

TRAINING REFERENCE FOR OIL SPILL RESPONSE

Department of Transportation
U.S. Coast Guard
Research and Special Programs Administration



Environmental Protection Agency



Department of the Interior
Minerals Management Service



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Section 1: Introduction

The Oil Pollution Act of 1990 (OPA) amended the Federal Water Pollution Control Act (FWPCA) to require tank vessel and facility response plans. The plans are intended to prepare the owner of a vessel or facility to respond to an oil or hazardous substance discharge. Response plans must describe the training of persons on a tank vessel which carries oil or hazardous substances in bulk as cargo or cargo residue, at an offshore facility, or at an onshore facility where its location could reasonably be expected to cause substantial harm to the environment by discharging oil or hazardous substances into the navigable waters, adjoining shoreline, or exclusive economic zone. The training is required to ensure the safety of the vessel or facility and to mitigate or prevent a discharge of oil or a hazardous substance. The definition of a facility is very broad under OPA and includes any offshore facility, onshore facility, motor vehicle, rolling stock, or pipeline used for oil exploration, production, storing, handling, transferring, processing, or transporting oil.

In addition to OPA-required response training, there are other federal and state response training requirements. Vessel and facility owners or operators are responsible for ensuring that all private response personnel which they employ are trained to meet the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations Standard (29 CFR 1910.120.) These requirements, commonly referred to as the HAZWOPER regulations, were established to ensure the health and safety of personnel employed in hazardous substance response and clean-up operations. Personnel employed at facilities which transfer or store products in bulk, classified as hazardous substances by OSHA, must also comply with HAZWOPER regulations. Crude oil, petroleum oil, and petroleum distillates are considered hazardous substances by OSHA. In addition to the HAZWOPER regulations, employers must comply with federal requirements contained in 49 CFR Parts 172 and 176 to train employees handling hazardous materials.

There are four federal agencies with responsibilities under OPA to require vessel and facility response plans: the U.S. Coast Guard (USCG), the U.S. Environmental Protection Agency (EPA), the Department of Transportation's Research and Special Programs Administration (RSPA), and the Minerals Management Service (MMS). These agencies recognize that pollution response training should be directly related to the duties and responsibilities of the workers in the response organization. Workers with a limited role in a response need to be trained to protect their health and to perform their normal duties in a safe manner. They must also be trained to conduct the proper notifications to the National Response Center and to immediately intervene to mitigate a spill once it has occurred. Workers with spill clean-up responsibilities will need to be trained to deploy and operate the equipment they will actually use in the response. Other personnel with a more active role in the response organization or with supervisory responsibilities may need additional training in such subjects as response or clean-up technology, spill trajectory forecasting or response management strategies.

In order to assist companies in meeting their regulatory responsibilities to develop training programs for their personnel, the four federal agencies have developed this training reference manual for oil spill response. The contents provide a foundation of suggested subject material for training personnel with responsibilities identified in response plans. Subject material is provided for each of the key individuals or groups of people required to be identified in response plans as well as for worker health and safety as follows:

- ✕ Qualified Individual (Section 3)
- ✕ Spill Management Team (Section 4)
 - ✕ Vessel Personnel (Section 5)
 - ✕ Facility Personnel (Section 6)
- ✕ Oil Spill Removal Organizations (Section 7)
 - ✕ Worker Health and Safety (Section 8)

The training elements included are not intended to be a "cookbook" providing a complete training program of lesson plans to cover all subject areas. Rather, they are intended to be a foundation upon which individual companies may build training to suit their needs. Some of the material may not be applicable to the needs of the company or roles of the company personnel in the company's response organization. In order to assist industry and governmental response organizations, we have included some lesson plans used to train USCG personnel in pollution response. We expect that some modifications or enhancements to the lesson plans may be required to meet the training needs of your organization. The lesson plans also do not cover all of the technical subjects, (i.e., vessel salvage,) required to be addressed by individual plan holders. Although initially intended as information for vessel and facility owners or operators, we have determined that the training elements may prove useful to any industry which handles, stores, or transports oil, regardless of location. The training elements may also prove useful to state agencies or governmental response organizations. The training elements are intended to be strictly voluntary and non-regulatory. Any conflict with existing federal or state regulations in this document is unintentional and does not relieve owners or operators of facilities or vessels from compliance with federal or state laws or regulations.

The International Maritime Organization (IMO), based in London, England, has been developing training courses for oil spill response. Resolution seven of the International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (OPRC), committed IMO to the "development and implementation of a training program for oil pollution preparedness and response." After analyzing responses to major oil spills, IMO recognized that the capability of a nation to respond to an oil spill is dependent on both the availability of adequate equipment and trained response personnel to operate the equipment. A special need was identified to assist developing countries by providing training to their response personnel. As a result, IMO invited interested member governments to help develop training programs in preparedness and response. IMO working groups then identified three levels of training for oil spill response:

- ✕ Level 1 – First responder level (or operational staff).
- ✕ Level 2 – Middle management level (supervisors or on-scene commanders).
 - ✕ Level 3 – Senior management level (decision makers at the upper level)

The Canadian Coast Guard agreed to act as lead country of a correspondence group in the design work for these IMO courses. Drawing upon its own expertise and that of member nations, the Canadian Coast Guard has actively pursued course development.

Design work on the first two courses has been completed. The subsequent stages of course development, testing, implementation, and evaluation are expected to follow.

The course design material for the first two IMO courses has been modified slightly to make it more relevant to the oil spill training needs of the United States. The design material, presented in the form of a job task analysis, is included in the appendix sections of this document for your information only. The IMO courses were never intended to be promulgated as standards or regulations and should not be used as such. Please consider the material as a menu of training elements from which to select relevant material that may be incorporated into your own training program on an as-needed basis. ■

Section 2: Regulatory Summary

On February 5, 1993, the USCG published interim final rules requiring vessel and facility owners to identify the training to be provided to each individual who has responsibilities as described in company response plans [58 FR 7424 (vessels); and 58 FR 7352 (facilities)]. The USCG regulates and is required to review and approve all deepwater port, vessel, and marine transportation-related facility response plans. Rather than develop highly prescriptive regulatory requirements, the USCG has allowed vessel and marine transportation-related facility owners and operators the flexibility to choose the manner in which they describe training in their response plans. USCG regulations are found in 33 CFR parts 150, 154 and 155.

EPA regulates non-transportation related onshore facilities and certain offshore facilities located landward of the coastline under the oil pollution prevention regulations (40 CFR part 112). EPA published a final rule in the Federal Register on July 1, 1994, to amend these regulations to include response plan requirements under OPA [50 FR 34097]. The final rule requires the owner or operator of a substantial harm facility to develop and implement a facility response plan, which includes a training program for those personnel involved in oil spill response activities. The rule recommends that the training program be based on this reference manual, as applicable to facility operations. An alternative training program can also be acceptable, subject to approval by the Regional Administrator.

Under OPA, the MMS regulates offshore facilities, including associated pipelines, other than deepwater ports subject to the Deepwater Port Act. Under a Memorandum of Understanding among the Department of the Interior, the Department of Transportation, and the EPA, MMS only regulates those offshore facilities located seaward of the coastline. The MMS published an interim final rule (IFR) on February 8, 1993, requiring spill response plans from offshore facilities [58 FR 7490]. The IFR will expire on February 18, 1995, or when superseded by a final rule. The MMS is currently preparing a notice of proposed rulemaking (NPRM) for the final rule on spill response plans.

RSPA's Office of Pipeline Safety regulates onshore transportation-related natural gas, hazardous liquid (including oil and refined products), and carbon dioxide pipelines. RSPA plans to issue regulations establishing training qualifications for pipeline personnel involved in operations, maintenance, and emergency response functions. A notice of proposed rulemaking is expected in late summer of 1994. ■

Section 3: Training for Qualified Individuals

Industry response plan holders must identify a qualified individual who will act as the point of contact between the federal government and the owner or Operator of the vessel or facility. This individual is also referred to as the emergency response coordinator by EPA regulations. The responsibilities of the qualified individual go far beyond that of a mere intermediary. As defined in OPA, the qualified individual is that person identified in a response plan having "full authority to implement removal actions" on behalf of the plan holder. The qualified individual must have the authority to commit the financial resources of the company to prevent or clean up a spill.

One of the primary responsibilities of the qualified individual is, upon learning of a spill or potential spill of an oil or hazardous substance, to immediately communicate with the appropriate federal official and the persons providing personnel and equipment for the spill response. This procedure will ensure timely notification of federal officials so that they may activate Area Contingency Plans notify other federal, state, and local agencies ensure adequate measures are taken by the responsible party and activate governmental response resources when necessary. It also ensures that response resources identified by the plan holder will commence appropriate response actions in a timely manner.

Federal regulations require response plan holders to identify the type of training the qualified individual will receive. The goal is to ensure that the qualified individual is fully capable to perform his or her duties. Although the qualified individual is not expected to be a technical expert in vessel salvage, clean-up technology, or pipeline repair, the qualified individual must be familiar enough with the company's response plan to know what measures must be taken under the circumstances. The qualified individual must ensure adequate steps are taken to mitigate the situation and should know the capabilities of any oil spill removal organization (OSRO) which is contracted to respond on behalf of the company. The qualified individual should be thoroughly familiar with procedures to activate and contract with the company's OSRO.

The following TAB provides suggested elements which could be incorporated into the training program for a qualified individual. The material should not be considered as mandatory training nor should it be considered all-inclusive. A training program which provided all of the suggested training elements would certainly be very comprehensive. An individual receiving this training would have an excellent educational foundation to help him or her play a highly pro active role in the plan holder's response organization. Plan holders must decide the actual role of the qualified individual in their organizations and customize their training programs accordingly.

TAB A

Suggested training elements for qualified individuals:

Demonstrate knowledge of the following:

- ◆ Captain of the Port (COTP) Zones or Environmental Protection Agency (EPA) Regions in which the vessel will operate or facility is located.

- ◆ Notification procedures and requirements for vessel or facility owners or operators; internal response organizations; federal and state agencies; and contracted oil spill removal organizations (OSROs) and the information required for those organizations.

- ◆ Communication system used for the notifications.

- ◆ Information on the cargoes carried by the vessel or transferred, stored, or used by the facility, including familiarity with the material safety data sheets, special handling procedures, health and safety hazards, spill and fire fighting procedures.

- ◆ Procedures the crew or facility personnel may use to mitigate or prevent any discharge or a substantial threat of a discharge of oil resulting from shipboard or facility operational activities associated with internal or external cargo transfers, storage, or use.

- ◆ Procedures the vessel's crew may use to mitigate or prevent any discharge or a substantial threat of a discharge of oil in the event of --
 - Grounding or stranding;
 - Collision;
 - Explosion or fire;
 - Hull failure;
 - Excessive list; or
 - Equipment failure.

- ◆ Procedures for both the internal and ship-to-ship transfers of cargo in an emergency.

- ◆ Procedures and arrangements for emergency towing, including the rigging and operation of any emergency towing equipment aboard the vessel.

- ◆ Vessel crew or facility personnel responsibilities, and procedures for use of shipboard or facility equipment which may be carried to mitigate an oil discharge.

- ◆ The vessel crew's responsibilities, if any, to initiate a response and supervise shore-based response resources.

- ◆ Operational capabilities of the contracted OSROs to respond to the following:
 - Average most probable discharge (small discharge);
 - Maximum most probable discharge (medium discharge); and
 - Worst case discharge.

- ◆ Responsibilities and authorities of the qualified individual as described in the vessel or facility response plan and company response organization.
- ◆ Procedures, if applicable, for transferring responsibility for direction of response activities from vessel personnel to the shore-based spill management team.
- ◆ The organizational structure that will be used to manage the response actions, including --
 - Command and control;
 - Public information;
 - Safety;
 - Liaison with government agencies;
 - Spill response operations;
 - Planning;
 - Logistics support; and
 - Finance.
- ◆ The responsibilities and duties of each oil spill management team member within the organizational structure.
- ◆ The drill and exercise program to meet federal and state regulations as required under OPA.
- ◆ The role of the qualified individual in the post discharge review of the plan to evaluate and validate its effectiveness.
- ◆ Area Contingency Plans (ACPs) for the areas in which the vessel operates or the facility is located.
- ◆ The National Contingency Plan (NCP).
- ◆ Roles and responsibilities of federal and state agencies in pollution response.
- ◆ Available response resources identified in response plan.
- ◆ Contracting and ordering procedures to acquire oil spill removal organization resources identified in the response plan.
- ◆ Occupational Safety and Health Administration (OSHA) requirements for worker health and safety (29 CFR 1910.120).
- ◆ Incident Command System/Unified Command System.
- ◆ Public affairs.
- ◆ Crisis management.
- ◆ Procedures for the plan holder's ship salvage arrangements.
- ◆ Procedures for obtaining approval for dispersant use or in-situ burning of the spill.
- ◆ Oil spill trajectory analyses.
- ◆ Sensitive biological areas.■

Section 4: Training for Spill Management Teams

A spill management team is also required to be designated by USCG regulations. The function of the team is to assist or relieve the company's qualified individual in the actual response to an oil or hazardous substance spill. The team staffs the organizational structure the company has identified to manage response plan implementation. The team may also provide the operational oversight of field response personnel.

Although the size and qualifications of the spill management team have not been federally mandated, the team must be adequately staffed to ensure a credible response depending on the size of the spill. The number of members will be expected to grow if the situation warrants 24 hour per day operations and a cast of several thousand clean-up personnel. A well-structured response organization will be able to accommodate changes in the size of the spill management team and rapidly integrate additional members.

Many private companies have chosen response organizations based on the Incident Command System (ICS) model which was developed in the early 1970's in California by federal, state, and local officials to fight major forest fires. There are many systems that are used throughout the United States for the direction and control of resources in emergencies. The National Fire Academy and the National Interagency Incident Management System have both developed popular models for ICS-based response organizations. However, regardless of the specifics of the systems, all ICS systems are based on the same basic business management principles. In a business or government environment, managers and leaders perform the basic daily tasks of planning, directing, organizing, coordinating, communicating, delegating, and evaluating. The same is true for emergency response management.

OSHA requires the senior emergency response official of hazardous substance emergency response organizations to use a site-specific ICS. The response management organization is built around five major management activities:

- ✕ Command;
- ✕ Operations;
- ✕ Planning;
- ✕ Logistics; and
- ✕ Administration and Finance.

OPA requires the On-Scene Coordinator (OSC) to work with state and local officials in the development of ACPs, to ensure pre-planning of joint response efforts, and to expedite decisions for the use of dispersants and other mitigating substances. The Federal Government, through its NCP, uses a Unified Command Structure (UCS). This structure is intended to bring the OSC, state official, and the responsible party together to facilitate the decision making processes and optimize the combined response efforts of all participants. The UCS structure can easily integrate members of the spill management team who will be most likely invited to participate.

The key to training spill management team members is to train them according to their functional role within the response organization. Members staffing an operations center need to be trained differently from members whose primary function is logistics. Many of the company's personnel will be able to draw upon skills they use and training they

have obtained in the company's everyday activities of running the facility or vessel operation. Personnel designated to administer the financial duties of spill response and cost documentation are especially likely to have such experience. Other personnel will be asked to fill roles which they may only perform in a crisis situation; therefore, due to the infrequency of an actual crisis, these personnel would need extra periodic training to perform crisis functions.

If the individual will always fill the same spill management team function, training requirements will be narrowed in scope. If a company desires greater flexibility in use of their personnel and redundancy in available knowledge in case key personnel are unavailable, it may choose to add to the curricula presented to team members. The goal is to train these personnel so that the team can function as a coordinated unit and direct the clean-up activities or preventative measures in an efficient and timely manner.

4-A provides suggested elements which could be incorporated into the training program for the spill management team. The material should not be considered as mandatory training nor should it be considered all-inclusive. A training program which provided all of the suggested training elements would certainly be very comprehensive. Team members receiving this training would have an excellent educational foundation to help them play a highly pro active role in the plan holder's response organization. Plan holders must decide the actual role of their spill management team members in their organizations and customize their training programs accordingly.

4.A. Suggested training elements for Spill Management Team members:

Demonstrate knowledge of the following:

- ◆ The Captain of the Port (COTP) Zones or EPA Regions in which the vessel will operate or facility is located.
- ◆ Notification procedures and requirements for vessel or facility owners or operators, internal response organizations, federal and state agencies; and contracted oil spill removal organizations and information required for those organizations.
- ◆ Communication systems used for the notifications.
- ◆ Information on the cargoes carried by the vessel or transferred, stored, or used by the facility, including familiarity with the material safety data sheets, special handling procedures, health and safety hazards, spill and firefighting procedures.
- ◆ Procedures the vessel's crew may use to mitigate or prevent any discharge or a substantial threat of a discharge of oil in the event of --
 - Grounding or stranding;
 - Collision;
 - Explosion or fire;
 - Hull failure;
 - Excessive list; or
 - Equipment failure.
- ◆ Vessel crew or facility personnel responsibilities, and procedures for use of shipboard or facility equipment which may be carried to mitigate an oil discharge.
- ◆ Vessel crew's responsibilities, if any, to initiate a response and supervise shore-based response resources.

- ◆ The operational capabilities of the contracted oil spill removal organizations (OSROs) to respond to the --
 - Average most probable discharge (small discharge);
 - Maximum most probable discharge (medium discharge); and
 - Worst case discharge.
- ◆ Responsibilities and authority of the qualified individual as described in the vessel or facility response plan and company response organization.
- ◆ Procedures, if applicable, for transferring responsibility for direction of response activities from vessel personnel to the shore-based spill management team.
- ◆ The organizational structure that will be used to manage the response actions, including --
 - Command and control;
 - Public information;
 - Safety;
 - Liaison with government agencies;
 - Spill response operations;
 - Planning;
 - Logistics support; and
 - Finance.
- ◆ The responsibilities and duties of the oil spill management team member within the organizational structure, in accordance with designated job responsibilities.
- ◆ The training procedures as described in the response plan for members of the spill management team.
- ◆ The drill and exercise program to meet the federal and state regulations as required by OPA.
- ◆ Procedures for the post discharge review of the plan to evaluate and validate its effectiveness.
- ◆ The Area Contingency Plans (ACPs) for the areas in which the vessel operates or the facility is located.
- ◆ The National Contingency Plan.
- ◆ Roles and responsibilities of federal and state agencies in pollution response.
- ◆ Available response resources.
- ◆ Contracting and ordering procedures to acquire OSRO resources, in accordance with designated job responsibilities.
- ◆ Basic information on spill operations and oil spill clean-up technology including --
 - Oil containment;
 - Oil recovery methods and devices;
 - Equipment limitations and uses;

- Shoreline clean-up and protection;
 - Spill trajectory analysis;
 - Use of dispersants, in-situ burning, bioremediation; and
 - Waste storage and disposal considerations.
- ◆ Hazard recognition and evaluation.
 - ◆ Site safety and security procedures.
 - ◆ OSHA requirements for worker health and safety (29 CFR 1910.120).
 - ◆ Incident Command System and Unified Command System.
 - ◆ Public affairs, as applicable to designated job responsibilities.
 - ◆ Crisis management, as applicable to designated job responsibilities.
 - ◆ Personnel management, as applicable to designated job responsibilities.
 - ◆ Ship salvage procedures, vessel damage stability and hull stress considerations when performing shipboard mitigation procedures, as applicable to designated job responsibilities.
 - ◆ Emergency cargo transfer procedures, as applicable to designated job responsibilities.
 - ◆ Procedures for both the internal and ship-to-ship transfers of cargo in an emergency, as applicable to designated job responsibilities.
 - ◆ Procedures and arrangements for emergency towing, including the rigging and operation of any emergency towing equipment aboard the vessel, as applicable to designated job responsibilities.
 - ◆ Sensitive biological areas, as applicable to designated job responsibilities.
 - ◆ Procedures for directing the deployment and use of spill response equipment, as applicable to designated job responsibilities.

Appendix A: Oil Spill Response Courses

The USCG has worked closely with IMO and the Canadian Coast Guard in the development of course curricula for oil spill response. In August 1993, the USCG distributed two sets of draft voluntary training guidelines for oil pollution response. The guidelines were modifications of training material which IMO will be using to train members of the international community. The guidelines provided industry with an outline of recommended subject areas in which personnel involved in oil spill response and clean-up could be trained in. They were presented in the form of a job task analysis for two separate training courses. One course was designed for non-supervisory operational personnel, while the other course was designed for supervisory operational personnel. The guidelines were intended to assist owners and operators of vessels, marine transportation-related (MTR) facilities, and deepwater ports in developing or choosing training programs for oil spill response for their operational personnel.

A job task analysis (JTA) can be considered a job performance outline. Job requirements are broken into specific performance elements referred to as tasks and sub-tasks. For instance, task number 13, "Transfer oily wastes," is subdivided into three sub-tasks:

- ✕ 13.1 Categorize and quantify collected materials;
- ✕ 13.2 Select pump, conveyors, and other equipment; and
- ✕ 13.3 Safely operate transfer equipment.

