Mike Faulkner, National Response Team (NRT) Executive Director, U.S. Environmental Protection Agency (EPA)

Bakken crude is a very light volatile type of crude that acts more like refined products such as gasoline when involved in fire. It also contains a variety of other chemicals such as benzene and hydrogen sulfide, creating additional dangers to first responders, especially respiratory. Additionally, Bakken has a higher gas content, higher vapor pressure, lower flash point and boiling point and thus a higher degree of volatility than most other crudes in the U.S., which correlates to increased ignitability and flammability.

There have been eight major crude oil accidents in 2013 and 2014 combined:

- **July 6, 2013 – Lac Megantic, Quebec**: 47 deaths, 63 of the 72 tank cars derailed, the blast pattern was over half a mile, 30 buildings were destroyed (slide photo)
- **October 19, 2013 – Gainford, Alberta**: No injuries, 100 people evacuated, 13 cars derailed
- **November 8, 2013 – Aliceville, Alabama**: No injuries, 30 cars carrying North Dakota crude oil derailed
- **December 30, 2013 – Casselton, North Dakota**: No injuries, 1,400 people evacuated, 34 cars derailed
- **January 7, 2014 – Plaster Rock, New Brunswick**: No injuries, 17 cars derailed
- **January 20, 2014 – Philadelphia, Pennsylvania**: No injuries, 7 cars derailed
- **February 13, 2014 – Vandergrift, Pennsylvania**: No injuries, 21 cars derailed
- **April 30, 2014 – Lynchburg, Virginia**: No injuries, 15 cars carrying crude oil derailed
- **May 9, 2014 – LaSalle, Colorado**: No injuries, 6 cars carrying crude oil derailed

Speakers

- Mike Faulkner, EPA, National Response Team Executive Director
- Ed Levine, NOAA, Scientific Support Coordinator
- Arron Mitchell, DOT, Director, Outreach, Training and Grants
- Shaun Singh, Transport Canada, Containment Specialist
- Christine Petitti, OSHA, Safety and Occupational Health Specialist
- Brian Kovak, EPA, Environmental Response Team
- Greg Powell, EPA, Environmental Response Team
- Patrick Lambert, Environment Canada, Head, Field Work and Response Unit
- Jordan Garrard, EPA, Region 4, On Scene Coordinator

Content

- Where is Bakken oil coming from?
- How is it being transported?
- Bakken chemistry
- Response issues
- Recent incidents
- Question & Answer Session

A railroad oil tanker car is parked along Interstate 787 in downtown Albany, N.Y., on Friday, Feb. 7, 2014. The Port of Albany has become a hub for the U.S. oil business, taking shipments from North Dakota's Bakken shale daily by mile-long trains and shipping it in tankers down the Hudson River to refineries. Opponents of a proposal to build boilers to liquefy heavy crude passing through Albany by rail are drawing attention to the capital's emergence as a major hub for the transport of oil that's widely considered risky from an environmental and safety standpoint. (AP Photo/Mike Groll)

Because the product is coming in to highly populated areas in large quantities, it is vital for first responders to engage in planning activities and preparedness efforts.

Objectives

- Provide background information on Bakken crude oil production and transportation methods
- Provide information on recent regulatory efforts to deal with Bakken crude oil transportation methods and routes
- Provide an overview of Health and Safety issues facing first responders
- Provide case studies of recent incidents

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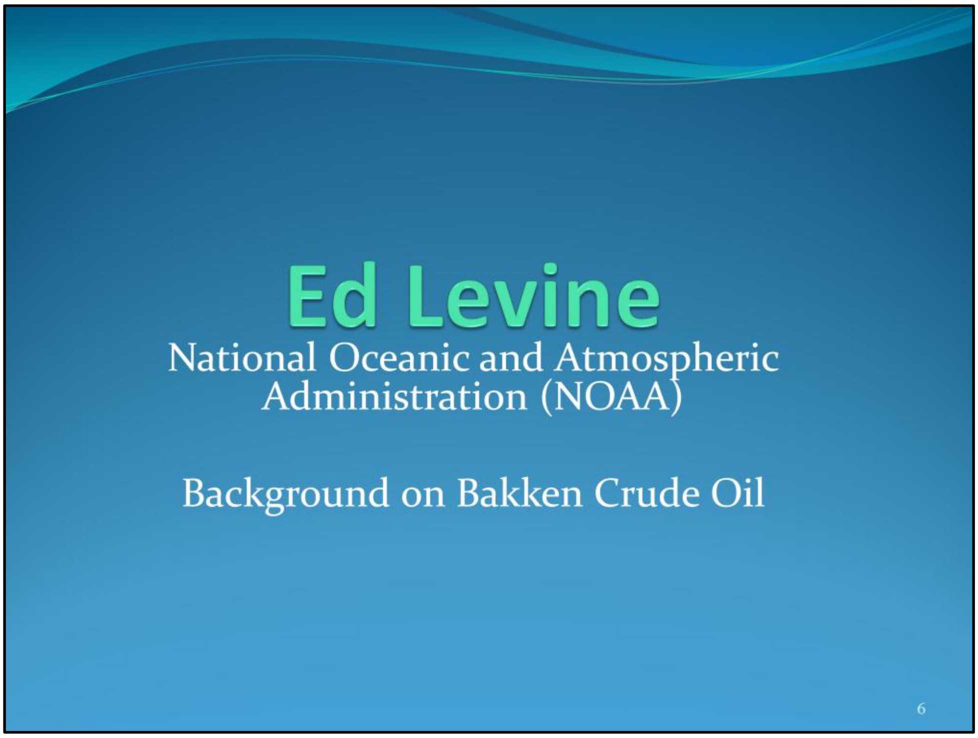
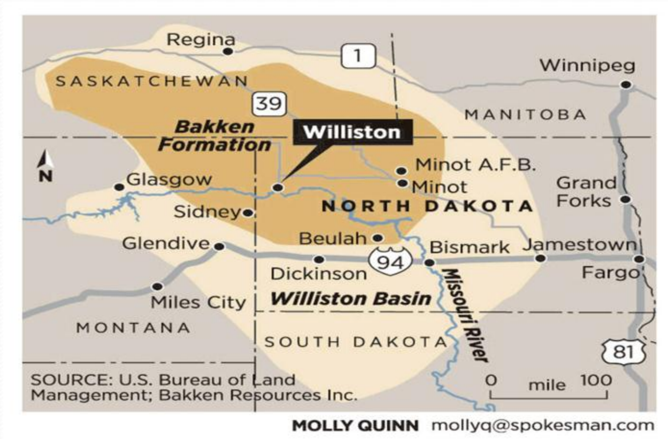
This presentation will emphasize Health and Safety.

Mike Faulkner (U.S. Environmental Protection Agency (EPA)) introduces Ed Levine (National Oceanic and Atmospheric Administration (NOAA)).



Ed Levine, the NOAA Scientific Support Coordinator in New York. This section of the presentation will cover background information on Bakken oil.

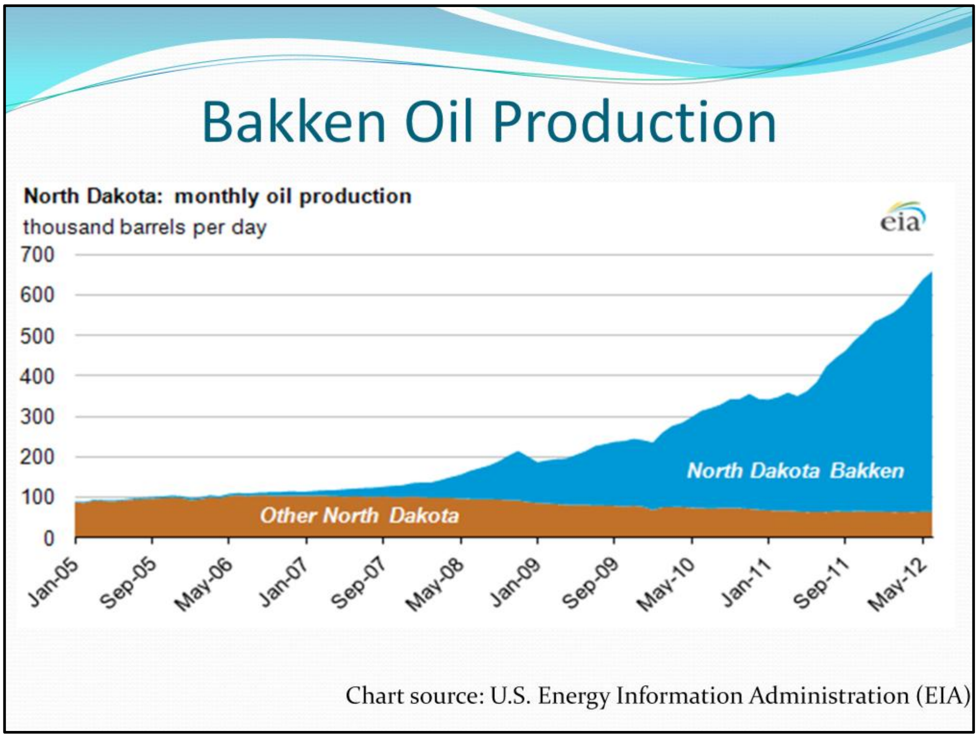
Bakken Oil Formation



The Bakken formation occupies about 200,000 square miles and underlies parts of Montana, North Dakota, Saskatchewan and Manitoba. It is named after Henry Bakken, a farmer who owned the land where the formation was initially discovered.

