WRITTEN STATEMENT OF
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U.S. DEPARTMENT OF TRANSPORTATION
BEFORE THE SUBCOMMITTEES ON ENERGY AND OVERSIGHT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

BAKKEN PETROLEUM: THE SUBSTANCE OF ENERGY INDEPENDENCE

September 9, 2014

Chairmen Lummis and Broun, Ranking Members Swalwell and Maffei, and Members of the Subcommittees, thank you for the opportunity to provide testimony on the Pipeline and Hazardous Materials Safety Administration's (PHMSA) data results on the testing of Bakken shale crude oil. While rail is safer today than it's been in a generation or more, high-profile train accidents, such as the ones we've seen in Lac-Mégantic, Quebec, Canada; Aliceville, Alabama; Casselton, North Dakota; and Lynchburg, Virginia, underscore how important it is to be ever-vigilant in protecting local communities and the environment.

Safety is the number one priority for Secretary Foxx, everyone at PHMSA, and the other modal administrations in the U.S. Department of Transportation (DOT). PHMSA continues to work diligently to protect the American people and the environment from the risks of hazardous materials transportation by all modes. PHMSA works to achieve its safety mission through efforts intended to prevent and mitigate transportation incidents involving hazardous materials. These efforts include, but are not limited to, developing regulations and guidance, engaging in rigorous inspection and enforcement actions, collaborating with stakeholders, and educating industry, public safety officials, and the public.

On August 1, 2014, DOT issued two comprehensive rulemakings: a Notice of Proposed Rulemaking on Enhanced Tank Car Standards and Operational Controls for High-Hazard

Flammable Trains and an Advance Notice of Proposed Rulemaking on Oil Spill Response Plans for High-Hazard Flammable Trains. Both proposals are designed to address the risks associated with increased shipments of bulk flammable liquids by rail. Concurrently, PHMSA also publicly released its data summary that detailed the agency's current testing and sampling program for Bakken crude oil. The data stressed the importance of proper classification of hazardous materials, provided the preliminary conclusions drawn of our testing from August 2013 through May 2014, and described the methods and tests used to attain the data. PHMSA's crude oil testing and sampling efforts have provided its field investigators a greater understanding of the characteristics of this mined material. This greater understanding is helping PHMSA achieve our safety mission.

This testimony will include a brief overview of our regulatory framework as it relates to the classification of hazardous materials, and the importance of proper classification as the foundation of our transportation safety system. In addition, a brief overview of the characteristics of crude oil from different sources, which have become more relevant because of the growth in production of energy products in the U.S., will be included in order to put the Bakken shale oil safety issue into context. Finally, this testimony will also include a comprehensive review of PHMSA's July 23, 2014 "Operation Safe Delivery Update" posted on PHMSA's Web site and will cover the following elements:

- The technical analysis and process PHMSA used to classify and characterize these crude oil samples (including limitations of the methods used);
- The specific accepted industry standards that are being used as part of our sampling and testing program; and
- The preliminary data gathered in 2014 indicates that crude oil from the Bakken region may be "more volatile than most other types of crude produced in the U.S. – which correlates to increased ignitability and flammability."[1]

[1] DOT's "Operation Safe Delivery Update," p. 16.

The initial testing and analysis conducted during Operation Safe Delivery has provided PHMSA with some valuable information. Given the range of data available on Bakken crude (from industry and other sources), PHMSA plans to validate preliminary conclusions discussed below.

I. PHMSA's Regulatory Framework

PHMSA issues the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180), which prescribe requirements for the safe transportation of hazardous materials in commerce by all modes. The proper classification of any hazardous material is required prior to offering it into transportation. Proper classification and characterization of hazardous materials are the foundation of our transportation safety system. Proper packaging selection, marking, labeling, shipping papers, and placarding are all dependent upon this first, critical step.

The HMR has nine hazard classes, which are defined to characterize the predominant risk that a hazardous material poses. Some materials meet the definition of more than one hazard class with primary risks and subsidiary risks. Once a hazardous material is classified into one or more hazard classes, the HMR further delineates risk of certain hazardous materials through specific packing groups (PG). Some hazardous materials are assigned to one of three PGs based upon their degree of hazard, ranging from high hazard (PG I), to medium hazard (PG II), to low hazard (PG III). The quality, damage resistance, and performance standards of the container or package authorized in each packing group are designed for the hazards of the material being transported.

