OSHAcademy™
Occupational Safety & Health Training

Oil Spill Cleanup

Oil spill cleanup workers can face potential hazards from oil byproducts, dispersants, detergents and degreasers. This course explains what an oil spill is, describes the characteristics of an oil spill, and how to identify and control hazards during the response and cleanup phases of an oil spill.

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OSHAcademy Course 906 Study Guide

Oil Spill Cleanup

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 906.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

Oil spill cleanup workers can face potential hazards from oil byproducts, dispersants, detergents and degreasers. Drowning, heat illness and falls also pose hazards, as can encounters with insects, snakes and other wild species native to the impacted areas. In these situations, OSHA's goals include ensuring workers receive appropriate training and protective equipment.

This course draws from information developed by National Institute of Health, and National Institute of Environmental Health Sciences. It can be used as a guide for "skilled support personnel" who will participate in an oil spill response and cleanup.

Employer Responsibilities and Worker Rights

Employers have responsibilities and workers have rights under the OSH Act.

- The Occupational Safety and Health Act requires employers to provide a safe and healthful workplace free of recognized hazards. Employers must also provide training and required protective equipment.
- Workers must follow the employer's safety and health rules that comply with OSHA standards and wear or use all required gear and equipment. Workers are encouraged to report hazardous conditions to a supervisor and report hazardous conditions to OSHA if employers do not fix them.

At the end of this awareness-level training you will be able to:

- Explain what an oil spill is
- Describe the characteristics of a spill response
- Describe how to identify and control hazards during the response and cleanup phases of an oil spill

Advanced/Additional Training Required

- This training course does not replace any additional duty specific training or PPE specific training requirements.

- Regardless of work scope, many topics covered in this awareness-level training have corresponding OSHA standards. Such standards must be met in order to safely and legally perform associated job duties.

- Cleanup workers should always stop what they are doing and ask questions if they have doubts about the safety of an activity. Be sure you are safe before continuing.

- Contact the NIEHS National Clearinghouse for Worker Safety and Health Training (202-331-7733) for information regarding advanced training for an oil spill response.

Special thanks to OSHA and the National Oceanic and Atmospheric Administration (NOAA) for the content and images within this course.

Module 1: Introduction to Oil Spill Cleanup

National Oil and Hazardous Substance Pollution Contingency Plan

This is the federal government's blueprint for responding to both oil spills and hazardous substance releases. The National Oil and Hazardous Substance Pollution Contingency Plan is the result of the country's efforts to develop a national response capability and promote overall coordination among the hierarchy of responders and contingency plans.

Health and Safety Plans

OSHA has regulations that require employers to have detailed Health and Safety Plans to protect workers involved in cleanup operations. The Health and Safety Plan serves as a guide for employers and workers to follow during their daily operations to prevent the spread of contamination, injury, and death.

All Health and Safety Plans must cover the following:

- Introduction
- Key Personnel
- Hazard Assessment
- Training
- PPE
- Temperature Extremes
- Medical Surveillance
- Exposure Monitoring and Air Sampling
- Site Control
- Decontamination
- Emergency Response/Contingency Plan

- Emergency Action Plan
- Confined Space Entry
- Spill Containment

OSHA's HAZWOPER Standard

- Activities related to stopping the oil spill or containing the spilled oil are considered "emergency response" activities under OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120 and 1926.65.
- In addition, cleanup sites may be considered or may become hazardous waste sites and should follow the requirements for hazardous waste sites under HAZWOPER, requiring specific training and control measures, if certain criteria apply. Shoreline cleanup is considered "post-emergency clean-up operations."
- Furthermore, if HAZWOPER conflicts or overlaps with any other OSHA standard, the provision more protective of employee safety and health must be followed.

HAZWOPER Requirements that Apply to Marine Oil Spills

- Marine oil spill cleanup is organized and managed according to the regulations found in the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) at 40 CFR 300.
- Response actions conducted under the NCP must comply with the provisions of HAZWOPER.
- See specifically the HAZWOPER provisions in paragraph (q) (Emergency response operations) and paragraph (q) (11) Post-emergency response cleanup operations.

Proper Instruction for Cleanup Workers

Training is important. To work in the cleanup, workers must be trained on the hazards of their job in a language that they understand. Workers must be trained before they begin oil spill response and cleanup work.

All oil spill cleanup workers should be trained in the following:

- An initial briefing utilizing the Site Safety Plan or National Incident Management System (NIMS) assignment form at the site prior to their participation
- A briefing on emergency procedures under the site-specific Health and Safety Plan (HASP)
- Instruction in the wearing of appropriate personal protective equipment
- Information on what health hazards from oil and other chemicals might be encountered
- Explanation of what duties are to be performed
- Chain of command
- Instruction on the decontamination procedures to be followed
- All other appropriate safety and health precautions

Hazardous Materials and Hazard Communication

- Specific Hazard Communication training is required on the hazards from the oil and from any hazardous materials being used.
- Safety Data Sheets (SDS) must be available for all hazardous materials. Review them and follow as appropriate.
- Warning labels, such as NFPA 704M may be found on chemical containers being used.
- Do not handle unmarked unlabeled containers.

Oil is a single substance, but there actually are many different kinds of oil. Kinds of oil differ from each other in their viscosity, volatility, and toxicity.

- **Viscosity** refers to oil's resistance to flow.
- **Volatility** refers to how quickly the oil evaporates into the air.
- **Toxicity** refers to how toxic, or poisonous, the oil is to either people or other organisms.

When spilled, the various types of oil can affect the environment differently. They also differ in how hard they are to clean up.