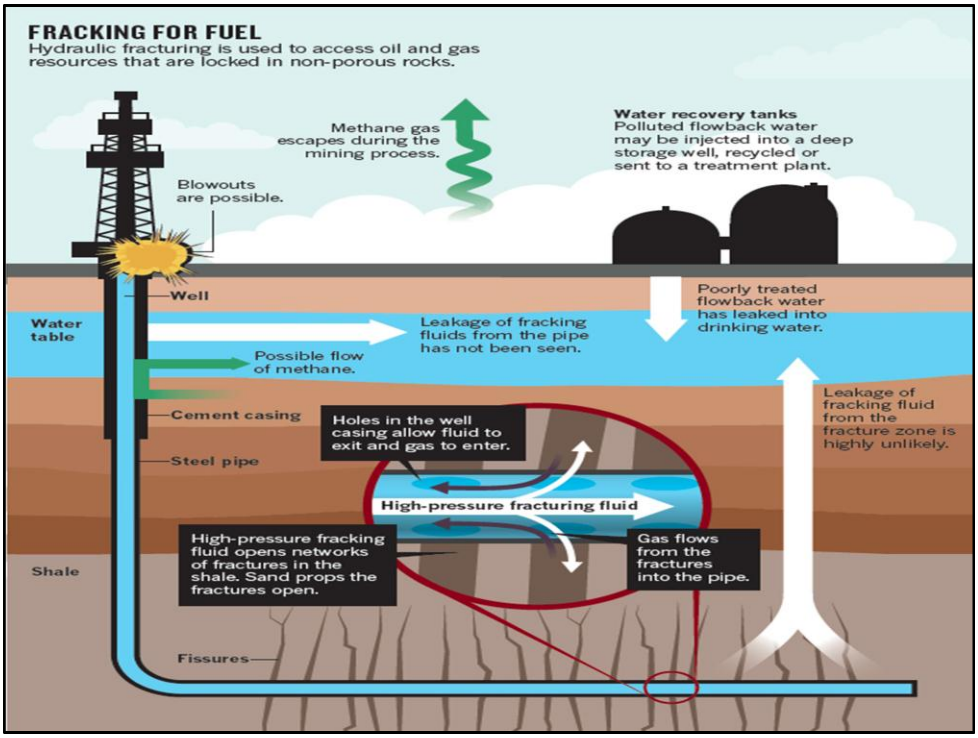
There is currently a lack of infrastructure in the area but construction is beginning to catch up to oil production activities.

Presently, the Bakken field is the area being developed, but there are other fields to be developed in the near future.



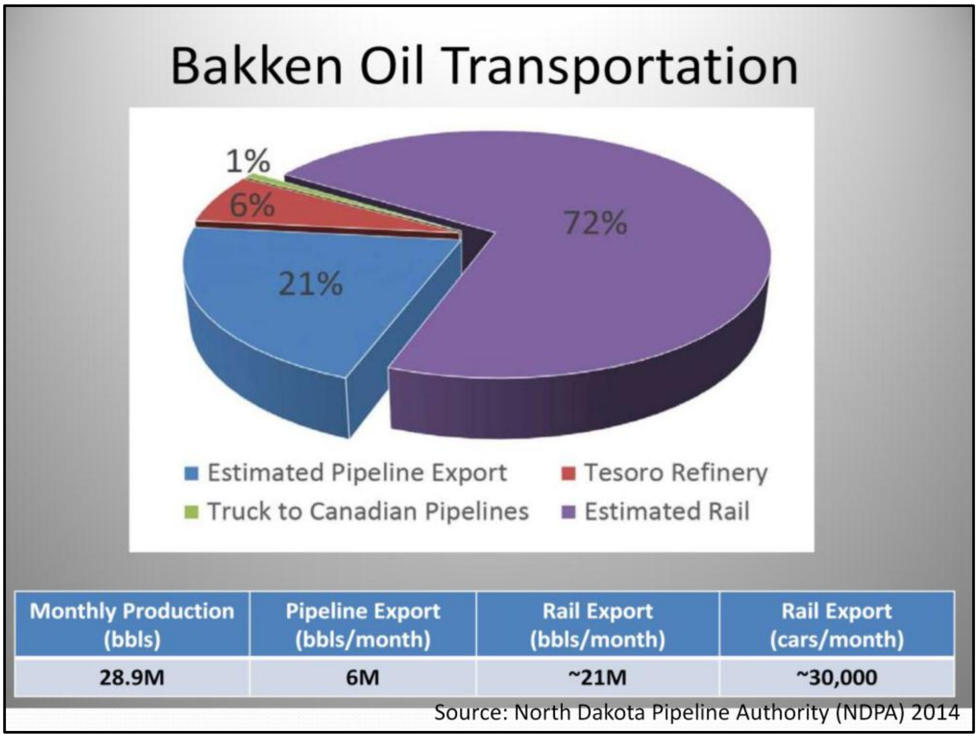
In this chart you can see the growth of Bakken oil production since 2005. In November 2013, over 10,000 Bakken wells produced about 29 million barrels of oil, over 900,000 barrels of oil daily. Growth is expected to continue. The process of hydrologic fracturing, or commonly referred to as "fracking," is the method leading to the capability to extract this oil.

Chart source: U.S. Energy Information Administration (EIA)



This slide illustrates the hydraulic fracturing process. The main difference with conventional oil drilling is the use of high-pressure fracking fluids to open fractures in the shale to allow oil and gas to flow into the pipe.

Bakken oil is a thin, light, non-conventional crude oil, not visibly distinguishable from other conventional crude oils.



Here is a pie chart showing the transportation modes for moving Bakken oil.

72% is moved by rail; 21% by pipeline; 1% trucked to Canada for transport into pipelines; and 6% of Bakken is heading to the Tesoro Refinery in the State of Washington on trains and pipeline for refining.

Source: North Dakota Pipeline Authority (NDPA) 2014

Characteristics Of The Five Types Of Oil Classifications

Gasoline Products (Group I)	Diesel-like Products and Light Crude Oils (Group II)	Medium-grade Crude Oils and Intermediate Products (Group III)	Heavy Crude Oils and Residual Products (Group IV)	Low API Oils - heavier than water (Group V)
Examples – Gasoline	Examples – No. 2 fuel oil, jet fuels, kerosene, West Texas crude, Alberta crude	Examples – North Slope crude, South Louisiana crude, No. 4 fuel oil, IFO 180, lube oils	Examples – Venezuela crude, San Joaquin Valley crude, Bunker C, No. 6 fuel oil	Examples – Very heavy No. 6 fuel oil, Residual Oils, Vacuum Bottoms, Heavy slurry oils
•Very volatile and highly flammable (flash point near 100°F/40°C)	•Moderately volatile (flash point varies 100-150°F/40-65°C)	•Moderately volatile (flash point higher than 125°F/50°C)	• Slightly volatile (flash point greater than 150°F/65°C)	• Very low volatility
•High evaporation rates; narrow cut fraction with no residues	•Refined products can evaporate to no residue; crude oils do have a residue after evaporation is completed	•Up to one-third will evaporate in the first 24 hours	• Very little product loss by evaporation	• No evaporation when submerged
• Low viscosity; spread rapidly to a thin sheen	•Low to moderate viscosity; spread rapidly into thin slicks	•Moderate to high viscosity	• Very viscous to semisolid	• Very viscous to semisolid
	•Specific gravity of <0.85; API gravity of 35-45	•Specific gravity of 0.85-0.95; API gravity of 17.5-35	• Specific gravity of 0.95-1.00; API gravity of 10-17.5	• Specific gravity greater than 1.00; API gravity less than 10
• High acute toxicity to biota	•Moderate to high acute toxicity to biota; product-specific toxicity related to type and concentration of aromatic compounds	•Variable acute toxicity, depending on amount of light fraction present	• Low acute toxicity relative to other oil types	• Low acute toxicity relative to other oil types
•Does not emulsify	•Can form stable emulsions	•Can form stable emulsions	• Can form stable emulsions	• Can form stable emulsions
•Will penetrate substrate; non-adhesive	•Tend to penetrate substrate; fresh spills are not adhesive	•Variable substrate penetration and adhesion	• Little penetration of substrate likely, but can be highly adhesive	• Little penetration of substrate likely, but can be highly adhesive
	•Stranded light crudes tend to smother organisms	•Stranded oil tends to smother organisms	• Stranded oil tends to smother organisms	• Stranded and submerged oil tends to smother organisms

This table shows the 5 Groups of oil and some properties associated with each. Oils within each of these groups are also being transported by vessels, trucks, rails and pipelines and have different chemical and physical properties.

Fresh Bakken oil is classified as a Group I oil which is very flammable, has an initial high rate of evaporation, low viscosity – spreading rapidly into sheens, may be acutely toxic, does not easily emulsify, and may penetrate substrates. Once the Bakken weathers after several hours it will behave more like a Group II or III oil.

Ed Levine (National Oceanic and Atmospheric Administration (NOAA)) introduces Shaun Singh (Transport Canada) and Aaron Mitchel (U.S. Department of Transportation (DOT)).

Shaun Singh

Transport Canada

Aaron Mitchell

U.S. Department of Transportation (DOT)

Transportation of Bakken Crude Oil

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More than two-thirds of crude oil is shipped by rail in unit trains. At the terminus of the rail shipment, oil has to be trucked or loaded onto barges for the final delivery to refineries. Unit trains are comprised of a single commodity throughout the entire train. While observing a long string of rail cars containing hazardous materials may indicate all other cars in the train are the same, the only way to be certain is to access the hazardous materials shipping documents.

It is important to note the following:

- There has been a significant increase in crude oil supply in North America, due to growing production in the Canadian oil sands and recent expansion of shale oil and natural gas production in the U.S. and Canada.
- 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 across North America.
- Transport Canada data shows that in 2008 there were small quantities of crude oil transported by rail, 128,000 carloads (89M barrels) in 2013, and a forecast of 410,000 carloads (287M barrels) by 2017.
- From 2011 to 2013, there was an exponential increase of almost 2700% in crude oil carloads by rail in Canada.
- Industry forecast indicate an increasing amounts of crude oil will continue to be transported on rail within Canada, or between Canada and the U.S., or from the U.S. through Canada back to the U.S.