The knowledge which must be communicated to teach each sub-task and the resulting skills which the student must demonstrate after training is completed are also provided. Because of the different job responsibilities of each employee and their intended role in the vessel or facility plan, the JTA should be customized by the trainer. Trainers may use the guidelines as a menu of subject areas from which to select relevant topics depending on the duties and responsibilities of the individual employee. This procedure ensures a direct correlation between the job which is performed and the training which is provided to perform that job. Specific lesson plans must be developed by the instructor to actually deliver the subject material to the student. ■

Section 5: Training for Vessel Personnel

OPA clearly requires vessel response plans include information on training and response actions of vessel crews to ensure the safety of their vessel and to mitigate or prevent an oil or hazardous substance discharge. Therefore, the basic training elements which should be addressed include both --

- a. **Prevention training** to prevent a spill from occurring and the tank ship or tank barge from endangering its cargo, and
- b. **Response training** so that each crew member knows what his or her role is in a marine emergency, and how to respond if the crew has failed in its efforts to prevent a discharge of cargo onto the deck or into the surrounding water.

Prevention training is used to hone the normal operational skills of the mariner. It ensures the safe operation of the vessel during transit and during cargo transfer operations. Theoretically, if a comprehensive prevention training program is implemented by the vessel owners and employees, it will substantially reduce the number and severity of oil and hazardous substance spills. Unfortunately, many factors combine to cause pollution incidents: these factors include but are not limited to minor errors in judgment, equipment failure, crew fatigue, and severe weather conditions. Response training will ensure the preparedness of the vessel's crew to respond if prevention training has failed. A response plan training program which does not include elements of both prevention and response is not a complete program.

The USCG has issued interim final rules in codified at 33 CFR part 155 which require tank vessels and offshore tank barges to carry appropriate equipment and supplies for the containment and removal of on-deck oil cargo spills. The amount of oil which the vessel's crew must be able to contain is dependent upon the size of the vessel. Inland oil barges must have appropriate equipment and supplies ready for immediate use to control and remove on-deck oil spills of at least one barrel. The Coast Guard recognizes that the use of vessel crews in the control and clean-up of oil spills, once the spill hits the surrounding water, is inefficient given the present state of technology and endangers the vessel, crew, and the remainder of the cargo on board. Control and clean-up of oil on the water is more appropriately handled by shore-based response resources. Owners or operators of tank vessels or facilities must ensure the availability of, through contract or other approved means, the resources to respond to an oil discharge from a tank vessel or facility.

5-A provides suggested elements which could be incorporated into the training program for vessel personnel. The material should not be considered as mandatory training nor should it be considered all-inclusive. A training program which provided all of the suggested training elements would certainly be very comprehensive. Vessel crews receiving this training would have an excellent educational foundation to help them play a highly proactive role in the plan holder's response organization. Plan holders must decide the actual role of their vessel crews in their organizations and customize their training programs accordingly.

5.A. Suggested training requirements for vessel response plans to comply with 33 CFR 155.1035, 155.1040, and 155.1055 (Vessels carrying oil as primary cargo; unmanned tank barges).

- ◆ A response plan submitted to meet the requirements of 33 CFR 155.1035 (manned vessels carrying oil as a primary cargo) must identify the training to be provided to members of the vessel crew having responsibilities under the plan, the qualified individual, and the spill management team.
- ◆ A response plan submitted to meet the requirements of 33 CFR 155.1040 (unmanned tank barges carrying oil as a primary cargo) must identify the training to be provided to the spill management team, the qualified individual, and other personnel in 33 CFR 155.1040 with specific responsibilities under the plan.
- ◆ The alternate qualified individual, designated to meet the requirements of 33 CFR 155.1026, should complete the same training program as the primary qualified individual.
- ◆ The training program must differentiate between that training provided to vessel personnel and that training provided to shore-based personnel.
- ◆ A vessel owner or operator may identify equivalent work experience which fulfills specific training requirements.
- ◆ The training program for manned vessels and unmanned tankbarges carrying oil as a primary cargo should include participation in periodic announced and unannounced drills or exercises conducted in compliance of 33 CFR 155.1060. Participation in drills or exercises should approximate the actual roles and responsibilities of individuals as specified in the vessel response plan.
- ◆ Training should be conducted periodically to reinforce the required knowledge and to ensure an adequate degree of preparedness by individuals with responsibilities under the vessel response plan.
- ◆ Training may be delivered via classroom sessions, group discussions, videotapes, self-study workbooks, resident training courses, on-the-job training, or other means as deemed appropriate to ensure proper instruction.
- ◆ New employees should complete the training program prior to being assigned job responsibilities which require participation in emergency response situations.

5.B. Suggested training requirements for vessel response plans to comply with 33 CFR 155.1045 (Oil carried as secondary cargo).

- ◆ A response plan submitted to meet the requirements of 33 CFR 155.1045 (vessels carrying oil as a secondary cargo) must identify the training to be provided to all personnel with responsibilities under the plan.
- ◆ The alternate qualified individual, designated to meet the requirements of 33 CFR 155.1026, should complete the same training program as the primary qualified individual.

- ◆ A vessel owner or operator may identify equivalent work experience which fulfills specific training requirements.
- ◆ The training program for vessels carrying oil as a secondary cargo should include participation in periodic drills or exercises conducted in compliance of 33 CFR 155.1045(h). Participation in drills or exercises should approximate the actual roles and responsibilities of individuals as specified in the vessel response plan.
- ◆ Training should be conducted periodically to reinforce the required knowledge and to ensure an adequate degree of preparedness by individuals with responsibilities under the vessel response plan.
- ◆ Training may be delivered via classroom sessions, group discussions, videotapes, self-study workbooks, resident training courses, on-the-job training, or other means as deemed appropriate to ensure proper instruction.
- ◆ New employees should complete the training program prior to being assigned job responsibilities which require participation in emergency response situations.

5.C. Suggested training elements for members of the vessel crew having responsibilities under the plan:

1) Training elements for ship's officers:

Demonstrate knowledge of the following:

- ◆ The Captain of the Port (COTP) Zones in which the vessel will operate.
- ◆ Notification procedures and requirements for vessel owners or operators, internal response organizations; federal and state agencies; and contracted oil spill removal organizations (OSROs) and the information required for those organizations.
- ◆ Primary and secondary (if applicable) communication systems used for the notifications.
- ◆ Information on the cargoes carried by the vessel, including familiarity with the cargo material safety data sheets, chemical characteristics, special handling procedures, health and safety hazards, and spill and firefighting procedures.
- ◆ Procedures the crew may use to mitigate or prevent any discharge or a substantial threat of a discharge of oil resulting from shipboard operational activities associated with internal or external cargo transfers.
- ◆ Personnel actions to take in the event of a transfer system leak, tank overflow, or suspected cargo tank or hull leak.
- ◆ Procedures the crew may use to mitigate or prevent any discharge or a substantial threat of a discharge of oil in the event of —
 - Grounding or stranding;
 - Collision;
 - Explosion or fire;
 - Hull failure;
 - Excessive list; or
 - Equipment failure.
- ◆ Ship salvage procedures, damage stability, and hull stress considerations when performing shipboard mitigation measures.
- ◆ Familiarity with the vessel's —
 - General arrangement plan;
 - Midship section plan;
 - Lines plan;
 - Tank tables;
 - Load line assignment; and
 - Light ship characteristics.
- ◆ Procedures for both the internal and ship-to-ship transfers of cargo in an emergency.
- ◆ Procedures and response resources necessary to carry out cargo transfers involving —

- Fendering equipment;
 - Transfer hoses and connection equipment;
 - Portable pumps and ancillary equipment;
 - Lightering and mooring masters; and
 - Vessel and barge brokers.
- ◆ Procedures and arrangements for emergency towing, including the rigging and operation of any emergency towing equipment aboard the vessel.
 - ◆ Crew's responsibilities, and procedures for use of shipboard equipment which may be carried to mitigate an oil discharge.
 - ◆ Crew's responsibilities, if any, for recordkeeping, sampling of spilled oil, and applicable worker safety procedures.
 - ◆ Crew's responsibilities, if any, to initiate a response and supervise shore-based response resources.
 - ◆ Operational capabilities of the contracted OSROs to respond to the ---
 - Average most probable discharge;
 - Maximum most probable discharge; and
 - Worst case discharge.
 - ◆ Procedures, if applicable, for transferring responsibility for direction of response activities from vessel personnel to the shore-based spill management team.
 - ◆ Training procedures as described in the vessel response plan for members of the vessel's crew.
 - ◆ Drill and exercise program to meet the requirements of 33 CFR 155.1060.
 - ◆ The role of the vessel's crew in the post discharge review of the plan to evaluate and validate its effectiveness.
 - ◆ Available response resources identified in response plan.
 - ◆ OSHA requirements for worker health and safety (29 CFR 1910.120).
 - ◆ Name of the qualified individual and how to contact him or her.
 - ◆ General responsibilities and authority of the qualified individual as described in the vessel response plan and company response organization.
 - ◆ Area Contingency Plans for the areas in which the vessel operates.
 - ◆ The National Contingency Plan.
 - ◆ Roles and responsibilities of federal and state agencies in pollution response.

2) Training elements for ship's crew members with responsibilities under the plan.

Demonstrate knowledge of —

- ◆ Information on the cargos carried by the vessel, including familiarity with the cargo material safety data sheets, special handling procedures, health and safety hazards, spill and fire fighting procedures.
- ◆ Procedures, in accordance with designated job responsibilities, to mitigate or prevent any discharge or a substantial threat of a discharge of oil resulting from shipboard operational activities associated with internal or external cargo transfers.
- ◆ Actions to take, in accordance with designated job responsibilities, in the event of a transfer system leak, tank overflow, or suspected cargo tank or hull leak.
- ◆ Procedures, in accordance with designated job responsibilities, to mitigate or prevent any discharge or a substantial threat of a discharge of oil in the event of --
 - Grounding or stranding;
 - Collision;
 - Explosion or fire;
 - Hull failure;
 - Excessive list; or
 - Equipment failure.
- ◆ Procedures, in accordance with designated job responsibilities, to perform ship salvage while performing shipboard mitigation measures.
- ◆ Procedures, in accordance with designated job responsibilities, for both the internal and ship-to-ship transfers of cargo in an emergency.
- ◆ Individual duties, in accordance with designated job responsibilities, to carry out cargo transfers involving --
 - Fendering equipment;
 - Transfer hoses and connection equipment; and
 - Portable pumps and ancillary equipment.
- ◆ Individual duties, in accordance with designated job responsibilities, to conduct emergency towing, including the rigging and operation of any emergency towing equipment aboard the vessel.
- ◆ Individual duties, in accordance with designated job responsibilities, for use of shipboard equipment which may be carried to mitigate an oil discharge.
- ◆ OSHA requirements for worker health and safety (29 CFR 1910.120).
- ◆ Notification procedures and requirements for vessel owners or operators; internal response organizations; federal and state agencies; and contracted OSROs and the information required for those organizations.
- ◆ Primary and secondary (if applicable) communication systems used for the notifications.

5.D Suggested training elements for other personnel as described in 33 CFR 155.1040 (unmanned tank barges) with specific responsibilities under the plan:

Demonstrate knowledge of —

- ◆ Notification procedures in the event of a discharge of oil or substantial threat of a discharge of oil for the towing vessel, for the vessel owner or operator, or for the qualified individual.
- ◆ Notification procedures to contact the vessel's owner or operator, qualified individual, National Response Center, and state agencies, and the information required to be provided in the initial and any follow-up notifications.
- ◆ Information on the cargoes carried by the barge including familiarity with the cargo material safety data sheets, special handling procedures, health and safety hazards, and spill and firefighting procedures.
- ◆ Procedures, in accordance with designated job responsibilities, to mitigate or prevent any discharge or a substantial threat of a discharge of oil resulting from barge operational activities and casualties.
- ◆ Actions to take, in accordance with designated job responsibilities, in the event of a transfer system leak, tank overflow, or suspected cargo tank or hull leak.
- ◆ Procedures, in accordance with designated job responsibilities, to mitigate or prevent any discharge or a substantial threat of a discharge of oil in the event of —
 - Grounding or stranding;
 - Collision;
 - Explosion or fire;
 - Hull failure; or
 - Excessive list.
- ◆ Damage stability and hull stress considerations when performing shipboard mitigation measures in accordance with designated job responsibilities.
- ◆ Procedures, in accordance with designated job responsibilities, for both the internal and barge-to-barge transfers of cargo in an emergency.
- ◆ Procedures and arrangements to conduct emergency towing, including the rigging and operation of any emergency towing equipment aboard the barge.
- ◆ Procedures for use of barge equipment which may be carried to mitigate an oil discharge.
- ◆ The responsibilities, if any, of the towing vessel crew, or facility or fleeting area personnel to initiate a response and supervise shore-based response resources.
- ◆ OSHA requirements for worker health and safety (29 CFR 1910.120).
- ◆ Name of the qualified individual and how to contact him or her.
- ◆ General responsibilities and authority of the qualified individual as described in the vessel response plan and company response organization.

- ◆ Primary and secondary (if applicable) communication system used for the notifications.
- ◆ Organizational structure that will be used to manage the response actions, including --
 - Command and control;
 - Safety; and
 - Spill response operations.
- ◆ Available response resources.
- ◆ The Captain of the Port Zones (COTP) in which the tank barges covered by the response plan will operate.
- ◆ Procedures for the post discharge review of the plan to evaluate and validate its effectiveness. ■

Section 6: Training for Facility Personnel

Facility owners and operators are required to explain in detail how to implement the facility's emergency response plan by describing response actions to be carried out under the plan to ensure the safety of the facility and to mitigate or prevent discharges. They must identify the response resources for worst case discharges and identify facility personnel responsible for performing specific procedures to mitigate or prevent a discharge or potential discharge.

Prevention Training Requirements: EPA's current oil pollution prevention regulations (40 CFR part 112), also known as the Spill Prevention, Control and Countermeasures (SPCC) rule, states that training exercises should be conducted at least yearly for all personnel. Training should be given to new employees within one week of beginning work, and spill prevention briefings should be scheduled and conducted for the facility's operating personnel at least once a year. Prevention training must include, but is not limited to, the following subjects:

- ✕ Operations and maintenance of equipment;
- ✕ Applicable pollution control laws;
- ✕ Contents of facility's SPCC plan; and
- ✕ General facility operations.

EPA has proposed, but not finalized, several additional prevention training requirements as follows: (1) the training previously described is proposed as a requirement, and (2) personnel involved in oil-handling activities at facilities with certain operations are proposed to receive at least 8 hours of training initially and at least 4 hours of refresher training per year.

Response Training Requirements: EPA's final facility response plan rule requires the owner or operator of a substantial harm facility to have a training program for those personnel involved in oil spill response activities [59 FR 34097; July 1, 1994]. The rule recommends that the training program be based on this reference manual, as applicable to facility operations, or a facility can develop its own response training program subject to approval by the appropriate EPA Regional Administrator.

MMS regulations require that personnel who respond to spills through deployment and operation of oil spill response equipment be provided with hands-on training classes at least annually [30 CFR 250.43]. In addition, future MMS regulations may require a description of the training to be carried out under the plan.

Coast Guard regulations require the owner or operator of marine-transportation-related (MTR) facilities to identify the training to be provided to each individual with responsibilities in the response plan.

If the individual will always fill the same function in the facility response plan, training requirements will be narrowed in scope. If a company desires greater flexibility in use of its personnel and redundancy in available knowledge in case key personnel are unavailable, it may choose to add to the curricula presented to facility operators. The following 6-A provides suggested elements which could be incorporated into the training program for facility personnel. The material should not be considered as mandatory training nor should it be considered all-inclusive. A training program which provided all

of the suggested training elements would certainly be very comprehensive. Facility personnel receiving this training would have an excellent educational foundation to help them play a highly proactive role in the plan holder's response organization. Plan holders must decide the actual role of their facility personnel in their organizations and customize their training programs accordingly.

6.A. Suggested training elements for Facility Personnel:

Demonstrate knowledge of —

- ◆ The Captain of the Port (COTP) Zone or EPA Region in which the facility is located.
- ◆ Notification procedures and requirements for facility owners or operators, internal response organizations, federal and state agencies; and contracted oil spill response organizations (OSROs), and the information required for those organizations.
- ◆ Communication system used for the notifications.
- ◆ Information on the products stored, used, or transferred by the facility, including familiarity with the material safety data sheets, special handling procedures, health and safety hazards, and spill and firefighting procedures.
- ◆ Facility personnel responsibilities, and procedures for use of facility equipment which may be available to mitigate or prevent an oil discharge.
- ◆ Specific procedures to shut down affected operations.
- ◆ Procedures to follow in the event of discharge, potential discharge, or emergency involving the following equipment or scenarios:
 - Tank overfill;
 - Tank rupture;
 - Piping or pipeline rupture;
 - Piping or pipeline leak, both under pressure and not under pressure, if applicable;
 - Explosion or fire;
 - Equipment failure; and
 - Failure of secondary containment system.
- ◆ The operational capabilities of the contracted OSROs to respond to the —
 - Average most probable discharge (small discharge);
 - Maximum most probable discharge (medium discharge); and
 - Worst case discharge.
- ◆ Name of the qualified individual and how to contact him or her.
- ◆ General responsibilities and authorities of the qualified individual as described in the facility response plan and company response organization.
- ◆ The organizational structure that will be used to manage the response actions, including —
 - Command and control;

- Public information;
 - Safety;
 - Liaison with government agencies;
 - Spill response operations;
 - Planning;
 - Logistics support; and
 - Finance.
-
- ◆ The drill and exercise program to meet the federal requirements.
 - ◆ The Area Contingency Plan for the area in which the facility is located.
 - ◆ The National Contingency Plan.
 - ◆ Roles and responsibilities of federal and state agencies in pollution response.
 - ◆ OSHA requirements for worker health and safety (29 CFR 1910.120). ■

Section 7: Training for Oil Spill Removal Organizations

Federal regulations require owners and operators of tank vessels and facilities to ensure, through contracts or other approved means, sufficient private resources to remove specific volumes of oil. A USCG-classified oil spill removal organization (OSRO) may be identified in the response plan instead of providing a detailed list of equipment and personnel resources. USCG regulations require marine transportation-related (MTR) facility or vessel owners or operators to ensure that an OSRO identified in the facility or vessel response plan maintains records to document training of the OSRO's personnel. These training records must be available for inspection by the vessel or facility management personnel, qualified individual, or federal inspectors. OSRO personnel must also be trained to meet OSHA regulations in 29 CFR 1910.120.

OSROs may provide the contracted resources for oil and hazardous substance response and clean-up. In some response plans, the OSRO may be contracted to provide the spill management team, all of the response equipment, and the operational personnel needed to deploy, operate and maintain the equipment. In other response plans, the OSRO is merely contracted to provide the bulk of the response equipment on-scene. The equipment may then be deployed and operated by responsible party personnel. As an alternative to contracting with an OSRO, facilities are allowed to own, operate, or have under their direct control the personnel and equipment necessary for timely response. Active membership in a local or regional OSRO commonly referred to as a cooperative is another means of compliance.

OSRO personnel are involved in the direct operational functions of oil spill clean-up. Personnel should be trained in hazard recognition, worker health and safety issues, oil containment, oil recovery methods and devices, equipment operation, shoreline clean-up, and waste storage and disposal considerations. Specialized training may involve such topics as the use of dispersants, slick trajectory forecasting, in-situ burning, bioremediation, or ship salvage. Training methods may include a variety of techniques but an emphasis should be placed on hands-on equipment deployment and operations.

Because of the large number of OSRO personnel involved in major pollution incidents and the fact that many of these people are hired as temporary employees, it is expected that only senior supervisory personnel will receive broad-based training or experience in oil spill removal technology. The majority of the OSRO's personnel may, as appropriate, receive training to enable them to safely and efficiently perform the specific duties assigned to them within the organization. For example, someone who will only perform beach clean-up operations should not be expected to know how to operate, repair, or maintain a weir skimmer.

The Level 1 and Level 2 courses for oil spill response described in Appendix A to this document provide suggested training elements in the form of tasks and sub-tasks. Some of these elements could be incorporated into the training program for personnel employed by an OSRO. The material should not be considered as mandatory training nor should it be considered all-inclusive. A training program which provided all of the suggested training elements would certainly be very comprehensive. Personnel employed by an OSRO receiving this training would have an excellent educational foundation to help them play a highly proactive role in all aspects of the organization's clean-up efforts. Each OSRO must decide the actual role of its personnel in their own organization and customize its company's training program accordingly. ■

Section 8: Training for Worker Health and Safety

Vessel and facility owners or operators must ensure that all private response personnel, volunteers, or casual laborers, which they employ are trained to meet the OSHA standards for emergency response operations promulgated in 29 CFR 1910.120. These requirements, commonly referred to as the HAZWOPER regulations, were established to ensure the health and safety of personnel employed in hazardous substance response and cleanup operations. OSHA has defined hazardous substances as any substance "exposure to which results or may result in adverse affects on health or safety of employees." [29 CFR 1919.120] This includes substances defined under 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, those listed by the Department of Transportation (DOT) as designated hazardous substances under 49 CFR Part 172.101, hazardous wastes, and biological agents. DOT regulations designate petroleum crude oil, petroleum distillates, and petroleum oil (DOT hazard class 3, flammable liquids) as hazardous substances.

Responding to oil spills is typically different from other hazardous material emergencies in that worker safety issues are often a more significant concern than is protection from toxic chemicals. This focus on worker safety does not mean that we are not concerned with the potential affects of toxic chemicals to the worker. The danger to the responder, however, from a large variety of oils is more probable to occur from common hazards such as slipping or tripping while trying to clean up a highly slippery substance. Relatively minor health problems such as dermatitis can be prevented by wearing proper gloves, boots and protective clothing. However, there are also oils, such as high sulfur crude oils or oils with a high benzene content, which may cause life threatening health concerns. Proper personal protective equipment, including respiratory protection, must be worn by the responder when responding to incidents involving these oils or other hazardous substances with a respiratory hazard.

