there a conservative packaging that could be used for smokeless powders that meet certain defined parameters, that would result in a 1-4 classification without the extensive testing, or with less testing?

So what are the parameters, how can we define these parameters and what testing would need to be done to maintain confidence in the classification and maintain this equivalent level of safety?

All right. So that was quick and brief. We are having, tomorrow, a breakout session on this. So I'm hoping that this gives you an idea of what we're looking for, and for those interested in tomorrow, we want to use that forum tomorrow to expound upon all of this, entertain additional ideas, things we haven't thought of, and ways to move forward.

MR. BHARATH: Cool. Any questions for Andrea?

(No response.)

MR. BHARATH: Well, you know where to

catch her tomorrow. You get the plug for the breakout session.

(Applause.)

MR. BHARATH: All right. The next subsection we're going to move into is related to emergency response, and first up we're going to have Dave Brown from Argonne National Labs to talk about the protective action distance estimation and the ERG, which is the emergency response guidebook. Thank you Dave.

MR. BROWN: Yes, and this doesn't quite match the title that was in the agenda, but -- or closely matches what I'm going to talk about.

So I'm going to talk first about just a little background on the emergency response guidebook itself and the protective action distances, then talk about some of the analysis procedure we use in determination of the distances, and then delve into reactivity considerations, and by reactivity I mean the reaction of these TIH materials with the natural surfaces and surroundings, which is actually a mitigation mechanism that we've been looking at experimentally for PHMSA.

So most of you are familiar with ERG, but just a real quick background. It's obviously developed by DOT I think back in the 80's.

The first one was maybe '87. Right now it's on a four year upgrade cycle, so every four years there's a new version that comes out.

The 2016 version, I think as Rick had mentioned, is at the printers now. It catalogues over 1,300 materials cross-referenced by a common chemical name and U.N. ID number. For a small subset of these materials, about 250 plus toxic by inhalation substances, there are protective action or initial isolation and protective action distances.

These materials are pure substances, generic substances, mixtures and solutions, and water reactive materials, which is a little different than the other reactivity I was going to talk about. Water reactive materials are materials that are normally non-TIHs. They may be toxic but they're not an inhalation toxicity.

But if you get them wet, they release toxic by inhalation materials and are thus a considerable hazard in those instances. So delving down into the initial isolation protective action distances, the distances are provided for small spills and large spills.

Small spills are everything up to 200 liters spilled; large spills are everything else, up to and including tank cars. So that's a huge category of potential releases. There's a snippet at the table here from 2012, just showing how it's laid out in the guidebook.

For the protective action distances, they're also provided in terms of day and night. So the reason that is is because the dispersion conditions and the dilution within the atmosphere is much different in the day versus night, day being much more convective and a lot more dilution and shorter distances to a safe concentration, night being the opposite end.

For six what we call high volume materials, large spill distances are further broken out by container type in transportation mode, highway or rail. An example -- the file here.

This gives the distances in so-called Table 3 and there's three tables. There's Table 1, which is the initial isolation protective action distance; Table 2 is for the water reactive materials and what these materials produce. Usually they're HCl emitters but some emit phosphine and other types of nasty materials, and Table 3 is some more specific tables for six materials, chlorine, ammonia, sulfur dioxide, hydrogen chloride, hydrogen fluoride and ethylene oxide.

Those six materials comprise over 95 percent of all TIH transportation. So we sought to give them a little more special treatment. So these are -- this is an example for chlorine. It's broken out by rail car, highway, tank truck or trailer, multiple ton cylinders or single ton cylinder, multiple small cylinders, all being large spill releases.

This table has the same look and feel as what's in the guidebook, but here I've given a comparison of 2016 versus 2012, and if you look very carefully, you'll see the 2016 numbers are quite a bit smaller, especially for the low wind speed cases, and this is because of the experimental work we've done on reactivity that I'm going to talk about in a bit and how that's reflected in the guidebook.

I will point out that Shannon Fox, who's in the room, has also done a lot of work in chlorine releases out at Dugway, and they just did a nice series of tests last fall. They're going to do another series this fall, and that's really going to help guide and influence the chlorine numbers going forward.

Now, the analysis procedure. Basically, the way we've been doing for really since '93 now is looking at it at a very risk-based approach. So how does one balance the risk of over-protection against or balance the risk of insufficient protection with the risk of over-response?

And you know, the solution really is the risk-based approach, where we specify a level of protection which is essentially the percentage of time that the protective action distance will be sufficient. The model we use for this is something we've developed over last 20 years that's called CASRAM, Chemical Accident Statistical Risk Assessment Model, and it's a Monte Carlo-based approach which I'll talk about in a little bit.

The components are emission rate models, dispersion models. We have a very extensive meteorological database built in. Actually, that slide's a little bit out of date, because now it's about 11 years of data or ten years of data for over 100 cities.

It's closer to 150, as well as ignition, thermal radiation and blast overpressure algorithms, which have been used in the past but aren't part of our ERG work right now.

So the tools and data we use in this are the transportation regulations themselves, because that really informs the containers that these materials are shipped in. We've done a lot of work with historical accident data, mainly the HMIS database, which gives us a good idea of how much is typically released in an accident.

Commodity flow data for certain chemicals, meteorological data as I indicated, obviously chemical property data comes into the mix and of course the models within CASRAM.

So the analysis steps are basically you simulate over a million accidents for every chemical, sort results into small, large spill, day and night, and set up a protective action distance as the 90th percentile of that, and that is that level of protection that I've talked about before.

It's noted then for six major chemicals on transportation mode we have much more specific or container-specific information as I mentioned a few slides back.

Another key element of this besides the models themselves, the physical release, source and dispersion models are what protective health action are we using, and the basis for the protective action distances is the AEGL-2, the AEGL-2. Again, I assume most of you are familiar or at least have some familiarity with the AEGLs.

The chart definition of this really is the threshold for serious long-lasting health effects or an inability to escape. There's three AEGL values that are published. There's an AEGL-1, which is basically a no effects limit. The AEGL-2 is defined up there, and an AEGL-3 which is more of a fatality threshold, where you expect to see fatalities to show up for various sensitive populations.

As mentioned, these do apply to sensitive populations. So the health values can be quite conservative. For chlorine, for instance, the one hour AEGL-2 is two ppm. So if you release a tank car of chlorine, generally you have to go out quite a ways before that dilutes down to a two ppm level.

In the ERG analysis, we used both interim and final AEGL values, and we have a rank ordering process. If a final AEGL-2 is available, we use that. If not, if an ERPG-2, which is a similar criteria that was in use really before the AEGLs came around, we would use that. Then we go to an interim AEGL-2.