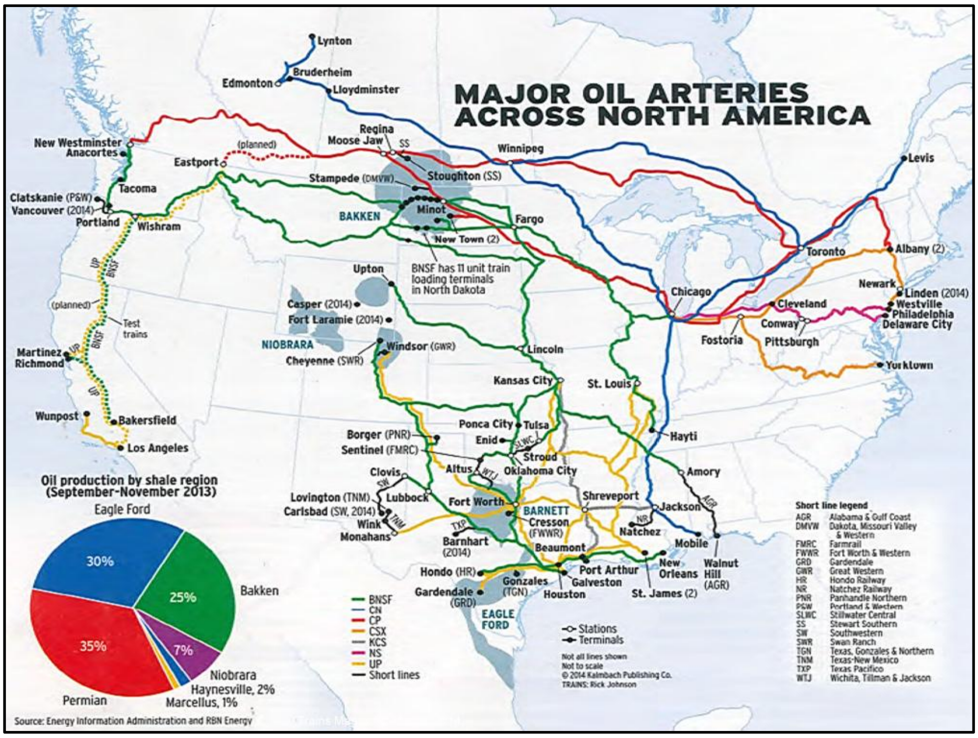
CN Rail line and Tundra Energy Marketing Ltd. constructed a crude oil railroad tank car loading terminal near Cromer, Manitoba, to meet the needs of Bakken crude oil producers in Manitoba and Saskatchewan. The terminal can currently load 30,000 barrels of crude oil per day into tank cars (about 50 cars worth). The facility has the potential to accommodate a unit train of 100 tank cars, with **each train carrying approximately 60,000 barrels (about 2.5 million gallons) per day of crude oil.** (Source: William C. Vantuono, Editor-in-Chief, RailwayAge)

Railroad tank cars used to transport hazardous materials are regulated by the U.S. Department of Transportation (DOT) and Transport Canada (TC). Almost all flammable liquids move in DOT specification 111 series tank cars (DOT 111). A DOT 111 built with an order date after October 2011, and intended to transport flammable liquids like crude oil and ethanol, will have enhanced safety features such as additional tank thickness, jacket protection, head shield protecting the ends of the tank, roll-over protection to prevent sheering of valves on top of the car and possibly thermal protection to protect the car in a fire. (Source: 2014 CSX Emergency Response to Unit Train Incidents).

The Canadian requirements are similar to the American ones, however there are differences in the regulatory department (i.e. Transport Canada) and the classification order (i.e. Protective Direction #31 http://news.gc.ca/web/article-en.do?nid=829359).

Shaun Singh (Transport Canada) introduces Aaron Mitchell (U.S. Department of Transportation (DOT)

The U.S. Department of Transportation recently issued an Emergency Order requiring all shippers to test product from the Bakken before it is transported to ensure the crude is transported in the proper packing group. The DOT uses nine different hazard classes as a guide to properly classify each material, and the material type determines one of three possible packing groups.
http://www.dot.gov/sites/dot.gov/files/docs/Amended%20Emergency%20Order%20030614.pdf



This shows the current transportation network of crude oil in the U.S.

Note: Destinations are to ports NW, NE, S and refineries (mostly in the south).

Although there are pipelines that service certain areas, infrastructure is not in place to support transport of product from the Bakken region (and other future reserves) in sufficient volume to other parts of the nation.

Pipeline and Hazardous Materials Safety Administration (PHMSA) Safety Alert

- Safety alert to notify the general public, emergency responders and shippers and carriers that recent derailments and resulting fires indicate that the type of crude oil being transported from the Bakken region may be more flammable than traditional heavy crude oil.

- PHMSA reinforced the requirement to properly test, characterize, classify, and where appropriate sufficiently degasify hazardous materials prior to and during transportation.

PHMSA Operation Safe Delivery website:
http://www.phmsa.dot.gov/hazmat/osd/emergencyresponse

NORTH DAKOTA:

Regulators order conditioning for all Bakken crude

Blake Sobczak, E&E reporter

Published: Wednesday, December 10, 2014

North Dakota energy companies will have to treat "every barrel" of crude produced in the oil-rich Bakken and Three Forks shale formations under new regulations set to take effect next year. The three-member North Dakota Industrial Commission unanimously adopted Order No. 25417 yesterday, aiming to reduce the risk of shipping the state's light, "sweet" crude oil by rail.

Specifically, the order caps crude's vapor pressure -- a rough measure of volatility -- at 13.7 pounds per square inch.

Department of Transportation (DOT) Emergency Order

- The DOT issued an **Emergency Order** (EO) that requires that each railroad operating trains containing >1,000,000 gallons of Bakken crude oil to provide notification to the SERCs about shipments.
- The EO also requires the railroads provide contact information for at least one responsible party to the SERCs and assist them as necessary to share the information with emergency responders.

In addition to the safety alerts, DOT has issued an emergency order that requires each railroad operating trains containing 1M gallons or more of Bakken crude oil, to provide notification to the State Emergency Response Commissioners (SERCs) about the shipments.

The EO also requires the railroads to provide contact information to the SERCs to assist them in sharing the information with emergency responders.

In addition to the Federal government's actions, State regulations are also being established. For instances, in North Dakota, energy companies will have to treat "every barrel" of crude produced in the Bakken and Three Forks shale formations under new regulations set to take effect next year. Specifically, the new order caps crude's vapor pressure which is a rough measure of volatility -- at 13.7 pounds per square inch.

For more information on DOT safety alerts, advisories, and emergency orders, please visit our PHMSA website at www.phmsa.dot.gov and search Safe Transportation of Energy Products.

Source: DOT docket number dot-ost-2014-0067

http://www.fra.dot.gov/eLib/Details/L05225 link to Emergency Order

Aaron Mitchell (U.S. Department of Transportation (DOT)) introduces Christine Petitti (Occupational Safety and Health Administration (OSHA)).

Christine Petitti

Occupational Safety and Health Administration (OSHA)

Health and Safety issues associated with Bakken Crude Oil

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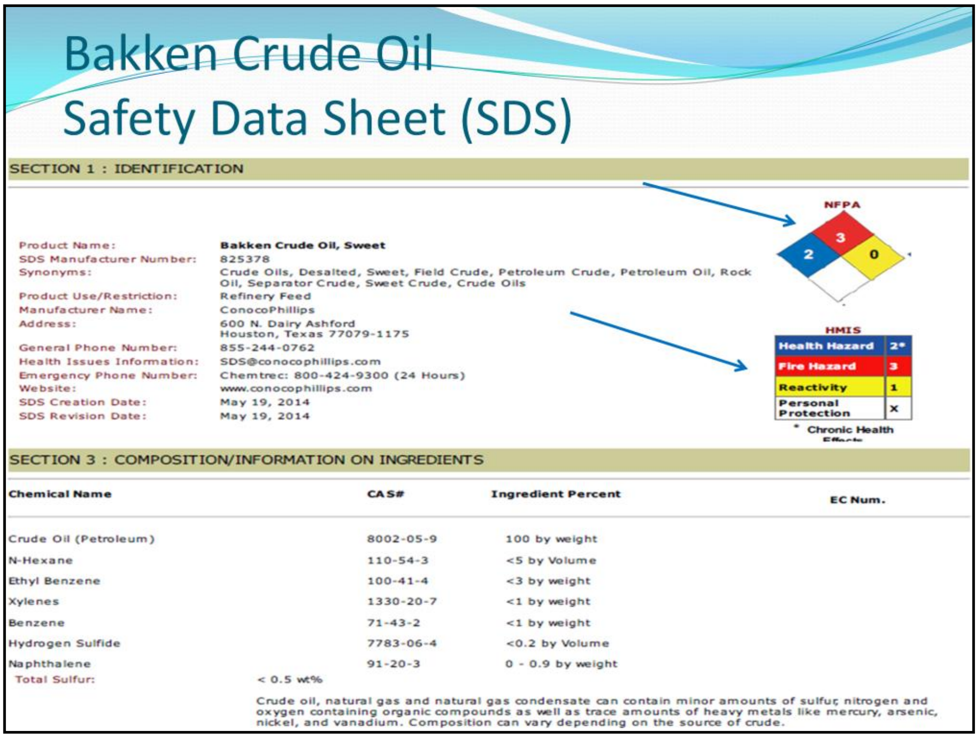


Bakken Crude Oil
Safety Data Sheet (SDS)

SECTION 1 : IDENTIFICATION

Product Name: Bakken Crude Oil, Sweet
SDS Manufacturer Number: 825378
Synonyms: Crude Oils, Desalted, Sweet, Field Crude, Petroleum Crude, Petroleum Oil, Rock Oil, Separator Crude, Sweet Crude, Crude Oils
Product Use/Restriction: Refinery Feed
Manufacturer Name: ConocoPhillips
Address: 600 N. Dairy Ashford
Houston, Texas 77079-1175
General Phone Number: 855-244-0762
Health Issues Information: SDS@conocophillips.com
Emergency Phone Number: Chemtrec: 800-424-9300 (24 Hours)
Website: www.conocophillips.com
SDS Creation Date: May 19, 2014
SDS Revision Date: May 19, 2014

NFPA
2
3
0

HMIS

Health Hazard	2*
Fire Hazard	3
Reactivity	1
Personal Protection	X

* Chronic Health

SECTION 3 : COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Ingredient Percent	EC Num.
Crude Oil (Petroleum)	8002-05-9	100 by weight	
N-Hexane	110-54-3	<5 by Volume	
Ethyl Benzene	100-41-4	<3 by weight	
Xylenes	1330-20-7	<1 by weight	
Benzene	71-43-2	<1 by weight	
Hydrogen Sulfide	7783-06-4	<0.2 by Volume	
Naphthalene	91-20-3	0 - 0.9 by weight	

Total Sulfur: < 0.5 wt%

Crude oil, natural gas and natural gas condensate can contain minor amounts of sulfur, nitrogen and oxygen containing organic compounds as well as trace amounts of heavy metals like mercury, arsenic, nickel, and vanadium. Composition can vary depending on the source of crude.