In general, personnel must be provided with adequate training to do their jobs safely. This includes the fundamentals of site safety which apply generally to personnel working at hazardous waste sites. It further includes safety conscious operational training for the particular job (e.g., methods of deploying boom safely by boat). An ongoing training program to reinforce and build upon previous training is also required (i.e., annual refresher training). It is not necessary to conduct all training in one block of time, or restrict it to a single training event.

OSHA's Hazardous Waste Operations Standard (29 CFR 1910.120) sets basic requirements for training of personnel. These requirements are dependent on the operations (e.g., general site operations, emergency response operations, and post-emergency response operations); on the individual's duties (e.g., first responders, general site workers, supervisors, special short term operations, technicians, etc.); and on the degree of exposure (e.g., minimal exposure, unknown exposures, etc.). It is important to recognize that these requirements may change as the operations progress from emergency phase to post-emergency phase. At the same time, the degree of exposure risk is also changing with time. For example, as high vapor pressure products which might pose an inhalation hazard evaporate from the weathering oil, or as the hazards become better characterized the amount of potential danger is also altered. 6-A and 6-B provide more specific information on OSHA requirements and training qualifications.

8.A. Outline of General Requirements for Emergency Phase and Post-emergency Response Operations.

1. General requirements for emergency phase response operations (e.g., spill control measures conducted prior to recovery). Specific competencies are listed in 29 CFR 1910.120(q)(6).

a. LEVEL 1--First Responder (awareness).

This level is characterized as personnel that might discover a release and who are simply expected to report the incident.

- (1) Sufficient training OR proven experience in specific competencies; AND
- (2) Annual refresher training.

b. LEVEL 2--First Responder (operations).

This level is characterized by responding to a release in a DEFENSIVE manner and generally without being exposed to risk (e.g., no attempts to stop leaks).

- (1) Level 1 competency;
- (2) Eight hours initial training OR proven experience in specific competencies; AND
- (3) Annual refresher training.

c. LEVEL 3--Hazardous Material (HAZMAT) Technician.

This level is characterized by responding AGGRESSIVELY to stop a release (e.g., expecting some risk of exposure).

- (1) Twenty-four hours of Level 2 training;
- (2) Proven experience in specific competencies; and
- (3) Annual refresher training.

d. LEVEL 4-- HAZMAT Specialist.

This level is characterized by responding with and in support of technicians but having specialty knowledge and competence.

- (1) Twenty-four hours of Level 3 training;
- (2) Proven experience in specific competencies; AND
- (3) Annual refresher training.

e. LEVEL 5--On-Scene Incident Commander.

This level is for personnel that may be called upon to assume supervisory (incident command) responsibilities on-scene.

- (1) Twenty-four hours of Level 2 training;
- (2) Proven experience in specific competencies; AND
- (3) Annual refresher training.

2. General requirements for post-emergency response operations are described in 29 CFR 1910.120(q)(11) which simply refers to the training requirements for general hazardous waste operations at 29 CFR 1910.120(e). The regulations require initial training; management and supervisory training; and annual refresher training.

a. The general subjects to be covered by this training include --

- (1) Key personnel responsible for site safety and health;
- (2) Hazards present on site;
- (3) Use of personal protective equipment;
- (4) Safe work practices;
- (5) Safe use of engineering controls and other equipment on site;
- (6) Medical surveillance requirements and recognition of signs and symptoms of overexposure; and
- (7) The contents of site specific safety and health plans (e.g., decontamination procedures, emergency procedures, confined space entry procedures, and spill containment program in particular).

b. **Initial training.** There are three categories of initial training depending on the degree of exposure and the amount of time expected to be spent on site.

(1) **General site workers.** General site workers (e.g., general laborers or equipment operators) must have the following:

- > 40 hours off-site training.
- > 24 hours supervised field experience.
- > 8 hours annual refresher training.

(2) **Minimal hazard workers.** Routine site workers who work in areas that have been monitored and fully characterized such that exposures are within permissible limits (and published limits or other hazards),

OR.....

non-routine site employees who are on site only occasionally for a specific limited task, and who are unlikely to be exposed over permissible exposure limits (or published limits) may be trained as follows:

- > 24 hours off-site training.
- > 8 hours supervised field experience.
- > 8 hours annual refresher training.

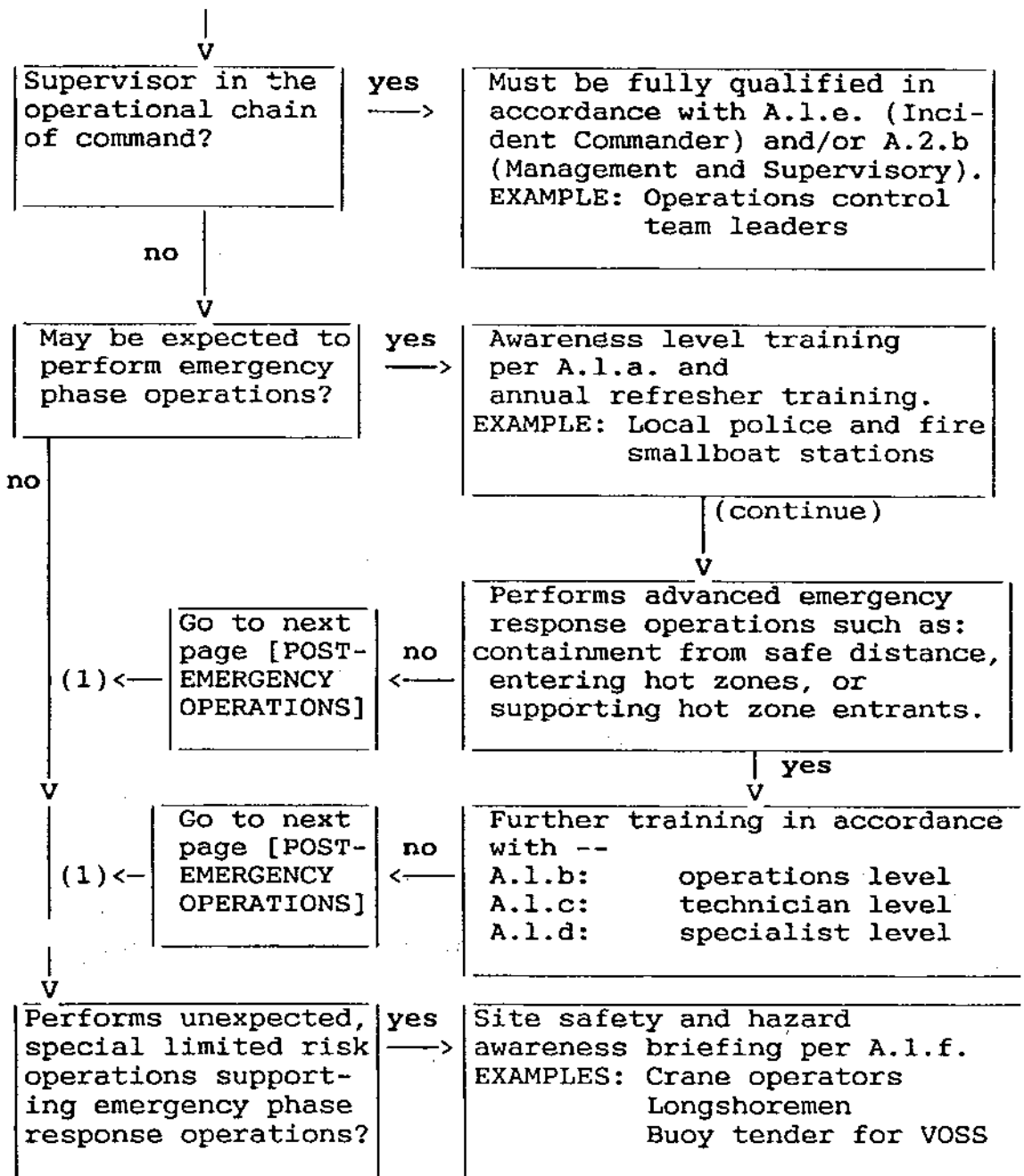
c. Management and supervisory training. On-site management and supervisors directly responsible for, or who supervise employees engaged in, hazardous waste operations shall have the same initial training as the personnel they supervise. They then must receive at least another 8 hours of training in hazardous waste operations management as follows:

- > 40 hours off-site training, which may be reduced to 24 hrs if all employees supervised are permitted to be trained at this level;
- > 24 hours supervised field experience, which may be reduced to 8 hrs if all employees supervised are permitted to be trained at this level; and
- > 8 hours annual refresher training; PLUS
- > 8 hours of hazardous waste operation management training.

d. Refresher training. Refresher training may include incident debriefs, or response drills and exercises. OSHA officials have indicated that those workers involved in the post-emergency phase of a spill response whose job duties and responsibilities have a low magnitude of risk may be allowed to have fewer than 24 hours of training. Specifically, OSHA has issued an instruction stating that a minimum of 4 hours of training is appropriate in most situations involving post-emergency clean-up workers (See "Inspection Guidelines for Post-Emergency Operations Under 29 CFR 1910.120," OSHA Instruction CPL 2-2.41, Nov. 5, 1990). Under OSHA instruction, OSHA Regional Response Team representative is responsible for making determinations of when fewer than 24 hours of training is required.

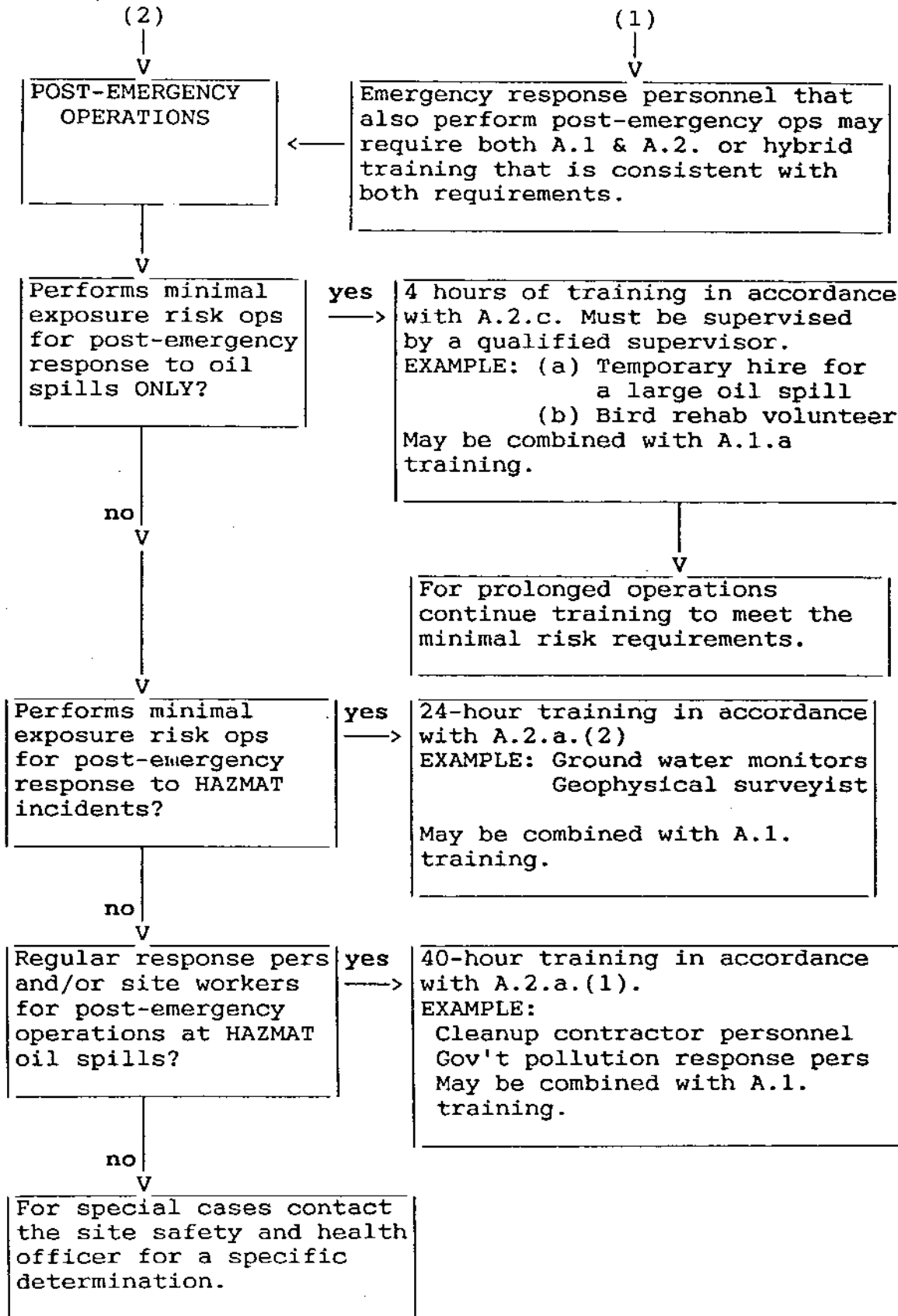
e. Certain oil spill response personnel. Guidelines have been published by OSHA with regards to the training requirements for post-emergency response to oil spills. OSHA recognizes that reduced training for certain categories of personnel involved in oil spill operations may be necessary, and may not constitute a serious violation of the regulations (i.e., a "de minimis" violation). In general, 4 hours of training is expected to be adequate to meet the "de minimis" criteria. This requirement may change based on the specific state requirements, response circumstances, or both. Other requirements must also be met (e.g., adequate characterization of minimal hazards, and adequate supervision by fully trained personnel). ■

6.B. Decision Guide for On-site Training Requirements.



NOTE: Ops at the same site may include emergency phase and post-emergency phase work. IN GENERAL, ops intended to control a continuing release should be treated as emergency phase, while ops intended to recover product, should be treated as post-emergency. Operations at a remedial site should be treated as routine and post-emergency phase operations.

(continued):



Appendix A: Oil Spill Response Courses

The USCG has worked closely with IMO and the Canadian Coast Guard in the development of course curricula for oil spill response. In August 1993, the USCG distributed two sets of draft voluntary training guidelines for oil pollution response. The guidelines were modifications of training material which IMO will be using to train members of the international community. The guidelines provided industry with an outline of recommended subject areas in which personnel involved in oil spill response and clean-up could be trained in. They were presented in the form of a job task analysis for two separate training courses. One course was designed for non-supervisory operational personnel, while the other course was designed for supervisory operational personnel. The guidelines were intended to assist owners and operators of vessels, marine transportation-related (MTR) facilities, and deepwater ports in developing or choosing training programs for oil spill response for their operational personnel.

A job task analysis (JTA) can be considered a job performance outline. Job requirements are broken into specific performance elements referred to as tasks and sub-tasks. For instance, task number 13, "Transfer oily wastes," is subdivided into three sub-tasks:

- ✧ 13.1 Categorize and quantify collected materials;
- ✧ 13.2 Select pump, conveyors, and other equipment; and
- ✧ 13.3 Safely operate transfer equipment.

The knowledge which must be communicated to teach each sub-task and the resulting skills which the student must demonstrate after training is completed are also provided. Because of the different job responsibilities of each employee and their intended role in the vessel or facility plan, the JTA should be customized by the trainer. Trainers may use the guidelines as a menu of subject areas from which to select relevant topics depending on the duties and responsibilities of the individual employee. This procedure ensures a direct correlation between the job which is performed and the training which is provided to perform that job. Specific lesson plans must be developed by the instructor to actually deliver the subject material to the student.■

LEVEL 1 COURSE FOR OIL SPILL RESPONSE

TASK 1: ASSESS SPILL AND RESPONSE OPERATION.

SUB-TASK	KNOWLEDGE	SKILL
<p>1.1 Assist in initial assessment of spill source and potential impacts.</p>	<ul style="list-style-type: none"> • Type and volume of spill sources: e.g., tankers, barges, pipelines, etc. • General description of causes of spills: e.g., collisions; breakups; groundings; mechanical, human, and environmental factors. • Spill volume • Oil types: e.g., crude, bunker fuels, gasoline, diesel, and non-petroleum. • Proximity to shoreline. • Potential impacts on resources and amenities. • Effects on flora and fauna. • Persistence of oil on shorelines. 	<ul style="list-style-type: none"> • Recognize oil type, behavior and properties. • Determine slick trajectory. • Predict fate and consequences.
<p>1.2 Hazard recognition.</p>	<ul style="list-style-type: none"> • Awareness of physical chemistry of oil and product. • Awareness of oil toxicology. • Material safety data sheet. • Fire and explosion hazards. • Potential hazards to human health. 	<ul style="list-style-type: none"> • Identify hazards associated with spilled oil or product.

- 1.3 Assess water and weather conditions.
 - Influence of water and weather conditions on oil properties and slick behavior.
 - Boating safety
 - Implications of water conditions and wind speed on response operations.

- 1.4 Identify and stop pollution source, if continuing.
 - Causes of spills.
 - Options to stop oil flow.

- 1.5 Identify response priorities and select countermeasures.
 - Description of clean-up phases and hardware alternatives.
 - Response steps: stopping, monitoring, containment, deflection, removal, storage, disposal.
 - Planning and logistics: timing, resource utilization, safety, incident command structure.
 - Protection priorities.
 - Spill control options.
 - Deployment requirements.
 - Operational efficiency of equipment and alternative resources.
 - Changing oil properties and environmental factors.
 - New information.

- 1.6 Reassess cleanup requirements on ongoing basis.
 - Accounting of personnel, expenditures, and equipment.
 - Recording of impacts, response actions and locations.
 - Recording of sampling, legal statements and/or discussions.
 - Organization of personnel and task assignments.

- 1.7 Perform administrative duties.
 - Recognize limitations of response equipment.
 - Use data to predict speed and direction of slick transport, fate, and behavior.
 - Assist in selecting control measures.
 - Prioritize sensitivity, identify protection zones.
 - Review merits and disadvantages of spill control alternatives.
 - Assist in determining best response methodology.
 - Apply changing data to the selection of cleanup gear and to the choice of response effort locations to optimize operations.
 - Keep records and conduct assigned tasks.

1.8 Take samples from source and slicks.

- Legal sampling methods.
- Storage and chain of custody requirements.

- Take samples from water and source admissible as court evidence.
- Process samples so that the accuracy of test results is ensured.

TASK 2: ASSESS THE EFFECTS OF OIL MOVEMENT AND WEATHERING ON RESPONSE OPERATIONS

SUB-TASK	KNOWLEDGE	SKILL
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2.1 Identify oil types and their properties.

- Types of oil: crude, gasoline, diesel, bunker, non-petroleum.
- Properties: e.g., specific gravity, viscosity, pour point, flash point, and solubility.

Demonstrate general knowledge of oil types, grades, physical, and chemical properties.

2.2 Forecast slick transport and spreading.

- Effect of oil properties, sea state, and water and weather conditions on spread rate and transport.
- Spill volume as a function of slick area, thickness and appearance.
- Trajectory modeling.
- Interaction with ice (where appropriate).

Estimate spill volume and direction of movement.

2.3 Identify the effect of weathering on response operations, hazards and impacts.

- Weathering processes: e.g., evaporation, oxidation, dissolution, sinking, emulsification, biodegradation, and sedimentation.
- Effect of weather, sea state and oil type on weathering.
- Fire hazards
- Implications to countermeasures operations.

Assess effect of environmental conditions on oil and product.

TASK 3: DETERMINE AND IMPLEMENT SAFETY PROCEDURES

SUB-TASK	KNOWLEDGE	SKILL
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3.1 Ensure provision of first aid and access to medical facilities.

- Safety risks of petroleum and non-petroleum oils; e.g., fire, and explosion.
- Effects of exposure: e.g., inhalation, dermal, and ingestion.
- Safety risks and handling guidance of mechanical, and electrical equipment.
- Safe boating practices and guidelines.
- First aid.
- Marine safety data sheets.

- Attend or facilitate attendance to injured.
- Prevent self-injury.

3.2 Implement safety procedures.

- Safety checklist for response operations.
- Safe work practices: e.g., clean-up equipment, petroleum products, and site.
- Personal protective clothing and equipment.
- Capability of personnel: e.g., length of shift, and level of training.
- Decontamination procedures.

- Recognize need for and properly use personal protective clothing and equipment.
- Use safety equipment.
- Prevent unsafe worker performance.

3.3 Take appropriate site security measures.

- Site security and access procedures.

- Ensure security of work site.

TASK 4: SELECT AND OPERATE MEANS OF TRANSPORT

SUB-TASK

KNOWLEDGE

SKILL

4.1 Assess transport needs. . Ongoing transportation needs . Determine transportation requirements of ALL cleanup phases.

4.2 Choose appropriate response vessels or mobile response equipment. . Capabilities of available small boats. . Safe deployment and operation of boats. . Navigation: aids, areas of operation. . Effects of environmental factors an operation of vessels or mobile response equipment.

TASK 5: ESTABLISH AND MAINTAIN COMMUNICATIONS

SUB-TASK

KNOWLEDGE

SKILL

5.1 Use communications equipment. . Response information and communication needs. . Portable UHF/VHF radios cellular telephones. . Capabilities and limits of available systems. . Radio operations protocols and use. . Communicate effectively to facilitate response.