If none of those are available, then we actually have to fall back to LC-50 concentrations, which are the lethal concentrations for 50 percent of the population, and there we use one percent of that value. So for 2016, fortunately, AEGL-2s were available for most of our list. A lot were published really between 2010 and 2012 and '14.

Right now, most of the rest are ERPG-2s and then we only have 25 now that we really have to rely on this LC-50 concentration data for.

Now the interesting part, reactivity considerations, and this really delves into the work we've been doing recently for DOT. The reactivity in the surface definition of these materials has been recognized in the modeling community anyway as being a real gap in the understanding of these hazardous material releases.

There's been, you know, a lot of attention paid to the fact that for, you know, some of these major accidents that have occurred, we don't see the concentrations or these, you know, serious health effects going out as far as the models might suggest given the release amounts and the meteorology.

So you know, one of the key parts of this, at least I think, is this reactivity on surfaces, and the consumption of the material both, you know, in the near source area but as well as, you know, kilometers out as it's drifting through vegetation and reacting with the ground.

There's been a lot of studies that have shown that looking at, for instance, AEGL-3 concentrations, which is a point a lot of people have looked at because it's generally only a few kilometers out, the distances of those concentrations are significantly reduced if one makes some fairly realistic assumptions about surface deposition.

As noted, most of this is driven by vegetation uptake. Although soil is very important, too, as I'll talk about in a bit with ammonia, and fortunately as long as we have the empirical data to drive it, the actual inclusion of deposition in a dispersion model is actually very straightforward.

One defines what's called a deposition velocity and it's actually used as a sink term in the mathematical part of it. Fortunately for us too, we have some of the other parameters in the modeling itself that really inform and help drive that.

For instance, land use and season,

vegetation parameters such as vegetation type and leaf area index, as well as some of the atmospheric boundary layer properties, which are important and which I'll talk about in a bit.

Now the real problem with this and why we can't just open up a guide book or a series of papers and pull the values out and put them in the model is they don't really exist. This surface reactivity is not well-characterized, even for major commodities. We've looked a lot at the research in chlorine and ammonia and often, you know, the values are anecdotal or especially in a lot of the early research, people focused on things such as deposition velocity itself, which is problematic because it also has an atmospheric component built into that.

So there's, you know, there's a disconnect in the literature that was out there. So what we try to do was build, you know, was design a series of experiments that would tend to give us more fundamental parameters of this.

Another key issue we have with the ERG

is that we're dealing with, you know, 150 to 170 separate chemicals that we would need data for. Fortunately, the vast majority of incidents as I mentioned are really limited to six or eight materials.

But the guide book by necessity has to list distances for every TIH material that has a U.N. number, whether it's transported in any quantity or not.

Really, if you look at the 150, there's probably only a few dozen that are in transportation, maybe 40, and a lot of those are very small amounts. So the basis for our experiments is to really calculate a deposition of velocity in a chamber test, where we release the material into a chamber, the chemical into a chamber, measure its concentration as a function of time when exposed to certain vegetation types.

Using that, we can isolate in on this surface depletion resistance. There's three resistances up here. This is a common formulation in the literature. I'm sorry to have to put an equation in here. One is the atmospheric resistance, which just tells us how easy is it for that material to get from the atmosphere down to the surface or within the vegetation.

RB is a surface boundary layer resistance. Basically boundary layer is in the leaves and stuff. That's fairly easy to estimate. It's atmospheric resistance can be a little trickier, but we have it in a model already. Then RC, which is the surface depletion resistance, which is a parameter that we are aiming to measure in the experiments.

And since we use a vessel that's well-mixed, we could pretty much, you know, we minimize the effect of basically this RA and RB. So looking at how the concentration varies as a function of time and how much leaf area is in this chamber, we can estimate directly this deposition velocity and then the inverse of that is this resistance.

That's all I'll talk about now here.

So the experimental apparatus we used is shown here. Basically, we have ten liter chambers. We have vegetation that we either grow in the lab or get on site, that we've been very careful to estimate the area of. The folks we have doing this came up with some very novel ways to scan the materials in and get areas from them.

We put the material in the vessels, again expose it to the chemical of interest and look at the concentrations as a function of time. So this is a series of data for clover and clover is something if you look in the literature, everyone seems to start with clover. So that's what we did, just to see if we can get comparative values.

Typically we do this many, many times to try to get a, you know, some idea of the statistical variability. What you see at the top is a series of lines that show, you know, loss of the empty container itself. Some of that might be photolysis.

We did find especially with chlorine

we needed to condition the containers first, because the container would actually absorb some of it. But then that settled out and then we could look at the actual loss due to vegetation.

So here, if you put that into a spreadsheet, you can calculate a deposition velocity of about 8/10ths or 8/100ths of a centimeter a second, which translates to an RC value of 650 seconds per meter, which lines up fairly well with some of the other data in the literature. So we felt pretty confident about this.

So racking and stacking everything for chlorine and then we looked at sulfur dioxide, hydrogen chloride and ammonia, and then mapping the vegetations we use and we use clover, shamrock, grass, just a normal lawn type grass, as well as a conifer which is the spruce, we were able to map into some of the -- or the vegetation types that are very common in land surface models.

We also looked at a variety of soils,

just bare soils and also at a variety of different moisture levels from completely dry to about ten percent moisture. So when we ran our data and ran the statistics on them, here's the RC values we got for them as we map into the vegetation classes we used within our model. So this is what went into the emergency response guidebook analysis in 2016.

So what are the next steps in this? Well, we want to continue these tests and we actually have a proposal in to do just that. A couple of analysis options here is we can expand to a new set of chemicals, you know, a few chemicals that are of interest and are also in transportation, things like hydrogen sulfide, methyl mercaptan, carbon dioxide, phos, things like that.

And/or we can conduct additional experiments on chlorine and ammonia. Chlorine and ammonia account for about 90 percent alone of all TIH transportation. So you know, we'd like to have a very good idea of what happens with those materials.

We are going to be coordinating very closely with Shannon's group, who are also looking at doing a similar series of tests actually in the field, where they can expose these to much higher concentrations.

We're a little bit limited to what we can do in the lab just for safety reasons for that. So you know in the field, you know, you might be able to go up to 1,000 PPM, whereas we, you know, we can't -- for something like chlorine, which we can't do anything quite like that.

So that's it and you want to talk -- and we'll do questions or not?

MR. BHARATH: Yeah, sure. Questions, yeah. Really fast, so long as the questions don't get out of line.