Safety Data Sheet (SDS) provides comprehensive information for use in workplace chemical management. Employers and workers use the SDS as sources of information about hazards and to obtain advice on safety precautions.

Under the New Global Harmonization Standards, the National Fire Protection Association diamond and Hazardous Materials Identification System symbol are acceptable but neither are mandated.

In the SDS, firefighting measures are specified including:

-Suitable (and unsuitable) extinguishing media.

-Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products).

-Special protective equipment and precautions for firefighters.

SECTION 5 : FIRE FIGHTING MEASURES

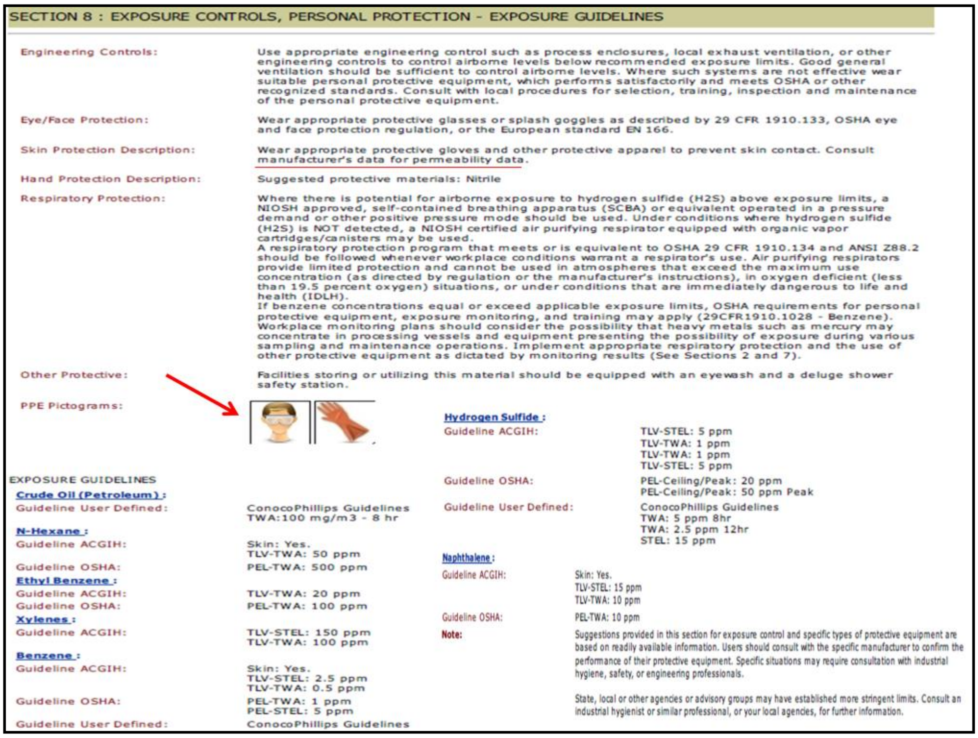
Flammable Properties:	Extremely flammable.
Flash Point:	<-20°F (<-29°C)
Flash Point Method:	Manual ASTM D53
Auto Ignition Temperature:	Not determined.
Lower Flammable/Explosive Limit:	Not determined.
Upper Flammable/Explosive Limit:	Not determined.
Fire Fighting Instructions:	Long-duration fires involving crude or residual fuel oil stored in tanks may result in a boilover. The contents of the tank may be expelled beyond the containment dikes or ditches. All personnel should be kept back a safe distance when a boilover is anticipated (reference NFPA 11 or API 2021). For fires beyond the initial stage, emergency responders in the immediate hazard area should wear protective clothing. When the potential chemical hazard is unknown, in enclosed or confined spaces, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8). Isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from immediate hazard area if it can be done safely. Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done safely. Avoid spreading burning liquid with water used for cooling purposes.
Extinguishing Media:	Dry chemical, carbon dioxide, or foam is recommended. Water spray is recommended to cool or protect exposed materials or structures. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters.
Protective Equipment:	As in any fire, wear Self-Contained Breathing Apparatus (SCBA), MSHA/NIOSH (approved or equivalent) and full protective gear.
Unusual Fire Hazards:	This material can be ignited by heat, sparks, flames, or other sources of ignition (e.g., static electricity, pilot lights, mechanical/electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. May create vapor/air explosion hazard indoors, in confined spaces, outdoors, or in sewers. This product will float and can be reignited on surface water. Vapors are heavier than air and can accumulate in low areas. If container is not properly cooled, it can rupture in the heat of a fire.
Hazardous Combustion Byproducts:	Combustion may yield smoke, carbon monoxide, and other products of incomplete combustion. Hydrogen sulfide and oxides of nitrogen and sulfur may also be formed. Hazardous combustion/decomposition products, including hydrogen sulfide, may be released by this material when exposed to heat or fire. Use caution and wear protective clothing, including respiratory protection.
NFPA Ratings:	
NFPA Health:	2
NFPA Flammability:	3
NFPA Reactivity:	0

Bakken composition is a mixture. Bakken crude is not a uniform substance and its physical and chemical properties may vary from oilfield to oilfield or within wells located in the same oilfield. The composition depends on the area it comes from and depth from which it is drilled.

Flash points vary and can depend on which lab method was used for measuring. The NFPA flammability for this example is a Class 3.

The train conductor should have the train “consist” which identifies where the cars were in the train and what is/was contained within the cars. The “consist” will contain information for contacting the company in case of further technical information requirements as well as the SDS.

This information assists in problem identification-Identify, confirm and verify the presence of hazardous materials and their quantity.



SECTION 8 : EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES

Engineering Controls:	Use appropriate engineering control such as process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Good general ventilation should be sufficient to control airborne levels. Where such systems are not effective wear suitable personal protective equipment, which performs satisfactorily and meets OSHA or other recognized standards. Consult with local procedures for selection, training, inspection and maintenance of the personal protective equipment.
Eye/Face Protection:	Wear appropriate protective glasses or splash goggles as described by 29 CFR 1910.133, OSHA eye and face protection regulation, or the European standard EN 166.
Skin Protection Description:	Wear appropriate protective gloves and other protective apparel to prevent skin contact. Consult manufacturer's data for permeability data.
Hand Protection Description:	Suggested protective materials: Nitrile
Respiratory Protection:	Where there is potential for airborne exposure to hydrogen sulfide (H2S) above exposure limits, a NIOSH approved, self-contained breathing apparatus (SCBA) or equivalent operated in a pressure demand or other positive pressure mode should be used. Under conditions where hydrogen sulfide (H2S) is NOT detected, a NIOSH certified air purifying respirator equipped with organic vapor cartridges/canisters may be used. A respiratory protection program that meets or is equivalent to OSHA 29 CFR 1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant a respirator's use. Air purifying respirators provide limited protection and cannot be used in atmospheres that exceed the maximum use concentration (as directed by regulation or the manufacturer's instructions), in oxygen deficient (less than 19.5 percent oxygen) situations, or under conditions that are immediately dangerous to life and health (IDLH). If benzene concentrations equal or exceed applicable exposure limits, OSHA requirements for personal protective equipment, exposure monitoring, and training may apply (29CFR1910.1028 - Benzene). Workplace monitoring plans should consider the possibility that heavy metals such as mercury may concentrate in processing vessels and equipment presenting the possibility of exposure during various sampling and maintenance operations. Implement appropriate respiratory protection and the use of other protective equipment as dictated by monitoring results (See Sections 2 and 7).
Other Protective:	Facilities storing or utilizing this material should be equipped with an eyewash and a deluge shower safety station.
PPE Pictograms:	

EXPOSURE GUIDELINES

Crude Oil (Petroleum) :

Guideline User Defined:	ConocoPhillips Guidelines TWA:100 mg/m3 - 8 hr

N-Hexane :

Guideline ACGIH:	Skin: Yes. TLV-TWA: 50 ppm
Guideline OSHA:	PEL-TWA: 500 ppm

Ethyl Benzene :

Guideline ACGIH:	TLV-TWA: 20 ppm
Guideline OSHA:	PEL-TWA: 100 ppm

Xylenes :

Guideline ACGIH:	TLV-STEL: 150 ppm TLV-TWA: 100 ppm

Benzene :

Guideline ACGIH:	Skin: Yes. TLV-STEL: 2.5 ppm TLV-TWA: 0.5 ppm
Guideline OSHA:	PEL-TWA: 1 ppm PEL-STEL: 5 ppm
Guideline User Defined:	ConocoPhillips Guidelines

Hydrogen Sulfide :

Guideline ACGIH:	TLV-STEL: 5 ppm TLV-TWA: 1 ppm TLV-TWA: 1 ppm TLV-STEL: 5 ppm
Guideline OSHA:	PEL-Ceiling/Peak: 20 ppm PEL-Ceiling/Peak: 50 ppm Peak
Guideline User Defined:	ConocoPhillips Guidelines TWA: 5 ppm 8hr TWA: 2.5 ppm 12hr STEL: 15 ppm

Naphthalene :

Guideline ACGIH:	Skin: Yes. TLV-STEL: 15 ppm TLV-TWA: 10 ppm
Guideline OSHA:	PEL-TWA: 10 ppm
Note:	Suggestions provided in this section for exposure control and specific types of protective equipment are based on readily available information. Users should consult with the specific manufacturer to confirm the performance of their protective equipment. Specific situations may require consultation with industrial hygiene, safety, or engineering professionals. State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

This slide focus is Personnel Protective Equipment (PPE) and DOT Emergency Response Guide #128.

Structural firefighting protective clothing (SFPC) will only provide limited protection. SFPC is porous and will absorb liquids.

Decontamination will most likely be needed for a Bakken response.

ERG is meant to supplement the hazard communication information provided with the shipping papers.

