

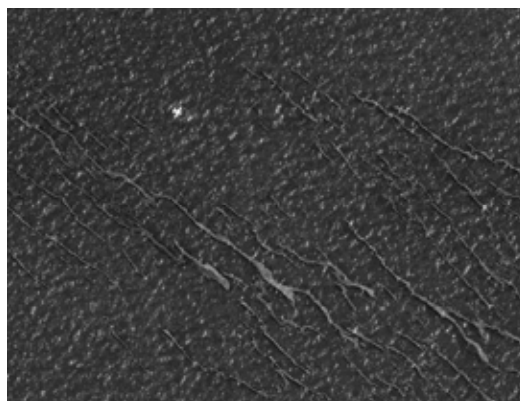
# Anatomy of an Oil Spill Gulf of Mexico 2010

Satellite Conference and Live Webcast  
Tuesday, June 29, 2010  
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Produced by the Alabama Department of Public Health  
Video Communications and Distance Learning Division

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**Goals and Objectives**

- Part 1
  - Describe the incident, characteristics of oil, and dispersants

**Goals and Objectives**

- Part 2
  - Address public health issues
    - Exposure to air contaminants
    - Seafood
    - Beach advisories
    - Worker safety

**Explosion and Fire on the Deepwater Horizon**

On April 20, 2010 the Deepwater Horizon exploded, and sank 2 days later




**Explosion and Fire on the Deepwater Horizon**

Eleven people died and many others injured




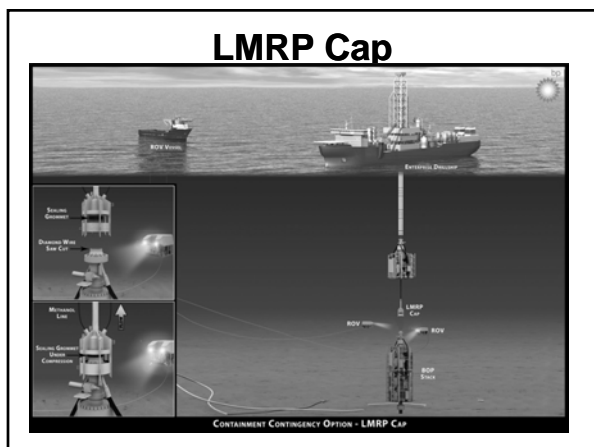
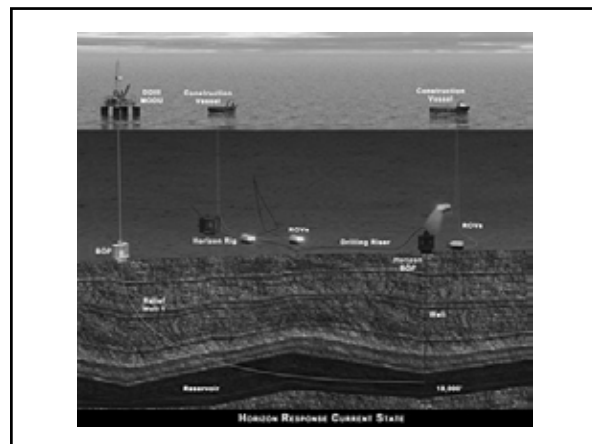
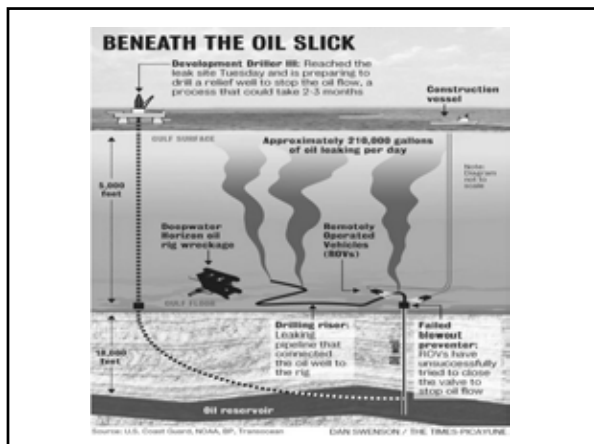
**Explosion and Fire on the Deepwater Horizon**

