# CHAPTER 3

# CHARACTERISTICS OF SPILLS

## 3.1. INTRODUCTION

This chapter identifies the types of oil and hazardous substances (HS) used by the Navy; sources and causes of spills; potential impacts of an oil or HS spill; and, typical deficiencies in oil and HS storage and transfer equipment, spill control equipment, and operational procedures which often lead to a spill.

## 3.2. CHARACTERISTICS OF OIL AND HAZARDOUS SUBSTANCES

The Navy uses large quantities of petroleum products and chemicals to accomplish each organization's mission. Petroleum products are used to operate vehicles, aircraft and vessels, to lubricate machinery, and to heat and provide power for Navy areas. Chemicals are used for many purposes, including painting and various cleaning operations.

### 3.2.1. Common Oils

Crude oil, as it is extracted from the ground, contains thousands of chemical compounds, most of which are composed of the elements carbon and hydrogen and are called hydrocarbons. Petroleum products are produced from crude oils in the refining operation, which initially uses distillation columns to separate the component compounds into fractions. These fractions or portions thereof (cuts) may be further processed, blended, or a combination of both to produce the products which meet specific requirements of the Navy. The necessary products are centrally procured in bulk quantities by the Defense Fuel Supply Center, Cameron Station, Alexandria, VA, to satisfy worldwide requirements. Navy products are delivered from refineries (after inspection by Government representatives) by tankers, pipeline, rail, or truck.

An appreciation of the various types of oils and their unique physical and chemical properties is important because they will affect an oil's storage requirements, spill behavior, and spill containment structure design. The paragraphs below discuss the various types of oil commonly used by the Navy.

#### 3.2.1.1. Gasolines

The Navy purchases several grades of gasoline for use in vehicles, equipment, and aircraft, for varying conditions of climate and combat status. Gasolines have a significant tendency to volatilize as indicated by the range of Reid vapor pressures of 5.5 to 7.0 psi for aviation fuels to 14 psi for automotive fuels. They also have low flash points (temperature at which sufficient vapors are given off to support combustion by a "spark" or other ignition sources). Consequently, these volatile materials can present a fire and explosion hazard to property and persons if spilled in a confined area. Additionally, gasolines have low surface tension and viscosity; as a result, gasoline spills spread quickly.

#### 3.2.1.2. Turbine Fuels: Jet Fuels

The jet fuels used are JP-4, JP-5, and JP-5/JP-8 Standard. The two common jet fuels are JP-4 and JP-5. JP-4 fuel is the primary fuel for U.S. Air Force aircraft. This fuel is a wide cut, gasoline-based fuel with a flash point only slightly higher than that of gasolines. Its high volatility and low flashpoint presents significant explosion risk, therefore, JP-4 fuel cannot be carried on U.S. Navy combatant vessels safely. JP-5 fuel, the primary fuel for naval aircraft, is a kerosene-based fuel with a minimum flash point of 140°F and maximum specific gravity of 0.845. The specifications for JP-4, JP-5, and JP-5/JP-8 Standard are SPEC No. MIL-T-5624P, Turbine Fuel Aviation. Jet fuels have low viscosity and surface tension, and as result, jet fuel spills spread quickly.

#### 3.2.1.3. Fuel Oil: Automotive Diesel

Three grades of diesel fuel oils are purchased for use in automotive diesel (compression ignition) engines. The specifications for these fuel grades are SPEC No. VV-F-800D, Fuel Oil, Diesel. These fuel grades, DF-A, DF-1, and DF-2, range in viscosity from 1.2 to 4.3 centistokes at 100°F and have flash points of 100°F or greater. DF-A is an arctic grade fuel for cold temperature use, DF-1 for use in the continental U.S. locations with low temperatures in the winter, and DF-2 is a general grade for summer use and moderate ambient temperatures.

#### 3.2.1.4. Fuel Oil: Naval Distillate Fuel

Naval Distillate Fuel (NDF), formally known as Diesel Fuel Marine (DFM), is another fuel consumed by the Navy and is used principally on Navy vessels. NDF (SPEC No. MIL-F-16884H) has less tendency to form stable emulsions in water, is less viscous, and has a lower flash point than fuels which it replaced. This low-viscosity liquid can be expected to spread rapidly over any surface on which it is spilled.

