GLOBAL COMPANIES LLC 800 South Street P.O. Box 9161 Waltham, MA 02454-9161 ph: 781-894-8800 fx: 781-398-9000

October 16, 2014

Mr. William Clarke
Regional Permit Administrator
NYS Department of Environmental Conservation
1130 North Westcott Road
Schenectady, NY 12306-2014

RE: MOSF #4-1200 – Global Facility
Albany, NY

Dear Mr. Clarke:

Global Companies LLC (Global) is in receipt of your September 10, 2014 correspondence requesting additional information relative to the pending modification of the facilities air permit application submitted in June 2013. Below are responses to the Department's request for additional information.

A. **In its answer to Question #10, Global indicates that "To reduce viscosity and improve flow characteristics, lighter end petroleum hydrocarbons are blended into certain crude oils." Does Global currently store heavy crude oils mixed with diluents at the Facility? If so, please describe such storage that may have occurred during the current calendar year. Please also describe assays/characteristics of the diluents, including the source of that information.**

Prior to the May 15, 2014 response to the Departments initial request for information dated March 24, 2014, the Global Albany terminal had not received full railcars containing diluted heavy crude oil. However, a small percentage of diluted heavy crude oil or diluted bitumen may have been present in rail cars received at the terminal as a residue from previous shipments to other facilities. Since May 15, 2014, the terminal, as permitted, has received a number of railcars (less than 10) containing diluted heavy crude oil and/or diluted bitumen. These products have been transferred and blended into tanks containing light sweet crude oil.

As stated in Response #10 from the May 15, 2014 letter, the diluents typically consist of petroleum condensates or light crude oils. These are common commodities within the petroleum industry. A history of analyses of a typical condensate blend was previously provided to the DEC Region 4 air permitting staff on March 17, 2014. The analyses identified the condensate consists primarily of light hydrocarbons with approximately 90 percent of the hydrocarbons being lighter than C12 and 60 percent being lighter than C7 hydrocarbons. The condensate exhibited an average API gravity of approximately 65. The analyses were obtained from the Canadian Crude Quality Monitoring Program Website.

B. With respect to the required testing of crude oil prior to being offered into transportation (see answer to Question #10), how is the testing done (i.e method, frequency)? What specific information is obtained by testing and where and to whom is that information made available? Is all the information obtained through the required testing made available? Is the information that is obtained by the required testing entered in the bills of lading? Please provide a representative set of bills of lading for crude oil types received at the facility.

Per the USDOT requirements under Amended and Restated Emergency Restriction/Prohibition Order on Docket No. DOT-OST-2014-0025, persons who offer bulk quantities of petroleum crude oil for transportation in commerce by rail in tank cars must ensure that the material is properly tested (conducted with sufficient frequency and quality) and classed in accordance with the Amended Order and the Hazardous Material Regulations (HMR). Neither the HMR nor the Amended Order is prescriptive regarding the analytical methods used to characterize the crude oil shipments or the frequency of testing. Since the DOT has not been prescriptive in their testing requirements, the analytical methodologies and frequency of testing may vary based on the facilities from which the crude oil is sourced and the requirements of the shippers of the product (Global and its third party customers).

By way of example, much of the crude oil received at the Albany terminal is loaded at Global's rail transloading facility in Stampede, North Dakota, which is owned and operated by Basin Transload, LLC, a 60% owned subsidiary of Global Partners LP. The storage tanks at the transloading facility are sampled on a weekly basis by a third party laboratory and analyzed for the following parameters in order to properly classify the shipments.

ASTM Method D6377	Determination of Vapor Pressure of Crude Oil
ASTM Method D5002	Density and Relative Density of Crude Oils
ASTM Method D4294	Sulfur Content in Petroleum Products by ED-XRF
ITM Method 3468	Determination of Hydrogen Sulfide in Vapor Phase of Volatile Samples
ASTM Method D86	Distillation of Petroleum Products / Initial Boiling Point
ASTM Method D56	Flash Point by Tag Closed Cup Tester
ISM/NACE Method TM0172	Determining Corrosive Properties of Cargoes in Petroleum Pipelines
ASTM Method D7900	Light Hydrocarbons in Stabilized Crude Oils by GC

The testing determines information regarding the characteristics of the crude oil such that an appropriate DOT Hazardous Material Classification (i.e. Class 3 Flammable Liquid) and Packing Group can be assigned to the shipment. The analytical information is not entered directly on the Bills of Lading. The analytical results are typically kept on file at the loading facility and all

analytical information is available to the DOT or other regulatory agencies during routine inspections.
Nearly all the crude oil shipped to the Albany facility is classified as Petroleum Crude Oil UN 1267 and shipped under Packing Group I. Representative Bills of Lading are attached as Exhibit 1.

In September 2014, API released Recommended Procedure AP-3000 "Classifying and Loading of Crude Oil into Rail Tank Cars". Global is currently reviewing the Recommended Procedure and will evaluate its current sampling procedures based on the recommended procedures

C. Does Global have data regarding the hydrogen sulfide content of mercaptan content of the crude oil received at the Facility? If so, please provide that information. If the hydrogen sulfide content or mercaptan is elevated, what steps are or should be taken to protect workers, the community and the environment?

Global does not receive crude oil exhibiting elevated Hydrogen Sulfide (H2S) levels in vapor at the terminal and has contractual obligations with its third party customers prohibiting the shipment of crude oil to the terminal exhibiting elevated H2S concentrations in vapor. Testing of representative crude oil samples indicates that the oil stored at the terminal exhibits vapor phase concentrations of H2S well below the OSHA Permissible Exposure Limit of 20 parts per million (ppm). In fact, the concentrations are typically below the laboratory method detection limit of 1 ppm. Information regarding H2S concentrations was previously submitted to the DEC Region 4 permitting staff on May 13, 2014. The potential to emit (PTE) for the facility submitted with previous air application materials assumed an H2S concentration in liquid (100 ppm) that translates to a vapor concentration orders of magnitude higher than the levels stored at the terminal (>10,000 ppm). This was done to provide a conservative demonstration that any fence-line concentrations of H2S, if detectable, would meet the published criteria. Industry data indicates that mercaptan concentrations are typically low in the light sweet crude oils (<10ppm), but may be higher other heavier oils.

Global fully recognizes the importance having contingencies to protect our workers, the surrounding community and the environment in the event of an upset. The contingencies implemented at the terminal related to H2S and mercaptan vapors include a combination of work practices, monitoring systems and air emission controls.

Workers at the terminal are provided with H2S awareness training which informs them of the potential hazards associated with H2S and what to do in the event of an emergency involving elevated concentrations of H2S in air. Workers involved in crude oil handling operations wear personal H2S monitors which constantly monitor the ambient air for H2S. The alarms on the air monitors are set to activate at the National Institution for Occupational Safety and Health (NIOSH) exposure ceiling of 10 ppm H2S. In the event of an alarm, personnel would

immediately evacuate upwind to a safe location and inform other employees of the alarm condition. An exclusion zone (the area exhibiting a concentration above 10 ppm) would then be established by monitoring the downwind area utilizing the personal monitors. In the event of a major incident or other incident where monitoring indicated the community may be at risk, the Albany fire department and other agencies would be contacted in accordance with the terminal's emergency plans.

There are also emissions controls in place at the terminal to address and mitigate potential emissions of H2S and mercaptan. These controls include internal floating roofs (IFRs) installed within the crude oil storage tanks. The IFRs are barriers that float on the liquid surface in the tanks to mitigate the release of volatile compounds into the air, and are required by state and federal regulations to reduce emissions of volatile organic compounds (VOCs) from tanks storing volatile products such as light sweet crude oil. In addition, vapor combustion units (VCUs) are installed at the marine dock to capture and treat vapors displaced while loading products onto marine vessels. Although these controls and treatment technologies are installed primarily to control emissions of VOCs, they are also effective and widely used in the industry as air emission controls for H2S and mercaptan vapor emissions.

D. Does Global have information of the Total Acid Number or TAN of the crude oil received at the Facility? If so, please provide that information. If the TAN is elevated, what steps are or should be taken to address potential corrosion and the risk of accidental release.

As mentioned in the response to Question B, Global typically uses methodologies adopted by the National Association of Corrosion Engineers (NACE) to evaluate the corrosivity of crude oil and other products. Total Acid Number (TAN) is another methodology commonly used to evaluate corrosivity. Information regarding the TAN of the crude oil received at the facility is available through the North Dakota Petroleum Council (NDPC). In May of 2014, the NDPC released the initial results of their Bakken Crude Quality Assurance Study (available at http://www.ndoil.org/resources/documents and included as Exhibit 2). The study demonstrated that the Bakken oil consistently exhibits TAN numbers well below that which would be considered corrosive. A report also released in May of 2014 from the American Fuel and Petrochemical Manufacturers Association entitled "A Survey of Bakken Crude Oil Characteristics Assembled for the U.S. Department of Transportation" (also included as Exhibit 2) also indicated that the Bakken Crude oil is not characteristically corrosive. The results of Global's NACE testing indicates the same.

The bulk storage tanks at the terminal undergo comprehensive 10 year inspections as recommended by the American Petroleum Institute and required by NYS Petroleum Bulk Storage regulations. These inspections are conducted by an inspector certified by the American Petroleum Institute (API) and include a detailed analysis of the corrosion rate of the tank shell. Following the inspection, and upon completion of any necessary repairs, the API inspector certifies that the

tank may be placed back in service for the next 10 year period, or other period as determined by the corrosion rate analysis. Were the facility to consistently store crude oil that exhibited an elevated NACE corrosion rating or TAN number, Global would consult with our certified API inspector to determine an appropriate inspection frequency for storage tanks and associated pipelines, as necessary.

E. **In its answer to Question #11, Global states, in part, that "At the Albany terminal, Global is permitted to receive, store and distribute a wide variety of petroleum products, including gasoline, diesel fuel, home-heating oil, kerosene, crude oil, and renewable fuels such as ethanol. Global is seeking to add handling of biodiesel at the Albany terminal, Global is also seeking to heat certain grades of products that are already permitted to be received, stored and distributed." In response to Question #23, Global states, in part, that "The types of crude oil shipped at the terminal will consist of Group 1, Group 2, Group 3 and Group 4 oils."**

Please provide an estimate of the minimum and maximum amounts of each type of petroleum product, by Group and by the categories used in the answer to Question #11 (e.g., ethanol, home-heating oil), that are expected to be received at the facility. With respect to crude oil, please also break down such estimates by Bakken crude oil, "tar sands" crude oil and the other major types of crude oil. Please also provide an estimate of the throughputs of each type of product and each Group, assuming the proposed modification is approved.

The potential types and volumes of products handled at the terminal can fluctuate and are based on the market conditions under which we operate and the limitations of our permits. Because of the rapidly changing nature of those markets, it is difficult to reliably and meaningfully predict the minimum and maximum amounts of each particular type of petroleum product or crude oil that will be handled at the terminal at any specific time. The volumes of products may vary from a minimum of zero gallons to a maximum of the specific volume limitations identified in our Title V Air operating permit.

It is important to note that the facility does not have the capacity to simultaneously maximize all of the permitted volumes of products in the Title V permit due to operational constraints; however, the terminal does currently have the capability and operational flexibility to achieve any of the individual throughput limits identified in the Title V Air Permit at any time.

F. **The first part of Question #12 was, "What actions does Global plan to implements to address any unique qualities associated with bitumen crude oil with respect to fires, explosivity, spill prevention and response and describe how these potential impacts to the community can be successfully avoided?" In addition to the discussion of prevention and response contained in Global's answer to Question #12, are there steps that can be taken to**

improve prevention and response to spills of bitumen crude oil, in light of its greater tendency to sink in water that lighter crude oils?

Global has a robust oil spill prevention and response program. We conduct extensive training in spill response and prevention and are contracted with National Response Corporation (NRC) as our primary Oil Spill Response Organization (OSRO). NRC is a premier OSRO and meets specific classifications under the EPA/USCG for response to spills of all types of oil including Group 5 (heavier than water) oils.

Global's commitment to spill prevention does not change with the types of oil we store. Our goal is to have no accidental releases of product to the environment. With respect to spill response associated with heavy crude oils, diluted products and/or higher specific gravity oils (which we have previously indicated may or may not fall under the EPA definition of a Group 3 or a Group 4 oil at the time of shipment), there are additional considerations that Global has undertaken in accordance with EPA and USCG regulations. These steps are summarized below.

a. Updated our Facility Response Plan (FRP) and associated Emergency Response Action Plan (ERAP) to account for Persistent Oils – this involved inclusion of Group 2 oils into our response plans and increasing the planning distance for identification and evaluation of vulnerable resources.
b. Subsequently updated the FRP and ERAP for Group 3 and Group 4 Oils – This update was recently completed and submitted to the DEC MOSF Staff on August 29, 2014. The update included completion of worksheets to plan for additional resources associated with response to a Worse Case Discharge of Group 3 or Group 4 Oils.
c. Coordinated with our Spill Responder – Prior to the August 29, 2014 update to the Response Plans, meetings were held with NRC to confirm they have the additional resources to respond to a Worse Case Discharge of Group 3 or Group 4 oil and can deploy those resources within the required timeframes.

We have also taken steps that go beyond what is required by regulation. Although the terminal is not subject to the planning requirements for Group 5 Oils at this time, Global is committed to having appropriate Group 5 response resources available through our OSRO. These additional resources are available to mitigate the impacts associated with the sinking component of the products we may store and transfer to marine vessels. These resources, as appropriate, are specified under the EPA Facility Response Plan Rule (Appendix E to Subpart 112 Section 7.6.1) and include: sonar, sampling equipment, or other methods for locating the oil on the bottom or suspended in the water column; containment boom, sorbent boom, silt curtains, or other methods for containing the oil that may remain floating on the surface or to reduce spreading on the bottom; and dredges, pumps, or other equipment necessary to recover oil from the bottom and shoreline.

G. Global's response to Question #19 states that vents on the railcars are opened only after offloading has begun, but does not explain when the vents are closed. Global should specifically describe when the vents are closed and explain whether and how its procedures ensure that vents are closed as soon as offloading ceases.

The railcar valves are closed upon confirming that the railcar is empty. Global's current procedures require that after the operators have confirmed that the flow has stopped from each railcar, the bottom discharge valve is shut, the railcar is gauged to confirm the car is empty, and the vent valve is closed. Usually one operator is stationed on the ground to close the bottom valve and a second operator is on the top of the railcar to verify the car is empty and to close the top valve.

H. Also in response to Question #19, Global explains that oils that can be pumped at ambient temperatures, such as Bakken crude, will not be heated. Global points out that it will check shipping papers to confirm the product that is contained in the railcars. What additional safeguards are proposed to ensure that lighter oil are not heated? Also, will Global be heating heavier crudes that have been diluted with "lighter end petroleum hydrocarbons" (See response to Question #10)? If so, what precautions will Global take to mitigate any risk of fire or excess emissions from the heating process.

Global has implemented operational procedures at the Kenwood Yard offloading facility to safely offload products. These operational procedures include close and repeated coordination with our rail carrier, and extensive training with our operators to ensure that the products we handle (ethanol and crude oil) are received and offloaded properly. Improper management involving the movement of products across the terminal can not only violate our permits but can result in large monetary losses due to inadvertent mixing of commodities. With respect to the issues identified in Question H, the following procedural elements are in place currently and will be used to safeguard against lighter oils being mistakenly heated.

- Rail Car Tracking – Coordination meetings are held each morning between our rail operations group and the management at the terminal. In the coordination meetings a daily operational plan is formulated to determine where and when railcars will be offloaded based on product content and what the anticipated schedule is for arrival of incoming shipments. This operational plan will include the number of railcars that require heating since these cars will need to be offloaded on the rail-spurs equipped with steam lines. Each day the operational plan will include the number of railcars to be heated and the operators will confirm that the proper number of cars is in place prior to heating or offloading the railcars on the rail-spurs equipped with the steam lines.

- Coordination with Canadian Pacific – Meetings are held with Canadian Pacific each morning to discuss the location and progress of rail shipments, and confirm the daily

operational plan discussed above. At this meeting, our rail operations group confirms the products being shipped and the anticipated schedule for the multiple shipments that may be in transit. Electronic notices are sent 22, 17, 12, 6 and 3 hours in advance of delivery of the rail cars to the terminal with a list of cars. The notices used to verify all cars and shipping documents for each car multiple times before the cars arrive. Any changes required to the daily operational plan are communicated back to the terminal.

- Work Procedures – Our current work procedures require that the operators must verify each railcar identification number against the tank car shipping list received from the railroad. No railcars are offloaded (nor will any railcars be heated) until they are confirmed against the tank car shipping list.

It is important to note that Global and the industry in general have evaluated the characteristics of the lighter oils (i.e. Bakken Crude Oil) at elevated temperatures. A report released in May of 2014 from the American Fuel and Petrochemical Manufacturers Association entitled "A Survey of Bakken Crude Oil Characteristics Assembled for the U.S. Department of Transportation" (See Exhibit 2) identified that the vapor pressures of Bakken Oil samples measured at 50 degrees Celsius (or 122 degrees Fahrenheit) were less than half the pressure vent settings on railcars which are typically set to trigger at 75 psi. This data indicates that even if a car in Kenwood Yard were inadvertently heated to the maximum proposed temperature outlined in the application of 120 degrees F, the pressure vent on the railcar would not be activated.

Global has included provisions in its air application to heat diluted heavy oils. If the characteristics of the products indicate that their viscosity meets a pipeline specification, then no heating is necessary, however, there are certain "underdiluted oils" that may require minimal heating. There are no additional fire precautions necessary, since these products are significantly less volatile, even when heated, in comparison to other products we currently handle. Similarly, handling of these minimally heated products results in less air emissions than other products that we handle. The emissions from heating of these products are fully contemplated in our air permit application and do not require any additional air emission controls. Furthermore, the emissions would not be considered "excess emissions" in the sense that they are not emissions beyond what is included in the air permit application.

I. **In response to Question #19, which also requests that Global "identify all procedures and tools that Global utilizes, or plans to utilize, to detect and repair leaks of air pollution of other fugitive emissions from any aspect of its operations." Global states that its daily inspections include "inspection of equipment for unanticipated liquid and vapor leaks," but it does not explain how the inspections are done. It also refers generally to monthly inspections. Please explain these daily and monthly inspections in more detail: What equipment/processes at Global are inspected on a daily/monthly basis? What tools are used for these inspections? What is the process for repairing leaks (e.g. how quickly are the leaks repaired)?**

The following is a more detailed description of the documented inspections conducted at the terminal to detect and repair vapor leaks and fugitive emissions. In general, it is our policy and practice to identify the cause and to repair leaks immediately. However, conditions may occur where leaks cannot be immediately repaired. EPA regulations recognize that not all vapor leaks can be immediately repaired and generally require notification to EPA and DEC if a response cannot be initiated within 5 days of discovery and/or the leak cannot be repaired within 15 days of discovery.

- Daily Shift Inspections – facility inspections are conducted twice per day. This inspection includes the truck yard and truck loading rack facilities, the rail loading and unloading facilities, the marine dock loading/offloading facility, the additive/chemical bulk storage tanks, the product pumps, and other oil transfer areas. These areas are evaluated for liquid and vapor leaks using sight/sound/smell as part of the inspection.