The well began leaking oil from 5,000 feet below the surface of the water



**Deepwater Horizon Site**

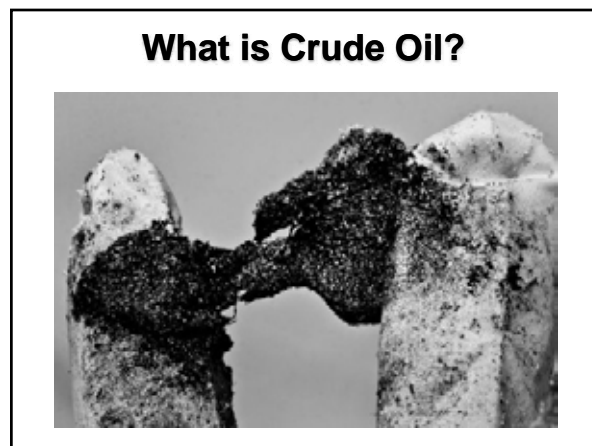




### What is Crude Oil?

# Carbons	Product	Health Effects	Physical State	Fate
C <sub>1</sub> -C <sub>2</sub> C <sub>3</sub> -C <sub>4</sub>	Natural gas; Propane and Butane	Few	Gas	
C <sub>5</sub> -C <sub>10</sub> C <sub>9</sub> -C <sub>15</sub> C <sub>5</sub> -C <sub>16</sub>	Gasoline Kerosene Jet and Turbo fuel	Moderate	Volatile Liquids	↑ ↑ ↑ Evaporates from oil in or on surface of the water
C <sub>17</sub> - C <sub>24</sub>	Mineral Oil Lubricating oil	Few	Heavy Liquids	Goopy Liquid
C <sub>24</sub> - higher	Paraffin Asphaltenes	Few	Solids	Tar Balls

Crude Oil (top section)  
Weathered Crude (bottom section)



## What is Crude Oil?



## Type of Oil: Light Sweet Crude

- Light crude
  - More of the smaller mol. wt. compounds including more gas
- Deepwater Horizon oil is very light with a large amount of gas and few heavy hydrocarbons

## Type of Oil: Light Sweet Crude

- Heavy crude
  - Less gas and more of the larger mol. wt. compounds
  - Exxon Valdez
- Sweet crude
  - Does not have H<sub>2</sub>S
  - Deepwater Horizon crude is sweet

## Type of Oil: Light Sweet Crude

- Sour crude
  - Contains H<sub>2</sub>S and has a bad odor

## Toxicology of Petroleum Hydrocarbons

- In general, hydrocarbons have a low degree of toxicity to humans
  - That means, it takes a large amount to cause adverse effects
  - Most common effects: irritation, headache, nausea
  - Symptoms get better when removed from exposure

## Toxicology of Petroleum Hydrocarbons

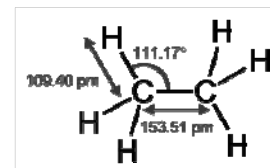
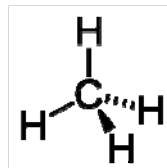
- The aquatic and ecological toxicity of oil is different than human health toxicity
  - Ecological effects are most frequently related to the physical coating of marine life and birds

### Gases: C1 to C4

- Methane, Ethane, Propane, Butane
  - May compose up to 40% of leaking crude
  - Fire and explosive hazard
  - No direct chemically toxic effects
  - Asphyxiation by displacement of O<sub>2</sub> in confined spaces

### Gases: C1 to C4

- Ecological
  - Question
    - Have large amounts of methane remained in the Gulf waters?