TASK 6: CONTAIN SPILLED OIL

SUB-TASK

KNOWLEDGE

SKILL

6.1 Select appropriate boom.

- . Main uses of boom: e.g., containment, deflection, and protection.
- . Boom components and structure.
- . Types of commercial and improvised booms: skirt, fence, sorbent, others.
- . Selection criteria for offshore, near-shore use.
- . Boom failure mechanisms and solutions: entrapment, drainage, splashover, boom submergence and planning.
- . Response time.
- . Safety warning for spills of gasoline or other explosive products.
- . Site specific considerations: wetland damage at low tide, mooring to existing structures, location of nearby amenities or sensitive areas.

. Select boom upon consideration of location, oil type, and environmental factors.

6.2 Deploy booms.

- . Deployment equipment and safety requirements.
- . Slick behavior.
- . Selecting booms for response, which would depend upon sea state and application.
- . Typical deployment configurations for containment and deflection.
- . Determination of boom angle.

. Deploy and moor booms to safely and effectively concentrate oil for recovery, to protect resources, and to deflect slicks.

- . Vessel or deployment vehicle selection.
 - . Preparation and inspection.
 - . Towing: e.g., tow line length attachment to tow post.
 - . Mooring: e.g., anchor size and number, length of mooring line, and mooring arrangement.
 - . Safety checklist for operations.
- 6.3 Assess water and weather conditions.
- . Influence of water, wind, and currents on ability to contain oil.
 - . Safety implications.
- 6.4 Retrieve booms
- . Recovery, cleaning, disassembly, and storage of equipment.
 - . Monitor and assess boom performance.
 - . Redeploy booms as tides, currents, and oil volumes dictate.
 - . Safely recover booms without damage, clean and store.

TASK 7: OPERATE OIL RECOVERY EQUIPMENT		
SUB-TASK	KNOWLEDGE	SKILL

- 7.1 Select appropriate skimmer.
- . Skimming principles and types: i.e., weir, oleophilic, suction and other.
 - . Common nomenclature of skimmers and hardware.
 - . Select appropriate skimmer for intended application.
- 7.2 Operate skimmers.
- . Basic engine types; fuel needs; control, lube and hydraulic systems; fittings and connections.
 - . Operational difficulties: e.g., breakdown and debris.
 - . Safety considerations.
 - . Start, operate and shut down skimmer.
 - . Monitor for optimum performance and reselect skimmer, if needed.
 - . Troubleshoot minor problems.

- 7.3 Equipment maintenance.
 - Cleaning, disassembly, and storage.
 - Check and repair equipment.
- Remove oil and debris, repair broken or worn parts and store skimmer in ready to use condition.

TASK 8: REMOVE OIL USING SORBENTS

SUB-TASK

KNOWLEDGE

SKILL

- 8.1 Select sorbents.
 - Characteristics.
 - Sorbent types and effectiveness.
- 8.2 Use sorbents.
 - Application of effective sorbent to spill conditions (e.g., water or land)
 - Select effective sorbents.
 - Apply, recover, and reuse sorbents effectively.

TASK 9: ASSIST IN APPLICATION OF BIOREMEDIATION PROCESS/SYSTEMS

SUB-TASK

KNOWLEDGE

SKILL

- 9.1 Identify appropriate conditions for conducting bioremediation.
 - Principle of process, agents and application methods.
 - Limitations and advantages.
 - Restrictions governing application and pre-approval.
- 9.2 Assist in applying bioremediation techniques.
 - Application methods strategies and safety concerns.
- Determine applicability of bioremediation to oil clean-up.
- Assist in implementation.

TASK 10: ASSIST IN APPLICATION OF CHEMICAL DISPERSION SYSTEMS

SUB-TASK	KNOWLEDGE	SKILL
10.1	<p>Identify appropriate conditions for dispersing oil.</p> <ul style="list-style-type: none"> . Action of dispersant: e.g., surface tension, emulsion formation, and water column distribution. . Effective application conditions: e.g., oil type, slick thickness, mixing energy, and water temperature. . Limitation: e.g., ineffective (calm) conditions, interference with mechanical countermeasures, and overall effectiveness. . Toxicity of chemical and dispersed hydrocarbon in water column. . Advantages: i.e., oil degradation rate, tar residue formation, hydrocarbon flammability, and reduction in impacts to shoreline and water fowl. . Restrictions governing application and pre-approval. 	<ul style="list-style-type: none"> . Determine whether or not dispersants are potentially applicable.
10.2	<p>Assist in chemical dispersion of oil.</p> <ul style="list-style-type: none"> . Choice and effectiveness of agents, and dosage, application equipment and methods. . Safety considerations. 	<ul style="list-style-type: none"> . Assist in the safe use and monitoring dispersants.

TASK 11: ASSIST IN CONDUCTING IN-SITU BURNING

SUB-TASK

KNOWLEDGE

SKILL

11.1 Identify appropriate conditions for conducting in-situ burning.

- Conditions conducive to combustion: e.g., slick thickness, oil type and weathering, weather and sea state and proper timing.
- Safety considerations: e.g., highly trained personnel, air quality, fire hazard to nearby facilities, ecological and wildlife, and nearby populations.
- Advantages: e.g., removal rates, shoreline impacts, storage, and disposal.
- Restrictions governing use and pre-approval.

- Determine whether or not combustion will be successful and appropriate.

11.2 Assist in conducting in-situ burning.

- Principles of process or operation.
- Equipment: e.g., fire containment boom, ignition system, and residue clean-up.
- Equipment requirements and constraints.

- Assess impact of combustion by-products to public and worker safety.
- Assist in their safe use and monitoring.

TASK 12: CLEANUP SHORELINE

SUB-TASK

KNOWLEDGE

SKILL

12.1 Assist in selection of appropriate techniques.

- Methods and required equipment: e.g., natural, mechanical, manual, and flushing.

- Assess factors dictating shoreline response.
- Assist in selection of appropriate cleanup methods.

- Clean-up alternatives vs. environmental sensitivities.
- Habitat disturbance from clean-up operations.
- Changing conditions: e.g., seasonal, diurnal, and tidal.
- Practical considerations: e.g., access and disposal.

- 12.2 Clean up shoreline.
- Safety considerations: tides, equipment, animals.
 - Careful and efficient execution of response.
 - Safely conduct and organize shoreline cleanup activities.
 - Minimize disturbance to shoreline.
 - Minimize amount of non-oily wastes collected.

TASK 13: TRANSFER OIL WATERS

SUB-TASK

KNOWLEDGE

SKILL

13.1 Categorize and quantify collected materials.

- Oily liquids and solids generated during clean-up.

- Determine factors affecting operation of transfer equipment.

13.2 Select pumps, conveyors and other equipment.

- Transfer options and mechanical principles: e.g., pumps (centrifugal, lobe, gear, intermeshing screw vane, flexible impeller, screw auger, progressing cavity, piston, and diaphragm).
- Other: aire conveyor, vacuum truck, portable vacuum unit.

- Determine suitable means to transfer materials.

- Capabilities of transfer equipment: e.g., oil viscosity, pour point, debris, abrasives, portability; emulsification; cold weather operation and ease of repair and handling.
- Lightering operations

- Preparation, operation and disconnection of equipment.
- Use of controls.
- Safety considerations.
- Safely operate pumps, conveyors, and other equipment.
- Troubleshoot minor problems.

TASK 14 STORE AND DISPOSE OF OILY WASTES

SUB-TASK	KNOWLEDGE	SKILL
14.1 Store materials by cleanup.	<ul style="list-style-type: none"> • Land-based and-water-based storage options: e.g., pit; prefabricated kit; towable tank; drum; trucks (tank, vacuum, dump, pickup), barges (tank, deck, and hooper); vessels (workboat, skimmer, supply boat, and tanker), plastic bag and tubing; and spent boom. • Factors re: selection of storage sites (environmental regulatory). • Permit requirements. 	<ul style="list-style-type: none"> • Assist in the selection of storage sites and options. • Set up and use storage facilities.
14.2 Segregate and minimize waste.	<ul style="list-style-type: none"> • Segregation of materials. • Waste reduction, practices: e.g., re-use; oiland water separation; minimal collection of non-oiled material; and minimal formation of waste water. 	<ul style="list-style-type: none"> • Sort materials to facilitate storage and disposal. • Separate and recycle waste.
14.3 Facilitate disposal of collected materials.	<ul style="list-style-type: none"> • Disposal options: e.g., reprocessing, recycling, landfilling, stabilization, burning, incineration, bioremediation, and landfarming. • Capabilities of equipment and techniques. 	<ul style="list-style-type: none"> • Assist in the selection of disposal sites and options. • Operate on-site disposal methods. • Provide feedstock for disposal units.

- Factors re: selection of disposal options: e.g., environmental, regulatory, access, and security factors.
- On-site disposal for remote locations.
- Safety: e.g., fire control equipment.
- Permit requirements.

TASK 15: PERFORM POST-SPILL ACTIVITIES

SUB-TASK

KNOWLEDGE

SKILL

- Health and safety guidelines.
- Facility set-up.
- Equipment decontamination procedures.
- Cleaning requirements and method.
- Waste water collection.
- Equipment maintenance and storage.
- Technical problems and solutions.
- Set up and use personnel decontamination facilities.
- Perform equipment restoration activities.
- Suggest improved response methods.

15.1 Ensure decontamination of personnel.

15.2 Restore equipment to pre-spill condition.

15.3 Participate in debriefing.

LEVEL 2 COURSE FOR OIL SPILL RESPONSE

TASK 1: ASSESS SITUATION

SUB-TASK

KNOWLEDGE

SKILL

- | | | |
|---|---|---|
| <p>1.1 Receive incident report.</p> <p>1.2 Gather and verify additional information.</p> | <p>• Standard spill reporting forms and procedure for use.</p> <p>• Knowledge of construction and operation of various pollution sources such as --
vessels and damage assessment of vessels; pipeline; storage tanks; oil rigs and platforms; and terminals.</p> <p>• Plotting skills.</p> <p>• Use of charts and tide tables.</p> <p>• Introductory meteorology.</p> <p>• Local sensitivities.</p> <p>• Metric and US measurement conversion.</p> <p>• Methods to estimate spill volume.</p> <p>• Physical oil types and API ratings.</p> <p>• Awareness of oil physical chemistry.</p> | <p>• Ensure accuracy of report and document on standard report forms.</p> <p>• Demonstrate ability to gather enough supporting data to facilitate an appropriate response.</p> |
| <p>1.3 Assess size, product, source, and magnitude of spill.</p> <p>1.4 Hazard recognition.</p> | <p>• Awareness of oil and product physical chemistry.</p> <p>• Marine Safety Data Sheets.</p> | <p>• Estimate spill size.</p> <p>• Determine spill source.</p> <p>• Convert metric to US.</p> <p>• Assess potential political and economic significance.</p> <p>• Identify spilled product.</p> <p>• Identify potential threat to people and the environment.</p> |

- . Awareness of oil and product toxicology.
 - . Fire and explosion hazards.
 - . Potential hazards to human health.
 - . Recovery capabilities of coastal and inland areas.
 - . Effects on flora and fauna.
 - . Sensitivity mapping.
- 1.5 Hazard evaluation
- . Prevent accidental injury to personnel.
 - . Sampling techniques
 - . Sampling instruments (e.g., CG/O2 meter, Draeger, etc.).
 - . Monitoring techniques.
 - . Site characterization and analysis.

TASK 2: ACTIVATE RESPONSE PLAN

SUB-TASK

KNOWLEDGE

SKILL

- 2.1 Notify appropriate authorities and alert key personnel according to plan.
- . Vessel and facility plans.
 - . Notification of authorities.
 - . Clean-up resources.
 - . How and when to mobilize resources.
- 2.2 Initiate response.
- . Baseline survey techniques and requirements.
 - . Contracting procedures.
 - . Salvage/mitigation.
 - . Liability issues.
 - . Equipment uses and limitations.
 - . Funding sources.
- Demonstrate practical activation of plan through drills and exercises.
- Identify and coordinate immediate response activities.

- Natural resource damage assessment, including assessment of statutory and regulatory requirements.

TASK 3: PREPARE A RESPONSE ACTION PLAN (STRATEGY)		
SUB-TASK	KNOWLEDGE	SKILL

3.1 Identify and prioritize resources at risk.

- Shoreline and inland types.
- Relative sensitivity of coastal types.
- Sensitivity mapping.
- Local geography.
- Local oceanography.
- Critical habitats.
- Use of tide and tidal current tables.

- Identify protection priorities.
- Identify clean-up priorities.

3.2 Spill trajectory forecasting.

- Influence of water and weather conditions on oil properties and slick behavior and spread rate.
- Estimating spill size.
- Trajectory modeling.

- Use data to predict speed and direction of oil movement.

3.3 Identify resources required.

- Use and limitations of --
 - dispersants;
 - tracking systems;
 - booms;
 - skimmers;
 - pumps;
 - portable storage;
 - chemical barriers;
 - sorbents;
 - bioremediation;
 - communication equipment;
 - shoreline cleanup;

- Selection of proper equipment for the given circumstance.
- Determine personnel requirements.
- Determine surveillance requirements.
- Determine funding required.
- Determine logistical needs: i.e., food, shelter, hygiene.

- equipment; and
- in-situ burning.
- Logistics
- Funding sources
- Permits and other approvals required.

3.4 Identify additional resources.

- Location of additional resources.
- Means to obtain resources.
- Regional agreements.
- International agreements.
- Negotiations.
- Contract procedures.

3.5 Maintain records as required.

- Contract agreements.
- Market rates.
- Purchase order systems.
- Change order agreements.
- Accounting procedures.

• Establish log keeping procedures for the following:

- contractors.
- subcontractors.
- hired equipment.
- consumables used.
- personnel hired.

3.6 Prepare response action plan.

• Prepare and brief appropriate members of response community.

- Elements of a viable response plan including --
 - time available;
 - resources available;
 - containment plan;
 - protection/deflection plan;
 - oil recovery plan;
 - temporary storage and disposal plan;
 - application of chemicals, etc.;
 - method of deployment of equipment;
 - site safety plan;
 - personnel protective equipment;
 - plan adjustment mechanisms; and
 - permits and other Federal and state approvals required.

TASK 4; ACTIVATE ORGANIZATIONAL RESPONSE

SUB-TASK	KNOWLEDGE	SKILL
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4.1 Define operation team command structure.

- . Typical spill response organization which would depend on scale of the spill (e.g., minor, medium, or major).
- . Typical spill response command structure.
- . Roles and responsibilities of team members.
- . Incident Command System and Unified Command System.
- . Tiered response methods.

- . Organize response structure.
- . Delegate responsibilities.

4.2 Establish internal and external communication procedures.

- . Log-keeping requirements.
- . Standardized report forms.
- . Common communication problems.
- . Reporting schedules.

- . Control information flow as follows:
 - . Downwards to operations level; and
 - . Upwards to supervisors.

4.3 Establish command post

- . Site selection consideration:
 - . infrastructure.
 - . logistics concerns.
 - . future expansion.
- . Reporting schedules.

- . Select appropriate command post site.
- . Provide for logistics.

4.4 Implement safety and security procedures.

- . Reasons for security and safety.
- . Potential problems with security and safety.
- . Local resources.
- . Training requirements and skill level of personnel.
- . Occupational safety and health requirements.

- . Organize safety/security operations structure.
- . Delegate responsibilities.

- . Environmental monitoring requirements (e.g., lower explosive limit and toxicity).

- . Claims procedures.
- . Regulatory requirements.

- . Contracting procedures.
- . Basic ordering agreements.
- . Market rates.
- . Daily work sheets.

4.5 Establish claims office.

4.6 Coordinate subcontracted services.

- . Organize claims office.
- . Delegate responsibilities.
- . Assess need for subcontracted services.
- . Execute contracts.
- . Define role of subcontractors in overall response organization.
- . Monitor work.

TASK 5: MANAGE ONGOING OPERATIONAL RESPONSE

SUB-TASK	KNOWLEDGE	SKILL
5.1 Management of operational response activities.	<ul style="list-style-type: none"> • Use and limitations of pollution control, equipment and techniques • Logistics concerns, such as personnel and equipment. 	<ul style="list-style-type: none"> • Direct & supervise -- <ul style="list-style-type: none"> - secure source; - chemical/biological treatment methods; - containment methods; - protection & deflection procedures; and - recovery and clean-up procedures. • Monitor adherence to site safety and security plans. • Coordinate disposal of pollutants. • Direct and supervise logistical support.
5.2 Conducting briefings.	<ul style="list-style-type: none"> • Briefing techniques. 	<ul style="list-style-type: none"> • Conduct briefings for -- <ul style="list-style-type: none"> - supervisors; - subordinates; - media; - community; and - public officials.
5.3 Adjust ing operations or organization as needed.	<ul style="list-style-type: none"> • Methods for changing response priorities. • Methods for monitoring information flow. • Methods for progress measurement. • Methods for monitoring contracted services. 	<ul style="list-style-type: none"> • Revise operation. • Revise organization. • Evaluate changing conditions to modify and adjust response considering the following factors: <ul style="list-style-type: none"> - Safety. - Strategy. - Tactics.
5.4 Personnel management.	<ul style="list-style-type: none"> • Team leadership. • Time management. • Stress management. • Delegation methods. 	<ul style="list-style-type: none"> • Identify, define and assign tasks and expectations. • Monitor results.
5.5 Assisting in scientific monitoring of affected area.	<ul style="list-style-type: none"> • Methods scientists use to collect data and document harm to the environment (e.g., sampling, storage, custody, documentation). 	<ul style="list-style-type: none"> • Assist in sampling for later scientific analysis. • Describe environmental monitoring program. • Describe aerial surveillance.

TASK 6: DEACTIVATE RESPONSE

SUB-TASK	KNOWLEDGE	SKILL
6.1 Conduct analysis to determine if response should be continued, suspended or terminated with appropriate agencies.	<ul style="list-style-type: none"> • Effort and benefit analysis as follows: <ul style="list-style-type: none"> <u>Effort</u>: manpower; equipment and time requirements, environmental damage, and area use interference <u>Benefits</u>: aesthetic benefits, environmental, economical, and social water use benefits; and addressing public pressure. • Location of remaining oil in the environment or in the source. • Trajectory modeling. • Final survey techniques. 	<ul style="list-style-type: none"> • Rank the different criteria. • Use effort and benefit analysis method.
6.2 Assess potential for recontamination.	<ul style="list-style-type: none"> • Updated inventory and location of equipment and personnel. • Procedures to terminate operations. 	<ul style="list-style-type: none"> • Use spill projection models. • Determine whether cleanup should be continued or terminated.
6.3 Shut down field operations.		<ul style="list-style-type: none"> • Describe how the operations should be terminated in an orderly manner.

TASK 7: CONSOLIDATE COSTS

SUB-TASK	KNOWLEDGE	SKILL
7.1 Verify and certify costs.	<ul style="list-style-type: none"> • Reasons for cost documentation. • Liability, and cost recovery. • Daily log procedures. • Equipment cost report. • Manpower forms. • Invoices for contract services. • Personnel activity sheets. • Daily work sheets. • Travel claims. 	<ul style="list-style-type: none"> • Present a plan for filing and record maintenance. • Consolidate records and produce reports of expenditures by category.
7.2 Provide final cost documentation report.	<ul style="list-style-type: none"> • Cost documentation procedures and report writing techniques. • Coding structure. 	<ul style="list-style-type: none"> • Construct a simple coding structure for the response. • Produce final cost report.

TASK 8: DEBRIEF AND REPORT

SUB-TASK

KNOWLEDGE

SKILL

- 8.1 Conduct operational review of the response.
- 8.2 Provide information, documentation and evidence to final operations report.

- . Daily report.
- . Purpose of review.
- . Daily report and chronological report.
- . Maps, charts, or diagrams.
- . Message traffic, telex, radio, and fax.
- . Shoreline survey evaluation form.
- . Photographic documentation.

- 8.3 Make recommendations for improved preparedness.

- . Familiarity with existing contingency plan.

- . Conduct an effective and productive team review of response.
- . Consolidate information to produce operations report.
- . Demonstrate the ability to make pertinent recommendations for improvements to the contingency plan.
- . demonstrate analytical skills.

Appendix B: Training Resources

The federal government encourages private industry and training institutions to develop and further refine courses available for oil and hazardous substance spill prevention and response. While training for pollution response is important, emphasis should be given to improving the training available for the prevention of all spills. This goal would be best accomplished by existing in-house training programs developed by companies which are more familiar with the operational job requirements of their own employees.

Private sources have developed a large number of training courses for the oil and chemical industries. The International Tanker Owners Pollution Federation, Limited has published a manual for oil spill response titled *Response to Marine Oil Spills* and has also produced accompanying training video tapes. The Texas A & M University offers a wide variety of courses on oil and hazardous substance prevention and response at its National Spill Control School in Corpus Christi, Texas, at the Texas Engineering Extension Service, and at the Center for Marine Training and Safety in Galveston, Texas. The Paul Hall Training Center in Piney Point, Maryland offers courses in hazardous materials and oil spill response as well as a wide variety of courses for the professional mariner. The Massachusetts Maritime Academy has also developed courses for qualified individuals and supervisory personnel. Other maritime academies either have existing courses or are in the process of developing courses to better serve the changing needs of the maritime industry.

Numerous commercial and government sources have developed videotapes and course booklets designed for hazardous substance response teams and chemical industry employees. Commercial companies offer training videotapes on all aspects of hazardous substance response. Interested parties are advised to contact the training officer for their state emergency management agency for specific recommendations on commercial or state hazardous substance response courses. Many large companies within the oil and chemical industries have also developed highly professional in-house training programs to indoctrinate their personnel in safe work practices and response techniques.