- Monthly SPCC Inspection – This is a comprehensive inspection of all the petroleum bulk storage tanks, associated piping, valves, flanges, and other appurtenances for leaks. Leak inspection of all equipment in gasoline service is required under the Leak Detection and Repair (LDAR) provisions of 40 CFR 63.11089 (Subpart BBBBBB). In addition to equipment in gasoline service, Global also conducts this inspection for equipment in other volatile product service including crude oil and ethanol.

- Monthly Loading Rack Inspection – This inspection is conducted on the truck loading rack as required under 40 CFR 60.502(j) (Subpart XX). The vapor collection equipment in each bay of the truck loading rack loading gasoline is inspected via sight/sound/smell to ensure that it is in good condition and not leaking.

- Quarterly Internal Floating Roof Inspection – Each IFR is visually inspected from the roof hatch of each tank containing an IFR in conformance with 40 CFR 60.112b (Subpart Kb). A meter is used to collect and analyze a sample of air from within the tank to confirm that the roof is operating as designed.

- Vapor Treatment Unit Inspections – The vapor recovery unit at the truck loading rack and the vapor combustion unit at the rail loading rack are inspected on a daily basis for proper operation and leaks via sight/sound/smell. The marine vapor combustion units are inspected prior to, and during, each barge loading. In addition, quarterly to semiannual preventative maintenance inspections are conducted by the manufacturer on the units to ensure proper operation. Periodic performance tests are conducted on all the vapor treatment units. During the performance tests, the vapor capture systems are tested for leaks following EPA established leak detection protocols.

- Railcar inspections – prior to offloading railcars, each car is inspected for vapor / liquid leaks in accordance with DOT requirements.

More than 75 inspections have been conducted by state and federal agencies at the Global Albany Terminal in 2014, including two in-depth surveys by the EPA using an infra-red camera for the specific purpose of detecting fugitive emissions. EPA also collected several air samples from the storage tanks and tank dike areas during these inspections, and DEC conducted a comprehensive air sampling program in Albany's South End Neighborhood. None of these inspections or the results of air sampling programs indicated that there were any abnormal fugitive emissions from operations at the terminal.

J. Indicate how the weight fraction in the vapor and liquid are derived, including sample calculations. Also, show how the molecular weights of the vapor and liquid fractions for each heated product are derived.

Information related to the weight factions and molecular weights in the vapor and liquid for each heated product was previously provided to the DEC Region 4 air permitting staff on August 5, 2014. Supporting EPA TANKS 4.09d reports were included. The provided memo detailed how liquid and vapor fractions were derived including sample calculations. Molecular weights were not discussed since the molecular weight of a compound, such as benzene, does not change (MW of Benzene = 78.11 g/mol). Established molecular weights of mixtures are from the EPA TANKS 4.09d program.

K. In its reply to Question #22, Global states that piping runs located outside areas with secondary containment are limited in scope and that Global relies on facility drainage to contain a spill from such piping. Please provide an assessment of the feasibility of adding containment or automatic leak detection to these areas.

As detailed in our May 2014 response, there is limited piping outside of traditional secondary containment areas on the non-transportation related portion of the facility, however, the topography and/or drainage systems in these areas are designed to control a spill. In addition, the marine dock piping on the transportation related portion of the facility is located outside of secondary containment and is pressure tested annually.

As mentioned in the response to Question I, our spill prevention practices include a wide array of daily, monthly and other inspections to identify issues with equipment and piping at the terminal. In addition, we conduct regularly scheduled preventative maintenance activities and closely monitor all transfer operations. We feel that the configuration of the terminal and the spill prevention practices in place meet an appropriate standard of care with respect to preventing a release of oil to the environment.

L. In reply to Question #23, Global states that its Facility Response Plan currently covers spill planning and response for Group 1 and Group 2 oils, but would need to be updated to include Group 3 and Group 4 oils if the permit modification were approved. How would Global increase its spill recovery capacity for Group 3 and 4 oil? Please confirm that Global does not currently handle type 3 and 4 oils at the Facility.

Please refer to the response related to Question F for information related to updating the response plans for Group 3 and Group 4 Oils. EPA regulations under Appendix E to 40 CFR Part 112 state that the planning requirements for Non-Persistent and Persistent Oils (including Group 3 and Group 4 oils) are applicable to the oils characteristics at the time of shipment. To the extent that Global has accepted limited railcar shipments of heavy oils or dilbits during calendar year 2014, the oils stored and marine loaded at the terminal have not met the characteristics of a Group 3 or Group 4 Oil.

M. Also in response to Question #23, Global states, in part, that "Although the terminal is permitted to store any type of crude oil, to ship Group 5 oils Global would need to conduct additional spill plan amendments and engineering analyses consistent with MOSF and API requirements." Does Global intend to accept Group 5 oils? If so, what additional steps would Global take to enable it to handle this product?

As mentioned in the response to Question L, EPA regulations under Appendix E to 40 CFR Part 112 state that the planning requirements for Non-Persistent and Persistent Oils (including Group 5 oils having a specific gravity equal to or greater than 1.0) are applicable to the oil's characteristics at the time of shipment. Global has not, and cannot currently store oils in its bulk petroleum storage tanks exceeding a specific gravity of 1.0. However, this does not preclude Global from accepting limited quantities of oils above a specific gravity of 1.0 and blending the product in a tank to maintain a specific gravity below 1.0. If Global were to store and ship Group 5 oils, an engineering analysis would need to be completed to reevaluate the maximum capacity of the storage tanks that would store the Group 5 oil and the Facility Response Plan would need to be updated to include the provisions contained in Appendix E to Subpart 112 Section 7.6.1.

N. In reply to Question #26, Global states, in part, that "Liability for damages during the transport of the oil is established by both statutory and common law and the terms of the applicable rail transportation agreements." Please provide copies of Global's rail transportation agreements with respect to the Facility.

With respect to the Department's request for rail transportation agreements, Global objects to the need or relevance of private confidential contracts in the Department's review of the pending application for the Boiler Project. The contractual agreements are highly confidential, as denoted in the title "confidential contract", and governed by a number of non-disclosure and confidentiality provisions. If the Department is able to articulate and provide a basis for why

these agreements are necessary and relevant to the ongoing permit modification process, Global can reach out to its rail partners, seek permission from those rail partners to release the document, as required by the agreements, and advise the Department whether or not Global can comply with its contractual obligations while disclosing the contract. Even assuming such disclosure would be permissible, Global would be required to redact trade secret and other confidential business information and seek confidentiality under the Department's regulations and the NY Freedom of Information Law. But, without an understanding of the need for, and relevance, of why the Department must have such contracts, [which are preexisting and unrelated to the Boiler Project application], Global cannot make disclosures prohibited by the agreement. Please provide us with the reasons why disclosure of the rail carrier contract is necessary and relevant to the pending permit modification.

O. Also in reply to Question #26, Global states that "... Global maintains insurance of various types with varying levels of coverage" with respect to certain specified shipments of crude oil. Does the insurance cover shipments of crude oil in locations other than the facility? Please specify which locations are covered.

Yes, Global maintains comprehensive general liability insurance, including property damage, bodily injury and pollution coverage, which covers rail shipments in transit from terminals operated, managed, leased or maintained by Global. Shipments in transit from third party locations are also covered, but only to the extent that Global is negligent.

P. Also in response to Question #26, Global states that "Global also maintains financial assurance required by the State Navigation Law." Please specify the mechanism(s) used to provide such financial assurance. Please clarify whether the only mechanism is insurance, as suggested in reply to Questions #28 and #29.

The mechanism used to provide financial assurance for our rail and terminal operations is insurance. Global maintains more than $100mm of comprehensive general liability insurance, including property damage, bodily injury and pollution coverage.

Thank you for your patience in allowing Global to provide this additional information in relation to the September 10, 2014 request.

Sincerely

Thomas F. Keefe
Vice President, Environmental, Health and Safety Operations

Enclosures

cc Dean Sommer, Esq.

EXHIBIT 1

REPRESENTATIVE BILLS OF LANDING

GeoMetrix
Empowered Logistics

STRAIGHT BILL OF LADING

Short Form - Railcar
Manual Billing

Bill of Lading
S1131

Equipment: **SHPX223455**

BOL Issue 09/04/2014 **Shipped** 09/04/2014

Ship in the Name of (Consignor):
GLOBAL PARTNERS LP
800 SOUTH ST
WALTHAM,MA
02453

Ship From (Origin):
BASIN TRANSLOAD LLC-STAMPEDE
10154 93RD AVE NW
COLUMBUS,ND
58727

Routing:
From:STAMPEDE,ND To:ALBANY,NY
Via:CPRS
Transmission Railroad:CPRS

Freight:PREPAID
Rule 11:NO
Carrier:CPRS Contract:

Consignee:
PHILLIPS 66 COMPANY
411 S KEELER AVE
BARTLESVILLE,OK
74004

Product:
UN1267, PETROLEUM CRUDE OIL,3, PG I
STCC:4910191
HMRC: 4910191

Care of Party:
GLOBAL COMPANIES, LLC
50 CHURCH ST
ALBANY,NY
12202

Send Freight Bill To:
GLOBAL PARTNERS LP
800 SOUTH ST
WALTHAM,MA
02453

Seal No's 8207604 8207605 8207606

Tank Car Capacity		Outage			Gross Volume Loaded	Loaded		Density @60°F	Net Volume		Net Weight	
		Outage Table	Inch	Outage Volume		Temp.	Coef.					
									720.39	BBL	204,848.8	LBS

Bill of Lading Notes:
608-137
CCN# 675104

THIS IS TO CERTIFY THAT THE ABOVE NAMED MATERIALS ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED AND LABELED AND ARE IN PROPER CONDITION FOR TRANSPORTATION ACCORDING TO THE APPLICABLE REGULATION OF THE DEPARTMENT OF TRANSPORTATION.

Certified by: Rick Pederson

24 Hour EMERGENCY CONTACT: For Chemical Emergency Involving Spill, Leak, Fire, Exposure or Accident in USA call CHEMTREC at (800) 424-9300

Per: _____

*****DANGEROUS****

Shipping Document - Straight Bill Of Lading

Shippers BOL No.	Revision
002732VH	0

FOR EMERGENCY CONTACT IN U.S. CALL CHEMTREC (CCN 681568) 800-424-9300

Car No: MULTI-CARS **Bill Type:** REVENUE **Ship Date:** 09/02/2014
Destination: ALBANY, NY **Origin:** NEW TOWN, ND
Routing: CPRS
Switching Info:

CareOf/ShipTo
GLOBAL COMPANIES LLC
50 CHURCH ST
ALBANY , NY 12202

Shipper
VAN HOOK CRUDE TERMINAL
3850 83RD AVENUE NW
NEWTOWN , ND 58763

Consignee
GLOBAL COMPANIES LLC
800 SOUTH STREET
WALTHAM F , MA 02454

Freight Charges
GLOBAL COMPANIES LLC
800 SOUTH STREET
WALTHAM , MA 02454

Lessee: **Sect 7:** NO

Freight: PREPAID **Fob:** **Rule-11:**

Reference No

AP- PLAINS MARKETING LP
333 CLAY STREET
HOUSTON, TX

RR Contract:

Product: PETROLEUM CRUDE OIL
STCC Code: 4910191

HAZMAT Information
UN1267// PETROLEUM CRUDE OIL//3//PGI
PG TESTING CONFIRMED 2014-07-24

Placards: PLACARDED FLAMMABLE

No. Of Packages: 2 RAILCARS **Seal No's:**

Car Capacity Gallons	Outage			Loaded - ORIGIN WEIGHTS							CERTIFIED OR TARIFF WEIGHT (SUBJECT TO CORRECTION)
	TABLE	INS	GAL+VC	GALLONS	UM	GRAVITY	TEMP	VCF	GALS@60	LBS/GAL	
U.S.									48,398		324,896
										LITRES	

Comments: BAKKEN CRUDE OIL

This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

BRIAN TROXEL
SIGNATURE

Shippers BOL Number
002732VH / 0

Product: PETROLEUM CRUDE OIL

Car Capacity Gallons	Outage			Loaded							CERTIFIED OR TARIFF WEIGHT (SUBJECT TO CORRECTION)
	TABLE	INS	GAL@VC	GALLONS	UM	GRAVITY	TEMP	VCF	GALS@60	LBS/GAL	
Car No: SHPX 212000											
U.S. 25,590	2075	9.000	1,321	24,232	GAL	44.00000	68.0	0.99579	24,269	6.7130	162,918
Seal No's: 1368714, 1368715, 1368716, 1962										LITRES	
Car No: SHPX 212235											
U.S. 25,500	2076	8.500	1,371	24,289	GAL	44.00000	69.0	0.99526	24,129	6.7130	161,978
Seal No's: 1368711, 1368712, 1368713, 1961										LITRES	

EXHIBIT 2

INDUSTRY GROUP STUDIES

BAKKEN CRUDE
QUALITY ASSURANCE STUDY

ABOUT THE RESEARCHERS

The North Dakota Petroleum Council (NDPC) commissioned Turner, Mason & Company and SGS Laboratories to study the range and variability of Bakken crude qualities. Turner, Mason & Company is an internationally recognized refining consultant with more than 43 years of experience in the petroleum and petrochemical industries. SGS Laboratories is a world leading testing and inspection company and has provided inspection, verification, testing, and certification services for more than 135 years.

METHODOLOGY

With cooperation from North Dakota producers and rail operators, a total of 15 well sites and 7 rail loading facilities covering the entire Bakken area were sampled and tested multiple times over a one month period, ending in late April. With more than 150 samples and a broad slate of tests conducted, this quality program is perhaps the most comprehensive of its kind for a U.S. oilfield ever.

Sampling began on March 25, 2014 and was completed on April 24, 2014. Seven samples were taken from each location, with well sites representing producers with more than 50 percent of total North Dakota production and well sites representing more than 50 percent of North Dakota rail capacity. Testing is now 95 percent complete and a final report on study results will be released in June.

Testing focused on parameters that are relevant to Department of Transportation (DOT) hazardous material compliance. The test slate includes:

- **API Gravity:** the density of liquid petroleum products. The API gravity is used to classify oils as light, medium, heavy, or extra heavy.
- **Vapor Pressure:** the pressure exerted by a vapor on the solid or liquid phase with which it is in equilibrium. In this case, it would refer to the liquids ability to hold gases rather than releasing them into vapor.
- **Flash Point:** the lowest temperature at which it can vaporize to form an ignitable mixture in air. Measuring a flash point requires an ignition source.
- **Initial Boiling Point (IBP):** the temperature a liquid will start form vapor in the air.
- **Sulfur weight:** measurement of the presence of sulfur in crude. A sweet crude has a low sulfur content and corrosivity while a sour crude has high sulfur content and higher rate of corrosivity.

STUDY RESULTS & BAKKEN CHARACTERISTICS SUMMARY

MEASUREMENT	CHARACTERISTIC	WHAT IT MEANS
API	The average weight for Bakken crude was 41.0°.	A light crude must have an API gravity of greater than 31.1°. The gravity for Bakken is as expected for light crude.
Vapor Pressure (PSI)	Average of 11.7	This is typical for a light crude and means it can safely be transported using existing DOT-111 tank cars. DOT-111 tank cars are designed to accept vapor pressures of up to 100 PSI, meaning even Bakken's maximum vapor pressure (14.4) is three times lower than the accepted threshold.
Flash Point	<73° F	This is consistent with a Class 3, flammable liquid of Packing Group I or II.
Initial Boiling Point	Avg.: 99.6°F Max: 107.2°F Min: 91.9°F	Bakken crude falls within the normal range for classification of a Packing Group I or II flammable liquid, and has been properly categorized, packed and transported as such. The study did identify flaws in the classification methodology, however, which are summarized below.
Sulfur Weight %	Avg.: 0.14	Bakken is a sweet crude low in sulfur and hydrogen sulfide and therefore not corrosive.

The study also showed that these qualities remained consistent throughout the Bakken field and did not change significantly during transit via rail to its destination more than 1,500 miles away. The study also found that the vapor pressure stayed within a relatively narrow range despite widely varying seasonal atmospheric temperatures.

CONCLUSION: The study confirmed that Bakken is a light, sweet crude with low corrosivity, and that it may be hauled safely using existing DOT-111 tank cars under current federal specifications.

STEPS FORWARD

The study also found that one of the tests DOT requires to determine the packing group for flammable liquids like crude oil is not optimal. The limitations of the test required for measuring initial boiling point can result in the same sample of crude being assigned to Packing Group I (<95°F IBP) or Packing Group II (>95°F IBP). The American Petroleum Institute is currently working to determine improved, more precise classification standards for assigning flammable liquid packing groups.

The data gathered by the study provides a thorough baseline of Bakken crude characteristics. NDPC recommends using study results to establish a new crude oil benchmark to complement existing benchmarks like WTI and Brent. The benefits of doing so would be threefold:

1. A benchmark will create a more accurate market price reference for buyers and sellers of crude oil
2. Producers and shippers will be compelled to follow specific field standards in order meet the BKN specifications; and,
3. It will ensure that proper Bakken oil characterization continues going forward.

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We keep North Dakota going strong

BKN QUALITY & SAFETY INITIATIVE

NDPC Bakken Crude Characterization Task Force
Presentation of Preliminary Results

Williston Basin Petroleum Conference
Bismarck, North Dakota - May 20, 2014

www.ndoil.org

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Key Findings

- Bakken Quality is very consistent
  - Typical Class 3 Flammable Liquid
  - Both well-to-well and throughout the supply chain
  - Little variation throughout entire basin
  - Shows no “spiking” with NGL’s before rail shipment
  - No practical changes in quality during transit
- Produced for over 60 years
  - Recently passed one billion barrel mark
  - Moved by rail, pipeline, truck
  - No corrosion noted by any stakeholder

Key Findings (continued)

- Very desirable to refiners
  - High transportation fuel yield (gasoline, jet fuel and diesel)
  - Low Metals/ConCarbon contents
- PHMSA mandated IBP test (D86) appears not to be the optimal test method for PG determination
  - Significant variability between labs on same sample
  - Not designed for wide boiling range material like crude oil
  - Other groups, including API, are working on recommendations

Why study was initiated?