#### 3.2.1.5. Fuel Oil: Burner Oils

Burner fuel oils are used by the Navy for heat and power generation as described in ASTM D396 (DoD Adopted), Standard Specification for Fuel Oils. These oils are numerically graded 1 through 6.

Grades Number 1 and Number 2 are distillate or "light end" fractions with a maximum viscosity in the range of 2.2 - 3.6 centistokes at 100°F, a minimum flash point of 100°F, and a specific gravity of approximately 0.85. Generally, Number 1 is used in space heaters, and Number 2 is used for residential heating.

Grade Number 3 is no longer used.

Grade Number 4 oil is rarely used, although it is available as light residual or heavy distillate cuts. Grade Number 5 burner oil is also available in light and heavy cuts of the residual oil fraction. Heavy residual (grade 5) has a viscosity range of 75 -162 centistokes at 100°F, and a flash point of 130°F, reflecting the intermediate characteristics of this fuel oil.

Grade Number 6 oil is very viscous. This residual oil, also known as Bunker C, is used in many commercial ships and shore station power plants. This oil has a flash point of 150°F and viscosity in the range of 92 to 638 centistokes at 122°F. It must be heated prior to use to facilitate handling. Low-grade fuel oils such as Number 6 (in addition to heavier fraction oils such as lube oils) are less mobile, less likely to deteriorate gaskets and seals, and less toxic than the lighter fraction fuels and oils.

#### 3.2.1.6. Lubricating Oils

The lubricating (lube) oils used by the Navy include both synthetic and natural petroleum products. No synthetic products are purchased in bulk quantities for use in the Navy. The three types of petroleum base lubricants handled in bulk by the Navy are: Aircraft Piston Engine Oil (ANSI/SAE J1899-95, DoD Adopted); Shipboard Diesel Engine Oil (SPEC No. MIL-L-9000H), which is commonly referred to as 9250; and steam turbine oil (SPEC No. MIL-L-17331H), which is commonly referred to as 2190 TEP. These lube oils are in the SAE 30-50 viscosity range, have high flash points, and very low volatility.

#### 3.2.1.7. Transformer/Mineral Oils

Transformer oil is a petroleum based oil consisting of mineral oil, middle distillates, and other petroleum based products. It is a white or clear oily liquid with a slight hydrocarbon odor. It is used as a transformer cooling medium and typically is stored in small quantities at Navy facilities. Transformer oil has a typical boiling point in excess of 300 F and can ignite at temperatures approaching its boiling point. The inhalation of transformer oil at elevated temperatures or ingestion should be avoided.

#### 3.2.1.8. Bilge Water

Oily wastewater is generated from ship bilges. In recent years, there has been a phase-out of donuts for the treatment of bilge water. As a result, bilge water is treated at shore facilities prior to direct discharge or disposal to industrial wastewater treatment facilities. For the purposes of spill planning, bilge water should be treated as oil.

### 3.2.2. Common Hazardous Substances

Common chemicals used by the Navy include solvents, acids, caustics, paints, pesticides, toxic and reactive metals, PCBs, compressed gases, petroleum fuels, and lubricants. A list of all HS under CERCLA can be found in 40 CFR 302. For spill prevention purposes, it is convenient to group these substances into corrosives, flammable/combustible liquids, compressed gases, poisons, oxidizers, reactive substances, and organic peroxides. Table 3-1 lists HS commonly found in the Navy for each group. These groups have distinct chemical and physical characteristics, which are particularly important when addressing such things as storage compatibility, area design, equipment selection, and spill mitigation. The following paragraphs briefly review the characteristics of each group.

