Emerging Risks
Responder Awareness Training
Bakken Crude Oil
Bakken Crude Oil
DEVELOPED BY NRT TRAINING SUBCOMMITTEE,
JUNE 2014
Content

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

- Mike Faulkner, U.S. EPA
- Ed Levine, NOAA
- Brian Schleiger, U.S. EPA
- TBD, U.S. DOT
- Josee Boudreau, Environment Canada
- Christine Petitti, OSHA
- Brian Kovack, U.S. EPA
- Greg Powell, U.S. EPA
- Patrick Lambert, Environment Canada
- Jordan Garrard, U.S. EPA
Bakken Oil Formation
Bakken Oil Production

North Dakota: monthly oil production
thousand barrels per day

Jan-05, Sep-05, May-06, Jan-07, Sep-07, May-08, Jan-09, Sep-09, May-10, Jan-11, Sep-11, May-12

North Dakota Bakken
Other North Dakota
Bakken Oil Transportation

- Estimated Pipeline Export: 72%
- Truck to Canadian Pipelines: 6%
- Tesoro Refinery: 1%
- Estimated Rail: 21%

<table>
<thead>
<tr>
<th>Monthly Production (bbls)</th>
<th>Pipeline Export (bbls/month)</th>
<th>Rail Export (bbls/month)</th>
<th>Rail Export (cars/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.9M</td>
<td>6M</td>
<td>~21M</td>
<td>~30,000</td>
</tr>
</tbody>
</table>
There are other oil sands products you need to be aware of transported by rail and pipeline:

- **Oil sands (tar sands):** Naturally-occurring combination of bitumen, clay, sand, and water
- **Bitumen:** Semi-solid raw petroleum product resulting from in-situ partial biodegradation of crude oil reserve
- **Diluent:** Any lighter viscosity petroleum product used to dilute bitumen for transportation
- **Dilbit:** Diluted bitumen, bitumen mixed with any diluent for transport
- **Synbit:** Bitumen combined with synthetic crude oil
- **Dilsynbit:** Synbit combined with a diluent
Brian Schlieger

U.S. EPA
By Pipeline....

Photo: Huffington Post
Pipeline Break

Photo: NTSB
By Rail....
TBD
U.S. DOT
U.S. Oil Transport by Rail

Waybill Sample 2010 - All Commodities

Legend:
- Major Cities
- All Commodities — Net Tons
  - < 10,000,000
  - 10,000,001 - 50,000,000
  - 50,000,001 - 100,000,000
  - > 100,000,000

Image: Department of Transportation – Federal Railroad Administration
New tank cars are being built to meet shipping demands

- Manufactured for 286,000 lb. capacity
- Meets AAR roll-over protection requirements for 49 CFR, Part 172, Packaging Groups I, II and III
- Equipped with half head-shields

Image Credit: American Railcar Industries
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)
PHMSA Safety Alert

• Emergency responders should remember that light sweet crude oil, such as that coming from the Bakken region, is typically assigned a packing group (PG) I or II

• The PGs mean that the material’s flashpoint is below 73 degrees Fahrenheit and, for PG I materials, the boiling point is below 95 degrees Fahrenheit

• This means the materials pose significant fire risk if released from the package in an accident
DOT Emergency Order

- Trains carrying large amounts of crude oil from the Bakken region are required to notify State Emergency Response Commissions (SERCs) of their trains' operation through their states, if the trains are carrying more than 1 million gallons of Bakken crude, or about 35 tank cars.
- This notification must include estimated volumes of Bakken crude oil, frequency of anticipated train traffic, and the route the train is taking.
- The railroad must provide contact information for at least one responsible party at the railroads to the SERCs.
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

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS#</th>
<th>Ingredient Percent</th>
<th>EC Num.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Oil (Petroleum)</td>
<td>8002-05-9</td>
<td>100 by weight</td>
<td></td>
</tr>
<tr>
<td>N-Hexane</td>
<td>110-54-3</td>
<td>&lt;5 by Volume</td>
<td></td>
</tr>
<tr>
<td>Ethyl Benzene</td>
<td>100-41-4</td>
<td>&lt;3 by weight</td>
<td></td>
</tr>
<tr>
<td>Xylenes</td>
<td>1330-20-7</td>
<td>&lt;1 by weight</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>&lt;1 by weight</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>7783-06-4</td>
<td>&lt;0.2 by Volume</td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td>0 - 0.9 by weight</td>
<td></td>
</tr>
<tr>
<td>Total Sulfur</td>
<td></td>
<td>&lt; 0.5 wt%</td>
<td></td>
</tr>
</tbody>
</table>

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.
## 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 |
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).