- Address the following:
  - Measure true Volatility
  - Determine Classification: Flammable Liquid or Flammable Gas
  - Measure presence of subsidiary hazards
    - Corrosivity
    - H_2S Concentration
- All analyses conclude Bakken is properly classified as a Flammable Liquid
- Three studies all in agreement: NDPC, AFPM and Transport Canada

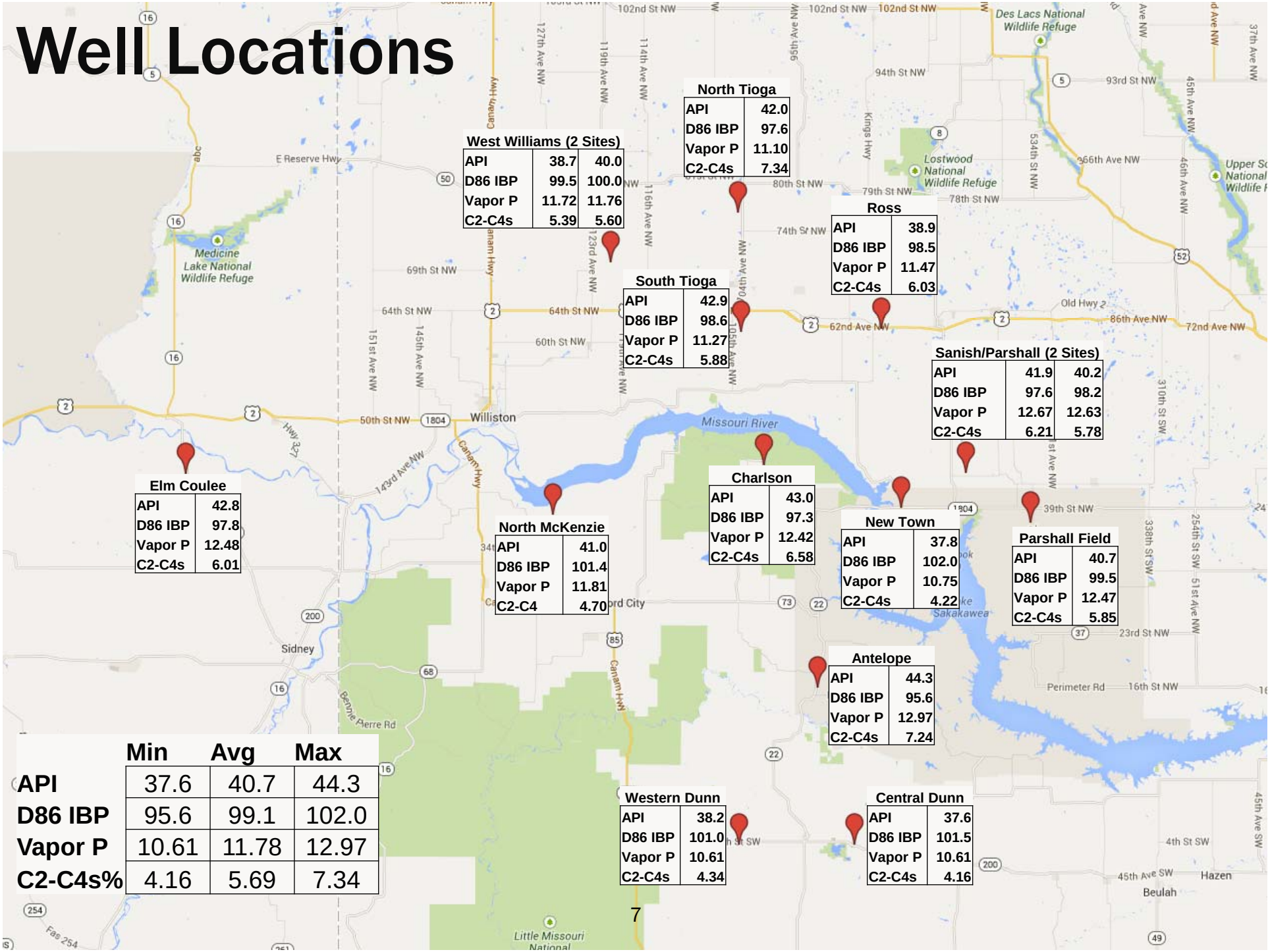
Project Contractors

- Turner, Mason & Company – Overall Project Coordinator
  - Internationally recognized refining consultants
  - 43 years in business
  - TM&C staff supplemented by outside expertise
- SGS - Sampling and Testing Contractor
  - World leading testing and inspection company
  - Over 135 years in business
  - Utilized both local and USGC laboratories
- Overall cost $400,000

Project Overview

- NDPC commissioned comprehensive sampling and testing program to establish quality baseline
- BKN crude sampled from both well and rail sites
  - 15 well sites and 7 rail-loading terminals
  - Well sites represent producers with over 50% of total ND production
  - Rail sites represent about 50% of total ND rail capacity
  - Significant geographic dispersion for both well and rail sites
- Sampling initiated on 3/25 and completed on 4/24
  - 7 samples at each site
  - Initial samples at well sites included both top and bottom
- Sampling Complete; Testing over 95% complete
  - 152 total samples – 103 from well sites; 49 from rail sites
- Supplemental data provided by member companies

Well Locations



North Tioga

API	42.0
D86 IBP	97.6
Vapor P	11.10
C2-C4s	7.34

West Williams (2 Sites)

API	38.7	40.0
D86 IBP	99.5	100.0
Vapor P	11.72	11.76
C2-C4s	5.39	5.60

Ross

API	38.9
D86 IBP	98.5
Vapor P	11.47
C2-C4s	6.03

South Tioga

API	42.9
D86 IBP	98.6
Vapor P	11.27
C2-C4s	5.88

Sanish/Parshall (2 Sites)

API	41.9	40.2
D86 IBP	97.6	98.2
Vapor P	12.67	12.63
C2-C4s	6.21	5.78

Elm Coulee

API	42.8
D86 IBP	97.8
Vapor P	12.48
C2-C4s	6.01

North McKenzie

API	41.0
D86 IBP	101.4
Vapor P	11.81
C2-C4	4.70

Charlson

API	43.0
D86 IBP	97.3
Vapor P	12.42
C2-C4s	6.58

New Town

API	37.8
D86 IBP	102.0
Vapor P	10.75
C2-C4s	4.22

Parshall Field

API	40.7
D86 IBP	99.5
Vapor P	12.47
C2-C4s	5.85

Antelope

API	44.3
D86 IBP	95.6
Vapor P	12.97
C2-C4s	7.24

Western Dunn

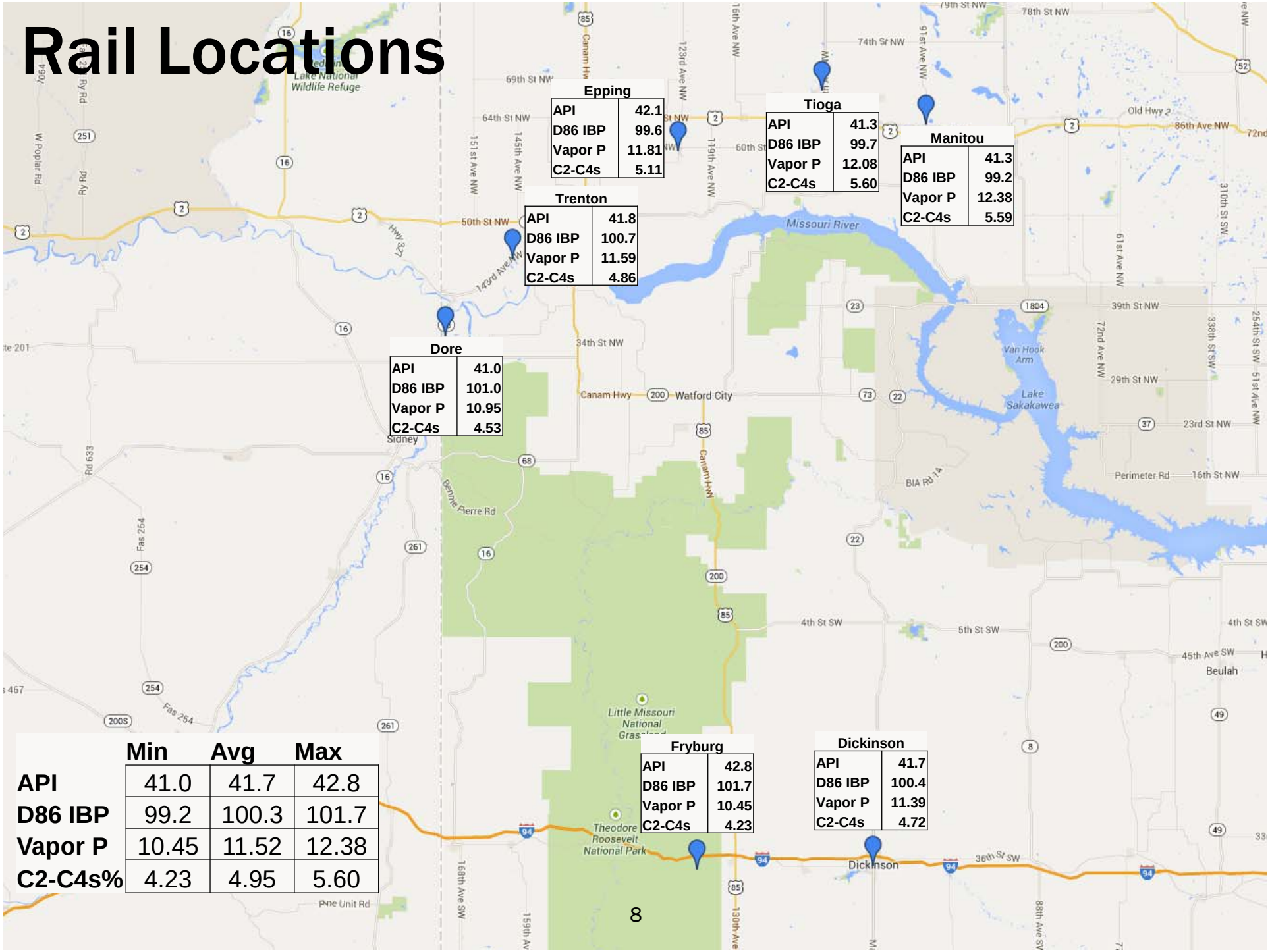
API	38.2
D86 IBP	101.0
Vapor P	10.61
C2-C4s	4.34

Central Dunn

API	37.6
D86 IBP	101.5
Vapor P	10.61
C2-C4s	4.16

	Min	Avg	Max
API	37.6	40.7	44.3
D86 IBP	95.6	99.1	102.0
Vapor P	10.61	11.78	12.97
C2-C4s%	4.16	5.69	7.34

Rail Locations



	Min	Avg	Max
API	41.0	41.7	42.8
D86 IBP	99.2	100.3	101.7
Vapor P	10.45	11.52	12.38
C2-C4s%	4.23	4.95	5.60

Testing Protocol

- Testing focused on parameters relevant to DOT hazardous material compliance
- The test slate included:
  - API Gravity
  - Flash Point by ASTM D3278
  - Initial Boiling Point (IBP) by ASTM D86
  - Vapor Pressure by ASTM D6377 at 37.8°C (100°F) *
  - Light Ends Analyses by IP344
  - High Temperature Simulated Distillation (HTSD) by ASTM D7169

* Results about 1 psi higher than if D323 RVP test method is used

Class 3 Flammable Liquid, Packing Group I or II

- Defined by Hazardous Materials Regulations (HMR) as having the characteristics:
  - Material is a liquid at 68°F (room temp.)
  - Material has Vapor Pressure <43.5 psig at 122°F
  - Flashpoint <73°F and:
    - Initial boiling point >95°F - Packing Group II
    - Initial boiling point < or =95°F - Packing Group I
  - Bakken = Flammable Liquid, PG I or II

Lab Result Summary

Sample Date Range Total (152 Samples)	3/25 to 4/24/2014 Avg	Min	Max
Ambient Temp (°F)*	34	10	65
API Gravity	41.0	36.7	46.3
Vapor Pressure (PSI)	11.7	8.9	14.4
D86 IBP (°F)	99.5 (PG II)	91.9 (PG I)	106.8 (PG II)
Light Ends (C2-C4s)	5.48	3.52	9.30
Rail (49 Samples)	**Avg**	**Min**	**Max**
Ambient Temp (°F)*	29	10	47
API Gravity	41.7	39.2	44.0
Vapor Pressure (PSI)	11.5	9.6	12.9
D86 IBP (°F)	100.3 (PG II)	96.7 (PG II)	104.1 (PG II)
Light Ends (C2-C4s)	4.95	3.91	6.44
Well (103 Samples)	**Avg**	**Min**	**Max**
Ambient Temp (°F)*	36	11	65
API Gravity	40.6	36.7	46.3
Vapor Pressure (PSI)	11.8	8.9	14.4
D86 IBP (°F)	99.1 (PG II)	91.9 (PG I)	106.8 (PG II)
Light Ends (C2-C4s)	5.76	3.52	9.30

←API/Vapor Pressure Typical For Light Crude Oil

Rail Cars Used Rated For 100 PSI Transport

←Packing Group Crude Currently Categorized/ Transported as Expected

*Some later samples missing Ambient Temp readings, may skew results colder

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Bakken Characteristics (Mar-Apr 2014)

- Average API Gravity of 41°
  - Consistent as a light crude oil
- Average Vapor pressure 11.5-11.8 psig
  - 61% below regulatory threshold
- Flashpoint <73°F
  - Consistent for flammable liquid, Packing Group I or II
- Initial Boiling Point midpoint 95°F
  - Consistent for flammable liquid, Packing Group I or II
- Low H2S & Total Acid Number (TAN)
  - No corrosivity

Class 3 Flammable Liquid, Packing Group I or II

- Defined by Hazardous Materials Regulations (HMR) as having the characteristics:
  - Material is a liquid at 68°F (room temperature)
  - Material has Vapor Pressure <43.5 psig at 122°F
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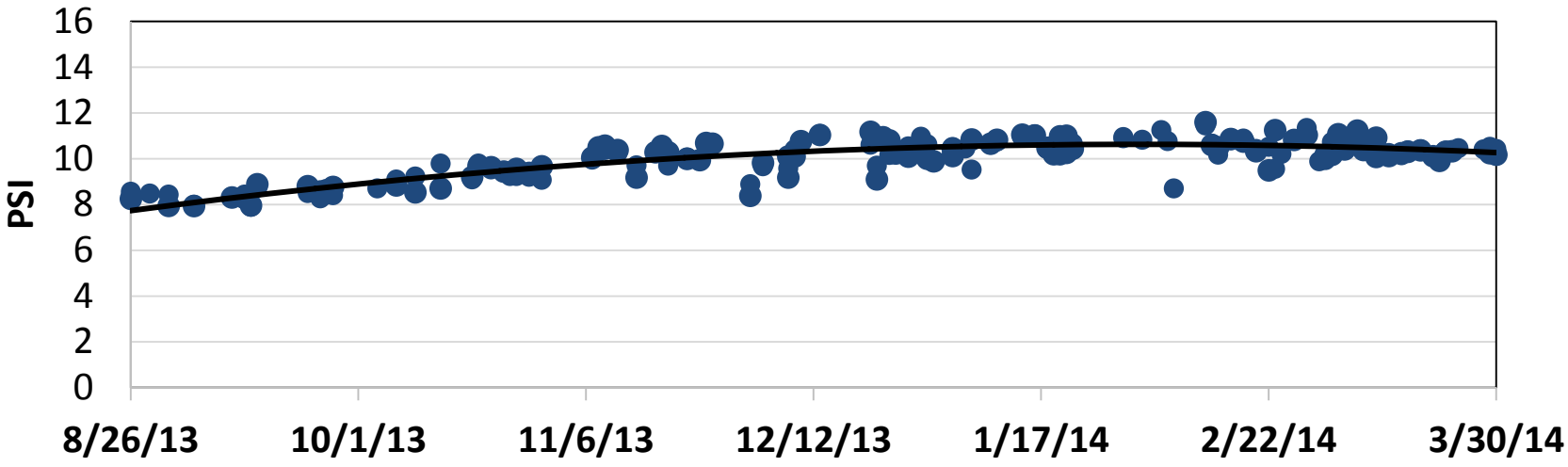
  - Flashpoint <73°F and:
    - Initial boiling point >95°F - Packing Group II
    - Initial boiling point < or =95°F - Packing Group I
  - Bakken = Flammable Liquid, PG I or II

Vapor Pressure

- BKN Average Vapor pressure 11.5-11.8 psig (Mar-Apr)
  - 61% below regulatory threshold
- Seasonality (Rail terminal data outside control data set)



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Vapor Pressure Seasonality

- While there was some variability to the data, it shows seasonal variation over a narrow range: 8 psi to 11 psi
- This was exactly as expected, with a predictable pattern of higher vapor pressure in the winter and lower vapor pressures in the hotter summer months
- Over this entire 7-month period, there were <u>no</u> unusually high values
- This study demonstrates a predictable, consistent crude oil stream

SGS/Intertek Round Robin Testing

- Three labs* tested four identical Bakken crude samples for the following:
  - API Gravity by ASTM D5002
  - Vapor Pressure of Crude at 37.8°C (100°F), 4:1 V/L Ratio, by ASTM D6377
  - Initial Boiling Point (IBP) by ASTM D86 distillation

*Two in North Dakota and one in Louisiana

Round Robin Testing - Summary

- Excellent agreement on API Gravity and Vapor Pressure
  - Supports sample integrity maintained throughout transport and good lab performance
- Poor agreement on D86 IBP
  - Results for the same sample in each case fall on either side of the 95°F level used for PG I/PG II determination
  - Underscores shortcomings of tests required by PHMSA
  - API committee studying this, as well as alternatives

Results – D86 IBP

- All samples fall within Class 3 – Either PG 1 or 2
  - Shipped on same rail cars, same EMS response
- PHMSA prescribed methodology may not be optimal test for crude oil
  - Not designed for wide boiling range materials like crude oil
  - As a result, poor agreement on Packing Group determination

		D86 IBP (°F)			
Sample Location	**Date @ Time**	**Intertek Mandan**	**SGS St. Rose**	**SGS Williston**	**Max Delta**
1	5/1/14 @ 16:30	89.9	95.4	101.8	11.9
2	5/1/14 @ 16:30	83.1	89.1	102.6	19.5
3	4/30/14 @ 16:00	87.8	90.7	105.5	17.7
4	5/1/14 @ 16:30	89.2	94.5	102.2	13.0

Is Bakken Corrosive?

- Hazardous Materials Regulations (HMR) defines a corrosive material as one that corrodes steel or aluminum at rate of 0.25 inch per year
- Bakken sulfur content is <0.14%
- Bakken has a Low* Total Acid Number (TAN)
- Bakken is not corrosive

*Bakken TAN is in the 0.1-0.2 mg KOH/g, comparable to WTI and lower than LLS, two common benchmark crudes.
Crudes below 0.5 are considered low TAN and rarely a concern. Crudes above 1.0 are considered high TAN, and require special refinery processing techniques.