MR. RAJ: In the tests that you just showed, was the vessel closed?

MR. BROWN: Oh yeah, yeah. Closed and sealed.

(Simultaneous speaking.)

MR. RAJ: Was the pressure changing continuously? The concentration of chlorine was changing?

MR. BROWN: Yes, within the vessel continuously right, and the vessel was completely closed, right.

MR. RAJ: So how does that translate to the real world outside, where it's diluting and concentration is changing?

MR. BROWN: Well because we don't -- we're not losing -- I mean first of all, we're not introducing additional chlorine. The chlorine that was in there originally is getting depleted by the vegetation. So we did test, of course this isn't going to be working for me now.

Notice when I had that graph up, we did test with a chamber, and maybe I didn't explain that right, without any vegetation. So it's an empty chamber, nothing in it. We introduced the chlorine and see how that varies as a function of time.

Then we introduced the vegetation and we see how that varies as a function of time, and then we take the end, you know, and then we use it -- use basically a difference approach. One thing I forgot to point out in that last slide is for ammonia, if you noticed this surface resistance value is very high for vegetation but very low for soil.

So there wasn't a lot of reaction of ammonia with the vegetation. There's a lot of reaction with the soil, especially the wet soil. Just sucked it right up.

MS. HILTON: I know that DHS has done a lot of testing in this area, and if you haven't talked you guys probably should talk.

MR. BROWN: Yeah. We've been -- Shannon and I have been collaborating on this. Actually Shannon came out to the lab when we were doing this.

MR. BOYLE: They go back to Jackrabbit 1.

MR. BROWN: Yeah. Well before that.

MR. BOYLE: We didn't know it was Jackrabbit 1.

MR. BROWN: Right, exactly. It was a jackrabbit then, right.

MR. BOYLE: It was two.

(Off mic comments.)

MR. FOX: Yeah thanks Dave. I'm Shannon Fox with DHS CSAC, and we are doing this fall a second round of large-scale chlorine release testing from 10 to 20 tons outdoors, and we will be trying to coordinate our experiments with reactivity with what you've done Dave, to explore the high end up to 100,000 parts per million, with a realistic release.

We want to include vegetation similar to what you did. I wanted to know how you determined the surface area for the different vegetation, given that it will be variable between each sample that's put in there.

MR. BROWN: Right, right. And so what we did is for instance like on what was shown there, the clover. So we would use typically four clover leafs and we did very careful measurements of several sets of those, got an average basically of what a chlorine -- or of what a clover leaf was.

So there would be -- the guy that was doing this, Bill Haney who you met, would actually scan. He had a piece of software that would basically tell, you know, exactly what that area was and it turned out it was pretty -- it was pretty, you know, as long as he picked leafs that were all around the same size, you know, visually when he scanned them they were all very close.

So you know, we tried to, you know, we tried to standardize that as much as possible. The most difficult, as you might imagine, was the conifer, because it's a triangular leaf and he had to make a guess of that. The grass was also very difficult. So but that, you know, when you talk about shamrock and clover, that was easy.

(Applause.)

MR. BOYLE: I do laugh Shannon.

Every time they talk about that one, I see Dave's small lab setup and he can count clover and measure. I said what do you do out at Dugway, where you're bring in a truckload of fir trees and work with that. Maybe you can count clover for them out at Dugway and get paid huge amounts of money to say that's ten leaves or 20.

So it was entertaining when I first heard that we counted clovers and measured them in the lab, and I did think of you. I'm going to do three things really quick, because Veda has a mean hook. He will kick me right off. He doesn't care.

First thing I'm going to do is a little bit of an update. I'm just going to tell you how we stand with the 2016 ERG. The next thing I'm going to do is I'm going to beg you to participate in our discussion group tomorrow, because we need to know do you want to take the ERG.

We want to do it more online. You've seen a lot of discussion as to what can do online, what resources can we make available, how can we improve our product? Not everything has to be in a book form. So I'm going to beg you to participate in our discussion group tomorrow morning, to say what direction should we go. What we're saying the interactive, the online ERG.

I'm going to beg you to participate in that, and then I'm going to close with telling you a little bit of how tomorrow's going to work, and that's primarily for the people that are streaming in and want to participate. We're not going to have six or seven cameras at each table and stream, and you pick a group. It's not going to work that way.

It's going to be like teleconference. So I just want to explain how we're going to -- how tomorrow's going to work and I should still be done before Veda gets upset with me.

There we go. That's what the 2016 ERG is going to look like, and since he's not here, Tom Kiddy's out in Louisville is the printing company. I asked him, because they've already reviewed the proofs. I said can I have one of the proofs so I can pretend to have a 2016 ERG?

He said no, that wouldn't be fair. You don't get the first one. So I don't get it. That's what it's going to look like. That's what the proof looks like. You'll see it's got a top band on it. They are printing them now. They should be delivered and there was somebody from the fire chief.

The distribution list is put together by our training and outreach people. They've gone state to state. So they'll know where they're going in the state.

If you have a question as to where are they going in your state or who gets them and how do you get access to them, please submit a comment card or email to us and I can get back to you. I don't have all 50 states and all the coordinators.

They're also they're going to be in Spanish, French and English. They'll go to

Canada. We're always interested in how they're going to get into Mexico. They seem to be stuck at the Mexican border all the time. We're promised they'll flow into Mexico seamlessly.

As we've done in the past, we don't release our data files until our book is out. That means we get to hit the street first. So that means if we distribute the books in April, the data files will be available in April. It will lag a week or two. We tend to let Tom Kiddy who does it, who's in our Outreach and Training Group, we tend to let him come back. He gets to spend two weeks printing the book.

We give him a week to relax and everything, and then we say you've got to start working on the data files, to make sure they're released. So they won't lag too much longer. I don't see Bob Richard here anymore from LabelMaster and the other groups that always want the data files as soon as possible. But they will come out.

Print edition updates. I can read

them to you. What we're going to do is we did it at the beginning. Instead of verbally telling you how to use the book, we gave you a flow chart on how to use the book. The table of placards is bigger.

One of the comments is the rail car and the road trailer identification charts are always so small, and it's really hard to tell the difference between which one was which.

So we made that section a little bit bigger. We used better drawings. We cleaned them up more. So we hope you'll see better things there. Bob Fonczak is still here. If you take all of the work that Dave Brown did, and the reactivity work, we filled all that back into the CASRAM model. So you'll see the protective action guides being very different, particularly the Table 3 models.