In the federal government, the Federal Emergency Management Agency (FEMA) National Fire Academy, and the EPA have developed and now provide courses on hazardous substance response. These courses are primarily designed for local, state, and federal agency response personnel. The EPA's Office of Emergency and Remedial Response (OERR) is responsible for the EPA's Environmental Response Training Program (ERTP). EPA has developed numerous courses designed for emergency response personnel and those who investigate and remediate hazardous waste sites. ERTP courses are offered in each EPA region and at the EPA's Environmental Response Training Centers located in Cincinnati, Ohio, and Edison, New Jersey. Although federal, state, and local government employees are given priority for course attendance, private sector employees are considered on a space available basis. Inquiries on available course offerings and registration procedures should be directed to:

Training Registrar
U. S. EPA Environmental Response Training Program
3280 River Road
Cincinnati, OH 45204
Tel: (513) 251-7776; FAX: (513) 251-4137.

Under an interagency agreement with the Department of Transportation, FEMA's Emergency Management Institute has developed a manual on hazardous materials training. The first edition of the manual titled *Guidelines for Public Sector Hazardous Material Training* will be available to the public in 1994. The manual emphasizes hazardous material course content and the methods used in course evaluations. Another FEMA office, the National Audiovisual Center, is the central repository for over 8,000 video programs, films, slide sets, and other training material on hazardous substances and response produced by, or for, the U. S. Government. The courses may be ordered by contacting:

The National Audiovisual Center
8700 Edgeworth Drive
Capital Heights, MD 30243-3701
Tel: (301) 763-1896.

FEMA also operates the National Emergency Training Center in Emmitsburg, Maryland. The Center houses the U. S. Fire Administration, the National Fire Academy, and the Emergency Management Institute. The Center offers a wide variety of resident and nonresident courses in emergency preparedness and several courses on hazardous substances. Interested individuals may correspond to the following:

National Emergency Training Center
Office of Admissions
16825 South Seton Ave.
Emmitsburg, MD 21727. ■

APPENDIX C

Sample Lesson Plans

TAB A OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

OUTLINE

In this lesson will be discussing the following topics:

- ◆ Purpose of containment
 - ◆ Reference material
 - ◆ Boom Selection
 - ◆ Commercial Floating Boom
 - ◆ Improvised Boom
 - ◆ Sorbent Boom
 - ◆ Air or Water Streams
 - ◆ Bubble Barriers
 - ◆ Chemical Barriers

 - ◆ Containment Techniques & Applications
 - o Exclusion Booming
 - o Diversion Booming
 - o Containment Booming
 - o Sorbent Booming
 - o Sorbent Barriers

 - ◆ Boom Failures
 - o Sheet Breakaway [Entrainment]
 - o Droplet Breakaway [Drainage]
 - o Splash-over [Submergence/Planing]
 - o Wave Induced Failure

 - ◆ Recovery
 - ◆ Skimmers
 - o Weir
 - o Suction
 - o Centrifugal
 - o Submersion
 - o Sorbent Surface

 - ◆ Sorbents
 - o Classes
 - o Uses

 - ◆ Manual Recovery
 - ◆ Solidifying Agents
 - ◆ Chemical Agents
 - o Collecting Agents
 - o Dispersing Agents
 - o Sinking Agents
 - o Burning Agents
 - o Biological Agents
 - o Gelling Agents
 - o Neutralizing Agents
-

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

PURPOSE

- ◆ **CONTAINMENT** of an oil spill is the process of preventing its spread by confining the oil to the area in which it has been discharged.
 - ◆ The purpose of containment is not only to localize the spill and thus minimize pollution BUT to facilitate removal of the oil by causing it to concentrate in thick layers on the surface of the water.
 - ◆ In short, **EFFECTIVE** containment systems:
 - o COLLECT the pollutant to aid in recovery ops.
 - o DIVERT the pollutant to areas where cleanup can be conducted.
 - o PREVENT the spread of pollutants over a wide area.
 - o PROTECT specific areas such as entrances to harbors/ivers and environmentally or economically sensitive areas.
-
-

REFERENCES

- ◆ You can find information on containment and recovery in the following references:
 - o EPA's "Manual of Practice for Protection and Cleanup of Shorelines"
 - o "The Basics of Oil Spill Cleanup" by Mervin Fingas
 - o "Response to Marine Oil Spills" by The International Tanker Owners Pollution Federation – ITOFF
 - o World Catalog of Oil Spill Response Products – a complete listing of equipment throughout the world.
-
-

World Catalog
6514 Rockburn Hill Rd
Elkridge, MD 21227
1-800-937-5078

TYPES OF SYSTEMS

- ◆ The most common types of containment systems are:
 - o Commercial floating boom (curtain & fence)
 - o Improvised boom and barriers
 - o Sorbent boom and sorbent barriers
 - o Air or water streams
 - o Bubble barriers
 - o Chemical Barriers
-
-

BOOM SELECTION

- ◆ Boom selection must take into consideration:
 - o The type of pollutant to be contained.
 - o The conditions it will be operating in (i.e. wind, wave height, open or closed water area, current speed and tides).
 - o The logistical requirements for deployment and availability

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

- o of manpower.
- o Its compatibility with other types of booms.
- o The location of access points for recovery equipment.
- o Deployment areas must have good anchoring locations for shoreside and waterside ends of the boom.
- o Its buoyancy.
- o Its roll response in currents.
- o Its heave response in waves.
- o Does it have adequate freeboard height and skirt depth.
- o Is it easily visible in daylight: yellow or international orange is good.
- o Can it be packaged for ease of transportation.
- o Is it easy to assemble, deploy and retrieve.
- o Are there anchor points at about 50 foot (15m) intervals.
- o Are the surfaces smooth to permit laminar (layered) fluid flow & prevent the collection of debris.
- o Is it easy to assemble, deploy and retrieve.

Boom containment devices are generally designed for oil pollution, but some types are designed for floating hazardous materials such as acids, bases and solvents. For HAZMAT especially, the physical and chemical properties of the pollutant and the compatibility of the pollutant with boom material must be carefully considered prior to deployment.

COMMERCIAL FLOATING BOOM COMPONENTS

- ◆ There are five basic components of boom:

- o Means of flotation

Floats may be rigid or flexible. Flotation elements should be relatively smooth so that they don't trap debris or produce vortices in moving water causing loss of oil under the boom.

- o Freeboard (prevents/reduces splash-over)

The vertical height of a boom above the water line. The freeboard prevents oil from washing over the top of the boom, but if it is too high, the boom may be pushed over in high winds.

- o Skirt (prevents oil from being swept underneath the boom)

The continuous portion of a boom below the floats. Since the force of current on a boom is proportional to the skirt area, increasing skirt depth beyond what is really necessary puts an unusually high load on tension members of the boom.

- o Ballast System

Weight applied to the skirt to improve performance. Ballast may be a series of weights attached to the skirt along the entire length, a chain, or metal rods supported along the bottom of the skirt.

- o Tension line/strength member

Tension members are often cables, chains or lines running along the skirt of the boom and/or along the freeboard.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆ In addition, containment booms may have some or all of the following auxiliary or support components:

- o Anchor points
- o End connectors
- o Handholds
- o Hinge
- o Lifting Points
- o Stiffeners

◆ There are 8 different types of boom connectors:

- o Quick
- o Universal slide
- o Slide
- o Slotted tube
- o Raised Channel
- o Bolt
- o Hinged Plate and Pin
- o Hinge and Pin

◆ There are two types of booms in general use today: **FENCE** and **CURTAIN** booms.

Fence booms have a rigid or semi-solid material as a vertical screen against oil floating on the water. Curtain booms have a flexible skirt that is held down by ballasting weights or separate tension lines.

Fence booms can be classified according to the type of flotation used:

- o Centerline flotation,
- o Outboard flotation, and
- o One-sided outboard flotation.

Fence booms are usually easy to deploy, resistant to damage, but bulky for storage.

Curtain booms have centerline flotation provided by air, inert gas, solid foam bars, flexible foam roll, or granulated foam contained in a plastic cylinder. They have flexible skirts which are free to move independently of the floats.

Several kinds of specialized booms are also available. They are:

- o Tidal seal booms (for tidal flats)
- o Fireproof booms
- o Ice booms

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

IMPROVISED BOOM

Can be used to contain relatively small spills which occur in sheltered waters or as a temporary measure until more suitable boom is brought on-site.

◆ **EXAMPLES:**

- o inflated fire hose
- o telephone poles
- o logs
- o linked railroad ties
- o earthen dams

◆ **USES:**

- o As diversion boom to divert oil to area where commercial boom is already deployed.
- o Collection point for river debris to protect main containment boom.
- o **GOOD** in streams or ditches which are too shallow for conventional boom.

A major problem with this system is that the oil can readily spill over the top or in-between sections.

SORBENT BOOMS AND BARRIERS

Specialized containment devices that absorb oil in porous materials such as straw or synthetic materials [This will be covered in more detail in the **RECOVERY** portion of the lesson]. Used when the oil slick is relatively thin because efficiency rapidly decreases once the porous surface is saturated with oil.

◆ **DRAWBACKS:**

- o Requires considerable additional support to avoid breakage under the force of wind/current.
 - o Often requires some method of additional flotation to prevent sinking when saturated with oil & water.
 - o A great deal of caution must be used to prevent the contaminated side of the boom from turning over and recontaminating the water.
-

AIR OR WATER STREAMS

Under some circumstances, the force of a water stream from a fire hose or pump can be used to contain or divert an oil slick. A high-pressure airflow will produce the same results.

◆ **USES:**

- o Keep oil out of a gap between conventional floating booms.
- o Temporary containment measure while a boom is being deployed.
- o Direct oil towards a recovery sight.
- o Flush oil from beneath a dock.
- o Adjust booms that have already been deployed.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆ DRAWBACKS:

- o ONLY effective when current is less than .5 knots.
- o If current exceeds 1 knot this systems adds to the problem by causing the oil to form emulsions hindering cleanup.
- o Requires continuous use.
- o Requires considerable skill to use effectively.
- o Requires close coordination between operators and recovery personnel.

BUBBLE BARRIERS

A rising curtain of bubbles can be produced when air is pumped into a perforated pipe located below the water's surface. This rising curtain causes the surface water to spread horizontally in two directions perpendicular to the submerged pipe, thereby forming a natural barrier.

◆ BASIC PRINCIPLE:

- o Oil will not cross the two-way current.

◆ USE/ADVANTAGES:

- o Most suited to relatively calm harbors.
- o Allows for the passage of vessels.
- o Will hold oil against water flows up to .7 knots.

◆ DISADVANTAGES:

- o Costly installation and maintenance costs.
- o HIGH power output required to produce a sufficient bubble stream to disrupt the surface of the water.
- o Redistribution of bottom silt (shoaling).

There has been success using the system when installed on an angle to the current providing a diverting action to a shoreline area.

CHEMICAL BARRIERS

Certain chemicals act as surface tension modifiers and inhibit the spread of oil. These are known as "herders". When relatively small quantities of these chemicals are placed on the water's surface next to the floating oil, the oil is pushed away as a result of the stronger spreading force (low surface tension) of the chemical.

◆ HOW DISPERSED:

- o Sprayed from a boat, helicopter or plane.
- o Sprayed so that the slick is surrounded by the chemical and corralled/concentrated in thick layers.
- o Sprayed so as to divert oil to a recovery area.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆DRAWBACKS:

- o Acts only on fresh oils -- must be used early in spill.
 - o Effects only last a few hours.
 - o Recovery must begin immediately after application.
 - o Approval must be obtained from proper authorities/regulatory agencies prior to use.
 - o Public/health issues must be considered before use.
 - o Impact on environmentally sensitive areas.
 - o Less effective on viscous oils.
 - o Don't work well in icy or cold waters.
 - o Don't work well where wind, current or wave action is significant.
-
-

CONTAINMENT TECHNIQUES & APPLICATIONS

◆The five basic containment techniques/applications are:

- o **Exclusion** booming,
 - o **Diversion** booming,
 - o **Containment** booming,
 - o **Sorbent** booming, and
 - o **Sorbent** barriers.
-
-

EXCLUSION BOOMING

A boom is deployed across or around a sensitive area to "exclude" a pollutant from contaminating the area. The pollutant is either deflected or contained by the exclusion boom. A good example of this would be putting a boom around a tank vessel while it is conducting transfer operations.

In some cases, booms are positioned in a semicircle along a specific section of shoreline to aid in containing oil which has been removed from the shore or beach and is awaiting recovery.

DIVERSION BOOMING

A boom is deployed at an angle to the approaching pollutant. The pollutant is either "diverted" away from a sensitive area or diverted to a central collection point to ease recovery. This technique is primarily done in inshore, river or harbor areas.

Primarily used when currents are less than .7 knots and breaking waves are negligible.

The velocity of water in a stream or river is not equal at all points across its width; higher velocities are generally found in the deeper central parts and along the outside curves. Therefore oil will naturally be forced into the QUIET areas of the stream or river.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆HOW DEPLOYED:

- o Chevron pattern – The boom is angled in a chevron or inverted V pattern so that all floating oil and debris is deflected to either side of the stream.
- o Cascading pattern – Varying lengths of boom are progressively staggered along the watercourse so that the oil is directed to one side of the watercourse. – Particularly effective in rivers which are too wide to allow use of the more simple chevron pattern – or – where currents are very strong and single booms fail.

NOTE: There are tremendous forces on any boom in a diversionary mode, so it **MUST** be firmly anchored to the shore. Recommend putting numerous anchors throughout the entire length of the boom.

CONTAINMENT BOOMING

A boom is deployed in a "U" or "V" shape in front of the approaching pollutant. The ends of the booms are anchored or secured to work vessels. The pollutant is contained within the "U" or "V" and prevented from spreading.

- ◆Primarily used on the open water with offshore boom.
- ◆Often used in combination with skimming vessels or devices.
- ◆When used in relatively sheltered waters, such as estuaries, ports and harbors, containment barriers are often anchored to the bottom. Depending on local current and wave conditions, inshore boom may be used. A major consideration is to ensure the anchoring system takes into consideration current direction, velocity and tidal shifts.

SORBENT BOOMING

Boom composed of sorbent material. This type of boom is usually deployed along a shoreline to protect sensitive areas or keep heavier, emulsified oils from spreading.

Primarily used on quiet waters that are not heavily contaminated.

SORBENT BARRIERS

A sorbent barrier is usually constructed of wire mesh, stakes and loose sorbent materials. It is often deployed across a waterway or outfall. It allows water to flow through it but retains and absorbs oil on the water's surface. Primarily used in small, low-velocity streams, tidal inlets or channels.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

BOOM FAILURES

Oil loss resulting from boom failure may be attributed to one or more of the following causes:

- o Underflow [ENTRAINMENT/DRAINAGE] caused by currents (Sheet and/or Droplet breakaway).
 - o Splash-over caused by winds.
 - o Submergence or rollover [PLANING] caused by waves/currents
 - o Mechanical failure of structural members or joint connections.
 - o Improper anchoring.
 - o Improper positioning of the boom with respect to current direction.
 - o Failure of cleanup crews to compensate for tidal changes and/or current force & direction.
-

SHEET BREAKAWAY

◆ Sheet Breakaway [ENTRAINMENT] is the most common type of boom failure because:

1. Boom acts as a dam, so...
2. The surface water is deflected downwards, and
3. The surface water accelerates in an attempt to keep up with the water normally flowing under the skirt (the depth of the skirt affects acceleration speed); therefore,
4. Oil is drawn down under the boom (entrainment).

◆ The amount of oil lost in headwave failure depends on the thickness of the oil in the headwave, which is a combination of water velocity and specific gravity of the oil. The current velocity which creates this phenomenon is called "critical velocity" and varies with:

- o Skirt depth,
- o Oil viscosity,
- o Specific gravity of oil, and
- o Thickness of oil film contained in the boom.

GENERAL RULE: Oil will begin to escape beneath the skirt of most booms when current velocity exceeds .7 knots. Entrainment loss determines how fast a boom can be towed or the maximum current in which it will be effective.

This type of boom failure can be overcome, to a certain degree, by placing the boom at an angle to the current. Spill containment performance depends on the angle between the boom and the current. They can be expected to take some catenary shape. When the angle with the direction of flow becomes small, the catenary may be more like a J-shape. The curvature of the "J" presents a greater angle to the flow and therefore has a lower speed at which failure occurs. Therefore, one would expect failure

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

to occur first in that part of the boom curving to cross the direction of flow.

When booms fail in fast currents, oil escaping under the boom tends to collect in the water flowing along the backside of the boom. This provides a spill response crew with another opportunity for containment. A second boom can be deployed just downstream from the boom that is showing failure.

DROPLET BREAKAWAY

High velocity currents cause another type of failure (oil loss) known as DROPLET BREAKAWAY [DRAINAGE] because:

1. Oil mass forms a headwave, and
2. The rear of the headwave becomes unstable, so...
3. Oil droplets are torn off and entrained in water flow, flowing under the skirt.

This phenomenon begins to occur at about .3 knots.

The problem is aggravated by having a deeper skirt. Increasing skirt depth also increases the distance water must travel to stay with the flow, which causes drainage to occur at a lower critical velocity.

Both entrainment and drainage failures involve leakage from large pools of oil that may collect ahead of the boom. Failure can often be avoided by eliminating the pools that are the source of the leakage. To prevent leakage, deploy skimmers where oil has pooled in the area of the headwave.

"SPLASH OVER"

Wind is a **SECONDARY** factor affecting a boom's efficiency when the current is the dominant factor.

If the boom is not securely anchored on both sides and the wind is blowing opposite the current, the boom will move back and forth causing "SPLASH OVER".

If the wind is moving in the same direction as the current, "splash over" will also occur. In a worst case, the boom will fail.

WAVE INDUCED FAILURE

◆ Waves affect the efficiency of booms. Typical failures are:

- o Submergence
- o Roll over [Planing]

Submergence may occur when a boom is deployed or anchored in a fast current, or is being towed at a high velocity in still water. The tendency of a boom to submerge at a given velocity is determined by its reserve buoyancy.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

A strong wind and strong current moving in opposite directions may cause a boom to heel flat on the water surface. The resulting loss of oil is called planing failure.

Most booms perform well in gentle swells. If swells are long (length to height rate is 10:1) with a long period between crests, and the boom is flexible – there should be LITTLE problems. Waves with medium swells and significant wave heights (5:1) or short choppy waves with high winds will cause excessive turbulence at the apex of the boom and result in splash-over.

RECOVERY

After the oil is contained, the next step in the response operation is to recover it from the water. In most instances the containment and recovery phases proceed simultaneously.

RECOVERY APPROACHES

◆ There are 3 distinct approaches to the physical recovery of oil from the water. They are:

- o Use of mechanical skimmers.
- o Use of sorbents.
- o Use of manual labor.

In most spills, each approach is used to a certain extent and each has specific limitations depending on geographic location and ambient climatic conditions.

FACTS ABOUT SKIMMERS

A skimmer is a mechanical recovery device designed to remove the pollutant from the water's surface without causing major alterations in its physical or chemical properties. All skimmers work best in calm waters with little or no wave action. Skimmer types can be classified according to their basic principles of operation. They fall into two categories: **Suction Skimmers** or **Adhesion Skimmers**. Viscosity (see special note) of the pollutant will help determine the most appropriate skimmer and pump types to be utilized for a particular incident.

SPECIAL NOTE: Viscosity is defined as the measure of a fluid's internal friction or its resistance to flow; a fluid's surface tension. Lower viscosity substances are lighter and when spilled or released into a waterway will spread out over a greater area. Higher viscosity substances will not spread out as much. Hence, the product will remain "thicker".

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

Skimmer performance varies widely depending on the viscosity of the oil being recovered. Most skimmers have a range of viscosities in which they work best: They are

Light Oil Viscosity 3–10 Cst, .83–.88 Sp. gravity

Weir, Suction, Submersion belts, Submersion planes.

Medium Oil Viscosity 100–300 Cst, .90–.94 Sp. gravity

Disc, Drum, Rope mop, Floating head belt, Sorbent lifting belt, Sorbent submersion belt, Submersion belt, Drum brush, Chain brush, submersion planes, boom-skimmer, Vortex.

Heavy Oil Viscosity 500–2000 Cst, .94–.97 Sp. gravity

Paddle belt, Sorbent lifting belt, Rope Mop, Drum brush, chain brush, Oil head weir.

Waves and currents have a significant effect on skimmer performance. Waves affect performance because rough seas move the skimmer away from the oil floating on the water surface. Currents affect the performance of skimmers because fast currents generally cause oil to escape under collection booms.

◆ There are generally five different types of skimmers:

- Weir,
- Suction,
- Centrifugal,
- Submersion, and
- Sorbent surface.

WEIR

This type of skimmer takes advantage of gravity to drain the oil off the water's surface. It consists of a weir or dam, a holding tank and an attachment which is connected to external pumping equipment.

Two types of weir skimmers are:

1. Sweeping arm weir.
2. Oil head weir.

◆ OPERATION:

- The top edge is positioned at a certain level with respect to the oil/water interface, then
- Floating oil falls over weir or is forced over it by currents where...
- Oil is continually removed by pumps.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆ADVANTAGES:

- o Simple, reliable, most available of all skimmers.
- o Given a thick layer of oil the weir can recover large volumes of product at high rates with a recovery efficiency of about 50%.