Consistent Quality – Rail vs. Well

- Quality is consistent between well and rail
- Indicates there is no spiking of crudes before shipment

	Well	Rail
API Gravity	40.6	41.7
D86 IBP (°F)	99.1	100.3
Vap P D6330 (PSI)	11.8	11.5
Light Ends %		
Ethane	0.24	0.23
Propane	1.63	1.40
Isobutane	0.66	0.58
n-Butane	3.18	2.75
n-Pentane	2.92	2.72
C2-C4s	5.76	4.95
C2-C5	10.22	9.10

SimDist (°F)	Well	Rail
IBP	<97	<97
5%	107	114
10%	155	166
20%	233	239
30%	312	317
40%	396	397
50%	483	483
60%	574	574
70%	673	672
80%	787	789
90%	936	943
95%	1055	1061
FBP	1271	1278

Loading vs. Destination Testing

- 5 Railcars loaded in North Dakota - Discharged at St. James, Louisiana

Test	Units	Avg. ND Rail Terminal Car Samples	Avg. St. James Rail Terminal Car Samples	Avg. NDPC Data for Same Rail Terminal
VPCR 4 (37.8° C)	psi	10.47	10.61	10.45
IBP	°F	94.7	90.4	101.7
Flash Point	°F	<50	<50	<73
H2S in Vapor Phase	ppm v/v	<1	<1	
C2-C4s	Vol %	4.00	4.08	4.23
C2-C5s	Vol %	8.01	7.89	8.13

Key Findings

- Quality is very consistent
  - Both well-to-well and throughout the supply chain
  - Little variation throughout entire basin
  - Shows no “spiking” with NGL’s before rail shipment
  - No practical changes in quality during transit
- Very desirable to refiners
  - High gasoline, jet fuel and diesel yields
  - Very low TAN and metals/ConCarbon contents
- Produced for over 60 years
  - Recently passed one billion barrel mark
  - Moved by rail, pipeline, truck

Key Findings (continued)

- PHMSA mandated IBP test (D86) appears not to be the optimal test method for PG determination
  - Significant variability between labs on same sample
  - Not designed for wide boiling range material like crude oil
  - Other groups, including API, are working on recommendations

Remaining Work

- Analyze operating conditions/quality data
  - Ambient Temperatures
  - Separator and treater temps and pressures
  - Production rates/last movements out of tank
  - Tank heights
  - Vapor capture status
- Develop field operating standards at well site operations
- Final Report to be issued in late June
- Establish BKN Benchmark

Establish BKN Benchmark

- Define BKN specifications
- Value:
  - Create reference point for buyers and sellers
  - Producers will follow specific field standards to meet BKN specifications
  - Ensure proper BKN oil characterization, both now and in the future

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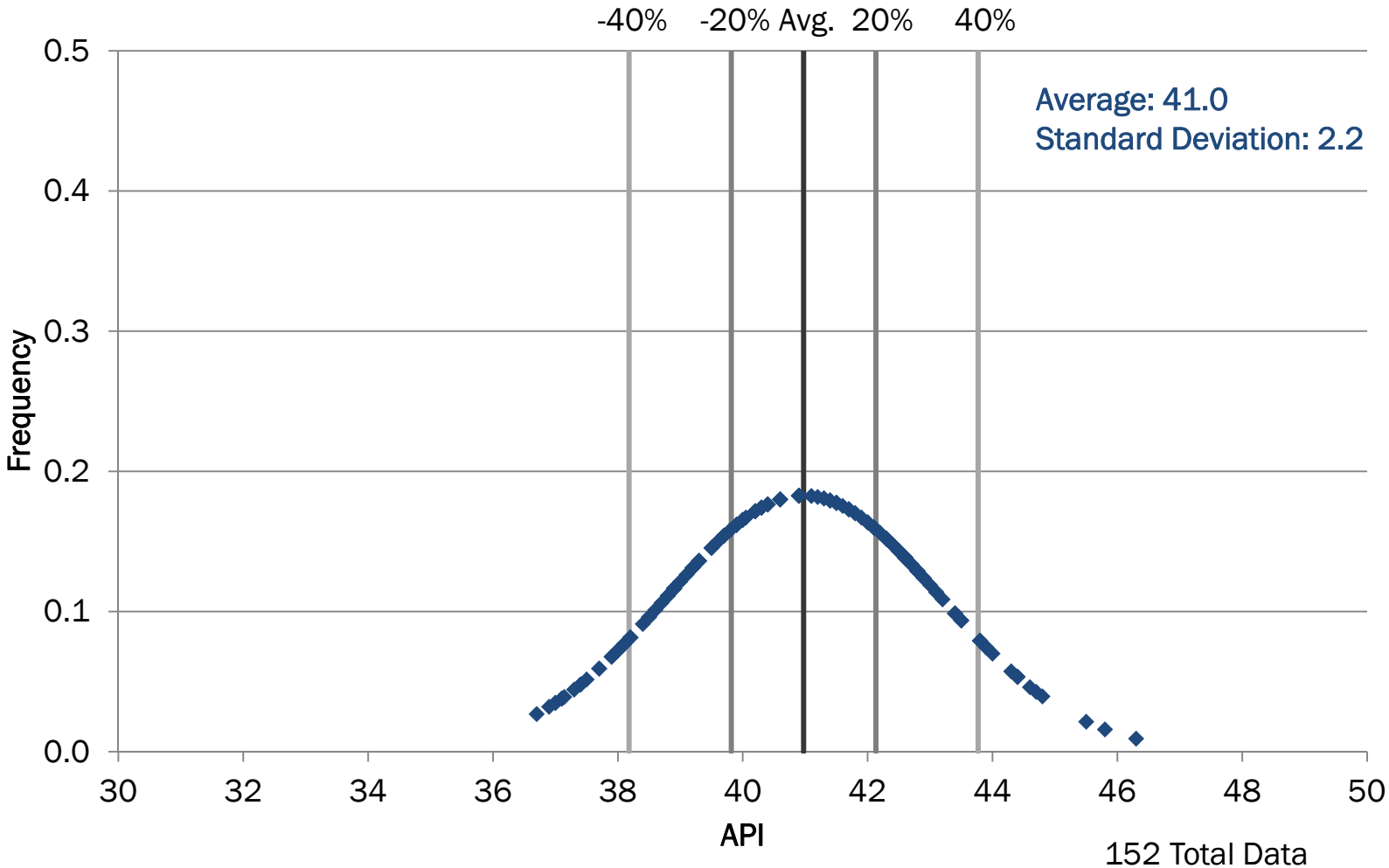
Discussion and Questions?

API Gravity



152 Total Data Points

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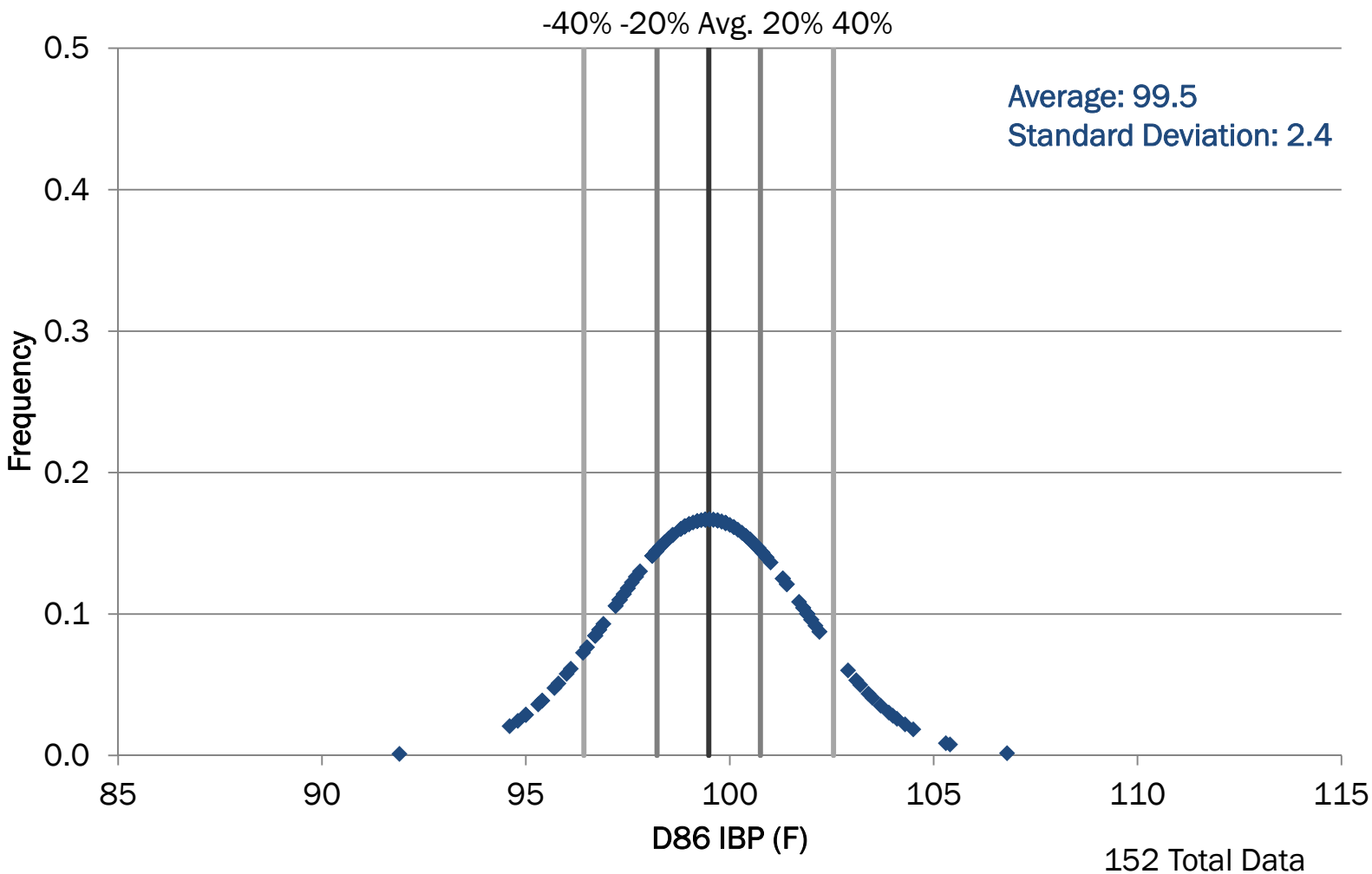
D86 IBP



152 Total Data Points

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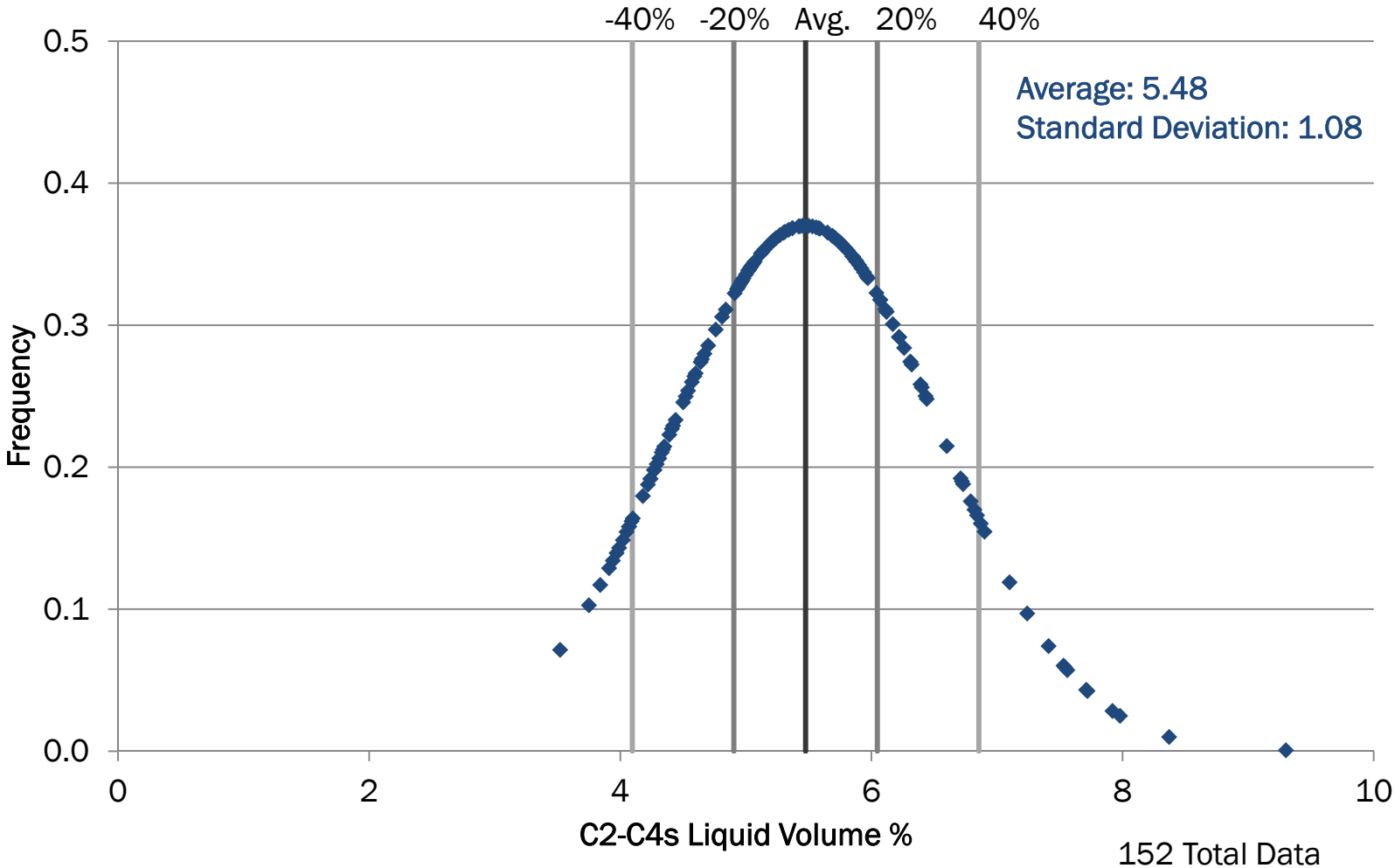
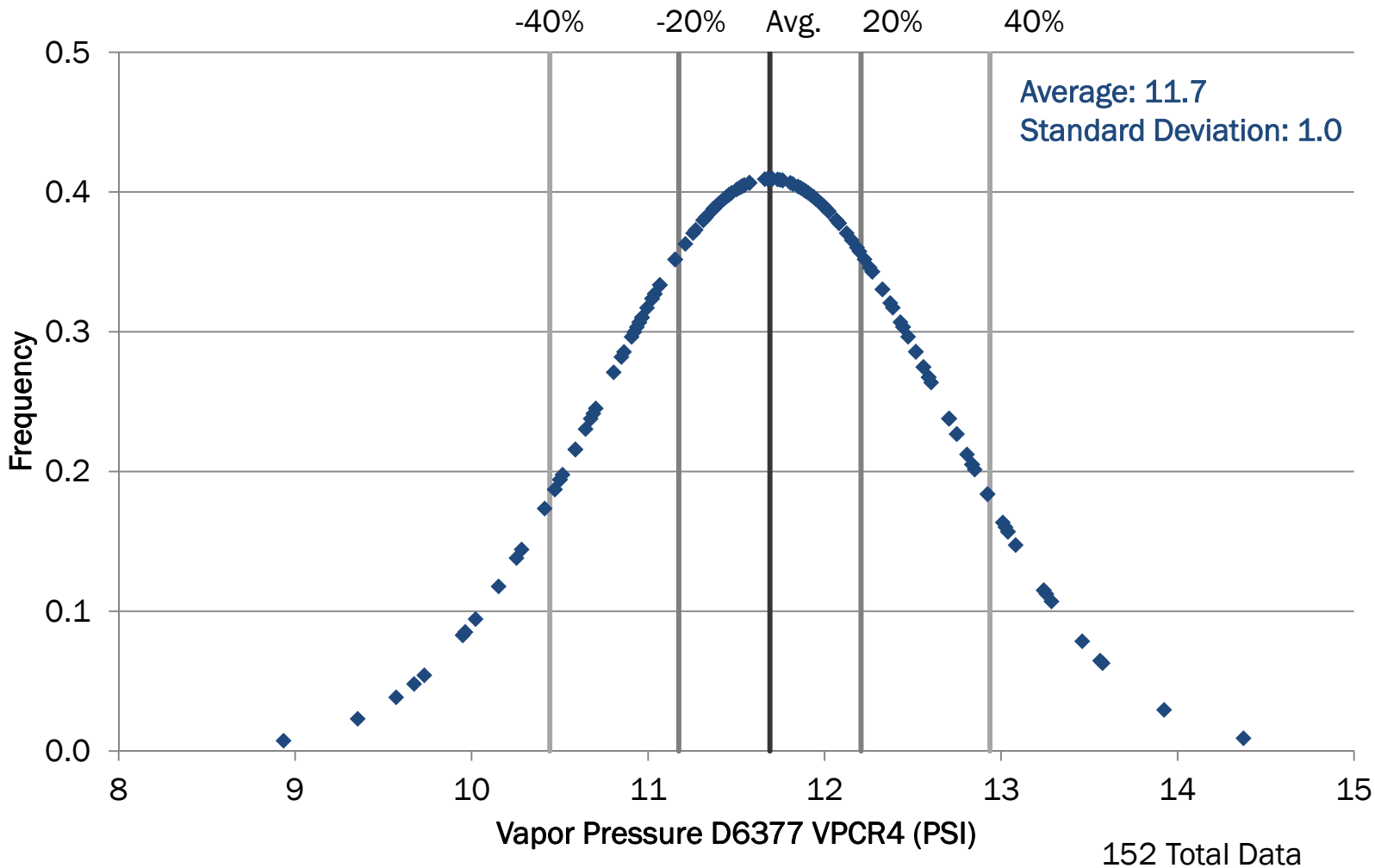
Light Ends (C2-C4s) Liquid Volume%



152 Total Data Points

Vapor Pressure (PSI)



152 Total Data Points

Results - API Gravity

- Excellent agreement across all three labs
- This indicates the integrity of the samples was well maintained, even upon shipping

		Density, D5002 (API Gravity)			
Sample Location	**Date @ Time**	**Intertek Mandan**	**SGS St. Rose**	**SGS Williston**	**Max Delta**
1	5/1/14 @ 16:30	40.2	40.2	40.2	0.0
2	5/1/14 @ 16:30	43.0	42.9	42.9	0.1
3	4/30/14 @ 16:00	43.6	43.6	43.6	0.0
4	5/1/14 @ 16:30	43.0	42.9	42.9	0.1

A Survey of Bakken Crude Oil Characteristics Assembled For the U.S. Department of Transportation

Submitted by

American Fuel & Petrochemical Manufacturers

Prepared by

Dangerous Goods Transport Consulting, Inc.

May 14, 2014

Table of Contents

Executive Summary: Summary Table on Bakken Crude Oil Characteristics Evaluated in AFPM's Survey

I. Introduction

II. Discussions on Transportation Considerations – Regulatory, Practice and Hazard Characteristics
Definitions of gas and liquid; Reid Vapor Pressure (RVP); Degree of hazard; Packing Group; Flammability; Initial boiling point; DOT flammable liquid classification criteria; Emergency Response; Flammable gases dissolved in liquids; Hydrogen sulfide; Light crude oils; Bakken crude oil; Crude oil processing.

III. Survey Results

A. Testing Used to Evaluate Bakken Crude Oils

B. Test Methods Used to Characterize the Hazards of Crude Oil

C. Reported Information and Test Results - Discussion and Range
Flashpoint; Initial boiling point; Vapor pressure of crude oil in transportation, tank car pressures; Flammable Gas Content; Hydrogen sulfide content; Corrosivity to metals.