The entity that offers hazardous materials for transportation is considered a shipper (e.g., both initial offerors and subsequent, downstream offerors). It is the shipper's responsibility to properly classify and to describe a hazardous material, including determining the constituents present and any multiple hazard classes present.

Each shipment of a hazardous material must be accompanied by a shipping document that must include a statement certifying that the material is in compliance with all appropriate regulations, including classification and packaging. In summary, anyone offering a hazardous material for shipment must do the following:

1. Properly identify all the **hazards** of the material.
2. Determine which of the **nine hazard classes** are applicable to the material as the primary and subsidiary hazards.
3. Assign the material to a **packing group**, if applicable.

The diagram below provides a summary of the process that a shipper must perform to properly classify crude oil and then select the appropriate shipping description and assign the proper packing group for the material. Each step in the process is critical to ensure the safe transportation of a hazardous material.

The HMR provides a safety system that, when implemented properly, can help prevent transportation incidents, mitigate the consequences of such incidents should one occur, and communicate the hazards and emergency response information. The effectiveness of this safety approach is, in part, dependent on the proper classification and characterization of the hazardous material being transported. The improper classification and/or characterization can diminish the intended effectiveness of the HMR.

II. State of Crude Oil

Oil and gas production is at an historic high in the United States – a positive development for our economy and our energy independence – but the responsibilities that come along with that production are serious. More crude oil is being shipped by all modes of surface transportation than ever before, and it is DOT's responsibility to ensure these crude oil shipments travel safely.

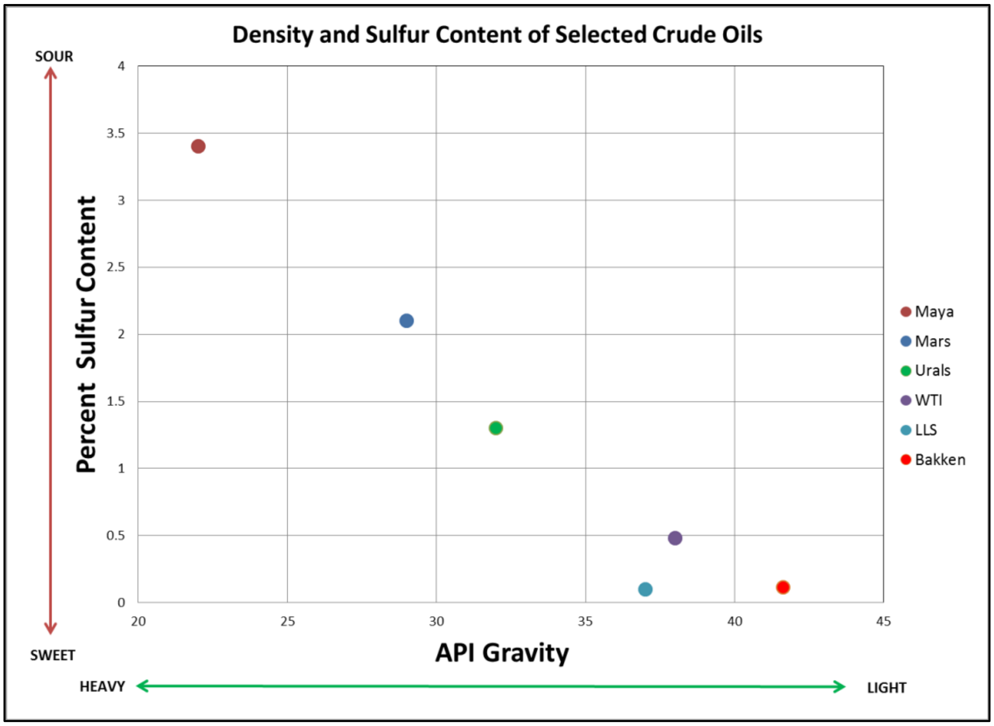
One important center of this increased crude oil production is the Bakken shale formation (Bakken Formation), occupying about 200,000 square miles (520,000 square kilometers) in the U.S. and Canada. Production from the Bakken Formation in recent years has elevated North Dakota to one of the most important sources of oil in the United States. As of August 2014, the Bakken Formation produced 1,136 thousand barrels per day compared to just over 200 thousand barrels per day in 2009.[2]

Unlike manufactured goods, mined natural resources, including crude oil, may have variable chemical compositions, presenting a challenge in regards to classification. Differences in the chemical makeup of a raw material such as crude oil can vary based on many factors including geographical location of the well, age of the well, and environmental factors such as temperature at which the oil is stored at the well site.