SECTION 9 : PHYSICAL and CHEMICAL PROPERTIES

Physical State:	Liquid.
Color:	Amber to Black
Odor:	Petroleum. Rotten egg / sulfurous
Odor Threshold:	Not determined.
Boiling Point:	70 to 110 ºF (21 to 43 ºC)
Melting Point:	Not determined.
Density:	5.83-8.58 lbs/gal Bulk
Specific Gravity:	0.7-1.03 @ 60ºF (15.6ºC) Reference water = 1
Solubility:	Negligible solubility in water.
Vapor Density:	>1 (air = 1)
Vapor Pressure:	8.5-15 psia (Reid VP) @ 100ºF (37.8ºC)
Percent Volatile:	Not determined.
Evaporation Rate:	Not determined.
pH:	Not applicable.
Viscosity:	Not determined.
Coefficient of Water/Oil Distribution:	Not determined.
Flash Point:	<-20ºF (<-29ºC)
Flash Point Method:	Manual ASTM D53
Auto Ignition Temperature:	Not determined.
Note:	Unless otherwise stated, values are determined at 20ºC (68ºF) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

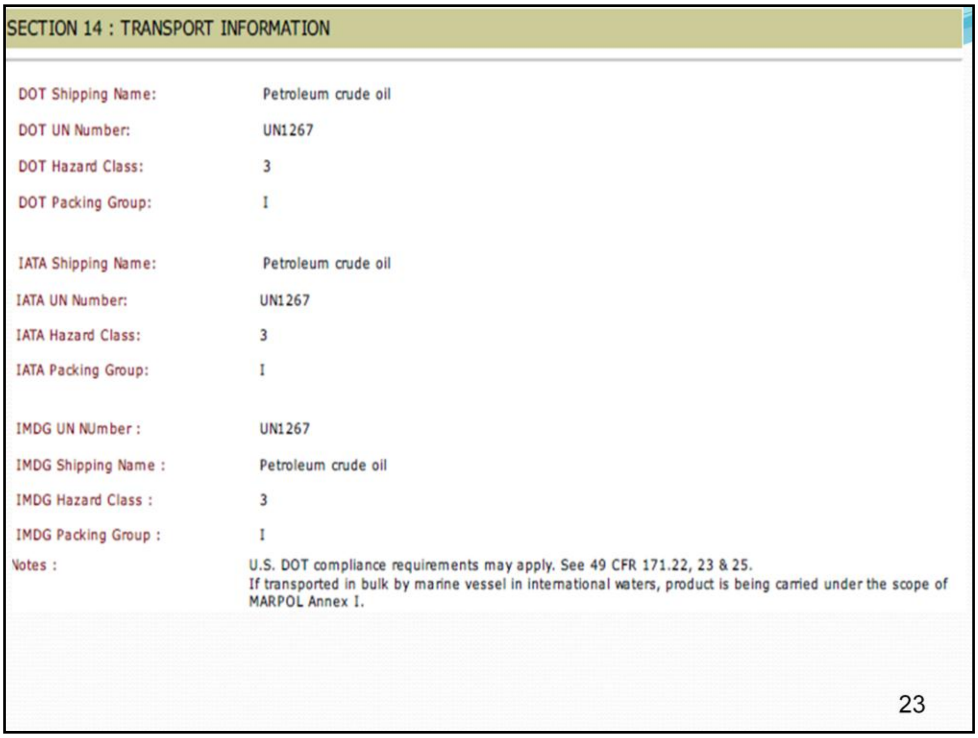
SECTION 10 : STABILITY and REACTIVITY

Chemical Stability:	Stable under normal ambient and anticipated conditions of use.
Hazardous Polymerization:	Hazardous Polymerization does not occur.
Conditions to Avoid:	Avoid high temperatures and all sources of ignition. Prevent vapor accumulation.
Incompatible Materials:	Avoid contact with strong oxidizing agents and strong reducing agents.
Special Decomposition Products:	Thermal decomposition or combustion may liberate carbon oxides, aldehydes, and other toxic gases or vapors

Specific gravity varies but the majority of Bakken floats on water.

Many SDS do not contain complete response information and first responders may need to follow up with manufacturer/technical expert for more product-specific information. Note “not determined” in a number of categories.

This can impede progress in the response and cause safety issues.



SECTION 14 : TRANSPORT INFORMATION

DOT Shipping Name:	Petroleum crude oil
DOT UN Number:	UN1267
DOT Hazard Class:	3
DOT Packing Group:	I
IATA Shipping Name:	Petroleum crude oil
IATA UN Number:	UN1267
IATA Hazard Class:	3
IATA Packing Group:	I
IMDG UN NUmber :	UN1267
IMDG Shipping Name :	Petroleum crude oil
IMDG Hazard Class :	3
IMDG Packing Group :	I
Notes :	U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 25. If transported in bulk by marine vessel in international waters, product is being carried under the scope of MARPOL Annex I.

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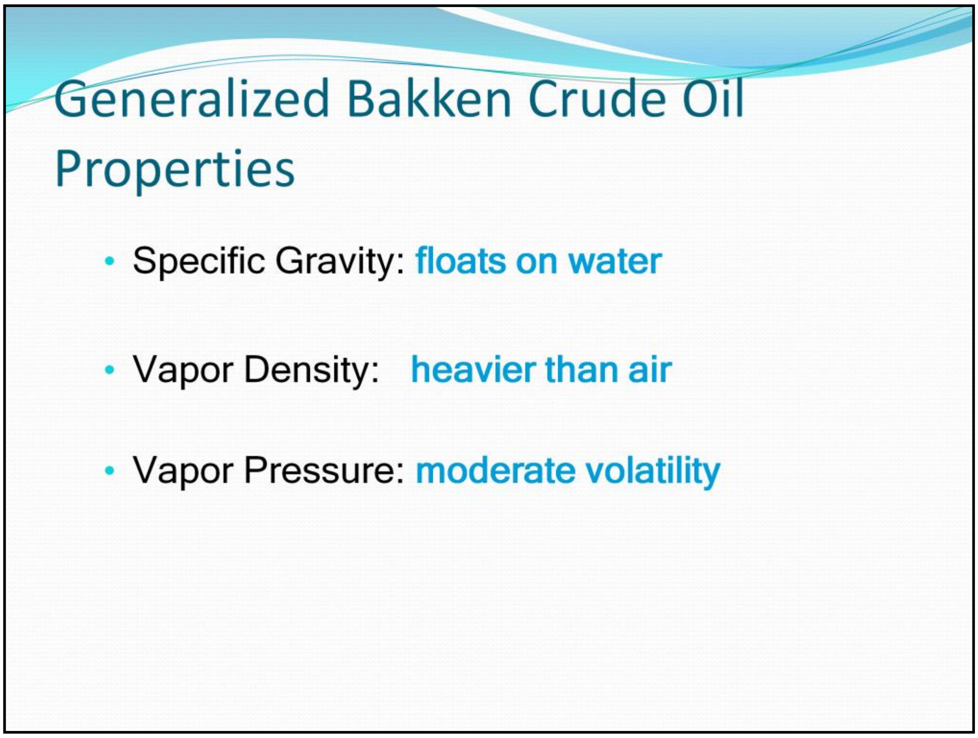
UN IDs are four-digit numbers that identify hazardous substances, in the framework of international transport. Some hazardous substances have their own UN numbers (e.g. acrylamide has UN2074), while sometimes groups of chemicals or products with similar properties receive a common UN number (e.g. flammable liquids, not otherwise specified, have UN1993). A chemical in its solid state may receive a different UN number than the liquid phase if their hazardous properties differ significantly; substances with different levels of purity (or concentration in solution) may also receive different UN numbers.

The hazard assessment and risk evaluation process is a critical step to identify the level of danger posed by an incident involving the chemical(s),containers, and their behavior.

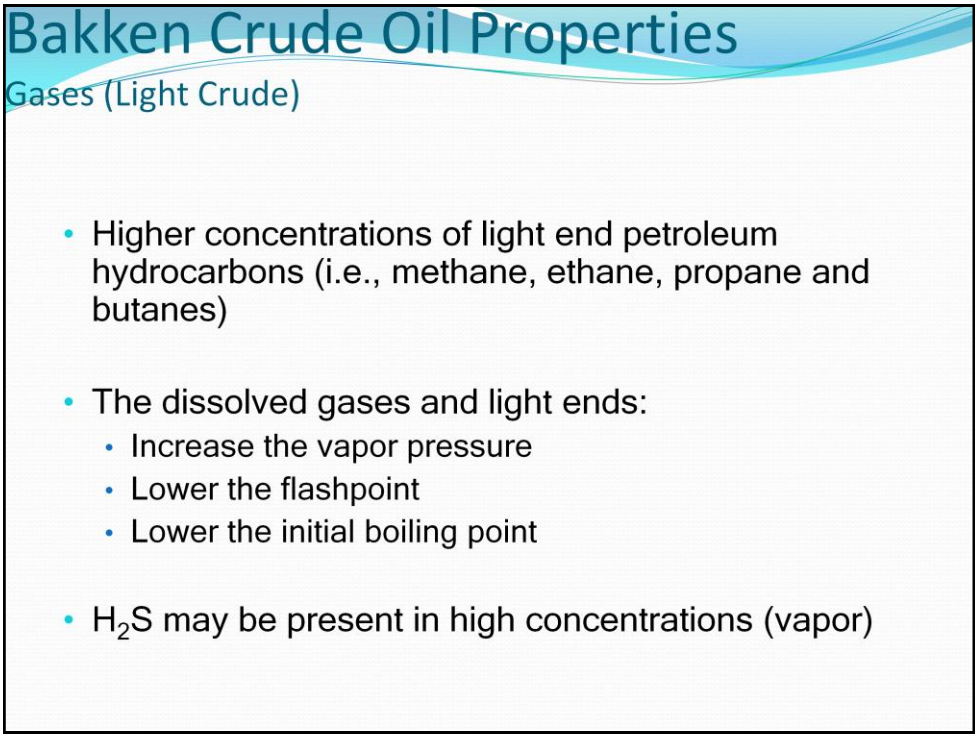


Generalized Bakken Crude Oil Properties:

- Specific Gravity 0.7 – 0.8 : **floats on water**
- Vapor Density 2.5 – 5.0: **heavier than air**
- Vapor Pressure, 280-360 mmHg: **moderate volatility**
  - Water 12.5 mmHg
  - Gasoline 400 mmHg

Volatility is the measure of how quickly a substance forms a vapor at ordinary temperatures.