**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:

**N-Hexane:**
Guideline ACGIH: TWA: 100 mg/m 3 - 8 hr
Guideline OSHA: PEL: 150 ppm

**Ethyl Benzene:**
Guideline ACGIH: TWA: 100 ppm
Guideline OSHA: PEL: 150 ppm

**Xylenes:**
Guideline ACGIH: TWA: 100 ppm
Guideline OSHA: PEL: 150 ppm

**Benzene:**
Guideline ACGIH: TWA: 100 ppm
Guideline OSHA: PEL: 150 ppm
Guideline User Defined: ConocoPhillips Guidelines

**Hydrogen Sulfide:**
Guideline ACGIH: TLV-STEL: 15 ppm
Guideline OSHA: PEL-Ceiling/Peak: 20 ppm

**Naphthalene:**
Guideline ACGIH: TLV-STEL: 15 ppm
Guideline OSHA: PEL-STEL: 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.
### SECTION 9: PHYSICAL and CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical State</td>
<td>Liquid</td>
</tr>
<tr>
<td>Color</td>
<td>Amber to Black</td>
</tr>
<tr>
<td>Odor</td>
<td>Petroleum, Rotten egg / sulfurous</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>Not determined</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>70 to 110 °F (21 to 43 °C)</td>
</tr>
<tr>
<td>Melting Point</td>
<td>Not determined</td>
</tr>
<tr>
<td>Density</td>
<td>5.83-8.58 lbs/gal Bulk</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.7-1.03 @ 60°F (15.6°C) Reference water = 1</td>
</tr>
<tr>
<td>Solubility</td>
<td>Negligible solubility in water</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>&gt;1 (air = 1)</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>8.5-15 psia (Reid VP) @ 100°F (37.8°C)</td>
</tr>
<tr>
<td>Percent Volatile</td>
<td>Not determined</td>
</tr>
<tr>
<td>Evaporation Rate</td>
<td>Not determined</td>
</tr>
<tr>
<td>pH</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Viscosity</td>
<td>Not determined</td>
</tr>
<tr>
<td>Coefficient of Water/Oil Distribution</td>
<td>Not determined</td>
</tr>
<tr>
<td>Flash Point</td>
<td>&lt; -20°F (-29°C)</td>
</tr>
<tr>
<td>Flash Point Method</td>
<td>Manual ASTM D53</td>
</tr>
<tr>
<td>Auto Ignition Temperature</td>
<td>Not determined</td>
</tr>
</tbody>
</table>

**Note:** Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

### SECTION 10: STABILITY and REACTIVITY

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Stability</td>
<td>Stable under normal ambient and anticipated conditions of use.</td>
</tr>
<tr>
<td>Hazardous Polymerization</td>
<td>Hazardous Polymerization does not occur.</td>
</tr>
<tr>
<td>Conditions to Avoid</td>
<td>Avoid high temperatures and all sources of ignition. Prevent vapor accumulation.</td>
</tr>
<tr>
<td>Incompatible Materials</td>
<td>Avoid contact with strong oxidizing agents and strong reducing agents.</td>
</tr>
<tr>
<td>Special Decomposition Products</td>
<td>Thermal decomposition or combustion may liberate carbon oxides, aldehydes, and other toxic gases or vapors</td>
</tr>
</tbody>
</table>
## SECTION 14: TRANSPORT INFORMATION

<table>
<thead>
<tr>
<th>DOT Shipping Name:</th>
<th>Petroleum crude oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT UN Number:</td>
<td>UN1267</td>
</tr>
<tr>
<td>DOT Hazard Class:</td>
<td>3</td>
</tr>
<tr>
<td>DOT Packing Group:</td>
<td>I</td>
</tr>
<tr>
<td>IATA Shipping Name:</td>
<td>Petroleum crude oil</td>
</tr>
<tr>
<td>IATA UN Number:</td>
<td>UN1267</td>
</tr>
<tr>
<td>IATA Hazard Class:</td>
<td>3</td>
</tr>
<tr>
<td>IATA Packing Group:</td>
<td>I</td>
</tr>
<tr>
<td>IMDG UN Number:</td>
<td>UN1267</td>
</tr>
<tr>
<td>IMDG Shipping Name:</td>
<td>Petroleum crude oil</td>
</tr>
<tr>
<td>IMDG Hazard Class:</td>
<td>3</td>
</tr>
<tr>
<td>IMDG Packing Group:</td>
<td>I</td>
</tr>
</tbody>
</table>

