BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

In The Matter Of:	)	
Application No. 2013-01	)	
	)	
TESORO SAVAGE, LLC	)	Case No. 15-001
	)	
VANCOUVER ENERGY DISTRIBUTION TERMINAL	)	
	)	

HEARING, Volume 20

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ADMINISTRATIVE LAW JUDGE CASSANDRA NOBLE

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PROCEEDINGS

JUDGE NOBLE: Good morning. We're back before the board of -- State of Washington Energy Facility Siting Council in the Matter of Application No. 2013-01, Vancouver Energy Distribution Terminal.

This morning I anticipate that we're going to have a witness from the proponents that was not able to appear in these proceedings previously.

MR. KISIELIUS: That's correct, Your Honor.

JUDGE NOBLE: All right. Are the parties ready to proceed?

MR. KISIELIUS: We are, Your Honor.

JUDGE NOBLE: All right. Then let's get going.

You may call your first witness.

MR. KISIELIUS: The applicant would like to call Dr. Chris Barkan.

JUDGE NOBLE: Good morning, Dr. Barkan. Would you raise your right hand, please.

(Witness sworn.)

JUDGE NOBLE: Thank you. Please be seated.

I need to add the date. It is now June -- July 27, 2016. Thank you.

You may proceed.

KISIELIUS / BARKAN

CHRISTOPHER BARKAN,
having been first duly sworn,
testified as follows:
DIRECT EXAMINATION

BY MR. KISIELIUS:

Q. Good morning, Dr. Barkan.

A. Morning.

Q. Could you please state and spell your name for the record.

A. Sure. Christopher Barkan, C-h-r-i-s-t-o-p-h-e-r, last name is Barkan, B-a-r-k-a-n.

Q. And, Dr. Barkan, could you please state your occupation.

A. Yes. I'm a professor in the department of civil and environmental engineering at the University of Illinois Urbana-Champaign, and I also serve as the director of the rail transportation and engineering center at the university.

JUDGE NOBLE: Dr. Barkan, could you speak into the microphone a little bit more. And also we always caution the witnesses to speak as slowly as is comfortable for the court reporter.

THE WITNESS: Thank you.

JUDGE NOBLE: Thanks.

BY MR. KISIELIUS:

Q. Why don't you tell us about your research interests at -- and your professional life.

A. Okay. I've been involved in railroad transportation research since 1988, and a principal focus of my research, perhaps the principal focus, has been related to railway safety, including investigations of train derailment causes, tank car safety performance, hazardous materials risk in transportation, also environmental impacts of hazardous materials transportation. I've also worked quite a bit, since coming to the university, in the area of railway capacity analysis.

Q. I'm going to ask you, if you'd pull the microphone up a bit towards -- so up a little higher, it will probably pick your voice up a little bit better.

A. Thank you.

Q. How would you describe your research in the train and tank car safety and risk analysis?

A. So really the focus of my research throughout my career has been on understanding quantitative analysis of the factors that affect train derailments, tank car safety performance, quantifying the risk of an event occurring, the magnitude of that event, the -- what we sometimes call it in the world of risk analysis, the

receptors; in other words, environmental features or humans or property that might be impacted by that. And so the idea is to develop a quantitative understanding of how likely events of different types are and what products might be involved in terms of hazmats.

JUDGE NOBLE: A little slower, Dr. Barkan.

THE WITNESS: Still too fast? Okay. Sorry.

BY MR. KISIELIUS:

Q. And have you published any of your research?

A. Yes. As an academic, of course, I'm expected to publish, and the University of Illinois has a particularly rigorous publication expectation. I have published over 60 peer-reviewed journal articles, approximately 20 reports, a number of technical articles for the professional literature, and I think that's it.

Q. So you've described your research in your work at the university. Do you hold any other professional positions?

A. Yes. So in addition to the ones I just mentioned, I'm also the director of what's called the National University Rail Center, or NURail Center, that's a USDOT-sponsored university transportation center. It was actually the first rail-focused university transportation center in the program's history.

Q. Okay. What did you do before you joined the University of Illinois?

A. I worked for ten years at the Association of American Railroads in their research and test department and their safety and operations department. My role there, again, was to manage and direct the railroad industry's cooperative research program in the area of tank car safety, hazardous material transportations risk and environmental performance.

Q. I presume if you publish your research at the university, that you teach courses related to this field as well?

A. Yes, I teach a number of courses, but two I teach on a recurring basis. One is called railroad transportation engineering, and the other is called railway signal and control. The first one is really a general introduction to students about essentially all the hardware of the railroad transportation, the track, the rolling stock, the locomotives, the economics of the operation, the energy requirements and that sort of thing. And I should say that these classes are -- typically the students that would enroll are seniors and graduate students. The railway signaling and control class is focused on, as the name implies, how railroads safely manage operation over their rail lines, and

there's a variety of very sophisticated protocols that the railroads use. And so we basically go through all of those protocols from the most simplest all the way up to the most complex.

MR. KISIELIUS: And for the council's benefit, Dr. Barkan's CV has been entered into evidence as Exhibit 316.

BY MR. KISIELIUS:

Q. Dr. Barkan, are you familiar with the proposed Tesoro Savage Vancouver Energy terminal?

A. I am.

Q. And what aspect of the proposal were you asked to evaluate?

A. I was asked to evaluate the transportation risks associated with moving trains of crude oil from the Washington-Idaho state line near Newman Lake, I think it is, to the facility here in the Port of Vancouver.

Q. And can you explain at a higher level your approach to assessing the risks of rail transportation associated with this project?

A. Yes. We use what I would consider a fairly standard approach for risk analysis, but adapted to the specifics of a railroad transportation risk analysis. So it's kind of an area of logical ordered process of first calculating what the factors are that contribute

to derailments and derailment rates, and then if we have a derailment, what is the distribution of cars derailed, how many cars may be derailed. In the case of tank cars, we're interested, of course, in how many of those are derailed and how many of them release. Then we also quantify the quantity released from each car. And if we're also interested in consequence analysis, we will look at the interaction of that product that's released with the environment, again, whether it's a natural injury on human populations.

Q. I'll ask you some more detailed questions about each of those components. I want to start with, what assumptions about the train makeup did you use in your risk analysis?

A. Well, we were provided information about the configuration of the train as we understand it to be operated. I believe it's three locomotives, two in the front and one in the rear; two buffer cars, one in the front and one in the rear; and then 118 loaded tank cars, all of which would be the so-called DOT-117, the newest specification the DOT announced last year.

Q. And what did you use to calculate the probability of a derailment?

A. So one of the things that we were -- we, frankly, and this nation, are fortunate, is the Federal

Railroad Administration maintains an extremely detailed database of railroad accidents. And all accidents above a certain monetary threshold are required by regulation to be -- extensive details are required to be reported to the agency. They compile all of that in a database that's available online. And my students and I regularly download that database and use it for these sorts of analyses.

Q. And did you also look at derailment trends?

A. Yes. And I should also mention in terms of rates, we need to understand what I just mentioned was the enumerator, the derailments that occurred and how many of them there were and what the causes were, but we also need to understand the traffic, how many trains were operated, whether it was ten trains a day or 50 trains a day or one train a day. All of these factors are estimating the rate of occurrence. I'm sorry. Your question again, Tadas?

Q. Did you look at the trends?

A. The trends, yes. So actually an ongoing activity of ours is monitoring both hazardous materials transportation and traffic as well as safety trends for the railroad industry. We provide an annual report to the AAR, and there's a whole section that includes statistics on various aspects of the accident trends and

rates, and so we've been monitoring that -- I've been responsible for that, of course, since the year 2000.

Q. Okay. Did any other aspects of this specific proposal enter into your analysis? Do you look at, for example, the specific geography involved with the specific tracks?

A. Well, so when we did this analysis, it's very important for a risk analysis such as this, to factor in the specific characteristics of the route. And our research has found that there are three factors that are significantly correlated with derailment rate, and those are the Federal Railroad Administration track class, the volume of traffic on the route and whether it's got wayside signals or not. So we used information from the railroad to very carefully characterize every mile along the entire route and then used that, along with our information in our -- the statistical models we developed to estimate what the derailment rate for this particular route would be.

MR. KISIELIUS: And for the council's benefit, the papers that Dr. Barkan -- in which he describes those factors have been entered into evidence as Exhibits 239 and 240. Rather than pulling them up, I'll ask a little bit more about those in the higher level, bigger picture.

JUDGE NOBLE: And, again, Dr. Barkan, slower.

THE WITNESS: I'm sorry?

JUDGE NOBLE: You need to be slower.

THE WITNESS: Sorry. I read all the transcripts so far. This keeps being a recurring theme, and I try to remind myself.

BY MR. KISIELIUS:

Q. So how does the derailment rate on this route, the one in question that you described in Washington, compare to the derailment rate on an average route? And I guess here I'm focused on how would you compare it based on the three factors you just identified?

A. It's, I would say, significantly lower than average, the derailment rate is lower than average. To put it another way, it's a safer route than average. And that's because I mentioned those three factors. Well, the FRA track class on most of the route is FRA Class 4, and the higher the track class, the lower the derailment rate, and that corresponds with the more stringent engineering standards that are associated with this higher class of track. It's also entirely as wayside signals and, again, wayside signals are correlated with lower derailment rates. And finally, it's an above-average traffic density on this route,

above the national average, I should say. It's more than 20 million gross tons per year, which is the gross weight of all the rolling stock and laden travels over and around -- that too is --

JUDGE NOBLE: Mr. Barkan, we missed the last sentence because you were speaking too fast. I'm sorry to keep interrupting.

THE WITNESS: Yeah, I'm sorry.

BY MR. KISIELIUS:

Q. You might just try pulling that closer to you and raising the microphone. It's very hard to hear because the speakers are coming out of there and not over here.

A. Is this on?

Q. That's for the court reporter. So if you pull that closer, that will help him too. But the council is having a hard time hearing you, and they can hear you through this microphone. So you might just try to raise your voice a little bit.

JUDGE NOBLE: It's not so much a matter of volume, it's a matter of the speed that you're speaking.

THE WITNESS: All right. Again, I apologize.

JUDGE NOBLE: We have a lot of time today for your testimony.

THE WITNESS: So do I.

A. Okay. So should I repeat the last sentence?

BY MR. KISIELIUS:

Q. You were just going through the three factors, and I think you had finished. Maybe you should start with the third one where you're describing --

A. The gross tonnage?

Q. Yes.

A. Okay. So the route in question has above the national average in terms of the annual gross tonnage, the traffic, that's the way we measure traffic. Gross tonnage is the total weight of the rail cars, locomotives and the lading that they transport. And so, again, our statistical analysis found a significant relationship with higher gross tonnage equating to lower derailment rates. This might sound counterintuitive to some people, but the explanation we believe is when -- when there's more traffic, the railroad invests more efforts and resources into maintaining it for higher quality at higher operating speeds.

Q. So let me ask you, the analysis that you ran for this specific route, we're going to talk about it in some more detail in some of your conclusions, I'm going to start maybe at the back end. Do you believe your analysis under- or overestimates the risk?

A. I think there's a variety of reasons why we probably have overestimated the risk using our model. BNSF as a system has a lower-than-average derailment rate. We run statistics for the entire nation and we can look at individual railroads as well and BNSF has consistently had a lower-than-average derailment rate systemwide.

We also didn't make any assumptions about future investments in technology -- which actually it's more or less back to the point about the trains. There's been a steady downward trend in the derailment rate, again, nationwide, as well as on BNSF, and there's no reason to think that that's going to stop. That's happening because railroads are continuing to invest in their infrastructure and in new and emerging technologies to detect flaws before they can cause an accident. And so we made no allowance for that projecting into the future. We didn't account for the fact that BNSF is installing possible train control on this route.

Q. Okay. And did you prepare a report summarizing your conclusions?

A. I just remembered one more reason why. So the other thing we did, I should say, is after we completed our analysis of the route using our model, we did a validation exercise where we actually looked at what

BNSF had experienced on this particular route over a ten-year time period. Our estimates predicted that they would have had more accidents than they actually did.

Q. Thank you.

A. But not a great amount. I felt comfortable that our model had been well-validated, but, again, the empirical experience was lower than the actuals observed -- I mean, than the model predicted.

Q. Again, returning to the report, did you prepare a report for your analysis on the train traffic associated with this facility?

A. Yes.

MR. KISIELIUS: For the council's benefit; that's Exhibit 123.

BY MR. KISIELIUS:

Q. Dr. Barkan, you've got two binders in front of you. The smaller one includes your report and some of the associated exhibits. So should you need to refer to that at all during your testimony, you should feel free. The larger binder includes the prefiled testimony from some of the intervenor witnesses. So should you need to refer to that, you should feel free throughout the course of the morning here.

So given the assumptions you stated earlier about the train makeup, what's your calculation of how

likely it is a train associated with this project will derail anywhere along the rail route?

A. So it is important to make that distinction. There's a certain -- a level of analysis in our report where we looked at the entire route as a whole and then we also considered what the average location or the average rate would be at specific locations -- or individual locations on the route.

So the overall route estimate is approximately .75 derailments per year, and --

Q. I'm going to ask you to --

A. I'm sorry, per million train miles, and then the estimated frequency, in other words, per year, is 0.4. And that corresponds to a -- would expect a derailment approximately every 2.4 years, again, according to my model.

Q. And will all of those derailments lead to spills?

A. No.

Q. How do you calculate the probability of a spill?

A. So as I mentioned earlier, one of the key elements of our research is to understand not only when derailments might occur, but also how severe they may be. And severity can be measured in a number of ways, but one common one is the number of cars derailed. The

number of cars derailed is affected by the speed that the train was traveling at the time of the derailment. So at higher speeds, as you might expect, derailments tend to be larger and at lower speeds, derailments tend to be smaller. But, again, it's a statistical distribution. You can get variability depending upon the particular circumstances of the accident.

Q. And what did -- what data did you use to make that assessment?

A. Yeah, the Federal Railroad Administration database that I mentioned earlier, as I said, contains comprehensive information on a range of variables associated with the derailment, and one of the ones that they provide is the FRA track class, where the derailment occurred, the speed of the derailment, the number of cars that derailed, also the number of cars that were hazardous materials cars, and also that number of hazardous material cars that derailed and released. So all that is available in the FRA's online database. There's a lot of -- again, numerous other characteristics about the circumstances of the accident.

Q. And just order of magnitude, about how many accidents are included in that database?

A. Well, tens of thousands. We, of course, don't -- the database dates back to 1975, but we don't

use data from that far back. We will typically use data from a recent five-year or sometimes a ten-year period.

Q. What are key elements to the database? I think you've already mentioned the speed and track class. Does it include information about damage sustained?

A. Well, yes. So as I mentioned, the database -- the FRA database contains information about the number of cars that derailed, again, whether they released. But I should say that at this point, we switched to another database in terms of understanding the performance of the tank cars. In this case we have another database. I think this council has heard about the Pipeline and Hazardous Materials Safety Administration, or PHMSA database, but that's just a small piece of what we use. We use something called the Railway Supply Institute Association of American Railroads tank car accident database. This is an extremely comprehensive database of tank cars derailed in accidents anywhere in the US and Canada. We get detailed information on the design of the cars that were derailed, so specification, but, again, dozens of other parameters, such as the tank thickness, whether or not it had a head shield, its top fittings configuration.

We also get information on the nature of the damage that a tank car may have suffered in an accident.

And, again, details about that damage, how much lading might have been lost, if it was carrying lading, and, of course, as I've already mentioned, we have extensive information from the FRA on the accident characteristics themselves. So those three elements of the tank car accident database allows -- allowed us statistical power to, again, understand how design characteristics of tank cars correlate with the performance of those tank cars in accidents.

Q. You talked about loss of lading. Based on that database, will -- in your opinion, is it typical for cars that spill to release their entire contents?

A. No. In fact, it's -- normally, cars do not release their entire contents. Again, it's a statistical distribution. Sometimes they may lose only a few dozen or a hundred gallons. There are times they'll lose an intermediate amount and sometimes they will lose the entire quantity. And so one of our ongoing statistical efforts is to compile that information so we understand what the distribution of the quantity lost in accidents is.

And I should add that that distribution also varies depending upon what part of the tank car was damaged. So if you have a puncture of the shell or the head of the tank, we tend to have larger releases. If

you have damage to the top or bottom, those tend to lead to lower quantity releases. And so we have that information for all of the components of the tank car, and also we understand how that relates to the specific design of each of those elements of the tank car.

Q. I'm going to ask you a Statistics 101-type question because you're using the phrase "distribution," and just to be clear that we understand from a statistical standpoint, when you refer to a distribution, what do you mean?

A. Yeah, it's very important to understand that because, you know, you can do a simple analysis where you just take a single value, an average or something like that. But our database allows us to actually understand the frequency distribution -- that's a tautology. I'm defining my terms with the same term -- but how frequently different outcomes occur. And I'm sure you all know normal distributions, and that's an example where you have a bell-shaped curve.

Now, in our case, the distributions are typically not a normal distribution. So, for example, in the quantity released, we tend to have -- the most frequent outcome is a relatively small quantity released and there are certainly intermediate level that result in partial release of the contents and then another

higher mode, but not as high as the low end, of a large quantity released from the car.

And so the distribution, again, is just how frequently these different outcomes occur. And this applies to the derailments as well. So, for instance, we have a distribution of the number of cars derailed in accidents and a distribution of a number of cars that release. And all of this -- these distributions, these different frequencies, are factored into our model. And in the world of risk analysis, it's preferable if you have those distributions, because you want to understand how likely it is that events of different magnitude are going to occur. And it gives, I think, a policy maker such as yourselves, as well as risk managers, a better understanding of how likely it is that events of different magnitude are going to occur.

Q. And you talked about the loss of lading in smaller quantities tends to be the most frequent. How many tank cars that spill end up releasing 5 percent or less of the tank car's contents?

A. Yeah, that's actually in the record here. If anybody wants to look at it, it's Exhibit 0123, page 11 and Figure 4. 34 percent of the circumstances -- 34 percent of the tank cars that are releasing will release 5 percent or less. And you can actually see

that distribution that I was just referring to in that figure, if anybody is interested.

Q. So earlier you mentioned the DOT-117 tank car, and we've heard testimony that the applicant is only going to accept rail cars that meet or exceed that standard. How likely is it that a derailment of one of those cars will lead to any spill at all?

A. Okay. So there's actually two metrics, one of which appears in the record, and I realize there's another one that's commonly cited in the media so I will present both.

So the DOT-117 tank car, using the database that I've been describing, it's estimated that 5.1 percent of those, if they're involved in what we call an FRA reportable derailment, will release 5.1 -- will have a release of -- I'm sorry. In 5.1 percent of the cases, they will release at least some of their contents.

The other statistic you may see in the public domain, because it's been discussed in a lot of the context, is what was called CPR-100, which means the probability of 100 or more gallons are lost and that, for these cars, is 2.9 percent.

Q. I want to ask you some questions about how your report calculates the anticipated performance of the DOT-117 tank cars. To help us with that, I want to

refer to an exhibit that has not yet been admitted into the record. It's one that there's an outstanding objection. It's Exhibit 250. So before we talk about it, Dr. Barkan, I'm going to ask you -- and you can look at it in your binder there. Did you prepare this article?

A. Yes. I mean, I'm the first author, but with two others, my -- two former graduate students of mine, but I did most of the writing on this.

BY MR. KISIELIUS:

Q. And does this communicate your analysis and understanding of the subject matter of the article?

A. What it is, it's a -- this was a summary article we wrote for a magazine called TR News. It's the -- sort of a technical, professional magazine of the Transportation Research Board, which I expect some people here are familiar with. And what this report describes is all of the science and engineering work that went into the development of the DOT-117 tank car. So some of this research is ours and some of it is other organizations, the Federal Railroad Administration, the RSI-AAR tank car project, as well as me and my students and, again, several other organizations. It was an ongoing effort that took several years to uncover all of the information we used to develop what the industry and

government both agreed on was the appropriate new tank car for transportation of petroleum crude oil and other refined oils.

MR. KISIELIUS: Your Honor, I move for admission of Exhibit 250.

JUDGE NOBLE: Is there an objection to Exhibit 250?

MS. BRIMMER: No.

JUDGE NOBLE: Exhibit 250 will be admitted.

MR. KISIELIUS: Ms. Mastro, could you please display page 3 of Exhibit 250. If you could zoom in there on Figure 4.

THE WITNESS: Yeah, the tank car.

BY MR. KISIELIUS:

Q. So, Dr. Barkan, as I said, I want to ask you some questions about how your report calculates the anticipated performance of the 117. What -- first, what are the elements of a tank car that can fail in an accident?

A. Basically there are four elements that fail in accidents. You can see all of them in this photo -- or drawing. So the tank itself, which we break down into the shell, the cylindrical longitudinal portion of the tank, and the end of the tank which is referred to as the head of the tank. And then there are fittings on

both the top and the bottom for loading and unloading, and those two are subject to damage in accidents. And so when I referred earlier to our limiting measure of the configuration of each of those, you know, for instance, the tank, we'll know the thickness of the tank, we'll know whether or not there's an external jacket, steel jacket; same thing with the head, we'll know the thickness of the head and we'll know whether or not there is a head shield, which is an additional layer of steel on the end of the car. We'll know whether or not the car has top fittings protection and, if so, something about the design of that. Again, similarly for the bottom fittings, whether their pressure devices are at the level of protection for those -- those elements of the car.

Q. I'll ask you to slow down one more time.

A. Sorry.

Q. It's okay. We'll just keep reminding you. Do those four elements that you just described differ in how they resist damage in the event of an accident?

A. Yes, considerably. So for instance, I think it's kind of common sense that the thicker the layer of steel, the more resistant it is to puncture in accidents. And so we've -- as part of our analysis of the database, we've been able to develop a pretty good

quantitative understanding of the relationship between the tank thickness and whether or not it's punctured in accidents or not.

The same thing with the head shield. You add an extra layer, an extra half-inch layer of steel on the end, it stands to reason and it is confirmed by statistics, that that car will be less likely to be punctured through the head. And, again, we can not only say it's less likely, we can quantify how much less likely it is.

The top fittings protection, if there's a protective housing, as you can see there is on this car, that sort of thing sticking up on the top, that's made of a half-inch thick layer of steel and the fittings inside which otherwise would be vulnerable to damage in accidents are protected if the car is involved in a derailment. And that's actually a very good example of how this car -- there's a number of things, but how these cars differ from the so-called Legacy 111s that we hear people talk about and that have been involved in many of the accidents that have raised public concern about the transportation of flammable liquids. A Legacy 111 would have no protective housing on the top. Fittings would all just be exposed. A Legacy 111 car is non-jacketed, which most of them were, would not have an

external steel jacket and it would be manufactured with a thinner tank of a less -- of a lower strength steel.

So the point is, this car that you're looking at, which is the DOT-117, represents, again, all of the things that we talked about in this Exhibit 250 about all of the different improvements in the new tank car. And, again, what this article is describing was the science and engineering that went into selecting this design.

Q. So I want to ask you a question about your analysis of the 117. These are a relatively new design?

A. Uh-huh.

Q. So how is it that you have data on their anticipated performance?

A. Yeah. So what's really new about the 117 is the combination of features as opposed to their particular design parameters. So, for example, the shell thickness, the tank thickness on this car is nine-sixteenths inch thick. Well, there's many other cars in the tank car population, and there have been for many years, with that thickness of tank. There's many other cars with a head shield -- a full head -- head shield. There's other cars with the top fittings configuration. So again, this is part of the power of this very large, robust statistical database we have to

estimate tank car performance, because we can take each component by itself and quantify its performance in accidents and then develop a robust estimate of how -- if we put all these together in one car, how it's likely to perform.

Q. And is the combination of some of these elements consistent or similar to other existing tank car designs?

A. Yeah. As it -- after all was said and done, this car has a lot of similarities to a car that we would call the 112-J340, and that's the tank car that's been used for transportation of liquified petroleum gas, or LPG, for many decades, including -- and one thing I didn't mention, is the thermal protection. This car is now required to have a thermal blanket. And that's located between the jacket in the tank, and that's -- the purpose of that is if the car gets into an accident and it's in a fire -- again, one of the things I'm sure you've heard about and familiar with is the cars when in a fire, the contents heat up, pressure increases and at the same time the tank steel, because of the exposure to fire, weakens. This was recognized as a problem for the 112 cars 40-odd years ago, and so this thermal protection attenuates the rate of heat on the tank getting into the contents, as well as to the metal, and

it has been found to substantially increase the life of these cars should they be involved in an accident and in a fire.

And, again, as I was saying, none of these characteristics are on the Legacy 111s. One more thing I'll mention in relationship to the 112-J340, again, it's a car that's similar to this and many of its parameters, it's transporting LPG which is actually a more energetic material than petroleum crude oil, and we've had a very good safety record with those cars since the mid 1970s.

Q. So I want to ask you to summarize your opinion on the extent to which the 117 or 120 car will reduce the risk as compared to a Legacy 111.

A. I think you can actually see it in one of these exhibits. Let's turn to that. Yeah, so in Exhibit 0123 on page 4, which is the summary page, there's a big table and I can kind of walk through a few things there. If they want to bring it up, they could.

MR. KISIELIUS: Ms. Mastro, could you please pull up page 4 of Exhibit 123.

A. Actually page 3.

MR. KISIELIUS: Excuse me, page 3.

BY MR. KISIELIUS:

Q. And while she's --

A. Yeah, I can speak to it. So a few moments ago, I referred to the conditional probability of release of a single car. The DOT-117 has a 5.1 percent -- right where your little mouse is, is the 117. It's probably impossible to read. Anyway, it's 5.1 percent, as I said, for the DOT-117. By contrast, the Legacy 111s non-jacketed cars have a 30.3 percent chance of releasing if they're involved in the same accident as this car. And another car you've heard a lot about are the CPC-1232 non-jacketed cars. That's the middle column on this chart. Those have a conditional probability of release if they're in --

Q. Say it again a little slower.

A. So the CPC-1232s have a 16 percent chance of releasing if they're involved in an accident. And so in terms of percentage improvements, the 117 is 83 percent less likely to have a release if it's in an accident. And the DOT-117 is 68 percent less likely to have a release compared to the non-jacketed CPC-1232. So you can see that in both of these examples, that there's a big reduction in the likelihood that we will have a release when using the DOT-117s, which, of course, was exactly the objective of the government and the industry when they developed this specification and then DOT implemented it in their rulemaking.

KISIELIUS / BARKAN

Q. So you've talked about your statistical analysis, and I want to come back to this chart, but I want to ask you a question about a different analysis. We've heard some testimony about structural analysis of tank cars, dynamic structural analysis. Can you describe that and how that lines up with the statistical analysis that you do?

A. Yeah. This is an ongoing area of interest in my research as well as RSI's AAR tank car project as well as the -- this is an ongoing area of my interest as well as that of the USDOT and the RSI's AAR tank car project. So what we're -- what I've been describing and what we've worked on here are data on tank cars that were involved in accidents as well as on the accidents themselves. And so we can perform a statistical analysis evaluating what those data are telling us.

But a parallel and complementary line of research is to understand how a tank -- think of a tank car -- or a tank as a structure, and so we are working with structural dynamic modelers -- structural dynamics modelers. They can develop these very sophisticated models where you can apply a certain level of force to the side of the tank car or the head of the tank car and you can modify the shape of that. So you can make it look like a coupler or like a rail or some other object

that might hit the side of the car. And you can, in your computer models, manipulate or vary the force that's being applied to any part of the car and then predict how likely it is to fail, what the extent of that failure is going to be. And this is a very powerful tool that's important in understanding how to improve the design of tank cars. And, again, it's parallel and complementary to the statistical work which is derived, as you might have inferred, from actual real-world experience with these cars.

Those -- it's important to understand that these dynamic models, dynamic structural models, are not just the creation of some investigator. They are, in turn, based on and validated from extensive physical tests. I sometimes call them rock 'em sock 'em tank cars because they literally will go out to the transportation technology center in Pueblo, Colorado, and they'll set up a tank car and they'll just cover it with instrumentation and they'll then ram another car into it or some object into it and measure to, you know, the thousandths of a second, or even more detailed, exactly the strains being applied to that car and that structure and essentially watch it fail, or not fail depending upon the level of force they have applied. And so these are used to develop and then validate these dynamics

models that I'm talking about.