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **The _____ serves as a guide for employers and workers to follow during their daily operations.**

    a. company policy
    b. mission statement
    c. vision statement
    d. health and safety plan

2. **All health and safety plans must include which of the following?**

    a. Spill containment
    b. Temperature extremes
    c. Site control
    d. All the above

3. **Workers do not need to be trained on the decontamination procedures to be followed during an oil spill.**

    a. True
    b. False

4. **_____ refers to how quickly the oil evaporates into the air.**

    a. Viscosity
    b. Volatility
    c. Toxicity
    d. Concentration

5. **Workers must be trained in the wearing of appropriate personal protective equipment.**

    a. True
    b. False

Module 2: What is an Oil Spill?

An oil spill is the release of a liquid petroleum hydrocarbon into the environment due to human activity and is a form of pollution. Oil spills stem from accidents involving tankers, barges, pipelines, refineries, and storage facilities, often while the oil is being transported to its users.

For instance, the April 2010 Gulf of Mexico oil spill involved crude oil that was released from the explosion of the off-shore drilling rig.

During an oil spill cleanup, workers may encounter many types of crude oil, including fresh and weathered, which contain carcinogenic volatile aromatic compounds like benzene, toluene and naphthalene.

The Four Types of Oil

The first thing we need to discuss is the various types of oil that might require cleanup. Spill responders group oil into four basic types, which you can see here, along with a general summary of how each type can affect shorelines.

Type 1: Very Light Oils (Jet Fuels, Gasoline)

- highly volatile (should evaporate within 1-2 days)
- high concentrations of toxic (soluble) compounds
- localized, severe impacts to water column and intertidal resources
- no cleanup possible

Type 2: Light Oils (Diesel, No. 2 Fuel Oil, Light Crudes)

- moderately volatile and will leave residue (up to one-third of spill amount) after a few days
- moderate concentrations of toxic (soluble) compounds
- will "oil" intertidal resources with long-term contamination potential
- cleanup can be very effective

Type 3: Medium Oils (Most Crude Oils)

- about one-third will evaporate within 24 hours
- oil contamination of intertidal areas can be severe and long-term
- oil impacts to waterfowl and fur-bearing mammals can be severe
- cleanup most effective if conducted quickly

Type 4: Heavy Oils (Heavy Crude Oils, No. 6 Fuel Oil, Bunker C)

- little or no evaporation or dissolution
- heavy contamination of intertidal areas likely
- severe impacts to waterfowl and fur-bearing mammals (coating and ingestion)
- long-term contamination of sediments possible
- weathers very slowly
- shoreline cleanup difficult under all conditions

What is Crude Oil?

- Crude oil is a mixture of hydrocarbons and consists of light, medium and heavy chemicals.
- The hydrocarbons in crude oil are mostly alkanes, cycloalkanes and various aromatic hydrocarbons while the other organic compounds contain nitrogen, oxygen and sulfur, and trace amounts of metals such as iron, nickel, copper and vanadium. The exact molecular composition varies widely.
- The light parts, such as benzene, xylene, toluene and ethyl benzene generally evaporate into the air in the first 24 hours of a spill (usually before reaching the shore).
- The medium and heavy parts (consistency much like motor oil) are what cleanup operations on the land and near shore areas focus on.
- Complex mixture of carcinogenic substances.

Health Hazards and Exposure

Health hazards generally associated with crude oils include:

- Inhalation of the toxic volatile hydrocarbon components, such as benzene, and dermatitis from repeated or prolonged skin contact can cause dermatitis or skin cancer.

Occupational Exposure Limits (OEL)

- Cleanup workers typically work more than 8 hours/day for 7-14 days in a row.
- Workers should be informed that OELs based on standard times are not appropriate for monitoring.
- OELs don't include skin contact, absorption and ingestion, which are common in cleanups.
- Check with your site supervisor for additional guidance!

Be cautious during cleanup operations. If you are unsure, ask your supervisor before proceeding!

Weathered Crude Oil

Weathered crude or "mousse" is crude petroleum that has lost an appreciable quantity of its more volatile components and has mixed with sea water and organic matter. This is caused by evaporation and other natural causes during the spill landing on the shore and during oily waste handling, storage and treatment or disposal.

The various types of oil differ in how they weather (chemically or physically change when exposed to the elements). Most crude oil blends will emulsify quickly when spilled, creating a stable mousse that presents a more persistent cleanup and removal challenge.

Even in high winds, usually over 70% of a Fuel Oil No. 6 spill will persist as floating or beached oil for a week or longer. On the other hand, over 90% of the diesel in a small spill in the marine environment is either evaporated or naturally dispersed into the water column in time frames of a couple of hours to a couple of days.

Weathered Crude Oil Terms

Weathering is a series of chemical and physical changes that cause spilled oil to break down and become heavier than water. Winds, waves, and currents may result in natural dispersion, breaking a slick into droplets which are then distributed throughout the water. These droplets may also result in the creation of a secondary slick or thin film on the surface of the water.

Adsorption (sedimentation) is the process by which one substance is attracted to and adheres to the surface of another substance without actually penetrating its internal structure.

Biodegradation is the degradation of substances resulting from their use as food energy sources by certain micro-organisms including bacteria, fungi, and yeasts.

Dispersion is the distribution of spilled oil into the upper layers of the water column by natural wave action or application of chemical dispersants.

Dissolution is the act or process of dissolving one substance in another.

Emulsification is the process whereby one liquid is dispersed into another liquid in the form of small droplets.

Evaporation occurs when the lighter substances within the oil mixture become vapors and leave the surface of the water. This process leaves behind the heavier components of the oil, which may undergo further weathering or may sink to the ocean floor.

Oxidation occurs when oil contacts the water and oxygen combines with the oil to produce water-soluble compounds. This process affects oil slicks mostly around their edges. Photo Oxidation is a sunlight-promoted chemical reaction of oxygen in the air and oil.