Vapor pressure is the pressure exerted by a vapor in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in a closed system. A substance with a high vapor pressure at normal temperatures is referred to as *volatile*. Vapors with density heavier than air can hug ground and travel to an ignition source.



Lighter crude oils are generally regarded to have higher concentrations of light ends. This increases the vapor pressure and lowers the flash point and initial boiling point. This affects the Packaging Group of the load.

Flash Point Range = -59^{o}C[-74^{0}F] to 50^{o}C [122^{o}F]

The lower BP = greater volatility (Used to evaluate risk)

H_2S is typically low in Bakken crude due to it being a “sweet” crude but there have been instances of high concentrations.

Cited from **American Fuel & Petrochemical Manufacturers** (AFPM) 2014 paper, “A Survey of Bakken Crude Oil Characteristics Assembled for the U.S. Department of Transportation”

Bakken Crude Oil Properties

Flammability

- NFPA Flammability = 3-4
  - Sensitive to static discharge
- Explosive Limits variable:
  - LEL 0.4%
  - UEL 15.0%
- Flash point : - 40° to 212° F
  - - 74° to 122° F (AFPM data)

LEL: Lower Explosive Limit
UEL: Upper Explosive Limit

When LEL & UEL are not on the SDS, call the shipper.

Christine Petitti (Occupational Safety and Health Administration (OSHA)) introduces Brian Kovak (U.S. Environmental Protection Agency (EPA)).

Brian Kovak

U.S. Environmental Protection Agency (EPA)

Health and Safety Issues - continued

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H_2S Concentration & Health Effects

Concentration (ppm)	Health Effect
0.01 - 0.3	Odor Threshold (variable)
1.0 - 5.0	Odor, Nausea, eye irritation, headache
20 - 50	Keratoconjunctivitis, lung irritation
100	IDLH, Olfactory fatigue in 3-5 minutes; altered respiration, coughing, drowsiness
100 - 150	Eye & lung irritation, olfactory paralysis
200	Olfactory fatigue shortly; stinging eyes and throat, death after 1-2 hours exposure
250 - 500	Pulmonary edema, convulsions, risk of "knockdown"
500 - 1000	Unconsciousness, risk of respiratory paralysis, loss of muscle control, self-rescue impossible
> 1000	Respiratory paralysis, death

Chemical characteristics of hydrogen sulfide:

- Colorless, flammable, toxic gas, rotten egg odor
- Heavier than air, soluble in water and oil
- Explosive in air: 4.3 - 45.5% concentration (volume)
- Auto ignition at 500°F

Spill Response Considerations

Monitoring Equipment

- For Spill:
  - 4 or 5 gas monitors for O_2, LEL, H_2S
  - PID/FID for VOCs (FIDs may be more sensitive)
  - Chemical-specific monitors for benzene
    - Colorimetric tubes
    - PID with benzene tube
- Additionally, for fire:
  - Particulate monitors for Polynuclear Aromatic Hydrocarbons (PAHs) sampling
  - Monitors or sampling equipment for particulates (smoke)

Bakken oil vaporizes much more quickly than other crude oils. The oil contains more light ends, it is more flammable, and more volatile than other crude oils.

Spill Response Considerations

Safety

- Air monitoring - ***Spill***
  - O_2
  - Explosive Levels – LEL/UEL
  - H_2S
  - Benzene
  - Organic vapors (VOCs)

Spill Response Considerations

Safety

- Air monitoring - ***Fire***
  - O_2
  - CO
  - Explosive Levels – LEL/UEL
  - H_2S
  - Benzene
  - Organic vapors (VOCs)
  - Sulfur and Nitrogen Oxides
  - Particulates - smoke

Exposure Guidelines

Component	ACGIH	NIOSH	OSHA
Petroleum (8002-05-9)	Not established	CEIL: 1800 mg/m3 TWA: 350 mg/m3	Not established
Hydrogen sulfide (7783-06-4) [Oregon <1]	TWA: 1 ppm STEL: 5 ppm	CEIL: 10 ppm	CEIL: 20 ppm
Benzene (71-43-2) [Oregon 0.25 ppm]	TWA: 0.5 ppm STEL: 2.5 ppm	TWA: 0.1 ppm STEL: 1 ppm	TWA: 1 ppm STEL: 5 ppm
Ethylbenzene (100-41-4)	TWA: 20 ppm	TWA: 100 ppm STEL: 125 ppm	TWA: 100 ppm
Toluene (108-88-3)	TWA: 20 ppm	TWA: 100 ppm STEL: 150 ppm	TWA: 200 ppm CEIL: 500 ppm

The **permissible exposure limit** (**PEL** or **OSHA PEL**) is a limit for exposure of an employee to a chemical substance or physical agent. A PEL is usually given as a time-weighted average (TWA), although some are short term exposure limits (STEL) or ceiling limits (CEIL).

The NIOSH recommended exposure limits (**REL**s) are listed in the center column. For NIOSH RELs, "**TWA**" indicates a time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek. A short-term exposure limit (STEL) is designated by "**ST**" preceding the value; unless noted otherwise, the STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday. A ceiling REL is designated by "**C**" preceding the value; unless noted otherwise, the ceiling value should not be exceeded at any time.

TWA concentrations for OSHA **PEL**s must not be exceeded during any 8-hour workshift of a 40-hour workweek. A STEL is designated by "**ST**" preceding the value and is measured over a 15-minute period unless noted otherwise. OSHA ceiling concentrations (designated by "**C**" preceding the value) must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.

Brian Kovak (U.S. Environmental Protection Agency (EPA)) introduces Greg Powell (U.S. Environmental Protection Agency (EPA)).

Greg Powell

U.S. Environmental Protection Agency (EPA)

Response issues associated with a Bakken Crude Oil spill

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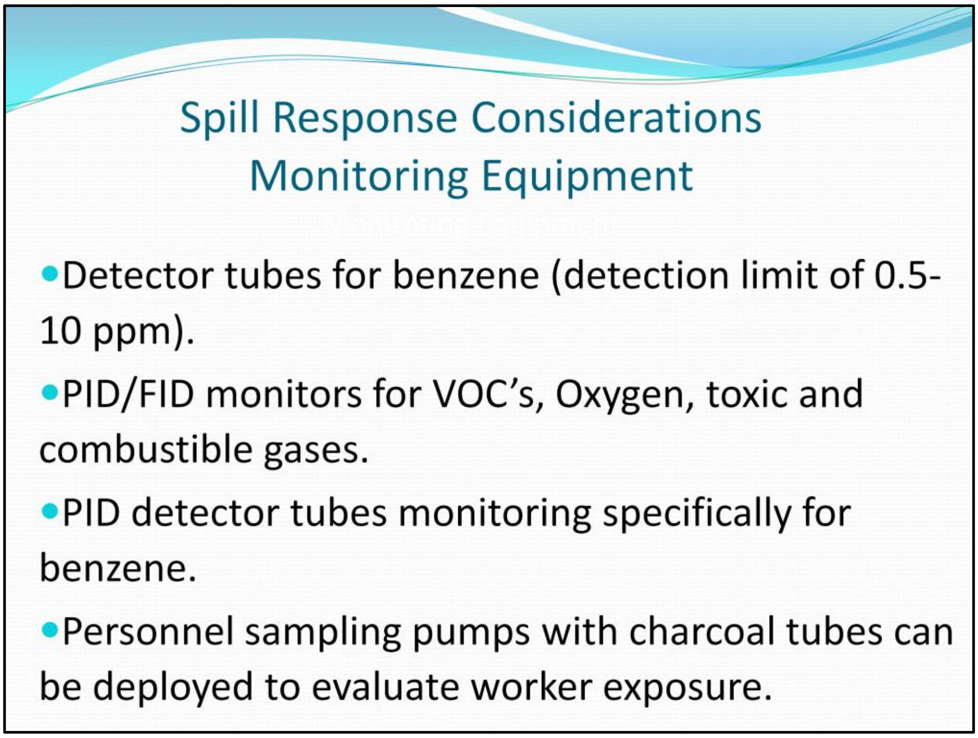
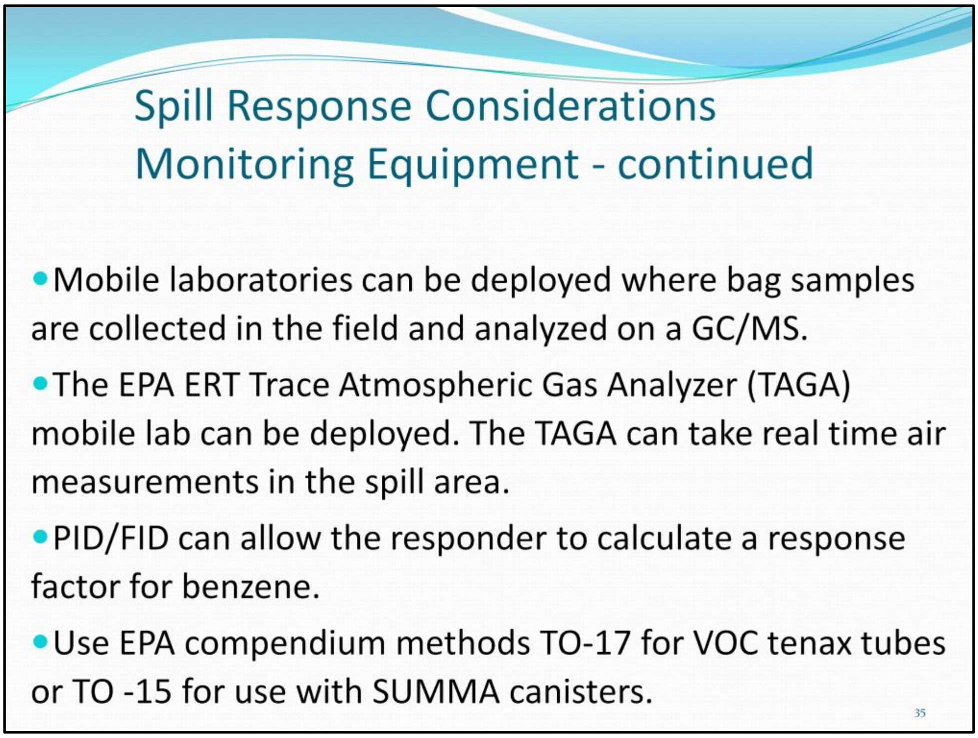


MultiRae Pro electrochemical sensors can be selected for specific compounds. Benzene is not one of the compounds .