And the reason we need these models is because, as you might imagine, a test like that is extremely expensive and it takes a long time to set up. So the DOT has been sponsoring numerous tests of the nature I've just described. They've also sponsored the development of these dynamics models. And the tank car research community works together with these, the modeling work, the testing work, the statistical work, to understand what they're all telling us about the safety of tank cars.

And so as, again, common sense would tell you, when we increase the thickness of the steel or increase the strength of the steel or we add an extra layer of steel, it requires more energy for the car to fail and we can measure how much more energy and how, again, the shape -- geometric shape of the impacting object affects that likelihood of failure or the nature of failure. So those results are compared to our statistical results to see do they make sense. And the short answer is that they do make sense, that we see parallel kinds of relationships between the design configuration of these tank car elements and their statistical performance, the dynamic modeling and the physical testing results.

Q. I want to ask you a couple of questions about

variation on the 117 that we've also heard a lot about in recent weeks, and that's the 117R, the retrofit. How do you expect the 117R tank cars to perform in relation to the new 117 tank cars?

A. I think we have a -- I think it's that same Exhibit 250, if you want to turn there.

MR. KISIELIUS: Ms. Mastro, could we return to 250 -- we're going to come back to this one in a second, but can we go to 250.

MS. MASTRO: Actually that's not admitted yet.

JUDGE NOBLE: 250 or 215?

THE WITNESS: 250. Sorry about that.

MR. KISIELIUS: I thought we just admitted that.

MS. MASTRO: I apologize.

THE WITNESS: She thought I said 215.

BY MR. KISIELIUS:

Q. And I believe we're going to be looking at page 2.

A. Correct.

MS. MASTRO: Page number 2.

MR. KISIELIUS: Two.

THE WITNESS: And it's Figure 2. So if we could zoom in on that chart, please.

A. So what this is, is similar to the data you looked at a few moments ago in that table and it's presented as a bar chart. So on the far left, again, we have our Legacy 111 car, non-jacketed. On the far right, you have the DOT-117. And the two -- two of the three cars on the right side of this chart are, starting from the right, the DOT-117. So when we build new 117 tank cars, that's how we estimate they're going to perform. The next one over is -- it's just labeled jacketed one half inch, that's going to be one of the types of DOT-117Rs. And then the next one to the left of that is the jacketed CPC-1232 that says seven-sixteenths.

So those three cars, the two cars to the left of the 117, are approximately how the DOT-117R can be expected to perform, those two varieties, with one key difference. One of the provisions of the regulation -- I can't actually remember if this is in the regulation or the FAST Act, but they're going to have to modify the bottom outlet valve so that the handle comes off, which is one of the causes of releases, and these don't have that factored in. So that will slightly reduce both of those bars from the DOT-117R. It will have a better -- slightly better performance, a slightly lower likelihood of releasing as a result of that change.

MR. KISIELIUS: Sorry to have you jump around, Ms. Mastro, but I would now like to return to Exhibit 123.

BY MR. KISIELIUS:

Q. And while she's pulling that up, Dr. Barkan, I would like you to talk about the use of the phrase "return." You're calculating a return of an incident when --

A. It shows up in this table.

Q. So what does that mean?

A. So oftentimes when we're talking about an annual -- I'll just use a hypothetical. Supposing it's a one-tenth of a percent -- or one -- a 0.1 annual probability. So one-tenth basically. Sometimes that's hard to understand what that means. But the inverse of that is basically we're saying we would expect it to happen approximately once every ten years. So the return period is just the inverse of the annual probability. So an annual probability of .5 would be every two years, an annual probability of .1 would be every ten. An annual probability of .01 would be once every hundred years, and upwards. Again, as evident from one of -- it should be evident from this, one of the reasons we use this is because many of the probabilities are quite low, so it's easier for people

to understand and comprehend what it means when we express it in a return period as opposed to an annual probability.

Q. So I would like to just walk through your findings there on the various increments and the returns for incidents of a particular size. And how long would you expect there to be -- what's the return on an incident in which a derailment led to a spill of any kind somewhere along the route for a 117?

A. Yes. Yes. So for a 117, and those that want to follow along, we're looking at the right column of numbers there. So any spill, we would expect -- estimate approximately every 6.4 years, every six and a half years, let's say.

Q. And how about the next increment there of spill of more than 700 barrels somewhere along the route?

A. Which is approximately one tank carload, 30,000 gallons. So that we would expect to occur about once every 23 years.

Q. How about the next increment?

A. Yes, the 2,200 barrels or 92,000 gallons, we would expect that to occur once about every 110 years.

Q. And I think the last one?

A. That was specifically picked out to address this concept of expected worst-case discharge quantitatively,

20,000 barrels or 840,000 gallons, and the return period for that we estimate is approximately once every 20,000 years on this route -- on this route due to the traffic associated with this project.

Q. So -- and you distinguished before about the risk of probability of something happening somewhere along the route, which I understand is what you've just described. Did you calculate the risk or the probability of these incidents occurring at any given location on the route?

A. Yes. So -- and that's what the lower portion of this table is telling us. So if we take our three hundred and -- I forget, is it a 385-mile route? We can estimate, based on kind of the typical characteristics of the route, what the average return period at any given location will be. So, again, the upper table is referring to any occurrence anywhere on the route. The lower table is referring to a one-mile segment on that route. So, again, there's this sort of corresponding set of values, so that a 30,000-gallon spill at a particular location, we would estimate would happen approximately once every 9,000 years; at a particular location, a spill of 92,000 gallons we would estimate it occurring about once every 42,000 years; and the expected worst-case discharge, north of 7 million years.

The point, of course, is, especially for those higher quantities, that the probability of a spill at a particular location is quite remote.

Q. I would like to turn to now responding to some testimony we've heard, and in particular, I'm going to start by focusing on allegations about differences in the way tank cars behave as compared to other freight. Are you aware of any evidence that would support calculating the derailment and spill probabilities for crude oil tank cars differently due to the weight of those tank cars?

A. No. These cars are no heavier, they have no higher -- again, a term of art in the rail industry is gross rail load or maximum gross rail load. The standard for North America is 286,000 pounds. It has been for well over a decade. And so these tank cars conform to all of the engineering and mechanical design requirements for a car with that maximum gross rail load.

The Association of American Railroads maintains extensive mechanical standards that cars must comply with if they're going to be offered for service -- interchange service. And the reason for those standards is to ensure safety of all rail cars. It would be obviously not a good thing if some rail cars weren't as

safe as other cars. And so the AAR maintains these mechanical standards and these tank cars conform to that standard and perform accordingly.

Q. Are you aware of any evidence that would support calculating the derailment and spill probabilities for tank cars differently due to what's been described as sloshing?

A. Yeah. This has been a subject of interest for decades actually. The RSI-AAR tank car project I mentioned a moment ago did research on the subject in the 1970s. The DOT has investigated it. I think some of the individual railroads have investigated it because, you know, if you're a railroad, you want to know if the cars that are operating on your railroad have a tendency to behave in an unsafe manner, and obviously the DOT and the FRA do as well. And so studies have been done, I'll just sort of roughly say a half a dozen or so studies have been done over the last three decades at least, looking for an effect and nobody has ever found a significant effect.

I can say that the railroad industry themselves last year, you know, re-asked this question because of the concern about some of the recent derailments. And, again, looked through all of the literature that they could find and all of the tests and could find no

evidence that this was having an effect.

Q. Switch subjects and talk about some other testimony we've heard in the last week and a half. You reviewed the testimony of Mr. Hildebrand?

A. Yes.

Q. Mr. Hildebrand testified about a couple of hypothetical scenarios in Vancouver and Spokane, and I would like to ask you about those. I see you're already doing it. I was going to tell you to feel free to reference his testimony.

One of his scenarios, he testified about a derailment near an overpass in Downtown Vancouver. Can you -- have you looked at the probability of an event the size that he described -- an event of that magnitude at that location?

A. Yes. So in that first scenario, he talks about a tank car being punctured and losing 30,000 gallons, another one being punctured and losing 15,000 gallons, and a third one having its valves damaged, the fittings that I referred to earlier, and losing 3,000 gallons. And, you know, what we would estimate -- actually somewhat conservatively, it would be somewhere between -- at that particular location, the probability would be somewhere between the 9,000-year return rate and the 42,000, closer to the 9,000. And so the

probability of that release event occurring as a result of the impact suffered in the initial derailment are in that range.

Now, I take some issue with Mr. Hildebrand's scenario in the latter part, because he then goes on to talk about how tank cars in -- if a fire ensues and other tank cars subsequently fail as a result of the heating effects I referred to earlier. And he describes another 60,000 gallons being released, five -- let's see. How many additional cars? He doesn't specify. He just says additional tank cars are breached and another 60,000 gallons of crude oil are involved in the fire.

I understand why somebody would have been concerned with that. There's no question we saw this happening at places like Casselton and Mount Carbon and a few other accidents, but this was very specifically one of the factors that the tank car community, again, both government and industry, wanted to address with the 117 car. So when I refer to the thermal protection system, it includes -- specifically includes what's called a thermal blanket, and this is a half-inch layer of material that is engineered to substantially attenuate heat transfer from a fire into the tank. And, again, we've had decades of experience with similar material on the LPG tank cars, the 340s I mentioned, and

have had extremely good luck. There have been very few failures of those cars over the last, you know, three or four decades. And as I said, LPG is a more energetic material than petroleum crude oil.

So the point is that I think it's quite unlikely that in this matter of a few hours that Mr. Hildebrand described, that that secondary thermal failure is going to occur.

Q. Staying with his testimony related to the City of Vancouver, he had a second scenario hypothetical in which a train derails near Marine Park. Are you familiar with that one?

A. Yes. And so here --

Q. Can you tell -- just to -- can you tell us -- can you try to assess the probability of the derailment scenario he describes in that location.

A. Yes. So -- and, again, bearing in mind that what I've said earlier is there's a probability of a derailment, probability of a tank car involved, a probability that those cars will release some of their contents and obviously the quantity released. Each of those is developed based on our statistics on actual accidents of -- in the analysis. And so that would correspond roughly to the middle on the lower table for the 117, the 42,000 interval. So we would estimate that

an incident of this magnitude at this particular location has a likelihood of happening about once every 42,000 years, let's say.

But here again, he goes on to refer to 13 cars breached due to thermal damage from the fire and an additional 275,000. I just consider that highly unlikely given the new design of these tank cars. Again, that was specifically one of the objectives of the new spec tank car, was to prevent that kind of secondary thermal failure that I think everybody is concerned about.

Q. Switch sides of the state. He also filed testimony on behalf of the City of Spokane in which he identified three specific locations in which the response would be challenging. Are you familiar with that testimony?

A. Yes. And I think -- if I recall -- I'm looking at it, and my recollection of reading all this was that I didn't -- I'm not sure he specified how much. But if he -- but let's just say a 30,000 gallon spill. Again, that would -- that would -- those locations would correspond to the 9,000 year return period based on the average you would expect along this route.

And I don't know if this is a good time to bring up the matter of the multiple car.

Q. Sure. So let's go --

MR. KISIELIUS: Ms. Mastro, sorry for making you jump around. Could you go back --

A. Same exhibit, though.

BY MR. KISIELIUS:

Q. I'm sorry. You're right.

MR. KISIELIUS: Could you turn to page --

A. Probably page 14, exhibit -- Figure 8, because it speaks directly to these sort of average location-type incidents.

BY MR. KISIELIUS:

Q. So earlier we were talking, in Exhibit 250 you showed that bar graph. Was that the probability of release for a single car?

A. I'm sorry, not Figure 8, the next figure down. This is -- thank you very much.

Q. So, Dr. Barkan, was the bar chart -- the per-car derailment incident?

A. Yes. So when I showed you that bar chart showing you the different -- again, what we call conditional probability of a release, or CPR, it's the likelihood that a particular car involved in an FRA reportable accident releases some or all of its contents. And for many years that was kind of the standard way we compared tank car safety performance.

But what we realized in the late 2000s was that with the advent of trains, unit trains of petroleum crude oil and before that ethanol, you needed to think more about the likelihood of large numbers of cars releasing. So if you consider Mr. Hildebrand's scenarios where he talks about three cars in one and I forget the number in the other, but the point is -- and obviously some of the ones that have raised public concern about are larger numbers of cars releasing.

And so I worked with a colleague and our graduate student, Xiang Liu, who is now a professor at Rutgers University, and what you're looking at is derived from his -- Xiang Liu's dissertation, Ph.D. dissertation work, where instead of just looking at single cars by themselves, we asked, what's the probability of multiple cars releasing in a given incident? And that's what this chart is telling us. So if we look at tank car releasing on the horizontal axis and the return period on the vertical axis -- and, again, this -- we applied Dr. Liu's model to the particular characteristics of the route that we've been discussing here. And the way to interpret this chart is that the farther the curve is to the left, the safer it is, you might say, because basically what's happening is that return period, the higher it is, the longer the

return period is. And so, again, the very left-most area, the DOT-117, and you can see it actually goes off the chart at 10,000 years and intersects at three cars releasing. So we can use this kind of a chart to say what's the likelihood at any given location that we will have one car, two cars, three cars, et cetera, releasing at least some of their contents at a particular location.

Pertinent to the discussion about the DOT-117R, it's not labeled as such here because there's been -- we're now starting to settle on a label where the 117Rs are going to be here, but it's labeled here as a jacketed CPC-1232. That corresponds to one of the 117R configurations. Again, not accounting for the removal of off-load valve, which will slightly improve its performance.

The other one that's not shown here is between those two. So basically if you look at those two curves and envision one in between those, that's kind of what the estimated -- as I say here in the caption, the estimated interval between release events is going to be in terms of numbers of cars. And we can project these curves farther up. We chose to cut it off at 10,000 years, but our model will allow us to project up higher.

So that's -- hopefully this is helpful. Because, again, by contrast, that non-jacketed 111 tank car has the same return period on this route for 12 cars releasing. So obviously a much higher number of -- a much larger number of cars releasing over the same interval, and you can read it either way. You could also read downwards from that three cars releasing the non-jacketed 111 with a 2,000-year return period as compared to the 10,000 for the 117.

Q. So staying on the subject of different scenarios, we talked about Mr. Hildebrand's scenarios. In oral testimony, Mr. Hildebrand and others have talked about an event on the scale of what recently occurred in Mosier happening somewhere else. So first I want to ask you, are you aware of the June derailment incident in Mosier?

A. Yes. Yeah, I was unfortunately aware of it very quickly after it happened.

Q. And what's your understanding of the type of tank cars that were involved in the Mosier incident?

A. So those were CPC-1232s jacketed, but without a layer of thermal protection, so similar to this car or one of the cars in here. I apologize, I'm slightly forgetting. I'm thinking 16 cars derailed there. There are conflicting reports about how many cars released.

Three cars released, for sure, in the accident, one due to a puncture I think of the shell, one due to the bottom outlet being damaged in the wreck, and the third was after the fire started, there was some gasket material that I believe was damaged by the fire.

Some reports are referring to a fourth car that released due to bottom outlet damage, but I've heard from several sources that that actually occurred secondarily when the car was being moved to -- basically as part of the wreck cleanup, the valve got turned open. And so it's either three or four cars released there, but the reports I am inclined to believe are that three were due to the wreck itself.

Q. So given the size -- I guess I was -- I wanted to ask you to put Mosier in perspective based on your probability analysis. Based on the number of cars derailing and releasing, what's the likelihood of that type of an event occurring to a train traveling to this facility at any specific location on the rail route?

A. A lot of numbers to remember. That's why we write them down.

Q. Take your time.

A. So that -- the reports I've heard were that it was something in the neighborhood of 40 to 42,000 gallons released, again, for those three cars

that were damaged. And we would expect at a particular location -- again, we would read that table that we looked at already. Anywhere on the route, we would expect a return period of somewhere between 23 and 110 years. And in terms of a specific location, somewhere between 9,000 and 42,000 years at that particular location.

There's another thing about the Mosier incident that was -- again, those of us who pay attention to details of how tank cars perform, that fire burned for 14 hours, but there were no thermal failures. Now, we don't know a lot about the circumstances about that, but the point is that certainly if you refer to Mr. Hildebrand's testimony, he talks about within a few hours other cars failing. Well, those cars were in the fire -- some of those cars were in the fire for 14 hours, none of them had a thermal failure. But what makes the CPC-1232 car different than some of these other accidents that you've heard about, is that it does have a layer of insulation and a steel jacket. And as part of our research on developing thermal protection requirements, we found that just a jacket and insulation gives you a lot of benefit in terms of protecting you from thermal failures.

The 117 is going to have -- specifically going

to have a half-inch layer of thermal protection which our research has shown is even more effective at preventing a thermal failure. So as unfortunate as the Mosier accident was, it also gave us some confirmation that our understanding of the jacket and the insulation itself provides a fair degree of protection, even without the layer of thermal protection. So the point is the 117 should be expected to perform even better than those cars could in that regard.

Q. So the questions -- or the testimony, I should say, about these events occurring, for example, in Spokane or Vancouver, I think indicate a concern about these happening in population centers. Have you evaluated how much total crude-by-rail and ethanol-by-rail traffic travels through urban areas?

A. Yeah. One of the studies we did a couple of years ago was to do a nationwide risk analysis for the two high-volume flammable liquids, alcohol and petroleum crude oil. So we looked at the entire US rail network. We knew how much -- we knew how much traffic of each of these products travel on each of these routes, and we did -- used geographic information systems, GIS, to do an overlay of the population density along these routes. And --

MS. BRIMMER: Your Honor, I'm not sure I

want to interpose an objection because I'm a little confused about where this is going, but maybe I do. This testimony is outside of the prefiled written testimony. So I'm unclear about where this is going, because this traffic volume is entirely outside of what was prefiled. So this person was not presented as a fact witness and this doesn't appear to be fact testimony, so I'm just not sure where this is coming from.

JUDGE NOBLE: Do you want to respond?

MR. KISIELIUS: Yes, please, Your Honor. In addition to his direct testimony, Dr. Barkan, like all of our witnesses, is prepared to respond to and rebut testimony that appeared both in the prefiled and also in previous weeks. And he is explaining and responding to some of the concerns that were expressed in prefiled and oral testimony related to incidents occurring in population centers.

MS. BRIMMER: Let's be clear. There was no testimony from the opponents concerning traffic volumes. That is not something that needs to be rebutted. I think that's an expansive characterization. Mr. -- Dr. Barkan has responded to Mr. Hildebrand's examples of incidents. He talked about frequency and that's fine. I understand that's rebuttal. But there was no

testimony from any one of the opponents on this topic of traffic volumes in urban centers.

JUDGE NOBLE: I am going to overrule the objection. I think that the testimony is generally relevant.

THE WITNESS: I don't have to talk about traffic volumes.

JUDGE NOBLE: Just a minute. Just a minute, let me finish making the record here.

And, in general, we've taken a lenient approach toward adding to prefiled direct testimony for both sides and so this would be consistent with that.

Now, as far as the travel through urban areas, I don't recall testimony that is as broad as throughout the whole United States or other countries. But it does relate to the travel through the urban areas that are involved in the route for this facility. And so I think that it's relevant as long as it doesn't go too far afield.

MS. BRIMMER: Your Honor, for the purposes of the record, I just want to make very clear that this significantly also hampers opponents' ability to deal with this information. This is the second-to-the-last day of this hearing that we are hearing this information and, again, it does -- as you recognize, it does go

outside the testimony offered by us. There's no ability for us to respond to this at this point in time.

JUDGE NOBLE: And that's why I'm limiting it and I will stop the witness if we go very far down this road. If there's some way that I can allow some kind of telephone testimony to respond to some of this specifically, I would certainly allow that. I think we're going to have a little bit of extra time. So let's hear the answer and -- I think you got through the rest of the question.

And do you understand my limitation based on his testimony, Mr. Kisielius?

MR. KISIELIUS: I think I do, Your Honor. And, again, I think Ms. Brimmer may be anticipating a step we're not taking here. We're simply testifying to the hazmat traffic and the percentage of it that goes through urban areas as it relates to the concerns expressed in opponents' testimony, including exhibits entered by Columbia Riverkeeper.

JUDGE NOBLE: Yes. And are we going to limit that to relevant population areas, like the state of Washington, or are we going talking about the entire United States?

MR. KISIELIUS: Well, Your Honor, this witness is prepared to testify to the trend in the

United States and how it informs the analysis of this specific line.

JUDGE NOBLE: All right. Let's hear the first answer and then -- we won't be going too far down this road. I'll interrupt you if you do.

MR. KISIELIUS: All right.

JUDGE NOBLE: Thanks.

BY MR. KISIELIUS:

Q. So, Dr. Barkan, did you prepare a graph depicting your review of the analysis -- your analysis of the data of percentages of hazmat -- excuse me, not hazmat, crude oil and ethanol traffic that goes through population areas?

A. Yes.

MR. KISIELIUS: Your Honor, this is an exhibit that has not yet been admitted, Exhibit 249. There is an outstanding objection to it.

BY MR. KISIELIUS:

Q. I'll ask, Dr. Barkan, is this graph prepared at your direction?

A. Yes, this is part of our research effort.

Q. And does it communicate that information you were just describing?

A. Yes.

MR. KISIELIUS: Your Honor, I move for the

admission of Exhibit 249.

JUDGE NOBLE: I didn't hear the first part of what you said. Are you offering it for admission?

MR. KISIELIUS: Yes, Your Honor, it's already been offered. There's an outstanding objection, so it's one of the unresolved ones in the list.

JUDGE NOBLE: Thank you. Could I hear the objection to this Exhibit 249, if there still is one?

MS. BRIMMER: There is still an objection. First and foremost, the objection would be the objection that we had to this topic. But we will also object additionally because this exhibit -- the foundation was unclear. We didn't know its relevance because it was outside of Dr. Barkan's report and the analysis that he did with his report. The other exhibits, his studies were clearly related. This graph was just hanging out there and so we didn't think it was relevant or related.

MR. KISIELIUS: May I respond?

JUDGE NOBLE: Thank you. Go ahead. I'm just looking at the exhibit now. It looks like just one graph.

MR. KISIELIUS: That's correct. And if I may respond to the objection.

JUDGE NOBLE: Sure.

MR. KISIELIUS: This is like many of the

exhibits that were presented by the opposing parties that witnesses have prepared to respond to testimony of the other parties that we reviewed in prefiled testimony. This is among the tools that Dr. Barkan would like to use to rebut written testimony about the concerns of an incident occurring in a population center.

JUDGE NOBLE: I'm looking at the exhibit now and it will be admitted. Thank you.

MR. KISIELIUS: Thank you, Your Honor.

Ms. Mastro --

JUDGE NOBLE: That is Exhibit 249.

BY MR. KISIELIUS:

Q. Dr. Barkan, can you explain this graph and what it shows.

A. Yes. So what this is telling us is each of those on a horizontal axis are the population density, persons per square miles in US census data. And on the right-hand graph is -- the vertical axis are the car miles of petroleum and alcohol in millions of car miles. And what it's showing, of course, is that the large bars are on the left and the red line is the cumulative line, accumulates the -- from left to right as the blue bars. And what you can see is, is that 90 percent of the traffic is to the right of the thousand to -- 1,000 to

3,000 persons per square mile, the 1,000 to 3,000 and 3,000 to 10,000 and greater than 10,000 are urban areas, and the runs on the left are the -- outside of urban areas. So the main message is that 90 percent of this traffic is traveling outside of urban areas.

JUDGE NOBLE: Dr. Barkan, what -- do you know the time period that this data is collected for?

THE WITNESS: Yes. This was 2012.

JUDGE NOBLE: Thank you.

BY MR. KISIELIUS:

Q. And how does that correspond to what -- your understanding of this specific line?

A. So while I have not done a specific quantitative analysis of this line population, but if you look at the line, there's really only two urban areas, Vancouver and Spokane. The rest are in the -- are lower population areas. And so it's my -- I believe this is probably a reasonable approximation, subject to a detailed analysis of this particular route.

Q. I would like to turn to the testimony of Fred Millar. Have you reviewed that testimony?

A. Yes, I have.

Q. And I'm going to ask you a couple of questions. And I believe, again, his testimony may be in the larger binder next to you should you need to refer to it.

Do you agree with Dr. Millar's assertion that recent changes in the last two years do, quote, little to address the overall hazards of transporting crude-by-rail?

A. No. When you consider how much -- the dramatic improvement in the safety of the 117 tank car compared to the tank cars that have been used in this service, I can't see how anybody could argue that that's not a substantial improvement in the reduction of risk. Perhaps he's turning the point on the fact that the 117 is not -- is just beginning to be introduced. But it will be -- you know, it will be coming in per the federal requirement that it must be installed -- these must be installed in the coming years.

Q. And Dr. Millar testifies to speed restrictions. What impact do mandatory and voluntary speed restrictions have in your opinion on the safety of rail transport?

A. So speed restrictions reduce the energy of an accident, of the kinetic energy of an accident. And so, that, again, affects several different parameters. It reduces the average number of cars that derail, it reduces the average number of cars that release and it may also reduce the severity of the accident -- of the damage to the cars so the releases are smaller.

So those speed restrictions that have been implemented since this issue sort of emerged, especially in urban areas where we have population exposure, I think have had a significant effect on risk.

Q. Dr. Millar also states that train derailments occur nearly every week in the Pacific Northwest. Do you agree with that testimony?

A. So I looked at how he defined the Pacific Northwest, and I would ask how many council members think Fargo, North Dakota, is part of the Pacific Northwest. He basically defined the Pacific Northwest as all the states from Oregon and Washington east to the Minnesota state line, and that's where he drew his statistics from. So I -- my daughter lives in Portland and she doesn't think that Fargo, North Dakota, is part of the Pacific Northwest.

The other thing that he did when he calculated his statistics, is he included not just mainline accidents, which are potentially of concern in this, but he also included yard accidents, which are typically low-energy collisions or run-throughs, which is as the term goes. They're not -- they can reach the FRA damage threshold, but they're generally not posing a great deal of risk.

And then even for the mainline accidents, he

included them -- all severity levels. He didn't include the ones that have the likelihood of release leading to the kind of derailments that I think, you know, we would be concerned with in general. So I think his numbers tended to overstate the risks in the actual what most people, I think, would consider the Pacific Northwest, for a variety of reasons.

Q. If you look at derailments that occurred along this route that we're discussing today and the traffic along the route, how does that data compare to the data that Dr. Millar relied on compared to your data upon the more specific line in question?

A. Well, again, he included incidents that really, you know, yard incidents that don't qualify for the kind of concern we're talking about. You know, we did do the validation analysis of reportable mainline accidents and found that, in fact, BNSF has experienced fewer of those than our model would have predicted.

Q. Do you agree with Dr. Millar's assertion that the railroad track at issue is in a current state of disrepair?

A. No, because that really, in my opinion, flies in the face of evidence. What -- as I mentioned, we compile annual statistics and monitor the trends in terms of train derailment rates, and those have trended

steadily downward for more than a decade. They're at their lowest level since the FRA started recording this data in 1975. And so to argue that a steadily downward trend in derailment rate is consistent with a state of disrepair seems inconsistent to me.

It's furthermore countered by the fact that the railroad industry, including BNSF, have been investing billions per year in the renewal of their infrastructure because -- motivated by both safety and business reasons, the infrastructure -- most -- most railroad engineering experts that I know would actually say that they think that the railroad industry's -- Class 1 railroad's infrastructure is as good as it's ever been. And there continues to be extensive research and development by both the railroads as well as the USDOT on identifying ways to further improve safety, whether it's improving the infrastructure, improving the rolling stock, improving the operating control systems, all of these things are a continued subject of research and development, as well as implementation, to continue improving railroad safety.

MR. KISIELIUS: Your Honor, we are prepared to proceed. Dr. Barkan has a good bit of testimony remaining. I'm just observing the time. So if there's a -- we can keep going until later.

JUDGE NOBLE: Thank you. No, I think we need to take a break for 15 minutes. But before we do, I want to tell you that I'm considering allowing additional written testimony to be submitted that is in response to this testimony. As everyone knows, Dr. Barkan has been taken out of order because of an unavoidable circumstance, which is understandable. But I am mindful of the position that places the opponents in, in not being able to consider -- or have time for responsive testimony. So what I'm considering is an opportunity for additional written testimony to be submitted.