◆DISADVANTAGES:

- o Efficiency is reduced in cold weather.
- o Tends to draw too much water relative to oil which requires constant adjustment of the pumping rate.
- o Presence of debris reduces efficiency.
- o EXTREMELY susceptible to wave action.
- o Tendency to turn over in rough water.
- o Intake of air can cause the pumps to lose prime, causing the skimmer to stop operating.
- o Will turn over in rough water.

Best when used in calm, protected waters. Rarely used in open ocean incidents.

SUCTION

Suction skimmers are similar in many respects to weir-type devices. These skimmers also sit on the water surface, generally use an external vacuum pump system and are adjusted to float at the oil-water interface. Due to their compactness and shallow draft, suction skimmers are particularly useful in shallow water and in confined areas such as under docks.

◆ADVANTAGES:

- o Simple to operate.
- o Have a shallow draft.
- o Can be used nearly everywhere, even under piers.
- o Require little or no adjustment.
- o Efficiently recovers a wide range of different viscosity oils.

◆DISADVANTAGES:

- o Susceptible to clogging.
- o Doesn't work well in choppy waves.
- o Loses suction (planing) if current exceeds .6 knots.
- o Must be tended with lines from ashore or a boat.
- o Susceptible to clogging.

These skimmers work well in calm waters when containment barriers are used to direct the flow of oil toward the skimmer's floating head.

Another form of suction recovery is the use of a vacuum truck.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

CENTRIFUGAL

This skimmer operates by the creation of a water vortex or whirlpool, which draws the oil into a collection area where it is pumped to an oil-water separator.

◆ADVANTAGE:

- o Not susceptible to clogging with debris (debris screen).

◆DISADVANTAGES:

- o Currents and waves limit its effectiveness.
- o Does not work well when current exceeds .6 knots.

The most common centrifugal skimmer is the **VORTEX** skimmer.

SUBMERSION

This type of skimmer is usually mounted on or incorporated within a powered vessel. Oil in the path of the skimmer is forced beneath the water's surface by a moving belt inclined at an angle to the surface. The belt forces the oil downward toward the mouth of a collection well where it rises to the surface. Water collected with the oil simply passes under the collection well and out a discharge port. Oil adheres to the belt and is removed by a mechanical scraping device. The oil is then pumped to an onboard or adjacent storage facility.

The most common of these skimmers are:

1. Solid belt,
2. Sorbent belt.

◆ADVANTAGES:

- o Efficient with low viscosity oils and when slick is thin.
- o Will work, but not as well, with high viscosity oil.
- o Not seriously hampered by debris.
- o Not seriously hampered by waves.
- o Good for uncontained slicks.
- o Rate of recovery and amount of recovered oil is **HIGHER** than other skimmers.

◆DISADVANTAGES:

- o Large and must be in motion to recover oil.
 - o Not well suited for confined areas or adjacent to containment boom.
-

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

SORBENT SURFACE (OLEOPHILIC)

This type of skimmer incorporates a surface to which oil can adhere in order to facilitate its recovery from the water. The sorbent, or "oleophilic", surface can be in the form of a drum, disc, belt or rope which is continuously moved through the oil film. The collected oil is removed by a wiper blade or pressure roller and is then deposited in an onboard container or pumped to a storage facility.

The most common types are:

1. Rope mop,
2. Disc,
3. Drum,
4. Paddle belt,
5. Sorbent lifting belt, and
6. Brush (drum or chain).

◆ADVANTAGES:

- o Of all the types of skimmers, this one is least affected by waves. Wave action can enhance oil recovery in some models by increasing the surface area of the sorbent component.
- o Can be operated from a stationary location and is most suited for use within containment booms and adjacent docks.

◆DISADVANTAGES:

- o Rotating surface tends to drive oil away from skimmer where it enters the water, especially when the skimmer is moving.
- o Debris can damage rollers, wringers and wiper assemblies.

SORBENTS

◆A sorbent is a material which will recover oil through either absorption or adsorption.

◆In "**absorption**", the oil actually penetrates the surface of the sorbent.

◆In "**adsorption**", the oil is attracted to and adheres to the sorbent.

◆Sorbents should be hydrophobic or water repellent.

◆The ideal sorbent absorbs oil quickly with retention. It also absorbs large amounts of oil per its unit weight with very little water.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

- ◆ The sorbent should be easy to apply and non-toxic to both handlers and the environment.
 - ◆ Those to be used on water will be able to take on large amounts of oil without sinking.
 - ◆ They should be easy to recover and be strong enough to be handled without tearing.
-

CLASSES

- ◆ The three basic classes of sorbents are:

- o Natural organic:
 - peat moss,
 - straw,
 - hay,
 - sawdust,
 - ground corn cobs,
 - chicken feathers,
 - cork, wool, clay.
 - snow.

They can pick up from 5 to 15 times their weight in oil.

- o Inorganic/Mineral Based:
 - vermiculite (silicates),
 - perlite (natural volcanic glass),
 - volcanic ash,
 - glass wool,
 - volcanic ash/rock.

They usually sorb about four to eight times their weight in oil. Some of these are difficult to apply because they blow in the wind. Others are hazardous and require operators to wear breathing apparatus (respirators).

- o Synthetic Organic:
 - rubber,
 - polyester foam,
 - polyurethane,
 - polystyrene,
 - nylon fibers.

These are highly oleophilic and hydrophobic and are ideal for recovering oil floating on water. They are generally strong enough to be used several times.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

Sorbents are available in a great many forms:
o Rolls, sheets, blankets, web, loose particulates, pillows or sorbent booms.

Sawdust, peat moss and cotton will soak up oil but tend to sink once water saturated – this will intensify the cleanup problem. Recovery of large amounts of natural sorbents required lots of manpower.

MANUAL RECOVERY

Where access is difficult, oil may have to be removed using a bucket.

Manual recovery can be manpower intensive and expensive.

SOLIDIFYING AGENTS

Although not an oil recovery technique in its own right, chemicals have been developed that convert liquid oil into solid mats, thereby facilitating recovery by manual means or nets. While such chemicals have been demonstrated successfully in the laboratory, difficulties in achieving the required intensive mixing into the oil and their high cost are likely to preclude their use except for small pockets of oil in restricted locations.

CHEMICAL AGENTS

◆ A chemical agent is a substance or chemical used in pollution cleanup/recovery and mitigation. Some chemical agents are designed specifically for oil products (hydrocarbons), while others are designed for classes of hazardous materials (acids, bases and solvents).

Types of agents are:

- o Collecting,
 - o Dispersing,
 - o Sinking,
 - o Burning,
 - o Biological,
 - o Gelling,
 - o Neutralizing.
-
-

COLLECTING AGENTS

◆ Cause the oil to herd to a collection point. Works by affecting the surface tension of the oil.

DISPERSING AGENTS

◆ Dispersants contain chemicals which reduce the surface tension between oil and water and therefore result in the breakup and dispersal of the slick throughout the water column in the form of an

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

oil-in-water emulsion. However, the oil IS NOT removed from the water.

- ◆ The basic argument in favor of their use is that dispersion of the oil will increase the opportunity for oxidation, biodegradation and other weathering processes and reduce immediate damage to waterfowl or other wildlife which could be adversely affected by a surface slick. Dispersants are also used to prevent oil from adhering to solid surfaces such as piers.
- ◆ Older dispersants contained a large proportion of inherently toxic hydrocarbon-based solvents such as kerosene, mineral spirits and naphtha, which, when applied to an oil slick, increased the volume of hydrocarbon pollutants present in the water. The major organic solvents contained in modern dispersants are alcohols, glycols and glycol ethers. These substances tend to be somewhat less toxic than the older components.
- ◆ A variety of equipment such as spray applicators and portable pumps may be used to apply dispersants to the oil slick. And, even in the presence of waves, it is often necessary to agitate the water to facilitate formation of oil-in-water emulsions. Application of these chemicals without thorough mixing in the surface water is a waste of time, manpower and cleanup funds.
- ◆ Dispersants are most effective on unweathered oils with low viscosities and low pour points in relatively warm water.
- ◆ Their use is usually considered a last resort in most cleanup programs since dispersion of oil throughout the water column may harm a far greater number and variety of organisms than are affected when the oil is concentrated on the surface.

◆ Advantages:

- o Increased oil degradation,
- o Less tendency for the oil to form tarry residues,
- o Reduced fire hazard with some petroleum products,
- o Decreased impact on waterfowl.

◆ Disadvantages:

- o Potential toxic effects on aquatic life,
- o Increased exposure of organisms to toxic hydrocarbons,
- o Lack of knowledge regarding the fate of dispersed oil.

ALL DECISIONS REGARDING THE USE OF DISPERSANTS ARE MADE AFTER CAREFUL EVALUATION OF THE SITUATION AND CONSULTATION WITH REGULATORY AGENCIES.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

SINKING AGENTS

- ◆ Special materials can be applied to the oil slick which adsorb the oil to their surface. The combination of the oil and the sinking agent is heavier than water, therefore it sinks.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆ Common sinking agents are:

- o treated sand
- o brick dust
- o cement
- o silicone-treated materials
- o chalk

◆ Large quantities of sinking agents are required in relation to the size of the slick and it is often difficult to wet the surface of these materials with oil. Once the oil has adsorbed to the material and has sunk, there is no guarantee that it will not resurface, perhaps in other areas which are environmentally more sensitive.

◆ Sinking agents are not particularly effective with low viscosity oils or when the oil slick is relatively thick.

◆ Like dispersants, sinking agents may cause considerable damage to bottom-dwelling organisms, so their use is generally prohibited by regulatory agencies.

BURNING AGENTS

Facilitates "In-Situ" burning.

◆ A substance that will make it possible to ignite the oil on the surface of the water or upon a shoreline. It creates a buffer between the oil and the water's surface, which allows for ignition. Most oils will burn on water or land provided that the oil is thick, sufficiently emulsified and heated to its ignition temperature.

◆ However, despite the fact that many hydrocarbons are flammable, this is often difficult since the fire must be kept hot enough to continually support combustion and must be supplied with sufficient oxygen. It is virtually impossible to ignite a thin layer of oil on water because it is cooled by the water beneath it.

◆ Typical agents are:

- o Gasoline.
 - o Light crude oils.
-

BIOLOGICAL AGENTS

◆ A combination of enzymes, natural organisms and nutrients which increase the rate of natural degradation of oil. Since it works as a "natural" process, this method's effectiveness is measured over a period of many months and years. It is a LONG TERM technique.

GELLING AGENTS

◆ Gelling agents are chemicals which increase the viscosity of the oil slick and thereby reduce its rate of spread over the water's surface. Some gelling agents change the oil into cellular-like foam, while others actually coat the oil with a material having the consistency of plastic thread.

OIL SPILL CONTAINMENT & RECOVERY EQUIPMENT

◆ These chemicals are rarely used since the quantities required to gel an oil are extremely high in relation to the volume of oil, and it takes at least eight hours before the gel is sufficiently strong to allow recovery.

Gelling agents are used as a first step for other cleanup methods (i.e. gelling agent is used on a light oil to thicken it so a skimmer can remove it from the water's surface).

NEUTRALIZING AGENTS

◆ Some hazardous materials can be neutralized by applying other materials, neutralizing agents, to the spill, which will react chemically to form less harmful substances.

For example: Acids neutralized by bases such as sodium bicarbonate and soda ash.

The neutralization process is also known as CHEMICAL INACTIVATION.

APPROVAL FOR USE

◆ The OSC has the authority to deploy chemical agents only under the following circumstances:

- The EPA and state agree to such use, and
 - The chemical is listed in the National Contingency Plan Product Schedule (means the product is approved) - OR -
 - The OSC determines that the use of an agent is necessary when the spill poses a threat to human life - OR -
 - There are previously approved plans authorizing such use.
-
-

TAB B OVERVIEW

Introduction

When there is an oil pollution incident, cleanup efforts should be implemented as rapidly as possible to reduce or minimize the harmful effects of the pollution. Shoreline cleanup or countermeasures following an oil spill are a critical element in determining the ultimate environmental impact and cost resulting from a spill. As with most aspects of spill response, careful planning can significantly increase the effectiveness of treatment operations.

Outline

This lesson is designed to provide you the information needed to plan a effective treatment operation and discusses:

Types of Shorelines

- ◆ Introduction
- ◆ Seawalls and piers
- ◆ Exposed wave-cut platforms
- ◆ Fine-grained sand beaches
- ◆ Coarse-grained sand beaches
- ◆ Mixed sand gravel (or shell) beaches
- ◆ Gravel beaches and riprap structures
- ◆ Exposed tidal flats
- ◆ Sheltered rocky shores
- ◆ Sheltered tidal flats
- ◆ Fringing and extensive salt marshes

Environmental Concerns

- ◆ Introduction
- ◆ Human life

Wildlife Resources and Habitats

- ◆ Introduction
 - ◆ Seawalls and piers
 - ◆ Exposed wave-cut platforms
 - ◆ Fine-grained sand beaches
 - ◆ Coarse-grained sand beaches
 - ◆ Mixed sand gravel (or shell) beaches
 - ◆ Gravel beaches and riprap structures
 - ◆ Exposed tidal flats
 - ◆ Sheltered rocky shores
 - ◆ Sheltered tidal flats
 - ◆ Fringing and extensive salt marshes
-

OVERVIEW (cont)

Outline (cont)

Economical Impact

- ◆ Introduction
- ◆ Public access
- ◆ Commercial harvest
- ◆ Other trades

Commonly Used Cleanup Methods

- ◆ Introduction
- ◆ Rocks
- ◆ Cobble Stone
- ◆ Sand beaches
- ◆ Marshes

Recommended Response Activity

- ◆ Introduction
- ◆ Seawalls and piers
- ◆ Exposed wave-cut platforms
- ◆ Fine-grained sand beaches
- ◆ Coarse-grained sand beaches
- ◆ Mixed sand gravel (or shell) beaches
- ◆ Gravel beaches and riprap structures
- ◆ Exposed tidal flats
- ◆ Sheltered rocky shores
- ◆ Sheltered tidal flats
- ◆ Fringing and extensive salt marshes

RCRA

- ◆ Background
- ◆ Solid Waste Definition
- ◆ Hazardous Waste Definition

Disposal of Oil

- ◆ Background
 - ◆ Recycling
 - ◆ In-situ Burning
 - ◆ Incineration
 - ◆ Landfills
 - ◆ Land Farming
 - ◆ State Law
-

OVERVIEW (cont)

Outline (cont)

Hazardous Waste Handlers

- ◆ Generator Definition
- ◆ Generator Requirements
- ◆ Hazardous Waste Manifests
- ◆ Transporter Definition
- ◆ Transporter Requirements
- ◆ Accidental Releases
- ◆ Treatment, Storage, and Disposal Facilities

RCRA Penalties

- ◆ Civil
 - ◆ Criminal
 - ◆ Federal Facilities
-

TYPES OF SHORELINES

Introduction

Before cleanup operations may begin, the area to be cleaned must be evaluated. This is done by determining:

- ◆ the type of shoreline,
- ◆ the degree of exposure to waves and currents,
- ◆ the associated biological sensitivity, and
- ◆ the ease of cleanup.

All of these factors are used to determine an Environmental Sensitivity Index (ESI), which ranks shoreline environments on a scale of 1 to 10. Generally speaking, areas exposed to high levels of physical energy such as wave action and tidal currents and have low biological activity rank low on the scale (1); while sheltered areas associated with high biological activity have the highest ranking (10). The shoreline ranking system provides a useful first step in the evaluation process because it identifies the priority areas that require maximum effort for protection and cleanup. The ESI is prioritized as follows with 1 being the lowest concern and 10 being the highest concern:

1. Seawalls and piers,
2. Exposed wave-cut platforms,
3. Fine-grained sand beaches,
4. Coarse-grained sand beaches,
5. Mixed sand and gravel (or shell) beaches,
6. Gravel beaches and riprap structures,
7. Exposed tidal flats,
8. Sheltered rocky shores,
9. Sheltered tidal flats,
10. Fringing and extensive salt marshes.

Seawalls and Piers

Seawalls and piers are divided into two categories:

- ◆ Exposed Wave-Cut Cliffs (1a)
 - ⌘ The intertidal zone is steep (greater than 30 degrees slope), with very little width.
 - ⌘ Sediment accumulations are uncommon and usually ephemeral (lasting a short time), since waves remove the debris that has slumped from the eroding cliffs.
 - ⌘ They are often found interspersed with other shoreline types.
-

TYPES OF SHORELINES (cont)

Seawalls and Piers (cont)

- ◆ Seawalls and Piers (1b)
 - ✘ Are particularly common in developed areas, providing protection to residential and industrial developments.
 - ✘ They are also common along inlets, urbanized areas and developed beach front sites.
 - ✘ They are composed of concrete and stone, wooden or metal bulkheads and wooden pilings.
-

Exposed Wave-Cut Platforms

- ◆ The intertidal zone consists of a flat rock bench of highly variable width.
 - ◆ The shoreline may be backed by a steep scarp or low bluff.
 - ◆ There may be a narrow, perched beach or gravel to boulder sized sediments at the base of the scarp.
 - ◆ The platform surface is irregular and tidal pools are common.
 - ◆ Small accumulations of gravel can be found in the tidal pools and crevices in the platform.
 - ◆ Pockets of sandy "tidal flats" can occur on the platform in less exposed settings.
-

Fine-Grained Sand Beaches

- ◆ These beaches are generally flat, wide and hard packed.
 - ◆ They are commonly backed by dunes or seawalls along exposed outer coasts.
 - ◆ Along sheltered bays, they are narrower, often fronted by tidal flats.
-

TYPES OF SHORELINES (cont)

Coarse-Grained Sand Beaches

- ◆ These beaches are moderate to steep, of variable width, and have soft sediment.
 - ◆ They are commonly backed by dunes or seawalls along exposed outer coasts.
-

Mixed Sand and Gravel (or Shell) Beaches

- ◆ Moderately sloping beach composed of a mixture of sand (greater than 20 percent) and gravel (greater than 25 percent).
 - ◆ The high tide berm area is usually composed of sand or fine gravel (pebbles to cobbles), whereas the lower part of the beach is coarser, with cobbles to boulders.
 - ◆ Because of the mixed sediment sizes, there may be zones of sand, pebbles or cobbles.
-

Gravel Beaches and Riprap Structures

- ◆ Gravel beaches are composed of sediment ranging in size from pebbles to boulders.
 - ◆ They can be very steep, with multiple wave built berms forming the upper beach.
 - ◆ Attached animals and plants are usually restricted to the lowest parts of the beach, where the sediment are less mobile.
 - ◆ Riprap structures are composed of cobble to boulder size rocks.
 - ◆ Riprap structures are placed for shoreline protection and inlet stabilization.
-

TYPES OF SHORELINES (cont)

Exposed Tidal Flats

- ◆ Are composed primarily of sand and mud.
 - ◆ The presence of sand indicates that the tidal or wind currents and waves are strong enough to mobilize the sediment.
 - ◆ They are always associated with another shoreline type on the landward side of the flat.
 - ◆ The sediments are water saturated, with only the topographically higher ridges drying out during low tide.
-

Sheltered Rocky Shores

- ◆ They consist of bedrock shores of variable slope (from vertical cliffs to wide rocky ledges) that are sheltered from exposure to most wave and tidal energy.
 - ◆ The wider shores may have some surface sediment, but the bedrock is the dominant substrate type.
-

Sheltered Tidal Flats

- ◆ They are composed primarily of silt and clay.
 - ◆ They are present in calm water habitats, sheltered from major wave activity and frequently fronted by marshes.
 - ◆ Wave energy is very low, although there may be strong tidal currents active on parts of the flat and in channels across the flat.
 - ◆ The sediments are very soft and cannot support even light foot traffic.
-

TYPES OF SHORELINES (cont)

Fringing & Extensive

- ◆ Marshes are intertidal wetlands containing emergent, herbaceous (relating to an herb as distinguished from a woody plant) vegetation

Salt Marshes

- ◆ Width of the marsh can vary widely, from a narrow fringe to extensive.
 - ◆ They are relatively sheltered from waves and strong tidal currents.
-

ENVIRONMENTAL CONCERNS

Introduction Establishing environmental priorities will determine the allocation of resources and dictate the actions of cleanup personnel throughout the response. When determining environmental priorities one must keep in mind the following hierarchy:

1. Human life
 2. Wildlife resources and habitats
 3. Economical impact
-

Human Life Human life concerns can be broken down into two categories: general population and on-site workers.