The chart below demonstrates that many types of crude oil mined around the world have varying chemical characteristics. In fact the market value of an individual stream of crude oil reflects its quality characteristics. Two of the most important quality characteristics are density and sulfur content. Density ranges from light to heavy, while sulfur content is characterized as sweet (low sulfur) or sour (high sulfur). The crude oils represented in the chart below are a selection of some of the crude oils marketed in various parts of the world. There are some crude oils both below and above the American Petroleum Institute's (API) gravity[3] range shown in the chart. In addition to these quality characteristics, there are other chemical characteristics that may affect transportation classification under the HMR. These chemical characteristics include flash and boiling points, as well as vapor pressure. These properties may differ considerably depending upon the percentage of dissolved gases, particularly lower-boiling point hydrocarbons, known as light ends.

[2] U.S. Energy Information Administration, *Bakken Region Drilling Productivity Report* http://www.eia.gov/petroleum/drilling/pdf/bakken.pdf

[3] "API gravity" is a measure of how heavy or light a petroleum liquid is compared to water, and is used to compare relative densities of petroleum liquids and also gives an indication of relative volatility.



Source: U.S. Energy Information Administration, based on Energy Intelligence Group—International Crude Oil Market Handbook. Bakken data is based on PHMSA sampling and testing
Note 1: Points on the graph are labeled by country and benchmark name. The graph does not indicate price or volume output values. MAYA = Mexico; MARS = United State offshore drilling site in the Gulf of Mexico; URALS = Former Soviet Union; WTI = West Texas Intermediate; LLS = Louisiana Light Sweet; and Bakken is the Williston Basin

DOT has taken steps to strengthen compliance and existing orders and regulations related to the safe transportation of flammable liquids, and Bakken crude oil in particular. Those steps include the issuance of emergency orders and the advancement of new rail safety and tank car safety regulations.[4] As the shipment and distance traveled of bulk quantities of Bakken crude oil is relatively new, and crude oils around the world have demonstrated that these products may vary in chemical characteristics, PHMSA launched its sampling and analysis program to further assess the characteristics of Bakken crude oil and determine the degree to which shippers were properly classifying and assigning packing groups prior to shipment. Specifically, the results of the sampling and analysis would be used to determine the potential volatility of Bakken crude oil compared with other crude oils.

[4] See Operation Safe Delivery Chronology at http://www.phmsa.dot.gov/hazmat/osd/chronology

III. Operation Safe Delivery Update

Prior to the launch of our sampling and analysis program, DOT inspectors identified that many crude oil loading facilities were basing classification solely on a generic Safety Data Sheet (SDS)[5], and often neglecting to conduct any sort of chemical testing or analysis to confirm the information on the SDS. SDS data can provide a wide range of material properties, including information such as boiling point, flash point, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. These inspections revealed that SDSs for crude oil were often out-of-date with unverified information and provided ranges of chemical and physical property values instead of specific measured values. Further, these ranges often crossed the thresholds between PG I and II and PG II and III, making it difficult to assign the proper packing group. Given the potential variability of crude oil, DOT believed that operators' reliance on generic information was a safety concern. In fact, in a letter to API, FRA enumerated concerns related to crude oil and informed industry that it would use PHMSA's test sampling program to ensure that crude oil is being properly tested and classified.[6]

In August 2013, the Department embarked on Operation Classification in the Bakken Formation, where crude oil production has skyrocketed and the practice of using generic and outdated SDSs to classify crude oil was observed. We were particularly focused on the Bakken region because there was some question of whether materials were properly classified and characterized by shippers. .

Operation Classification is focused on ensuring shippers are properly classifying crude oil for transportation in accordance with Federal regulations, and on better understanding the unique characteristics of mined gases and oils from the Bakken region. The intent of Operation Safe Delivery's sampling and analysis component is to determine whether shippers are properly classifying crude oil for transportation. The intent is also to quantify the range of physical and chemical properties of crude oil.

[5] Formerly known as Material Safety Data Sheets or MSDSs.
[6] See FRA letter http://www.fra.dot.gov/eLib/details/L04717

Technical Analysis

The initial activities of Operation Classification were conducted in two phases. The first phase was conducted from August through November 2013. In this phase PHMSA was focused on determining and verifying hazard classes and packing group selection. Tests focused on flash point and boiling point and then expanded to address other chemical characteristics of crude oil. Forty-seven total samples from rail loading facilities, cargo tanks, storage tanks, and pipelines used to load rail cars were collected.