There was a motion prior to this hearing regarding the filing of the amended application, and I allowed extra time -- extra written submittals in response to that, and I would consider allowing response -- submittals responsive to Dr. Barkan's testimony as well. So I would ask you to talk about that and see if there's an objection to that during the break.

MR. KISIELIUS: Okay.

JUDGE NOBLE: Thank you.

MS. REED: Your Honor, could I just request clarification?

JUDGE NOBLE: Sure.

MS. REED: There we go. I wanted to request clarification of whether this additional written testimony would be with respect to all of the oral direct testimony presented or just this figure that's being displayed now.

JUDGE NOBLE: Of Dr. Barkan?

MS. REED: Of Dr. Barkan's testimony.

JUDGE NOBLE: No, responsive to all of Dr. Barkan's testimony.

MS. REED: Okay. Thank you.

MR. KISIELIUS: Your Honor, I think we -- just to be clear on the record, we sincerely appreciate the opponents working with us to schedule Dr. Barkan due to his health issues, and so we appreciate that and understand if the direction is to allow to provide written rebuttal. I think the only thing we'd ask is that we be offered the opportunity, again, as the applicant, the way the process is done, if there's something truly new that's raised there as would follow the normal course, that we also get that reply opportunity.

JUDGE NOBLE: I understand. And you can refer to my order having to do with the additional testimony that I've already issued, and it will be the same time period for that. And I assume you're saying,

then, you would have no objection?

MR. KISIELIUS: That's correct.

JUDGE NOBLE: All right, then. That will be the order, that additional written testimony may be submitted responsive to Dr. Barkan's testimony with the same deadlines as the other additional testimony that's to be submitted. In addition, it was submittals -- the order was submittals, so if there's some kind of written exhibit as well, that would be allowed. But if there's an issue about that, I'll have to rule on that comment at that time.

MR. KISIELIUS: And the only -- I guess we can talk more about it during the break, but, I think, really it is about, as Ms. Reed said, I think, to the extent that there's something different than what Dr. Barkan has said in his prefiled testimony, because understandably they've had his prefiled testimony since May 13th and had opportunities to rebut that during the hearing. It's really focused on if there's something new that he's saying and his response to the written testimony that he's reviewed that we're really focused on.

JUDGE NOBLE: I'm not going to limit it in that way because if he had been a witness that had appeared in the normal course of things, then they would

have a broader opportunity to ask for time to submit testimony that was basically surrebuttal for that. And so I'm not going to put that constriction on it.

MR. KISIELIUS: Okay. Thank you.

JUDGE NOBLE: Thank you. Now we really are on break until 10:55. Wait a minute, that's a little too much time. 10:50. Off the record.

(Recess taken from 10:38 a.m. to 10:57 a.m.)

JUDGE NOBLE: We ready to go back on the record?

MR. KISIELIUS: Yes, Your Honor.

JUDGE NOBLE: You may proceed, Mr. Kisielius.

BY MR. KISIELIUS:

Q. Dr. Barkan, before the break -- proceed carefully here with the feedback. Before the break, we were talking about some responses to Dr. Millar's testimony. I want to switch to a different assertion. Dr. Millar suggested that the length and weight of a crude oil unit train increases the risks associated with its transportation. And we've already talked -- try to stay back here maybe. We've already talked about the weight of the tank car. I want to talk about the collection of tank cars as a unit train.

Do you -- first of all, do you agree with his

assertion that the unit train combination of tank cars increases the risk associated with this form -- with rail transportation?

A. So there's -- it's kind of a mixed answer to that. I would actually say that in some ways you could say the jury is out, we're doing research on this subject, but let me talk to a couple of the elements of this.

So first of all, unit trains in themselves -- in and of themselves I don't think are any less safe than other trains; the other train we would typically talk about is manifest freights, which are a mixture of different car types and also some are loaded and some are empty. And, in fact, those trains would have more complicated dynamics as the train's, you know, brakes are applied or they accelerate and they go over hills and things. And so we refer to that as track train dynamics. And in that sense, a unit train is a more uniformly configured train. It's by definition either all loaded cars or all empty cars, which reduces that sort of mix of dynamic conditions. So in that sense I'm told by experienced railroad operators that they tend to be simpler to operate.

On the other hand, if we're talking about a -- and so unit trains in general in terms of their track

train dynamics I don't think are any more prone whether or not they're transporting oil or any other product.

Having said that, if you derail a unit train of petroleum crude oil, as I referred to earlier in my testimony, when you're estimating the likelihood of a derailment, one of the things you determine is -- actually, I didn't mention this, but where the train derailment occurs and how many cars derail, and that may or may not involve hazardous material cars in the manifest train. In a unit train of crude oil, if you have a derailment, kind of by definition you are likely to derail one or more of the hazardous materials cars, the tank cars in this case. So that -- that's a factor to the potential derailment severity.

But the alternative would be, in the case of moving this volume of traffic, would -- instead of moving them all in one train, is you'd move these cars in other trains, in manifest trains, and -- multiple manifest trains, and never mind whether that's operationally feasible, given various other market factors. Now, you have more trains operating, transporting this hazardous material thereby exposing them to more potential derailment events.

And so this is actually a subject of current research by my group to understand how to quantify the

risk of hazardous materials transportation in unit trains versus spread out in manifest trains. But, again, assuming you're moving the same volume of traffic, you have this trade-off between a unit train, which may be handled better compared to a manifest train, but on the other hand you have a higher likelihood of involving the hazmat cars. In the manifest train, you have more different opportunities for exposure to derailment because of more trains -- it being in more trains.

To sum it up, I -- as I said a moment ago, I think that this is an important research question which again my group is currently investigating. We're not in a position to say that we have answers yet. But I apologize if it's a little bit of an ambiguous answer, but I think that is the state we are at right now.

Q. And do you think it's fair in the meantime to conclude that they definitively are less safe, unit trains, that is?

A. No. No, I do not think that's correct. I think we don't know. It's a risk management, a risk balancing problem that I'm hoping our research will maybe -- we may be in a position a year or so from now to start speaking more quantitatively about it.

Q. I'm a little hesitant to ask you to do this

given the feedback problems we've just had, but I think we've swung to the other extreme now and --

A. Speak up?

Q. Yeah. Thank you.

A. That would work. It's less likely to cause feedback, I'll get a little closer.

Q. I want to ask you about an exhibit, 5557, which was entered into evidence. It's been admitted. We haven't had any testimony about it, but because it's within your area of expertise, I'm going to ask you to talk about it. I believe this is a 1983 report on the probability and impact of railroad hazardous materials incidents. Are you familiar with that report?

A. Yeah, I'm -- okay. That experiment failed. Yes, I'm quite familiar with that report by NIAC, et al., we refer to it. That was to my --

MR. KISIELIUS: Your Honor, should we try to proceed or should we pause to try to fix this?

JUDGE NOBLE: I think -- let's just try to proceed one more time, and then I'll pause it.

MR. KISIELIUS: Sorry to interrupt.

JUDGE NOBLE: Just maybe a little bit farther from the mic.

THE WITNESS: Yeah, I'll try this.

JUDGE NOBLE: Let's see if we can find a

happy medium.

A. Okay. NIAC, et al. So, yes, since my earliest days working in railroad safety and risks, I've been familiar with that report. I would consider it the first report that attempted to address some of the very questions we've addressed in our research, namely the relationship between -- in their study -- it's a big report. I don't claim to remember everything in it. But one of the important -- sorry. One of the important elements of it is that they addressed the relationship between FRA track class and derailment rate and found a qualitatively similar relationship as we have found, which is that the higher the track class, the lower the derailment rate. Again, this makes perfect sense when you understand that the higher the FRA track class, the more stringent the engineering and inspection requirements are. So they conducted a study to quantify -- well, first identify and then quantify that relationship.

I've been involved in three subsequent studies to update that report. That report used data from, I believe, 1975 to 1977. So some of the data are over 40 years old. I believe that that report would substantially overstate today's derailment rate. We know that the derailment rate has come down something

like 90 percent since 1980. And so there's been a major reduction in derailment rate. So they're using this early data.

That was also in the era before what's called the Staggers Act economically deregulated the railroads, and the significance of the Staggers Act was that it encouraged reinvestment, capital investment, in the physical plant of railroads and one of the objectives was to encourage this investment that would improve safety. So, again, the 90 percent reduction is part of the payoff from that.

So anyway, in light of the fact that the rail infrastructure had been improving over the last 30 years or more -- as I say, I've been involved in three different studies to update it. So we did one in the early '90s. We did another study in the early 2000s, and then the report that I've already referred to by Professor Xiang Liu as my former Ph.D. student, we worked on the most recent update of the NIAC, et al., approach. But what distinguishes our current work from that work from 1983, is that we've incorporated additional variables and identified, as I mentioned earlier, not only is FRA track classes significantly correlated, but so is whether or not the line is signaled and whether or not the line has above average

or below average traffic density.

So we cite the NIAC, et al., report in many of our papers. It's an important sort of foundational piece of work, but it's not at all representative of today's safety performance. And, again, we've identified additional factors above and beyond what NIAC, et al., were aware of when they conducted that research.

BY MR. KISIELIUS:

Q. This may be implicit in your prior answers, but do you consider this report to be more reliable than the information you used in reaching your conclusions in your assessment of this particular line?

A. No. As I said, it's -- the value of this report is -- you know, as an academic, we're always very interested in the development of new analytical techniques and investigation of questions. And in its time it was a seminal report. We have built upon that report by using up-to-date data, more sophisticated statistical methods and additional variables that we have discovered are also significant predictors of derailment rate.

Q. I'm going to switch topics and talk about the testimony of Robert Chipkevich. Have you reviewed that?

A. Yes, I have.

Q. So he asserts that crude oil unit trains are more difficult to control. Do you agree with that?

A. No. As I said a few moments ago, and I'm -- railroad operators, as well as what are called track train vehicle dynamics experts, I believe, will generally say that a uniformly loaded train has less of the sort of heterogeneity in the dynamics than a manifest freight. And so -- and furthermore, unit trains are not new. Modern incarnations of unit trains have been operating for at least 40 decades and, in fact, as I believe was pointed out by other testimony, unit trains could argue -- you could argue that they go back for more than a century in terms of movement of petroleum. So the only thing new about the current use of unit trains is that -- obviously, the large volumes of first ethanol and then petroleum crude oil that began moving in the mid to late 2000s.

Q. So he expresses a specific concern about the likelihood of derailment of a unit train in emergency braking situations. Do you believe that they are more likely to experience a derailment in those conditions than non-unit trains?

A. No. Again, for the reasons that I have said. What happens in emergency braking is that the -- each car has a control valve that controls the brakes on the

train -- on each car, and it has a -- what's called the auxiliary brake, which is -- and then there's the emergency brake.

In an emergency situation, both -- the air pressure in both of these reservoirs is applied full force to cause the brakes to go on. Again, because of the differences in the train mass, if you were -- if you had a manifest train, you have empty cars mixed up with loaded cars and big cars mixed up with little cars sometimes. So you get a lot more of these dynamics than you would with a uniform train of -- whether it's hopper cars or tank cars or other things that are typically transported by a unit train.

Q. His testimony also suggests that loaded crude oil tank cars are stiffer and don't react well to track work.

A. Yeah, I was curious about his assertion about that. I've known Bob for a long time and respect his knowledge, but I think he may -- he may have this confused. There was a problem, I'm going to guess twenty-something years ago, maybe a little more than that, where it was -- and it took a while to sort of diagnose -- where empty tank cars, particularly stiff ones which were -- had thicker shells, if you can kind of envision freight cars, you may look at them as a

solid object. In fact, they are somewhat flexible. And so they need to, in certain circumstances, adjust to the track geometry, some of the irregularities in the track or as you go into a curve you get some super elevation.

Well, a loaded car has plenty of mass pushing down and so it's going to conform pretty well to those track geometry conditions. But this problem that I believe Mr. Chipkevich is referring to was a problem with empty stiff cars where they would go into curves and they didn't quite -- because they weren't loaded, they didn't have this mass pushing down helping them conform to the track structure, it caused the wheels to sometimes lift off as they entered what's called the spiral of a curve. And it was a perplexing problem for the -- all the parties involved because they would look at the cars and they would say, well, all of the mechanical parameters are in spec, and then they would look at the track geometry and they would say, it's in spec. And, again, this is not my corridor of expertise, but I was familiar with the problem when it was around and I've read about it since then. The eventual solution, as I understand it, was to take a more sort of holistic view of the car's dynamics, the track's geometry and modify both so that we would eliminate this problem. I don't believe that this is going to be a

problem for these trains because, again, in the condition we're most concerned about, of course, they're loaded. And secondly, my understanding is this is a problem that's been solved for several decades.

Q. Mr. Chipkevich relies on PHMSA's draft regulatory impact analysis related to the tank car rule. Are you familiar with that analysis?

A. Yes.

Q. How was -- how was your analysis of this specific route different from PHMSA's examination of derailment and incidents on the entire rail network?

A. So PHMSA, again, the Pipeline and Hazardous Materials Administration, which is the branch of the USDOT that's responsible for hazardous materials packaging and things, they, of course, were charged with evaluating whether or not a regulation to change tank cars was needed. And part of their mandate is that they had to conduct a cost-benefit analysis of the rule.

So what they were doing was a high-level cost-benefit analysis of how much benefit would be derived in dollars and cents and how much cost would be incurred to -- you know, as a result of the implementation of this rule. They didn't need the same level of granularity and detail that we need for a route risk analysis of the route we're talking about here.

So, again, they didn't get into details about FRA track class and whether or not the track was signaled and what the traffic density was and various other details of our work that I believe are necessary for a quality, reliable risk analysis. And this isn't a criticism of PHMSA. There was no reason for them to do that level of detail. It's not needed for the questions they were trying to answer.

But for this analysis, we did incorporate all of that, as well as very specific understanding of the performance of the tank car. And, again, when they did that analysis, the 117 wasn't really part of the picture yet. So again, we incorporated the specific design characteristics of the 117, as well as the infrastructure and the train configuration, which also wasn't part of PHMSA.

So the point is theirs was a high-level sort of macro study; ours was a fine-grained detailed study of this particular route.

Q. Can you speak to the data set that PHMSA used in terms of the consequence analysis?

A. So one of the things that distinguishes our research -- and I should really give credit where credit is due -- the RSI-AAR tank car safety projects research from PHMSA, PHMSA's sort of mandate is -- and it's in

the regulations, for railroads, they only receive information and the railroads are only obliged to provide information if there's a release of a hazardous material.

Well, it's not unusual to look at an FRA accident report and they'll say, you know, X numbers of hazmat cars were derailed but none of them released. That requires -- if they -- if the -- if the derailment exceeded the FRA's reporting threshold, it has to be reported to the FRA, but there's no need to report that to PHMSA because there were no hazardous materials released. And so PHMSA, by definition, doesn't have a representative sample of tank car derailments. They only have a sample of derailment -- well, of tank car incidents in which some quantity of hazardous materials were released.

And that's one of the big differences between the PHMSA database, which is an input to our data but by no means the only source, and the RSI-AAR tank car project database, where the RSI-AAR tank car project, which has been around for over 40 years, long ago recognized that they wanted to get information on every single tank car that was derailed, if possible, because to assess tank car performance, you need to know the failures, but you also need to know the successes. And

by "success," I mean a tank car that derails but doesn't release its contents.

And so -- and so the project goes to great efforts to obtain data on all derailments involving tank cars in which one or more tank cars were derailed and damaged in that accident. So that's a big distinction I would say. And even with -- if you combined FRA and PHMSA, you still don't get all of the information, because the FRA doesn't contain any information on the type of tank car design. It just says hazmat car derailed, hazmat car released, and the only car you know anything about is what they call "the causing car." But the other ten cars that derailed, they don't tell you anything -- they don't even identify those cars.

Q. To be clear, the RSI-AAR database that you used, does it include that information?

A. Yes. Yes. And, again, RSI-AAR stands for Railway Supply Institute and Association of American Railroads.

Q. Can you say that again for the court reporter's benefit?

A. Yeah, sure. RSI-AAR stands for Railway Supply Institute and Association of American Railroads.

Q. So in addition to his reliance on the PHMSA regulatory impact analysis, Mr. Chipkevich relies

significantly on 24 derailment incidents from 2006 to 2015. Do you believe that the reliance on that list of incidents accurately reflects the risks associated with trains involved in this project?

A. No. His -- his report wasn't really a risk analysis. It was a summary of relatively high-profile incidents. To do a risk analysis, one has to understand what the -- again, basic risk analysis is probability times consequence. So most of what I'm involved with in the context of this work is the probability side of that, how -- what's the probability or likelihood of events occurring of various magnitude.

The work that PHMSA did and Mr. Chipkevich was referencing, again, it's a summary of these high-profile incidents that captured a lot of people's attention and frankly helped us all understand that we needed to address a problem, but it doesn't really tell you much about risk. It gives you some idea -- and I think this is what he said, it gives you some idea of what the potential consequences might be.

But the other thing that's not reflected in Mr. Chipkevich's work is anything about what's changed. So most of those incidents that he was talking about either involved the Legacy 111 tank cars or some of the non-jacketed CPC-1232 cars, which were an improved

version of the Legacy car, but as we've learned, not sufficiently improved to address the risk. And all of those -- that information was becoming clear over the course of, let's say, the last five, six, seven years which led to -- it culminated in the development of the DOT-117 specification.

Q. And did he consider derailment rates or trends in derailment rates?

A. No. No, that's the other thing. He doesn't -- not only does he not account for the change in the tank car design, he doesn't allow for the fact that -- USDOT statistics will bear this out -- the accident rate has been declining, was declining over the period of this incident -- of his incidents, and it just doesn't account for changes that are likely in the future as opposed to what was happening in the past when those events occurred.

Q. Are there any problems, in your opinion, in using incidents from around the country and trying to extrapolate a risk profile on a specific line?

A. Well, yes. So that's another problem with that -- with what was presented there, which is that there seemed to be no -- no recognition of the distinction between considering derailments over -- I forget his time period, but it's something like close to

ten years or maybe eight years in both the US and Canada, encompassing the volume of these products moving, again, throughout the nation, versus four trains a day on a 380-mile route in the state of Washington, which is just a fraction of all of the exposure to accidents that is reflected in Mr. Chipkevich's work.

Q. Does he distinguish between releases caused by the derailment incident from secondary releases?

A. I don't actually remember whether he did or not. But that is a very important factor and, again, one that we in the tank car safety research community understood. And when I talk about conditional probability of release, or CPR as I often shorten it, that is the likelihood, as I mentioned earlier, that a tank car is involved in a derailment, suffers damages and releases some fraction of its contents, again, anywhere from a few gallons to its total load.

But a number of the high-profile accidents were made much more severe by what I would call the secondary thermal failure of the tank cars. Galena, Illinois, is one that comes to mind where I believe the initial release was from a single car, at most maybe two. That started a fire. The other cars were engaged -- engulfed in that fire and one by one they suffered thermal failures, which then fed the fire and made other cars be

exposed, so it's just kind of this chain reaction. So it went from a small, relatively modest incident to a much more high-profile one. Fortunately nobody was injured or killed or anything and I don't think there were -- I don't know about the environmental impacts.

But the point is Mount Carbon was a CSX accident, which is kind of a similar thing, it was a little bit -- a lot of the cars failed from the secondary failure mechanism.

Well, when I talk -- spoke before about thermal protection, that was a specific response to the recognition that it's not just making the car safer in the initial impacts of the derailment that's important; it's also protecting cars from the thermal effects and the subsequent thermal failure. And, again, Mr. Hildebrand refers to this in his scenarios as well. It's a known problem and, I -- you know, all of the evidence that we have and the research we've done suggests that the 117 would have solved that problem. And, again, it's not just theory because, as I mentioned, we refer to the LP gas tank car success over the last several decades which has a similar system already in place.

Q. Mr. Chipkevich testifies that BNSF had 780 derailments between 2008 and 2015. In your opinion,

does that mean that BNSF's tracks are unsafe?

A. No, because as I mentioned earlier, BNSF overall as a system has a lower derailment rate than average. Second of all, they're a huge system. I'm thinking there's something in the neighborhood of 24,000 miles throughout the western half of the United States and even a little bit into the east.

That number includes derailments of all severities. So again, you know -- well, I don't know if we specifically talked about this. But for an accident to be reported to the Federal Railroad Administration, it has to exceed a specified monetary threshold of damage to infrastructure and equipment and the signal system, it's all laid out in the regulations and on their web page, and that amount is periodically adjusted upward for inflation, but over the period of -- it's currently somewhere like $10,500. Over the period of Mr. Chipkevich's study, I think it ranged in the 9 to 10,000 range. Now, to all of us that sounds like a lot of damages, but railroad infrastructure and rolling stock is very expensive and so it's very easy to do $10,000 worth of damage with even a small derailment. They sometimes refer to that sort of low threshold as the equivalent of a railroad fender bender. It's un- -- very unlikely that people were injured or any serious

consequences ensued, but it meets this lower threshold of having to be reported to the Federal Railroad Administration. And from a statistical standpoint that's a good thing for us, because it means we have this wealth of data on numerous accidents, even the relatively modest ones, that allows more robust statistical analysis of trains and a better understanding of everything from low-consequence accidents all the way up to the worst type.

Q. You touched on that range of consequence of a reportable FRA accident. To be clear, are all FRA reportable accidents derailments?

A. No. Again, without getting too far into the details of what FRA -- so for instance, FRA also requires that all grade crossing incidents be reported. That's a separate database, although sometimes there's overlap, but I don't think this council needs to get into that. I have a Ph.D. student working on that study right now.

But in terms of the ones that are part of this sort of reportable threshold, it's collisions, derailments, fires, explosions, acts of God, but derailments are the principal one followed by collisions, which are somewhere in the 3 to 5 percent of all these incidents and I think the others are -- we

don't hear too much about it. Fires --

JUDGE NOBLE: Excuse me, Dr. Barkan, you're tailing off at the end of your answers and I can see that the court reporter is not getting all of that.

THE WITNESS: Okay.

JUDGE NOBLE: Thanks.

BY MR. KISIELIUS:

Q. I was trying to find that sweet spot again of loud enough to hear but not --

A. I got intimidated by the PA system.

Q. So just to be clear, again, given the definition of "accident" and that threshold, does every reported accident present a risk to public safety?

A. No. Again, there's a large percentage that are at that low end of the reporting threshold and, again, they provide information to the railroad and information to the FRA and information to us, as researchers trying to improve railway safety, but they're not where the bulk of the risk lies.

And so reporting all of the FRA reportable accidents, as Mr. Chipkevich did, I think overstates the higher consequence -- the likelihood of higher consequence incidents that can lead to derailments of hazardous materials cars and releases and the sort of things that we're concerned with.

Q. How do you respond to Mr. Chipkevich's claim that your statistical analysis is not consistent with what's going on in the real world?

A. You know, I was perplexed by that statement since our data are directly derived from the real world. They are -- as I've just been explaining, they're data that come from the Federal Railroad Administration as a result of reporting requirements, they're data on actual tank cars that were damaged in accidents and are part of the RSI-AAR tank car project database. So I would say our data are fundamentally real world. We didn't invent them. They come from well-respected authorized sources where there're very detailed protocols for reporting these incidents. And, again, if they err anyway, they err on the side of trying to get even the most -- try to get as many incidents as possible so that we really have the detailed information on all incidents and the magnitude of those incidents. So I don't agree at all.

I think we've done a -- our data are more comprehensive than the data that he was referring to. Again, he selected a handful of incidents that were of interest in terms of the consequences of a large incident, but they don't -- they're no more -- they're no more real world than ours, and I would argue that in a sense ours is far more real world because they're more

comprehensive. They're certainly more representative.

Q. So let me switch subjects here. Did you review the testimony of Audie Huber?

A. I did.

Q. And I think there was an accompanying letter from Mr. Hall.

A. Uh-huh.

Q. Mr. Huber's testimony presents the letter from Mr. Hall as a study. What conclusions about the risks associated with this project can be drawn from a list of less than ten examples of past derailments?

A. Yeah, I think Mr. Hall's report suffers from the same things I just referred to with regard to Mr. Chipkevich's report. It's really not a risk analysis at all. It's a listing of some high-profile accidents and it's saying, you know, under the circumstances that prevailed at the time those accidents occurs, which are different than the circumstances that are occurring now, and certainly different than the ones if this project were to be approved because, again, things like changes in railroad infrastructure, changes in railroad operating practice, very importantly, changes in the tank car that we've been talking about. It's not a risk analysis; it's a list of incidents with no attempt to calculate a rate of occurrence and how

traffic on this particular line affects that risk.

Q. You had earlier testified that in terms of assessing the consequence of a derailment that speed's important. I'm going to ask you about some questions related to the trains traveling in the loop line at the facility. And in particular there's been some testimony and some questions about the impact of an earthquake on a train in that loop line. I know you're not a seismologist, but I just want you to assume that there's an earthquake big enough to cause a train to topple.

A. I'm not a seismologist, but I know seismologists.

Q. Assume that there's an earthquake large enough to cause the tank cars to topple.

A. Right. Right.

Q. How would you expect the tank cars to perform in that type of an incident?

A. Yeah, so as I understand it, there's sort of two scenarios in the facility. One is cars are parked transloading and the other is a train is slowly entering at something like 5 miles per hour. The cars that are parked -- well, let's start with the car -- the train that's moving. So that's -- a seismically caused derailment I don't think is going to have substantially different impacts than any other type of derailment. So

you have a train derailing at 5 miles per hour --

MS. BRIMMER: Your Honor, I'm going to interpose an objection. I think we've strayed beyond this witness' expertise. He's an expert in taking data and doing some probability analyses and risk assessment. He's not an engineer, he's not a tank car engineer and I think this is, in fact, testimony about what actually happens to the engineering of a tank car with a specific incident. It is not about probability of a derailment and a release and the other things that are part of his expertise.

JUDGE NOBLE: Response?

MR. KISIELIUS: Yes, Your Honor. Half of -- derailment is a component of Dr. Barkan's analysis. The other half is what happens to the tank car that is involved in a derailment incident and how does it perform and what's the risk and probability of a release from that incident. Dr. Barkan is now testifying to how the tank cars will perform if they were to go off the tracks in those circumstances. That's entirely within his area of expertise and the report that he's already provided.

MS. BRIMMER: No, Your Honor, it's entirely different. The expertise that he has is to take data and information from others who are, in fact, engineers

and apply that in a probability model scenario. But what he's being asked to testify to right now is the actual engineering and what breaks off, what doesn't break off based upon a future event. It's not about taking somebody else's work and plugging it into his model. This is a very distinct engineering question that he is being asked and he does not have that expertise.

MR. KISIELIUS: Your Honor, if I might. He's testified already today at great length about the different components of a tank car that could fail and how that informs his analysis and the robust data sets that he has on each of the different elements of tank car failure when subjected to impact. This is entirely within everything he's testified about before.

JUDGE NOBLE: I have to agree with you, Mr. Kisielius, and it's also consistent with the testimony related to an agreed exhibit that we looked at earlier about tank car construction. And so I'll overrule the objection.

I would ask that he be specific about what he's basing his testimony on, if you would back up a little and ask him that.

MR. KISIELIUS: Sure.

JUDGE NOBLE: Thank you.

BY MR. KISIELIUS:

Q. Dr. Barkan, I'll make you start again. In that scenario, I think you're describing two potential ones, one where it's moving at a slow speed and one where it's parked and I believe you were beginning with the scenario in which it's moving.

A. Yes.

Q. So if you could explain how a tank car that derails would perform and also explain on what you're basing that assessment.

A. Yes. And I should say that that -- something like a seismic event is potentially part of the -- I don't remember if there's a specific cause code, but there are various elements in the FRA data that we do analyze that would, you know, be similar to the circumstance.

So a 5-mile-an-hour derailment, as I think you would probably expect, is not going to be a very high-consequence derailment. A few cars will probably derail. The seismic effect -- the seismic --

JUDGE NOBLE: Excuse me, Dr. Barkan. What I wanted you to do was to testify about what in your background, experience and knowledge informs your testimony about this.