Because of the reactivity data, we were able to put in. So please take a look at those. Our Pipeline Group, remember we're PHMSA, which is pipeline and hazardous material, they updated their section and that's included. This -- I don't know if it's the first time.

First time for me. We put the GHS markings in and that's going to be a topic tomorrow. Where should we go with that? How much farther should we put? Should we do more with the GHS system in the ERG, how should we work with that, what's really going to happen? So I'll put that out as a discussion.

Again, we have to always update the U.N. ID numbers and the proper shipping names. They will be up to date with the 19th edition of the U.N. Orange Book. Same here, we always have the ten year rule.

If the name has been used in any regulation, Canadian or U.S. or U.N., if it's been used within the last ten years it stays in the ERG. It doesn't come out just because it's not in the 19th edition or in 41 C.F.R. We'll leave it in there for time in case something's been prepared for transit and then transported.

And then for Canada, we have an

expanded emergency response assistance plan. There's additional data that's Canadian. We don't have a Canadian edition and a U.S. edition, so you'll see it all put in the same one.

Now we also have the electronic edition, which is for Android, Apple, Windows and it's also going out on the iPad this year. We've put those out. I'm not as up to speed on that because we contract that out. That gets sent out to a different company to take that and put the data together.

This is what we're begging you to participate tomorrow and say what direction should we go with this. A complaint, if you will, not too big a complaint is in a sense if you don't put it on a iPhone or an Android, just having PDFs and having it be the exact same as the book. It's useful, but in a sense you can do better.

We said well, what do you want to do better, because we don't want to make the site or the app so complicated that it can't be used anymore, that there's so many things on it, or the dropdown screen is so complicated, it's not really meeting the intention of the 15 minutes' initial response.

So what we said is should we put more in that site? Should we develop a separate site? What should we do? So that's what we're looking at as to what would be a good improvement, but still be useful for the first responder, and then should we develop a second app or a second website to say this is where we could put in more training information, more response information, outreach information for us. How much more could we do, either in a separate site or just do it through our own website?

So that's going to be a lot of the discussion tomorrow if you're setting at the table. I think it's the first, the opening session, one of the opening sessions. We're going to talk about hazard communication. Mark will be there with -- he's facilitating it, so he'll certainly be there for the hazard communication note papers.

So we'll be looking at that. So when you get to the 2020 look-ahead, we're certainly -- we're not going to give away too many secrets. We may not fund everything that Dave wants, but we're certainly going to fund farther reactivity work. We found the first group who was very productive as we went through the, we will say the top six.

So we'd like to see the rest of the table with the justification on it. The Orange guides, I've only been involved in the last two ERGs. But we haven't really had a lot of expertise or we had very little expertise in true emergency response. So we'd like to verify those guides. Things certainly do change, so we'd like to see those verified better and make sure all the distances are correct and the responses are correct.

We'd like to verify the Orange guides, and again, this is tied into my plea to participate tomorrow. What should our electronic edition be? Should it be web-based? Should it be an app? Should we have one system that's really for the first responder and then a second system that gives more response information when you have more time?

Should there be something for inspectors? How should we work it, what should we do? And again, that's should we incorporate additional training? We've developed a new electronics Code of Federal Regulations. That's in PHH-10, where it's going to be a one-site-fits-all.

You're going to go in. We're linked to the e-gov where you can pull down 49 C.F.R. But what you'll be able to see is all the special permits we have, any interpretations we've had. What we've been questioned is could we tie the ERG back into the table in 172? Could we tie all the ERG information back into that?

We're going to have to look at it. We don't know. As you know, that table of materials is very large. Could we tie it all back in?

We're going to look at that, and then again, whatever we come up with today and tomorrow we want to put into how do we improve it for 2020.

So my last slide will be thanking you, but what I want to do is tell you how tomorrow will work. What we're going to do is the room will be set up in tables tomorrow, instead of in a theater seating, and we've picked the topics lineup with our strategic plan topics.

Then we have facilitated discussions on what are the opening topics for those areas. If you want to go further, if you want to discuss something else, all that is okay. We're going to have a lot of what we're calling research needs statements, which are problem statements. Where are the gaps? We're going to have those available to the groups.

The goal is for the groups to create as many of those as we can. What we'll do is then flush those out and then those will go back into that hopper at the top where we're saying this is research that needs to be done.

Again, since we want to have people that you don't have to be here to participate, if you're listening in, streaming in, phoning in, please send an -- and you want to participate tomorrow, send us your phone number, in which groups you want to participate in to hazmat research@dot.gov. That's hazmatresearch@dot.gov.

What we're going to do is set up conference calls. So we'll all just dial into the same number and whoever wants to participate in that, we'll have -- it will probably be just on the iPhone or our cell phone.

But we'll be calling in on a speaker phone and then people that want to come in or people who want to participate from outside will just call in, and we'll try to set the tables far enough apart. It should only be six or seven tables, so that's how it will work.

So if you're listening in and you want to participate, or if you're just going back to your office and say I'd rather do it by phone, give us your name and phone number and what group you want to be in, and we will contact you with what phone number you should call in for.

We'll probably also post the list and say here are all the call-in numbers for the groups. But it's going to be a lot easier for us if -- for you and us if you tell us you want to participate so we can push the number to you. I think Veda is getting nervous, so I must be done.

As we get into the, I don't want to steal Veda's thunder, we do have three emerging risks presentations to go. So it's not the end of the day. We have three. I think Cynthia Hilton's going to give us something with Energetic Material, and then Britain Bruner has some Natural Gas, and then Troy from SMS has a follow up to his presentation last year. So I'll turn it back to Veda.

MS. HILTON: You don't want a question?

MR. BOYLE: I love questions. Sit down, we're having questions.

MS. HILTON: I am so sorry. I've got

to say this. You know there has been some criticism, not that, you know, not from me necessarily, but on the guide, and whether or not it's to serve incidents in transportation or a wider universe of locations.

Like first responders may use it when they go to fixed facilities. I'm sure you've heard this. So the only reason I tee this question up that way is that you have the GHS stuff in there, and there's a wide group of industry that is concerned about duplicative hazard, hazcom in transportation.

So I don't know who suggested that. I don't know how it showed up in there, but at some level if the ERG is supposed to be for transportation incidents, this is a concerning thing, because we want to communicate hazard, but we don't want to have duplicative communications out there and we're all for not confusing things.

So I'm just -- I'm making that as a statement. I'm just making it.