**Table 3-1**
**Common Hazardous Substances Used At Naval Facilities**

Corrosives

- Acetic acid
- Cresol
- Hydrochloric acid
- Hydrofluoric acid
- Sodium hydroxide (caustic soda)
- Sodium sulfite
- Sulfuric acid

Flammable / Combustible Liquids

- Aniline
- Ethylene glycol
- Glycolethers
- Hydrazine
- Isopropyl alcohol
- Ketone solvents (acetone, methyl ethyl ketone, methyl isobutyl ketone)
- Methyl alcohol
- Methylene chloride
- Mineral spirits
- N-hexane
- Paint thinner
- Paints
- Petroleum distillates
- Stoddard solvent (PD-680)
- Toluene
- Turco solvent
- Xylene

Compressed Gases

- Acetylene
- Ammonia
- Carbon dioxide
- Chlorine
- Freon®
- Helium
- Oxygen
- Nitrogen

Poisons

- 2,4-D
- Baygon
- Chlordane
- Diazinon
- Malathion
- Pentachlorophenol
- Pyrenone
- Sevin

Oxidizers

- Hydrogen peroxide
- Magnesium perchlorate
- Potassium perchlorate
- Silver nitrates

Reactive Substances

- Acetic anhydride
- Lithium
- Sodium

Organic Peroxides

### 3.2.2.1. Corrosives

Corrosives are any substances that significantly attack common metals or metal alloys and liquids with severe corrosion rates on steel (>0.25 in./year on SAE 2000 steel at 130°F). Corrosives contribute to significant equipment deterioration. They are commonly used in small quantities at most maintenance and repair shops and are also found stored in bulk at metal plating and cleaning shops, battery shops, and industrial waste treatment plants.

### 3.2.2.2. Flammable / Combustible Liquids

Flammable/combustible liquids have a flash point below 100°F and will readily ignite. Safeguards such as grounding, bonding, and proper ventilation are required. Flammable vapors of these liquids also expand when subject to high temperatures and can damage containers and even explode due to overpressurization. Flammable liquids require special lockers and protection against high temperatures. Many solvents and waste fuels are flammable. Flammable liquids are commonly stored in 55-gallon or smaller containers, although occasionally bulk tanks are used.

### 3.2.2.3. Compressed Gases

Compressed gases may be flammable, toxic, or strong oxidizers, and can displace air in enclosed storage areas and create a breathing hazard. Common Navy compressed gases includes acetylene, carbon dioxide, chlorine, Freon®, helium, oxygen, nitrogen, and other gases. Compressed gases are most often stored in cylinders, although chlorine is sometimes stored in 1-ton high-pressure tanks. Please note that spill prevention measures for compressed gases differs significantly from measures used for liquid and solid materials. For example, secondary containment cubing is not applicable. Compressed gases are not generally a threat to navigable waters, but a release may be toxic to humans or pose a fire or explosion hazard.

### 3.2.2.4. Poisons

Poisons are toxic to humans or other forms of life, even in very low doses, and can have adverse acute or chronic effects. Extreme care must be taken to avoid exposure during handling. Common Navy poisons includes insecticides, pesticides, rodenticides, and herbicides. These materials are normally found at pest control shops in small containers (5-gallon) and 55-gallon drums.

### 3.2.2.5. Oxidizers

Oxidizers yield oxygen readily to stimulate the oxidation or even combustion of other materials. Compatibility considerations are important to avoid container deterioration and adverse reactions with storage and transfer systems. Common Navy oxidizers, such as cleaning and photographic solutions, are found in small quantities and stored in 55-gallon or smaller containers, although larger quantities may be found stored in tanks.

### 3.2.2.6. Reactive Substances

Reactive substances ignite spontaneously when exposed to water or air and may even generate a violent reaction. These chemicals require air and water tight containers and must be stored away from all sources of air and water such as fire control systems. These substances are not widely used in the Navy. Lithium batteries, often used to power navigation aids, is an example of a water-reactive substance.

#### 3.2.2.7. Organic Peroxides

Organic peroxide is any organic compound containing oxygen in the bivalent structure. Organic peroxide may be considered a derivative of hydrogen peroxide, where one or more of the hydrogen atoms have been replaced by organic radicals. Organic peroxides are extremely hazardous, since almost all of them are intrinsically unstable. These compounds potentially present serious fire and explosion hazards, and may deflagrate. They are commercially available as liquids and solids, although most are generally dissolved in water or an organic solvent to reduce the concentration. Organic peroxides are not too common or widely used at Navy areas, only for specialty uses such as research, explosives, or repellents, and are commonly stored in small containers.