THE WITNESS: Okay.

A. So one of the lines of research that's occurring right now at the US Department of Transportation, are what I'll refer to -- for lack of a better term, I'll refer to as tank car tipover tests. There's an engineering consulting firm that we work with periodically in the Chicago area that has a contract with the FRA -- and by the way, something I didn't mention about my qualifications, I serve on the Federal Railroad Administration's Research and Development Oversight Committee. And so I work with the director of that program and his various associates and the contractors that do work with them evaluating and prioritizing a wide range of research.

Anyway, so there's -- one of the areas which of interest right now is to understand how -- when a tank car tips over, what kind of damage occurs. And the principal concern here are the top fittings, the -- the sort of thing when a tank car rolls over on its own weight, there's really -- you'll bend some fittings and things like that, but it's not going to -- it's very unlikely that this would lead to a release except for the damage to those top fittings. So if you'll remember that diagram, if it tips over -- and so the DOT is -- and this contractor have developed what I would consider a very aggressive test where the tank car's actually

raised up and it falls down and hits a concrete structure intended to sort of impose the maximal stresses on this car that's turning over. And so in a seismic event that's the sort of thing that we would expect to be happening.

And those tests are in progress right now. They have conducted tests on the Legacy 111 without those protective top -- anything protecting the top fittings. Not surprisingly, they failed when they hit this concrete block. They've tested some experimental top fittings protection systems. They have not yet tested the design that's going to be used on the -- or is being used on the 117. So that's really research that's in progress in terms of that. But I should again point out that that test scenario is a particularly aggressive test condition that may or may not be duplicated in the facility.

THE WITNESS: Is that okay?

JUDGE NOBLE: Thank you.

A. I can actually speak to one other aspect of this, which I think I do have experience on because of other research I did. It's my belief that if there's going to be another release -- again, the top fittings question is -- again the jury's kind of out until that research is done. But the other possible cause of a

release would be in the transloading piping and hoses that are used to move the product from the car into the system to transload it. Those are going to have a dry break connection. So basically what that means is these are special valves that are commonly used in a lot of circumstances where, once it's opened up, they automatically shut. So the extent of the loss would typically be expected to be what's in the piping at the time of that event and in the hoses, and the containment system of this facility would be able to capture that quantity, I would think, without any problem.

BY MR. KISIELIUS:

Q. So you focused on the upper piece, the fittings.

A. The top piece.

Q. How would you expect the tank shell to perform, based on the data on -- of that type of an event?

A. As I said, I think it's very unlikely that the tank shell would fail under such circumstances. It compares -- compared to the much more aggressive environment that it experiences in a higher speed, more violent derailment, it's just very unlikely that it would fail just because it was tipping over.

Q. And I presume that you had, I think, four different -- you earlier described the four different elements of the tank car design that could be subject,

so we talked about the shell, we talked about the upper fittings --

A. Right.

Q. Sorry. And what about the others that --

A. So the head -- you know, the end of the tank, it's really not going to be exposed to anything in a lateral tipover. And similarly with the bottom fittings, to the extent that the bottom fittings are going to be involved, it's the scenario I described a moment ago, where you have unloading apparatus connected to the car that would be disrupted as a result of this tipover.

JUDGE NOBLE: So, Dr. Barkan, you're basing your answers not on your knowledge of engineering; is that right? You're basing your answer on your knowledge of the data about these occurrences?

THE WITNESS: So I've spent 27 years working with tank car design and tank car transloading. I mean, I have experience above and beyond what we've referred to in the specific context of the statistics and the data. I mean, I don't --

JUDGE NOBLE: Thank you.

BY MR. KISIELIUS:

Q. So I want to switch topics here and ask you a couple of questions about rail traffic more generally to

put some of this in context. So let me ask you, do you consider and work with rail traffic data in general as part of your work?

A. Yes, I do in several respects. Again, as has already been discussed, it's part of the -- what we would call the denominator, the basis for establishing traffic volume to normalize our data to calculate rates. I also worked with another line of research that's -- a significant part of our activities, my activities, is what's called railroad capacity research, where we evaluate the capacity of a rail line to move trains and move traffic with varying degrees of reliability and efficiency. I've supervised something like a half a dozen theses on that and published something like a dozen papers in peer-reviewed journals.

And then another aspect specific to hazmat is that since about 2001, I think it is, we have been compiling the statistics for the Association of American Railroads on annual traffic volume of hazardous materials. And, again, it's an important element of our understanding of the rate of occurrence of various events.

Q. And so there's been some discussion about -- and concern expressed on some of the incidental impacts to the rail traffic. I think the concern is based on the

notion that this is going to increase the rail traffic in the state of Washington, this project. Do you believe it's a given that the project's going to increase rail traffic in Washington State?

A. No, I don't, because rail traffic is a dynamic thing. I mean, it fluctuates -- you know, railroads acquire customers and lose customers, traffic fluctuates at sort of a macro level as a result of the economy, different products start to move or cease moving. And so part of -- and this actually relates to our railroad capacity analysis where -- understanding not only what the traffic demands are now, but projecting into the future what they're going to be and how to best design the infrastructure to accommodate those changes in traffic. And it's not just changes in volume. It's also changes in the characteristics of their operation.

But to make a long story short, traffic is often fluctuating, and in the state of Washington, BNSF, for example, has three different routes across the state. And as part of their operations, they will dispatch trains differently, depending upon what the condition of the network or this portion of the network is at any given time. So it's over -- it's an oversimplification to say, we're going to bring four trains on this route, that means we'll have four more trains per day on this

route. It may mean that some traffic moves to another route.

Q. And there's also been some concern about the movement of oil increasing the volume, overall volume, of exposure to potential hazardous materials -- derailments involving hazardous materials. Is crude oil the only hazardous material being shipped by rail in large quantities?

A. No. It's grown dramatically, of course, since 2009, but right now I would say it's somewhere in the neighborhood of 25 percent or at the very most 30 percent of total hazardous materials traffic.

Q. Okay. And I'm going to --

MR. KISIELIUS: I would like to offer into evidence a rebuttal exhibit. And so before we talk about it, I'm going to ask you some foundational questions. But this is Exhibit 375 that we circulated to the parties yesterday.

BY MR. KISIELIUS:

Q. Dr. Barkan, are you familiar with the FRA -- excuse me, the AAR reports on rail traffic and quantities of rail traffic?

A. Yeah, I receive those on a regular basis from the AAR.

Q. And do you believe they accurately communicate

data on percentages of rail freight traffic?

A. Yeah, they're very detailed, comprehensive reports of all traffic, and oftentimes they'll sort of talk about -- take other aspects of the market. Like I say, it's a very rich source of information.

Q. And have you had a chance to look at the most recent July report?

A. Yes.

Q. And is that the type of information that you would rely on in order to reach conclusions about percentages of freight traffic?

A. Yeah, it's one of two sources, but that's a -- that's the one I would be relying on right now. I get some annual statistics from another source, but in terms of the weekly ones, that's certainly the most current reflection of the traffic.

MR. KISIELIUS: Your Honor, I would move to admit Exhibit 375 into the record.

JUDGE NOBLE: Is there an objection to Exhibit 375?

MS. BRIMMER: Your Honor, we got this -- we did get this July 8th report yesterday at the end of the day, and I've looked at it. I don't have an objection, although to my -- see if the City does.

JUDGE NOBLE: City's objection?

MS. REED: Your Honor, we do have an objection based on the timeliness, and are also concerned that the information presented is not specific to the routes that will be used by trains servicing the facility or going through the affected jurisdictions. We would request the ability to respond, if we need to, in writing during the period for submitting additional written testimony. If that would be allowed, we could withdraw our objection.

JUDGE NOBLE: That will be allowed and so the exhibit will be admitted.

MS. REED: Thank you, Your Honor.

JUDGE NOBLE: I would ask the witness to respond to the concern about the specificity to the route that is at issue here, and also the fact that it is a monthly report. So what does it have to do with what the council is trying to decide?

Will you be questioning the witness about those things?

MR. KISIELIUS: I was just going to ask just a couple of questions about the data reported here and we could certainly address those topics.

JUDGE NOBLE: Thank you. That's good.

MR. KISIELIUS: Ms. Mastro, if you could load up Exhibit 375. And we're going to page 12.

MS. MASTRO: Twelve?

MR. KISIELIUS: Yes, please.

BY MR. KISIELIUS:

Q. I know it's very hard to see on the screen, Dr. Barkan, you've got -- there we go.

So does this data reflect your understanding of the volumes that you had just described in terms of the percentages of oil versus other hazardous materials?

A. Yeah. Now, there's -- I want to explain to council. So this is -- these are data on chemicals and petroleum products. Most chemicals are hazardous materials but they're not all. The same is true for petroleum. Not all petroleum and petroleum products are hazardous materials. But, again, this is I think a -- this is congruent with the detailed information that I work with on a regular basis regarding hazardous materials transportation. So that's why I was saying earlier, if you look at that number, it's -- the total is -- for chemicals and petroleum is 1.1 million, petroleum is about 300,000. So that's, as I was saying, somewhere in the 25 to 30 percent range. That's consistent with our detailed hazardous materials data that, again, I've been compiling for over 15 years.

Q. Okay. And, again, this is national data?

A. Right.

Q. And so -- have you done a more detailed look at the specific line in question?

A. I have not.

Q. But would you expect, given your understanding, this to be representative of just an order of magnitude estimate?

A. Certainly it's not going to be hugely different than this. I honestly don't know the details of the traffic mix on the BNSF. So I -- and this is part of the BNSF, so I -- I can't give a very definitive answer. I apologize.

Q. Okay. I have --

JUDGE NOBLE: We had a hard time hearing that answer.

A. I'll give a really simple answer. No, I don't have a very clear understanding of the percentage of petroleum as a percentage of all hazmat in the state of Washington.

JUDGE NOBLE: And what -- the microphone is not near your mouth, to you. Thank you. I think we did hear that.

Proceed.

BY MR. KISIELIUS:

Q. So I have just a couple of concluding questions for you. I think counsel for intervenor began this

hearing by quoting the captain of the Titanic saying, I cannot imagine any condition that would cause a ship to sink.

How do you compare your risk analysis to the captain's statements?

A. I would say they hadn't done a proper risk analysis. The nature of risk analysis is that you do exactly what the intervenor apparently said, which is that you try to identify all the possible failure modes. If you've ever seen one of these flowcharts and event trees, it's a very comprehensive approach to understanding what can go wrong, how it might go wrong, what its likelihood of going wrong is, and then assembling the data, again, from real-world sources to calculate the risk and what is contributing to the risk. Again, this is -- this speaks to a larger theme of my research literally throughout my professional career, which is understanding how things fail, why they fail, quantifying that level -- that rate of failure and -- as well as quantifying the ways that that could be -- those things could be mitigated.

And, again, as I said, one of the things that we're fortunate with in the rail world, and I know this because we did a study on the trucking side a few years ago, the railroad world, especially North American

railroads, are particularly rich in the availability of data on a wide range of accident causes in the form of the FRA accident database, and in the tank car failure modes in the form of the RSI-AAR tank car database I've been referring to.

So the theme of our work, and that's the same theme applied to this particular project, is to develop as accurate, comprehensive an understanding of the factors affecting the risk, to use the best quality data available to then quantify those risks, and then provide that information to the appropriate decision-makers who can use it to make better informed decisions, such as yourselves.

Q. And finally, is there anything in the prefiled testimony or the oral testimony of the intervenors that you've reviewed that causes you to change your opinions stated in your prefiled testimony or as expressed here today?

A. No, there is nothing.

MR. KISIELIUS: I have no further questions for this witness.

JUDGE NOBLE: We were having a discussion about the number of this -- availability of this exhibit.

So since there are no more questions for

you, except cross-examination, and so it's lunchtime, I think that we should break until 1:00 and start cross-examination at that time. Thank you.

MR. KISIELIUS: Thank you, Your Honor.

JUDGE NOBLE: We're off the record.

(Recess taken from 11:58 a.m. to 1:11 p.m.)

JUDGE NOBLE: We're ready to go back on the record.

Cross-examination?

MS. BRIMMER: Thank you, Your Honor.

CROSS-EXAMINATION

BY MS. BRIMMER:

Q. Good afternoon, Dr. Barkan. My name is Janette Brimmer. I represent some of the intervenors in this case. I'd like to start a little bit with your background, as other counsel did. You're employed by the Association of American Railroads for a little over a decade, correct?

A. Just about exactly ten years.

Q. And that's an industry organization?

A. Yes, it's the trade association representing the major railroads in North America.

Q. And in the summary on your CV, you state that you continue to serve the rail industry as a director of the AAR Affiliated Lab at the University of Illinois; is

that right?

A. That's correct.

Q. And as a deputy director for the Railway Supply Institute?

A. I'm sorry?

Q. And deputy director for the Railway Supply Institute?

A. No, it's slightly different.

Q. Okay.

A. I'll clarify. Earlier I referred to the RSI-AAR railroad tank car safety research and test project. So I serve as the AAR deputy director on that project. There's another person who serves as the director of that project. So -- but I can give you a copy of my card. That's got it on the back.

Q. Thank you. And I believe that your RAilTEC research website acknowledges that you do receive financial support from the industry, correct?

A. Yes, we do.

Q. In your report that was Attachment B to your prefiled testimony, you noted that you rely on -- I think you said, a unique combination of historical FRA accident data and proprietary rail industry data. Am I characterizing that correctly?

A. I guess I would like to see where I said that.

Q. Sure. I've got it on page 18 of attachment B.

JUDGE NOBLE: Do you have an exhibit number for that?

MS. BRIMMER: I can't remember if that was a separate exhibit. Is that 123, I think?

MR. KISIELIUS: Yes, Your Honor, 123.

JUDGE NOBLE: Thanks.

A. In the appendix. Is that what you're referring to?

BY MS. BRIMMER:

Q. Yes.

MR. POSNER: What page is that?

MS. BRIMMER: Page 18 of attachment B.

A. I'm not finding it, but I'm not saying it's not there.

BY MS. BRIMMER:

Q. Well, let me back up. Is it inaccurate for me to say that you rely on a combination of historical FRA accident data and proprietary rail industry data?

A. In the calculation of the train accident rates, that is accurate, that's correct.

JUDGE NOBLE: We can't hear you up here.

THE WITNESS: In the calculation of the train accident rates, it is correct that we use the combination that was referenced.

BY MS. BRIMMER:

Q. And you know the rail industry data is proprietary; that it is not generally available?

A. That is correct.

Q. It's not publicly available?

A. That's correct.

Q. And so with respect to the report to your testimony, you're unable to show a lot of the background data in some of your work associated with the report, correct?

A. There's a paper that's presently in review with the peer-reviewed journal, Accident Analysis & Prevention, that provides a fair amount of the data, you know, summarized in an appropriate manner.

Q. But that's not part of your report here, correct?

A. No. But -- well, no, I think it is one of the attachments.

Q. And it provides the proprietary rail data?

A. Let me -- you know, let me check, please. Yes. So it's Exhibit 0239. It's entitled "Freight-Train Derailment Rates for Railroad Safety and Risk Analysis."

Q. But is it your testimony that Exhibit 239 has all of the proprietary data that you use in your report here?

A. So as you might imagine, there's a large, vast database. What this contains is a summary of that database. It would be rare, the case, that we would provide -- anybody would provide an entire database such as this.

Q. Are you able to provide this data only with the permission of the rail industry?

A. The data that are in this paper, I have permission to publish this. As I say, it's currently in review in the journal of Accident Analysis & Prevention.

Q. So I would like to turn to the methods of analysis and some of the details of your report for this case. Am I correct that you used information that included all freight trains, regardless of freight?

JUDGE NOBLE: Speak up now, Dr. Barkan.

A. That is correct. We used information on all freight trains.

BY MS. BRIMMER:

Q. And I think I heard you earlier today testify that you used the information from the recent five- or ten-year period, although there is data that goes back to the '70s?

A. Yes. We -- so, again, the combination of our report and the paper we just discussed about rates, I believe, and I could look --

Q. Well, maybe I --

A. It is a recent ten-year period. Let me see what the exact time frame was.

Q. Well, let me help you out there. I think that the time scale that you indicate in your report is 2005 to 2009. Does that sound right?

A. Sounds right, yes.

Q. Crude-by-rail unit trains really started to increase in 2009, didn't they?

A. That is correct. Well, crude-by-rail, yes. Ethanol had already started.

Q. In the method that you use in your report, you look at each individual detail, like, for example, the probability of a particular type car breaching in an individual accident, right?

A. Can you repeat that again? I'm sorry.

Q. Sure. In your report you look at each individual detail, like the probability of a particular type of car breaching in an individual accident, correct?

A. I'm not sure I would phrase it exactly that way, but I think I agree with the intent of your question.

Q. In other words, it's not a larger umbrella kind of look?

A. No. We're trying to look at individual -- in

the context of tank cars, we're trying to look at each individual tank car specification which, as I said, physical parameters, design parameters that affect its likelihood of releasing if it's involved in a derailment.

Q. Are you familiar with that kind of analysis being described as a bottom-up risk assessment?

A. I am not.

Q. When you are looking at details, probability of derailment and, in particular, release of product on derailment is affected by train speeds. I think you've testified to that, correct?

A. Probability of derailment is typically not affected directly by train speed. Probability of derailment does appear to be correlated with the FRA track class. With higher FRA track classes corresponding to higher speeds, and as you'll recall in -- I said earlier there's a -- an inverse relationship between FRA track class and derailment rate, namely that the higher the FRA track class, the lower the derailment rate.

Q. So are you saying speed is not relevant to your analysis?

A. No, I'm not. Speed is relevant.

Q. And that's a factor that's been known for quite

some time, correct?

A. Yes. I don't -- one page of the -- another paper that's part of the exhibits here, a paper we wrote in 2001 or '3. Anyway, there's a relationship in there between certain aspects of derailment. So maybe to answer your question a moment ago, I think what you may have been getting at is not derailment rate but derailment severity. So derailment severity is correlated with speed and this other paper shows that. I don't think we were the first ones to find that relationship.

Q. Are you aware of industry opposition to speed limits that were recently imposed in federal regulation?

A. I am certainly aware of the discussion that was going on -- I mean, peripherally, let's put it that way. Peripherally involved -- aware of the discussion that was going on between the railroads, the AAR, the USDOT regarding speed restrictions. The railroads volunteered to speed restrictions and proposed that, and then I think there has been some discussion and proposals for further reduction of speed. I don't know the status of that discussion.

Q. A number of accidents have happened below the speed limits that have recently been imposed by federal regulation, correct?

A. That's correct.

Q. And that was both before and, in fact, after the federal regulation, correct?

A. That's -- I think that's correct, yes.

Q. Braking in all of its forms, types and when it happens, can also have an effect on derailments and the severity of derailments, correct?

A. There is a discussion going on now about -- this may be what you're referring to. About the merits of electrically controlled pneumatic brakes as a possible means of reducing the severity of derailments.

Q. And, in fact, that was a factor in the Mosier report, correct?

A. Yes, I believe it was mentioned there.

Q. Is braking considered at all in your report analysis?

A. Only in the sense that our database, by definition, incorporates whatever effects the brakes that were operating in the train would have -- you know, so in other words, if we had a derailment and the train went into emergency and, let's say, 12 cars derailed, that -- those -- that braking effect would -- in principle, could affect the severity of the derailment.

Q. But it's not a separate input into the model?

A. No, it's not.

Q. I think you talked a little bit about one of the factors is whether there are signals at crossings. Am I remembering that correctly?

A. No. I apologize for the misunderstanding. So when I talk about signals, I'm talking about wayside traffic control signals. I think what you might have been referring to are grade crossing signals. That's a different matter and a subject actually of a different line of research that we're involved with, but there's no conclusions coming forth from that yet.

Q. Thank you for that clarification. So crossing signals are not a factor in your analysis?

A. So what I would call them is grade crossings, grade crossing signals and warning systems are not part of our analysis.

Q. I assume, then, that tribal access for fishing sites crossings were not part of your analysis either?

A. No.

Q. What about location of an accident in terms of affecting severity, for example, steep hillsides or grade? Is that part of your analysis?

A. No, not specifically. Again, those conditions exist in the database of derailments -- I should say variability in those conditions exist in the database that was used, but there's no explicit accounting for

this condition versus that condition in the analysis.

Q. And in your analysis, did I hear you correctly that you only looked at the BNSF route here?

A. That's correct. For this particular study, yes.

Q. And Tesoro Savage project trains only; that you were doing your assessment just for those four daily trains?

A. That is correct.

Q. Are you familiar with what is Exhibit 5547 in this case? You don't have that in front of you, so I don't want you to look for it. But I will tell you that that is PHMSA's Draft Regulatory Impact Analysis from 2012. Are you familiar with that document?

A. I'm familiar with it. I haven't read it cover to cover and memorized it.

Q. Well, from memory, do you -- do you recall that it concludes -- or does this sound familiar: That there is a reason to believe that derailments of high-hazard trains will continue to involve more cars than derailments of other types of trains because features of oil unit trains, such as being longer and heavier, are more challenging to control and stop?

A. I think I recall them -- that being said and being discussed. I don't have any reason to believe -- agree with them on that point.

Q. I think your testimony today was that the jury was still out on that factor. Is that accurate?

A. Yes. Well, let me -- before I answer too quickly, let me think. So could you restate your question so I'm sure I'm answering the right question?

Q. Sure. You're familiar with the statement in the Draft Regulatory Impact Analysis, and I asked you to confirm that my understanding of your testimony today is that the jury is still out on that.

A. Okay. So what I believe the PHMSA report quote that you just mentioned, referred to "more severe derailments." I mean, what was -- if you can repeat that wording.

Q. Sure. I'll read it. There is reason to believe that derailments of high-hazard -- is it freight trains -- HHFTs?

A. No, flammable.

Q. Flammable, thank you -- will continue to involve more cars than derailments of other types of trains because of features with oil unit trains, such as being longer and heavier in total and more challenging to control or stop.

A. I would agree with you that I said the jury is still out.

Q. Okay.

A. It's a complicated sentence they wrote.

Q. Fair enough. In your report I think you cite to some data that underlie some of your statistical analyses that assume a release rate of 1.6 tank cars per accident. Does that sound right?

A. Again, I would want to look at my -- so in my report, let me find that.

Q. And I apologize, I don't have a page number for you.

A. Can you repeat the number again or the context or whatever?

Q. Sure. There are some data that underlie your analysis that assumes a release rate of 1.6 tank cars per accident. I think it's 47,000 tank cars and 30,000 accidents.

A. Oh, yes. Okay. So that's -- or if somebody wants to look at it, it's on page 7 -- well, the reference to 47 and 30,000, but I'm not seeing your --

JUDGE NOBLE: We can't hear you.

A. Okay. So I'm finding the 47,000 and the 30,000. I'm not finding the 1.6.

BY MS. BRIMMER:

Q. Let me back up. Does that equate to about 1.6 tank cars per accident, those two figures?

A. Oh, I see what you're saying. You're testing my

arithmetic skills.

Q. Yeah, and I didn't do this math myself.

A. That looks -- could be a little higher than that, but...

Q. Are you also familiar with data showing that over a nine-year period, from 2006 to 2015, there have been 24 oil or ethanol trail derailments in which product was released?

A. I'm sorry. Is this something I said or something somebody else said?

Q. No, I'm asking if you're familiar with that data.

A. How many again? Sorry.

Q. Sure. Between 2006 and 2015 --

A. Right.

Q. -- 24 oil or ethanol train derailments --

A. So this is, yes, Mr. Chipkevich, I think, cites this.

Q. Right.

A. If you're talking about the same table as him, yes, I'm familiar with that.

Q. Okay. And that equates to more than 1.6 tank cars per accident if you're using that data set, correct?

A. It certainly does. Which is part of what's

wrong with that data set.

Q. Similarly, your testimony is that in release -- that in release incidents between 2005 and 2009, the years you used, less than 5 percent of tank contents spilled; is that right?

A. I'm sorry.

Q. Sorry. And I apologize again for lacking a page number.

A. Huh?

Q. I apologize again for not having a page number.

A. So this is in my report?

Q. That's my understanding of your testimony, yes.

A. Can you repeat it and I'll try to find it?

Q. Sure. Actually, you know what? That's okay. Let's move on.

A. I should say, back to the 1.6 matter, I mean, I kind of responded quickly saying that's what's wrong with the data set.

Q. Sure.

A. It's related to what I said earlier, which is the PHMSA data only records information -- I won't say "what's wrong." It's a limitation of that data set. It records only -- first of all, the PHMSA database only records incidents in which a tank car released. And second of all, in that case, they were specifically

interested in tank cars that -- those were relatively high-consequence, high-profile incidents, kind of by definition, that's what PHMSA was interested in. So when we talk about the 47,000 and the 30,000, that's going to include many tank cars that did not release, and so we would expect the ratio would be different.

Q. Well, that's good. That's jumping ahead a little in my outline, but let's explore that. I think you were talking about -- in comparing your analysis to some of the testimony we heard from Mr. Chipkevich. Now, he investigates accidents and has been on the scene in his career; that was part of his job, his expertise, right?

A. Uh-huh. Yes.

Q. Okay. But that's not your work or role, correct? I mean, you are a probability risk analysis person, right?

A. I would describe my background and expertise and experience more broadly than that. I certainly have not been to the number of accidents that Mr. Chipkevich has been to, but I've been to some and spent a fair amount of time working with people who have been involved with railroad accidents, derailments as well as tank car -- and understanding tank car failure from a mechanical perspective as well as a statistical or data

perspective.

Q. And I think you characterized he was summarizing real incidents, which was different and distinct from the risk analysis that you were doing and I think, again, you pointed to the difference in the PHMSA database, right?

A. Yeah. I would -- I would say that his incidents are no more real -- or our incidents are no less real than the ones he's referring to. We work very hard, as does the FRA and PHMSA and the railroads and the tank car companies, to develop databases that are as comprehensive as possible, but they all come from real-world data.

Q. So I think you pointed out that the PHMSA database is only where there's a release, and so it would have fewer incidents reported than the other database you were referring to?

A. In general that's going to be correct. I won't say that PHMSA never records a rail incident where there wasn't a release, but that's primarily what their -- what the regulation requires, as I understand it.

Q. And as part of your report here, and I would fairly say everyone involved here, we care about releases, right? That's one of the things we examine.

A. We certainly do.

Q. So if you actually combine the database that is talking about releases, this thing that we care about here, with data that doesn't include releases, wouldn't that dilute the probability calculation for releases, the thing we're trying to avoid?

A. No, I think that's a misunderstanding of the concept. And let me also say that the 24 incidents that are in there, I believe omits some other incidents where there were releases and I also believe that it omits a number of incidents where there were not releases.

What I was trying to explain earlier today is that in order to understand the rate at which tank cars fail, and I can express it as simply as the following: We have a number of tank cars that fail -- let's start with we have a number of tank cars that derail and we have a number of tank cars that release, and the latter divided by the former is the rate of release. And if it helps, we can talk about baseball players' batting averages, because it's directly analogous. A batter's batting average is simply the number of at bats -- sorry, the number of hits divided by the number of at bats. That's a batting average. We might consider our tank car in the same fashion.

So to your point, if we only calculated a person's batting average on days when they went three

for four, they would have a really high batting average. If we only calculated their batting average on days when they had hits, they would have a higher-than-actual batting average. Batters go hitless on some days. Same thing happens in tank car accidents. Tank cars will derail and not release. And so to have a proper, accurate understanding of tank car safety performance, you need to have a complete denominator, the number of incidents, and an accurate numerator, the number of releases.

Q. Well, I think that actually gets us to another point about your report, which is I think you testified that proper risk analysis includes probability times consequences, right?

A. Correct.

Q. And, in fact, that's one of the things that that 1983 study, that is Exhibit 5557, talks about, all the way back then, you can't have a proper risk assessment without probability times consequences. Would you agree?

A. Yes. Well, you -- but there's some latitude in describing consequence. It depends on the objective of the study. And in our own papers we have defined the consequence differently depending upon the objectives of the research.

Q. I think you're anticipating my question. I think the consequences that you talk about in your report are primarily spilled oil, correct?