MR. BOYLE: I think you're -- to me,

I think you're absolutely right and we're not going to go backwards through my slides. But if you look, if you remember the 2016 is going to have a black bar at the top, and the bar says "This is for transportation incidents only." So we're trying. That wasn't --

PARTICIPANT: We don't mean ERG.

PARTICIPANT: Yeah, GHS.

MS. HILTON: Or GHS, I'm sorry. GHS, and we have got a position which I will submit for the record.

MR. BOYLE: We'd be happy to take that in. We did introduce it, because we did think people are seeing these. So we wanted to provide the information. If we've acted in error, 2020 will have great hindsight. Our vision will be clearer, and we can make the corrections.

We did put it in. We thought it was valuable, but we certainly agree. I think we struggled that the same point, that we said we don't intend this book to be for facility response, but we know people do respond, use it for facility response because they don't have anything.

So we had to say where do we draw the line and cut that off and we struggle with it. So if you have help or suggestions or comments, we'd love that, because we don't really know what to do with it. We're struggling with it ourselves.

MR. WILLAUER: David Willauer. Just to follow up, I think for planning purposes, it serves a great -- it's a great tool, because we often encourage communities to identify the primary hazards transported through their communities and identify those risks.

If you can understand what your protective actions are going to be within a certain distance of that particular route, then you can identify sensitive populations within those buffers, if you will. If it's a poison inhalation hazard, the buffer is going to be wider.

If it's a fuel, the buffer's going to

be very small for example, and those types of planning tools, additional tools for first responders are essential to know where to provide protection actions.

So not just for facilities, who often have -- which often have to put together risk management plans anyway. The distance, the corridors along with those chemicals and fuels are transported are just as important to study for their residents as well. How these chemicals get from A to B.

So that's another use of the ERG that we found to be really helpful. Thank you.

MR. BOYLE: Thank you. Possibly your response, Cynthia, to your question or comment, maybe that's why we need to split into two sites or two books and say here's the big bag, everything that we can think of and here's the emergency response portion. So we're open to whatever ideas come forward, and that will be tomorrow, I believe, at nine o'clock. One more question please?

MR. KRATOCHVIL: Joe Kratochvil from International Fire Chiefs. I don't want to believe this, but as a responder, it's not my first choice to use that book. But the way I look at it is that it's chlorine leaking from a tank car, is chlorine, the same chlorine leaking out of a building. So that's the way I use it as a responder, okay.

MR. BOYLE: Thanks. We know that, but I think what happens as Cynthia points out or anybody else could point out, we can't cover all types of facilities, and we have struggled with when we say is something better than nothing? We don't know, we don't know. It certainly doesn't work in ammonium nitrate plants. It's not a good idea. But thank you Veda for the extra time.

MR. BHARATH: No problems.

(Applause.)

MR. BHARATH: All right. Plenty to talk about tomorrow. All right. First up, Cynthia, Cynthia Hilton from IME, going to give us some feedback on some ideas related to emission technology. Hi Cynthia.

MS. HILTON: I am -- I thought there would be an empty room here except for the people who had DOT at the end of their emails. So I appreciate you. I understand that like I'm between you and the subway home. I don't have any video, but I have a lot of visual aids here and Veda, if I'm still here ten minutes from now, you need to -- I want you to -- I need to sit down.

So I'm Cynthia Hilton. I'm the executive vice president, Institute of Makers of Explosives, and I'm going to figure out how to do this. How do you do this?

(Off mic comments.)

MS. HILTON: That one, okay. We're going to just skip over. We're, you know, awesome people, you want to know all of us. But I'm just going to get to up here. I think this is it. Yeah, okay. So part of my visual aids are you all should have memorized this, the strategic plan, which is still good.

So I am here. We've heard, let's see, what do we do. Okay. So this identifies some priority issues that are not, you know, energy-related and energetic materials is one of those, and that's what I would like to be up here and talk about, what we see as future needs.

Rick gave some information. You understand this whole notion about the three year funding and they have carryover money, and the last data you gave to me is a little bit different than the data you presented today. So I don't know how much money is I want to say not unencumbered. It looked to me like you have fully committed your FY '14-'16 money. Is that what I heard there? Yes.

So I don't know how any of these other new projects, you know, may feed into this. I also want to recognize for other presenters here, I've heard a lot of good projects. This is really good that we do this forum, and it should go on the record as well that Rick and his team, Lad, have really listened to what industry has said about, you know, transparency, accountability and, you know, Joanna, a shout out to you.

I hope you're able to implement those things. I hope when we come next year we really, we see that kind of collaborative thing that you were trying to put together. So having said that, so there's four specific research things that we're interested in for explosives and one that has general applicability and -- okay.

So if any of you were here for the forum last year, we talked about the fact that we believe our IME 22 boxes, these are boxes that are used to put detonators in so that you can move them on vehicles with other explosives. Otherwise, that's forbidden.

We were working with the Coast Guard about 18 months ago or so on moving these boxes out to oil platforms on boats that have aluminum decks, and it came up about what is the fire risk if you've got aluminum decks and you've got explosives. The Coast Guard wanted a 60 minute window there, and we were not able to say well gee whiz, you've got a 60 minute window.

Subsequent to that, the National Science Foundation has reached out. They use these things to transport explosives and I don't know, or they were doing research for someone who uses them like in avalanche control and they want to know if there's a problem, how long, you know, before the fire.

So I'm just saying that what we asked last time is allow us to do a literature search, see where we are on that and bottom line we don't really have a fire rating. So we would like to partner with you guys. We think it's a good project. We would be happy to donate, you know, in kind the boxes and the material you would sacrifice.

But we are very interested in getting better grasp on what the, you know, the fire, you know. Can we -- is it 30 minutes or is it 60 minutes and are there things we could do to the existing standard -- oh I should tell everybody.

So this is a standard which is adopted in the HMR.

So DOT stands behind this standard, but are there things we could do to extend that time, you know. Okay. So next thing is -- the next thing really fast is Andrea, all right. You're still here somewhere, presented on our next few things, and they came out other -- they were revealed we worried about them and where's another handout I have?

Somewhere around here -- aha. A little meadow that came out that was awesome on February 22nd, talking about reforms that the agency wants to make in classification approvals, and we are supporting of all of them. Our next two ideas are Andrea's. I hope we can talk tomorrow to support you further in doing those, so I'm not going to spend time on that.

The last thing -- or the next thing is so, we support alignment with the U.N. model regulations, and when DOT adopted those back in 1990, they retained a domestic provision that limited the amount of explosives than can be in detonators to 25 grams when they're classes as a 1-5.