D. Response to additional PHMSA Survey Question

IV. Summary Remarks

Appendix 1 Questions Posed by PHMSA, January 29, 2014

Appendix 2 PHMSA Field Office Questionnaire

Appendix 3 Paper submitted by Canada and the U.S. to the 45th session of the UN Subcommittee on the Transport of Dangerous Goods

Appendix 4 Test methods used to evaluate selected Bakken Crude Oil Characteristics

Appendix 5 Guide page 128 from the 2012 Emergency Response Guidebook

Appendix 6 Glossary of Terms and Acronyms

About the Author: This report has been prepared for AFPM by Frits Wybenga of Dangerous Goods Transport Consulting, Inc. Mr. Wybenga has more than forty years' experience in the field of hazardous materials transportation. In 1971, he became the first U.S. Coast Guard officer with formal training related to hazardous materials in the Port of Houston, Texas. In succeeding years, he worked for the USCG in Washington, DC on matters dealing with technical and regulatory issues on safety and environmental protection relating to transportation of hazardous materials in bulk in tank barges, petroleum tank ships, chemical tankers, and liquefied gas carriers. Based on extensive technical and international experience, in 1989, he assumed responsibility for leading international activities on the transport of hazardous materials for the DOT Research and Special Programs Administration (subsequently renamed the Pipeline and Hazardous Materials Safety Administration). He served as the head of U.S. delegations to the United Nations Subcommittee of Experts on the Transport of Dangerous Goods (UNSCETDG) from 1989 to 2004 and served as the UN Subcommittee vice Chairman for 8 years. In 2000, he became the Deputy Associate Administrator for Hazardous Materials Safety and remained in this position until retiring from DOT in 2005. Among other recognitions, his contributions to safety and environmental protection were recognized by two separate DOT Secretary Silver Metal Awards and two Hammer Awards signed by Vice President Gore. Since retiring from his DOT position, he continues to participate in the UNSCETDG, representing a range of non-governmental organizations. He has degrees in chemical engineering, environmental engineering and business administration. He qualified as a registered professional engineer (chemical engineering) in the District of Columbia in 1974. He may be contacted at fwybenga@dg-transportation.com.

Executive Summary

Recent incidents in the U.S. and Canada involving the transport of Bakken crude oil originating in North Dakota has focused considerable attention on the transportation of Bakken crude oil by rail. Questions have been raised as to whether Bakken crude oils pose substantially different risks than crude oils that have traditionally been transported. At the request of the Department of Transportation (DOT), the American Fuel & Petrochemical Manufacturers (AFPM) conducted a survey of its members to address questions posed by DOT and developed this report of its findings. In addition to obtaining responses to the questions DOT raised, as part of its survey, AFPM also collected data stemming from analysis of approximately 1400 samples of Bakken crude oil in order to better understand its properties.

This report assembles AFPM member responses to questions posed by DOT and provides summary data on Bakken crude oil characteristics and hazards based on the sample information collected. The results show that Bakken crude oil may appropriately be classified as a flammable liquid based on DOT and international transportation requirements.[1] Comparison of assay data on Bakken crude oil with data from non-Bakken crude oils indicates that Bakken crude oil is within the norm with respect to the hazard characteristics of a light crude oil. While Bakken crude (and other light crudes) may contain higher amounts of dissolved flammable gases compared to some heavy crude oils, the percentage of dissolved gases would not cause Bakken crude to be transported under a DOT hazard class other than Class 3 Flammable Liquid and does not support the need to create a new DOT classification for rail transportation. Flammable gas content correlates with vapor pressure. The maximum vapor pressure observed based on data collected was 61% below the vapor pressure threshold limit for liquids under the HMR; demonstrating that Bakken crude oil is properly classified as a flammable liquid. With one exception, hydrogen sulfide concentrations were found to be extremely low – below the Short Term Exposure Limits for workers established by OSHA regulations. In the exceptional case, concentrations were substantially higher. Where they exist, high hydrogen sulfide concentrations are addressed under existing transportation and workplace safety regulatory provisions without affect to rail tank car authorizations. Data and experience indicate there to be no basis for classifying Bakken crude oil as having a corrosivity risk as defined by DOT Hazardous Materials Regulations.[2]

The information provided confirms that Bakken crude oil does not pose risks significantly different than other crude oils or other flammable liquids authorized for rail transport. Bakken and other crude oils have been classified as flammable liquids. As noted, Bakken crude poses a lower risk than other flammable liquids authorized for transport by rail in the same specification tank cars. Measured tank car pressures show that even the older DOT 111's authorized to

[1] The United Nations Recommendations on the Transport of Dangerous Goods form the basis for DOT regulations and regulations used widely throughout the world.
[2] Title 49 of the Code of Federal Regulations Parts 105 to 180.

transport Bakken crude oil are built with a wide margin of safety relative to the pressures that rail tanks may experience when transporting Bakken crude oil.

Survey results are summarized below. Bakken crude oil currently is transported in compliance with the HMR as a Class 3 flammable Liquid in either Packing Group I, II, or III. In conclusion, there is no identifiable basis for regulating Bakken crude differently than other flammable liquids regulated by the DOT Hazardous Materials Regulations.

Summary Table on Bakken Crude Oil Characteristics Evaluated in AFPM's Survey

Characteristic	Reported Values	Hazmat Transportation Regulatory Implications
Flashpoint	Range: -59°C to 50°C	Bakken crude oils meet the criteria for Packing Group I, II, or III flammable liquids or as combustible liquids[3]
Initial Boiling Point	Range: 2.2°C to 66.9°C	Bakken crude oils with an initial boiling point of 35 °C or less meet criteria for Packing Group I flammable liquids; others for Packing Group II or III flammable liquids or combustible liquids according to flashpoint
Vapor Pressure at 50°C	Maximum: 16.72 psia	All Bakken crude oils have a vapor pressure below 43 psia at 50°C and must be transported as liquids
Reid Vapor Pressure at 38°C	Maximum:15.4 psia	Not used by the regulations; confirm the vapor pressure at 50°C is well below the above 43psia limit and Bakken crude oils must be transported as liquids.
Rail tank car pressures on delivery	Maximum:11.3 psig	Demonstrates that Bakken crude may be safely transported in DOT specification 111 tank cars [4]
Flammable gas content	Maximum:12.0 liquid volume %	None; with the vapor pressures of all Bakken crudes oils examined not exceeding a vapor pressure of 43 psia at 50°C, all Bakken crude oils examined must be transported as liquids
Hydrogen sulfide content in the vapor space	Most reported H_2S concentrations were below the OSHA STEL; one reported a maximum level of 23000 ppm	None when low values are experienced; additional hazard communication to warn of the presence of H_2S when inhalation hazard levels are encountered[5]
Corrosivity	NACE B+ or B++	Data and experience indicate that Bakken crude oil does not corrode steel at a rate of ¼ inch per year or more so that Bakken crude oil is not a corrosive liquid

[3] *Note* the Bakken crude data submitted included only one sample that qualified as a combustible liquid, which has a lower risk than other flammable liquids.

[4] §179.201-1 provides summary specifications for DOT-111 rail tank cars. Earlier DOT 111's were designed to a 240 psig burst pressure whereas later designs are designed to a minimum burst pressure of 500 psig. Based on §179.15(b)(2)(ii) the minimum pressure relief valve settings for tank cars with a minimum burst pressure of 240 psig is 35 psig and for 500 psig designs the minimum setting is 75 psig.

[5] See §172.327.

I. Introduction

The American Fuel & Petrochemical Manufacturers (AFPM) is an industry association representing virtually all of the petroleum refiners and petrochemical manufacturers throughout the United States. The fuel and petrochemical manufacturing industries have a strong commitment to safety as well as environmental protection, and strive for opportunities to enhance safety and environmental protection. AFPM members depend upon a plentiful, affordable supply of crude oil as a feedstock for the transportation fuels and petrochemicals that they manufacture. Approximately 11 percent of the crude oil processed by AFPM members is transported by rail.

As manufacturers, AFPM members acquire crude oils from multiple sources, including crude oil produced from the Bakken formation. Based on concerns expressed by the U.S. Department of Transportation (DOT) over the properties of Bakken crude oil being transported by rail, AFPM, at DOT's request, conducted a survey of its members in an effort to characterize various hazard characteristics that could be relevant to the transportation of Bakken crude oils. For comparison purposes, the properties of crude oils from other fields were also considered.

Bakken crude oil is derived primarily from northwestern North Dakota and to a lesser extent northeastern Montana, and the bordering Canadian provinces of Manitoba and Saskatchewan. Due to the lack of pipeline infrastructure, Bakken crude oil is transported extensively by rail. The data submitted in response to the survey demonstrates that Bakken crude oil is properly transported in accordance with the DOT Hazardous Materials Regulations (HMR) as UN1267 Petroleum Crude Oil, or NA1993 Combustible Liquid, NOS.

Survey Scope

The initial questions posed to AFPM by DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) on January 29 are attached in Appendix 1 to this report. PHMSA personnel in a regional office posed additional questions to AFPM members and these are attached in Appendix 2. These two sets of questions formed the basis for the survey conducted by AFPM. More recently, the experts from Canada and the United States to the United Nations Subcommittee of Experts on the Transport of Dangerous Goods submitted a formal document noting recent rail transport incidents involving Bakken crude oil and soliciting the input of the Subcommittee as to whether crude oil such as Bakken crude oil derived from fracking operations posed a different degree of risk than other crude oils.[6] To the extent possible this report also responds to questions raised in the UN paper.

This report compiles information provided by 17 AFPM members who participated in the survey. Data analysis focused on Bakken crude oil as transported. Bakken data stems from sampling at loading points at well head locations, intermediate collection facilities (distribution

[6] A copy of the UN Paper is reprinted in Appendix 3.

centers) at which crude oil may be loaded into rail tank cars and at refinery locations taking receipt of crude oil after a rail journey. Data on approximately 1400 samples of Bakken crude oil was taken into account.

II. Discussions on Transportation Considerations – Regulatory, Practice and Hazard Characteristics

While PHMSA's Bakken Blitz data collection is ongoing, PHMSA staff has suggested that Bakken crude oil is different from other crudes oils that have traditionally been transported by rail in the United States. The Canada/U.S. UN paper reiterates this opinion concerning Bakken crude oil stating, "[t]his mostly 'younger' crude is being found to contain significantly higher 'light ends' than what has been traditionally transported as UN 1267." Again referring to crude oils like Bakken crude oil, the UN paper goes on to suggest, "lighter crude oil with a higher quantity of dissolved flammable gases pose a significantly different risk than heavier crude oils that do not have such a high constituency of more volatile components." Against this background, it may be instructive to first examine some relevant regulatory requirements, related crude oil hazard characteristics, and transport practices, particularly as they relate to Bakken crude oil.

Definitions of gas and liquid.[7] The HMR base the definition of a gas on whether a substance is a gas at 20°C (68°F). Substances with a vapor pressure of more than 300 kPa (43.5 psia) at 50°C (122°F) are also considered as gases irrespective of whether any liquid is still present at that temperature. Substances that have a vapor pressure of not more 300 kPa (43.5 psia) at 50°C (122°F) and with a melting point at or below 20°C (68°F) are generally considered liquids. Crude oil, including Bakken crude oil, is properly classified as a liquid – irrespective of light end concentration – provided its vapor pressure is not more than 300 kPa (43.5 psia) at 50°C (122°F). The AFPM survey confirms that vapor pressures of Bakken crude oil are well below the 300 kPa at 50°C (122°F) limit and are properly transported as liquids under the HMR.

Reid Vapor Pressure (RVP). Reid vapor pressure is a common measure of a substance's vapor pressure at 100°F (38°C). The RVP of crude oil increases with the increasing presence of flammable gases and other volatile flammable liquid components (e.g., pentanes).

Up until 1990, prior to harmonization of the HMR with international regulations, the HMR used RVP in place of the 300 kPa at 50°C (122°F) criterion for differentiating between a liquid and a gas.[8] A substance with an RVP of 40 psia or less was regarded as a liquid. In addition, earlier editions used flashpoint and RVP as a basis for identifying authorized packagings, including authorized rail tank cars, for various flammable liquids. Then, §173.119 differentiated substances with an RVP of 16 psia or less from more hazardous substances with RVP's between

[7] *See* 49 CFR § 171.8.
[8] 49 CFR §173.119 (1990 ed.).

16 and 27 psia and 27 and 40 psia; and used an RVP of 40 psia as the threshold for use of DOT specification 111 tank cars. It is noteworthy that Bakken crude oil RVP values obtained in this survey were all less than 16 psia so that the corresponding crude oils would all have been subject to earlier HMR packaging requirements appropriate for the two prior lowest hazard flammable liquid categories.

RVP continues to be used by other regulatory agencies and the petroleum industry. For example, U.S Coast Guard (USCG) regulations for tank ships and tank barges still use a 40 psia RVP criterion for differentiating between liquids and gases in the case of petroleum products, including crude oils. The USCG regulations permit substances to be transported in integral tanks (i.e., gravity tanks not designed for any appreciable pressure) when regarded as liquids (i.e., RVP of 40 psia or less).[9]

Though no longer used in the HMR, the considerable information on the RVP of Bakken crudes serves to provide insight into the characteristics of crude oils derived from the Bakken formation. The current regulatory limit of 300 kPa at 50°C is only marginally different from RVP in the case of crude oils so that RVP values may be deemed a close approximation of the vapor pressure at 50°C (122°F).

Degree of hazard. The HMR vary the stringency of requirements according to the degree of risk various substances pose in transportation. Many hazards, including the flammability hazard of liquids, are subdivided into three risk levels:

Packing Group I – encompasses substances regarded as posing a high hazard level;
Packing Group II – encompasses substances regarded as posing a medium hazard level; and
Packing Group III – encompasses substances regarded as posing a low hazard level.

Packing Group as it pertains to rail transport. While Packing Group is commonly used in the HMR for purposes of tiering the severity of regulatory requirements, in the case of rail transport of crude oil, it should be noted that DOT 111 rail tank cars are authorized for transporting Packing Group I, II and III crude oils under UN1267.[10] DOT 111's are widely used for transporting Bakken crude oil. While the HMR also authorize AAR Class 206 rail tank cars for Packing Groups II and III crude oil, these are legacy tank cars with few remaining in service. As such, Packing Group, in practice, has little to no impact on the integrity of rail tank cars used in transporting Bakken crude oil since DOT specification 111 tank cars are in common usage.[11]

DOT regulations and publications suggest that Packing Group is a secondary consideration in the case of emergency response. HMR placarding and rail tank car markings requirements, which are intended to communicate essential emergency response information, to emergency responders in the event of an accident or incident, do not communicate the Packing Group of the

[9] *See* 46 CFR §§ 30.10-22 (definition of a flammable liquid) and 30.10-39 (definition of a liquefied flammable gas).
[10] *See* 49 CFR §§ 173.242 and 173.243.
[11] For combustible liquids AAR 203W (less than 100) and 211W (less than 1100) tanks are also authorized.

hazmat involved. Further, the 2012 Emergency Response Guidebook (ERG)[12] does not take Packing Group into account when advising emergency responders on immediate first response measures.

The HMR require shippers to include the Packing Groups of hazardous materials on shipping papers and for rail transport this second level information for crude oil and other hazardous materials is available to emergency responders by accessing the train consist.[13] Bakken crude is described on shipping papers (or the train consist) depending on Packing Group in the following concise well recognized format:

- UN1267, Petroleum crude oil, 3, I;
- UN1267, Petroleum crude oil, 3, II; or
- UN1267, Petroleum crude oil, 3, III.

When Bakken crude oil is transported in DOT 111 rail tank cars, as is common practice, the difference in shipping paper descriptions is the only regulatory difference distinguishing Packing Group I, II or III Bakken crude oils as they are transported by rail.

Flammability. Flammable gases and vapors will ignite when they are mixed with air in certain concentration ranges. The lowest temperature at which flammable liquids produce vapor in sufficient amounts to support combustion is termed the liquid's *flashpoint*.

Under DOT and international regulations, a flammable liquid is a liquid that has a flashpoint of less than or equal to 60°C (140°F). Flammable liquids with a flashpoint of 23°C (73°F) or less are assigned to either Packing Group I or II. In essence, the flashpoint limits of 23°C (73°F) and 60°C (140°F) for flammable liquids indicate whether a substance has:

- Potential of producing a flammable vapor under moderate ambient temperature conditions – i.e., 23°C (73°F); or
- Potential of producing a flammable vapor under the most extreme ambient temperature conditions – i.e., 60°C (140°F).

Under the HMR, a flammable liquid with a flashpoint in the range of 38°C (100°F) and 60°C (140°F) may also be regarded as a combustible liquid, reflecting that such substances have a lower risk of igniting. Combustible liquids also include liquids with a flashpoint up to 93°C (200°F).

Except for classification under the HMR, flashpoint is not commonly used to characterize crude oil. Testing for flashpoint is an inherently dangerous test to conduct even under controlled laboratory conditions. Given the specific threshold values in the HMR, measurement of an exact

[12] The ERG is periodically prepared and published jointly by DOT and the governments of Canada and Mexico. Registration fees collected from hazmat shippers and carriers in accordance with 49 CFR Subpart G support its wide distribution to emergency responders in the U.S.
[13] *See* 49 CFR §§ 172.202(a) and 174.26.

flashpoint value is not required. For compliance with the HMR, it is important to know what range of values the flashpoint of a particular crude oil falls into (e.g.; 23°C or less) – not the specific flashpoint value. For this purpose, approximation methods may be used (e.g.; chromatography or calculation methods). This may be common practice in the case of routine screening of crude oil shipments. Test methods identified by the HMR are typically not valid for substances below -30°C (-22°F); and approximation methods may have been used in producing some of the flashpoint data discussed in this report.

While there is no regulatory limit on how low the flashpoint of a flammable liquid may be, diethyl ether, a Packing Group I flammable liquid transported as a pure substance, has a flashpoint of -45°C (-49°F).

Initial boiling point. The HMR and international regulations use initial boiling point as a classification criteria. Boiling point is considered indicative of a substance's volatility or its propensity to form flammable vapor plumes in air. Plume formation could occur after a spill of a flammable liquid when a fire is not involved. Increasing volatility leads to the formation of larger flammable vapor plumes. A lower boiling point generally implies increased volatility. As such, boiling point is used to evaluate the degree of risk a flammable liquid poses. The larger the flammable vapor plume a flammable liquid is capable of forming when spilled, the more dangerous it is considered to be, since the size of the plume affects the probability that flammable vapors will reach an ignition source and ignite. Predicting the size of a plume a particular liquid produces involves complex calculations accounting for ambient conditions and many other properties of a substance. Since boiling point is widely available, it is used as an approximation for gauging a substance's volatility. The HMR use *initial boiling point* as the basis for a differentiating between substances that have a Packing Group I high hazard risk (i.e., an initial boiling point of less than 35°C (95°F)) or a Packing Group II medium hazard risk.

Pure substances have a single boiling point and boil off completely at one temperature. Mixtures of flammable liquids made up of various components, like crude oil, boil over a temperature range. The more volatile components (e.g., dissolved gases in the case of crude oils) will boil off at the initial boiling point leaving less volatile components with higher boiling points in the liquid. Increasingly higher temperatures are required to boil off remaining components. Subsequent less volatile and less dangerous (from a flammability perspective) fractions of a liquid mixture may not boil off until significantly higher temperatures are reached. An assay of a Bakken crude oil indicates a boiling point range spanning approximately 500°C. From a flammability/volatility perspective, in comparing a pure substance with a flammable liquid mixture with the same initial boiling point, the pure substance is more volatile and more dangerous.