- ◆ General population concerns are factors which will affect the population in the immediate vicinity of the spill. These factors include:
 - ☒ Inhalation hazard, i.e. the pollutant is emitting a toxic plume. You need to know how large of an area will be affected by the plume and evaluate the need to evacuate.
 - ☒ Ingestion hazard, i.e. is there a possibility that the pollutant will affect water or food supplies.
 - ☒ Skin contact, i.e. does the pollutant pose a threat of absorption or corrosivity.
 - ☒ Flammability, i.e. is the pollutant emitting flammable vapors which pose a threat of fire.
 - ◆ On-site workers concerns are the same factors listed above, but also include:
 - ☒ Threat from wildlife in the area,
 - ☒ Hazards caused by the terrain, such as steep cliffs, and
 - ☒ Heat and cold stress.
-

WILDLIFE RESOURCES AND HABITATS (cont)

Exposed Wave-Cut Platforms

- ◆ Oil will not adhere to the rock platform but rather be transported across the platform and accumulate along the high tide line.
 - ◆ These habitats can support large populations of encrusting animals and plants with rich tidal pool communities.
 - ◆ Oil can penetrate and persist in the beach sediments, if present.
 - ◆ Persistence of oiled sediments is usually short term, except in wave shadows or larger sediment accumulations.
-

Fine- Grained Sand Beaches

- ◆ Light oil accumulations will be deposited as oily swashes or bands along the upper intertidal zone.
 - ◆ Heavy oil accumulations will cover the entire beach surface, although the oil will be lifted off the beach with the rising tide.
 - ◆ Maximum penetration of oil into fine-grained sand will be 10 centimeters (cm).
 - ◆ Burial of oiled layers by clean sands within the next few weeks will be less than 30 cm along the upper beach.
 - ◆ Upper beach fauna (animals as a whole) are scarce.
 - ◆ Organisms living in the beach sands may be killed either by smothering or by lethal oil concentrations in the water.
 - ◆ Shore birds may be killed if oiled, though they may shift to clean sites.
-

WILDLIFE RESOURCES AND HABITATS (cont)

Coarse-Grained Sand Beaches

- ◆ Light oil will be deposited primarily as a band along the high-tide line.
 - ◆ Under very heavy accumulations, oil may spread across the entire beach face, though the oil will be lifted off the lower beach with the rising tide.
 - ◆ Penetration of oil into coarse-grained sand can reach 25 centimeters (cm).
 - ◆ Burial of oiled layers by clean sands can be rapid, and up to 60 cm or more.
 - ◆ Burial over one meter deep is possible if the oil comes ashore at the start of a depositional period (the change from low to high tide).
 - ◆ Generally, species density and diversity is low.
 - ◆ Biological impacts include temporary declines in infaunal (aquatic animals living on the substrate) populations, which can also affect feeding shore birds.
-

Mixed Sand and Gravel (or Shell) Beaches

- ◆ During small spills, oil will be deposited along and above the high tide swash.
 - ◆ Large spills will spread across the entire intertidal area.
 - ◆ Oil penetration into the beach sediment may be up to 50 centimeters (cm); however, the sand fraction can be quite mobile, and oil behavior is much like on a sand beach if the sand fraction exceeds about 40 percent.
 - ◆ Burial of oil may be deep at and above the high tide line, where oil tends to persist, particularly where beaches are only intermittently exposed to waves.
 - ◆ On sheltered beaches, extensive pavements of asphalted sediments can form if there is no removal of heavy oil accumulations, because most of the oil remains on the surface.
 - ◆ Once formed, pavements are very stable and can persist for many years.
 - ◆ Oil can be stranded in the coarse sediments on the lower part of the beach, particularly if the oil is weathered or emulsified.
-

WILDLIFE RESOURCES AND HABITATS (cont)

Mixed Sand and Gravel (or Shell) Beaches (cont)

- ◆ Because of sediment mobility and desiccation (dry out) on exposed beaches, there are low densities of attached animals and plants.
 - ◆ The presence of attached algae, mussels and barnacles indicates beaches that are relatively sheltered, with the more stable substrate supporting a richer biota (animal and plant life of a particular region).
-

Gravel Beaches and Riprap Structures

- ◆ Deep penetration and rapid burial of stranded oil is likely on exposed beaches.
 - ◆ On exposed beaches, oil can be pushed over the high tide and storm berms, pooling and persisting above the normal zone of wave wash.
 - ◆ Long term persistence will be controlled by the depth of penetration versus the depth of routine reworking by storm waves.
 - ◆ On relatively sheltered beaches, formation of asphalt pavements is likely where accumulations are heavy.
 - ◆ On riprap structures, deep penetration of oil between the boulders is likely.
 - ◆ If oil is left uncleaned, it may become asphaltized.
 - ◆ Biota (animal and plant life of a particular region) on the riprap may be plentiful and varied.
 - ◆ Resident fauna (animals as a whole) and flora (plants as a whole) may be killed by the oil.
-

Exposed Tidal Flats

- ◆ Oil does not usually adhere to the surface of exposed tidal flats, but rather moves across the flat and accumulates at the high tide line.
 - ◆ Deposition of oil on the flat may occur on falling tide if concentrations are heavy.
 - ◆ Oil does not penetrate the water saturated sediments.
-

WILDLIFE RESOURCES AND HABITATS (cont)

Exposed Tidal Flats (cont)

- ◆ Biological utilization can be very high, with large numbers of infauna (aquatic animals living on the substrate) and heavy use by birds for roosting and foraging (rummage through for food).
 - ◆ Biological damage may be severe, primarily to infauna (aquatic animals living on the substrate), thereby reducing food sources for birds and other predators.
-

Sheltered Rocky Shores

- ◆ On rocky shores, oil will adhere readily to the rough rocky surface, particularly along the high tide line, forming a distinct oil band.
 - ◆ Fractures in the bedrock will be sites of pooling and oil persistence.
 - ◆ Even on wide ledges, the lower intertidal zone usually stays wet (particularly when algae covered), preventing oil from adhering to the rock surface.
 - ◆ Heavy and weathered oils can cover the upper zone with little impacts to the rich biological communities of the lower zone.
 - ◆ Where surface sediments are abundant, oil will penetrate into the crevices formed by the surface rubble and pool at the contact of the sediments and the surface.
 - ◆ Where the rubble is loosely packed, oil will penetrate deeply, causing long term contamination of the subsurface sediments.
 - ◆ Species density and diversity vary greatly, but barnacles, snails, mussels, clams, periwinkles (a small marine snail), amphipods (beach fleas), polychaetes (marine worm), rockweed and crabs are often very abundant.
 - ◆ Fresh oil and light refined products have high acute toxicities that can affect attached organisms after even short exposures.
-

Sheltered Tidal Flats

- ◆ Oil does not usually adhere to the surface of sheltered tidal flats, but rather moves across the flat and accumulates at the high tide line.
 - ◆ Deposition of oil on the flat may occur on a falling tide if concentrations are heavy.
-

WILDLIFE RESOURCES AND HABITATS (cont)

Sheltered Tidal Flats (cont)

- ◆ Oil will not penetrate the water saturated sediments at all.
 - ◆ In areas of high suspended sediments, sorption of oil can result in contaminated sediments that can be deposited on the flats.
 - ◆ There are usually large populations of clams, worms and snails.
 - ◆ Bird life is seasonally abundant.
 - ◆ Biological damage may be severe.
-

Fringing & Extensive Salt Marshes

- ◆ Oil adheres readily to marsh vegetation.
 - ◆ The band of coating will vary widely, depending upon the tidal stage at the time oil slicks are in the vegetation. There may be multiple bands.
 - ◆ Resident flora (plants as a whole) and fauna (animals as a whole) are abundant and consist of numerous species.
 - ◆ Marshes provide a nursery ground for numerous fish species.
 - ◆ Bird life is seasonally abundant.
 - ◆ Large slicks will persist through multiple tidal cycles and coat the entire stem from the high tide line to the base.
 - ◆ If the vegetation is thick, heavy oil coating will be restricted to the outer fringe, with penetration and lighter oiling to the limit of tidal influence.
 - ◆ Medium to heavy oils do not readily adhere or penetrate the fine sediments, but they can pool on the surface and in burrows.
 - ◆ Light oils can penetrate the top few centimeter of sediment and deeply into burrows and cracks (up to one meter).
-

ECONOMICAL IMPACT

Introduction

Every oil spill has the potential to effect local economies and can be categorized into three areas:

- ◆ Public Access
 - ◆ Commercial Harvest
 - ◆ Other Trades
-

Public Access

When oil has polluted populated regions or areas of recreational use, priorities and pressure for cleanup differ from remote or uninhabited coastline areas because of:

- ◆ Local business or boardwalks,
- ◆ Seasonal recreation such as water skiing or surfing,
- ◆ Historical tourist sites, or
- ◆ Scheduled events in the area.

In these cases, the time required for removal of oil by natural processes may be unacceptable and active cleanup action may be required.

Commercial Harvest

In some situations, shoreline areas are considered particularly sensitive to oil and the priority will be to protect these areas based on productivity. Such areas include:

- ◆ Kelp beds,
 - ◆ Coral reefs,
 - ◆ Submerged aquatic vegetation,
 - ◆ Anadromous (migrate up river from the sea to breed) fish spawning streams,
 - ◆ Shellfish seed beds, and
 - ◆ Crab, shrimp and lobster nursery areas.
-

Other Trades

Sometimes during an oil spill cleanup, it may become necessary to close off areas close to shore to prevent oil from damaging private property such as recreational boats or to prevent traffic from entering the spill site causing further contamination. Other trades that may be affect by this are:

- ◆ Marinas,
 - ◆ Marine transport such as freight or tank ships,
 - ◆ Maritime facilities, and
 - ◆ Log storage areas.
-

COMMONLY USED CLEANUP METHODS

Introduction

Methods of cleanup will greatly depend on the type of shoreline, access to the area and type of equipment available in the area. Based on the ESI, we can break down the types of shorelines into four categories:

- ◆ Rocks,
 - ◆ Cobble Stone,
 - ◆ Sand Beaches, and
 - ◆ Marshes.
-

Rocks

Methods of cleaning rough or porous surfaces such as rocks, boulders or man-made structures are:

- ◆ Steam cleaning or high pressure washing. When using this method, oil may be flushed down into a boom area at the water edge and collected by a skimmer or vacuum truck.
 - ◆ Dispersants can sometimes assist in the removal of oil, although their use should be restricted to areas where water movement will allow for rapid dilution to prevent damage to sensitive marine life. Stains can be removed by brushing dispersants into the oil or by applying it as a gel and then hosing off the oil/dispersant mixture.
-

Cobble Stone

Methods of cleaning cobble stone and pebbles are:

- ◆ High pressure flushing: This can be used to flush surface oil to the water's edge, but some of the oil will be driven into the beach. This will cause oil to leak out slowly, producing a sheen in the area over a period of weeks or longer.
 - ◆ Removal of oily stones: This is rarely practical and will usually only be possible if tracked front end loaders can be used. Stone removal should only be used if it is certain that it will not cause serious erosion.
 - ◆ Masking: This is another approach which might be used in locations subject to winter storms. Stones from higher up the beach are used to cover the oiled area, thereby providing a clean surface during the summer for those using the beach. This can only be used where the beach is moderately oiled.
-

COMMONLY USED CLEANUP METHODS (cont)

Sand Beaches

Very often, sand beaches are regarded as a valuable resource and priority is given to cleaning them. Methods of cleaning sand beaches are:

- ◆ **Mechanical equipment:** Recreation beaches often have good access, allowing mechanical equipment to be used to remove bulk oil and sand relatively easy, but a desire to clean them quickly can lead to difficulties. Coarse sand beaches are frequently unable to support any vehicle without its wheels or tracks sinking into the sand, causing oil to be mixed further into the beach.
- ◆ **Flooding:** Oil can be released from coarse grained sand by passing high volumes of water through sections of the beach. Sea water is drawn through a high capacity pump and distributed through a number of hoses at low pressure. By directing the water into a small area of beach, oil can be floated out and flushed to the waters edge for collection. This method is slow and limited to the treatment of small areas at a time.
- ◆ **Dispersants:** After most of the contaminated beach material has been removed, that remaining is likely to be very greasy and discolored. This is not usually sufficiently cleaned for recreation beaches. Dispersants can be used by applying the dispersant to the affected beach area and allowing it to sit for 30 minutes before being washed by the incoming tide or hosing down with sea water.

Marshes

Methods of cleaning marshes are:

- ◆ **Low pressure flushing:** This can be used to flush surface oil to open water where it can be contained in a boom and collected.
- ◆ **If birds are threatened,** cutting and removing oiled vegetation might be considered, but must be balanced against long term damage

Whenever possible, it is preferable to allow oil on this type of shoreline to weather naturally, particularly where it has been washed up into the vegetation. It has often been found that activities intended to clean pollution causes more damage than the oil itself.

RECOMMENDED RESPONSE ACTIVITY

Introduction

Once the priorities have been established and all environmental concerns have been addressed, shoreline cleanup can start. Shoreline cleanup is usually required in three stages:

- ◆ Stage I – Removal of heavy contamination and floating oil;
- ◆ Stage II – Cleanup of moderate contamination, such as, stranded oil and oiled beach material; and
- ◆ Stage III – Cleanup of lightly contaminated shoreline and removal of stains.

The recommended response activity will depend on the ESI and the following types of shorelines:

1. Seawalls and piers
 2. Exposed wave-cut platforms
 3. Fine-grained sand beaches
 4. Coarse-grained sand beaches
 5. Mixed sand and gravel (or shell) beaches
 6. Gravel beaches
 7. Exposed tidal flats
 8. Sheltered rocky shores
 9. Sheltered tidal flats
 10. Fringing and extensive salt marshes
-

Seawalls and Piers

Exposed Wave-Cut Cliffs (1a)

- ◆ Cleanup is usually not required.
- ◆ Access can be difficult and dangerous.

Seawalls and Piers (1b)

- ◆ High pressure spraying may be required in order to:
 - ☒ remove oil;
 - ☒ prepare substrate for recolonization of barnacles and oyster communities;
 - ☒ minimize aesthetic damage; and
 - ☒ prevent the chronic leaching of oil from the structure.
-

RECOMMENDED RESPONSE ACTIVITY (cont)

Exposed Wave-Cut Platforms

- ◆ Cleanup is usually not required.
 - ◆ Where the high tide area is accessible, it may be feasible to remove heavy oil accumulations and oiled debris.
-

Fine-Grained Sand Beaches

- ◆ These beaches are among the easiest beach types to clean.
 - ◆ Cleanup should concentrate on the removal of oil from the upper swash zone after all oil has come ashore.
 - ◆ Removal of sand from the beach should be minimal to avoid erosion problems; special caution is necessary in areas backed by seawalls.
 - ◆ Activity through both oiled and dune areas should be severely limited to prevent contamination of clean areas.
 - ◆ Manual cleanup, rather than road graders and front-end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal.
 - ◆ All efforts should focus on preventing the mixture of oil being pushed deeper into the sediments by vehicular and foot traffic.
-

Coarse-Grained Sand Beaches

- ◆ Remove oil primarily from the upper swash lines.
 - ◆ Removal of sediment should be limited to avoid erosion problems.
 - ◆ Mechanical reworking of the sediment into the surf zone may be used to release the oil without removal.
 - ◆ Activity in the oiled sand should be limited to prevent mixing oil deeper into the beach.
 - ◆ Use of heavy equipment for oil/sand removal may result in the removal of excessive amounts of sand; manual cleanup may be more effective.
-

RECOMMENDED RESPONSE ACTIVITY (cont)

Mixed Sand and Gravel (or Shell) Beaches

- ◆ Remove heavy accumulations of pooled oil from the upper beach face.
 - ◆ All oil debris should be removed.
 - ◆ Sediment removal should be limited as much as possible.
 - ◆ Low pressure flushing can be used to float oil away from the sediment for recovery by skimmers or sorbents.
 - ◆ High pressure spraying should be avoided because of potential for transporting the finer sediment (sand) to the lower intertidal or subtidal zones.
 - ◆ Mechanical reworking of oiled sediment from the high tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity. However, oiled sediment should not be relocated below the mid tide zone.
 - ◆ In place tilling may be used to reach deeply buried oil layers in the mid beach on exposed beaches.
-

Gravel Beaches and Riprap Structures

- ◆ Heavy accumulations of pooled oil should be quickly removed from the upper beach.
 - ◆ All oiled debris should be removed.
 - ◆ Sediment removal should be limited as much as possible.
 - ◆ Low to high pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents. Low to high pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents.
 - ◆ Mechanical reworking of oiled sediment from the high tide zone to the upper intertidal zone can be effective in areas regularly exposed to wave activity. However, oiled sediments should not be relocated below the mid tide zone.
 - ◆ In place tilling may be used to reach deeply buried oil layers in the mid beach on exposed beaches.
 - ◆ It may be necessary to remove heavy oiled riprap and replace it.
-

RECOMMENDED RESPONSE ACTIVITY (cont)

Exposed Tidal Flats

- ◆ Currents and waves can be very effective in natural removal of the oil.
 - ◆ Cleanup is very difficult (and possible only during low tides).
 - ◆ The use of heavy machinery should be restricted to prevent mixing of oil into the sediments.
 - ◆ On sand flats, oil will be removed naturally from the flat and deposited on the adjacent beaches where cleanup is more feasible.
-

Sheltered Rocky Shores

- ◆ Low to high pressure spraying at ambient water temperatures is most effective when the oil is fresh.
 - ◆ Extreme care must be taken not to spray in the biological rich lower intertidal zone or when the tidal level reaches that zone.
 - ◆ Cutting of oiled, attached algae is not recommended; tidal action will eventually float this oil off, so sorbent boom should be deployed.
-

Sheltered Tidal Flats

- ◆ These are high priority areas necessitating the use of spill protection devices to limit oil spill impact; deflection or sorbent booms and open water skimmers should be used.
 - ◆ Cleanup of the flat surface is very difficult because of the soft substrate and many methods may be restricted.
 - ◆ Manual operations and deployment of sorbents from shallow draft boats may be helpful.
-

RECOMMENDED RESPONSE ACTIVITY (cont)

Fringing & Extensive Salt Marshes

- ◆ Under light oiling, the best practice is to let the area recover naturally.
 - ◆ Heavy accumulations of pooled oil can be removed by vacuum, sorbents or low pressure flushing. During flushing, care must be taken to prevent transporting oil to sensitive areas down slope or along shore.
 - ◆ Cleanup activities should be carefully supervised to avoid vegetation damage.
 - ◆ Any cleanup activity must not mix the oil deeper into the sediments. Trampling of the roots must be minimized.
 - ◆ Cutting of oiled vegetation should be considered when other resources present are at great risk from leaving the oiled vegetation in place.
-

RCRA

Background

RCRA – Resource Conservation and Recovery Act remodeled solid waste management and added hazardous waste management in 1976. RCRA was expanded significantly in 1984 by the Hazardous and Solid Waste Amendments. RCRA has basically three goals:

- ◆ Protect human health and the environment.
- ◆ Reduce the amount of waste and conserve energy and natural resources.
- ◆ Reduce or eliminate generation of hazardous waste as expeditiously as possible.

RCRA can be divided into four separate, but interrelated, programs. They are:

- ◆ Solid Waste Program (Subtitle D)
- ◆ Hazardous Waste Program (Subtitle C)
- ◆ Underground Storage Tank Program (Subtitle I)
- ◆ Medical Waste Program (Subtitle J)

The objectives of Subtitle C (hazardous Waste Programs) are to control or manage hazardous waste from generation to disposal; i.e. from "cradle to grave."

Solid Waste Definition

The following are considered to be solid waste:

- ◆ Garbage
- ◆ Refuse
- ◆ Sludge
- ◆ Any other discarded material including solid, semisolid, liquid, or contained gaseous material. Not all solid waste is actually solid.

The following materials are not considered to be solid wastes:

- ◆ Domestic sewage
 - ◆ Industrial wastewater discharges
 - ◆ Irrigation return flows
 - ◆ Nuclear materials
-

RCRA (cont)

Hazardous Waste Definition

A Hazardous Waste is a solid waste that is not excluded, and meets one of the following criteria:

- ◆ Exhibits any of the following characteristics of a hazardous waste:
 - ☒ Corrosivity
 - ☒ Reactivity
 - ☒ Ignitability
 - ☒ Toxicity

- ◆ Is named and listed as a hazardous waste in regulation:
 - ☒ Nonspecific Source Waste (40 CFR 261.31) i.e. Dioxin wastes
 - ☒ Specific Source Waste (40 CFR 261.32) i.e. Wastewater treatment sludge from pigment production
 - ☒ Commercial Chemical Products (40 CFR 261.33) i.e. Chloroform, DDT

- ◆ Is a mixture containing a listed hazardous waste and a non-hazardous solid waste.

Note

Used oil, i.e. recovered oil and oily debris destined for disposal, is not listed as a hazardous waste. However, if the oil exhibits any of the characteristics of a hazardous waste, i.e. corrosivity, reactivity, ignitability, or toxicity, then it meets the definition of a hazardous waste and full RCRA requirements apply.

DISPOSAL OF OIL

Background

The disposal of recovered oil and oily debris from spill response operations has traditionally been one of the most difficult aspects of a response. Disposal options for oil and oily debris should be researched for your area during the planning process. Various oil disposal options consist of:

- ◆ Recycling
 - ◆ In-Situ Burning
 - ◆ Incineration
 - ◆ Landfills
 - ◆ Land Farming
-

Recycling

The recycling of used oil is the preferred method of disposing waste oil recovered from spill response operations. Recycling includes using recovered oil to be blended with fuel oils for burning and for use in asphalt batching. Used oil destined for recycling or burning for energy recovery should be subject to a system of management standards, which are somewhat more lenient than full waste requirements. These standards consist of:

- ◆ Labeling all used oil storage tanks and containers as "Used Oil";
 - ◆ Clean up any used oil spills or leaks;
 - ◆ Use only transporters with EPA ID numbers when shipping off-site; and
 - ◆ Track used oil shipments.
-

In-Situ Burning

In-Situ burning is the burning of oil and oily debris on-site in lieu of attempting recovery. In cases where marshes or other environmentally sensitive areas have been impacted, in-situ burning may be the only feasible response option. However, before in-situ burning can take place, approval, or in some cases even a permit, must be obtained from the state.