### Volatile Liquids: C5-C14

- Commonly known as VOCs
  - Volatile Organic Compounds
- Products from this component of crude oil include
  - Gasoline, kerosene, jet fuels
  - Many solvents are derived from this fraction
  - Contains both aliphatic and aromatic compounds

### Volatile Liquids: C5-C14

- Aliphatic compounds (straight or branched chain) hydrocarbons have a low degree of toxicity
- The aromatic compounds are the most toxic fraction of crude oil
  - Includes Benzene, Toluene, Ethyl Benzene, and Xylenes (BTEX)

### Volatile Liquids: C5-C14

- Health effects associated with the VOCs
  - Dermal, eye, and mucus membrane irritation
  - Volatile liquids cause respiratory irritation
  - Benzene: carcinogen

### Volatile Liquids: C5-C14

- Do not bioaccumulate
  - Readily metabolized and excreted
- The volatile compounds readily evaporate from the crude oil
  - Analysis of surface oil does not detect BTEX
- Air sampling is conducted along the coast to monitor for VOCs

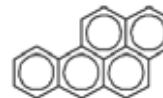
### Heavier Liquids: C16- C22

- Long chained hydrocarbons
  - Aliphatic: straight and branched chains
- Very low toxicity to humans
- Physical coating of aquatic life and birds



### Heavier Liquids: C16- C22

- Polycyclic Aromatic Hydrocarbons (PAH)
  - Common PAHs
    - Pyrene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, fluoranthrene, fluorene



### Heavier Liquids: C16- C22

- Carcinogenic activity
  - Benzo(a)pyrene is the most carcinogenic
- PAH do not bioaccumulate
  - Metabolized via CYP (cytochrome P-450) enzymes
- PAHs being monitored in seafood

### Solids: C22-C45+

- Heaviest components of crude oil
  - Asphaltenes
  - Parafins
  - Tars
- Practically non-toxic
- Components of the tarballs



### Solids: C22-C45+

Can be messy and ugly, but not toxic to people



### What is Weathered Crude???

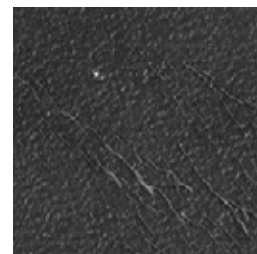
- Once on the water's surface, crude oil changes
- Since the site of the leak is 50 miles offshore, the oil "weathers" or "ages"
  - The smaller molecular weight compounds breakdown
  - Volatile compounds evaporate

### What is Weathered Crude???

- Contains primarily long chained compounds
- PAH may be present, but not always
- Weathered oil is thicker or more solid
  - Mousse
  - Tarballs

### Oil in the Gulf

- The oil is not evenly distributed across the spill area
  - Sheen
    - Very light layer of oil that is seen floating on the water



### Oil in the Gulf

- Mousse
  - Heavier layers of emulsified oil
    - Oil is emulsified with water as it rises to the surface at the leak
    - Contains more heavy hydrocarbons

### Oil in the Gulf

- Tarballs
  - Largest hydrocarbons that are solids
    - Tarballs are not likely to have toxic effects, but should be avoided

### Analysis of Weathered Oil Analysis of oil and water near Grand Isle and in Barataria Bay, Louisiana

	Weathered oil	Mousse	Tarball	Water
Total Petro Hydrocarbons C <sup>6</sup> -C <sup>10</sup>	ND	ND	ND	ND
Total Petro Hydrocarbons C <sup>10</sup> -C <sup>28</sup>	YES	YES	YES	YES
Total Petro Hydrocarbons >C <sup>28</sup> -C <sup>35</sup>	YES	YES	YES	YES
PAH	YES	ND	ND	ND
BTEX	ND	ND	ND	ND

Most common PAH detected: Crysene, Phenanthrene, pyrene  
Occasionally detected: Fluoranthene, Fluorene, benzo(a)anthracene  
In one sample: Benzo(a)pyrene

### Containing an Oil Spill



### Containing an Oil Spill

1. VOCs evaporate
  - Up to 40% of total volume
2. Booms along the coast
3. Burning
4. Skimming
5. Dispersants
6. Biodegradation

### Booming and Burning of Oil

- In situ burning destroys the oil and less reaches shore
  - Occurs off-shore and not along the coast



### Booming and Burning of Oil

- Particulates are generated
- Air monitoring for particulates along the coast
  - Have measured increases in PM on some days, but below health concerns