DOT flammable liquid classification criteria. The HMR and international regulations classify flammable liquids into three Packing Groups as follows:

Packing Group	Flash point (closed-cup)	Initial boiling point
I		≤35 °C (95 °F)
II	<23 °C (73 °F)	>35 °C (95 °F)
III	≥23 °C, ≤60 °C (≥73 °F, ≤140 °F)	>35 °C (95 °F)

Emergency Response. An important function of the HMR is to provide hazard information to emergency responders in the event of an accident or incident involving a hazardous material in transportation. The HMR hazard classification requirements result in the assignment a hazard class (e.g., flammable liquid), assignment of a UN number and proper shipping name and assignment of Packing Group. These determinations in turn lead to requirements for labeling and placarding to pictorially communicate the various HMR hazards, package markings to convey the UN number and proper shipping name, and shipping paper requirements providing additional information on the details of a hazardous material shipment.

The 2012 Emergency Response Guidebook (ERG) is intended to supplement hazard communication information provided on packages and shipping papers. It is intended for use by emergency responders first arriving on the scene of an accident or incident. First responders include law enforcement personnel and fire department personnel – both professionals and volunteers. DOT distributes the ERG widely throughout the United States with the objective of making it available to every potential first responder. The frequency of hazardous materials accidents and incidents is rare so that on average a first responder is expected to encounter less than one incident in a career. As such information must be basic and understandable to those who have a low probability of encountering a hazardous materials accident or incident.

The ERG serves this purpose. Through the UN number or proper shipping name of a substance, a first responder is able to access instructions on what steps to take upon arrival at the scene of an accident or incident. For crude oil assigned to UN 1267 Petroleum crude oil, irrespective of Packing Group, or crude oil meeting combustible liquid criteria and transported under NA 1993 Combustible liquid, NOS, guide page 128 of the ERG provides a first responder with the appropriate information (see Appendix 5). In this respect, it is important to note that the range of crude oils subject to the HMR (i.e., crude oils of Packing Groups I, II and III and combustible liquid crude oils) are addressed by one set of instructions made available to first responders. The same guide page is applicable to many other flammable liquids independent of the degree of hazard.

Flammable gases dissolved in liquids. Gases typically dissolve to some degree in liquids. For a given temperature, the amount of gas that dissolves in a liquid is directly proportional to the partial pressure of the gas in equilibrium with the liquid. The amount of gas that can dissolve in a liquid increases with pressure and decreasing temperature. For this reason, soda in a bottle bubbles when the top is removed as carbon dioxide held in the liquid is released as a gas because the bottle pressure no longer holds the carbon dioxide in the liquid. The same happens with crude oil where flammable gases such as methane, ethane, propane and butane, held in solution under high pressure underground, are released as the pressure is decreased when it is brought to the surface and stored. If stored at a low temperature, crude oil will retain more gas than if stored at a higher temperature.

Crude oil taken from the wellhead and placed in a stabilization tank continues to release dissolved gases until an equilibrium concentration between the gas dissolved in the crude oil and the concentration of the gas in the tank vapor space is reached.

The DOT definition of a gas places a regulatory limit on the amount of flammable gas that may be held in crude oil in transportation. If a crude oil had a vapor pressure in excess of 300 kPa at 50°C (122°F) due to a high dissolved gas concentration, it would be regarded as a gas and not as a liquid.

In some cases the HMR explicitly permit some quantities of certain gases to be transported in liquids. For example, up to 30% ethylene oxide (a toxic and flammable gas) may be transported in propylene oxide (a liquid) under UN 2983 Ethylene oxide and propylene oxide mixtures.

Hydrogen sulfide. In a pure form hydrogen sulfide is a gas and is regulated as a toxic and flammable gas under the HMR and OSHA regulations. Crude oil commonly contains some amount of sulfur. It may be present in hydrocarbon molecules (e.g., mercaptans) or as hydrogen sulfide dissolved in the liquid. The chemical/thermal and biological breakdown of the sulfur bearing hydrocarbon molecules in crude oil, as it is brought to the surface and is stored, may lead to increased evolution of hydrogen sulfide gas in crude oil liquid and vapor.

When a crude oil contains concentrations of hydrogen sulfide at levels that may present an inhalation hazard, the HMR require communication of its presence. Bakken crude oil is generally considered a sweet crude and the survey data confirm that sulfur and hydrogen sulfide concentrations are normally low. However, exceptions were noted in the case of one respondent.

Light crude oils. Light crude oils are generally regarded as those crude oils with an API gravity of 37 degrees or more. API gravity varies inversely with specific gravity so that increasing API gravity values reflect decreasing specific gravity or density. Light crudes tend to have higher concentrations of light ends (i.e., methane, ethane, propane, butanes and pentanes). The presence of increasing amounts of dissolved gases and other light ends (i.e., pentanes) has the effect of increasing the crude oil's vapor pressure, lowering its flashpoint and lowering its initial boiling point. Light crude oils may qualify as Packing Group I, II or III flammable liquids under the

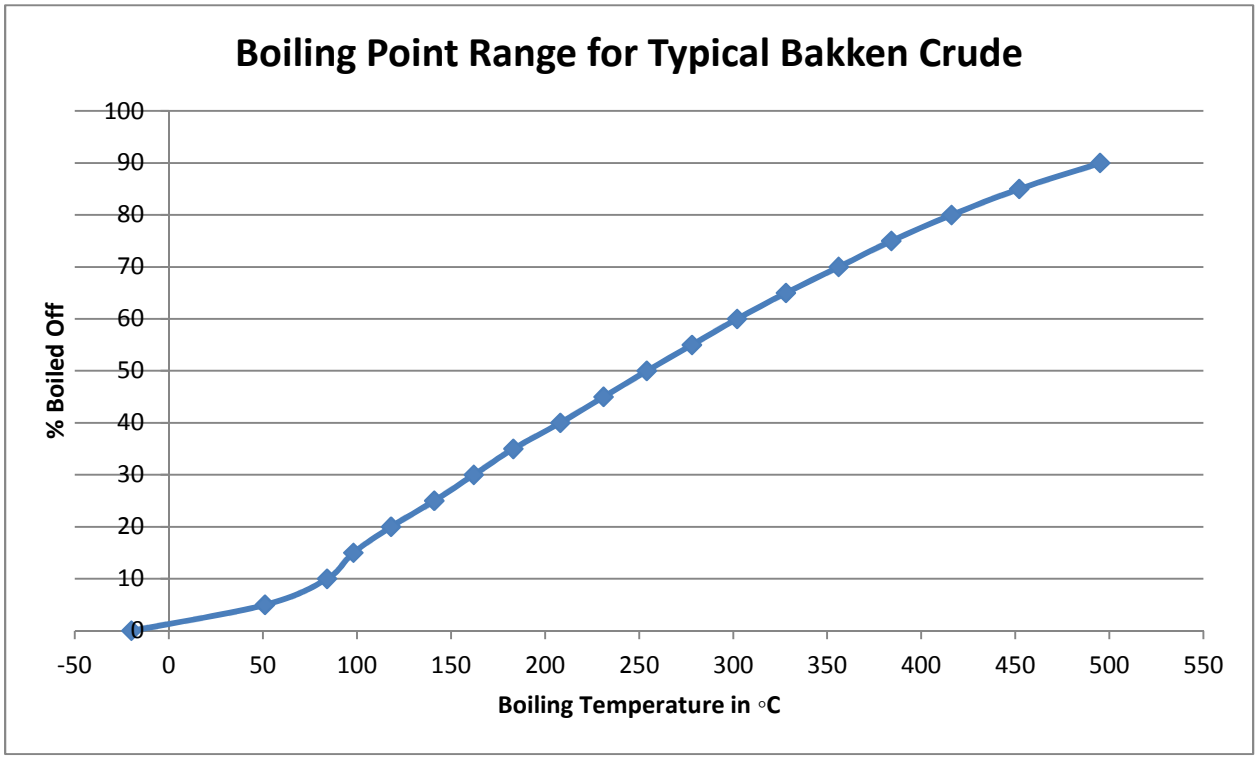
HMR depending on properties of the specific crude oil. Some may be transported as combustible liquids. Light crude oils are common throughout the world. Bakken crude oil is regarded as a light crude oil.

Bakken crude oil. Bakken crude oil, like other crude oils, consists of a range of primarily hydrocarbon gases and liquids. The table below illustrates the composition of a Bakken crude oil sampled at a distribution center prior to loading for rail transportation. The table also provides the HMR classification for each component. Division 2.1 refers to the HMR flammable gas classification and Class 3 refers to the HMR flammable liquid classification. The particular Bakken crude oil sample depicted in the sample below had an RVP of 7.6 psia.[14]

Hydrocarbon gas	Concentration in Liquid Volume %	DOT Classification
Methane	<0.01	Div. 2.1 Gas
Ethane	0.05	Div. 2.1 Gas
Propane	0.80	Div. 2.1 Gas
Iso-Butane	0.46	Div. 2.1 Gas
N- Butane	2.36	Div. 2.1 Gas
Total Gas	3.67	
Neopentane	<0.01	Class3; PG I
Iso-Pentane	1.33	Class 3; PG I
N-Pentane	2.36	Class 3; PG II
Hexanes	4.10	Class 3; PG II
Heptanes Plus	88.56	Varies Class 3; PG II to combustible liquid to non-regulated
Benzenes	0.08	Class 3; PG II

For the same crude oil, the figure below provides the boiling point range. Note that the boiling point temperature progressively increases after the more volatile components are boiled off.

[14] Among assays of Bakken crude oil, 7.6 psia is a normal RVP value.



[15]

Consideration of flashpoint and boiling point data for hydrocarbons suggests that, for the crude oil illustrated, when 40% of the crude oil is boiled off, the remainder would not be regulated as a flammable liquid.[16] As boiling continues beyond the 40% level, the remaining liquid would transition from a combustible liquid to a non-regulated substance. All else being equal, a pure flammable liquid with a boiling point comparable to the initial boiling point of the example crude oil would produce a flammable vapor plume 2.5 times larger than the example crude.[17] While a rough comparison, it illustrates that pure substances may be considerably more volatile than flammable liquid mixtures with identical initial boiling points.

The range of boiling points also suggests that in accident conditions where a tank is engulfed in flames, considerably more heat would be required to boil off the example crude oil than would be required of a pure substance with the same IBP. Consequently, based this and other factors, pressure buildup within a tank containing the example crude oil would be expected to be more gradual than that for a pure substance.

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[15] IBP values in this chart where based on ASTM 5307, a capillary chromatography method, producing lower values as compared to IBP data from samples provided which were based largely on ASTM D 86 – a method referenced in the HMR.

[16] Estimated based on the properties of n-dodecane, a C-12 hydrocarbon with a flashpoint of 71°C and a boiling point of 216°C, which is not subject to the DOT HMR as a flammable liquid. Crude oil compositions with a boiling point of 216°C or higher were assumed to not qualify as flammable liquids with a flashpoint less than 60°C.

[17] Some examples of other Class 3 Flammable Liquids that are transported in DOT 111's with a higher risk profile than Bakken crude would include: diethyl ether, acrylonitrile, and ethyl mercaptan.

Crude oil processing. When crude oil is extracted, it is typically processed to remove water and entrained gases, and stored in a tank prior to transportation. Processing, settling time in storage tanks and ambient temperature conditions all influence the extent to which light ends including gases are released from crude oil before it is transported.

III. Survey Results

A. Testing Used to Evaluate Bakken Crude Oils

As a Class 3 flammable liquid or a combustible liquid under the HMR, Bakken crude oil is subject to evaluation of its flashpoint and initial boiling point for classification purposes in accordance with the HMR. Other tests evaluating vapor pressure, flammable gas content, hydrogen sulfide content and corrosivity are also employed by industry and provide additional information relative to the hazards of crude oil.

Tests are carried out on crude oil samples taken at multiple locations along the distribution chain as it moves from the production point at a well to a refinery destination. Samples may be taken and evaluated at the well head, at gathering stations, at rail loading facilities, at pipeline facilities and when it is received at the refinery. Survey responses include data resulting from testing by AFPM members or independent laboratories (e.g. assays).[18] Data considered relevant for purposes of this survey was limited to data characterizing crude oil "in transportation," – ranging from data on samples taken at the well head location at the point of loading for transportation to data from samples taken where transportation ended at the refinery gate.

Members generally found variations in properties of specific crude oils to be minimal as these crude oils moved through the distribution chain. Summary data provided in the survey aggregates data obtained for samples taken along the distribution chain. A number of members noted seasonal variations in some properties of Bakken crude oils. The variations may be attributable to higher retention of flammable gases in crude oils in winter owing to lower ambient temperatures.

B. Test Methods Used to Characterize the Hazards of Crude Oil

PHMSA requested information on test methods used to characterize crude oil. The test methods used to evaluate selected characteristics are provided in Appendix 4.

[18] Crude oil assays are detailed evaluations of crude oils that are commonly performed for commercial non-regulatory purposes. They may be used to define crude oil purchased by a refiner from a producer. The values reported in an assay reflect the properties of a specific sample. They are intended to represent characteristics of crude oils to be purchased and do not normally account for variations that may be identified among multiple samples. For example, higher RVP values for Bakken crude oil are noted in this survey for other samples. In addition, data from more than one assay was used in this report. Even though the data in assays are not normally used for regulatory compliance purposes, consideration of assay data was instructive for purposes of this survey given the detailed information they provide.

C. Reported Information and Test Results - Discussion and Range

The following information on Bakken crude oil is based on responses from AFPM members and data provided on approximately 1400 samples of Bakken crude oils.[19] The data included data points on specific characteristics as follows:

Flash Point: 77 data points;
Initial Boiling Point: 275 data points;
RVP: 807 data points;
Rail Tank Car Pressure (PSIG): 387 data points;
Total C1-C4: 18 data points;
H_2S in Liquid: 37 data points;
H_2S in Vapor: 535 data points; and
Corrosivity to metal: 7 data points.[20]

For comparison purposes data from samples of non-Bakken crude oil was also considered.

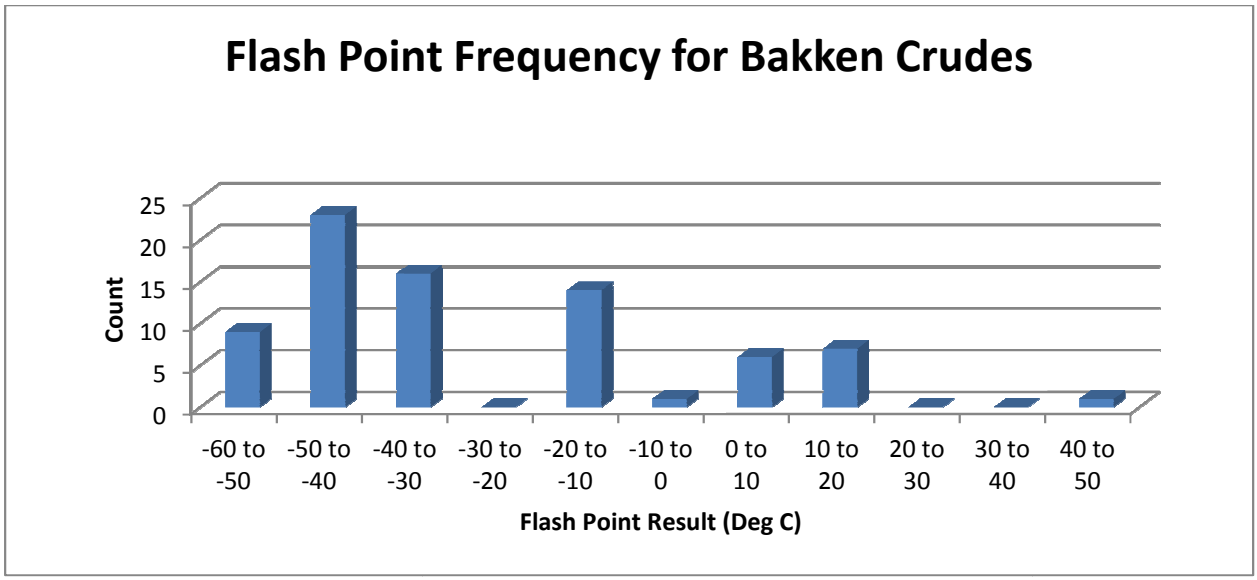
1. Flashpoint

Reported Bakken flashpoint range. Survey respondents reported flashpoints ranging from -59°C (-74°F) to 110°C (230°F). On the basis of this flashpoint information, Bakken crude oil in transportation ranges from being subject to regulation as flammable liquids (in all 3 Packing Groups), combustible liquids or not regulated as hazardous materials under the HMR.

The chart below shows the distribution of flashpoints among all Bakken crudes for which data was provided as part of this survey.

[19] Many of the samples were collected in February/March 2014 in North Dakota. Given the prevailing ambient temperature, these samples are expected to represent "worst case" conditions that contribute to higher flashpoint, vapor pressure and dissolved gasses.

[20] Data provided was initially acquired for a range of purposes and not necessarily for compliance with the HMR. As such data on samples did not always include data points on all of the characteristics considered in the survey.



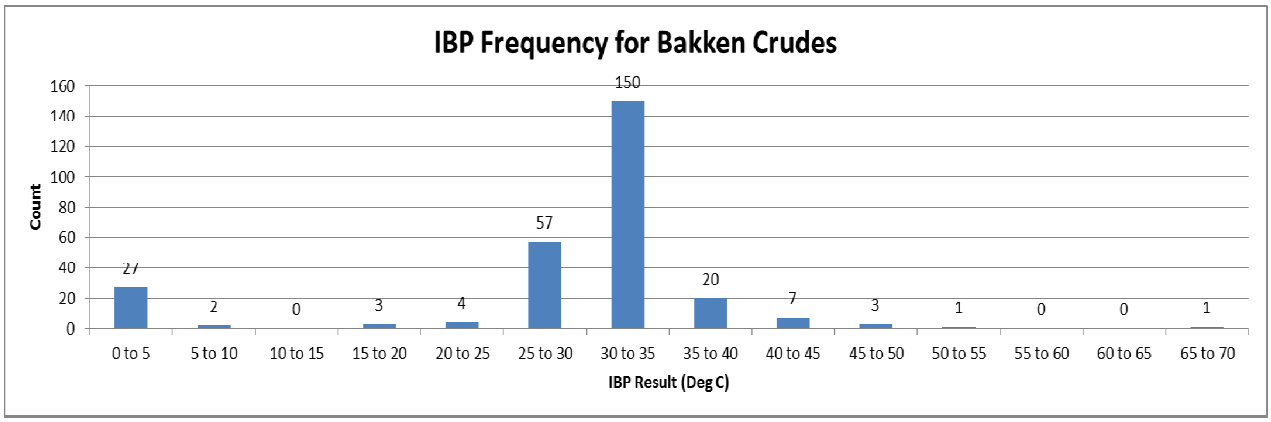
Mean	-27.1°C (-16.8°F)
Median	-36° C (-32.8°F)
Mode	-15.0 °C (5 °F)
Minimum	-59°C (-74.2°F)
Maximum	50°C (122°F)

Discussion on flashpoint data. Survey data indicate that 76 of the 77 crude oil samples meet the classification criteria for Packing Group I or II. One crude oil sample for which data was provided could be classified either as Packing Group III or as a combustible liquid.