Incineration

High temperature incineration can generate the high temperatures needed for the total combustion of oily waste. This incineration usually takes place at permitted TSD (Temporary Storage Disposal) facilities, but portable incinerators have been developed for on-site use. Incineration can be a costly disposal option, but may be preferred over landfill disposal.

DISPOSAL OF OIL (cont)

Landfills

Although landfills are still a common disposal method, their use is becoming increasingly difficult due to many states now regulating recovered oil and oily debris as a hazardous waste. In any case, recovered oily debris destined for a landfill site must be free of any free standing liquids that may separate from the solid debris.

Land Farming

Land farming is the spraying of recovered oil in a fine mist over a large area of land and then tilling the oil into the soil. Although it may take up to three years for the oil to break down in the soil, nutrients such as ammonium phosphate can be applied to enhance this process. The option is only feasible for small spills as the amount of land required is significant, the land should have low value, and has to be located away from potable water supplies.

State Law

In selecting any disposal option, it is important to consult with state environmental representatives to ensure the disposal option you wish to use is acceptable and within state law requirements.

HAZARDOUS WASTE HANDLERS

Introduction RCRA Subtitle C regulates three categories of hazardous waste handlers. They are:

- ◆ Generators
 - ◆ Transporters
 - ◆ Treatment Storage and Disposal Facilities (TSDFs)
-

Generator Definition

Generators are the first link in the "Cradle to Grave" chain of hazardous waste management. A generator is any owner, operator, or person who first creates a hazardous waste or the person who makes the waste subject to subtitle C regulation. There are three categories of generators:

- ◆ **Large Quantity** – Creates a quantity of waste greater than 1,000 kg per month or greater than 1 kg per month of acutely hazardous waste.
 - ◆ **Small Quantity** – Creates a quantity of waste greater than 100 kg per month and less than 1 kg per month of acutely hazardous waste.
 - ◆ **Conditionally Exempt** – Creates a quantity of waste less than 100 kg per month and less than 1 kg per month of acutely hazardous waste.
-

Generator Requirements

Large and small generators must comply with the regulations found in 40 CFR 262. These regulations require that they:

- ◆ Determine that a solid waste is hazardous;
 - ◆ Obtain an EPA Identification Number;
 - ◆ Prepare the waste for transportation IAW 49 CFR;
 - ◆ Follow accumulation and storage requirements;
 - ◆ Meet record-keeping and reporting requirements; and
 - ◆ Properly manifest the shipment IAW 40 CFR 262, using a hazardous waste manifest.
-

Hazardous Waste Manifest

Uniform hazardous waste manifesting is the key to managing hazardous waste "from the cradle to the grave." Through the use of manifests, generators can track the movement of the waste from the point of generation to the point of ultimate treatment, storage, or disposal. The manifest must contain the following information:

HAZARDOUS WASTE HANDLERS (cont)

Hazardous Waste

- ◆ Name and EPA ID number of the generator, transporter, and TSD facility;

Manifest

- ◆ The proper DOT shipping description of the waste;
- ◆ The address of the TSD facility; and
- ◆ The Hazardous and Solid Waste Amendments certification.

NOTE: If a Federal, state or local official determines that the immediate removal of a waste is necessary to protect human health or the environment, the official can authorize waste removal without the use of the manifest by a transporter lacking an EPA ID number.

HAZARDOUS WASTE HANDLERS (cont)

Transporter Definition

A Transporter is any person engaged in the off-site transportation of manifested hazardous waste by air, rail, highway, or water, and is the critical link between the generator and the TSD facility.

Transporter Requirements

Transporters must meet the requirements found in 40 CFR 263. These requirements include:

- ◆ Obtaining an EPA Identification number;
 - ◆ Complying with the manifesting system; and
 - ◆ Handling of accidental hazardous waste discharges.
 - ◆ In addition, all transporters must meet the requirements of each State that they intend to travel through.
-

Accidental Releases

If an accidental release of a hazardous waste occurs during transportation, the transporter must:

- ◆ Take immediate action to protect health and the environment;
 - ◆ Notify the National Response Center;
 - ◆ Notify the Center for Disease Control if the release involves a disease causing agent; and
 - ◆ File a report with the DOT within 15 days of the release.
-

TSD Facilities

A TSD facility is a permitted facility that accepts hazardous waste for treatment, storage, or disposal; i.e. landfills and high-temperature incinerators. It is the final link in the "cradle to grave" management system. A TSD facility must meet extensive requirements under 40 CFR 264 that outline design and operating criteria as well as performance standards. In addition, a TSD facility must:

- ◆ Return the manifest to the generator, completing the manifest loop;
 - ◆ Ensure that the waste described on the manifest is the waste actually on the truck; and
 - ◆ Keep operating records, make biennial reports, submit reports on releases, groundwater monitoring results, and closures.
-

RCRA PENALTIES

Civil A generator, transporter or TSD facility found not to be in compliance with applicable RCRA regulations may be fined up to \$25,000 per day of continued noncompliance.

Criminal Any violator who knowingly generates transports, treats, stores, or disposes of any hazardous waste in violation of RCRA is subject to a fine of not more than \$50,000 for each day of violation to a maximum of \$1,000,000, or imprisonment not to exceed five years, or both.

Federal Facilities In accordance with the Federal Facilities Compliance Act passed in October 1992:

- ◆ States can fine and penalize federal facilities for violations of solid and hazardous waste laws.
- ◆ Federal employees are protected from civil penalties when acting within scope of their duties.
- ◆ Federal employees are subject to criminal penalties for knowingly violating laws regarding responsible waste handling practices.

Note In criminal prosecutions, typically the government will not provide legal representation because conduct which forms the basis for criminal charges is almost always found to have been committed outside the scope of duty.

TAB C OVERVIEW

Introduction

You may encounter various types of oils and petroleum products during pollution response activities. It is imperative that you become familiar with the physical, chemical, and toxic properties of oil and how these properties change when oil is released into the environment. The physical and biological effects of an oil spill as well as the behavior of the slick and the efficiency of various cleanup methods are strongly influenced by the type of oil spilled. The properties of the oil will help you to determine the oil's potential health hazards along with the most practical cleanup techniques in order to develop an effective response plan and, more importantly, to take the proper safety precautions for yourself and the people that work for you.

Outline

This lesson is designed to give you a general overview of:

Sources and Composition of Oil

- ◆ Chemical composition of Oil
- ◆ Crude Oils
- ◆ Sources of spill

Physical and Chemical Properties of Oil

- ◆ Introduction
- ◆ Boiling Point
- ◆ Viscosity
- ◆ Specific Gravity
- ◆ Melting point

Toxic Properties of Oil

- ◆ Introduction
- ◆ Benzene content
- ◆ Sulfur content
- ◆ Skin hazards

Weathering Processes of Oil

- ◆ Background
 - ◆ Illustration
 - ◆ Spreading
 - ◆ Evaporation
 - ◆ Emulsification
 - ◆ Dispersion
-

SOURCES AND COMPOSITION OF OIL

Chemical Composition of Oil

Petroleum Oil is composed of hydrogen and carbon linked in many different forms of chains and rings (petroleum hydrocarbons) and may also contain small amounts of oxygen, sulfur, nitrogen, and mineral salts. These complex chains determine the physical, chemical, and toxic properties of the oil.

Crude Oils

Crude oils are the most chemically complex type of petroleum oils. Hundreds of different chemicals are found in any crude oil and each oil well produces its own unique blend of these chemicals. Crude oils are source oils used to produce, through distillation, many other refined oils and petroleum products including:

So in essence crude oils contain the chemical characteristics of many oils.

- ◆ Gasoline
 - ◆ Jet fuel (JP4)
 - ◆ Naphthas
 - ◆ Kerosene
 - ◆ Diesel fuel oils (#2 fuel oil)
 - ◆ Fuel Oils (Bunker C and #6 fuel oil)
 - ◆ Lubricating oils
 - ◆ Residuum (asphalts, tar)
-

Sources of Oil Spills

An estimate of the total petroleum oil introduced into the environment (land, sea and air) is about 3.2 million metric tons (25,600,000 barrels) per year. The biggest contribution comes from land sources such as industrial and municipal wastes. There are six major ways oil enters the environment:

- ◆ Industrial discharges and city runoff (37%)
 - ◆ Vessel operations (operational discharges of oily slops) (33%). These are cargo residues dumped, both legally and illegally, during tank cleaning and de-ballasting operations, as well as discharges of oily bilge water and fuel oil sludges. These can be controlled by strict management practices and regulatory requirements. That is why we have MARPOL ANNEX I "Vessel and Facility Requirements". We also need adequate shore reception facilities for these slops.
-

SOURCES AND COMPOSITION OF OIL (cont)

Sources of Oil Spills (cont)

- ◆ Tanker accidents during routine operations and collisions/groundings (12%) (loading, discharging and bunkering)
 - ◆ Atmosphere (9%) The main portion can be linked to exhaust fumes from road vehicles.
 - ◆ Natural sources (seepage and erosion) (7%) Seeps are associated with areas of tectonic activity (This is the structural deformation in the earth's crust caused by the constant shifting of the earth's plates.)
 - ◆ Offshore oil exploration and production (2%)
 - large release (blowouts)
 - small release (disposal of oil-based drilling muds)
-

PHYSICAL AND CHEMICAL PROPERTIES OF OIL

Introduction

Crude oils of different origins have a wide range of physical and chemical properties, whereas the refined oil products have more well-defined properties irrespective of the crude oil from which they are derived. Physical and chemical properties of petroleum oil defined and discussed below include:

- ◆ Boiling Point
 - ◆ Viscosity
 - ◆ Specific Gravity
 - ◆ Melting Point
-

Boiling Point

Boiling Point is the temperature at which a liquid boils. Low boiling point liquids are more volatile and will evaporate faster. Crude oil can be separated into its chemical components (cuts in a fractional distillation column based on the boiling points of these components). As the temperature of the crude oil is raised, different components reach their boiling point and in turn are distilled out, with the lower boiling point components rising towards the top of the column and the higher boiling point components settling towards the bottom of the column.

Note:

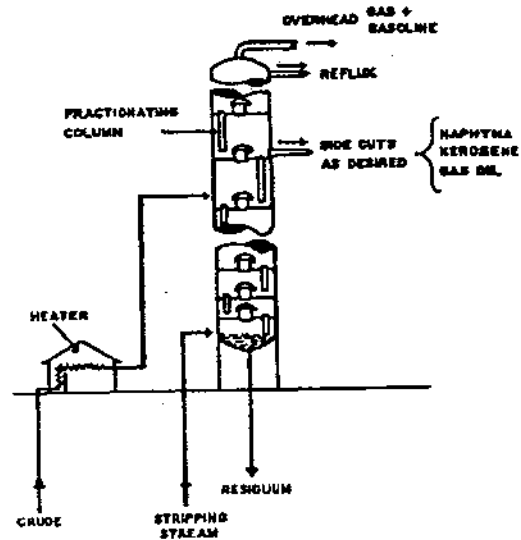
The boiling point is what separates the crude into different refined oils.

PHYSICAL AND CHEMICAL PROPERTIES OF OIL (cont)

Illustration The illustration below shows a fractional distillation column.

Low boiling points = light ends
(Gasoline)

High Boiling Pt. = Low Ends
(Asphalt)



Example

The hazards of a cleanup can be indicated by the boiling point of a product. Gasoline has a low boiling point and is more hazardous than asphalt which has a high boiling point.

Viscosity

Viscosity is a measurement of a liquid's resistance to flow. High viscosity oils flow with difficulty while those with low viscosities are highly mobile. Viscosity is affected by ambient water and air temperature. As the temperatures increases, viscosity decreases. Some examples are:

- ◆ Water – Low viscosity
- ◆ Honey – Hi viscosity
- ◆ Gasoline – Low viscosity
- ◆ #6 fuel oil – Hi viscosity

PHYSICAL AND CHEMICAL PROPERTIES OF OIL (cont)

Viscosity (cont)

Units for viscosity vary based on measurement method, but are commonly reported as centistokes (cST) at 38° C (100.4° F). Viscosity is an important property for determining appropriate oil recovery techniques.

Example:

What type of sorbent materials would be better to use on a spill? Absorbents distribute the material taken up throughout the body of the absorbing material. They work better on light to medium viscosity oils.

Adsorbents distribute the material on the surface of the adsorbing material. It is generally considered that adsorbents work better on high viscosity oils.

Specific Gravity (S.G.)

Specific Gravity represents a liquid's density in relation to pure water and has no unit.

Note

The specific gravity of water is 1.0.

- ◆ S.G. < 1.0 Oil floats on water
 - ◆ S.G. > 1.0 Oil sinks in water
-

Melting Point

Melting point represents the temperature below which an oil will not flow due to its paraffin wax content. The greater the wax content, the higher its Melting point. Melting point reveals the physical state of the oil. (liquid or solid)

Melting point tells us whether the oil will act as a solid or a liquid.

Melting point is one of the most important properties in terms of impact to the shoreline and subsequent cleanup techniques.

Note

If ambient temperature < Melting point, oil will behave as solid/semi - solid. This will prevent an oil such as # 6 heating oil from dispersing and cleanup may consist of using pitchforks and shovels to remove the product from the water.

Melting point also determines the pumping temperatures needed for moving the oil through a pipeline or transfer system.

Example

Heavy oils with high Melting points such as asphalt need to be heated via steam lines to be transferred from a ship to a facility.

TOXIC PROPERTIES OF OIL

Introduction

Petroleum oils may pose health hazards through inhalation or skin contact due to the toxicity of any chemical components within the oil. This is why we must consider the use of personal protective equipment (tyvek suits and respirators) for the safety of cleanup personnel. The most common toxic properties of petroleum oil defined and discussed below are:

- ◆ Benzene content
 - ◆ Sulfur content
 - ◆ Skin hazards
-

Benzene Content

Different petroleum oils contain varying concentrations of liquid benzene as a chemical component. Benzene is an inhalation hazard at certain oil spills because it has a high vapor pressure relative to very low exposure limits and it is a known human carcinogen. This is another reason we would want to check the atmosphere we will be working in and wear the appropriate personal protective equipment to ensure our safety.

Sulfur Content

Sulfur content reveals important toxicity hazards about the oil; specifically, hydrogen sulfide hazards. The amount of sulfur (by weight percentage) in a crude oil determines whether it is labeled as "sweet" or "sour" crude oil:

- ◆ Sweet crude has a Low sulfur content and
- ◆ Sour crude has a High sulfur content

Sour crude oils pose a serious health hazard because the High sulfur components generate toxic hydrogen sulfide gas which has an odor of rotten eggs. A human's nose can become desensitized after initial inhalation of hydrogen sulfide, making it extremely hazardous. Once we stop smelling it, we do not realize we are still being exposed to its toxic effects.

NOTE

Measuring devices like a Draeger Multi Gas Detector and detection tubes that determine the presence of hydrogen sulfide gas are critically important so we can take the proper safety measures such as wearing a respirator or other personal protection.

RULE OF THUMB

>2% SULFUR = SOUR CRUDE
5% - 6% SULFUR = HIGH SOUR CRUDE

TOXIC PROPERTIES OF OIL (CONT)

Skin Hazards

Crude oils and certain oils (asphalts and tar) contain several chemical solvents considered to be "defatting agents." These chemicals in essence remove the natural oils in our skin and cause it to dry out, crack and peel. This is a very painful. When these solvents contact the skin they can cause direct skin irritation leading to painful damage known as "contact dermatitis." These oils also contain chemical compounds of hydrocarbons known to cause skin cancer upon prolonged or repeated (chronic) contact with the skin. This carcinogenic process may be accelerated greatly by exposure to ultraviolet rays from the sun, which underscores the need for workers to have adequate skin protection on cleanups to prevent exposure to this type of potential cancer causing agent. This would include the use of tyvec suits and gloves.

WEATHERING PROCESSES OF OIL

Background

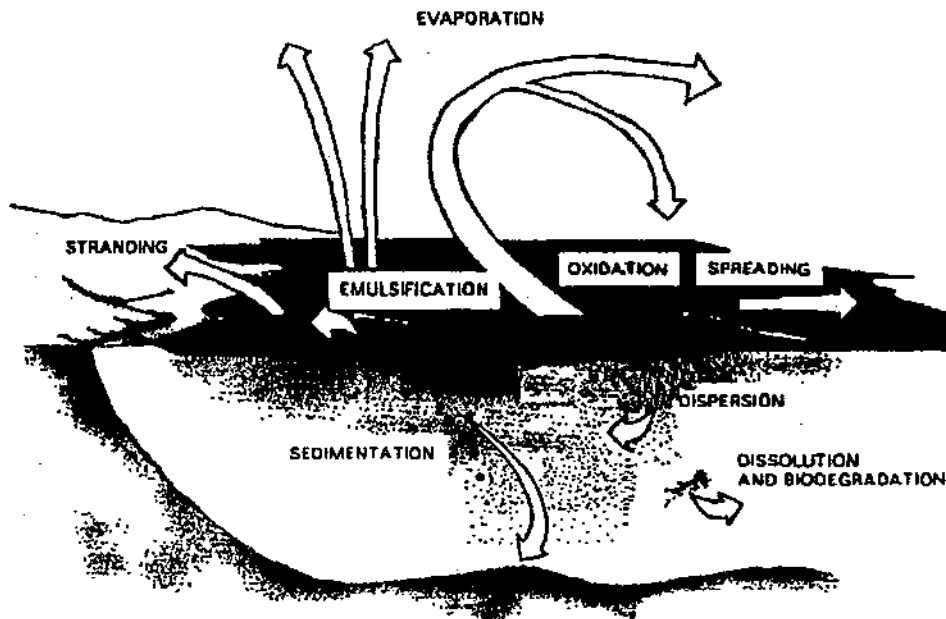
Weathering of oil represents the physical and chemical processes which oil undergoes upon release into the environment. The most important weathering processes for a responder to understand during the early stages of an oil spill include:

- ◆ Spreading
- ◆ Evaporation – (Most predominant for short term duration)
- ◆ Emulsification
- ◆ Dispersion

Oxidation, sedimentation, dissolution, and biodegradation are long-term weathering processes which determine the ultimate fate of oil.

Illustration

The illustration below shows the weathering processes.



WEATHERING PROCESSES OF OIL (CONT)

Spreading

Spreading is one of the most significant processes during the early stages of a spill. It is dependent on the oil's weight, viscosity, melting point, as well as the weather and sea state. High viscosity oils spread very slowly and those spilled at temperatures below their melting point barely spread at all. Low viscosity oils spread rapidly. After a few hours, the slick begins to break up and form narrow bands parallel to the wind direction. At this stage, the fluidity of the oil becomes less important since further spreading is primarily due to winds, weather and turbulence at the sea surface. It should be appreciated that except in the case of small spills of low viscosity oils, spreading is not uniform and large variations of oil thickness occur within the slick.

Example:

A large quantity of oil spilled at a fast rate will spread more rapidly than a large quantity of oil spilled at a slow rate,

Note:

Time is an important factor in cleanup operations. As more time elapses, the amount of recoverable oil becomes less and less because of spreading.

Evaporation

Evaporation accounts for the largest proportion of volumetric loss of oil after a spill. It is the single most important weathering process that affects the oil's characteristics. The following are influencing factors that affect evaporation rates:

- ◆ Higher API gravity oils have higher evaporation rates due to higher concentration of low boiling point volatile components [light ends](gasolines, kerosenes, benzene).
- ◆ The greater the oil spread rate, the greater the evaporation rate due to larger oil surface area.
- ◆ The greater the seas and wind speeds, the greater the evaporation rate.
- ◆ The greater the ambient temperatures, the greater the evaporation rate.

Note

It is estimated that approximately 30% – 80% of spilled product can be lost to evaporation. A higher % is lost by light crudes, gasolines etc.. A lower % is lost by heavy crudes and heavy refined oils like #6 oil, etc..

WEATHERING PROCESSES OF OIL (CONT)

Emulsification Many oils tend to absorb and mix with water to form emulsions which can increase the total amount of pollutant by a factor between 3 and 4. Such emulsions possess a high viscosity and thus retards the other processes which would dissipate the oil. Rough sea conditions increase the emulsification process. This causes a change in the original oil's properties. Absorption of water usually results in black oil changing color to brown, orange or yellow. As the amount of water absorbed increases, the density of the emulsion approaches that of sea water.

Note This can effect the type of cleanup method used to remove the oil from the water.

Example Sorbents do not work well on emulsified oil because of the oil water mixture. You would be better off employing skimmers and vacuum trucks to remove the oil water mixture.

Dispersion Dispersion occurs when waves and turbulence at the sea surface act on the slick to produce oil droplets with a range of sizes. Small droplets remain in suspension while the larger ones rise back to the surface where they reform the slick. Droplets small enough to remain in suspension become mixed in the water column and the increased surface area presented by this dispersed oil can enhance other long term processes such as biodegradation and sedimentation. Rough sea conditions (breaking waves) increase the rate of natural dispersion. High viscosity oils or those that form stable emulsions tend to form thick lenses on the water surface and show little tendency to disperse. They can persist for several weeks. Low viscosity oils which remain fluid and can spread unhindered may disperse completely in moderate sea conditions within a few days.

Note This effects recovery in that:

- ◆ If we are dealing with a low viscosity oil and the cleanup effort is not immediate, there will be very little if any oil to recover.
- ◆ If it is a high viscosity oil that is spilled even though some time has elapsed, there may still be a fair amount of oil to recover.

The end result is that dispersion hinders cleanup efforts and makes time an important factor in cleanup efforts.