A. Yes. It's the quantity -- it's the distribution of the quantity of spilled oil, that's correct.

Q. But there's nothing about the effects of that spilled oil, whether it's environmental or human or anything like that?

A. No, that was not an objective of our study.

Q. And I think that you talked a little bit about you also didn't include secondary effects, such as fire or things that happen as a result of the spilled oil?

A. That's correct.

Q. So I'd like you to refer to your report, I think it's Exhibit 123, Figure 6.

A. Yes. I think it's before this. It's on page 12, if we're talking about the same one. This is it.

Q. There we go.

MS. BRIMMER: Could we blow that up a little bit, Ms. Mastro?

MS. MASTRO: At the bottom?

THE WITNESS: It's the bottom figure on that page.

MS. BRIMMER: No, not the bottom one. It's

Figure 6 on that top page.

THE WITNESS: It's the bottom one on that page if you want Figure 6, but I don't know which one you want.

BY MS. BRIMMER:

Q. Yes, I want Figure 6, please.

A. So that's it right there.

Q. All right. That's the --

A. It keeps flipping. That's the problem with the -- don't touch it.

Q. Perfect. So the scale on the left-hand side, that's in 100-year intervals?

A. No, it's actually in year intervals, return period in years, and it increments -- well, okay. Yes. 100, 200, 300.

Q. All right. I'm sorry, increments, 100-year increments?

A. Yes.

Q. So it's a little hard to see when all the lines are squished down at the bottom. I think you said that in certain instances you can expect a derailment every 2.4 years. Am I recalling that testimony correctly?

A. Yeah. And I'm not going to suggest that the -- that we move to a different table, but, yes, in the summary of the probability estimates on page 3, the

derailment return rate we calculated for this route on average was 2.4 years.

Q. And that's -- I think if I'm reading this correctly, that's -- that's on the end of five cars or less derailing -- or releasing, I'm sorry, releasing?

A. So a derailment does not equate to a release.

Q. I understand that.

A. So in other words, we're saying one of these trains might derail roughly every 2.4 years somewhere on the route, and then what this tells us is what the distribution of expectations would be regarding the number of cars releasing depending upon which of the five particular tank cars we considered here is. Does that help?

Q. Yeah. Now, in Mosier we had three or four cars releasing. I think you disputed whether the fourth car was a result of the accident, but the range of three to four; is that right?

A. I won't say I dispute it. I'm aware of a question related to that, but yes.

Q. So are we right in -- are you confident enough in your model to say that because that happened in Mosier, we're now good to go for some significant period of time?

A. No. We could have that derailment tomorrow.

The nature of risk analysis and probability, assuming the events are independent of one another, which we generally think that they are, we could go many, many years without another incident like this -- and of course, remember, that's on a different railroad, a different line, different circumstances, but nevertheless, that's the nature of these sort of risk predictions. They are expected values but they are random and independent processes. I know I'm using some stochastic jargon here, but the point is, is that we would -- well, there's no -- there's no relationship between the Mosier incident and when the next incident is going to occur, except to say that on average on the BNSF route that we analyzed, it would occur whatever frequency we calculate here.

Q. So you know trains for the facility will potentially travel also on the Union Pacific route, right?

A. I'm sorry?

Q. You know that trains coming to the proposed facility will potentially travel on the Union Pacific route as well, right?

A. Actually I -- I don't think I did know that, but it makes sense, perhaps. I would have to defer to the applicant.

Q. So I think you said that we can't read your work here as saying because something happened in Mosier we're not going to see another effect for a hundred years because that's not how probability works, right?

A. That's correct. And frankly if the derailment had occurred on this route, it wouldn't -- the same result would apply.

Q. And part of that problem is that there's a lot of variables at play on any given day, many of which we can't know, right?

A. Sure.

Q. It's not like a situation where -- I think you used baseball as an example. I'm going to use -- it's not like we can figure out something with a finite set of information, like the chance of drawing an ace out of a deck of cards; it's not like that?

A. Right. Let me see how I want to respond.

Q. That's -- let's move on to the cars and car design information.

A. I guess I do want to say one thing about that, though. So we do understand that there are variables that affect that probability both up and down, one of which is, of course, in terms of releases, the design of the tank car. But there are also these infrastructure characteristics. So what we have observed is a

statistically significant and not just a -- it's a strong statistically significant relationship between those three parameters and derailment rate --

JUDGE NOBLE: Your voice is dropping and we can't hear you.

A. What we have observed is a statistically significant and strong relationship between those three variables I've mentioned earlier. But there is -- like any stochastic process, which is in some sense what this is, there still is going to be some residual remaining variability that accounts for this uncertainty. I mean -- and frankly, if we could plan derailments, we would plan not to have them.

BY MS. BRIMMER:

Q. Indeed. So turning to some of your testimony in your reports concerning cars and car design, you did talk a little bit about what's been called the 117Rs, the retrofits.

A. That's correct.

Q. So in your report when you've got a column for 117s, does that include the retrofits in that column?

A. No. At the time the report was prepared, there was still sort of questions about exactly what the 117Rs were going to look like. But I can actually tell you now, now that I know more, where they're going to fall

in this chart. If you look at the -- on the left-hand curve, you have the DOT-117 --

Q. Actually, Dr. Barkan, let's go to -- I think there's the actual chart that has all the numbers in it.

A. Sure. That's the --

Q. I think it's page 3.

A. -- the table --

Q. Yeah, the table. Let's go to that. That's maybe an easier way to just talk about this.

A. Okay. That's it.

Q. So I had asked you whether this included 117Rs. I think you had said no, but you could tell us where it would be included; is that right?

A. Yeah. And I slightly misspoke. So the jacketed CPC-1232, which is the first column to the left of the right-hand one -- so everybody see that?

Q. Uh-huh.

A. -- that is similar to one of the 117Rs. Another one is going to fall between that one and the DOT-117, and -- for the sake of discussion but I wouldn't -- the numbers will roughly be intermediate between that row of columns -- or those two columns. So what we're looking at in the left-hand side of this table is similar to -- in my terminology, we bound the -- bound the conditions of 117s and 117Rs.

Q. So are you saying that you've rerun your model and you would now change this chart, or are you just saying, knowing what you know, you'd eyeball that it would go in those places?

A. No, I'm -- so, yes, we would have to -- to get formal numbers, we'd have to rerun our model. But what I'm trying to say is the jacketed CPC-1232 represents a certain class of 117Rs. The DOT is still trying to make some decisions about exactly how they're going to -- whether they're going to require thermal protection be added to those cars or not. But that doesn't affect these probabilities. It would have some effect on the likelihood of secondary failure if these cars get into accidents.

The column that's missing would be the same as the DOT-117, except the thickness would be one-half inch instead of nine-sixteenths. And if you'll notice, the jacketed CPC is seven-sixteenths, so a half inch is in between. But it's not necessarily exactly a linear relationship between those two, but the numbers would fall roughly intermediate between the numbers on those two columns, with one further exception that I mentioned this morning, which is that they will be required to have this detachable bottom fittings handle, which will somewhat reduce the likelihood of releases from bottom

fittings, the amount which we don't know yet, but it will -- so in -- you guys should go to the tank car committee and have these conversations. So the tank -- the CPC-1232, the seven-sixteenth inch car values will alter slightly as a result of this bottom fitting change. Sorry for the complex wordy explanation.

Q. So the -- you understand that the retrofits are not going to have the thicker steel?

A. No, you can't retrofit steel thickness. All you can do is take an existing tank and add -- in the case in particular of the non-jacketed CPC-1232s, they're going to add a layer of thermal protection, they're going to add a jacket, they're going to replace the half-height head shield with a full-height head shield, they're going to modify the bottom fittings handle. And I'm not aware of any other differences.

Q. I think I understood your testimony earlier today to be that steel thickness is one of the important factors in why the 117s are estimated to perform better than the other cars. Is that an accurate characterization of your testimony?

A. Yes, it is.

Q. I'm going to turn to your testimony about 117s and estimates. I think you referenced a database for 117s, but, in fact, there's no database of actual

accidents for 117s, right?

A. I don't think I referenced a database of 117s.

Q. Okay.

A. But what I -- I mean, I can...

Q. I think what we have is some of what you've published in the paper and I think, am I right, there's about a half dozen tests that have been done for 117s; is that right?

A. I don't know.

Q. The Mosier incident involved jacketed CPC-1232s, right?

A. That's correct.

Q. And they were going under allowable speeds?

A. I believe it was a 25-mile-an-hour derailment on a 30-mile-an-hour curve.

Q. And I think you said something about a number of the tank cars did not release even though they were, and I wrote this down, in the fire.

A. Yeah.

Q. Were there, in fact, tank cars in the fire that did not release?

A. I mean, what I understand, and we still don't have all of the information about that report -- or that accident, but as the cars that were exposed to fire, some of them did release and some of them did not, but

none of them failed due to what I would call thermal failure or -- the kind of failures that we have been trying to prevent with the addition of thermal protection. So in other words, one car had a gasket melt, one car had a bottom fitting damage or valve open and one car was punctured through the shell.

Q. So they were exposed to fire, some pieces of them, but they weren't in the fire?

A. I don't know. I mean, I know that some cars were exposed to fire. That I'm quite certain of. I just don't know how many were and which specific ones were. That's what I'm trying to say.

Q. And I think that when you were talking about that fourth car, you said you had some information that you thought that it released not because of the initial derailment but because when they were trying to get the track clear again, that's when it released oil?

A. There is -- I have heard that. It's -- in the process of wreck clearing, sometimes that can happen. I don't know how much product was lost as a result of that.

Q. I assume that kind of release is not included in your report?

A. That's correct.

Q. You talked about the database you relied on for

tank car performance as including a lot of information over a long number of years. Is that a right characterization?

A. No. The database on the tank car safety performance involves tank cars from potentially anywhere in North America. What is important are the characteristics of the route and how they affect derailment probability.

Q. Well, let me be clear. I think you said that -- and, again, correct me if I'm not characterizing or remembering this correctly, but that there was a data set for the 111s and the 1232s that went back a long time. Is that accurate?

A. I don't think I said it that way.

Q. Okay. Correct me.

A. What I think I said is that our database for the tank -- the tank car safety project database began in 1970, but there's not -- it's not like we -- we don't -- we don't just learn about how a tank car performs by analyzing tank cars of a specific specification. So in other words, let's just use 111s as an example. So 111s are in our database and that means that we have shells and heads of those that are going to typically be seven-sixteenth-inch steel of a certain grade, and those will be analyzed for the performance, those components

of the cars with those physical parameters. And we can then analyze -- I'm probably making this too complicated.

The long and the short of it is that for our most recent statistical estimates of tank car safety performance, we have used a set of data from more recent years that we think is more representative of the current tank car population. We haven't used data all the way back to the origin of the project in 1970.

Q. So when you said that -- I think you said this info has been around a long time, you weren't referring all the way back to the 1970s but some subset of that information?

A. I guess I would have to know what info I was referring to.

Q. Okay. Well, let me use a more specific example I took down in my notes. The thermal problems with -- I think you said the 112s have been known for 40-odd years?

A. Yes.

Q. Okay. But the standards for tank cars got finalized within the last year, right?

A. For these cars were finalized -- the DOT issued the new regulation in May, and then I think there were some modifications -- as I noted, there were some

modifications as a result of the FAST Act in December of last year. The reason -- I don't know -- I mean, I can explain that the 112 tank car underwent -- which was used for liquified petroleum gas, underwent some changes as a result of research that was conducted in the late '60s and early 1970s to develop a safer 112 tank car. We didn't recognize the problems with the 111 until more recently, and that's what led to a -- a series of events that led to the development of the 117 last year.

Q. Problems with the 111, did the recognition roughly coincide with the increase in crude-by-rail?

A. No, I think that there have been questions about 111s for hazardous materials that date back before that.

Q. Okay. But then we just standardized -- or we just imposed standards relative to those within the last year?

A. So what changed was, again, this large volume of traffic, particularly the ethanol and petroleum crude oil, that led to unit trains of operations and some of the accidents that we've been talking about. And I think that the public's tolerance for those accidents, as well as the industry and the government's tolerance for those accidents, changed as a result of the more frequent traffic, the more frequent accidents, the larger scale of those accidents. And so where really

all parties were largely satisfied with the performance of the 111, let's say, through the '80s and '90s and early 2000s, they became less satisfied with the safety performance beginning in the mid 2000s when we started having these larger accidents.

Q. Let's go back to your chart that's Exhibit 123, page 3. You've got a term there I think you use in your testimony too. I'll wait till you scroll down a little bit.

A. Where are we?

Q. It's the chart that we were on before. You don't need to change.

A. Figure 6, you mean?

Q. No. The chart that was actually up there.

A. The table, that one there?

Q. There we go.

A. All right.

MS. BRIMMER: Can we blow it up just a teeny bit? That would be great. Thank you. That's good.

BY MS. BRIMMER:

Q. You use a term under "Route Estimates" on the far left, "Conditional Probability." Can you explain to me what "conditional" means?

A. Yeah, it simply means the -- in the world of statistics, there's a term -- there's probability and

then there's conditional probabilities. Conditional probabilities simply means it's conditioned on some other prior event. In this case it's conditioned upon the tank car being involved in what's called -- we call an FRA reportable derailment, and this morning I referred to FRA reportable derailments as those that exceed a certain monetary threshold of damages to equipment and infrastructure. So that's the only thing that's conditional about it. It's conditioned upon this tank car being involved.

And to use an example of something that wouldn't be considered that, if we had a -- and this, you know, sometimes happens. You'll have a tank car with a wheel on the ground, just kind of a railroad term where -- in a yard, happened at 3 miles an hour. That would be very unlikely to generate enough damages to be an FRA reportable accident. So that would not -- that would not get into this calculation. So we sort of set this lower threshold for accident severity of when we're interested in understanding tank car performance because these lower incident accidents are established as kind of a common baseline condition.

Q. The reporting to FRA, is that mandatory or voluntary?

A. For accidents that exceed the threshold as

specified in the regulations, it's mandatory.

Q. Okay. And so the jacketed 117s, conditional probability of release, I'm looking at the second -- by train, so looking at the second line, is 36.7 percent?

A. That's correct.

Q. Jacketed CP 1232s is almost 50 percent? No, 45.4?

A. 45.4 percent. And what that's saying is -- the distinction between those two rows -- the upper row is just saying, if we take one of those cars and we derail it in an FRA reportable accident, for the 117 there's a 5.1 percent chance that it will release at least a gallon of -- you know, some small quantity. It could release more, but that's the point, is it will release something.

The second one, the larger number, the 36.7 percent, is saying that if we derail a train that conforms to the configurations we analyzed, in an FRA reportable derailment, on average we expect at least one car in the train to release at least some of its contents 36.7 percent of the time.

Q. The applicant here has pointed out that it will, unlike other trains, voluntarily use DOT-117s including the retrofits. But other trains moving along this route through Vancouver that are carrying crude oil will not

be so required. Is that your understanding?

A. Well, they will be once the DOT regulations kick in. There's a schedule for when shippers have to use these cars for various products. There was a phase-in period recognized in the regulation and in the FAST Act because of the finite capacity to build and retrofit cars. So one of the things that was agreed upon was to try to prioritize the petroleum -- I believe the petroleum crude oil cars were the first cars to get in -- first products to get into the new cars. The next group I think is the alcohol. I could be wrong on this. And then other flammable liquids I think are the third. And this was based on an assessment of the relative risk, to address the highest risk first.

I should say one more thing, at least the applicant themselves have agreed to not only the 117, but to a 120, which actually exceeds the safety performance of the 117.

Q. You think the applicant has agreed to only accept 120s?

A. No, I believe that that's what they're going to purchase -- or lease probably, but, yeah.

MS. BRIMMER: Could we please go to Exhibit 5547.

A. Can you help me out with that the --

BY MS. BRIMMER:

Q. I'm sorry, Dr. Barkan, that won't be in your books. We'll have to look up here for it. And, in fact, I'm going to start -- well, that's okay. We're on this page. Let's go with this page.

MS. BRIMMER: Could you blow up just the graph at the bottom, please.

BY MS. BRIMMER:

Q. So, Dr. Barkan, I read your prefiled testimony and report to say that generally derailments have been in decline. Do you recall that?

A. The derailment rate has been in decline.

Q. Do you recognize Exhibit 5547 as PHMSA's draft regulatory analysis for the recent tank car rule?

A. I recognize it by reading the source caption there.

Q. Have you read that document in the past?

A. Isn't this the same one we talked about earlier, the regulatory analysis?

Q. Yes.

A. Yeah, I looked at that two years ago. As I said, I did not study it intensely.

Q. Well, looking at figure, I think it's ES5, there at the bottom, "Carloads of Crude Oil Shipped and Rail Accidents," would you agree that that would at least

seem to indicate crude oil accidents have increased with crude oil shipments?

A. I think that this figure is hard to draw any conclusions because you have such a small sample size on crude oil accidents. You have a year in 2005 when there's one and then you have 2006 and '7 when there's zero, and it pops up to two, then down to one again and there looks like a -- the five in 2013. It's certainly -- I would agree that petroleum derailments have increased with traffic. But as I've already said, one of the motivations for really all parties involved, whether it was industry or government, to address the tank car safety problem was that this increase in the volume of shipments, the corresponding increase in the number of accidents and releases meant that we needed to do something about improving the safety of the cars used for these products.

Q. And I think if you turn to page 25 of your prefiled testimony -- or paragraph 25, pardon me.

MS. BRIMMER: And I don't need that up on the screen. That's all right.

A. Paragraph 25?

BY MS. BRIMMER:

Q. Paragraph 25. If you go back, there's the stuff that looks like it's the official filing in the case

towards the beginning there.

A. I'm afraid I'm confused.

Q. Keep going. You're going in the right direction. Keep going.

A. So you mean my -- it's called prefiled testimony?

Q. Correct.

A. I'm learning things here.

Q. That's okay. Paragraph numbered 25.

A. Right.

Q. Are you there?

A. Yeah.

Q. I'll give you just a minute to refresh your recollection and then I'm going to ask you a question about that.

(Witness reviews document.)

A. Yeah, okay.

BY MS. BRIMMER:

Q. So I read that paragraph of your testimony as you saying that the increased incidence of crude oil unit train derailments in recent years is more likely the result of the enormous, more than 40-fold increase in petroleum crude oil traffic since 2009, and that the substantial growth in that traffic meant these trains are exposed to greater potential involvement of

accidents.

So are you talking about what's going on in this graph there?

A. Again, you know, not being completely comfortable with PHMSA -- I'm saying, not knowing all of the background behind PHMSA's data that went into this, but I would say that this -- there is a relation -- it's obvious there's a -- this increase in traffic in the '10, '11, '12, '13 period and then you kind of see a spike in '13 when accidents -- five accidents occurred. I don't recall the 2014 or '15 numbers. I would say that another one of my documents speaks to this a little bit.

Q. That's okay. We'll get to that. Let's -- I want to stay on this document so we don't get confused about what we're referring to.

MS. BRIMMER: Can we go to -- it's page 118 of the internal pagination, Table TC32. Can you just scroll down so we can -- I'm sorry, that's on a page break. Yeah, right there. Maybe that's even better and now it's kind of small.

BY MS. BRIMMER:

Q. So, again, Dr. Barkan, I know that you said it's been a couple of years since you've reviewed this. Are you familiar with the shell puncture velocity, that

information that's being reflected here?

A. I think this is probably referring to some of what I was discussing this morning, about the dynamic modeling and the physical testing that's been done to develop the validation of that modeling. You can see that the full validation of this modeling has been accomplished using results of the puncture test performed by TTCI. So, yes, this is probably the same thing I was talking about.

Q. Okay. And I think you were saying that the 117 car is going to be a dramatic improvement. Is that a proper characterization of your testimony here and in your prefiled?

A. I believe it's going to have a dramatic effect compared to the two cars that have most commonly been used to transport petroleum in the previous decade, let's say, which were the non-jacketed 111 and the CPC-1232 non-jacketed car. In terms of the probability that a car will release some or all of its contents in a derailment is, as I -- that was one of the numbers I -- one of the numerical comparisons I did this morning which -- and a 68 percent improvement in -- or reduction in release probability compared to the non-jacketed CPC-1232, and an 83 percent reduction compared to the Legacy non-jacketed 111 car. So I consider those

numbers significant.

Q. Okay. So -- all right. So I'm reading the exhibit that's on the screen, and it looks like the 1232 unjacketed, you've got an 8.5-miles-per-hour puncture velocity, right? And I'm sorry we don't see the top of the graph.

MS. BRIMMER: Maybe you can scroll up and see that.

A. Yeah, but you'll get in trouble with the --

BY MS. BRIMMER:

Q. Yeah, I'm not really asking for that.

A. Although you could -- maybe she could go on to scroll mode as opposed to full-page mode. That might help.

Q. I think we saw it for a split second and it said, "Shell Puncture Velocity."

A. And that's probably what the results showed.

Q. There we go.

A. "Shell Puncture Velocity" and "Head Puncture," yeah.

Q. All right.

A. "Shell Puncture Velocity" and "Head Puncture Velocity."

Q. Thank you. And then the options, those are the 117 numbers; is that right?

A. I don't recall -- I apologize. I don't remember. There was all this Option 1, Option 2, Option 3 stuff, and I don't remember which one ended up being the final 117.

Q. Well, let's go with the best one, 12.3. So we're going to improve the 1232 unjacketed to the best 117 option, and it goes from 8.5-miles-per-hour puncture velocity to 12.3. Does that look right?

A. Yeah. And I think actually now it's coming back to me. I think the Option 1 and 2 both have a tank head and shell that's the same as what was adopted in the 117. So this is -- I agree with that.

Q. And the Mosier accident happened at what speed?

A. I believe it was 25 miles per hour.

MS. BRIMMER: I would like to go the graph that you used this morning, Exhibit 249, please.

BY MS. BRIMMER:

Q. And, Dr. Barkan, I'll maybe try to start -- oh, wow, that was speedy. Okay.

A. That's the one you objected to.

Q. Uh-huh. Came in, though. So where would tribal fishing access go in terms of -- I mean, is that the far left side of this graph?

A. I'm afraid I am unfamiliar with the population density at a typical tribal access location. I would

guess it's not greater than 10,000 people per square mile, though.

Q. Now, this exhibit is -- represents national information, right, national --

A. That's correct, yes.

Q. And, in fact, in the east, don't these high-hazard trains go around urban areas?

A. No, not necessarily. I think they're going -- I don't really know at that level of detail, but I believe some go through urban areas and some do not.

Q. Well, some are required to go around urban areas, aren't they?

A. Not that I'm aware of.

Q. But they don't go around urban areas here in the west, correct?

A. I honestly -- I mean, I can speak with regard to this route. I believe it does go through both Spokane and Vancouver.

Q. And Washougal and the Tri-Cities?

A. Yes. I apologize, I don't have all of Washington geography memorized, but those sound like familiar town names.

Q. Your testimony is not for these -- these areas where it's now particularly dense or there's -- I think you said there's a long return period for some

point-specific --

A. Yes.

Q. -- areas. You're not suggesting that we're not concerned about that, just that it's a low probability. That's your testimony, right?

A. Yeah, obviously an accident anywhere is a concern and certainly, you know, we -- right. But I guess it's reasonable to say that if you have an incident where there's a high population, the consequences are potentially greater and so those are of particular concern. I would agree with that.

Q. But consequences are -- of that nature aren't factored into your report?

A. No. No, that's correct.

Q. And I apologize for skipping around, but that's the nature of the notes.

MS. BRIMMER: I want to go back to Exhibit 123 and that chart that we had up there, please. Thank you.

BY MS. BRIMMER:

Q. In the bottom part, I think that's your frequency of return, right?

A. For -- it's a -- as it says, it's "Average Route Location Estimates." The distinction between the lower table and the upper table is the upper table has figures

for occurrences anywhere on the route. The lower one are estimates of location -- of rates at particular locations or particular average locations on the route.

Q. I think you testified this morning that the smaller events are the ones that are most common, in other words, where you have small amounts released, right?

A. Yes. In general that's right. So --

Q. I think you said that was the largest part of the curve. You were talking about a curve, right?

A. Yeah. There was actually a frequency distribution on one of the papers that we wrote that shows like 34 percent released 5 percent or less of their contents.

Q. But you don't include the more common smaller amounts or events on either part of that chart in Exhibit 123, right? I see only median and large; is that correct?

A. Yeah. I mean, we have those figures, some for -- we thought that this would be what you'd be interested in. So the median spill is one tank car, the large spill is three tank cars and then, of course, the EWCD is something of interest to the state.

Q. So if that was included, that would be a more frequent number on both those charts; is that right?

A. Yes. I think I'll try to put some bounds on that. Well, yeah, we do actually have a category.

Q. That's okay. You can wait for a question.

A. I'm still answering this question. It's directly pertinent to the question you just asked.

Q. Well, I asked if you included -- if you included the smaller events, would it be a higher number of incidents, and I think you said yes.

A. Yeah, and the information is on this table, if the council's interested.

Q. Okay. So near the end of your testimony this morning, you'll recall there was some testimony about what happens with an earthquake. You recall that?

A. Uh-huh.

Q. And you talked about a rail car laying over from --

A. Tipping over.

Q. Tipping over. There's been testimony in this case and questions about uneven settling in an earthquake. I don't know if you saw that testimony or not.

A. I didn't, but I've had some previous work. I did -- I had funding from the Mid America Earthquake Center to look at how earthquakes affected the rail network and affected rail structures in that network,

and I am familiar with the notion of liquefaction and possible subsidence as a result of seismic activity.

Q. So you're aware that when there is settling from seismic activity, it's not uniform?

A. Yes.

Q. So if we've got a 110-car train on a loop, part of it in the unloading facility and we have a Cascadia subduction earthquake, is the train all just going to tip over?

A. So I don't think anybody could tell you the answer to that question. I think that it's a knowable answer in the sense that I think we could model the lateral movement with earthquakes of varying magnitude and various forms of, you know, ground activity and then understand what the center of gravity of the cars would be and how many and in what orientation to the movement of the fault would tip over. But I don't think -- I would be surprised if anybody knows the answer to that right now.

Q. Last series of questions you talked about rail traffic being dynamic and fluctuating.

A. Uh-huh.

Q. Is that a yes?

A. Yes. Yes, sorry.

Q. And you're aware that the facility expects to

bring in four trains per day --

A. Yes, I am.

Q. -- on average?

A. Yes.

Q. And you would agree that's four trains on top of whatever fluctuation there is; in other words, whatever the fluctuation is on any given day, there's going to be four trains coming to this facility?

A. If -- as I understand it, that's sort of the maximum level of traffic that's expected to come in. It doesn't all -- every day there won't necessarily be four trains a day, but that is kind of the design maximum they're planning for.

MS. BRIMMER: I have nothing further.

JUDGE NOBLE: We are going to have redirect next, but it's 2:23 and I think this is a good time for a break, maybe a ten-minute break, and then later on we'll have another ten-minute break. So 2:35. Thank you. Off the record.

(Recess taken from 2:24 p.m. to 2:39 p.m.)

JUDGE NOBLE: We're ready to go back on the record with redirect of Mr. Barkan -- Dr. Barkan.

MR. KISIELIUS: Yes, Your Honor.

REDIRECT EXAMINATION

BY MR. KISIELIUS:

Q. Dr. Barkan, I have just a couple of questions for you before we turn to council questions. Ms. Brimmer asked you whether industry provides financial support to some of your research efforts. Do you consider your analysis objective and unbiased?

A. Yes, I do, in the strongest possible terms. I have no reason to not provide all of the parties the most objective evaluation possible of this matter.

Q. Ms. Brimmer also asked you some questions about the data set that you used on the derailment rate. The years there were 2009 through --

A. 2005 through 2009 were the derailment rate, yes.

Q. Can you explain why that date range?

A. It just really has to do with when the study was conducted. The railroads were interested -- totally unrelated to the question of -- the question before the council today. There was other reasons why they wanted to have a better understanding of how these factors related to -- or affected derailment rate, "these factors" again being FRA track class, signal or nonsignal and traffic volume on the route. And so they frankly worked very hard. It was a big effort for them to gather the data, it was a big effort for us to

analyze the data and we conducted the study. I would very much like to update the study and do it on a more recent basis, but, again, we would all have to -- the railroads would have to agree to collect the data. And so it's -- I just feel very strongly that it is the best current estimate of derailment rate as a function of these factors available in North America.