In conducting the sampling and analysis for this phase, PHMSA used American Society for Testing and Materials (ASTM), industry-recognized testing and sampling methods. ASTM is a globally recognized leader in the development and delivery of international, voluntary consensus standards. Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence.

The collection of these samples to be analyzed in this phase was conducted by PHMSA field operations personnel. These personnel were trained in collection methods described in ASTM D4057 titled "Standard Practice for Manual Sampling of Petroleum and Petroleum Products." In addition a Crude Oil Sampling Plan was developed by our National Field Training Office. This plan detailed sampling and handling protocols designed to ensure consistency, accuracy and repeatability. All samples collected by PHMSA were sent to Intertek Laboratories, which is a nationally recognized lab to test crude oils. The specific standards used in the first phase are listed below with a brief description of the method and the levels of certainty of each test.

OPERATION CLASSIFICATION (PHASE 1)		
Test Method	**Summary**	**Test Limitations**
Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method) (ASTM D323).	Determines Reid vapor pressure measured with a vapor-to-liquid ratio of 4:1 and temperature of 100 degrees Fahrenheit (°F).	Utilizes open sampling and allows samples to mix with air before measurement. Minimizes the contribution of dissolved gases to vapor pressure

		measurement.
Standard Test Method for Determination of Individual Components of Crude Oil (ASTM D6730 MOD).	Determines concentration of individual hydrocarbon components with boiling ranges up to 437 °F using gas chromatography.	Sampling method could affect results.
Standard Test Method for Water and Sediment in Crude Oil (ASTM D4007).	Centrifuge method to determine water and sediment concentrations within crude oil.	May underestimate water content
Standard Test Method for Sulfur in Petroleum and Petroleum Products (ASTM D4294).	X-ray fluorescence spectrometry to determine sulfur concentrations within petroleum and petroleum products.	Limited to concentrations <4.6% by mass.
Standard Test Method for Measurement of Hydrogen Sulfide in the Vapor Phase Above Residual Fuel Oils Hydrogen Sulfide Content (ASTM D5705).[#]	Determines the concentration of hydrogen sulfide within the vapor phase above a material for understanding the health and safety risks posed.	Limited to concentrations between 5 and 4000 parts per million by volume
Standard Test Method for Density and Relative Density for Crude Oil (ASTM D5002).	Determines the density or relative density of crude oils which are capable of being handled as liquids between 59 °F and 95 °F.	Lighter crude oils require special handling to prevent vapor losses.
Standard Test Method for Flash Point by Tag Closed Cup Tester (ASTM D56).[#]	Determines the flash point of a material in controlled conditions. Flash point is the lowest temperature at which a material can vaporize to form an ignitable mixture in air.	Limited to liquids with a viscosity < 5.5 cSt at 104 °F and a flash point < 200 °F
Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure (ASTM D86).[#]	Determines the boiling range of a petroleum product using distillation. The initial boiling point is recorded as the temperature at the instant the first drop of condensate falls from the lower end of the condenser tube.	Designed for the analysis of distillate fuels and is not applicable to products containing appreciable quantities of residual material.

 # These tests were also used at part of the American Fuel & Petrochemical Manufacturers' report "A Survey of Bakken Crude Oil Characteristics."

The second phase of testing involved additional inspectors assigned on a continual rotation in the Bakken region to collect samples. The majority of the samples were collected at rail loading facilities from storage tanks and pipelines that were used to load rail cars. Several were collected from cargo tanks. Four of the samples collected were drawn using a closed syringe-style cylinder connected to loading pipelines to determine if there were differences from previous samples collected using the open container sampling method and to ensure a more accurate and representative sample given the potential light end component losses when utilizing an open sampling method. In total 88 samples were taken between February 2014 through May 2014.

As with the first phase, the collection of these samples to be analyzed in this phase was conducted by PHMSA field operations personnel in accordance with ASTM D4057. In addition, our field operations personnel received information on how to use the syringe cylinders from the manufacturer of the cylinders, Welker Engineering.

As with the first phase, PHMSA utilized ASTM industry recognized testing methods to conduct the required analysis in the second phase, but also included alternative test methods to determine vapor pressure and corrosivity. The specific standards used in the second phase are listed below with a brief description of the method and the levels of certainty of each test.