This is Special Provision 103, and as far as we know the U.S. is the only country in the world that continues a limitation like that. At the time, RSPA supported it by saying that, you know, it's been in place for many years and they gave a couple of hypothetical examples that if they didn't retain it, gee whiz, you could design things that maybe two pounds of explosive material could be in a product.

However, we think that in the intervening time and the way tests have evolved and new tests have been implemented, that it's hard for us to see how you could get to a situation like that.

So we would ask the department either to remove Special Provision 103, so that you're consistent with the rest of the world, or devote some resources to go test it and find out why the rest of the world should listen to the U.S. and do limitations.

The last one which should be something that's of interest to everyone. We all love data. We wouldn't be here if we didn't, and data's really good. I have some examples here, however, of we need denominator data. In 2012, you put out this little document which is "Death and Injury, Hazardous Material Sensitive."

So there's no denominator data in here, so it limits the usefulness of this to identify where there are problems. I just went on your website and this is another thing that should be updated. You've got accidental deaths compared to hazmat stuff in the United States from 1999 to 2003, and it was posted in 2004 and probably should be updated because I'm sure that might have changed.

So basically denominator data. For those of you who remember, back when we used to have an Office of Technology Assessment in 1986, they had denominator data. Then that was updated by PHMSA in 1998, and there hasn't been something since then because we're told that they use the U.S. Economic Census that has commodity flow data.

But this works and it doesn't work, because if you read this and I love all the people in the room who are here because of flammable materials, but just reading this it's like 85 percent of all hazmat is flammable material. So all of the rest of us, we may need to leave right?

Or maybe that tells us something. But some of the data they have here about Class 1 materials are Class 1 materials. It isn't what we would say. Like they say the average trip for a Class 1 material is over 800 miles. Now in our industry, it ain't over 800 miles for an average trip.

So maybe Julie's here, maybe that's the fireworks, you know. Maybe it's the military, I don't know. But at some level it doesn't get to the detail that, you know, we would hope would help us to better, you know, assess where we are on things.

So doing something on denominator data would be nice and I think that's it. I appreciate your attention. We're committed to working with you and I did it in less than ten, right? Okay. Thank you all.

(Applause.)

MR. BOYLE: I'm just going to give a little comment. I didn't work this out with Cynthia, but it just worked out so well. What she put upon the screen, that's really what our research needs statement is. That's what we want tomorrow. You're not going to have write long papers.

Just give us -- this has always bothered me. This is a gap, a little bit of explanation. We had -- I have, I'll tell David and Joanna to give you a call and say what is Cynthia talking about? I don't get it. I don't know what an IME box is. But you figure it out, or talk to Joe Nicklous and he'll put one of his chemists on it, and they'll help you out.

But we're not looking for research papers. What Cynthia put up on the screen will be perfect tomorrow for us to develop a needs statement, for it to feed into our management information system as a project we're evaluating and prioritizing. So tomorrow, that kind of information or that kind of depth is all we're looking for.

So I'm sorry, I've run into Britain's time or Veda's time. But that's really what we'll be doing tomorrow is things like that.

MR. BHARATH: All right. I'll have some more about tomorrow. All right. Next up we have Britain Bruner from the Sciences Branch, and he's going to talk about hydrides and emerging risks associated with that.

MR. BRUNER: Thank you Veda. Yes, my name is Britain Bruner. I'm chemist in Hazmat. I'm still fairly new to the team, a Ph.D. from Baylor University about two years ago. For the last -- last year I talked about some concepts to either inert, hazard material, specifically crude oil, or materials that could be incorporated into rail car technologies.

Today, hydrates and the emerging field of natural gas, what's going to actually happen in the next five, ten, possibly even twenty years? The reason I say that time frame because this is emerging risks.

We've talked about a lot of the different hazards of transporting dangerous goods today. You've seen everything from explosives to gases. Not too much on radioactive materials or corrosives or oxidizers, but lithium batteries as well and miscellaneous.

But an emerging risk is something to me that is actually -- we're not actually looking at right now. It's down the road, it's not immediate, something that maybe we can start doing the leg work now, small incremental steps that can add up over the next ten years or so and do something revolutionary that will prevent another incident like Lac-Megantic or other more recent crude oil incidents.

So these, to kind of metaphor or harking back to your childhood, the story of the princess and the pea. I'm looking at unknown, ignored or unsolved problems that are so small that only the crazy or the very in the know know what's going on. Which am I? I'll let you decide on that subject. Probably a little bit of both, but that's just being healthy in my self-criticism.

So specifically, flammable gases. My interest in flammable gases is my hindsight for my work with crude oil. There have been recently a significant increase in proved gas reserves, not just in the United States but around the world, and even worrisomely, natural gas has outpaced coal for an energy resource.

So what does that actually mean in terms of transport, when we're actually having to concern ourselves with transportation of this commodity? Well, if you know anything about American consumerism, the more we make, the more we consume and it just adds and adds and adds and adds and it continues to expand.

We have all the resources that we need to meet our energy demands. Energy security's not a problem that I'm up here to talk about. It's the actual infrastructure for natural gas transportation.

So if you've been following the EIA and some of the different bloggers and journalists and academics out there, you can see our current consumption to production rate, and we're actually on track to be a net exporter, just because of the recent allowance of exporting natural gas.

Exportation of natural gas is supposed to far outpace our imports by 2017, and it's primarily LNG, liquefied natural gas. Over the next 20 years, you can see here -- does this section show up on the screen? No. Some of the different models predicting the changes in these imports and exports.

Dry production, we had a record this year for natural gas, 73.5 billion cubic feet per day. That's being produced. That's not even what's in transport yet. That's what's going to a facility to then be processed and then sent out for transportation.

I mentioned it earlier, the rate of proven reserves is continually increasing. Technologies are rapidly advancing and things that were remote, stranded or unconventional have been realized in the last five-ten years, and they are new technologies that are pressing even more stranded or more unconventional, if you could actually put that to a degree in terms of what natural gas is out there.

The EIG has a predicted energy rise from natural gas or a contribution from natural gas from about four to eight percent. That's going from about 30 to 34 percent overall with their conservative estimates. I believe that's actually too conservative with some of the technology I'm going to get to here in a little bit.

But you can see the different ratios

and the trends in energy consumption, the quadrillion BTUs and the energy production in trillion of kilowatt hours, and you can see from their estimates and their modeling, I'm talking about the EIA, how the trend's going to go.

Now that takes into account current proven reserves. There's not much when you actually go through their annual economic or annual energy reports. The rate of proving new reserves. So it's a little, it's a little under, which is why I say it's an emerging risk.