Health Risks of Weathered Crude Oil

Health risks associated with working while exposed to weathered crude oil include the following:

- Potential dermatitis hazard from skin contact.
- Inhaling oil droplets/oily particles put into the air during cleanup operations can be irritating to eyes, nose, throat and lungs.
- Evaporation that occurs during the first 24 to 48 hours after the spill greatly reduces inhalation hazards from the toxic volatile components, such as benzene.

NOTE: Even if air sampling shows no detectable levels or very low levels of volatile organic compounds (VOCs), there still may be health effects present.

Tarballs

Tarballs, the little, dark-colored pieces of oil that can sometimes stick to your feet when you go to the beach, are actually remnants of oil spills. When crude oil (or a heavier refined product) floats on the ocean surface, its physical characteristics change.

During the first few hours of a spill, the oil spreads into a thin slick. Winds and waves tear the slick into smaller patches that are scattered over a much wider area. Various physical, chemical, and biological processes change the appearance of the oil. These processes are generally called "weathering." Weathering processes eventually create a tarball that is hard and crusty on the outside and soft and gooey on the inside, not unlike a toasted marshmallow.

Tarballs are very persistent in the marine environment and can travel hundreds of miles. There is no magic trick to making tarballs disappear. Once tarballs hit the beaches, they may be picked up by hand or by beach-cleaning machinery. If the impact is severe, the top layer of sand containing the tarballs may be removed and replaced with clean sand.

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **An oil spill is considered a form of pollution.**

    a. True
    b. False

2. **During an oil spill cleanup, workers may encounter many types _____.**

    a. crude oil
    b. pollution
    c. animals
    d. erosion

3. **Jet fuel is a type of _____.**

    a. light oil
    b. medium oil
    c. very light oil
    d. heavy oil

4. **How much medium oil type should evaporate in 24 hours?**

    a. 1/4
    b. 1/3
    c. 2/3
    d. 3/4

5. **This occurs when oil contacts the water and oxygen combines with the oil to produce water-soluble compounds.**

    a. Dispersion
    b. Evaporation
    c. Oxidation
    d. Adsorption

Module 3: Effects on the Environment

Each type of crude oil and refined product has distinct physical properties that affect the way oil spreads, breaks down and affects the environment and man-made resources.

For example, light refined products, such as gasoline and kerosene, spread on water surfaces and penetrate porous soils quickly. Fire and toxic hazards are high, but the products evaporate quickly and leave little residue. Alternatively, heavier refined oil products may pose a lesser fire and toxic hazard and do not spread on water as readily. Heavier oils are more persistent, however, and may present a greater remediation challenge.

The rate at which an oil spill spreads will determine its effect on the environment. Most oils tend to spread horizontally into a smooth and slippery surface, called a slick, on top of the water. Factors which affect the ability of an oil spill to spread include surface tension, specific gravity, and viscosity.

1. **Surface tension** is the measure of attraction between the surface molecules of a liquid. The higher the oil's surface tension, the more likely a spill will remain in place. If the surface tension of the oil is low, the oil will spread even without help from wind and water currents. Because increased temperatures can reduce a liquid's surface tension, oil is more likely to spread in warmer waters than in very cold waters.

2. **Specific gravity** is the density of a substance compared to the density of water. Since most oils are lighter than water, they lie flat on top of it. However, the specific gravity of an oil spill can increase if the lighter substances within the oil evaporate.

3. **Viscosity** is the measure of a liquid's resistance to flow. The higher the viscosity of the oil, the greater the tendency for it to stay in one place.

Source: EPA

What Happens When the Oil Reaches Shore?

Oil exposure to the shoreline depends on wave energy and tides, substrate type, and slope of the shoreline. Shoreline type is classified by rank depending on how easy the oil would be to clean up, how long the oil would persist, and how sensitive the shoreline is.

Shorelines can vary dramatically in their forms and compositions:

- Some shorelines are narrow with beaches formed from rounded or flattened cobbles and pebbles
- Some are wide and covered in a layer of sand or broken shell fragments
- Some are steep cliffs with no beach at all

The composition and structure of the beach will determine the potential effects of oil on the shoreline. Oil may persist longer than expected based on microclimates. Some of the weathered crude may develop a thin "skin" which when disturbed during cleanup, releases fresher oil.

Oil may not weather into a semisolid tar because of the water emulsification and organic matter and vegetation mixed into the mousse.

Environmental Damage

- Workers should expect to encounter dead and bloated animal carcasses, struggling and dying wildlife, and crude oil impacts to the shoreline.

- There are several things affected by oil on the shoreline: Birds, Reptiles and Amphibians, Fish, Invertebrates, Habitats and Plants, Wetlands, and Marine Mammals and Terrestrial Mammals.

- Thousands of animals die immediately from being inundated with the oil.

- Higher death rates follow in subsequent years, partially because animals ingest prey from contaminated soil and from ingestion of oil residues on hair due to grooming.

Habitat Affected

Birds

Seabirds are amongst the most vulnerable inhabitants of open waters since they are easily harmed by floating oil. Species that dive for their food or which congregate on the sea surface are particularly at risk. Although oil ingested by birds during attempts to clean themselves by preening may be lethal, the most common cause of death is from drowning, starvation and loss of body heat following fouling of plumage by oil.

Cleaning and rehabilitation after oiling is often attempted, but for many species it is rare for more than a fraction of oiled birds to survive cleaning and rarer still for those that survive to breed successfully after release. Penguins are an exception and are much more resilient than

most other birds. When handled properly, the majority are likely to survive the cleaning process and rejoin breeding populations.

Rocks

When oil washes up on the shoreline, it coats and clings to every rock and grain of sand. Oil slick rocks cause increased slip, trip and fall hazards to emergency responders and cleanup workers.