OPERATION CLASSIFICATION (PHASE 2)		
Test Method	**Summary**	**Test Limitations**
Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method) (ASTM D323).	Determines Reid vapor pressure measured with a vapor-to-liquid ratio of 4:1 and temperature of 100 °F.	Utilizes open sampling and allows samples to mix with air before measurement. Minimizes the contribution of dissolved gases to vapor pressure measurement.
Standard Test Method for Determination of Individual Components of Crude Oil (ASTM D6730 MOD).	Determines concentration of individual hydrocarbon components with boiling ranges up to 437 °F using gas chromatography.	Sampling method could affect results.
Standard Test Method for Measurement of Hydrogen Sulfide in the Vapor Phase Above Residual Fuel Oils Hydrogen Sulfide Content (ASTM D5705).[#]	Determines the concentration of hydrogen sulfide within the vapor phase above a material for understanding the health and safety risks posed.	Limited to concentrations between 5 and 4000 parts per million by volume
Standard Test Method for Flash Point by Tag Closed Cup Tester (ASTM D56).[#]	Determines the flash point of a material in controlled conditions. Flash point is the lowest temperature at which a material can vaporize to form an ignitable mixture in air.	Limited to liquids with a viscosity < 5.5 cSt at 104 °F and a flash point < 200 °F

Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure (ASTM D86).#	Determines the boiling range of a petroleum product using distillation. The initial boiling point is recorded as the temperature at the instant the first drop of condensate falls from the lower end of the condenser tube.	Designed for the analysis of distillate fuels and is not applicable to products containing appreciable quantities of residual material.
Standard Test Method for Determination of Vapor Pressure of Crude Oil: VPCRx (Expansion Method) for both Vapor/Liquid ratios of 0.02 (at 122 °F) and 4 (at 100 °F).	Determines the vapor pressure of crude oils at varying vapor-to-liquid ratios from 4:1 to 0.02:1 and temperatures between 32 °F and 212 °F.	Suitable for materials with vapor pressures between 3.6 and 72.5 pounds per square inch.
U.N. Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Chapter 37 (corrosion to aluminum and carbon steel).	Determines the corrosion rate to steel and aluminum for a particular liquid, and its vapor.	Only necessary for transportation hazard classification

 # These tests were also used at part of the American Fuel & Petrochemical Manufacturers' (AFPM) report "A Survey of Bakken Crude Oil Characteristics."

The "Operation Safe Delivery Update" released on July 23, 2014 provides an update of our testing and sampling activities from August 2013 through May 2014. Since May 2014, PHMSA has continued its testing and sampling activities and refined the collection methods. PHMSA has purchased nine closed syringe-style cylinders and is collecting all sampling using these cylinders. Utilizing these types of cylinders minimizes the opportunity for any dissolved gases to be lost to the air during collection thus providing increased accuracy. In addition, PHMSA has taken samples at other shale play locations around the U.S. to further compare their characteristics against the Bakken region data.