**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.
Bakken Crude Oil Properties
(@60° F)

- 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
Bakken Crude Oil Properties

Gases (Light Crude)

• Higher concentrations of light end petroleum hydrocarbons (i.e., methane, ethane, propane and butanes)

• The dissolved gases and light ends:
  • Increase the vapor pressure
  • Lower the flashpoint
  • Lower the initial boiling point

• $\text{H}_2\text{S}$ may be present in high concentrations (vapor)
Bakken Crude Oil Properties

Flammability

- NFPA Flammability = 3-4 (sample -3)
  - Sensitive to static discharge

- Explosive Limits variable:
  - LEL 0.4% (sample - 0.1%)
  - UEL 15.0% (sample - 4.5%)

- Flash point : - 40° to 212° F
  - - 74° to 122° F (AFPM data)
  - Recent sample < 74° F
Brian Kovack
U.S. EPA
Health & Safety – H₂S

- Colorless, flammable, toxic gas, rotten egg odor, quick olfactory fatigue
- Heavier than air, soluble in water and oil
- Explosive in air: 4.3 - 45.5% concentration (volume)
- Auto ignition at 500°F
- Odor threshold 0.13 ppm
# H₂S Concentration & Health Effects

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Health Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 – 0.3</td>
<td>Odor threshold (variable)</td>
</tr>
<tr>
<td>1.0 – 5.0</td>
<td>Odor, nausea, eye irritation, headache</td>
</tr>
<tr>
<td>20 - 50</td>
<td>Keratoconjunctivitis, lung irritation</td>
</tr>
<tr>
<td>100 - 150</td>
<td>Eye &amp; lung irritation, olfactory paralysis</td>
</tr>
<tr>
<td>250 - 500</td>
<td>Pulmonary edema, convulsions, risk of “knockdown”</td>
</tr>
<tr>
<td>500 - 1000</td>
<td>Unconsciousness, risk of respiratory paralysis</td>
</tr>
<tr>
<td>&gt; 1000</td>
<td>Respiratory paralysis, death</td>
</tr>
</tbody>
</table>
Health & Safety – H₂S

- **Olfactory fatigue** - Sense of smell becomes rapidly fatigued and can not be relied upon to detect H₂S

- **100 ppm, IDLH** - Olfactory fatigue in 3-5 minutes; altered respiration, coughing, drowsiness

- **200 ppm** - Olfactory fatigue shortly; stinging eyes and throat, death after 1-2 hours exposure

- **500 ppm** - Dizziness, stinging eyes and throat, self rescue impossible, loss of muscle control, death

- **1000 ppm** - Unconscious at once, death within minutes
Why is Bakken oil dangerous?

### Under Pressure

Investigators are looking into how fast North Dakota crude emits gases and how that contributes to oil-train explosions.

Select types of crude oil that are commonly run in U.S. refineries, by average Reid Vapor Pressure:

<table>
<thead>
<tr>
<th>Type</th>
<th>Origin</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Dakota Sweet</td>
<td>North Dakota</td>
<td>8.56 psi</td>
</tr>
<tr>
<td>Brent</td>
<td>North Sea</td>
<td>6.17</td>
</tr>
<tr>
<td>Basra Light</td>
<td>Iraq</td>
<td>4.80</td>
</tr>
<tr>
<td>Thunder Horse</td>
<td>Gulf of Mexico</td>
<td>4.76</td>
</tr>
<tr>
<td>Arabian Extra Light</td>
<td>Saudi Arabia</td>
<td>4.72</td>
</tr>
<tr>
<td>Urals</td>
<td>Russia</td>
<td>4.61</td>
</tr>
<tr>
<td>Louisiana Light Sweet</td>
<td>Louisiana</td>
<td>3.33</td>
</tr>
<tr>
<td>Forcados</td>
<td>Nigeria</td>
<td>3.16</td>
</tr>
<tr>
<td>Oriente</td>
<td>Ecuador</td>
<td>2.83</td>
</tr>
<tr>
<td>Cabinda</td>
<td>Angola</td>
<td>2.66</td>
</tr>
</tbody>
</table>

*Reid Vapor Pressure is a common measurement of how quickly a liquid fuel evaporates and emits gases.