Plant Life

If the oil washes into coastal marshes, mangrove forests or other wetlands, fibrous plants and grasses absorb the oil, which can damage the plants and make the whole area unsuitable as wildlife habitat.

Marine Life

Since most oils float, the creatures most affected by oil are animals like sea otters and seabirds that are found on the sea surface or on shorelines if the oil comes ashore. During most oil spills, seabirds are harmed and killed in greater numbers than other kinds of creatures. Sea otters can easily be harmed by oil, since their ability to stay warm depends on their fur remaining clean. If oil remains on a beach for a while, other creatures, such as snails, clams, and terrestrial animals may suffer.

Ultimately, the severity of environmental damages caused by a particular oil spill depends on many factors, including the amount of the oil spilled, the type and weight of the oil, the location of the spill, the species of wildlife in the area, the timing or breeding cycles and seasonal migrations, and even the weather at sea during and immediately after the oil spill.

Source: National Oceanic and Atmospheric Administration (October 21, 2013)

http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-harms-animals-and-plants-marine-environments.html

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **_____is the measure of a liquid's resistance to flow.**

    a. Toxicity
    b. Viscosity
    c. Surface tension
    d. Specific gravity

2. **The higher the oil's _____, the more likely a spill will remain in place.**

    a. toxicity
    b. surface tension
    c. viscosity
    d. concentration

3. **The _____ and _____ of the beach will determine the potential effects of oil on the shoreline.**

    a. distance, erosion
    b. composition, structure
    c. composition, distance
    d. location, concentration

4. **The oil penetrates up the structure of the plumage of birds, reducing insulating ability.**

    a. True
    b. False

5. **Specific gravity is the density of a substance compared to the density of water.**

    a. True
    b. False

Module 4: Exposure to Toxic Components

Cleanup operations may expose workers to one or more of the following toxic components:

Nitrogen Dioxide (NO_2)

What is Nitrogen Dioxide?

- Gas with a distinctive reddish-brown color.
- Possible exposure from combustible engine exhaust (i.e., diesel fumes) and controlled burning operations.

Health Risks of Nitrogen Dioxide

- respiratory irritant and is capable of causing pulmonary edema
- a concentration of 50 ppm (parts per million) is moderately irritating to the eyes and nose
- may cause pulmonary edema and possibly subacute or chronic lesions in the lungs
- odor of NO_2 is first perceptible to most people in the range of 0.11 to 0.22 ppm

Occupational Exposure Limits (OEL)

Exposure limits regulated by OSHA and other agencies for NO2 range from 1-5 part-per-million (ppm) for a short 15-minute exposure period and 3-5 ppm average over a longer 8-hour exposure period.

NOTE: Workers should be informed that OELs based on standard times are not appropriate for monitoring. Also, OELs do not include skin contact, absorption and ingestion which are common in cleanups.

Check with your site supervisor for additional guidance!

Sulfur Dioxide (SO_2)

What is Sulfur Dioxide?

- SO_2 is released when burning crude oil and during degradation.

- Sulfur dioxide emissions are also a precursor to acid rain and atmospheric particulates.

Health Risks of Sulfur Dioxide

- Short-term exposures to SO2, ranging from 5 minutes to 24 hours, can cause adverse respiratory effects including bronchoconstriction and increased asthma symptoms.
- When reacting with other compounds in the atmosphere to form small particles, they can penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as:
    - emphysema and bronchitis
    - SO2 can aggravate existing heart disease, leading to increased hospital admissions and premature death.

Occupational Exposure Limits (OEL)

EPA set a 24-hour primary standard at 140 parts-per-billion (ppb) and an annual average standard at 30 ppb, and set a 3-hour average secondary standard at 500 ppb.

Carbon Dioxide (CO_2)

What is Carbon Dioxide?

- Carbon dioxide is colorless. At low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor.
- Possible exposure can come from combustible engine exhaust (i.e. diesel fumes) and controlled burning operations.

Health Risks of Carbon Dioxide

- CO_2 is an asphyxiant and an irritant.
- When it is inhaled, it can produce a sour taste in the mouth and a stinging sensation in the nose and throat.

Occupational Exposure Limits (OEL)

Amounts above 5,000 ppm are considered very unhealthy, and those above about 50,000 ppm (equal to 5% by volume) are considered dangerous.

Carbon Monoxide (CO) Exposure

Carbon Monoxide has no warning properties; it is a colorless odorless gas!

Carbon Monoxide may be present with:

- any activity using gasoline, diesel or propane-powered machinery
- work near operating equipment
- debris reduction sites
- work near hot work (cutting, welding) especially in confined spaces

Controlling Exposure

To control CO exposures:

- wear CO monitoring equipment
- do not use gas/diesel powered equipment indoors or in enclosed areas
- use forced air ventilation

Overexposure Symptoms

Symptoms include: Headache, dizziness, drowsiness, or nausea progressing to vomiting, loss of consciousness. Prolonged or high exposure can lead to coma or death. If you experience any of these symptoms where CO may be present - LEAVE AREA IMMEDIATELY.

Gasoline and Diesel Fuels

- Gasoline or petrol is a petroleum-derived liquid mixture which is primarily used as a fuel in internal combustion engines. Diesel fuel is any liquid fuel used in diesel engines. These and other fuels will be used on the cleanup and can add to worker hazards.

- Many of the non-aliphatic hydrocarbons naturally present in gasoline and diesel fuels are carcinogenic.
- Brief inhalation of these and similar substances can also produce many of the effects of alcohol intoxication and, sometimes, a hallucinogen-like "trip."
- Diesel combustion exhaust contains hazardous gases and particles which can be harmful if inhaled.

