Agency for Toxic Substances and Disease Registry: 
RRT

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Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
The findings and conclusions in this presentation have not been formally disseminated by the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.

Agenda

1. Overview of ATSDR—Cory Kokko
2. Oil Responses: Characteristics and Health Effects—Mark Johnson
3. Public Health Involvement in Oil Responses—Michelle Watters
Overview

• Who is ATSDR?
• ATSDR roles in Emergency Response
• Toxicology of Oil Constituents
• ATSDR Case Studies of Oil Response
Who is ATSDR?

- Federal public health agency
  - Part of Department of Health and Human Services
  - Prevent harmful exposures and disease related to toxic substances
- Protect Public Health
  - Environmental data assessment
  - Health data assessment
  - Gather information on Communities health-related concerns
- Public Health Education
  - Explain health-related issues at sites.
Protecting Communities

- Request
- Assess
- Investigate Further
- Educate
- Recommend Action

ATSDR’s Work With Communities
Partnerships

Community

EPA

ATSDR

Emergency Responders
ATSDR Coverage

- Atlanta Headquarters
- 10 Regional Offices
- EPA Headquarters Office
- Field offices in Alaska, Idaho, and Montana
Extensive Staff Expertise:

- Toxicology
- Environmental Science
- Environmental Medicine
- Health Education and Community Engagement
- Public Health
- Physical Science and Engineering (radiation, hydrology, modeling, etc.)
- Epidemiology
ATSDR Emergency Response Assistance

- 24-Hour Service
- Multidisciplinary Consult Team
- On-Site Response
ATSDR’s Role in Response

- Provide public health information to people
- Environmental data review
- Review screening levels proposed by EPA and States
- Answer health-related questions
Incident Information Flow

Solid lines are required by law or agreement. Dashed lines are not.

Timeline is hours or days

Incident Occurs

- CHEMTREC
- NRC
- States
- FOSC
- SSC
- Locals
- Poison Controls
- Healthcare
- ATSDR thru CDC/EOC
- ERC
- On-Site Response
- Verbal Consult
- Data Provided
- Referral
Emergency Response Consultations

- Chemical/Toxicological Properties
- Data Review and Interpretation
- Assessment of Potential Exposures
- Medical Management
- Secondary Exposure Prevention
- Worker Safety and Health Issues
- Public Health Impact Assessment
- Simple Air Dispersion Modeling
- Combustion/Reaction By-Products
- Sampling/Monitoring Plan Development Assistance
Public Health Information for the General Public

- ToxFAQs (Frequently Asked Questions)
- Public Health Statements
- Medical Management Guide Patient Information Sheet
- CDC’s Public Health Emergency Preparedness and Response Website at emergency.cdc.gov
Coffeyville Flood and Oil Spill

- 6/26 – 6/30
  - Verdigris River floods
  - Coffeyville Resources Refinery oil spill occurs
- 7/1
  - EPA responds to oil spill
- 7/2
  - EPA opens Emergency Operations Center (EOC)
  - EPA opened Mobile Command Posts
  - Presidential disaster declaration
ATSDR Role at EPA Emergency Operations Center (EOC)

- Provide public health information to people in flooded areas
- Environmental data review
- Review clean-up standards proposed by EPA
- Answer health-related questions
FOR IMMEDIATE RELEASE
(Kansas City, Kan., July 2, 2007) – The U.S. Environmental Protection Agency mobilized two On-Scene Coordinators to Coffeyville, Kan. in the early morning of July 1, 2007, to respond to an oil spill caused by major flooding in the area. The OSCs have collected air and water samples.
Public Health Service Announcements

ATSDR and KDHE partnership

- “Stay Safe” poster
- Distribution of health education materials
- Partner in public health meetings
Environmental Data Review

- Data review
  - Partnered with EPA to establish health screening criteria
  - Do contaminants pose a health hazard?
  - Report with conclusions and recommendations

- Clean up criteria
  - Review proposed standards
  - Concurrence

Photo courtesy of the O’Briens Group taken on 7/5/07
On-Site Response

- 7/6
  - EPA requested ATSDR on-site support
- 7/7
  - Emergency Response Coordinator deployed from Atlanta
- 7/8
  - Environmental Health Officer deployed from Kansas City
- 7/10
  - Coffeyville Public Health Meeting
- 7/12
  - Independence Public Health Meeting
- 7/14
  - Demobilization
Oil Responses: Characteristics and Health Effects

Mark Johnson, PhD, DABT
Toxicologist/Regional Director, ATSDR-R5
Statute Authority under the National Contingency Plan [40 CFR 300.175(b8)]