As already noted, flashpoint data may be based on estimation methods with the objective of determining the HMR flashpoint range a particular crude oil falls into (e.g., 23°C or less). While these methods suffice for HMR classification purposes in that they assign a substance to the appropriate flashpoint range they may not accurately reflect the precise flashpoint value that would be obtained using a method identified as suitable under the HMR. As such caution is advised when considering specific values.

2. Initial boiling point

Reported Initial Boiling Points. The chart below describes the range of initial boiling point data that was provided on Bakken samples from crude oil in transportation.



Mean	29.0°C (69.6°F)
Median	30.7° C (87.3°F)
Mode	30.2 °C (86.4 °F)
Minimum	2.2°C (36.0°F)
Maximum	66.9°C (152.4°F)

Discussion on Initial Boiling Point information. Based on the data provided in the survey, the majority of Bakken crude oils in transportation have an initial boiling point ranging from 15°C to 50°C. The low values shown in the lower left hand side of the chart stem from samples taken upon arrival at a refinery in the months of February to April suggesting that IBP is influenced by seasonal conditions.

The HMR utilize an IBP threshold criterion of 35°C to delineate between Packing Group I and II. Among Bakken crude oils, IBP values are clustered around the regulatory threshold. Respondents to the survey noted problems with the variability and repeatability of IBP tests. While no misclassification is implied, the clustering of IBP values around the 35°C threshold value combined with repeatability problems associated with IBP testing could present practical challenges with respect to the assignment to Packing Group I or II.

3. Vapor pressure of crude oil in transportation, tank car pressures

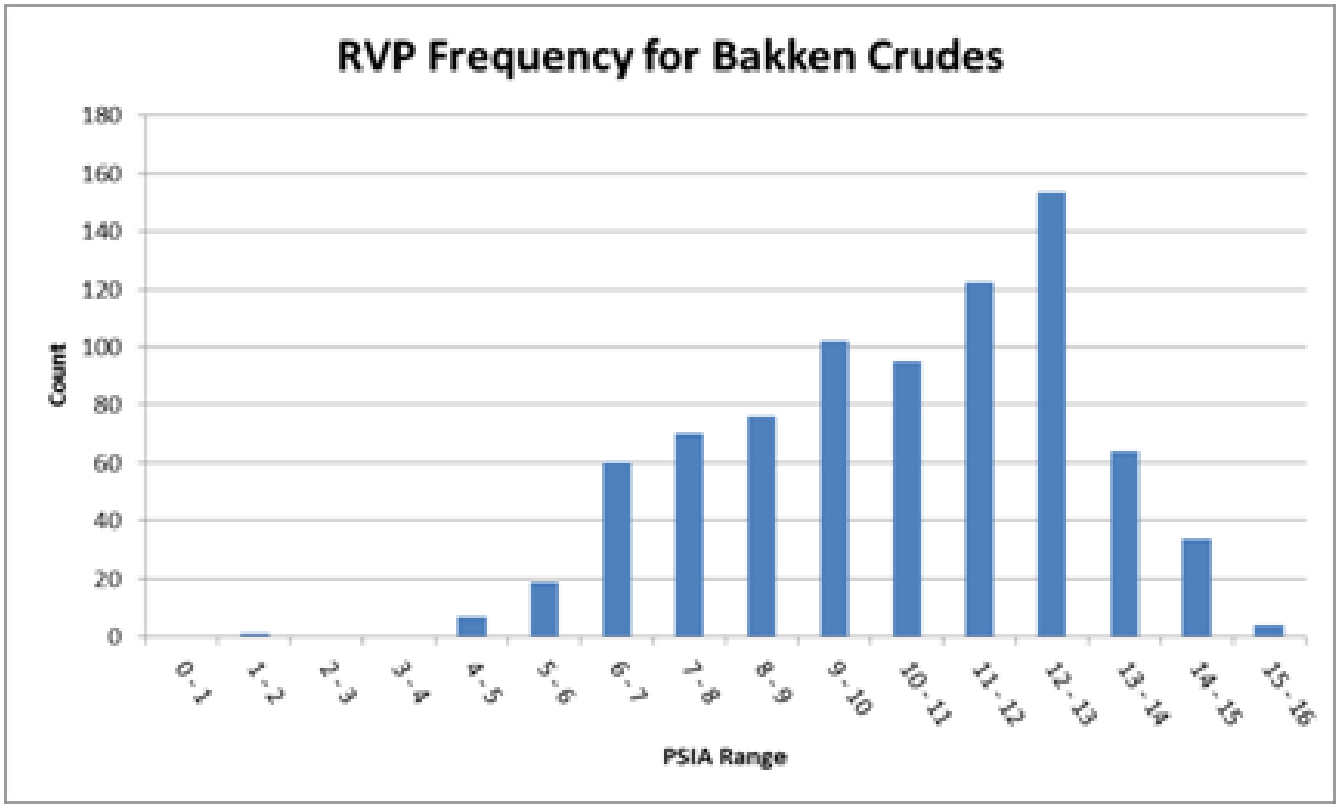
Reported vapor pressure at 50°C. Vapor pressure values were reported in data on nine Bakken samples. The vapor pressure values ranged from a low of 13.89 psia to 16.72 psia. Based on RVP data these values appear to be in the high range of what would normally be expected for Bakken crude oil – although well below the vapor pressure threshold for a flammable gas. All

but two samples were taken at the rail loading point in North Dakota. These values were from samples taken in February and March 2014. Lower vapor pressure values would be anticipated at other times during the year when ambient temperatures are higher.[21] The data confirm that Bakken crude oils fall within the definition of a liquid under the HMR in that they are well below the 300 kPa (43 psia) threshold value delineating between a gas and a liquid.

Note that the vapor pressure at 50 ^{o}C will normally correlate closely with the far more widely reported RVP which is measured at 38 ^{o}C (100 ^{o}F) as discussed below.

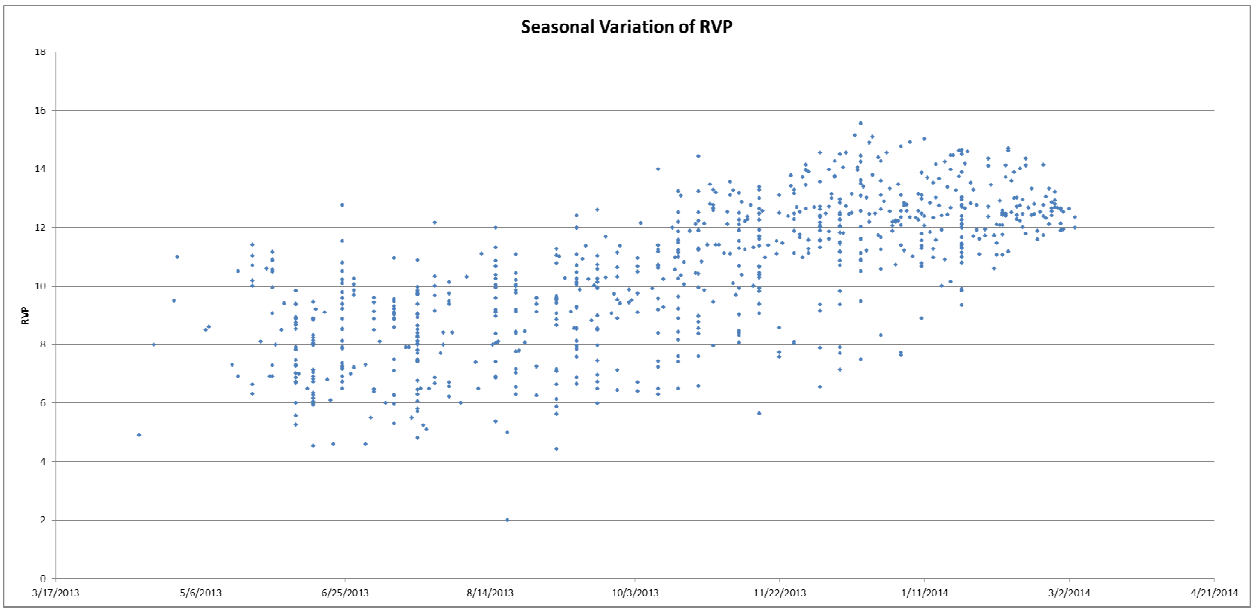
Reported Reid Vapor Pressure values (vapor pressure at 38 ^{o}C (100 ^{o}F)). Among the survey respondents and based on the data submitted, Bakken crude oil offered for transportation was found to have RVP values ranging from 0.8 to 15.54 psia.

The chart below shows the distribution of RVPs among all Bakken crudes for which data was obtained as part of this survey.



[21] The seasonal variation of RVP is discussed below.

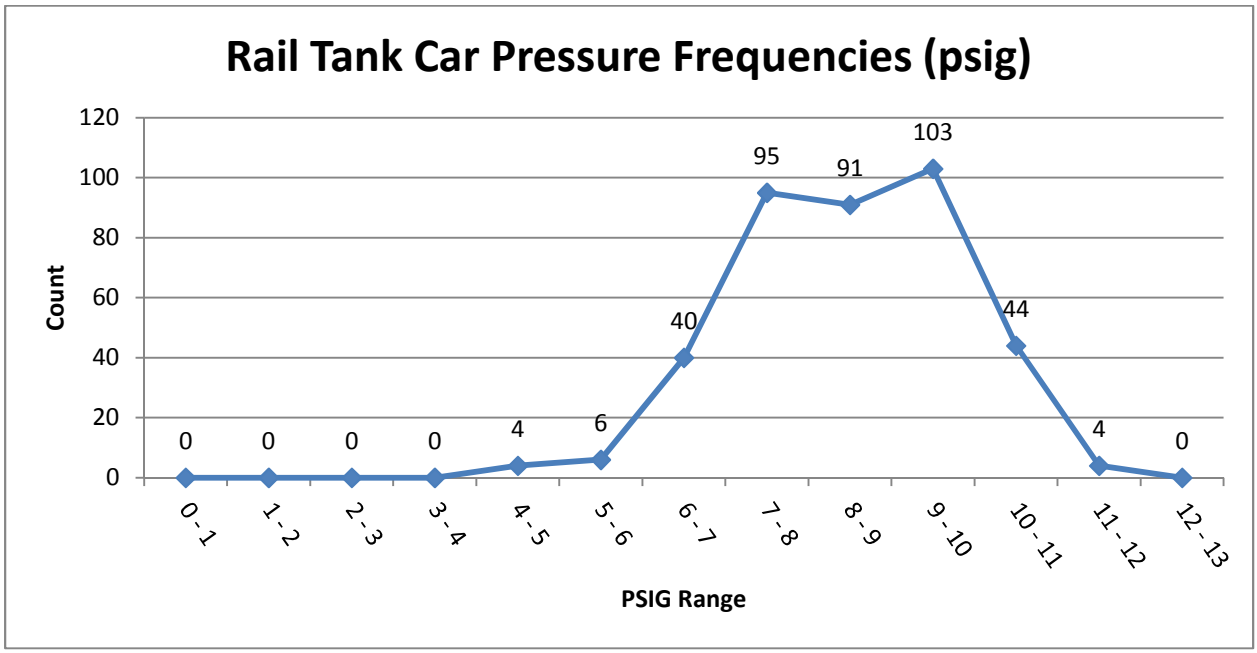
Seasonal variations of RVP. Seasonal variations of RVP are demonstrated in the following chart.



The chart shows that RVP values average 8 psia for warmer times of the year and average 12.5 psia during colder periods. RVP and other parameters are interrelated. As such, similar seasonal variations in other parameters such as flashpoint, initial boiling point, and flammable gas content are likely.

Operational limits on crude oil RVP. Respondents noted that, outside of the HMR, there are operational limits on the RVP of crude oil. First of all, it is common to store crude oil in floating roof tanks. Environmental regulations governing the release of volatile organic compounds (VOCs) restrict the RVP (or a variant known as TVP measured at ambient temperature) of crude oil in floating roof tanks to 10-11 psia. The floating roof tank pressure limits impose practical RVP limits on the crude oil transported by rail to refiners and petrochemical facilities. Recipients monitor crude oil for RVP to ensure compliance with these environmental regulations. One respondent noted that they test the RVP of every rail shipment at the time of loading and upon receipt. In their experience RVP values varied according to the time of year with RVP values as high as 15 psia in the winter and with lower RVP values typical in the summer. The second operational restriction on the transportation of high RVP value crude oils is due to increased potential for pump cavitation. A limiting RVP of 10 psia was reported as typical for crude oils transported by pipeline where pumping is required. Pipelines are a destination for some Bakken crude oils transported by rail. Finally, lower RVPs are also more desirable from a refinery operational perspective. One refinery respondent noted a contractual RVP limit of 9.5 psia.

Reported rail tank car pressure measurements. The chart below indicates pressures measured in rail tank cars upon arrival at a refinery. The highest value reported was 11.3 psig. This value is lower than the 35 psig minimum relief valve setting for older DOT 111 rail tanks cars and their required 240 psig minimum design burst pressure. This suggests that DOT 111's are built with an ample margin of safety relative to the pressures that rail tanks may experience when transporting Bakken crude oil.



Mean	8.5 psig
Median	8.5 psig
Mode	9.0 psig
Minimum	4.2 psig
Maximum	11.3 psig

4. Flammable Gas Content

Reported flammable gas concentrations. In response to the PHMSA question on ranges of flammable gas content of Bakken crude oil, respondents reported the following ranges:[22]

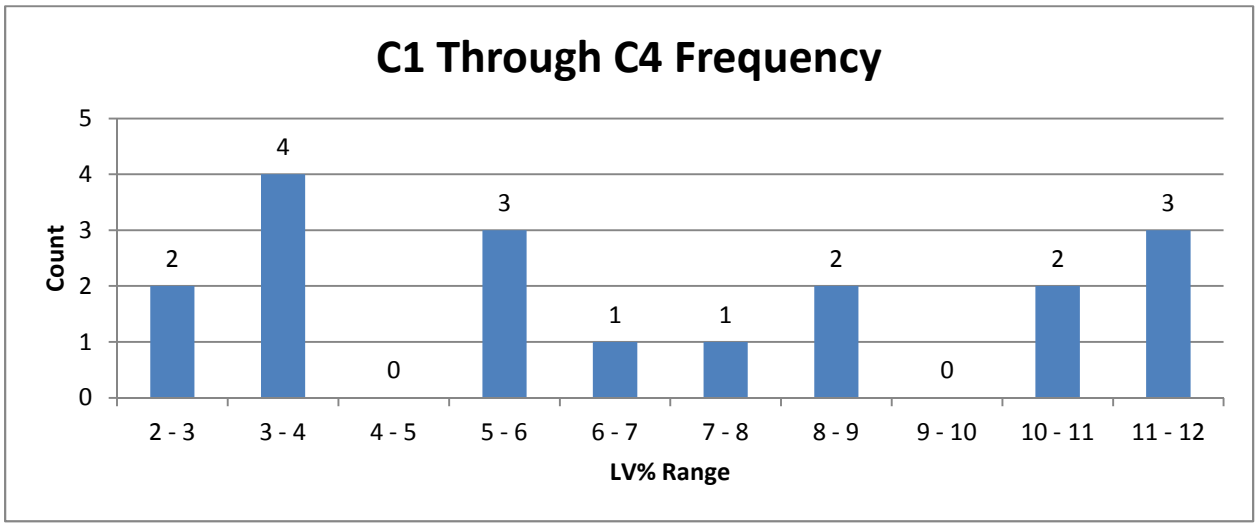
Hydrocarbon gas	Concentration in Liquid Volume %

[22] In data collected, some samples were found to have higher values than indicated in the range of values reported. Maximum values were 0.77 LV % for ethane, 3.4 LV % for propane, and 8.0 LV % for butane. As reflected in the bar chart below, based on sample data, the maximum total flammable gas content for all samples was 11.9 LV %. Samples were obtained in February and March.

Methane	<0.01
Ethane	0.50
Propane	<1-2%
Iso-, N-Butane	3-4%

Eighteen samples included measurements of flammable gas content. The information differs from light end content in that pentane, which is not a gas under the HMR, is commonly included in light end data. Data from three respondents indicated a maximum total flammable gas content (C1 to C4) of 3.5% Liquid Volume %.

Information provided by a fourth respondent, included data from 12 samples taken in a one month period beginning in early February and ending in early March. In the case of the latter samples, total flammable gas content ranged from 5.9% to 11.9%. Ambient temperatures affect these gas concentration values. The data obtained from all respondents is illustrated in the chart below.



Comparison with other crude oils. To determine whether Bakken crude oil's "light end" content is markedly different from other crude oils, data (primarily from assays) for other non-Bakken crude oils were examined.[23] The table below illustrates that some selected other crude oils have comparable gas contents and in addition illustrates some of the variations in characteristics that exist among crude oils with a range of API gravities. (Note that "light ends" as the term is used in the petroleum industry includes pentanes which are deemed flammable liquids under the HMR.) Based on assay data for Bakken and non-Bakken crude oils[24], the following table summarizes data obtained:

Crude Name	**Origin**	**API**	**RVP (psia)**	**Vol % of Light Ends (C2 – C5)**
Arabian Super Light	Saudi Arabia	51	20.7	12.53 wt %[25] (C1-C4 only)
Eagle Ford	Texas	48	7.95	8.3
Agbami	Nigeria	48	2.2	5.61 wt %
DJ Basin	Colorado	45	7.82	8.0
Sarahan Blend	Algeria	43	7.46	8.1
Bakken	North Dakota	42	7.83	7.2
WTI	Texas / New Mexico	41	5.90	6.1
Brent[26]	United Kingdom	37.5	9.33	5.28 wt %
API gravity of 37 or more defines light crude oil		37		
LLS	Louisiana	36	4.18	3.0
Alvheim blend	Norway	34.9	3.9	1.86 wt %
Arabian Heavy	Saudi Arabia	28.4	18.3	5.13 wt % (C1-C4)
Alberta Dilbit[27]	Alberta	21.1	7.18	7.30 wt %
Alba	United Kingdom	19.6	1.6	0.14 wt %

[23] *Note* "light ends" as the term is used in the petroleum industry includes pentanes which are deemed flammable liquids under the HMR.
[24] Sources included data collected as part of the survey as well as online data at http://www.oil-transport.info/crudedata/crudeoildata/crudeoildata.html and data at http://www.statoil.com/en/ouroperations/tradingproducts/crudeoil/crudeoilassays/pages/default.aspx
[25] Because the specific gravities of gases and pentanes in the liquid state are lower than that of other components, "wt %" is lower than "LV %". Conversion from wt % to LV% requires the concentrations of each individual component.
[26] Data from a sample taken at the loading point.
[27] Data from a sample taken at the loading point.

Using assay data allows for evaluating oils on a consistent basis. While survey data on specific samples of Bakken crude oils (like other light crude oils) showed higher gas content than assay data, it may be expected that similar variations arise in the case of non-Bakken crude oils. The data suggests that Bakken crude oil is within the norm for what might be expected in the case of light end content in light crude oils. Light crudes oils are not unique to new drilling practices and have been common since the advent of petroleum extraction.