### Booming and Burning of Oil

- Worker exposure issues and need for appropriate safety equipment

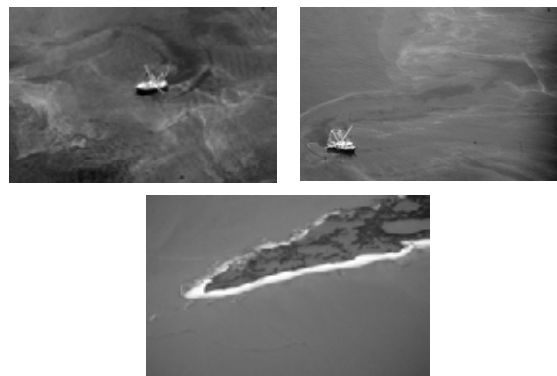


This oil spill was cleaned up through in-situ burning

### Booming Along the Coast



### Booming Along the Coast





### Dispersants

- Have become quite controversial



- Issues

- Why put more chemicals into the Gulf?
- Amount of dispersants used – over 1 million gallons
- Unknown factors with deep sea use

### Dispersants

- Ecological effects on aquatic life
- Possible human exposure
- Points of confusion
  - Aquatic toxicity data is confused with human health effects
  - Human exposure issues
    - Workers exposure
    - Dilution when used in water
    - Does not accumulate in food chain

### Dispersants



### How Dispersants Work

- Dispersants mix with both water and oil
- Dispersant is sprayed onto the oil



### How Dispersants Work

- Dispersant mixes with the oil



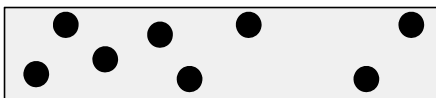
### How Dispersants Work

- Dispersant makes the oil mix with water



### How Dispersants Work

- Small oil droplets move below the surface of the water and are broken down by micro-organisms in the water



### How Dispersants Work

- Dispersants involve trade-offs
  - Dispersants move the oil to the water column
  - Keeps oil from reaching the coastline

### Dispersants: Corexit 9500

- Components of Corexit are commonly used in household products
  - Surfactants
  - Petroleum distillates
  - Propylene glycol

### Dispersants: Corexit 9500

- Corexit breaks down in the environment
  - Half-life: 2 days to 2 weeks
  - Does not bioaccumulate in the food chain

### Dispersants: Corexit 9500

- Dispersants do not change the amount of oil
  - Tool to manage the oil spill
  - Keeps oil from reaching the coast by moving to water column
  - The small droplets are more easily biodegraded by microorganisms

### Will the Oil Make Me Sick?

- For the oil to cause a health effect, you must come into contact with it



### Will the Oil Make Me Sick?

- Compounds in the oil have different types of effects
- Possible routes of exposure
  - Inhalation: Breathing air with contaminants
  - Ingestion: Eating food with contaminated oil
  - Dermal: Direct contact with the skin

### Will the Oil Make Me Sick?

- Monitoring programs are designed to find and prevent exposure to components in the oil

### What Could Be in the Air?

- Gases, volatile compounds and particulates may be in the air
  - Air sampling is designed to sample for components in crude oil that could be in the air
- Compounds of concern
  - Volatile organic compounds (VOCs)

### What Could Be in the Air?

- Including BTEX
- Particulate Matter (PM) - PM10 and PM2.5
  - Occurs from the burning of the oil off-shore

### Odors: What Do I Smell?

- People along the coast occasionally smell an “oily” odor, particularly if the wind is from the direction of the spill
- Some people can smell hydrocarbons at very low levels, far below those that would cause short-term health effects



### Odors: What Do I Smell?

- It is possible, but not common, for the odors to cause short-lived effects like headache, eye, nose, throat irritation, or nausea
- Air sampling monitors for VOCs, BTEX, PM