• “the primary response to a hazardous materials emergency comes from Agency for Toxic Substances and Disease Registry (ATSDR) and the Centers for Disease Control (CDC)…”

  – CDC takes the lead during petroleum releases regulated under the CWA and OPA

  – ATSDR takes the lead during chemical releases under CERCLA
Exposure to Crude Oil

- Releases from Drilling Operations
- Transportation incidents
  - Railcars
  - Pipelines
- Releases from Oil Storage facilities
- Burning of crude oil
Evaluation of Exposures to Oil Releases

- Environmental Media
  - Air, Surface Water, Groundwater

- Chemicals released
  - Oil-associated chemicals
  - Naturally-occurring constituents
  - Chemicals in Fracking materials

- Exposed Populations

- Exposure Pathways- Ingestion, Inhalation, Dermal
# Petroleum-related Compounds

<table>
<thead>
<tr>
<th>Aliphatics</th>
<th>Polycyclic Aromatic HCs</th>
<th>Sulfur Compounds</th>
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<tbody>
<tr>
<td>Methane</td>
<td>Pentane</td>
<td>Hydrogen Sulfide</td>
</tr>
<tr>
<td>Ethane</td>
<td>Hexane</td>
<td>Mercaptans/Thiols</td>
</tr>
<tr>
<td>Propane</td>
<td>Nonane</td>
<td></td>
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<tr>
<td>Butane</td>
<td>Decane</td>
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<tr>
<td>Isobutane</td>
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<td></td>
<td>Napralenes</td>
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<td></td>
<td>Phenanthrene</td>
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<td></td>
<td>Pyrenes</td>
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<tr>
<td>Aromatics</td>
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<tr>
<td>Benzene</td>
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<tr>
<td>Methylbenzenes</td>
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<tr>
<td>Toluene</td>
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<tr>
<td>Ethylbenzene</td>
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<tr>
<td>Xylenes</td>
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</tbody>
</table>
Shale Oil

- Oil present in Sedimentary Rock
- Kerogen
- 60-90% mineral matter
- VOCs
- Heavy metals
- May have elevated sulfur content
  - (0.7%, up to 10%)
Bakken Crude Oil Properties

- Benzene: 0.1-1%
- Hydrogen sulfide: (0.14% sulfur)
- Specific Gravity: 0.7 - 0.8
- Vapor Density: 2.5 - 5.0
- Vapor Pressure: 280 - 360 mmHg
- Explosive Range: 0.8-8%
- Flash Point: -35°C
Tar Sands Oil

Heavy Crude (50-70%) and Diluent (30-50%)

- Benzene: 0.03-0.3%
- Hydrogen sulfide: <0.1%
- Specific Gravity: 0.91-0.94
- Vapor Density: 2.5 – 5.0
- Vapor Pressure: 570 mmHg
- VOC content: 15-30%
- Explosive range: 0.8-8%
- Flash Point: < -35°C
Grades of Crude Oil

Source: The International Crude Oil Market Report
Potential Environmental Release Pathways

1. Volatile organic air releases from containment ponds
2. Air releases from drilling operations, blow-out, accidents, compressors, diesel engines, etc.
3. Liquid releases from containment /flowback ponds
4. Releases from drilling operations near the surface and on the drilling pad
5. Liquid or gas releases from casing failures
6. Liquid or gas releases from hydraulic fracturing – fissures and pressure will push material up but how far? (Not considered very likely path)
7. Transportation incidents
8. Dewatering and purifying of natural gas product – offgas and waste production
9. (Not shown) Public water supply degradation (high TDS-trihalomethanes)
Components of Hydraulic Fracturing Fluids

Water and Sand: 99.51%
Other: 0.49%

- KCl: 0.06%
- Surfactant: 0.085%
- Gelling Agent: 0.056%
- Acid: 0.123%
- Scale Inhibitor: 0.043%
- pH Adjusting Agent: 0.011%
- Friction Reducer: 0.088%
- Breaker: 0.01%
- Crosslinker: 0.007%
- Iron Control: 0.004%
- Corrosion Inhibitor: 0.002%
- Biocide: 0.001%

Potential Air Releases from Wastewater Impoundments
Statoil Eisenbarth Well Response
Clarington, OH

- June, 2014- Fire consumed well pad
- Hydraulic fluid release onto hot equipment initiated fire
- 25,000 gallons of fracking reagents on-site
- 70,000 fish kill in downstream creek; may be attributed to the biocide, tributyl tetradecyl phosphonium chloride (TTPC)
Exposure Dose

- Dose is determined by the:
  - Chemical concentration
  - Route of exposure
  - Frequency of exposure
  - Duration of exposure
  - Body weight
  - Other individual factors
Health Guidance Values (HGVs)