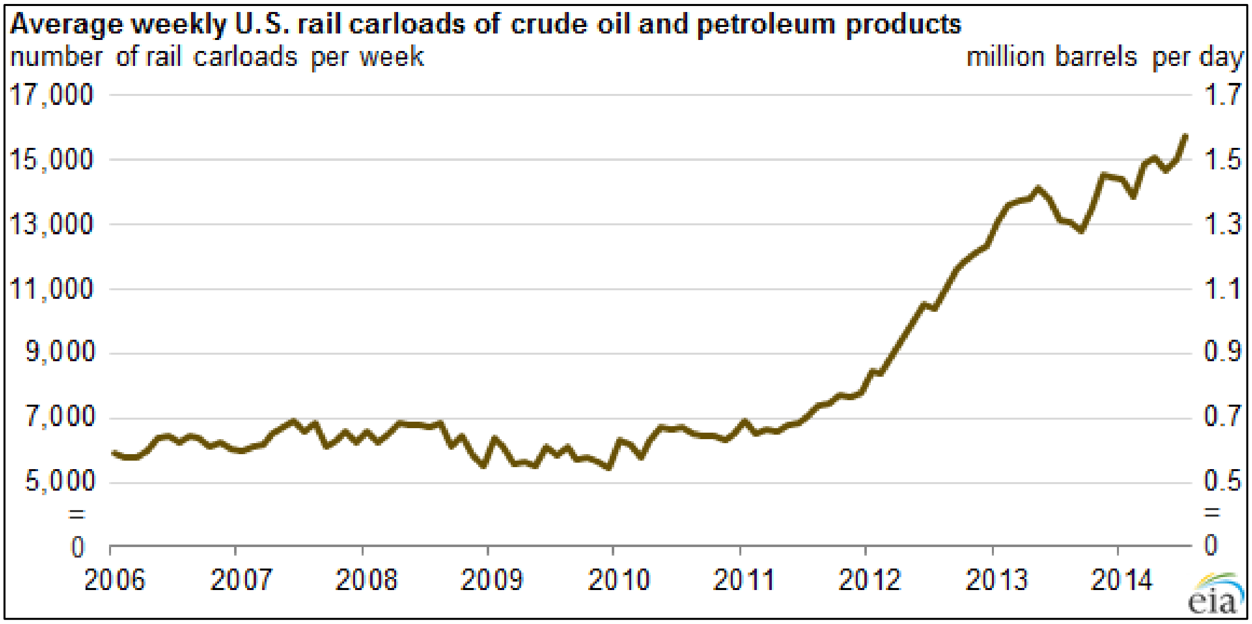
Data Summary

Our preliminary analysis of the results of months of unannounced inspections, testing, and analysis as part of Operation Classification suggests that the current classification applied to Bakken crude oil is appropriate under the current classification system detailed in the HMR. This is consistent with the findings of AFPM's "Survey of Bakken Crude Oil Characteristics." However, Operation Classification preliminary finding also suggest that Bakken crude oil may have a higher gas content, higher vapor pressure, lower flash point and boiling point and thus a higher degree of volatility[7] than some other crude oils. Based on the data PHMSA collected, Bakken crude oil would be considered a "light sweet crude oil." The PHMSA data show that Bakken crude oil's gas content, flash point, boiling point, and vapor pressure are not outside the norm for light crude oils. Light crude oils often have higher gas content, a low flash point, a low boiling point, and high vapor pressure.

AFPM's "Survey of Bakken Crude Oil Characteristics" concludes Bakken crude oil, when compared with other light crude oils, is determined to be within the norm in the case of light hydrocarbon content, including dissolved flammable gases. PHMSA does not dispute this conclusion. The primary difference between PHMSA's analysis and AFPM's analysis is that PHMSA considered a broader range of crude oils for comparison to Bakken crude oil, though both analyses determine that Bakken crude oil is within the norm for light crude oils. PHMSA notes that light sweet Bakken crude oil may be more ignitable and flammable than some other types of crude oil, specifically "heavy crude oil." Further, preliminary analysis suggests that the majority of crude oil analyzed from the Bakken region displayed characteristics that may be more consistent with those of a Class 3 flammable liquid, PG I or II, with a predominance of PG I, the most dangerous type of Class 3 flammable liquids. The volatility of Bakken crude oil, and its usual identification as a PG I, "light" crude oil, may be attributable to its higher concentrations of light end hydrocarbons, which are more ignitable.

PHMSA's review of crude oil transportation data also confirmed that large volumes of this oil are moving at long distances across the country. At any given time, shipments of more than two million gallons are often traveling distances of more than one thousand miles (see figure below).

[7] "Volatility" is a relative measure of a specific material's tendency to vaporize.



Source: EIA http://www.eia.gov/todayinenergy/detail.cfm?id=17751

Given the volume of Bakken crude being transported in individual trains, there is an increased risk of a significant incident involving this material, especially considering the routes and the long distances it can travel by rail from North Dakota to refineries throughout the United States. Trains transporting this material, referred to as unit trains, can contain more than 100 tank cars, carrying at least 2.5 million gallons within a single train. Unit trains only carry a single type of product; in this case, flammable crude oil. These trains often travel over a thousand miles from the Bakken region to refinery locations along the coasts.

DOT plans to continue the sampling and analysis activities of Operation Safe Delivery through the fall of 2014 and to work with the regulated community to ensure the safe transportation of crude oil across the Nation. The Department will continue to keep the public, regulated entities, and emergency responders informed about our efforts.

IV. Closing Remarks

Effective standards and regulations are important mechanisms for keeping America's people and its environment safe while providing for the transportation of the Nation's energy supplies. PHMSA will continue to seek greater understanding of all hazardous materials and use that knowledge to improve the effectiveness of our regulations and compliance activities and educate the regulated community and public on the risks of all hazardous materials.

In closing, the Department appreciates the Committee's attention to this important safety issue and will continue to work with Congress to address transportation related concerns, specifically those dealing with the bulk shipment of flammable liquids. Together, we will strive to keep America's people and its environment safe while providing for the reliable transportation of the Nation's energy supplies. Everyone at PHMSA is dedicated and committed to fulfilling our safety mission. Thank you again for the opportunity to speak with you today. I would be pleased to answer any questions you may have.