The UltraRae 3000 can monitor specifically for benzene. A benzene tube must be added to the instrument to scrub out compounds associated with benzene vapors. This provides a single time measurement for benzene. The range of detection is from 50 ppb to 200 ppm. High humidity can affect the tubes ability to scrub out aromatics.

Passive Samplers can be utilized for worker for protection. The sorbent media absorbs VOC's from the ambient air. There are several factors that affect sample uptake and retention including concentration of chemicals, time of exposure, interfering chemicals, humidity, etc.



A spill of crude oil will have a number of aromatics off gassing. The TVA 1000 will respond to all the detectable compounds; therefore, a response factor for benzene can not be calculated due to the number of compounds present. TVA 1000 PID/**FID** will allow the responder to calculate a response factor for benzene.

Spill Response Considerations
Additional Monitoring Equipment needs if a fire is involved

- Particulate sampling
- PAH monitoring with XAD absorption tubes (NIOSH method 5506)
- Monitor for SO_2 using real time reading instruments

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Patrick Lambert

Environment Canada

Lac- Megantic incident - Quebec

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At 01:15 on July 6, 2013 an unattended Montreal, Maine and Atlantic train derailed in the center of the Town of Lac-Megantic, Quebec, Canada. The train contained 72 railcars of petroleum crude oil UN 1267 originating from the Bakken shale oil deposit of North Dakota. The train was destined for the Irving Oil refinery in Saint John, New Brunswick. Only the 10 rear railcars remained upright on the tracks. Almost all the derailed railcars were damaged and many were significantly damaged with large breaches. Each railcar contained approximately 26,000 gallons of crude oil with the estimated total spill volume of about 1,600,000 gallons. The fire and explosions began almost immediately following the derailment and continued for more than a day. The initial response to the fire involved the local volunteer fire department but rapidly increased to include nearby fire services including those from Maine and the larger Cities from across Quebec. Water and foam were used to control and eventually suppress the flames. Three days following, on Monday, July 8, 2013 fire fighters were able to address the remaining hot spots. In all 2000 residences of a town of 6000 had to evacuate their homes. Tragically, 47 people lost their lives. Most of the downtown core of the town was destroyed.

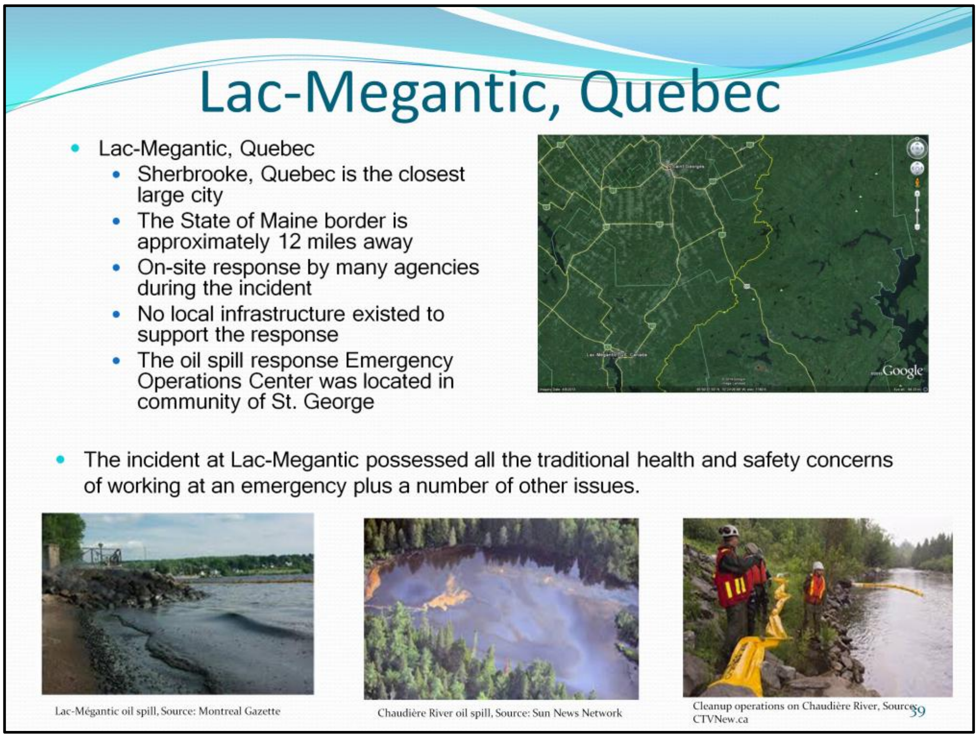


Photo Description – A GoogleEarth map and pictures of the crude oil which flowed from the derailment site to Lac-Mégantic and the Chaudière River.

In order to more clearly understand the issues related to health and safety it is necessary to provide some information from a logistical perspective. The community is located in the Province of Quebec near the State of Maine Border. Tourism, pulp and paper and the railway are prominent industries. Most of the roads in the area are 2 lane highways. The City of Sherbrooke, Quebec is approximately a 1.5 hour drive. Quebec City and Montreal are each about 1 hour additional driving distance. Lac-Mégantic did not possess sufficient infrastructure to support the required multi-agency response. The Emergency Operations Center was located in the community of St. George approximate 27 miles away. Thus, regardless of the location of ones operations center, health and safety planning had to take into consideration considerable travel times to reach and support field workers.

The incident at Lac-Mégantic possessed all the traditional health and safety concerns for emergency response personnel who are required to respond on-site at an emergency. Slip, trip, fall, traffic and heavy equipment, drowning, inclement weather, acoustic, falling from elevation, falling objects, heavy lifting, remote work sites and restricted access, biological hazards like vector borne diseases, etc., are examples. Work within the red zone was restricted to those directly involved in addressing the immediate public safety issues as well as the police investigation. In the yellow zone workers employed typical health and safety protocols for this type of incident and could safely manage their activities however, there was a large number of groups with heavy equipment operating throughout the yellow zone. Further down the Chaudière River, health and safety concerns more commonly linked to remote site work, took on a higher priority.

Some examples of specific health and safety concerns at Lac-Megantic noted by Environment Canada (EC) personnel dealing with the oil spill:

EC environmental emergency staff were deployed to the site on the morning of July 6, 2013. Crude oil had already reached the lake and river. Local fire and police officials had established and secured the site safety zones. The odor from the crude oil and fires was notable even outside the secured site safety zones. Initial chemical information on the crude oil including material safety data sheets was lacking but obtained several days later.

The fires were intense and continued for approximately two days following the initial derailment as each derailed railcar was a potential further fuel source for the fire. The fire destroyed structures near the derailment site down to their concrete foundations. Automobiles involved in the fire were almost unrecognizable. The fire created fractured rock and twisted the metal frame of the boardwalk near the lake.

There were numerous explosions during the first day. A risk of further fire and explosions existed throughout the recovery operations and for several weeks until all derailed railcars and crude oil were addressed. Crude oil was present in the railcars, saturated the ground and was present in pools in the foundations of houses within the red zone.

The presence of volatile organic compounds (VOCs), especially benzene was an immediate and ongoing health and safety concern. In additional to the red zone, VOCs were recorded in the yellow and green zones as well as by the oil spill response crews working along the full length of the lake and river. The Province of Quebec deployed their *Trace Atmospheric Gas Analyzer* (TAGA) mobile air monitoring vehicle in support to the response. Private contractors were also used to assist with air monitoring.

Various agencies including the police and fire departments were undertaking investigations. All workers, regardless of the zone in which they were undertaking their operations, were required to take appropriate health and safety protocols for workers who could come into contact with evidence.

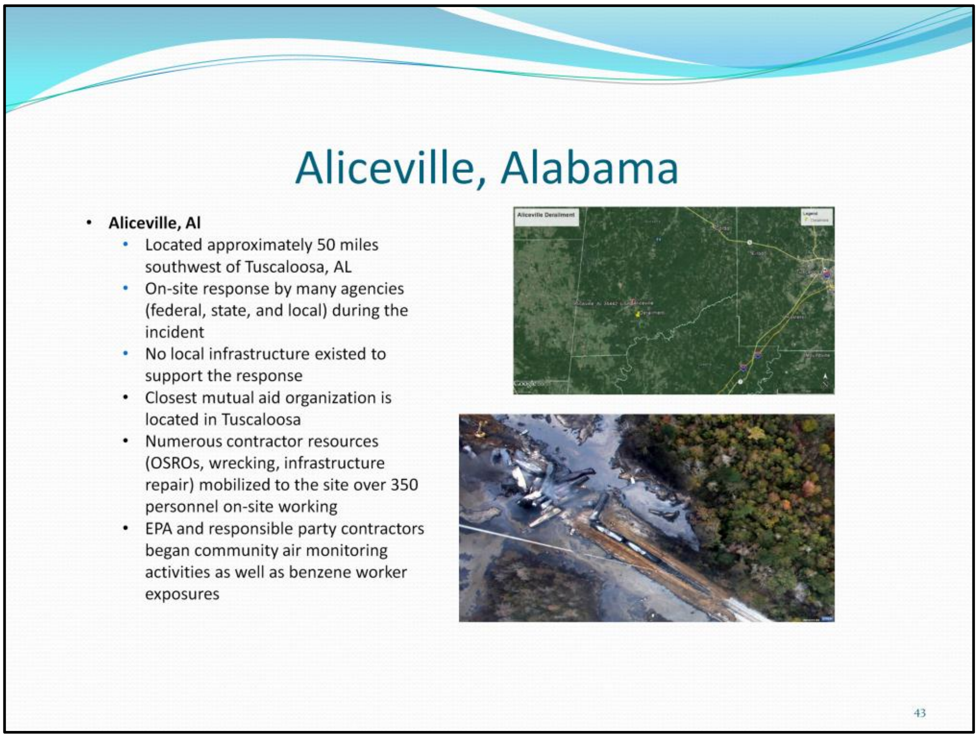
Patrick Lambert (Environment Canada) introduces Jordan Garrard (U.S. Environmental Protection Agency (EPA)), speaking about Aliceville, Alabama.