So currently there are infrastructure demands that no one's talking about from my research. There's a pipeline issue in California. You might have heard it as a duck curve. That's getting gas from the plants that are producing energy into the homes for heat and electricity.

The technology that's actually going to ramp this up is hydrates. Here's a map. Over here on the right, you can see an intensity plot of the amount of methane and natural gas that's actually trapped in a hydrate formation. Not too many people are familiar with hydrate formations. You might have seen a lot of the environmental concerns about -- I'm blanking on the term, but it was an equivalent of the massive environmental changes where all of these methane reserves would be spontaneously released.

That's again not a concern, and that's actually been disproven. But these are resources that we can use in the meantime to go towards a lower pollution rate, lower CO2 emissions as we build a green infrastructure and still meet all of the needs that we need for daily activity in the United States and around the world.

So yes, to reiterate or to repeat, I'm a little behind on my points, the hydrate volume, the tons of cubic feet versus a shale, which is recently is what has increased the EIA's prediction, is about 100, let's see. Yes, it's 100,000 trillion cubic feet versus the 7,000 trillion cubic feet. That's hydrate methane to shale methane.

That's a massive increase of natural gas that is available and can easily be inundated or can easily over-inundate an infrastructure for transportation. We're going to use it; the question is when and how. I mean we're not going to stop using energy. We're going to keep drilling and expanding. It's going to be all kinds of wonderful inventions. Life's going to be great. Agriculture's going to be good. We've got to figure out how to use it some way.

So this picture here is actually a picture of a Japanese company collecting methane hydrate from hydrate formation off the coast of Japan, and actually producing natural gas. They're able to transport it offshore to shore and then collect it, and ship it out by compression or liquefaction.

So it's already being done, and they're discovering more and more methane hydrate formations that are easily accessible, that were previously unaccounted for.

So hindsight, we saw what happened

with crude oil as shale oil or unconventional oil became mass produced. Everybody wanted more oil. We wanted to have more output. We wanted to grow and grow and grow.

While we couldn't use the pipeline systems and we didn't have the trucks available, so we went to rail shipments, and all saw what happened with rail shipments. We absolutely inundated an infrastructure that worked for a while, and then as the volume went up, because of the insane success rate, you're going to actually see these really small events more frequently.

I think it was 99.94 percent of all barrels of oil by truck are delivered safely. But how many people remember what happened at Galena, West Virginia. These are really statistically insignificant occurrences, but massive events that burns an image that nobody in any of the generations present will ever forget. So it's always going to deter them away from crude by rail.

So what's going to happen with the

natural gas going into the infrastructure that we have, the roads, the pipelines, the vessels? How is that going to impact our situation? What sorts of unrealized emerging risks are there, maybe not in five years, maybe not in ten years, but down the line when we're actually peaking with this natural gas consumption?

Simply we do not want to repeat what happened with crude oil. So what I would like to do while I am with PHMSA, and again these are small incremental steps, is kind of go back and identify some of the industry's and other government agencies' interest and how they plan to handle this, and actually have it not allow not the squeaky wheel of all the problems going on, but constantly moving forward and making progress towards understanding what we can do and what we should be doing.

For example, identifying technologies for midstream safety. Liquefaction is a wonderful way to transport massive amounts of natural gas safely. There's a huge economic burden that leaves a lot of individuals, as companies go, out of the market. CNG is ideal for most small production facilities, but it has its hazards as well.

Liquefaction has its -- we've hammered today; I don't really want to beat a dead horse with another stick. But project massive expansion ratios, violent rapid phase transitions, those are all things to be concerned about when you have a massive amount of natural gas in a system.

Compressed natural gas, you have really high pressures. Those are violent events when they go. So what can you do to maybe prevent those or what other technologies can you use? Personally from my research, what I've been doing the last year, clathrate hydrates seem to be a wonderful resource for midstream.

There are companies in Japan, Indonesia, Korea, China and Australia that are looking at using this -- what is actually what we're finding at the bottom of the ocean as a man-made product at the surface, that you can actually transport in a reefer car. Minus 20 degrees Celsius and one atmosphere.

You can ship solidified natural gas, and I emphasize solidified because that was my whole pitch last year with crude oil was solidified crude oil, which has some still development going on with our statements of work.

It's actually quite controversial as well. To me it seems really sensible, but this might be the crazy or this might be I'm the only one in the know. I'll let you decide. There have been numerous economic studies, let's see if I've got it on the slide, yes, that show the economic payoff between compressed natural gas, clathrate hydrate gas shipments and liquefied natural gas shipments.

Up to a certain distance, I apologize for how small this is, I can't even read it, so it's liquefied natural gas on the left, natural gas hydrates in the middle and compressed natural gas on the right, and when you set up the comp spaces for the natural gas hydrates, what you can see is that I believe this was taken at a distance less than 4,000 nautical miles and greater than a thousand.

So it's in the 1,000 to 4,000 nautical miles, because they were looking at vessels in this study, that the natural gas hydrate is the most economical form of transportation. Now where does that actually occur?

Well, there's an opportunity, if anyone's been following some of the natural gas production deals going on all around the world, Japan wants to buy a lot of natural gas, liquefied from Alaska, but Alaska is having trouble trying to foot the bill. They're a little upset by the cost of operation, depending on which newspaper you read and who's spending it which way.

That's right at 4,000 miles. So the technology is there to have a cost-effective way to safely ship massive amounts of natural gas. I didn't mention it, but the actual energy density storage for natural gas is the same as compressed gas. So that's why you see here, you've got your CNG vessel fleet, your natural gas vessel fleet and your natural gas hydrate.

It takes the same amount of infrastructure to transport in terms of volume the natural gas hydrate, but it's low pressure and it's compared to the liquefied natural gas relatively high temperature. And so here you can see kind of the payoff line for natural gas hydrate.

Transportation distance versus the total supply chain and the capital expenditures. This technology fits right in the middle. Is this something that agencies and industries need to be paying attention to, maybe incentivize by establishing the regulations that would inhibit transportation, that are currently inhibiting transportation.

Why isn't it that anyone's looking at this? That's all I really want to know and ask with this emerging risk idea. There's a lot of wonderful science and technology out there that just kind of seems to only ring with a few industries, a few countries, and it could be that it is highly specific to their needs.

But in either case, there is a large amount of natural gas that's going to be coming into our system, and it's something that we need to keep paying attention. Not just how is the LNG transported in the vessel; how can we handle going from -- I think one report had it projected from 42 vessels with LNG to 1,800 vessels with LNG.