- Emergency Response Planning Guidelines (ERPGs): 1 hr
- California EPA AIC: 1 hr
- Acute Exposure Guideline Levels (AEGLs): 10 min – 8 hrs
- ATSDR MRLs
  - Acute: hrs - 14 days
  - Intermediate: 14 days – 1 year
  - Chronic: >1 year
- EPA RfDs/RfCs: lifetime
Chemicals of Concern- Acute Effects

- Explosive Conditions: Methane, Ethane, Propane
- Asphyxiating Conditions: Displacement of Oxygen
- Chemical Toxicity
  - Benzene
  - Ethylbenzene
  - Toluene
  - Xylenes
  - Hydrogen sulfide
  - Naphthalene
Benzene Health Effects

- **Short-Term Effects**
  - CNS Depression
    - Headache
    - Dizziness
    - Nausea
    - Throat, eye and nose irritation
    - Coughing, wheezing
    - Immune Suppression

- **Long-Term Effects**
  - Cancer: Leukemia
  - Hemopoietic damage
  - Immune System Damage
Hydrogen sulfide

- $\text{H}_2\text{S}$ is a naturally occurring component of crude oil and natural gas

  Sedimentary rock

  Trapped decayed organic matter (kerogen)

  Petroleum oil and natural gas

  $\text{H}_2\text{S}$
Hydrogen sulfide

- $\text{H}_2\text{S}$ is the predominant impurity in natural gas.
- About 15 – 25% of natural gas in the US may contain $\text{H}_2\text{S}$
- Colorless, flammable gas, heavier than air (1.19)
- “rotten egg” odor; odor threshold: <10 ppb
- *Sour* Natural Gas: $\text{H}_2\text{S}$ is present at > 4 ppm
- *Sour* Crude Oil: >0.5% sulfur
# Acute Effects of Hydrogen Sulfide

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Effect</th>
</tr>
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<tbody>
<tr>
<td>0.01–0.3 ppm</td>
<td>Odor threshold</td>
</tr>
<tr>
<td>&gt;2 ppm</td>
<td>Respiratory effects (airway restriction</td>
</tr>
<tr>
<td></td>
<td>Neurologic effects (headaches, nausea)</td>
</tr>
<tr>
<td>&gt;20 ppm</td>
<td>Eye irritation</td>
</tr>
<tr>
<td>&gt;80 ppm</td>
<td>Cardiac effects</td>
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<tr>
<td></td>
<td>Olfactory necrosis- loss of smell</td>
</tr>
<tr>
<td>&gt;110 ppm</td>
<td>IDLH</td>
</tr>
<tr>
<td>&gt;500 ppm</td>
<td>Death- pulmonary and cerebral edema, coma, cyanosis</td>
</tr>
</tbody>
</table>
Petroleum Combustion By-Products

- VOCs
- Carbon Monoxide
- Particulates
  - PM 10 (particles < 10 micron diameter)
  - PM 2.5 (particles < 2.5 micron diameter)
- Nitrogen dioxide
- Sulfur dioxide
Chemicals detected in Validated Environmental Dataset

Is chemical associated with oil spill?
- Yes
- No

Does concentration exceed background?
- Yes
- No

Compare to appropriate duration-specific screening level
- Yes
- No

Are screening levels exceeded?
- Yes
- No

Evaluation
- temporal and spatial trends to determine extent
- consider if more intensive sampling is needed

Take Appropriate Action

No Further Action
Summary

- Understanding the composition of crude oil material is critical to anticipating potential exposure hazards
- Bakken oil is more flammable and more volatile than other crude oils because of dissolved gases
- High sulfur oil may result in release of hydrogen sulfide
- Use of diluents with oil material (e.g., tar sands) increases the exposure hazard
Public Health Involvement in Oil Responses

Michelle Watters, MD, PhD, MPH
Division Medical Officer,
Division of Community Health Investigations, ATSDR
Public Health Involvement

- Local, State, Federal Public Health Agencies
- Public Health Advisory Group
- Unified Command

Planning Section
- Public Health Unit
  - Toxicology and Analysis Sub-group
  - Fish Consumption Advisory Workgroup
- Environmental/Public Health Task Force

- Multi-Agency Coordination Group

- Responsibilities
- Jurisdiction
Public Health Involvement

• Needs assessment
• Surveillance and Epidemiology
  – Drinking water sources
  – Health Effects
• Organize delivery of health care services and supplies
• Health risk communication/health education
  – Proper sanitation and hygiene
  – Health effects of chemicals
• Environmental data review
• Review of sampling plans
Public Health Involvement

• Recommend actions that need to be taken to safeguard people's health
  – Personal Protective Equipment
  – Monitoring
  – Evacuation
  – Re-occupancy
  – Drinking water
  – Recreational Use
  – Fish advisories

• Site-specific action levels
Exposure concerns

• Health implications
  – Immediate hazards
  – Acute health effects
  – Chronic health effects
  – Increased cancer risk

• Past, present, future exposures

• Residential, occupational exposures
Enbridge Oil Spill – July 2010
Oil flows into Kalamazoo River

More than 800,000 gallons of oil have spilled into Talmadge Creek, near Marshall, and oil has flowed into the Kalamazoo River and is heading toward Kalamazoo.