### How Is the Air Monitored?

- Air toxics
  - Air sampling canister, Plaquemines Parish, LA



### How Is the Air Monitored?

- Air monitoring station in Grand Isle, LA



### How Is the Air Monitored?

- EPA measures two sizes of particulate



### How Is the Air Monitored?

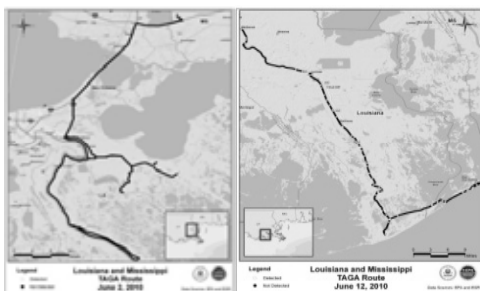
- Daily reports at:
  - <http://www.epa.gov/bpspill/air.html>

### Real-time Air Monitoring

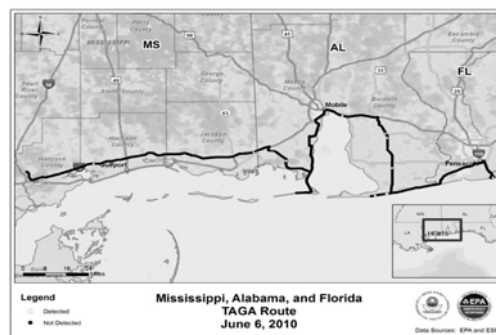
- Trace Atmospheric Gas Analyzers (TAGA)
- The TAGA bus analyzes the air along the Gulf Coast
  - Levels found so far are well below those likely to cause health effects



## Real-time Air Monitoring



## Real-time Air Monitoring



### Putting It Together: Air and VOCs

1. VOCs evaporate quickly in hot weather
2. Air sampling above the leak show low levels of VOCs
3. Air sampling along the coast line detect background levels of VOCs, including the BTEX

### Putting It Together: Air and VOCs

4. Analysis of the oil, mousse and tar balls do not detect BTEX
  - Exposure to BTEX or VOCs from the oil spill to the general public along the coast is not likely
  - Off shore workers should be monitored to prevent possible exposure to VOCs

### Keeping Seafood Safe

- With all the oil in the Gulf, people are naturally concerned about seafood
- Two issues with seafood in oil contaminated waters
  1. The long chain hydrocarbons get on the fish, shrimp, crabs, and oysters and taints the taste



### Keeping Seafood Safe

- Oil has an odor that can be readily smelled
- Seafood with oil will taste nasty
- 2. PAHs in the crude may be taken up by oysters
  - Cannot see or taste
  - Chemical analysis for PAH conducted



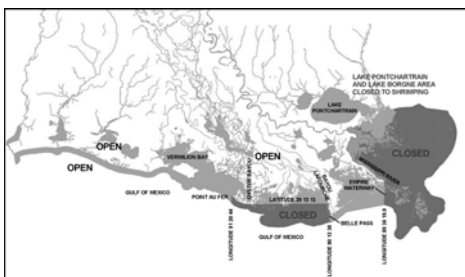
### Is the Seafood that Gets to Market Safe?

- Absolutely!!
- Seafood monitoring program
  1. Close areas with visible oil to fishing, shrimping and oystering
  2. Sensory analysis at docks and processors
  3. Chemical testing for longer-term components

### Is the Seafood that Gets to Market Safe?

- Once a fishing area is closed,
  - No visible oil must be present
  - The seafood must be chemically tested to be reopened
- There may be shortages of seafood, but the quality will be the same, or maybe even better

### Is the Seafood that Gets to Market Safe?



May 12, 2010 - Louisiana Department of Wildlife and Fisheries Recreational and Commercial Fishing Closure

### Seafood Monitoring

- Areas have been closed to fishing based on the presence of oil
- Personnel are being trained in sensory analysis
- In Louisiana, baseline testing for Aliphatic and PAHs did not detect these contaminants



### Seafood Monitoring

- Issues
  - Laboratory capacity
    - Approved labs
  - Use of approved standard methods for analysis
  - Limits of detection for some PAHs