Q. And to be clear, I think you distinguished between a derailment and the consequence of the derailment.

A. Yes.

Q. For the derailment rate, are you looking at a broader data set beyond just tank cars?

A. Yes, absolutely. And again, that's where the -- yeah. It's -- I mean, the rate is comprised of two -- in the simplest form, it's the FRA reportable derailments that I discussed earlier divided by the traffic volume under each of these different conditions. And that's what makes it challenging is you can get gross level traffic volume data, but what you have to work with the railroads is, is to get specifically for a particular track class and specifically for a particular -- what we call method of operation, that's the signal or nonsignals and specifically for the tonnage levels. It's that level of granularity that

requires much more effort on the part of both the railroads and our research staff to gather and properly analyze those data.

Q. So I'm going to ask you to keep the pace slower.

A. Sorry.

Q. Maybe bend the microphone up towards your mouth just a little bit. There we go.

Ms. Brimmer also asked you about the DOT-117R.

A. Uh-huh.

Q. And asked you about the tank shell thickness. Is that the only safety parameter that you're concerned about when determining the consequence of a derailment?

A. No. It's just one of the parameters. So there's the tank, the presence or absence of a head shield, the presence or absence of a jacket, which they all have a jacket now and they all have a head shield, the top fittings design and the bottom fittings design. And in particular, as I've mentioned, one of the beneficial attributes of the 117, and this applies to both the 117Rs and the 117s, is they will have that removable bottom outlet valve or handle which will reduce the incidence of bottom outlet failures as part of the car's resistance to release in accidents.

Q. Ms. Brimmer also asked you questions about tests of 117s and said there was no database of 117s because

they haven't been involved in an accident and then turned to dynamic modeling, but can you please confirm that you have done a statistical analysis of the 117 design parameters?

A. Yes, indeed. So, again, we have a large database that has a broad range of different tank cars, but the important thing to understand is that each parameter that makes up the 117 head thickness, the shell thickness, the design of the top fittings, design of the bottom fittings, each of those we have literally thousands of data points regarding their performance in accidents, in FRA reportable accidents. So we can -- and I should say for the statisticians among you, one might speculate, is there -- is the behavior of one independent of the other, and the answer is yes. That was one of the tests we did a number of years ago, was to check to be sure that there was no interactive effect between each of these different components of the tank car. So it allows us to essentially statistically deconstruct or statistically construct a tank car as long as we are using design elements that are -- for which we have sufficient empirical data, and that's very clearly the case in the case of the 117. It's a car that's, you know, very much in our comfort zone in terms of the quality and quantity of data we have.

I'll throw in one more thing for the statisticians in the room. We use regression analysis, and that means that not only can -- we can use the power of regression to understand the relationships along the entire set of variables. So if we're interested in nine-sixteenth-inch steel and how that's performing, information on other thicknesses of steel is also contributing to the statistical understanding at that particular thickness. So that's just an additional bit of insight into how we develop our understanding of the 117 tank car.

Q. I want to turn to the discussion you had with Ms. Brimmer about shell puncture velocity.

A. Right.

Q. Is that the same thing as conditional probability of release?

A. It's not -- it's related, but it's not the same. And I'm glad you asked me. Because when we do these physical tests, oftentimes where you literally are knocking one object into a tank car and measuring -- as I mentioned this morning, very carefully measuring the strains and the failure of the material in response to this impact loading, not surprisingly, speed or velocity of impact is one of the variables that we're both manipulating and interested in asking about. And those

figures that were shown represent, for a given tank car design, the puncture energy -- or the puncture speed where there's enough energy to puncture the surface of the car, or the shell of the car in that case and the head, both the head and the shell were there. And that is a physical measurement of different cars' resistance to puncture in accidents.

But -- and it's -- it's correlated with conditional probability of release, but it's not linearly correlated. Because what's happening in a derailment isn't this nice, clean experiment where we have this object puncture the tank. What's happening is kind of a -- it's a chaotic event. Let's face it, there's cars piling in and rolling around and crashing into one another in a wide range of possible configurations. And so the dynamics -- the derailment dynamics are much more complex than that simple test.

And, again, another project that I'm very much involved in is a project in which we're working with dynamic modelers and statisticians to try to unify these two so we can start to actually understand if we see that particular puncture speed and that particular angle of attack and that particular impact or that particular speed of failure, we can relate that particular design to these statistical results.

But that's a -- it's a state-of-the-art research problem that we've been working on now for about five years and I'm hopeful we'll start to have some -- we've done a pilot study that gave us promising results and the next phase of that study I hope will ensue and probably take another several years to finish up. But that will allow -- I'm kind of getting into my research spiel here. But that will allow us a lot more power to understand new and novel designs for tank cars.

Back to the comparison that was made, if you noticed, speed of puncture for the 117-like car, which I think is Options 1 and 2, was a higher speed than the speed of puncture for the lower car, the non-jacketed 111, and that's exactly consistent with what we see in our statistics, is that the amount of speed required to puncture the car that has a lower likelihood of puncturing according to our statistics is higher than -- so put another way, if I could -- if I made a tank car out of paper, I could stick my finger through it, but if it was a piece of steel, I couldn't. That's not very helpful, I guess. But the point is that that higher speed is directly related to the greater resistance to damage in an accident and the lower likelihood of puncture that's statistically represented by our statistics.

MR. KISIELIUS: Thank you. I have no further questions.

JUDGE NOBLE: Council questions?

Mr. Shafer?

MR. SHAFER: Dr. Barkan, thank you very much for your testimony today. A few questions.

In your body of research and work, do you look just generally -- I would say in the aggregate, the safest methods of transporting oil, whether that be by pipeline, shipping vessel, trucks, and if so, how would you rate those from the most safe to the least safe and where does rail -- train -- railroad trains come in there?

THE WITNESS: Yeah, I'm afraid I have not conducted a modal comparison of the nature you're asking so I really can't answer your question. I'm sorry.

MR. SHAFER: Okay. Early in your testimony, if I heard this right, I believe you cited three primary reasons for safety against derailment, one being the track class, the second you cited was relative to the volume of the train traffic and, third, the signals. And if I heard you right, I believe that you indicated that actually it is counterintuitive, but an increase in the volume can trend towards increase in safety. And I was a little confused by that and I know you took

council questions on this. In paragraph 25 of your prefiled, again, just a brief statement here, "The substantial growth in this traffic meant that these trains were exposed to greater potential involvement in accidents."

So could you help clarify that for me and maybe reconcile it? It seems to me those are -- there's some disparity there.

THE WITNESS: Sure, understandable. So let's talk about just the derailment rate for the time being and then we'll get on to the oil traffic. So what we did with what our statistical analysis found was that if we took a section of track that in every other respect was equal -- I do want to say this particular result is a correlation. We're not in a position to say caused that situation; we're just saying it's a strong statistical correlation, but I do think I have some insights as to why it occurred.

So if we take a section of track that's alike in every respect and in particular in the context of this, the same FRA track class, the same signal or nonsignal, and we statistically look at lines, let's say, that have 60 million gross tons a year, which would be a relatively busy line, or 5 million gross tons a year, which is kind of a light range line, we will see a

different rate of derailment on those two conditions with the following result: The 60 million gross tons will actually have a lower rate of derailment, rate normalized by numbers of trains passing or number of tons of traffic or whatever or however we want to measure that rate. Now, of course -- compared to the 5 million gross ton. So that's what I mean when I'm saying a rate. It's a rate at which we run traffic over this and a rate at which we expect those trains to derail.

I'll try to come up with a simple numerical example here. We still might get a higher absolute number of derailments on the high-density track even though the rate is lower. How can I come up with a good example for this? Maybe we can do a baseball example again. Yeah, that might work. I'll try it. A baseball player with a --

MR. SHAFER: The Mariners are playing, right?

THE WITNESS: Absolutely. Unless it's my Red Sox.

Suppose we have a 200 batter, okay, and he or she, he if it's major leagues these days. He plays 20 games. So the quick arithmetic here would be that he would -- we would expect him to get a hit about every

five times, so in 20 games I would expect him to get -- he's got three of them --

JUDGE NOBLE: No mumbling.

THE WITNESS: I've got to come up with something better than this. Let's just never mind games, let's just say at bats. So he's a 200 batter, he gets a hundred at bats. Okay. So he's going to get 20 hits, we would expect. A 500 player playing in five games -- five at bats might only get one hit. So, you see, even though the rates differ -- I don't think I'm helping here, but even though the rates differ, the absolute number of events can be either way really.

MR. SHAFER: Let me see if I can approach this.

THE WITNESS: I'm a teacher. I should know how to do this.

MR. SHAFER: In my simple thinking and I would say on a theoretical basis, if you had a train function operation, the more that they're running that, I could see that there's certainly potential that they would get better at it. But what concerns me is, it appears to me that we have actual data that is running contrary to that. So I'm looking at perhaps more the theoretical versus the actual.

THE WITNESS: Yeah, and I -- with all due

respect, I don't think the data do contradict that because, again, if you're running a lot more traffic even though your rate is lower, you're still going to expect a higher incidence of events. Does this help?

MR. SHAFER: Okay. So the overall volume is just so much higher, we're picking up more events, although the rate is still --

THE WITNESS: That's exactly right. I will stand by that quite strongly. I really believe that that's correct.

MR. SHAFER: Okay. Last question, and you do cite even in that same paragraph 25 and I think some other areas in your prefiled, that there is -- there is a recognizable significant jump beginning around the year 2013, at least up to 2015, in the number of incidents. And although that time period is relatively new and brief, was that data in any way brought into your modeling? Did it change it? Did it update it? Adjust it in any way?

THE WITNESS: So one thing we did do is because in recognition of the fact that the derailment rate from 2005 to 2009 was actually higher than it has been in the period 2010 to 2015, freight train derailment rate, not petroleum crude, but freight train derailment rate is -- actually came down. So -- during

that period. You know, I think if we're allowed to look at an exhibit -- is that -- are we allowed to do that?

JUDGE NOBLE: You're allowed to look at an exhibit if it's been admitted.

THE WITNESS: Yes, it's in here. It's in Exhibit 250. And it's on the first page. This may or may not be helpful. That's it. He's got it there. Yeah, so this chart. What we're looking at here -- now, I'm color blind, but I think the line is green; is that right? So that's the accident rate, which you can see has declined steadily from 2004 to 2014, but what the blue represents is ethanol and the orange represents crude oil. And so what we saw at the same time the derailment rate was coming down was this steadily upward trend in traffic of the type we're concerned with. And so even though the rate was lower, the much higher exposure of potential -- to potential accidents overcame that. We're actually working on an analysis right now to tell us specifically the answer to your question, which is has the rate of petroleum and alcohol accidents -- how has that changed over this period. Because this is looking at two sets of data which lead to a certain inference, but I want to know just like you do.

MR. SHAFER: And even though it may be more

of niche area, crude-by-rail only, we would want to, say, extract or isolate that data, right; I mean, that's specifically pertinent to this project?

THE WITNESS: You're correct.

MR. SHAFER: Thank you.

THE WITNESS: Again, I believe that the risk analysis we did is -- and I -- I believe it represents the state of the art of North American risk analysis for this project -- the transportation of this product right now. I lead a group that has continually conducted research onto new -- such as what you've just raised and others. So it's sort of a continuous process of furthering our understanding at the time.

MR. SHAFER: Thank you.

JUDGE NOBLE: Mr. Moss?

MR. MOSS: Thank you, Judge Noble.

Dr. Barkan, having read your testimony with all your exhibits and having heard about four and a half hours of your testimony today, I am impressed with the idea that you are something of an expert in the study of the Bakken oil production and the shipment of that production by trains.

THE WITNESS: Thank you.

MR. MOSS: Yes. My question to you is this: It relates -- actually we can look at Exhibit 250, which

we were just doing. And I notice you say there in the second paragraph of the article that you coauthored, "Transport of petroleum crude oil increased more than 50-fold from approximately 9500 carloads in 2008 to 500,000 in 2014, with further growth expected" -- and there's a footnote there. But that hasn't actually materialized, has it?

THE WITNESS: That's my understanding, that, in fact, traffic has abated a bit in the last year or so.

MR. MOSS: Yeah. And do you know what accounts for that?

THE WITNESS: Well, this is well outside my area of expertise. I mean, it's the economics of petroleum and supply and demand and what the Saudis are doing and, you know, all of that.

MR. MOSS: And what I was thinking of specifically was, are you aware that there has been a lot of pipeline development?

THE WITNESS: Yes, that's right, pipeline is another factor.

MR. MOSS: It's a lot cheaper to ship it by pipeline than it is by train, right?

THE WITNESS: Right. And, again, I've been reading, as you probably have as well, you know, how the

market dynamics have changed as a result of the price of crude. I mean, we've already seen at least three shifts in how this stuff is going. It was originally moving down to the Gulf Coast area, Oklahoma, Gulf Coast area, then it started moving east and now it's starting to move west, and it all has to do with these complex market and complex dynamics that are not my purview.

MR. MOSS: I don't want to try to push you too far down that road, then. I think perhaps that's as far as I do want to take you. I just have one more quick question for you, and this is sort of a point of curiosity. You said you unfortunately became aware of the Mosier incident very shortly after it happened, and I'm wondering why you view that as being unfortunate.

THE WITNESS: Well, any accident is unfortunate. And so I was sorry to hear that we had had yet another crude oil accident. The other reason is more personal. I was vacationing in Italy at the time and I knew that I was going to have to devote some attention to gathering information as part of my role with the RSI project, so I had to get on the phone and Internet with my students and colleagues and kind of mobilize some data-gathering information.

MR. MOSS: So you became familiar with that incident?

THE WITNESS: Yes. Yes. We -- as a -- our -- the RSI-AAR tank car project was, of course, very interested in that and actually had one of its representatives visit the accident site and collect information on the -- on the failure mode of the cars.

MR. MOSS: And so you know there was no pool fire?

THE WITNESS: I guess I'm not sure -- I -- you know, what I -- I saw big fires in pictures and I saw badly burned tank cars. If you want to define a pool fire in a certain way, then I will know that.

MR. MOSS: The reason I asked that was because we've had testimony earlier in this proceeding concerning the design of these rail cars and that the 117, despite the fact that it will have thermal shielding, will only last in a pool fire for, I forget what it is now, but maybe it's 100 minutes or 110 minutes or something like that. So you seem to -- you gave me the impression that you believe that the 117 design was essentially airtight and you didn't need to worry about rail fires anymore, and I just -- I questioned that. In light of your earlier testimony, I wonder if you have any comment on that.

THE WITNESS: Yeah, no, I'm glad we're having this conversation. So the 100 minutes -- the

100-minute rule prescribes a very intense situation, which doesn't necessarily occur in most accidents. I mean, it makes sense. We have a regulatory standard that's a very high bar, and one of the things that the DOT is considering right now is whether to elevate that standard to make it a longer standard. But, again, that's a bench test of the thermal protective material. And somewhat -- somewhat analogous to the discussion we were just having about puncture velocity, that bench test doesn't necessarily equate directly to all of the varied conditions that can happen in an accident.

I know what the railroad industry wanted was a much longer standard. This was actually a point of some contention between the AAR and the DOT last year and the interval between when the regulation was issued in May and it went on through the summer and fall where the railroads, and I think joined by other industries, petitioned the DOT to increase that standard and the DOT refused, for reasons I don't understand because you had the regulated parties saying, we want a safer standard; you have the regulator saying, we're not going to give it to you. I'll leave it at that because I have no idea why that -- they would take that position.

But that was remedied in part in the FAST Act. And what the FAST Act said is, thou shalt put a

layer of thermal protection on the cars, and part of -- so now that has to happen for the 117s and the 117Rs that will be re -- retrofitted from the non-jacketed CPC-1232s.

So I will now shift to one -- well, a series of histories we've had, which, as I mentioned, we've had a requirement for thermal protection since the 1970s for the LP gas cars. And functionally that has worked out to be a layer -- this thermal blanket, as it's called. And the experience there is that those cars performed very well. There have been very few thermal failures where before this that was -- and it was a crisis for the rail industry in the late '60s when some of these very bad accidents occurred. And there's a -- one anecdote that I like to relate when I talk about this is an accident that occurred in Weyauwega, Wisconsin, in the mid to early '90s. A train of LP gas cars derailed, caught on fire. Fortunately nobody was injured or killed, as far as I know. I know no one was killed. I don't know if anyone was injured. They were evacuated and Downtown Weyauwega was looking at this huge fire --

JUDGE NOBLE: This means slow down.

THE WITNESS: Okay. Yeah. Sorry. I'm almost done. When that accident was over, I actually got the fact reports from the field about the nature of

the damage and every single -- none of those cars suffered thermal failure. They had some that had punctured and others just sat in this fire for days. You know, their pressure relief valve had relieved pressure, but the point is that the system did exactly what it was supposed to do. And that's in general the way industry and government feels about the LP gas cars. And, again, as I mentioned this morning, LP gas is a more energetic material than petroleum crude oil. It's based on that experience. But I think once we get all this taken care of with the 117s, we are going to be looking at, again, a much lower likelihood of release in the first place because of the more robust design and much lower likelihood of subsequent thermal failure because of this man- -- federally mandated thermal protection system.

MR. MOSS: Thank you for elaborating on that. That's all I have for you.

JUDGE NOBLE: Mr. Stephenson?

MR. STEPHENSON: Thank you, Judge Noble. I have a bunch of questions but I think they're quick and easy. So if we can get Exhibit 249 up on the wall, please. Thank you.

First of all, there's two Y axes here, and the one on the left, the blue one that goes with the

blue bars -- and I'm assuming since the cars are the same, it makes sense -- is car miles of petroleum and alcohol, millions.

THE WITNESS: Correct.

MR. STEPHENSON: Millions per year?

THE WITNESS: Well, this was a one-year study, so 2012. But it's just -- it's just saying millions of car miles.

MR. STEPHENSON: Great. So that takes me to my second question, which is, what year?

THE WITNESS: 2012.

MR. STEPHENSON: And then the right axis, cumulative percent of what? Of time?

THE WITNESS: No, it's the cumulative -- it's the cumulation of those blue bars. So if you take all the possible -- if you add up all of the blue bars, they add up to 100 percent.

MR. STEPHENSON: Okay.

THE WITNESS: So we're just sort of seeing the same data in a different way.

MR. STEPHENSON: So is this the amount of time spent? These bars, is it showing the time it spends in those population densities, or is it the distance traveled through those population densities?

THE WITNESS: It's not the time. It's -- I

guess it's -- it's a combination of -- so a car mile is one car -- one rail car, one tank car traveling one mile. And so what we're saying is that those miles -- and so if I have a hundred cars move one mile, that's 100 car miles and if that's -- each of those is an exposure to people that may be adjacent to the tracks. And so we account for the fact that you might have anywhere from less than 20 people per square mile all the way up to more than 10,000 people per square mile. And so it's, again -- this is a direct metric of the exposure of US populations to this traffic. I'm not sure I've helped -- I'm clarifying that, though.

MR. STEPHENSON: Seems like it would have to be measured either in time spent in that spot or in distance traveled through that spot. I know the whole train has to -- say a small community that's a half a mile long, the whole train has to get through it, but is this metric around how long it took to get through it or --

THE WITNESS: Let's use that example. Suppose it's a hundred cars and your village is a half mile long -- or whatever. So that would be 50 car miles would be the result. And we just basically add up that exposure over the entire -- so if -- there's one train, it's 50 car miles, another train goes by it becomes a

hundred car miles. So we just add those occurrences up across the entire rail network.

MR. STEPHENSON: Okay. Thank you. You've answered a bunch of them. Two more, I think. One is if I add the blue bars, something like 220 and 175 and so on, so I get about 600 million car miles; is that right? Does that sound right? If I'm doing my arithmetic right.

THE WITNESS: Yeah, I believe you. I trust you.

MR. STEPHENSON: So in 2012 there were about 6 million car miles traveled with crude oil and ethanol trains in the US?

THE WITNESS: If that's what your number is.

MR. STEPHENSON: Thank you. Do you know a typical trip distance for a unit crude oil train?

THE WITNESS: It's in the -- we've calculated it before. We typically would say it's between 900 and 1100 miles. A thousand is probably a good average, maybe a little higher.

MR. STEPHENSON: Thank you. That's all I've got.

THE WITNESS: Again, that shifts a little bit with the market shift that we just talked about.

JUDGE NOBLE: Mr. Rossman?

MR. ROSSMAN: Thank you, Dr. Barkan, for your testimony today.

I'd like to ask you to turn to your prefiled testimony, page 9, line 20. And this is in an area where broadly you're discussing your estimates versus the DEIS, and I don't want to ask you to give any testimony in that regard, but I do want to ask about the range that you provide for the annual derailment frequency there. I see .424 to .672. Do you see what I'm referring to?

THE WITNESS: Actually it's part of paragraph 19, I think. But yes.

MR. ROSSMAN: I'm at line 20.

THE WITNESS: Sorry. Okay. Yeah. Estimated -- I'm just reading to myself.

THE REPORTER: Don't do that.

THE WITNESS: Okay.

MR. ROSSMAN: So am I right that the .424 annual derailment frequency, the inverse of that is that you'd expect one derailment roughly every 2.4 years?

THE WITNESS: Yeah. And I think that's what -- if you'll recall, the number we discussed this morning in my -- in the report itself on that table.

MR. ROSSMAN: I do recall that. And if we could look at that table, that's Exhibit 123, page 4.

First of all, I want to make sure that I'm right in understanding that the car and train conditional probabilities of release, those are independent from the derailment rate of return?

THE WITNESS: Say that again. The car and train --

MR. ROSSMAN: Car and train probability of release are independent from the rate of return of a derailment. So those are -- say, in a derailment these are the percentages --

THE WITNESS: No. Because, again, these are conditional probabilities of release. So you would have to have a derailment before you can have a release.

MR. ROSSMAN: Yes. But am I right that they're not dependent on the rate of return of the derailment? So if the derailment rate of return is higher or lesser still, conditionally you would expect these probabilities of release in a derailment?

THE WITNESS: I think you're right, yes. Certainly the 5.1, and I believe that applies to the train -- yes. Okay.

MR. ROSSMAN: That's fine.

THE WITNESS: No, you're right.

MR. ROSSMAN: And I believe that all of the rest of the numbers in that table below that, those are

all factors related to probabilities of release and derailment rates and then also probabilities of how many cars will release in each of those; is that right?

THE WITNESS: Yes. And so to maybe make the distinction that perhaps you're getting at, the first two lines, the 5.1 and 36 -- those are independent of the derailment rate, but the derailment rate then does affect every other number there. So just to give you a little bit richer understanding of this, we have a derailment rate, but that generates a distribution of derailment size or severity, so numbers of cars derailed. That, in turn, generates another distribution of numbers of cars releasing. And then each of those cars also has a distribution of quantity released. So we can do all -- we have to basically propagate those probability distributions all the way down to the end result.

MR. ROSSMAN: Got it. So if we were to take the other end of that range of derailment frequency that you provided in your prefiled testimony, the .672, I believe the inverse of that would be a derailment roughly once every 1.5 years, and I recognize that's asking you to do arithmetic.

THE WITNESS: That I haven't done lately. Yeah, and I -- I don't recall why we -- there's a reason

why we did the .4 -- I think we were -- I would have to go back and look. The .67 -- because we only have one estimate of derailment rate. But we put some kind of a range in there for reasons that frankly I don't remember. It may be something we got from the DEIS that we were trying to reflect. I apologize if this doesn't say that clearly enough. I definitely can find out.

MR. ROSSMAN: I just want to be clear that the DEIS number is different from the range that you talk about there, the .424 to point --

THE WITNESS: It's in between, if you'll notice, right. So theirs is a little higher than ours, but lower than our high-end estimate. But I just don't remember why we had a range there.

MR. ROSSMAN: So does 1.5 years rate of return sound roughly right if the -- if the derailment frequency were .672?

THE WITNESS: It's just one over the other one. Yeah, so it probably is. It's basically one over seven.

MR. ROSSMAN: Which is about 1.5?

THE WITNESS: I don't do these things in my head -- in my head in the afternoon anymore, especially when I'm on, you know -- I can do it. I can do it right now if you want.

MR. ROSSMAN: If you're willing, I would appreciate it. Thank you.

THE WITNESS: Anybody got a calculator?

MR. ROSSMAN: I actually plugged into Excel --

(Simultaneous discussion interrupted by reporter.)

THE WITNESS: So what's Excel say?

MR. ROSSMAN: 1.5 roughly. Rounding aside. But rounding to one digit, we have 1.5. And so --

JUDGE NOBLE: Going slow includes you.

MR. ROSSMAN: So am I right that if that figure were propagated through the rest of the table, we would see a higher rate of return for any spill and then also a higher rate of return for all the spills of particular volumes at a higher rate of return for those volumes at given locations?

THE WITNESS: Yeah. If we do it more often, it's going to reduce the return rate or return period.

MR. ROSSMAN: And not knowing the details of your model, can I take that simple ratio of 1.5 year rate of return instead of 2.4 year rate of return and then essentially multiply all the figures below that in the table by that ratio, or is there some way that I'm missing --

THE WITNESS: I would have to think about whether there's any nonlinearities in there.

MR. ROSSMAN: At spill that -- any spill return would there be nonlinearities?

THE WITNESS: I just -- I'd have to go and check. I just don't want to say that off the cuff. I'm not trying to hide anything. I just don't want to make a statement that's not correct.

MR. ROSSMAN: No, absolutely. That's why I'm asking because I'm not sure about the details of the model. And these are -- the rates of return here are annual such that if we were to have these trends running for multiple years -- I mean, for example, we would anticipate -- if the rate of return, for example, of the DOT-117 for any spill is 6.4, we'd anticipate having more of those -- more than one of those in 20 years; is that right?

THE WITNESS: If there were more traffic, if that's what you're asking.

MR. ROSSMAN: Well, the same volume of traffic per year, but running this 20 times. Or to put it a different way, if the estimated --

THE WITNESS: There is a way for us to calculate sort of the cumulative probability.

MR. ROSSMAN: I recognize that that would

get a little bit sophisticated, but fundamentally, these are -- these are not probabilities over a 20-year life of the project, but this is looking at a one-year period, is that right, at least in terms of the derailment frequency?

THE WITNESS: Well, what I would say would be that -- let's go to our 2.4 per year. No, it's a little bit more complicated to calculate what the probabilities would be over a given life span and I -- I would have to do that.

MR. ROSSMAN: Okay.

THE WITNESS: Sorry.

MR. ROSSMAN: No, that's fine. Is it fair to assume that, all things being equal, if we see a rate of return less than 20 years shown on this chart, the odds are --

THE WITNESS: Are less that it would occur, but not -- but they're not a guarantee it won't occur. So if -- if I can say this back to you. So supposing our derailment rate of return was 25 years instead of 2.4, so ten times higher than it is, the likelihood that there was a derailment over that, say, 20-year period would be lower, but it's by no means a guarantee that there wouldn't be a derailment, it just means that the probability would be low -- wouldn't be less.

MR. ROSSMAN: Okay. I think we're saying the same thing and I guess what I want to -- just to take a concrete example from the table, looking at the 15-year rate of return for the jacketed 1232, 700-barrel spill. That's a 15-year rate of return. So we can expect to see one of those more likely than not over a 20-year project with this volume of freight?

THE WITNESS: Somewhere on the route.

MR. ROSSMAN: Somewhere on the route?

THE WITNESS: Yeah. That's our estimate. Well, again, assuming -- remember what I said earlier, for a variety of reasons I think these are conservative estimates. In other words, they overestimate the likelihood. BNSF's -- the empirical data for BNSF for this route from BNSF would expect a lower rate. It also assumes that the derailment rate remains static for the next 20 years, which I -- highly doubtful that that's going to happen considering how much it's come down just in the last ten years. And, again, I haven't accounted for the implementation of positive train control. And, you know, other -- so those factors, I think -- and that was part of our intent, was that we didn't want to understate the risk. We felt if we're going to err, we should err on the higher side than the lower side.