Diesel Combustion Exhaust

- The largest components of most combustion gases are nitrogen (N_2), water vapor (H_2O), and carbon dioxide (CO_2).
- Relatively small components of it are noxious or toxic substances, such as carbon monoxide (CO), hydrocarbons, nitrogen oxides (NOx), Ozone (O_3), partly unburnt fuel, and particulate matter.
- Workers may be exposed to diesel combustion exhaust from working near diesel powered generators.

Hazardous Chemicals and Their Effects

Hazardous Chemicals	Adverse Health Effects
Benzene (crude oils high in BTEX, benzene, toluene, ethylbenzene, and xylene)	Irritation to eyes, skin, and respiratory system, dizziness, rapid heart rate, headaches, tremors, confusion, unconsciousness, anemia, cancer
Benzo(a)pyrene (a polycyclic aromatic hydrocarbon reproductive [see below], formed when oil or gasoline burns)	Irritation to eyes and skin, cancer
Carbon dioxide (inerting atmosphere, byproduct of combustion)	Dizziness, headaches, elevated blood pressure, rapid heart rate, loss of consciousness asphyxiation, coma
Carbon monoxide (byproduct of combustion)	Irritation to eyes, skin, and respiratory, dizziness, confusion, headaches, nausea, weakness, loss of consciousness, asphyxiation, coma
Ethyl benzene (high in gasoline)	Irritation to eyes, skin, and respiratory system, loss of consciousness, asphyxiation, nervous system effects
Hydrogen sulfide (oils high in sulfur, decaying plants and animals)	Irritation to eyes, skin, and respiratory system, dizziness, drowsiness, cough, headaches, nervous system effects

Methyl tert-butyl ether (MTBE) (octane booster and clean air additive for gasoline, or pure MTBE)	Irritation to eyes, skin, and respiratory system, headaches, nausea; dizziness, confusion, fatigue, weakness, nervous system, liver, and kidney
Polycyclic aromatic hydrocarbons (PAHs) (occur in crude oil, and formed during burning of oil)	Irritation to eyes and skin, cancer, possible reproductive effects, immune system effects
Sulfuric acid (byproduct of combustion of sour petroleum product)	Irritation to eyes, skin, teeth, and upper respiratory system, severe tissue burns, cancer
Toluene (high BTEX crude oils)	Irritation to eyes, skin, respiratory system, fatigue; confusion, dizziness; headaches, memory loss; nausea, nervous system, liver, and kidney effects
Xylenes (high BTEX crude oils)	Irritation to eyes, skin, respiratory system, dizziness, confusion, change in sense of balance, nervous system gastrointestinal system, liver, kidney, and blood effects

Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **EPA has set the 24-hour exposure limit for _____ at 140 parts-per-billion (ppb).**

    a. nitrogen dioxide
    b. carbon monoxide
    c. sulfur dioxide
    d. hydrogen dioxide

2. **Which of the following can cause adverse respiratory effects including bronchoconstriction and increased asthma symptoms after a short exposure?**

    a. Nitrogen dioxide
    b. Carbon monoxide
    c. Sulfur dioxide
    d. Hydrogen dioxide

3. **Irritation to the eyes, skin, etc., is a symptom of all the listed hazardous chemicals, except _____.**

    a. carbon dioxide
    b. benzene
    c. hydrogen sulfide
    d. toluene

4. **What is the most common symptom of overexposure to a hazardous chemical during an oil spill?**

    a. Fatigue and weakness
    b. Dizziness and loss of consciousness
    c. Nausea
    d. Irritation to eyes, skin etc.

5. **Brief inhalation of these can produce many of the effects of alcohol intoxication and, sometimes, a hallucinogen-like "trip."**

    a. Gasoline or petrol
    b. Light oil
    c. Crude oil
    d. All oils and derivatives

Module 5: Oil Spill Cleanup Equipment

When an oil spill occurs, there are many ways to clean it up. One method includes mechanical means to contain and clean up the oil. Let's take a look at some of the equipment needed:

Containment Boom

A containment boom is a flexible, fence-type, water-borne pollutant containment barrier that floats on the water.

How is it used?

- Used to contain oil slicks and lift the oil off the water.
- Boom is reusable and must be decontaminated after use.
- It is very heavy to carry and difficult to work with.

Oil Skimmer

Oil Skimmers are a floating devices used to skim oil off the surface of water or liquid. Many skimmers use oil-attracting materials to help draw the oil to the system and facilitate a more complete cleanup. Skimmers can be towed, self-propelled, moored in river currents, or even used from shore. Many types of skimmers are available for use, depending on the kind of oil spilled and the weather conditions.

There are three common types of skimmers:

- Weir skimmers function by allowing the oil floating on the surface of the water to flow over a weir. The height of the weir may be adjustable.
- Drum skimmers function by using a rotating element such as a drum, to which the oil adheres. The oil is wiped from the surface of the drum and collected.
- Oleophilic skimmers use ropes, discs, or drums that are treated with a substance or otherwise manufactured to adhere to oil.

Other Equipment

Other equipment used for oil spill cleanup includes the following:

Vacuums and Centrifuges

Oil can be sucked up along with the water, and then a centrifuge can be used to separate the oil from the water, allowing a tanker to be filled with near pure oil. Usually, the water is returned to the sea, making the process more efficient, but allowing small amounts of oil to go back as well.

Shovels and Other Road Equipment

Shovels are used to clean up oil on beaches.

Sorbents

These are large absorbents that absorb oil. To be useful in combating oil spills, sorbents need to be both oleophilic (oil-attracting) and hydrophobic (water-repellent). Although they may be used as the sole cleanup method in small spills, sorbents are most often used to remove final traces of oil or in areas that cannot be reached by skimmers. Sorbent materials used to recover oil must be disposed of in accordance with approved local, state, and federal regulations. Any oil that is removed from sorbent materials must also be properly disposed of or recycled. (EPA)

Sorbents can be divided into three basic categories:

1. **Natural organic sorbents** include peat moss, straw, hay, sawdust, ground corncobs, feathers, and other readily available carbon-based products.