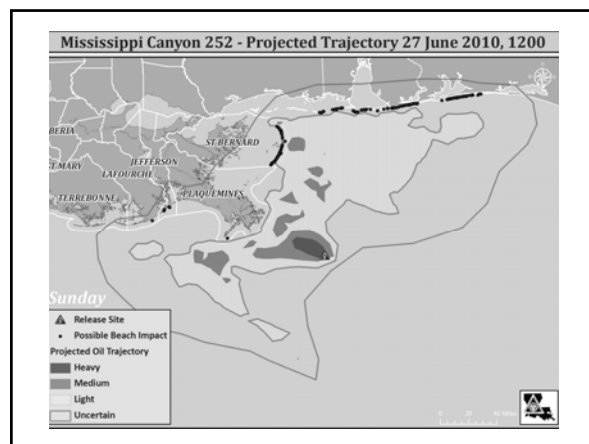


### Is it Safe to Go on Beaches??

- Oil has reached the coast in Louisiana, Alabama and Florida and the barrier islands in Mississippi
  - Beaches have different warnings depending on the presence of oil and form (mousse or tarball)
  - The oil is constantly moving so the warning may change from place to place or at different times

## Is it Safe to Go on Beaches??

- Guidelines for closing beaches or issuing warnings vary from state to state and even county to county



## Beach Safety

- The oil on the beaches will vary from very heavy mousse-like oil to minimal sheen
- Tarballs may be present without other forms of oil
- Beaches may be closed when large amounts of heavy oil reaches shore
- Swimming warnings may be posted for sheens or tarballs



## Should I Bring My Family to the Beach?

- Avoid direct contact with oil if found on a beach
- Do not swim in areas with visible oil
- Pregnant women and small children should stay away from oil on beach



## Should I Bring My Family to the Beach?

- Will direct contact with the oil make me sick?
  - It is not likely, but avoiding contact with the oil is recommended

## What Should I Do if I Come in Contact with Oil?

- Wash the oil off with soapy water
- Baby oil or a similar oil may help to remove the oil
- Do not use a solvent as it may promote the absorption of the oil
- Remove contaminated clothing or shoes before entering home/condo

### What Should I Do if I Come in Contact with Oil?

- Wash contaminated clothing separately from the family laundry
- Throw away anything that cannot be cleaned well



### Workers

- Most likely group to be exposed to toxic components in oil
- The exposure depends on their jobs, location, type of oil and duration

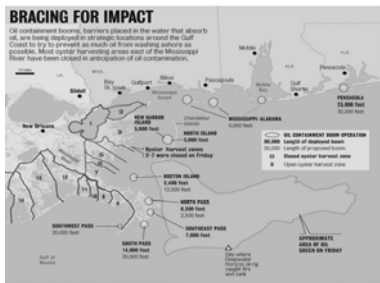


### Workers

- Requirement for PPE depend on the hazard and the type of exposure
  - Respirators
    - High levels of particulates
    - VOCs above health standards
  - Protective clothing
    - To prevent dermal contact

### Aquatic Life and Birds

- The oil is impacting marine life and birds in the affected areas



### Toxicity of Oil to Birds

- The harmful effects are due to the coating of the birds
  - The oil coats birds' feathers decreasing their ability to fly, eat or drink
  - Effects are predominantly due to the physical effects of oil, rather than chemical toxicity





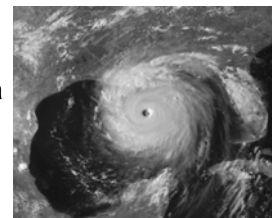
### **Toxicity of Oil to Birds**

- If found in time, the birds can be cleaned and rehabilitated and released



### **Oil Spill and Hurricanes**

- Wind and flood waters will drive water and oil deeper into the estuaries and the coast line
  - Oil will follow flooding and spread over a wider area
  - Oil will be diluted



### **Oil Spill and Hurricanes**

- The turbulence will break up the oil
- At the well head, work will stop and vessels will be removed
  - Oil collection will stop and will spew out
- Myth: not likely to “rain oil”
  - Several myths on the Internet

### **Lingering Issues**

- Unprecedented situation
  - Each action a new research project
- There is much we do not know about the health effects of oil
  - What are the long-term effects on workers?

### **Lingering Issues**

- What mental health issues will emerge and how can we best address them now?
- How long will it take the oil to biodegrade or remediate?
- What will the health surveillance show us in the long-term?