Operational limits on flammable gas content. Since flammable gas content and vapor pressure are closely linked, operational limitations identified relative to RVP (i.e., floating roof tank limits, pipeline pumping limits and refinery operational considerations) also apply in the case of flammable gas concentrations.

5. Hydrogen sulfide content

Reported hydrogen sulfide concentrations. Respondents indicated hydrogen sulfide vapor space concentrations were less than 10 ppm.

Data reviewed was for either hydrogen sulfide concentration in the liquid or hydrogen sulfide concentration in the vapor.

Data on H_2S in liquid. For samples, hydrogen sulfide concentrations (in ppm) in the liquid were reported as follows:

H2S in liquid	Count
x< 0.2	4
x<1.0	2
x< 2	22
x<5.0	1
x< 10	8
Total	**37**

These would suggest very low hydrogen sulfide vapor concentrations.

Data on H_2S in vapors. Reports of hydrogen sulfide (in ppm) in the vapor were reported as follows:

H2S in Vapor	Count
x<1	390
x<2.0	9
x>2000	6
Total	**535**

The above six values indicating "x>2000" stemmed from one of four respondents providing H_2S vapor data. In addition, the same respondent reported 129 measured H_2S values (in ppm) that are summarized as follows:

H2S in Vapor	
Mean	3580
Median	2000
Min	1
Max	23000

The data was based on samples taken at a gathering location where crude oil was being collected for transportation. For crude oils with H_2S concentrations posing an inhalation hazard, additional HMR hazard communication requirements apply, including warnings on rail tanks cars.[28]

Operational limits on hydrogen sulfide. With an OSHA short term exposure limit (STEL) of 15 ppm for 15 minutes exposure, occupational limits are far below those warranting communication of the toxic hazard under the HMR. Where there is potential for exposure, employees are fitted with monitors and ambient air is subject to gas sampling. Testing for hydrogen sulfide is common for rail unloading operations and one respondent noted that hydrogen sulfide levels greater than 15 ppm were not allowed at company rail unloading facilities. Another respondent noted that where high hydrogen sulfide crude oils are encountered, the crude oil is typically not transported before first being subjected to treatment using amine scavengers.

When appropriate, based on potential high levels of hydrogen sulfide which pose a health risk to workers, the risks of hydrogen sulfide are delineated on Safety Data Sheets.

6. Corrosivity to metals

Discussion. Under the HMR, in addition to criteria for corrosivity to skin, a substance is regarded as corrosive if it corrodes steel or aluminum at a rate of 6.25 mm (0.25 inches) per year. A substance with this degree of corrosivity would penetrate steel used in crude oil rail tank cars in a period of approximately two years. There is no evidence that Bakken crude corrodes steel or aluminum at this rate.

Reported corrosivity data. Data reported using NACE TM 172 indicates that Bakken crude oil scores as either B+ or B++ using this method. Generally, a NACE value of B+ or better is

[28] *See* 49 CFR §172.327.

required for transportation via pipeline. While crude oil does not meet the HMR corrosivity criteria, water, solids and H2S contaminants in crude may cause corrosion at rates less than that specified in the HMR for classification purposes. Industry deals with this lower level of corrosion from an asset management perspective.

D. What safety information is provided to carriers?

The HMR require that a considerable amount of information be provided to carriers, including:

1. UN number of the crude oil;
2. Proper shipping name under which it is transported;
3. Hazard class (Class 3);
4. Packing Group of the crude oil;
5. Total quantity being offered or the number of packagings (i.e., rail tank cars) involved;
6. Emergency response information that includes immediate hazards to health; risks of fire or explosion; intermediate methods to be taken for handling fires; initial methods for handling spills or leaks in the absence of a fire; and preliminary first aid measures; and
7. A 24-hour emergency telephone number where more detailed information may be obtained.

Upon request, carriers may also be provided material safety data sheets.

IV. Summary Remarks

Survey results obtained by AFPM members provide a considerable amount of information on which to assess the hazard characteristics of Bakken crude oil. The data obtained appears to be of good quality. From the data, it is clear that parameters such as vapor pressures, initial boiling points, flashpoints and dissolved gas content were influenced by seasonal variations. Yet even when considering data obtained during periods of cold weather, Bakken crude oil was found to be well within the limits for what is acceptable for transportation as a flammable liquid. Bakken crude oil was compared with other light crude oils and determined to be within the norm in the case of light hydrocarbon content, including dissolved flammable gases.

Measured tank car pressures show that even the older DOT 111's authorized to transport Bakken crude oil are built with a wide margin of safety relative to the pressures that rail tanks may experience when transporting Bakken crude oil.

Other factors influence the properties of crude that is transported. As manufacturers, AFPM members have an interest in limiting the RVP for purposes of operational efficiency and adherence to Clean Air Act requirements. RVP values correlate with values for flammable gas content, initial boiling point and flashpoint. Levels of all these parameters, consistent with an RVP of approximately 10 psia or lower are in the best interests of AFPM members. Compliance

with OSHA requirements related to exposure to H_2S also plays a role in reducing the hydrogen sulfide content of crude oil in transportation.

AFPM and its members appreciate the concerns raised in relation to rail transport of Bakken crude oil and stand ready to work cooperatively with DOT and other governmental organizations to ensure the safe transportation of Bakken crude oil. This survey shows that Bakken crude oil does not pose risks that are significantly different than other crude oils and other flammable liquids authorized for transportation as flammable liquids. In some respects Bakken crude oil may be regarded as posing a lower degree of risk than other flammable liquids transported in accordance with the HMR, particularly pure substances.[29]

[29] Some examples of other Class 3 Flammable Liquids that are transported in DOT 111's with a higher risk profile than Bakken crude would include: diethyl ether, acrylonitrile, and ethyl mercaptan.

Appendix 1

U.S. Department
of Transportation
**Pipeline and Hazardous
Materials Safety
Administration**

Administrator

1200 New Jersey Ave., S.E.
Washington, DC 20590

January 29, 2014

Mr. Charles Drevna
American Fuel and Petrochemical Manufacturers
1667 K Street, NW
Suite 700
Washington, DC 20006

Dear Mr. Drevna:

The recent railroad derailments and resulting fires in North Dakota, Alabama, New Brunswick, Ontario, and Lac-Megantic, Quebec have raised my concerns about the safety risks associated with the transportation of crude oil, specifically the crude oil originating from the Bakken region. One concern is whether this product has inherent properties and characteristics different from traditional crude oils historically transported and whether these characteristics pose additional transportation risks. In order to address my concerns, I invite you to meet with me in Washington, DC on Wednesday, February 5, 2014, from 10 a.m. to 11:30 a.m. at Department of Transportation headquarters to discuss potential safety issues related to truck and rail transportation of crude oil. I am specifically concerned about the methods and processes you use to meet your responsibilities in the Hazardous Material Regulations to properly test, characterize, and classify the crude oil for transportation by truck and rail.

Based upon preliminary information obtained from investigations into the derailments noted above, PHMSA issued a safety alert to the industry reiterating the requirement to properly test, characterize, and classify hazardous materials prior to transportation. Title 49 Code of Federal Regulations §172.204 requires offerors of hazardous materials to properly classify and describe the hazardous materials being offered for transportation. As part of this process, offerors must ensure that all potential hazards are properly characterized and communicated on shipping papers. Proper characterization identifies those properties that could affect the integrity of the packaging or present additional hazards, such as corrosivity, sulfur content, and dissolved gas content, in addition to how the product is classified for transportation. Proper classification, packing group assignment, and communication of all the hazards of product shipments are required and fundamental to the safe transportation of these materials, regardless of the mode of transportation.

In order to have meaningful discussions during your visit, please consider and be prepared to answer the following questions:

- What tests or methods do you use to determine the properties of the crude oil to include its vapor pressure, flammable gas content, flash point, boiling point, hydrogen sulfide content and corrosive properties prior to offering it in transportation?
- Who performs these tests and how frequently are they completed?
- When you find high levels of gases in crude, what actions do you require of your oilfield personnel before loading into a transport vehicle? What information about the crude oil properties, if any, is provided by the producers to you prior to transportation? How is this information communicated?
- What information do you share with truck and rail carriers about the crude oil properties?
- Are there any prescribed limits involving vapor pressure, flammable gas concentration or hydrogen sulfide content above which the crude oil is not placed into transportation? If so, what are these limits and how are they determined?

I welcome your insights to these questions and any other information that you may have about the chemical and hazardous properties of Bakken crude oil. I look forward to meeting you and working together on this critical transportation safety issue.

We are also extending this invitation to anyone else that you believe would benefit from attending or further contribute to this meeting. My executive assistant, Sabrina Morris, will contact your office to schedule the meeting. If you have any questions, please feel free to call me at (202) 366-4433.

Regards,

Cynthia L. Quarterman

Appendix 2

PHMSA Field Office Questionnaire

Company: _____ **Contact Name:** _____

Address: _____ **Title:** _____

City, State: _____ **Phone:** _____

Type: Refinery ☐ Transfer Terminal ☐ **Email:** _____

- What tests, if any, are performed on the crude oil upon receipt?
    - How frequently are they completed?
    - Are you willing to share the results with us?
- When you find high levels of gases in crude, what actions do you require of your personnel before unloading?
    - What information about the crude oil properties, if any, is provided by the offerors or carriers prior to receipt?
    - How is this information communicated?
- Have you had to add any special safety measures or make any procedural changes in the unloading process to protect workers or modify the flow to the facility?
- Are there any prescribed limits involving vapor pressure, flammable gas concentration or hydrogen sulfide content above which the crude oil is not accepted at terminal or refinery?
    - If so, what are these limits and how are they determined? (*Note: We have heard that one of the larger refineries in Canada placed gauges on top of rail cars to measure pressure before unloading and in turn rejected some 400 rail cars.*)

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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labeling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

Forty-fifth session

Geneva, 23 June – 2 July 2014

Item 4 (c) of the provisional agenda
Listing, classification and packing: miscellaneous

Classification and hazard communication provisions for crude oil

Transmitted by the experts from Canada and the United States of America[30]

Background

1. North America is experiencing a significant increase in crude oil supply, bolstered both by growing production in the Canadian oil sands and the recent expansion of shale oil and natural gas production in the United States of America and Canada.

2. North American shale oil and natural gas extraction has been mostly in geographic areas not linked to traditional crude oil or natural gas pipelines, resulting in an increase in surface transport. Surface transport has also enabled crude transport to different refinery capacities situated across North America. This mostly "younger" crude is being found to contain significantly higher "light ends" than what has been traditionally transported as UN 1267.

[30] In accordance with the programme of work of the Sub-Committee for 2013-2014 approved by the Committee at its sixth session (refer to ST/SG/AC.10/C.3/84, para. 86 and ST/SG/AC.10/40, para. 14).

3. This significant and exponential increased in surface movement of crude oil has led authorities within Canada and the United States of America to carefully consider transport safety impacts as well as potential impacts to the environment. These efforts have been prioritized based on a series of major accidents across North America involving crude oil transport by rail - including a catastrophic incident brought to the attention of the Sub-Committee at its previous session that caused numerous fatalities and destroyed much of Lac Mégantic, Quebec, in July 2013.

4. The increased production and experience has led to a renewed focus within North America on assessing the adequacy of the current provisions governing crude oil transport. While an assessment of relevant rail operational conditions have been major components of this effort, a significant portion of the experience gained is relevant to all modes and would benefit from broader review and discussion within the Sub-Committee. The purpose of this paper is to initiate discussions relevant to the experience recently gained, to raise important questions regarding the proper classification of - and transport provisions for – crude oil, and to invite the Sub-Committee to consider whether a review of the existing UN entries, assigned classifications, and transport provisions is warranted. This discussion may also eventually encumber other petroleum products such as natural gas condensates.

5. In particular, the Sub-Committee is invited to consider whether the current entries for crude oil in the Dangerous Goods List adequately distinguish between what can be significant variations in the flammable gas content of crude oils from different sources (see discussion below relevant to classification).

Discussion

6. This document contains no proposals. The Sub-Committee is invited to provide feedback as a first step towards evaluating the efficacy of the current provisions of the Model Regulations based on an evolving understanding of the risks inherent in the transport of crude oil. Specifically, based on the information available on various types of crude oils in global transport today, the Sub-Committee is requested to provide feedback with respect to the classification and hazard communication elements of the Model Regulations currently applicable to crude oil.

(a) Classification

Unlike other Class 3 manufactured goods, organic materials from oil and gas production represent a unique challenge in regards to classification. Differences in the chemical makeup of the raw material can vary day-to-day and from well head-to-well head. Unprocessed crude oil may present unique hazards based on the specific dissolved gas content, posing different hazards in transport. Would further distinctions beyond merely identifying the Packing Group relevant to the flammable liquid hazard or the flammable gas content of the crude be appropriate to account for the differing hazards posed by what can be significant quantities of dissolved flammable gases? What is the most appropriate measure of this volatility – boiling point or vapour pressure? Is the proposed measurement method a calculation based on the properties of the material or an observed value? What are the most appropriate sampling and testing procedures? And finally, at what threshold should revisions to the regulatory requirements be considered?

(b) Hazard communication

The current flammable liquid entries in the Dangerous Goods List provide for a distinction in hazard by the assignment of Packing Groups based on

the liquid's boiling and flash points. However, lighter crude oil with a higher quantity of dissolved flammable gases pose a significantly different risk than heavier crude oils that do not have such a high constituency of more volatile components. Would enhanced hazard communication distinguishing more volatile crude oils be beneficial for transport workers and emergency response personnel? If so, would a new table entry for such a material be sufficient?

Conclusion

7. The Sub-Committee is invited to consider appropriate next steps to ensure that the provisions of the Model Regulations adequately address the risks posed by the transport of crude oil. Based on the feedback received at this session, the experts from Canada and the United States of America would be willing to prepare specific proposals for consideration at a future session.

Appendix 4

Test methods used to evaluate selected Bakken Crude Oil Characteristics

1. Flashpoint *(Note: Some reported using the methods referenced in §173.120(c).)*
   - ASTM D56 Standard Test Method for Flash Point by Tag Closed Cup Tester
   - ASTM D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
   - ASTM D3278 Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

2. Initial boiling point *(Note: Some reported using the methods referenced in §173.121(a)(2).)*
   - ASTM D86 Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure
   - ASTM D1160 Standard Test Method for Distillation of Petroleum Products at Reduced Pressure
   - ASTM D2887 Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
   - ASTM D5134 Standard Test Method for Detailed Analysis of Petroleum Naphthas through n-Nonane by Capillary Gas Chromatography
   - ASTM D7169 Standard Test Method for Boiling Point Distribution of Samples with Residues Such as Crude Oils and Atmospheric and Vacuum Residues by High Temperature Gas Chromatography

3. Vapor pressure
   - ASTM D2879 Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope
   - ASTM D5191 Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method)

4. Flammable gas content
   - ASTM D-5134 Standard Test Method for Detailed Analysis of Petroleum Naphthas through n-Nonane by Capillary Gas Chromatography
   - ITM 6008 Light ends analysis by Gas Chromatography
   - IP 344 Determination of light hydrocarbons in stabilized crude oils - Gas chromatography method

5. Hydrogen sulfide content
   - ASTM D5705 Standard Test Method for Measurement of Hydrogen Sulfide in the Vapor Phase Above Residual Fuel Oils

- IP 507: Determination of boiling range distribution by gas chromatography method - Part 2: Heavy distillates and residual fuels
- UOP163 Hydrogen Sulfide and Mercaptan Sulfur in Liquid Hydrocarbons by Potentiometric Titration

6. Corrosivity to metal
   - NACE TM172 Standard Test Method - Determining Corrosive Properties of Cargoes in Petroleum Product Pipelines

Appendix 5

Guide 128 from the 2012 ERG

GUIDE 128 Flammable Liquids (Non-Polar/Water-Immiscible)

FIRE OR EXPLOSION
• HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.
• Vapors may form explosive mixtures with air.
• Vapors may travel to source of ignition and flash back.
• Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
• Vapor explosion hazard indoors, outdoors or in sewers.
• Those substances designated with a **(P)** may polymerize explosively when heated or involved in a fire.
• Runoff to sewer may create fire or explosion hazard.
• Containers may explode when heated.
• Many liquids are lighter than water.
• Substance may be transported hot.
• For UN3166, if Lithium ion batteries are involved, also consult GUIDE 147.
• If molten aluminum is involved, refer to GUIDE 169.

HEALTH
• Inhalation or contact with material may irritate or burn skin and eyes.
• Fire may produce irritating, corrosive and/or toxic gases.
• Vapors may cause dizziness or suffocation.
• Runoff from fire control or dilution water may cause pollution.

• CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.
• As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
• Keep unauthorized personnel away.
• Stay upwind.
• Keep out of low areas.
• Ventilate closed spaces before entering.

PROTECTIVE CLOTHING
• Wear positive pressure self-contained breathing apparatus (SCBA).
• Structural firefighters' protective clothing will only provide limited protection.

EVACUATION
Large Spill
• Consider initial downwind evacuation for at least 300 meters (1000 feet).
Fire
• If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

FIRE
CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.
CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.
Small Fire
• Dry chemical, CO_2, water spray or regular foam.
Large Fire
• Water spray, fog or regular foam.
• Do not use straight streams.
• Move containers from fire area if you can do it without risk.
Fire involving Tanks or Car/Trailer Loads
• Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
• Cool containers with flooding quantities of water until well after fire is out.
• Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
• ALWAYS stay away from tanks engulfed in fire.
• For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from

area and let fire burn.

SPILL OR LEAK

• ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
• All equipment used when handling the product must be grounded.
• Do not touch or walk through spilled material.
• Stop leak if you can do it without risk.
• Prevent entry into waterways, sewers, basements or confined areas.
• A vapor suppressing foam may be used to reduce vapors.
• Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
• Use clean non-sparking tools to collect absorbed material.

Large Spill

• Dike far ahead of liquid spill for later disposal.
• Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

• Move victim to fresh air.
• Call 911 or emergency medical service.
• Give artificial respiration if victim is not breathing.
• Administer oxygen if breathing is difficult.
• Remove and isolate contaminated clothing and shoes.
• In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
• Wash skin with soap and water.
• In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
• Keep victim warm and quiet.
• Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves

Appendix 6

Glossary of Terms and Acronyms

AFPM means the American Fuel & Petrochemical Manufacturers.

DOT means U.S. Department of Transportation.

ERG means the Emergency Response Guidebook produced by PHMSA in cooperation with the governments of Canada and Mexico and used throughout North America as the basis for the initial response to a hazardous materials emergency.

Flashpoint means the lowest temperature at which a liquid or gas produces a concentration of vapor in air that may be ignited.

H_2S means hydrogen sulfide.

HMR the Hazardous Materials Regulations in 49 CFR Parts 105 to 180.

IBP means initial boiling point.

OSHA means the Occupational Safety and Health Administration.

PHMSA means the DOT Pipeline and Hazardous Materials Administration.

Packing Group means the degree of hazard assigned to materials subject to the DOT HMR according to specified criteria. Hazard levels of Packing Group I (high), II (medium) and III (low) are possible.

RVP means Reid Vapor Pressure.

STEL means short term exposure limit for a specific substance in air. The value is commonly based on 15 minutes exposure.

TVP means True Vapor Pressure.