Additional details
Reports Monday afternoon say that oil has reached Battle Creek and Galesburg. The oil pipeline runs through Michigan between Ontario, Canada, and Indiana and is owned by Enbridge Energy Partners, which is based in Houston.

Source: Michigan Department of Natural Resources and Environment
Evacuation

• 50 to 9,750 ppb benzene
  – Monitoring data in residential areas in the vicinity of work areas (July 28, 2010)
  – Up to ~6,000 ppb (August 4, 2010)

• Voluntary evacuation notice to 60 homes Calhoun CO HD (July 29, 2010)
  – Door to door notification
Reoccupancy Decision Tree

- **ATSDR Intermediate MRL**
  - 6 ppb
  - Instrumentation specified

- **Voluntary Evacuation**
  Notice lifted August 18

- All samples are less than or equal to 6 ppb (20 ug/m³)
- Any reading greater than 6 ppb (20 ug/m³), restart two days of real-time sampling

- 8hr-24hr sample (time weighted average)

- Less than or equal to 6 ppb (20 ug/m³), residents can reoccupy (additional cleanup work in area may result in recommendation of evacuation)
- Greater than 6 ppb (20 ug/m³), restart 2 days of real-time monitoring
Potable Water Well

CCPHD issues **Bottled Water Advisory**

- Notified residents door-to-door
- Wells within 200 feet of the high water mark
- Wells were eligible for potable water well sampling program
  - Oil constituents
  - Biweekly, monthly, quarterly basis
  - Advisory lifted November 2010
Water Requirements

- Normal active person: 2 quarts of water per day
  - Increased need with pregnancy, nursing, illness or in a hot environment
- Emergency supply recommendation: 1 gallon per person per day
- Sanitation
- Safety

www.keysan.com
Municipal Drinking Water

- Water intake to Glendive Water Treatment Plant
  - Odor complaints
  - Detections of VOCs (benzene)
- Dawson County – DO NOT Drink order
  - Bottled water available at distribution centers
  - Need to decontaminate municipal water supply
    - Flushing of system
    - Instructions to residents and businesses
    - January 23, 2015 – bottled water distribution discontinued—MDEQ: water is safe to drink.
Recreational Use

• CCPHD issues **Recreation Ban (August 3, 2010)**
  
  – “[CCPHD] has also issued a ban on surface water activities on the Kalamazoo River as part of the county’s state of emergency, including swimming, wading, fishing, boating, canoeing and kayaking.”
  
  – Public access to 39 miles of the river system
  
  – June 2012—34 miles, plus entire 2 miles of Morrow Lake reopened
Fish Advisory

- “The Michigan Department of Community Health (MDCH) is advising that people not eat fish from Talmadge Creek or the Kalamazoo River following an oil spill that occurred on Monday, July 26, 2010.” (July 27, 2010)

- Downstream (west) of I-69 on the Kalamazoo River to the west end of Morrow Lake.

- June 28, 2012 – MDCH lifts “Do Not Eat” Fish Consumption Advisory on the affected stretch of the Kalamazoo River
Public Health Surveillance

- Hospital counts and medical abstractions.
- Calhoun and Kalamazoo counties’ medical care provider reports.
- MI Poison Control Center compiled reports.
Door-to-door Health Surveys

- Survey of 4 communities: one adult in each household
- Oil spill related health symptoms
- Odor intensity and duration
- Upstream community used as comparison.
- Headache, nausea, and respiratory symptoms were predominantly reported

![Bar chart showing percent of residents with any symptom by community.]

*Percent of Residents with Any Symptom by Community*
Acknowledgement

With thanks to
Dr. Linda Dykema, Michigan Department of Community Health
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CDC/ATSDR Emergency Contacts

- CDC Emergency Operations Center at 770 – 488 - 7100 (24/7)
  - For Chemical Emergencies: ask for ATSDR Duty Officer
  - For Petroleum Emergencies: ask for NCEH Duty Officer

- ATSDR Regional Offices
  - Region 5: 312-886-0840
  - Region 7: 312-551-1312