2. **Natural inorganic sorbents** consist of clay, perlite, vermiculite, glass wool, sand, or volcanic ash. They can adsorb from 4 to 20 times their weight in oil.

3. **Synthetic sorbents** include man-made materials that are similar to plastics, such as polyurethane, polyethylene, and polypropylene and are designed to adsorb liquids onto their surfaces.

Bioremediation

Studies by the U.S. Geological Survey (USGS) have shown microorganisms naturally present in the soils actively consume fuel-derived toxic compounds and transform them into harmless carbon dioxide. Furthermore, these studies have shown the rate of these biotransformations

could be greatly increased by the addition of nutrients. By "stimulating" the natural microbial community through nutrient addition, it is theoretically possible to increase rates of biodegradation and thereby shield the residential area from further contamination.

Bioremediation Accelerator

A bioremediation accelerator is a chemical containing no bacteria which bonds to soluble and insoluble hydrocarbons. Characteristics of bioremediation accelerators include the following:

- They chemically and physically bond to both soluble and insoluble hydrocarbons.
- They act as a herding agent in water and on the surface and the accelerator causes molecules to float to the surface of the water.
- These are usually chemical products with hazardous properties.
- Workers need additional training in their safe use and perhaps additional PPE. Check with your site supervisor for SDSs.

Controlled Burning

Controlled (In-situ) burning is the term given to the process of burning oil slicks at sea, at or close to the site of a spill. Burning may be seen as a simple method which has the potential to remove large amounts of oil from the sea surface. Controlled burns:

- burn the oil off of the water
- can effectively reduce the amount of oil in water
- can only be done in low wind
- can cause air pollution and respiratory ailments

There are a number of problems which limit the viability of this response technique. These include:

- the ignition of the oil
- maintaining combustion of the slick

- the generation of large quantities of smoke
- the formation and possible sinking of extremely viscous and dense residues
- safety concerns

A controlled burn to clear marsh grasses can also be used BEFORE the oil reaches the shore.

Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **A flexible, fence-type, water-borne pollutant containment barrier that floats on the water is called _____.**

   a. a containment boom
   b. a water skimmer
   c. an oil containment buoy
   d. a wave suppressor

2. **Which of the following is a machine that separates oil floating on water?**

   a. Containment boom
   b. Oil skimmer
   c. Oil containment buoy
   d. Oil vacuum

3. **Which of the following is a simple method which has the potential to remove large amounts of oil from the sea surface?**

   a. Containment booms
   b. Controlled burning
   c. Oil vacuums
   d. Detergents

4. **All the following are problems which limit the viability of controlled burning, <u>except</u> _____.**

   a. the ignition of the oil
   b. makes a lot of noise
   c. large quantities of smoke
   d. maintaining combustion of the slick

5. **Studies by the USGS had shown that _____ were actively consuming fuel-derived toxic compounds and transforming them into harmless carbon dioxide.**

    a. conversion units strategically placed
    b. microorganisms in the soils
    c. small marine mammals
    d. wetland invertebrates

Module 6: Oil Spill Worker Safety and Health

Introduction

The potential for an emergency situation to occur during an oil spill cleanup is large. To work in cleanup, you must be trained on the hazards of your job in a language that you understand. You must be trained before you begin oil spill response and cleanup work.

If an emergency occurs, notify your supervisor, safety officer or incident commander about all injuries and hazardous material exposures sustained at the site. Your employer's Health and Safety Plan will describe the emergency procedures to be followed.

- Ask what first aid support is available during your briefing; be sure you understand where it is located.
- For minor injuries or health concerns, go to:
  - First Aid
  - Local hospitals or clinics
  - EMT or nurse station
- For serious emergencies call your direct supervisor or 911.
- Know your exact location.
- Keep an injured worker in a safe location until assistance arrives.
- Don't move an injured worker unless safety is at risk.
- Use the "buddy system" to aid and help each other.

Protecting Yourself

Your first priority is to protect yourself! It's important that you work in a proactive manner with safety always being top priority. Be sure to do the following:

- Watch for lacerations, slips, falls, and trips, especially while working on oil-slick rocks.

- Be careful walking over and handling debris that is covered with water in order to avoid the risks associated with slips, trips and falls.
- Remain current with tetanus vaccination.
- Get the Hepatitis B vaccine series if you will be performing direct patient care or otherwise expect to have contact with bodily fluids.
- Avoid contact with stagnant water.
- Wear rubber type steel toe/shank footwear to protect your feet from injury and from oil exposure.
- Wear oil-resistant gloves when in contact with oil and oil waste
- Wear outer durable gloves when handling debris.
- Use hearing protection in noisy environments.
- Use decontamination procedures set by your employer before eating or drinking, using the toilet during the workday, and do a full decontamination, including a shower if available, at the end of shift.
- Wash and sanitize immediately if exposed to toxic substances.
- Know your medicines, allergies, and blood type.
- Do not stand in or come in contact with unknown liquids or substances.
- If in doubt, contact your supervisor!

The Hazards of Heat Stress

One of the most serious health hazards facing cleanup workers is heat stress. The risk from the heat and humidity is exacerbated by the long days worked and the protective equipment required.

Heat injury is caused when the body's ability to deal with heat is overwhelmed. Heat stress varies in severity but is common, serious and can be deadly. The good news is that it can be prevented.

Heat rash, also known as prickly heat, is skin irritation caused by sweat that does not evaporate from the skin. Heat rash is the most common problem in hot work environments. Heat rash usually appears on the neck, upper chest, in the groin, under the breasts and in elbow creases. The best treatment for heat rash is to provide a cooler, less humid work environment. Keep skin dry, use powders, not creams or ointments.