MR. ROSSMAN: Got it. That makes sense to

me. And then I'm looking at the prefiled testimony that's giving that range that includes up to a significantly higher frequency of derailments, and that was confusing to me.

THE WITNESS: Understandable. It's confusing to me right now. I'm looking at that. I'm going to go back and figure out why we put down that range.

JUDGE NOBLE: Dr. Barkan, there's a little bit of talking over. If you could let --

THE WITNESS: Sure, sorry.

JUDGE NOBLE: -- Mr. Rossman finish his question, your answer might be clearer. Thanks.

MR. ROSSMAN: So turning to a little bit of a different subject, we have heard testimony that something on the order of 99.997 or '998 percent of hazardous material shipments --

THE WITNESS: Reach their destination without incident.

MR. ROSSMAN: Yes. Are you familiar with those numbers?

THE WITNESS: Yes.

MR. ROSSMAN: Do you know how they're derived?

THE WITNESS: I don't -- to be honest, I

don't actually know who sits down and calculates that, but it's somebody at the Association of American Railroads.

MR. ROSSMAN: Do you know if it's calculated on the basis of trains or cars or --

THE WITNESS: Shipment's cars. Shipments.

MR. ROSSMAN: Cars?

THE WITNESS: Yeah, cars. Okay. No, I'm sorry. I use cars and shipments synonymously in this -- in this conversation. So, yes, we're saying the same thing. In fact, I think that the AAR quote is something like 99-point whatever it is percent of shipments of hazardous materials reach their destination --

MR. ROSSMAN: I think that's right, and I wasn't sure if shipment there meant --

THE WITNESS: I believe shipment means a car.

MR. ROSSMAN: Okay. Turning to Exhibit 250, we were just looking at a moment ago on that first page, there's a paragraph there saying -- your second paragraph with the main text says, "Railroad safety improved in the same period, declining from 4.39 accidents per million train miles to approximately 2.25 in 2014."

THE WITNESS: Can you remind me -- can you

remind me where you're seeing that?

MR. ROSSMAN: Yeah. That's Exhibit 250, page 1 in the second paragraph.

THE WITNESS: Back to that, yeah.

JUDGE NOBLE: You're talking over --

THE WITNESS: Sorry.

JUDGE NOBLE: -- Mr. Rossman, and I didn't hear the page reference.

MR. ROSSMAN: It's page --

THE WITNESS: It's page 1 -- it's actually the -- if you scroll down on that --

JUDGE NOBLE: You did it again.

THE WITNESS: I'm sorry. Just trying to help.

JUDGE NOBLE: Exhibit 250, page 1.

MR. ROSSMAN: Page 1.

JUDGE NOBLE: Thank you.

MR. ROSSMAN: The second paragraph of the main text.

THE WITNESS: It's the bottom of this page.

MR. ROSSMAN: It's actually right there, that paragraph right where the cursor is right now, the second sentence of that paragraph. We've declined to 2.25 accidents per million train miles. And that appears to me to be three times higher than the rate

that you're anticipating we will experience on this route, which I believe is .75. Is that your recollection?

THE WITNESS: So why do they differ?

MR. ROSSMAN: No, I think you gave a lot of testimony on why they differ in terms of the different types of classes and the specificity of the modeling here. I just want to make sure that you're thinking that under these specifications we'll have a third the number of accidents that generally occur for freight trains based on the most recent data here.

THE WITNESS: Yeah, and that does sound about right. In other words, we're looking at -- on this BNSF route, again, as I've said, it's got all the bells and whistles essentially. It's got Class 1 track almost the entire route, it's all signaled, it's all higher density. That's an average over the entire network with everything from the best to the worst and everything in between. So I think -- that kind of difference is within kind of the order of magnitude that I would expect. I hadn't actually made that comparison, so thank you.

MR. ROSSMAN: Are you able at all to help relate that 99.997 percent of shipments not having an accident to these numbers, the frequency per million

miles?

THE WITNESS: No, because I believe the AAR includes what they called nonaccident releases in that statistic, and that's a whole different category of release. There are releases that occur in accidents, which is what we're concerned with here, and then there are what -- to put it in sort of a common vernacular, leaky tank cars, they've got a valve that's dripping or something like that. And those are required to be reported to -- when we were talking before about what PHMSA requires, if you've got a tank car with hazmat and it's dripping, that's a reportable incident to PHMSA. It does not go to FRA because there was no accident, so that's why we call them nonaccident releases or NARs. I'm fairly sure that AAR includes all the NARs in their calculation of this, as they should. The public doesn't really care whether it -- well, it's important to reflect both accident-caused releases and nonaccident-caused releases in that statistic.

MR. ROSSMAN: Got it. And that goes to the accidents of interest for our inquiry being ones that could potentially cause a release in a derailment?

THE WITNESS: I'm sorry, could you repeat, please?

MR. ROSSMAN: The focus of your report is on

accidents that are severe enough that they could cause some derailment as you described earlier.

THE WITNESS: Yes. Yes. Right. The NARs are, I would have to say, exceedingly unlikely to result in the kind of incident that -- a high-magnitude incident. There's still a concern. We don't want leaking tank cars, but we can probably deal with one where we have to clean up a small spill as opposed to something that we want to -- we see in the headlines.

MR. ROSSMAN: Got it. Just a few more questions. If we could go back to Exhibit 123 and see page 12.

THE WITNESS: You said Exhibit 123?

MR. ROSSMAN: Yeah, that's your report.

THE WITNESS: My report. Okay. Right. And now page 12?

MR. ROSSMAN: Yeah. And Table 3 in the middle of that page, "Summary of estimated derailment rates on the route."

THE WITNESS: Right.

MR. ROSSMAN: And I believe that when I took that average that you have and multiplied that by the number of miles on the route, that gives us the .424 annual derailment frequency. My question is, can you help me interpret the minimum and the maximum there? Is

that based on some modeling and showing different probabilities of a release, or is that based on the most and least, let's say, dangerous miles of track and what the annual derailment rates are on those respective miles?

THE WITNESS: Yeah, it's -- what it is, is again, as we've discussed, there's -- this three-factor model we used to estimate derailment rate. So the lowest section of track -- lowest derailment rate on any section of track on this route, according to our calculation, was the minimum, and the highest derailment rate was the maximum.

MR. ROSSMAN: Thank you. That's what I thought. I just -- I was wondering if it had been the other, if this would explain in the prefiled -- I think that that's all my questions. Thank you.

THE WITNESS: Thank you.

JUDGE NOBLE: Any other questions for Dr. Barkan?

Mr. Stone?

MR. STONE: Good afternoon, Dr. Barkan. We've had a lot of testimony today and I'm not sure I absorbed it all, so I apologize in advance if I ask a question on a topic that's already been covered.

Your methodology for estimating derailment

rate, we heard a lot of testimony previously in this hearing about the importance of track inspections, the methods and frequency of track inspections. I see that that's not an element of your estimating derailment rate, so I'm wondering why that is.

THE WITNESS: It's not specifically, but it is implicitly. When I talk about different FRA track classes and different tonnages, traffic volumes measured in tonnages, those are directly related to the frequency of inspection. So the inspection frequency is implicitly captured in those two variables. Somewhat like the questions that were asked earlier. It's not a -- it's not a knob I can turn. In other words, it's not -- I don't have a separate input variable or let's say if they -- if inspection frequency was doubled, I could get this effect, but the differences in inspection frequency are definitely a factor in the model in the manner I just described.

MR. STONE: Do you mean the inspection frequency and methodology is established by track class?

THE WITNESS: Partly, as well as tonnage, as well as railroad practice.

MR. STONE: Okay. So you mentioned positive track control on this route through Washington which would serve this project. Can you tell us what the

status of implementing PTC is on this route?

THE WITNESS: Only that I've read somewhere, perhaps in the materials related to this proceeding, that BNSF plans to have it installed by -- now I'm forgetting, but I believe that they plan to have it installed perhaps before this begins operation. Within the next several years is what I understand.

MR. STONE: Okay.

THE WITNESS: But I think really the best thing to do is ask BNSF. I'm no -- ask BNSF, ask the railroad what their schedule for implementation of PTC would be.

MR. STONE: Okay. Comparing the 117 tank cars, that would be the 117J, the new version, and the 117R, which is the retrofit?

THE WITNESS: Correct.

MR. STONE: On paragraph 13 of your prefiled testimony, you list four design features of the 117J. And I'm wondering if all of those or just some of those would be also featured in the 117R. And I think you've partially answered this question. Are you there? There's four bullets on the -- in paragraph 13 of your prefiled.

THE WITNESS: I'm getting there.

MR. STONE: It's paragraph 13, not page 13.

THE WITNESS: Yeah. No, I've got it.

MR. STONE: So the retrofit car would not have the thicker tank; is that correct?

THE WITNESS: Well, it's a relative -- when I say "thicker," relative to what?

MR. STONE: Well, I wouldn't have the nine-sixteenth tank.

THE WITNESS: That's correct. Neither of the retrofits will have a nine-sixteenth, that's correct.

MR. STONE: The retrofit cars would have the full-height head shields?

THE WITNESS: Yes.

MR. STONE: I think you mentioned the retrofit car would have the bottom fittings within a robust protective structural steel housing, but I don't think you mentioned the top fittings. Would the retrofit car have both the bottom fittings and the top fittings in the housing?

THE WITNESS: I may have misspoken. So, in fact, the two CPC-1232 cars already have this protective housing. And somehow they're going to have to manage to put the jacket on around that. I don't know if they're going to have take it off and put it back on. But the point is, the cars that will be retrofit already have a

protective housing and will continue to have it. But I think I did refer to -- where it will differ on the bottom fittings, is this removable handle which makes it less prone to being opened up in accidents.

MR. STONE: Okay.

THE WITNESS: And I failed to mention that here, I see.

MR. STONE: And the retrofitted car would have the thermal protection system, correct?

THE WITNESS: The -- those cars retrofitted from the non-jacketed CPC-1232 cars will have the thermal blanket. What is -- in fact, I've gathered some deeper understanding of this just in the last few weeks. The USDOT is presently deciding whether they're going to -- they were directed in the FAST Act, I believe, to consider whether they need to do this, to develop a regulation, I'm not sure. The punch line is that the USDOT is presently considering whether they're going to require the jacketed cars -- because you basically have to peel the jacket off, put the thermal blanket on and put it back on, so that's more effort.

MR. STONE: Okay. You estimated a probability of release reduction for the 117J, which was 85 percent. Have you estimated a release reduction probability for the 117R?

THE WITNESS: I can if somebody would give me a calculator.

MR. STONE: Well, no, I just want to make sure I didn't miss something in your prefiled, because I saw that figure for the J but not the R.

THE WITNESS: Yeah. And the reason for that is because this whole question of what an R was going to be has been up in the air for some time. I've been seeking clarification for a variety of reasons, including, you know, being able to answer, you know, the questions for this project. But I didn't have it at the time that I prepared my report and the prefiled.

MR. STONE: Understood. My final question has to do with the statement of -- towards the end of your prefiled, the top of page 13 in paragraph No. 27. It starts out with the word -- "Furthermore, several high-profile incidents occurred under different circumstances, where accidents were more likely to occur, than those that exist along the BNSF route to the project site."

Could you elaborate on what that means?

THE WITNESS: If you'll bear with me, I need to find the -- that -- you said page -- what page?

MR. STONE: Page 13 at the top, and it's also within paragraph 27.

THE WITNESS: Yeah, certainly I know one thing I had in mind. Several of the high-profile accidents occurred on short lines. Lac-Megantic was a short line railroad. Aliceville was a short line railroad. I know there were a couple of others. And some other data. In fact, I think one of the reports that is here shows that short lines in general have a higher accident rate than the Class 1s in general.

MR. STONE: On that point, do the short line railroads have a different track class that would be considered less safe than a --

THE WITNESS: So the minimum -- so that's a good question. So the minimum standards from the FRA for track classes are the same irrespective of what kind of railroad you are. But one of the things that's pretty much standard operating practice for the Class 1s, and I know it is for BNSF, is that their engineering maintenance standards will often -- will exceed the regulatory minimum that the FRA sets. And they have a whole set of reasons for why they believe that's an appropriate thing to do.

I don't actually have any data or information why the short lines -- what the short lines do, but I do have statistics that indicate what I'm describing. And so -- and I think it's also the case

that short lines, on average, will have a lower FRA track class. They don't typically operate at the same speeds as a Class 1. So I think it's some combination of those two factors.

MR. STONE: Okay.

THE WITNESS: If I could actually just -- the matter of the maintenance standards exceeding the FRA, I have to say, I'm rather unsure about that. It may more be just the predominance of lower FRA track classes on short line railroads.

MR. STONE: Okay. Back to your statement of different circumstances. Anything else besides short line railroads?

THE WITNESS: I don't remember right now, which isn't to say that at the time I wrote this I had some other idea in mind.

MR. STONE: Okay. Thank you. That's all my questions.

JUDGE NOBLE: Additional questions from council?

Mr. Siemann?

MR. SIEMANN: Thank you for your endurance --

THE WITNESS: Actually, I did think of something. Yes, of course. The tank car's going to be

different. As we've been discussing pretty much all day, most of these incidents occurred with 111s, a few occurred with CPC -- non-jacketed CPC cars. We're talking about DOT-117s which is quite evident is a much more -- we believe a more damage-resistant car.

MR. STONE: Okay. Thank you for that addition.

JUDGE NOBLE: Mr. Siemann?

MR. SIEMANN: Again, thank you for your endurance today. And I too will ask you questions that you may have already answered, and I --

THE WITNESS: That's fine.

MR. SIEMANN: -- apologize --

JUDGE NOBLE: You're talking over Mr. Siemann.

MR. SIEMANN: All right. So I'm interested in how many derailments we might expect to see over the course of the 20-year life of this project. And if the rate of return is 2.4, can you just divide 20 by 2.4 to get what I calculate as 8.3? Is that a correct approach to that?

THE WITNESS: It's not quite that simple, and it's because of the independence notion of these things. But we could calculate an expected number of derailments per 20 years. This is -- this might have

been a question I think Mr. Rossman was alluding to as well. That's a knowable statistic, but I can't just spout it off.

MR. SIEMANN: So the fact that there's a return rate of 2.4 doesn't mean that you can sort of statistically add that up?

THE WITNESS: No.

MR. SIEMANN: I see. Okay. A different -- sort of related but different kind of question. So I have experience with flooding and floodplains in my sort of world. And so, you know, the 1 percent annual chance of flood, which is the FEMA flood plan, translates to a 26 percent probability of a flood occurring during -- in a specific place and during a 30-year mortgage. What I'm interested in is, have you taken your data and thought about that probability for the line that we're -- and the route that we're talking about here today?

THE WITNESS: That's -- it's directly akin to the question you just asked. Whatever technique you do that -- for that is going to be the same arithmetic approach, and I -- but it's the same concept. Just setting it at a particular time period, we can run our model just like FEMA does with that and figure out what the probability over any given interval of time of an

event of a given magnitude would be.

MR. SIEMANN: So using that data of 2.4 years in 20-year life, you could actually do a probability --

THE WITNESS: Yes. I didn't mean to imply it --

MR. SIEMANN: Got it.

THE WITNESS: Yes. I didn't mean to imply that it couldn't be done. I just can't do it reliably in my head right now.

MR. SIEMANN: Fair enough. Okay. I don't know if you could actually answer this, but have you considered what the additional -- the added risk is of these four trains per day, given that there are already trains -- crude oil unit trains on this route? And what I'm interested in is, do we know what additional risk these trains are posing?

THE WITNESS: That's exactly what this study is. This study is the incremental risk of these four trains added -- there's no estimation of the risk of the current traffic. Everything in this -- our report was the additional risk as a result of this potential additional traffic.

MR. SIEMANN: Got it. Okay. That's helpful. And, again, I don't know if you answered this,

but are there any segments of the track that present a higher risk of derailment? And by "the track," I mean, from Spokane, or wherever the falls area is, into Vancouver.

THE WITNESS: Areas where the track class is lower would have a higher derailment rate, unless the railroad is doing something that's not reflected in their -- in the data that we have. So, for example -- that was not feedback.

So here's an example. Supposing there's a section of Class 3 track, if the railroads are maintaining it -- if the railroad is maintaining it at a Class 4 standard, then its derailment rate, as best we would understand, would be the same as the Class 4, and I don't -- I can't know that. That's a question for the carrier.

MR. SIEMANN: According to your report, which is Exhibit 123, in Table 1, there are 41 miles of Class 2 and Class 3 track. Do you know where they are? Where they're located on the line?

THE WITNESS: Not from memory, I don't.

MR. SIEMANN: Did you -- did you consider the probability or the potential for derailment of the return trains?

THE WITNESS: No, I did not.

MR. SIEMANN: Given that they are also four trains per day of the same length, would you expect the same return rate?

THE WITNESS: Based on what we know now, yes. But, of course, they're not loaded. They're what we would call a residue train.

MR. SIEMANN: Does that change the likelihood of derailment?

THE WITNESS: No, it changes the consequences if there is a derailment.

MR. SIEMANN: Right. Thank you. Okay. And then --

THE WITNESS: I should just say to add, and we do have research underway right now that would potentially address the question of a loaded train versus an empty train, but again, we don't have any finished -- any results that I'm even confident enough to say anything about.

MR. SIEMANN: Okay. You also talked a lot about -- not a lot, but maybe a little bit about the speed of the train and the consequence of the derailment and the spill, the likelihood that fast -- trains running faster are going to cause more -- larger spills. Is there -- is that function linear, or are there steps or thresholds in the speed that affect the -- that

spill?

THE WITNESS: My recollection is that it depends upon the component being damaged. In other words, that speed relationship for the head or the shell is different than for the fittings damage. And right now I'm not remembering -- let's just say for the sake of discussion it's roughly linear. It may not be completely linear.

MR. SIEMANN: Okay. Thank you very much.

THE WITNESS: But again, the functions differ depending upon the component. The functions differ depending on the component, and I also remember the functional relationship is stronger for some components and much weaker for other components.

MR. SIEMANN: Do you know which ones they are stronger for?

THE WITNESS: Now, I would be -- I don't want to -- I don't want to -- I don't want to say something that I'm not sure is right.

MR. SIEMANN: Fair enough. All right. Thank you very much.

JUDGE NOBLE: Mr. Rossman has another question, but Mr. Snodgrass has questions first.

MR. SNODGRASS: Good afternoon. The -- I have a few questions. I just want to sort of fully

understand the parameters of the results so I understand this. Well, does it -- does your data include nonderailment releases, which I wouldn't have -- we've had some recent testimony that one of those occurred -- I guess, a landslide, a train that hit a rock kept going but there was a release. Does the data include those?

THE WITNESS: So I saw that in the testimony, and it didn't -- it wasn't specific, and I'm -- I have a suspicion that that was actually a punctured locomotive fuel tank and not a tank car, but it's just a hunch, and I could be wrong.

MR. SNODGRASS: But does your data include those?

THE WITNESS: Not unless that resulted in an FRA reportable derailment and --

MR. SNODGRASS: But again, it wasn't a derailment; it kept going, at least is my understanding from the testimony.

THE WITNESS: So good point. The FRA -- it would certainly be an oddball, I'll say that. But here's how it could actually get into the FRA database. It doesn't have to be a derailment. It just has to do, let's say, $10,500 worth of damage. Well, if I drag a rock along underneath the track and I damage enough ties and fasteners and things like that, I might do $10,000

worth of damage. So that would be -- that would require an FRA report, but it would not be classified as a derailment.

MR. SNODGRASS: Okay. And in terms of just understanding the data, it was -- you were pretty clear that this was for Washington-specific and I appreciate that. That's certainly our primary focus. If we wanted to roughly extrapolate the incidence rates along the total rail corridor, you know, which as we get into public safety concerns we certainly want to be aware of that, would we be far off if we simply measured the miles of track?

THE WITNESS: I don't know enough about the route east of the state line to -- we've never done an analysis on that, so I really don't know what the makeup of the infrastructure there is.

MR. SNODGRASS: Okay. And kind of the inverse, if we wanted to get a sense of, using your data, the incidence rates within urban areas, would we be far off by interpolating just the track mileage within those areas relative to your numbers for the full 385 in Washington -- miles in Washington?

THE WITNESS: Yes.

MR. SNODGRASS: Roughly.

THE WITNESS: Roughly. That's somewhat akin

to when I do the average one-mile segment, that's somewhat that we're doing there.

MR. SNODGRASS: Right. I just want to get a sense of is the difference in the way you see it or is the magnitude difference different on different segments of the --

THE WITNESS: So there is some heterogeneity along the route. Again, it's where those different FRA track classes are going to be. And to -- I'm reluctant to speculate, but it would not surprise me that the slower speeds are in some of the cities where that would then potentially correspond to a lower FRA track class, but, again, this goes to the point of what is the railroad doing in terms of their maintenance standards there. They may have a lower speed limit, but they may be maintaining the track to a standard equivalent to a higher speed limit. And I don't have that knowledge -- that information.

MR. SNODGRASS: Shifting gears a bit in terms of you mentioned you had done some checks on your analyses, and so I just -- based on what you've said subsequent, I assume those checks were on the total rate of -- on the derailment issues, setting aside the release, the total rate of derailment of all cars, not -- or let me say it another way. Did the checks you

do verify that your assumptions were correct when you compared it to strictly the crude-by-rail incidents?

THE WITNESS: So we -- what we did in our validation exercise was we wanted to understand is our derailment rate, does it -- this is a question I was asking. Is our derailment rate that we're estimating in the ballpark?

And so what we did is, we looked at a ten-year period for mainline derailments -- this is all mainline derailments -- over the exact route that was considered, and said, all right, how many FRA reportable derailments did we have over this period, which is basically exactly the criteria that we're interested in for our risk work. And what I -- as I said earlier, what we found was that we had -- that BNSF had actually had somewhat less. What's in memory is about 20 percent fewer FRA reportable derailments on their mainline on this particular mainline than we would have estimated.

MR. SNODGRASS: Total derailments. It was not --

THE WITNESS: Total derailments. Again, in all magnitudes. They could be little ones, big ones, medium ones. I don't recall if any of them were a hazmat derailment, but they may not have been.

MR. SNODGRASS: Okay. Just briefly on this

question of the increment of the four cars. Are you aware of earlier testimony I believe from the BNSF, I'm not sure, but to the effect that the four additional cars would not displace any rail traffic?

THE WITNESS: I am aware of that testimony, and I think there was some discussion about that this morning. BNSF has a -- you might say a small network in the state of Washington and so they have -- as I recall their map, they have three different ways to get into the Seattle area, and so they have options for moving traffic. Obviously traffic that's coming to Vancouver has to come one way or the other to Vancouver, but a train that's going to Seattle doesn't necessarily have to take this route and then go north. It could come in on the northern route or in the central state part of the route. And that's the sort of thing that railroad traffic managers and dispatchers are doing because they have to cope with combinations of the capacity of any given route, circumstances may arise where -- supposing they're doing maintenance on a route and they have to reduce the number -- they want to make what they call a maintenance window, so they'll maybe take it out of service for eight hours. Well, they'll route trains the other ways to create that maintenance window. They're doing that sort of thing all the time.

JUDGE NOBLE: Just to be clear, we're not talking about four additional cars, we're talking about --

THE WITNESS: Train --

(Simultaneous discussion interrupted by reporter.)

THE WITNESS: So that conversation we just had was in reference to four different trains, not four different cars.

JUDGE NOBLE: So are there other council questions?

MR. SNODGRASS: Yes, I do have some more questions.

JUDGE NOBLE: Maybe we could take a break before we -- we need to take a -- just a ten-minute break. So 4:10 we'll be back.

(Recess taken from 3:59 p.m. to 4:12 p.m.)

JUDGE NOBLE: We're ready to go back on the record with council questions, and we were in the middle of Mr. Snodgrass' questions.

MR. SNODGRASS: I understand there's a bit of a time crunch so I'll be quick. The -- as we transition to unit trains and as -- well, you had earlier testified that they're -- I don't know if you used this exact example, but having a unit train doesn't

necessarily pose a greater risk than, say, two separate trains of half that. Is that a fair paraphrase?

THE WITNESS: Yes.

MR. SNODGRASS: Okay. Would it, though, put more wear and tear on the track to have one -- one unit train versus two half trains?

THE WITNESS: No, it's -- the wear and tear is going to be linear in the amount of traffic. So if it's in two trains --

MR. SNODGRASS: So there's no added increment from a particularly heavy train that you wouldn't see on --

THE WITNESS: No, these trains are no heavier than -- like I said, there's a standard gross -- maximum gross rail load of 286,000 pounds is kind of the industry standard, so there's nothing abnormal about these trains compared to most other trains operating on this line.

MR. SNODGRASS: Thank you. The -- turning from rates of derailment to fire. We had -- earlier had been shown, for many of these incidents, some of the -- some of the fire involved and had -- I think they'd appropriately been advised, we can't just think of the consequence, we need to think of probability as well.

We have a database that shows 24 crude and

ethanol derailments and it looks like, if I'm counting right, fire in 20 of those derailments. Is there -- does your -- I think the answer is no, but tell us, does your data or do you have anything to advise us on how we consider the probability of fire from a crude oil train that derails and releases?

THE WITNESS: Yeah, I think that's a good question. So the -- if we spill petroleum crude oil, I think it's -- there's a fair chance that there's going to be an ignition source which will lead to a fire. I think the key difference between the accidents that have been discussed in this data set of 24 is that really all of them -- or none of them have tank cars that -- let me start. Most of those cars did not have any form of jacket or insulation and none of them had thermal protection. So the distinction is not so much that we would not have a fire, we would have -- there's a fair chance we'd have a fire, but that fire wouldn't get bigger because of secondary thermal failure of the tank cars. That's where this -- the benefit of the thermal protection comes in. I think that whatever initially releases and burns will -- has a high likelihood of being the extent of the fire.

Again, the sense I have in most of these is that part of what has sort of overwhelmed the fire --

the responders is that when you have a fire and then suddenly 30,000 more gallons is introduced to that fire because of a secondary failure, that's obviously a dangerous situation, and so you -- there's really -- it's hard to cope with. Again, this is why the regulated community and the regulators all came together and said, we have to eliminate that threat.

MR. SNODGRASS: So is it your testimony that the additional probability of a fire, given a derailment and release that's shown on the Table No. 24, is reasonable but perhaps the magnitude of the fire is less? Is that --

THE WITNESS: I'm not prepared to speak to that. No, actually I don't think -- I can't -- I don't consider that a representative data set, because part of the reason those accidents got into that database is because there was a fire, in many cases because there was a large fire. What's the one I was just thinking of? The one in Montana, is it Plevna? There was one in Montana last year that had, oh, I want to say, 20 -- I'm going from memory here, 22 cars derailed at something like 44 miles per hour. There were five releases, but there was no fire. And none of those -- so that's just an -- so the point is it goes to what I was saying earlier. That data set is not a representative data set

of incidents. It's -- they did -- they, for whatever reason, did not include other incidents. So there's many more incidents that are not in that data set that may not have been as big in terms of releases.

MR. SNODGRASS: You had testified earlier about having access to both -- yeah, proprietary data as well as public. Are you aware of any incidents that should be in this database?

THE WITNESS: But it's not a matter of being proprietary, because if there was a release of a hazardous material and it's -- it should have been reported to the PHMSA database.

MR. SNODGRASS: Right. I guess I'm saying, are you aware of any incidents where a crude oil train derailed and/or released that are not in this database?

THE WITNESS: Yes. One recent one and I -- again, I'm suddenly forgetting the name. Am I allowed to ask anybody? Plevna, Montana, I think is the name that happened I want to say in August of last year.

MR. SNODGRASS: It's No. 17 on the list.

THE WITNESS: Oh, it is there. Then I must be mistaken. Maybe I'm thinking of another one. So that one's there. I guess I just don't know enough about that database to use it as a basis for establishing ignition probability given the release.

MR. SNODGRASS: Fair enough. Just, I guess, the last question, turning larger -- we obviously as a council have to grapple with the probability of a major consequence event, and so I guess I'm struck by the difference in -- I don't know if you heard the testimony yesterday from I believe it was Mr. Taylor, about a very detailed analysis of the detailed -- risk treaty about the probability of fatalities in a facility. And so I wonder what guidance you can give us in thinking about fatalities, if there is a fire, and I would ask also -- well, let me -- I have a follow-up question to that, but go ahead and answer that.