Jordan Garrard

U.S. Environmental Protection Agency (EPA)

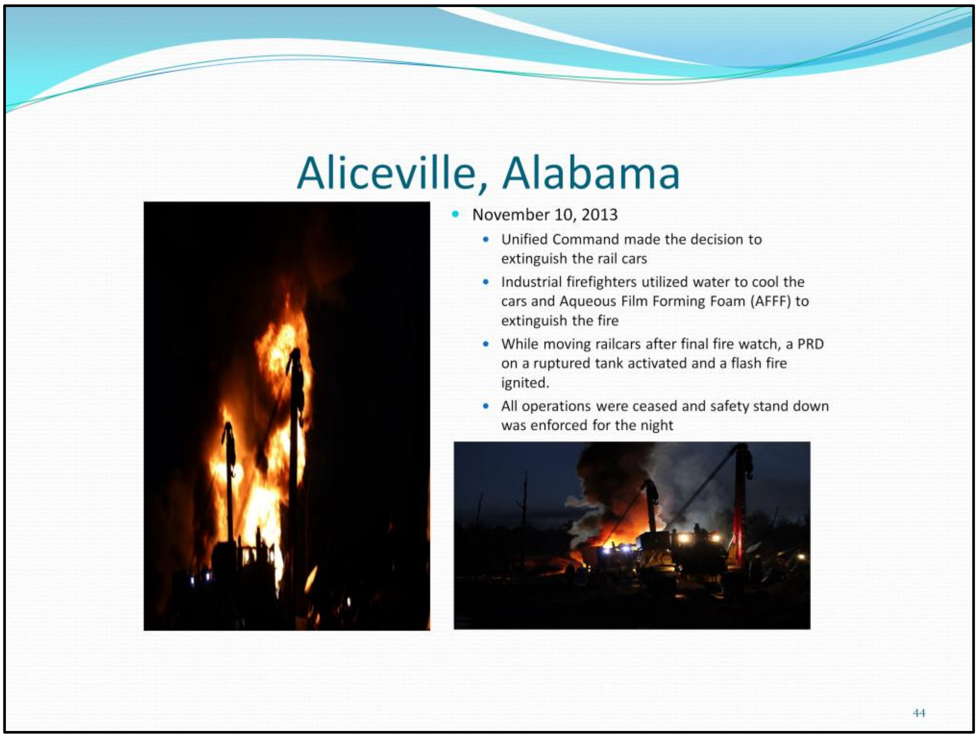
Aliceville incident - Alabama

At approximately midnight on Friday, November 8, 2013, A 90 car Bakken crude unit train derailed and caught fire outside of Aliceville, Ala. The train was heading to a pipeline injection terminal in Walnut Hill, Fl. Twenty six (26) DOT 111 tanker cars derailed and caught fire immediately. It is estimated the derailed railcars were carrying 750,000 gallons of Bakken crude oil. The derailment occurred in a wetland at the head waters of a tributary of Lubbub Creek. Lubbub Creek discharges into the Tombigbee River, which is utilized for by the surrounding communities as a source of drinking water and barge transportation. Due to the danger and difficulty accessing the tank cars, first responders decided to let the railcars burn themselves out. Initial responders included the Perry County volunteer fire department, and the hazardous materials team from the Tuscaloosa Alabama Fire Department. Multiple federal and state agencies including Alabama Department of Environmental Management, Federal Railroad Administration, and United States Environmental Protection Agency also responded and joined Unified Command. Alabama Gulf Coast Railway (AGR) also mobilized multiple contractor resources to respond to this incident.



Aliceville, Al is located approximately 1 hour southwest of Tuscaloosa, Al. Due to the isolated location of the derailment all responders needed to commute to spill, which add 2 hours to the 12-14 hour workday causing fatigue within the work force. The derailment occurred in an isolated swampy area, responding crews had to create access roads to get equipment to the spill location. The construction of access roads and traditional rail wrecking operations caused personnel to be working in close proximity to heavy equipment. With multiple contractors conducting different activities in the same congested area, the risk of personnel being struck by heavy equipment was significant. The use of spotters helped reduce those risks.

Community air monitoring was conducted throughout the response by EPA and Alabama Gulf Coast Rail. The surrounding area was monitored for VOCs, Benzene, Toluene, Xylene, NO2, SO2, H2S, CO, and particulates. Air monitoring at the derailment site indicated particulate concentrations as high as 2 mg/m^3 and benzene concentration of 0.3 ppm. Perimeter air monitoring revealed peak particulate concentrations of 385.1 ug/m^3 and total VOCs concentrations 2.6 ppm downwind of the derailment. Contractors conducted work place air monitoring throughout the entire response. A benzene worker exposure program was initiated as well. The benzene worker exposure program was comprised of a representative population of workers from the similar exposure groups or SEGs. The SEGs were defined by work task and their potential exposure to petroleum vapors. The selected workers wore benzene dosimeter badges which were then sent offsite for analysis.



On November 10th, Unified Command decided to move forward and extinguish the rail cars, utilizing aqueous film forming foam (AFFF) and contracted industrial fire fighters. While moving a rail car, after the final fire watch, a pressure relief device on a ruptured railcar activated and a flash fire ignited. A second flash fire occurred approximately 20 minutes later. The fires were extinguished again. All operations were ceased and a safety stand down for the evening was issued, canceling night operations. Industrial fire fighters continued to cool rail cars and rail bed for the remainder of the night. The source of the ignition was never determined but, it is believed that the fire was caused due to oil coming into contact with hot metal or ballast material. Due to the possible re-ignition of the oil, industrial firefighters remained on-scene until all oil was transferred from the impacted rail cars.

Aliceville, Alabama

- 748,000 gallons of oil in the derailed rail cars
- 208,952 gallons transferred from damaged rail cars
- 19,642 gallons of oil recovered from surface water
- 8,000 tons of soil excavated
- 539,751 gallons of discharged into the environment

Health and Safety Issues:

- Large sustained fire with re-ignitions
- The presence of volatile organic compounds (VOCs), including benzene, as well as particulates
- Multiple contractors conducting various activities with heavy equipment within close proximity
- Long work days excluding 2 hours of commuting

Photos: John Wathen

Approximately 750,000 gallons of oil was contained in the derailed rail cars. An estimated 539,000 gallons of oil was discharged into the environment. Cleanup crews were onsite for 31 days. Cleanup crews continue to make regular scheduled visits to the site to conduct remediation activities.


Mike Faulkner
U.S. Environmental Protection Agency (EPA)
NRT Executive Director
Summary
Questions/Answers
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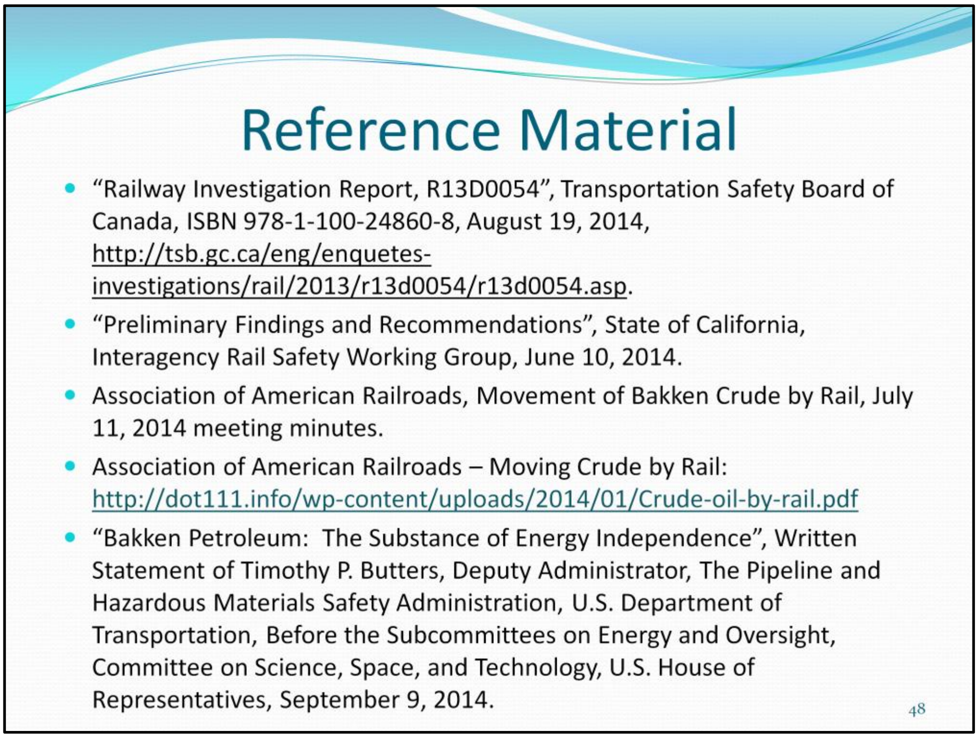
Bakken Oil Summary

- Flammable and more volatile because of dissolved gases and other petroleum hydrocarbon light ends
- As it weathers, recommend treating a Bakken response as similar to a very light crude oil
- May contain hydrogen sulfide in varying concentrations
- Transported by rail and pipeline, in addition to trucks and vessels
- New regulations are being developed to deal with the volatility of this flammable oil as well as enhanced rail safety
- Emergency personnel need to be aware of the chemical and physical characteristics as well as the health and safety issues associated with a Bakken oil spill response



- "Railway Investigation Report, R13D0054": The Transportation Safety Board is Canada's federal agency that investigates rail, air and other types of incidents. Much like the NTSB. They completed their investigation of the Lac-Megantic incident and their report is posted on the website listed on the slide.

Additional References:

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http://www.thestar.com/news/canada/2013/08/14/lac_megantic_air_water_quality_returning_to_normal_quebec_says.html

Développement durable, Environnement et Lutte contre les changements climatiques, Province of Québec, Tragédie ferroviaire à Lac-Mégantic, September 2014
http://www.mddelcc.gouv.qc.ca/lac-megantic/index.htm

Questions?

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Feedback

We welcome feedback regarding today's training.

Feedback should be submitted to Roberta Runge, NRT Training Subcommittee Chair, at Runge.Roberta@epa.gov.