Heat exhaustion is the body's response to loss of water and salt from heavy sweating. Signs include headache, nausea, dizziness, weakness, irritability, thirst, and heavy sweating. Make sure that someone stays with the worker until help arrives. If symptoms worsen, call 911 and get help immediately.

Heat stroke, the most serious form of heat-related illness, happens when the body becomes unable to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. When heat stroke occurs, the body temperature can rise above 104 °F within 10 to 15 minutes. Signs include confusion, loss of consciousness, and seizures. "Heat stroke is a medical emergency that may result in death! Call 911 immediately.

Heat Syncope is a fainting or near fainting episode or dizziness that usually occurs with prolonged standing or sudden rising from a sitting or lying position. Factors that may contribute to heat syncope include dehydration. Workers with heat syncope should sit or lie down in a cool place when they begin to feel symptoms, and slowly drink water or electrolyte drink. If they have fainted, then call 911, notify their supervisor and make arrangements for evaluation by EMS or medical personnel to eliminate other causes.

Heat cramps are caused by the loss of body salts and fluid during sweating. Low salt levels in muscles cause painful cramps. Tired muscles—those used for performing the work—are usually the ones most affected by cramps. Cramps may occur during or after working hours. Workers with heat cramps should replace fluid loss by drinking water and/or carbohydrate-electrolyte replacement liquids (e.g. sports drinks) every 15 to 20 minutes.

Factors Increasing the Heat Stress

Where does the heat come from that causes our bodies to overheat?

- high temperature and humidity

- direct sun exposure (with no shade) or extreme heat
- limited air movement (no breeze or wind)
- physical exertion (generates heat)
- wearing protective clothing and equipment

Working outdoors, especially in hot and humid weather, being in the sun, and doing hard physical work is something we have to take seriously.

Preventing Heat Injury

It is most important that you take steps to help prevent heat stress and injury by doing the following:

- Know signs/symptoms of heat illnesses; monitor yourself; watch out for your co-workers.
- Wear a hat to block out direct sun.
- Use cooling fans/air-conditioning for rest breaks and rest regularly in shaded areas.
- Wear lightweight, light colored, loose-fitting clothes.
- Wear protective clothing that actively cools the body.

Work and Rest Cycles

The work/rest cycle is one of several protective controls to decrease overall heat stress. It may not be mandatory if other controls such as air-conditioned rest areas or ice vests are in use and are sufficient to keep worker's body temperatures normal for the individual. Work/Rest cycles assume the resting place available to workers is shaded, but otherwise at the same ambient temperature as the work area.

During the rest period workers should remove protective clothing not required in the rest area to enhance their opportunity to cool. Important points:

- Your employer must set work and rest cycles.

- Work itself generates heat.
- Beach cleanup workers are currently working 20 minutes and resting for 40 minutes.
- When possible, work during the cooler parts of the day and rest mid-day.
- Adjust to the Heat
- If you are new to hot environments, begin work gradually.
- Start at about half of what you would usually do.
- Gradually increase how long you work and how hard you work over the first five workdays.
- If you are away from the heat for more than a week, start over.
- You will still need rest breaks every hour in hot weather, even when you are fully adjusted.

Other Risk Factors

Take extra care if you have any of the additional risk factors:

- diabetes, heart disease, obesity, pregnancy, any acute viral illness
- lack of recent exposure to heat
- some medications (including antihistamines, diuretics, some other medications – ask your health care provider or pharmacist)
- fatigue (We will discuss this more shortly)
- avoid drugs, especially cocaine and amphetamines

Fluid Intake

Drink plenty of cool water: drink before you are thirsty. Sports drinks are a good idea because they help to replace electrolytes. When you sweat, you lose minerals as well as water, and your body requires those minerals to work properly.

Drink small amounts often: a 6-ounce cup every 20 minutes, more depending on work load and heat.

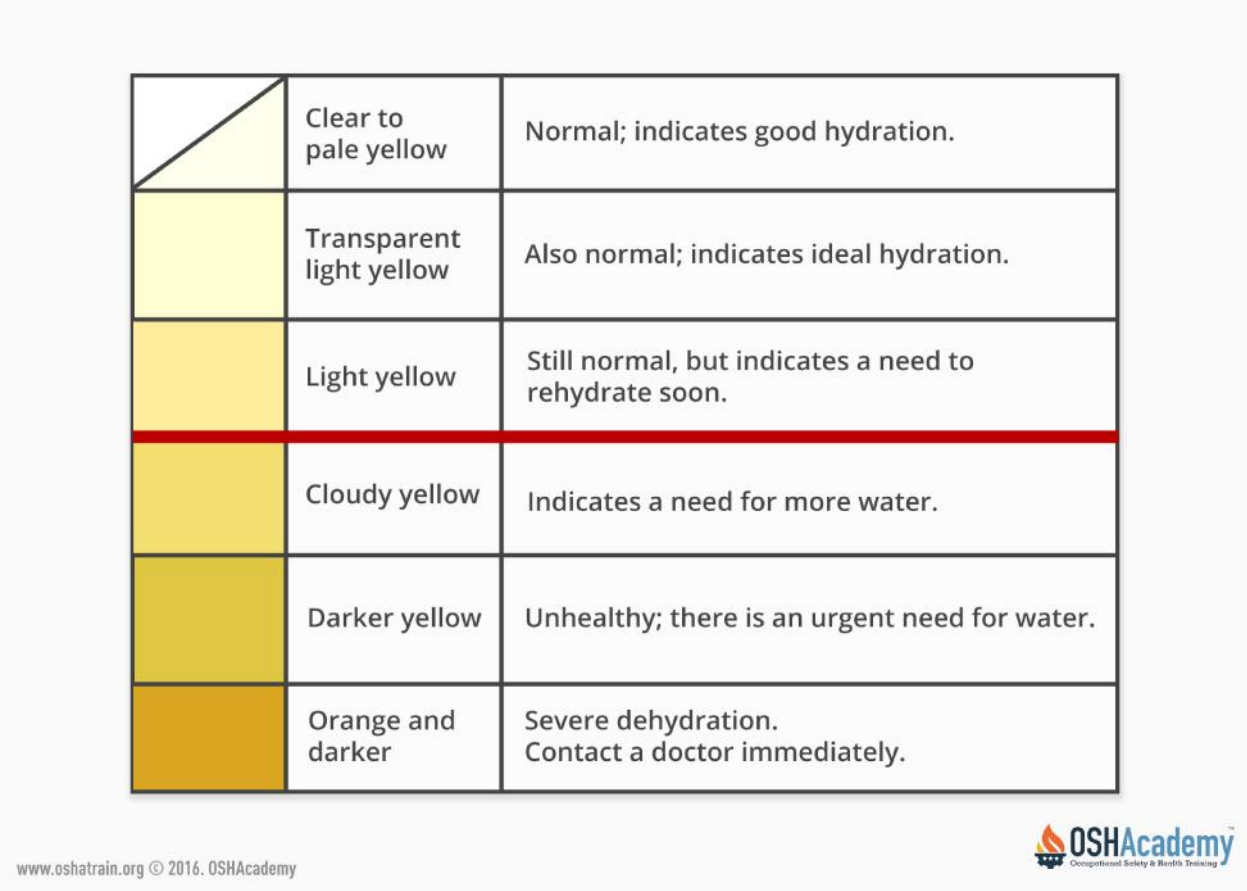
Don't drink more than a quart (32 ounces) in an hour (you can also get sick from too much water). In general, don't drink more than 12 quarts a day.