Source: Wall Street Journal analysis of Capline Pipeline data
The Wall Street Journal
## Bakken Crude Oil Properties

### Component Comparison with Fuels

<table>
<thead>
<tr>
<th>Oil Type</th>
<th>Bakken Crude</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>WTI Crude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SVOCs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napthalene</td>
<td>340 ppm</td>
<td>20,000 ppm</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>2-Methylnapthalene</td>
<td>860 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>150 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>1-Methylnapthalene</td>
<td>630 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><strong>VOCs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>1,400 ppm</td>
<td>49,000 ppm</td>
<td>/</td>
<td>1,380 ppm</td>
</tr>
<tr>
<td>Toluene</td>
<td>3,100 ppm</td>
<td>250,000 ppm</td>
<td>/</td>
<td>2,860 ppm</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>740 ppm</td>
<td>30,000 ppm</td>
<td>/</td>
<td>1,120 ppm</td>
</tr>
<tr>
<td>m,p-Xylene</td>
<td>3,600 ppm</td>
<td>/</td>
<td>/</td>
<td>4,290 ppm</td>
</tr>
<tr>
<td>o-Xylene</td>
<td>1,200 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>1,3,5-Trimethylbenzene</td>
<td>870 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene</td>
<td>2,700 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Isopropylbenzene</td>
<td>200 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>n-Butylbenzene</td>
<td>170 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Napthalene</td>
<td>275 ppm</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
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)
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

<table>
<thead>
<tr>
<th>Component</th>
<th>ACGIH</th>
<th>NIOSH</th>
<th>OSHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum (8002-05-9)</td>
<td>Not established</td>
<td>CEIL: 1800 mg/m³ TWA: 350 mg/m³</td>
<td>Not established</td>
</tr>
<tr>
<td>Hydrogen sulfide (7783-06-4) [Oregon &lt;1]</td>
<td>TWA: 1 ppm STEL: 5 ppm</td>
<td>CEIL: 10 ppm</td>
<td>CEIL: 20 ppm</td>
</tr>
<tr>
<td>Benzene (71-43-2) [Oregon 0.25 ppm]</td>
<td>TWA: 0.5 ppm STEL: 2.5 ppm</td>
<td>TWA: 0.1 ppm STEL: 1 ppm</td>
<td>TWA: 1 ppm STEL: 5 ppm</td>
</tr>
<tr>
<td>Ethylbenzene (100-41-4)</td>
<td>TWA: 20 ppm</td>
<td>TWA: 100 ppm STEL: 125 ppm</td>
<td>TWA: 100 ppm</td>
</tr>
<tr>
<td>Toluene (108-88-3)</td>
<td>TWA: 20 ppm</td>
<td>TWA: 100 ppm STEL: 150 ppm</td>
<td>TWA: 200 ppm CEIL: 500 ppm</td>
</tr>
</tbody>
</table>
Lac-Megantic, Quebec

Photo: Michael Forlan/Twitter
AP Photo: The Canadian Press, Paul Chiasson
Lac-Megantic, Quebec

- Lac-Megantic, Quebec
  - Sherbrooke, Quebec is the closest large city
  - The State of Maine border is approximately 12 miles away
  - On-site response by many agencies during the incident
  - No local infrastructure existed to support the response
  - The oil spill response Emergency Operations Center was located in community of St. George

- The incident at Lac-Megantic possessed all the traditional health and safety concerns of working at an emergency plus a number of other issues.
Examples of specific H&S concerns were as follows:

- Intense, sustained fire and numerous explosions during the initial days as well as risk of the further fire and explosions throughout recovery operations until all derailed railcars and crude oil were addressed.

- The presence of volatile organic compounds (VOCs), especially benzene, as well as particulates from the burning crude oil.

- Forensic investigation and evidence collection.

Lac-Mégantic recovery operations, Source: Macleans.ca

Lac-Mégantic recovery operations, Source: LeDevoir.com

Lac-Mégantic recovery operations, Source: Cnews.canoe.ca
Jordan Garrard
U.S. EPA
Aliceville, Alabama

Photo: Bill Castle/Associated Press
Night Operations
Containment
Extent of Contamination

Photos: John Wathen
Bakken Oil Summary

• Flammable and more volatile than other crude oils because of dissolved gases and other petroleum hydrocarbon light ends
• May contain hydrogen sulfide in high 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
• 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
Reference Material


- Association of American Railroads, Movement of Bakken Crude by Rail, July 11, 2014 meeting minutes.


Questions?