THE WITNESS: Sure. So what we have done when we've done -- we've sometimes done risk analyses where we were asking the question about people being affected, and we have used the DOT's emergency response guide evacuations on which, if memory serves, flammable liquid has a half-mile-radius evacuation zone. And we have done analyses where we've actually overlain -- if you think about a rail route, you can sort of overlay this half-inch radius -- half-mile radius, so one-mile-diameter area along the route, and then compared that to the same kind of population density I described earlier today. And we can come up with a metric for persons exposed. Doesn't say they're

injured, it doesn't say they're killed, it just says they have the potential to be involved in the sense that they were within the DOT's emergency response evacuation zone.

One can certainly do much more detailed consequence analyses, and I've been involved with studies where one does that. But that was -- it was not done in this study, and I would just say from the standpoint of some of the analyses we've been doing, we've probably been doing analyses like that for the past ten years. In general, the people that were interested in our results found that the most useful, because when you start trying to predict specific injuries and specific numbers of fatalities, it becomes a much more complicated exercise, subject to all kinds of things, like the wind direction at the time of the incident and, you know, there's just a whole other set of -- and if you're talking about a toxic material, the dose response curve. Just -- I'll just leave it that it's much more complicated. It's doable, but it's just a much more complicated exercise and it's not always clear that the additional resolution is worth the extra effort.

MR. SNODGRASS: Okay. Thank you.

JUDGE NOBLE: Mr. Paulson, did you have some

questions?

MR. PAULSON: Take Mr. Rossman first.

JUDGE NOBLE: All right. Mr. Rossman.

MR. ROSSMAN: Thank you. I have a few more questions for you, Dr. Barkan, on the probability and frequency conversation that we were having earlier. And I guess I'm really struggling to understand if each derailment incident would be independent of each other one, why would one not be able to multiply the annual derailment frequency by the number of years of interest to come up with an estimated number of derailments over that period?

THE WITNESS: I think -- don't you get into a situation where you've got a probability that's greater than one? Maybe I'm not doing this right. I'm not -- I honestly -- I just have to kind of go and sit in a quiet room and do my calculations to understand the answer to that. I'm not trying to be evasive.

MR. ROSSMAN: Can you help me understand, then, why the estimated derailment frequency is the inverse of the derailment rate of return? Why is there an inverse relationship there?

THE WITNESS: Because -- that's very simple. It's because it's an annual rate. And so if the annual rate was one -- .1, so one-tenth, then the reverse of

that is saying, well, we're expecting it to happen about once every ten years. In other words, the annual rate of occurrence is one-tenth. So that's -- it's as simple as that. If the annual rate of occurrence was five per year, we probably wouldn't need to do that. It's just when we start getting into these very low annual probabilities, it becomes -- it's really a risk communication thing that we do. It's to help people kind of understand it. It's not mathematically necessary, it's just a way to better, more effectively communicate the information.

MR. ROSSMAN: Is it a different mathematical relationship between the estimated derailment frequency and the rate of return than would be involved in taking a longer period and estimating the number of returns in that period?

THE WITNESS: Could you repeat your question, please?

MR. ROSSMAN: Yeah. Is it a different mathematical relationship, the derailment frequency and rate of return, than would be involved in estimating the number of returns in a longer period of time? So I guess, in other words, if the probability of a derailment in a given year is .424 and I were to take a two-year period of interest, I would assume that my

probability of derailment was .848, and then if I were to take another four-tenths of a year, I would assume that my probability of -- or estimated frequency -- probability of derailment gets up to that one which is why the rate of return is 2.4.

THE WITNESS: I'm not saying you're wrong, I just would want to -- I'm just not very -- I'm finding myself -- maybe -- I am -- maybe I am getting a little fatigued. I'm not thinking very clearly about that right now.

MR. ROSSMAN: Okay.

THE WITNESS: I can certainly, if I'm allowed to, provide a subsequent answer. I don't know if that's within the --

MR. ROSSMAN: I don't know if that's allowed either, but I would appreciate it if it's possible. And I guess this -- the answer to this may be the same, but during the break, I looked back at the various equations in your report that you describe as related to the probability of a tank car releasing, number of tank cars releasing, and I didn't see in any of those a place where the derailment rate would come back in such that we would expect a nonlinear relationship between the derailment rate and then the subsequent rates of releases of different volumes.

THE WITNESS: Yeah, and I did think about that one a little bit more. Again, I -- we have all these distributions. And I think I'm just not comfortable saying it's going to be a linear rate. I'm not saying it's not, but I would want to sort of carefully go through exactly how we'd calculate it before I answered that question.

MR. ROSSMAN: And, again, I don't know if it's possible for your testimony to be supplemented with that, but can --

THE WITNESS: I'll leave it to the legal experts here.

MR. ROSSMAN: But without you saying that you aren't sure there's no other place that comes in, can you think of any of those other probability distributions in which you know that it does come in?

THE WITNESS: Which comes in? I'm sorry.

MR. ROSSMAN: The overall derailment rate, rate of return of derailments.

THE WITNESS: I think it only -- I mean, it comes in -- I think where we're agreeing, it comes in when you start calculating return rates of releases of any quantity -- of different quantities. In other words, again, looking to this table, which I don't know if you need to bring it up, but it's those first two

lines we agreed were not -- were not a function of derailment rate, but then everything below that was, all those spill return rates are all --

MR. ROSSMAN: Absolutely. They're all functions of the return rate of derailment, absolutely.

THE WITNESS: Right.

MR. ROSSMAN: But if the rate -- if the return rate of derailment decreases from once every 2.4 years to once every 1.5 years, I had asked you earlier if I could take that same ratio and apply it to all the other factors in the table, and you responded that, I believe, that you didn't know, you weren't confident that I could do that.

THE WITNESS: I think it's going to get you a close answer. Just before I say, yes, you can do it, it's okay, I would want to check it. I apologize for my inadequacy in answering your question. It's -- I would like to answer your question.

MR. ROSSMAN: And I'm not meaning to repeat it. I guess I'm trying to ask a subtly different question, which is, can you think of any other probability distributions there in which that change in derailment rate would change that particular step of the calculation?

THE WITNESS: I don't think so.

MR. ROSSMAN: Okay. And I just want to make sure that for all of the rest of those figures on that table -- that's the summary of probability estimates on page 4 of Exhibit 123, for all of those numbers below the line of any spill return, I could take the inverse of those numbers, in other words, one divided by that number, to get the annual frequency of --

THE WITNESS: The annual rate.

MR. ROSSMAN: Annual rate of that type of spill. But again, you're not sure if I could then multiply that by 20 to get the odds of a spill during the life of the project?

THE WITNESS: No, I'm not sure about that.

MR. ROSSMAN: Okay. Thank you.

JUDGE NOBLE: Could I ask you, Ms. Brimmer, whether there would be a problem from your point of view with getting the answer to that question that Mr. Rossman keeps asking? If I could ask that it be submitted in writing, would that create a problem for the opponents to respond to it?

MS. BRIMMER: No, I have no problem with that at all.

JUDGE NOBLE: All right. Then I would ask that that question be answered in writing and submitted, along with the other written submittals that are coming

in, after the record is closed on Friday, except for these submittals.

MR. ROSSMAN: Judge Noble, I don't know if it's possible also to address the point in the prefiled testimony about the different possible rates of annual frequencies that I had also asked about.

JUDGE NOBLE: You don't think it's possible?

MR. ROSSMAN: I don't know if it would be possible for that also to be supplemented.

JUDGE NOBLE: So why don't you rephrase those two answer -- questions for the answers you're seeking, and then we'll get the answers in writing.

MR. ROSSMAN: To put them succinctly, on page 9, line 20 and 21 of the prefiled testimony, a range of estimated annual derailment frequency is provided, .424 to .672.

The first question is whether the witness can elaborate on why there is a range provided there; whereas the rest of the calculations only seem to take the lowest end of that range, the .424?

The second question is, assuming that higher end of the derailment frequency would correspond with a more frequent rate of return, can one simply propagate that rate of return down through the rest of the table, which is actually in his prefiled testimony at page 6,

to get a range of rates of return of the various other types of accidents being modeled?

THE WITNESS: Actually, I think I am prepared to answer that one now and the answer is yes. I think that that's -- I think -- I think that number is going to be just -- well, let's -- let me answer you in writing. I don't want to -- I'm trying to be helpful, but I don't want to cause trouble.

MR. ROSSMAN: No, thank you. But those are my two questions.

JUDGE NOBLE: I think we're looking for a fairly straightforward, short answer.

THE WITNESS: You bet.

MR. ROSSMAN: Thank you. And my apologizes again for belaboring a detail.

THE WITNESS: I apologize that I don't remember why there's that range.

JUDGE NOBLE: I would like these answers to be submitted in the same time frame of opportunity for the opponents to respond, if they need to. You don't have to respond unless you want that opportunity.

All right. Are there any other council questions?

Mr. Paulson?

MR. ROSSMAN: I will try and be brief.

Thank you, Dr. Barkan, for your patience here today.

You indicated earlier in your testimony, I believe, that rail traffic is dynamic, and I understand that. And you gave an example like there was three routes to Seattle. That would be BNSF, not counting the UP and the south --

THE WITNESS: Right.

MR. PAULSON: As a practical matter, though, aren't -- the westbound loaded unit trains generally prefer the Columbia River route?

THE WITNESS: I have no idea. I really don't know about BNSF's routing strategy for their unit trains.

MR. PAULSON: Okay. Would you know anything about the difference in the grade of the other two, for instance, Stevens Pass or Stampede Pass?

THE WITNESS: I recall from a long time ago that Stampede Pass had a pretty steep grade. The northern route, which that's, of course, the Cascade tunnel route, it wouldn't surprise me there's a grade there, so upon -- but somewhere -- when this Columbia River route, when it goes north up to Spokane, I don't know if it has a -- I don't know the geography in that area, so I don't know what its grade is.

MR. PAULSON: That's all I have. Thank you.

JUDGE NOBLE: Any further council questions? Are there questions based on council questions?

MS. BRIMMER: Yes.

RECROSS-EXAMINATION

BY MS. BRIMMER:

Q. Dr. Barkan, I'm just a little bit confused about the genesis, maybe, for want of a better word, of your study here. So in response to questions from council members, I think Mr. Snodgrass had a little and Mr. Shafer, you said that your study and your report here is specific to these four trains and this project. Do you recall that?

A. Yes.

Q. And at the beginning -- excuse me. In redirect, though, I heard you to say that the reason you used 2005 to 2009 data in this study is because this study actually was of interest to BNSF independent and well before this project, and that's why that earlier data was used. Was this study begun before, or was part of it done independent of the oil terminal project?

A. Yeah, I apologize for any misunderstanding. I think I can answer this pretty easily. So if we turn to Exhibit 0239 -- which is in here. We don't have to put it up there, but you can if you want -- that was a study

that was done in the 2010-11 time frame to address an entirely different set of questions that the railroad industry was interested in, and they wanted us to develop the most current estimates of derailment rate as a function of those three factors I've mentioned. Again, for -- had nothing to do with hazmat traffic or anything else. They wanted to just have a better sense of what the derailment rate was. So we conducted that research, prepared this manuscript and, again, it was a chapter in my -- Dr. Liu's Ph.D. dissertation.

Then when the desire to conduct this study came along -- and I've had -- we've done several studies of hazardous materials transportation lists for various reasons over the last five years, this -- we used this study of accident rates because, again, I believe that this is the most up to date understanding of derailment rates as a function of these three parameters that are all significantly related to derailment rate.

Q. So the study that you had done for this oil terminal project is based upon the other study. Is that what you're saying?

A. It uses these derailment rates. So, again, there -- as has been discussed, there's a different combination of track classes on this route. As it turns out, the whole route is signaled and the whole route has

traffic above 20 million gross tons, but we applied those values using this study's estimates of those derailment rates as a function of those parameters. There is one thing we did in addition to that which was reflecting that the derailment rate had come down since the 2005 to 2009 period when these data were collected. We used -- again, my former student, Dr. Liu, who is now a professor at Rutgers, had done a subsequent page, which I believe is also part of the record, where he projected how derailment rates were declining and so in order to get a current-day estimate of derailment rates, we used his estimates. It's suddenly occurring to me maybe that's why there's a range. I'll check. That could be why. It may be that the higher one is from the 2005 to 2009 study and the lower one is the current estimated derailment rate. This is helpful.

JUDGE NOBLE: You're supposed to be answering Ms. Brimmer's questions right now.

THE WITNESS: We're talking risks. It's fun.

BY MS. BRIMMER:

Q. We're all swimming in the same pool.

In response to Councilmember Rossman's questions, where I think he, on your chart, used the 15-year recurrence interval and said, does that mean

that within the 20-year life of this project we'd see an incident, and I think you answered, yes, although you then qualified your yes and said, assuming derailment remains constant -- derailment rates remain constant. Do you recall that?

A. If I said what you just said I said -- I'm not denying it -- I misspoke. So I would -- it's a random process. We have a -- on average an expectation of a derailment every 2.4 years somewhere on this route. We could definitely go 20 years and not have a single derailment. The longer that period of time that we project that is, the lower the probability of such an event occurring, but that's the nature of probability is that -- it's not like -- to put it -- the -- conversely, we could have a derailment tomorrow and then another one next week, even though that rate is once every 2.4 years. It cuts both ways.

But we can estimate what the probability distribution of a -- of certain numbers of events over a certain period of time would be using a bit more sophisticated arithmetic than shown in this report, and that's what I think the question I'm -- yeah.

Q. Well, I guess what I was interested in was the part of your answer to Mr. Rossman concerning assuming derailment rates remain static and you said something

about them going down. But if they went up, what you're saying, I guess, is that your reported chart here is a snapshot in time. And if derailment rates change, those probabilities change; is that correct?

A. That's correct.

MS. BRIMMER: That's all I have.

JUDGE NOBLE: Mr. Kisielius?

MR. KISIELIUS: I have no questions.

JUDGE NOBLE: Really?

MR. DERR: You get a cookie.

JUDGE NOBLE: All right. Dr. Barkan, we thank you very much for your testimony today and you're lucky you can go home tonight if you want. Thank you.

THE WITNESS: It's my mother's 90th birthday and that's where I'm going and my family's flying in, so it really would have been bad if I had to stay another day. Thank you for --

JUDGE NOBLE: Thank you. You're excused as a witness.

THE WITNESS: And I also thank you for delaying my participation today, as I think you know I had some health problems that interfered with my earlier travel.

JUDGE NOBLE: Not a problem. We're glad to see you today back at it. Thank you.

It is now 20 minutes of 5 and although we could start with another witness, I think we have enough room to begin that witness tomorrow and give everyone a 20-minute rest. What do you think?

MR. KISIELIUS: Your Honor --

JUDGE NOBLE: Would you like to start and go till 5:00?

MR. KISIELIUS: I think in light of the fact that we're running out of daylight here with hearing hours and now with the number of witnesses that we have left on the day for tomorrow --

JUDGE NOBLE: You want to start?

MR. KISIELIUS: If we could start --

JUDGE NOBLE: Sure.

MR. KISIELIUS: -- and I understand we're not going to finish, but that would at least give us a little headway tomorrow.

JUDGE NOBLE: That's good.

MR. KISIELIUS: So may I call the next witness?

JUDGE NOBLE: Yes, please do, Mr. Kisielius.

MR. KISIELIUS: The applicant would like to call Mr. Greg Rhodes -- recall Mr. Greg Rhodes.

JUDGE NOBLE: Mr. Rhodes, could you raise your right hand, please.

(Witness sworn.)

JUDGE NOBLE: Thank you. Please be seated.

GREG RHODES,

having been first duly sworn,

testified as follows:

DIRECT EXAMINATION

BY MR. KISIELIUS:

Q. Welcome back, Mr. Rhodes.

A. Thank you.

Q. I'm going to ask you a couple of questions about some of the testimony that we've heard about -- or heard from the last several weeks. I want to start with the testimony of Scott Johnson. Have you reviewed his testimony?

A. I have.

Q. And have you reviewed the mapping that he used, Exhibit 3136?

A. Yes, I have.

Q. Let's talk about the methodology in his mapping. Could you describe your understanding of the difference between the tools that you had relied on in your prior testimony and his for assessing the potential populations impacted by an evacuation area?

A. Certainly. In my review of Mr. Johnson's mapping work, it was my understanding from his work and

from his testimony that he used geographical information system, or GIS data, to produce his population densities. He assumed in some cases a half mile and in other cases a mile. The GIS is simply a database with data. It doesn't lead you to a decision. The data is what the data is.

The tools that I used in conducting mine were a set of tools developed by the EPA that I referenced in my previous testimony that are part of the CAMEO system. And that's the community -- Computer-Aided Management of Emergency Operations. It's a tool that's commonly used by emergency responders and emergency planners. And more specifically, within that suite of tools, I used a program called the RMP*Comp model, again, an EPA product.

The RMP*Comp model allows me to select a particular point, it allows me to enter chemical data, it allows me to enter information about the temperature of the product, other characteristics as to the release rate, the size of the release, timing of the release so that the model then does actual calculations as opposed to just a data set. The model does a set of calculations that gives me a result which is representative of how large an incident would be given a certain volume of a certain chemical.

Subsequent to that, another tool, the MARPLOT tool, again, I referenced in my earlier testimony, that's the mapping application for response planning of local operational tasks, M-A-R-P-L-O-T. The MARPLOT tool then looks at the area I've selected; it identifies population based upon the US census data. So for a release scenario and the size of that release scenario that I get from RMP*Comp, MARPLOT pulls that into the program and tells me how many people are within a particular area.

Q. So in terms of the population figures and the data that those tools use, how do you compare the information that he relied on with the information -- the data that your tools use?

A. MARPLOT uses US census data. The US census is done every ten years. So the accuracy of the MARPLOT data is only as good as the 2010 census data. I would certainly acknowledge that a GIS system that's done locally with a -- more updating of the data set may change the population numbers on a more accurate basis. However, again, the GIS system is not able to make any decisions about how large an area ought to be. It's just -- again, it's just a data set for a particular area.

So while I would concede that a GIS system as

was used in this case may be more accurate for population, my model is more accurate for release planning purposes. However, I do find it interesting that when I look at the data that Mr. Johnson reported in terms of population and I removed his circles to be more rail centric instead of located off of the rail line, I found that his population numbers were remarkably close to mine. We may be talking a difference of a hundred people, 200 people, but it's not an order of magnitude of difference in data.

Q. And let's talk about the four intersections. Are you familiar with the four intersections that he mapped?

A. I am.

Q. And I think Mr. Johnson acknowledged his -- the centers of those circles, the radius of the evacuation, were not centered on the rail line and I think he in his testimony specified the distance of those centers of those circles from the rail line. Did you get a chance to review those?

A. I did.

Q. And do you agree with his testimony about their proximity to the rail?

A. I want to make sure I understand your question, sir. I agree that in several of his radiuses, they were

not rail line centric. They were more intersection-based, as you would expect, using the GIS tool; whereas, again, my tool enables me to pick a click point anywhere and I always put it at the center of the rail which is where the incident would occur. In terms of the distance from my point to his point, I would -- I would agree with his distances, yes.

Q. And what difference does that make when you move the center line away from the rail line? How does that impact the results of the population that's captured within that circle?

A. Well, it's very possible that that will give you a skewed result in terms of number of people that would be actually within that response radius. The further you move the circle away from where the event actually occurs, you're creating -- you're extending that boundary out and there's potential for people in that extended boundary that really would not be impacted in a true linear half-mile radius.

Q. I'm going to focus on some of Mr. Johnson's testimony about half-mile radius versus mile radius. He originally testified that he used a half-mile radius consistent with the ERG, but then he said he relied on a mile radius when he was testifying live because, his words, it was probable, that's the word he used, that a

half-mile evacuation radius will grow to a mile radius in the event of an incident. So do you agree with that?

A. No, I don't agree with that statement.

Q. And why?

A. In both my personal experience as an emergency responder to train derailments and also in my review of the 24-incident data set that has been commonly referred to in this proceeding, when I looked at the 24-incident data set, I went back and I used either FRA reports, NTSB reports or Transport Canada reports. In some cases I had to use what was reported from local press. But of those 24 incidents, I identified that there were five incidents where there was a mile evacuation and identified 19 events where there was a half-mile evacuation. In none of those instances did I find where the evacuation was reported as growing from the initial evacuation. That is to say, of the 19 incidents where a half a mile was the evacuation distance, it remained at a half a mile throughout the event. If anything, we saw evacuation areas shrinking as incident commanders were more conservative in their response areas as -- in their evacuation areas and as more data became available and the situation became clear, that evacuation area typically shrunk, it did not increase. So to his comment about the probability of it increasing from a

half mile to a mile, my experience in data analysis tells me that that's not the case.

Q. Does it say anywhere in the ERG, the Emergency Response Guidebook, that the half-mile increases recommended there increase with additional rail cars involved in an event?

A. No. It does not say that in the Emergency Response Guidebook. And to further clarify that, again, I used the same modeling tools that I referenced earlier. And in this case instead of modeling for a release of one car at 30,000 gallons, I put in -- as my quantity of product, I put in 90,000 gallons, which would be representative of three cars. And, in fact, the impact radius only increased from .5 to .6 going from one car to three cars. So it is definitely not true that if it's a half a mile for one, that it's a mile for two, that it's a mile and a half for three and so on. That relationship does not exist.

Q. I want to switch subjects here, but sticking with Mr. Johnson's testimony. He testified to some degree about the state of risk management planning with the county and its cities. And have you had a chance to review some of the documents to which he referred, and I'm speaking to the Comprehensive Emergency Management Plan, the Hazard Identification and Vulnerability

Analysis and the Clark County Hazardous Materials Emergency Response Plan?

A. Yes, I reviewed all three of those documents.

Q. Did you find them on Mr. Johnson's agency website?

A. I did.

Q. Are these documents that you would review to gain an understanding of the county's planning for risks?

A. I'm sorry, could you repeat that question, please?

Q. In assessing how the county or the county risk agency has planned for emergency situations, are these the types of documents you would review to get an understanding of that?

A. Yes, that's correct, these are pretty common documents.

Q. And did you understand these documents to be the ones that Mr. Johnson was referring to?

A. Yes.

MR. KISIELIUS: Your Honor, we'd like to offer into evidence two of those documents. And, sorry, the exhibit number, I'll just take a second.

JUDGE NOBLE: 374 and 376?

MR. KISIELIUS: Yes, thank you.

JUDGE NOBLE: Is there any objection to the Exhibits 374 and 376?

MR. POTTER: Just for clarity, which of those three are those two?

JUDGE NOBLE: 374 is Clark Regional Comprehensive Emergency Plan, and 376 is Emergency Support Functions and Hazardous Materials.

MR. POTTER: No objection.

MR. KISIELIUS: And just for Mr. Johnson's -- we confirmed we were going to put the Hazard Identification Vulnerability Analysis in, but our understanding is that's already in the record.

MR. POTTER: Thank you.

JUDGE NOBLE: It is 375, I think?

MR. KISIELIUS: No, Your Honor, it's an exhibit that the County entered, I believe.

MR. HALLVIK: I think it's 2004.

JUDGE NOBLE: That's already in the record? All right. Exhibits 374 and 376 are admitted.

BY MR. KISIELIUS:

Q. So I want to focus on the Clark County Hazardous Materials Emergency Response Plan for a second. What's your understanding of that document? And I believe you have a copy of it there in front of you.

A. I do.

Q. How does it work with an emergency management plan?

A. The Comprehensive Emergency Management Plan, or Exhibit 0374, is the overall emergency plan for all types of emergencies in Clark County. Within the CEMP, it references a number of documents that it refers to as annexes or the terminology used here is "emergency support function" or ESF. The Clark County Hazardous Materials Emergency Response Plan integrates into the overall comprehensive emergency management plan as emergency support function 10, titled "Hazardous Materials." So the emergency support function annexes are more specific to a particular type of hazard risk or response challenge for the community.

Q. So looking at these documents, do they plan for risk of a hazardous materials release from a facility?

A. Yes, they include both for a facility and for transportation hazardous materials releases.

Q. And do they talk specifically about releases from rail?

A. They do.

Q. And do they describe facilities that handle hazardous materials in the city and in the county, I should say?

A. Yes, they do. If I can refer to the plan,

specifically page 9 of Exhibit 376. This is Roman numeral IV, "Situation and Assumptions." Again, on page 9. So at the bottom there, that A, the plan references that a variety of hazardous materials are manufactured, used, stored and transported in and through Clark County on a daily basis.

So that's identified at that paragraph. If you would go to the next page -- well, before we leave the bottom of that page, B, this plan identifies that there were 171 individual facilities that were reporting chemical inventory. That's part of the EPCRA, or the community right-to-know regulations, where fixed facilities are required to report to the local emergency planning commission on an annual basis hazardous materials or hazardous substances that they store on their site.

If you go to page 10, you'll see an item C, that 62 of these facilities reported extremely hazardous substances. These are materials that have higher toxicity. These would be possibly toxic products or gases.

Of particular interest to me is paragraph D. There are six facilities in Clark County that are required to submit what's known as a risk management plan or RMP. The RMP*Comp tool that I referenced

earlier ties directly into facilities like this. As part of the risk management plan, facilities are required to identify a worst-case scenario that involves off-site impact if the release of their products -- or if their products are released with no abatement in a worst-case scenario. So the six facilities that have RMPs, these are the type of facilities that would have chlorine anhydrous ammonia, propane, other flammable toxic gases.

And then you'll see, coming on down through the listing here, it talks about transportation routes, particularly under F, it talks about main arterial roads and rail lines. So from my read of this, the Hazardous Materials Emergency Response Plan certainly considered transportation in its plan.

Q. And I want to ask you a question about the facilities side again. Does the document itself list the facilities and their hazardous -- people responsible in -- contact person in the event of a hazardous materials release?

A. Yes, it does. Under Appendix A to this, are a list of facility emergency coordinators. From my review of this, it appears that that listing includes facilities that are reporting as part of that 171 companies or facilities that's listed under item B in

this document, within that listing, the BNSF is listed as an identified location, as is a current Tesoro facility.

Q. So would it be your expectation that the Vancouver Energy facility would eventually be added to the list of facilities in this appendix after construction?

A. Yes, I would fully expect that.

JUDGE NOBLE: Mr. Kisielius, it's now 5:00 and so I'm pretty sure we won't be finished with this witness within the next five minutes. I don't want him to have to hurry. And I know that we have a time constraint. So I think this would be a good time to stop. We have to go over what's happening tomorrow briefly.

MR. KISIELIUS: Thank you, Your Honor. Appreciate the ability to get started with this witness.

JUDGE NOBLE: Thank you.

THE WITNESS: Am I excused?

JUDGE NOBLE: Thank you very much, Mr. Rhodes, for accommodating the council by coming back tomorrow. We do appreciate that. Thank you.

Let me just say what I have -- what I have for tomorrow is the rest of Mr. Rhodes' testimony. Mr. Corpron --

MR. JOHNSON: None of them are working.

JUDGE NOBLE: The TV people -- for tomorrow, we have the rest of Mr. Rhodes' testimony, Mr. Corpron's testimony and Mr. Haugstad's testimony, Roach and Mr. Larrabee.

MR. JOHNSON: That's correct.

JUDGE NOBLE: And you've given the subjects of those testimony -- people's testimony already. So I anticipate we'll have a full day tomorrow and then followed by argument on Friday from the parties and also from the general public. Thank you.

Is there anything further we need to do on or off the record before we conclude today? All right. Thank you very much. We're adjourned until tomorrow morning at 9:00. Thank you.

(Hearing adjourned at 5:02 p.m.)

C E R T I F I C A T E

STATE OF WASHINGTON)
) SS.
COUNTY OF CLARK)

I, Micheal A. Johnson, Registered Diplomate Reporter and Certified Realtime Reporter, do hereby certify that the foregoing transcript is true and accurate to the best of my knowledge, skill and ability.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 31st day of July, 2016.

MICHEAL A. JOHNSON, RDR, CRR