Eat a normal diet. Frequent small meals are best. Sports drinks contain salts (which you lose as you sweat), so if you're not able to eat regularly, they are a good alternative.

Avoid alcohol or caffeinated drinks.

Urine Output Color

The color of your urine can help you tell if you are drinking enough water.



Fatigue

Experiencing fatigue during an oil spill cleanup can also be a factor in your overall health. Make sure you pace yourself, especially when working long shifts and many days in a row. Here are some other important factors to remember:

- Watch out for each other. Use the buddy system on your crews, especially in remote locations. Coworkers may not notice a hazard nearby or behind.
- Be conscious of those around you. Responders who are exhausted, feeling stressed or even temporarily distracted may place themselves and others at risk.
- Maintain as normal a schedule as possible. Regular eating and sleeping are crucial.
- Make sure that you drink plenty of fluids such as water or sports drinks.

Respiratory Protection

Respiratory protection must be worn whenever you are working in a hazardous atmosphere. The appropriate respirator will depend on the contaminant(s) to which you are exposed and the protection factor (PF) required.

Here are a few examples:

Single-strap dust masks (figure 1) must not be used to protect from hazardous atmospheres. However, they may be useful in providing comfort from pollen or other allergens.

Half-face respirators (figure 2) can be used for protection against most vapors, acid gases, dust or welding fumes. Cartridges/filters must match contaminant(s) and be changed periodically.

Full-face respirators (figure 3) are more protective than half-face respirators. They can also be used for protection against most vapors, acid gases, dust or welding fumes. The face-shield protects face and eyes from irritants and contaminants. Cartridges/filters must match contaminant(s) and be changed periodically.

A Self-Contained Breathing Apparatus (figure 4) is used for entry and escape from atmospheres that are considered immediately dangerous to life and health (IDLH) or oxygen deficient. They use their own air tank.

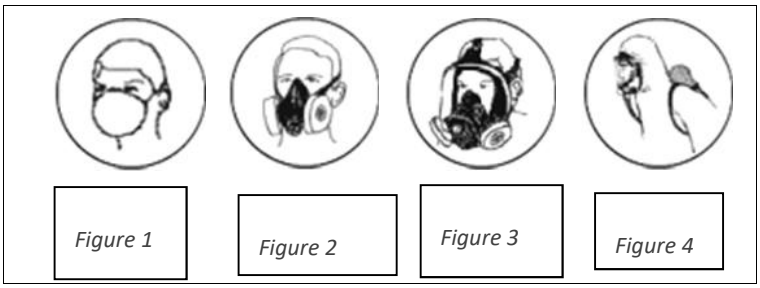


Figure 1

Figure 2

Figure 3

Figure 4

Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **During oil spill cleanup operations, workers should not drink more than a _____in an hour.**

    a. pint (16 ounces)
    b. quart (32 ounces)
    c. gallon (128 ounces)
    d. cup (8 ounces)

2. **When heat stroke occurs, the body temperature can rise _____ within 10 to 15 minutes.**

    a. above 98.5 deg F
    b. above 104 deg F
    c. to 102 deg F
    d. to 100 deg F

3. **Which of the following has symptoms that include confusion, loss of consciousness, and seizures?**

    a. Heat exhaustion
    b. Heat rash
    c. Heat stroke
    d. Heat cramps

4. **Which of the following is the most serious form of heat-related illness that happens when the body becomes unable to regulate its core temperature?**

    a. Heat exhaustion
    b. Heat rash
    c. Heat stroke
    d. Heat cramps

5. **The best treatment for _____ is to provide a cooler, less humid work environment. Keep skin dry, use powders, not creams or ointments.**

   a. heat exhaustion
   b. heat rash
   c. heat stroke
   d. heat cramps

Endnotes

1. National Institute of Environmental Health Sciences (June 2010, v7). Safety and Health Awareness for Oil Spill Cleanup Workers. Retrieved from: www.osha.gov/Publications/Oil_Spill_Booklet_05.11_v4.pdf

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