That's a Coast Guard problem. What do we -- what can we do to facilitate that understanding and that issue? If there is actual talk about shipping liquefied natural gas or CNG by rail up and down the East Coast, what can we do to actually facilitate that or prevent any incidents from occurring that we've seen in the past with crude oil?

So in the interest of time, I think there is one more person that has to -- or has some comments to say. Leave the questions for afterwards Veda? Or I'll take some questions now.

MR. BHARATH: Yes, take a couple of quick questions.

MR. BRUNER: Or tomorrow. I have a stack of research about this. I have all kinds of wonderful papers and graphs to talk about more, and some of the things I've learned over the last year.

MR. BHARATH: Any questions for Britain?

PARTICIPANT: Tomorrow.

MR. BHARATH: Tomorrow.

MR. BRUNER: Tomorrow, okay.

PARTICIPANT: Yes, tomorrow.

MR. BRUNER: That's ominous.

MR. BHARATH: Tomorrow, when we're not recorded. Thank you.

(Applause.)

MR. BHARATH: All right. Next up, Troy Gardner from SMS. He's going to take us home.

MR. GARDNER: All right. So I'm Troy Gardner with SMS and SMS is one of PHMSA's approved test laboratories, explosive test laboratories. So the topics that we would like for the R&D Forum to consider as potential projects, we have four new areas for consideration and one repeat area from last year's discussion.

And so for the first item, there is a U.S. flash composition test and HSL flash composition test, and the HSL flash composition test is one of the approved tests in the U.N. Manual of Testing Criteria, and it's for classification of flash powders.

The U.S. has a version of it, the U.S. Flash Composition Test. The HSL one uses half of a gram, 0.5 grams of the flash powder. The U.S. version uses 25 grams. So one is used in the time pressure apparatus; the HSL version is in the time pressure apparatus that we've heard about today. The U.S. version is in a tube setup and takes a lot greater quantity and so there's higher exposure to the test personnel.

But some ideas for improvement on that is currently, you measure -- the criteria is when you're looking at that witness plate, as it's bowed, you take a measurement at the greatest, at the peak of that indentation. So an idea was floated out of instead of just taking one point, one discrete point, why not have more of a model, something like a three model photo or something like that, that helps people understand what acceptable -- what a pass versus a fail criteria would be.

The Conan test, also in the U.N. manual, uses this same type of an approach. It shows diagrams, it shows examples of what acceptable pass and fail results are. So that was one idea there. The other idea was to change the witness plate. If we have a different type of witness plate or different thickness, maybe we'll have a different response.

Instead of -- instead of just it

bowing out the specific amount, maybe we'll reach a point at where we're perforating it through it so it will become more clear as to what the results are. So that's another additional idea for that one. Then the other, the other item is for both the HSL and the U.S. flash composition tests.

We've been talking about black powder today, black powder substitutes, equivalents, substitutes for black powder. Black powder in the HSL and in the U.S. Flash Composition Tests failed, and so -- but black powder is not considered a flash powder. So we're failing the flash powder test, but it's not a flash powder.

So the question comes up are we really measuring the correct things in this -- in this HSL and in the U.S. Flash Composition tests? So that's an idea for looking at.

The next one is for the 1.4S transport by air for aircraft. There's -- currently we run a U.N. Series 6D unconfined package test, and that unconfined package test is currently restricted to eight U.N. numbers for the United Nations. It's only applicable to eight different U.N. numbers.

Now Canada was the -- they started using the unconfined package test, and they currently require it for all, all parts -- all 1.4S classifications that are going by aircraft. It's a required test for them.

So that was the next question, is does this -- these eight U.N. numbers that we currently restrict this to and that the United Nations restricts it to, does this need to be expanded, just like Canada has expanded theirs?

The next item is a primed cambric replacement consideration for the U.N. Series 1 or 2 C-1, which is the time pressure test, which we've been discussing. The time pressure test calls out primed cambric.

In the 2015 Annual Explosives Testing Users Group, in that meeting Canada came to that meeting and had a presentation. I've provided that over to the R&D Forum and it will be made available, a PDF of that presentation. They went through and described what primed cambric is, what the source was.

They showed some photographic examples of it, and then had some suggestions of alternative things to possibly consider in the future, since primed cambric is not readily available.

One final item, one final new consideration is in the new U.N. Manual of Testing Criteria, they've added in a new section. It's part five, and part five of the new U.N. Manual of Testing Criteria deals with the GHS. It's the hazards classification of material in use, versus just a hazard classification for transport.

Currently, the only one in part five is a fire test for desensitized explosives, and the question we want to flow out there is are there other things that need to start being considered, new additional tests that need to be considered on the GHS side for products that are in use, such as moisture studies over time.

As things are being used, exposure to moisture. Aging studies, vibration studies, et cetera, things like that that should be incorporated for various explosive products.

The final one there, the fireworks noise levels, that was talked about last year and it was just mentioned that that's still on the radar, that that's still something to consider getting that instrumented and also to limit the variability, take out the parameters such as weather, distance, to remove those variables and then to be able to use sensors instead of operators for distinguishing noise levels associated with those tests.

The rest are the 2015 ideas. So those are still valid. So and I'm sure some of these Andrea mentioned about -- encouraged about having a minimum quantity of risk and approval for small quantities of explosives. So we'll take that offline for tomorrow as part of our discussion.

MR. BHARATH: Any questions for Troy?

(No response.)

MR. BHARATH: Everybody wants to go home. All right, I appreciate Troy. Thank you.

(Applause.)

MR. BHARATH: Anybody else who wants to mention anything? This is the last platform for the day to mention anything, particularly related to the Emerging Risks? Going once. All right. Well, I want to just thank all the speakers and all the attendees, particularly the speakers from near and far and the technical media center for hosting the meeting.

I know we had problems with the videos, but if you were to leave it up to me, it would have been worse. So that's good. Rick.

MR. BOYLE: Okay, that's good.

MR. BHARATH: All right.

MR. BOYLE: We'll start at nine o'clock tomorrow morning. We'll be in table setup. I'll put tents on so you know where to sit. Thank you for your patience today. It hasn't been perfect. Some of us like maybe talked too long, but have a great evening and we'll see you tomorrow morning.

MR. BHARATH: Tomorrow, nine o'clock.

(Whereupon, the above-entitled matter went off the record at 4:56 p.m.)

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C E R T I F I C A T E

This is to certify that the foregoing transcript

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was duly recorded and accurately transcribed under my direction; further, that said transcript is a true and accurate record of the proceedings.

Neal R Gross

Court Reporter