## 3.3. SOURCES AND CAUSES OF SPILLS

Any of the Navy oil and HS areas and associated equipment listed in Section 2.4 is a potential source of spills. Drums and smaller containers are the most common way to use and store oil and HS at Navy facilities. Bulk storage is less common and is typically associated with oily waste and solvents, industrial waste, or some other form of industrial operation.

### 3.3.1. Oil Spills

Navy oil spills can occur at sea, in harbor, or ashore; however, Spill Prevention, Control and Countermeasure (SPCC) regulations are concerned with non-transportation-related spills ashore. In Fiscal Year (FY) 1996, 53% of the Navy's reported oil spills occurred ashore, yet accounted for 91% of the total volume spilled. Of these spills ashore, 75% were contained on land, while 16% reached a navigable waterway.

Past spills provide an insight into the typical cause of oil spills. Table 3-2 lists the causes of oil spills reported by naval activities in FY96. Being familiar with typical causes of spills can help to identify a strategy for SPCC and to help reduce the frequency and impact of spills.

### 3.3.2. Hazardous Substance Spills

Past spills provide an insight into the typical cause of oil spills. Table 3-3 lists the causes of HS spills reported by naval activities in FY96. Being familiar with typical causes of spills can help to identify a strategy for SPCC and to help reduce the frequency and impact of HS spills.

**Table 3-2**
**Oil Spills by Cause, FY96**

| Cause | Number of Occurrences | Percent of Total Occurrences | Total Gallons Spilled | Percent of Total Spilled | Average per Occurrence (Gallons) |
|---|---|---|---|---|---|
| Act of God | 14 | 2.2 | 865 | 0.4 | 62 |
| Collision/Grounding/Sinking | 6 | 1.0 | 2713 | 1.2 | 452 |
| Container Leak | 7 | 1.1 | 365 | 0.2 | 52 |
| Contractor Error | 2 | 1.9 | 267 | 0.1 | 22 |
| Discovered | 76 | 12.1 | 3744 | 1.7 | 49 |
| Equipment Failure | 118 | 18.8 | 36,002 | 16.0 | 305 |
| Explosion | 1 | 0.2 | 1 | 0.0* | 1 |
| Leaching/Heat Expansion | 5 | 0.8 | 25 | 0.0* | 5 |
| None | 10 | 1.6 | 950 | 0.4 | 95 |
| Other | 89 | 14.2 | 6,170 | 2.7 | 69 |
| Personnel Error | 122 | 19.5 | 152,712 | 67.7 | 1252 |
| Pipe/Hose Failure | 49 | 7.8 | 3449 | 1.5 | 70 |
| Structural Failure | 16 | 2.6 | 10,236 | 4.5 | 640 |
| Tank Overflow | 48 | 7.7 | 6,441 | 2.9 | 134 |
| UST Excavation/Maintenance | 1 | 0.2 | 10 | 0.0* | 10 |
| Valve Failure/Loose/Leak | 47 | 7.5 | 1,554 | 0.7 | 33 |
| Vandalism | 1 | 0.2 | 50 | 0.0* | 50 |
| Vent Mast Leak | 4 | 0.6 | 111 | 0.0* | 28 |
| **Total** | **616** | **100** | **225,665** | **100** | **360** |
| Note: * = less than 0.5% | | | | | |

**Table 3-3**
**Hazardous Substance Spills by Cause, FY96**

| Cause | Number of Occurrences | Percent of Total Occurrences | Total Gallons Spilled | Percent of Total Spilled | Average per Occurrence (Gallons) |
|---|---|---|---|---|---|
| Act of God | 7 | 9.5 | 68 | 0.0 | 10 |
| Container Leak | 6 | 8.1 | 296 | 0.1 | 49 |
| Contractor Error | 3 | 4.1 | 212 | 0.1 | 71 |
| Discovered | 5 | 6.8 | 40 | 0.0 | 8 |
| Equipment Failure | 12 | 16.2 | 998 | 0.5 | 83 |
| Other | 6 | 8.1 | 105 | 0.1 | 18 |
| Personnel Error | 21 | 28.4 | 203,474 | 97.8 | 9,689 |
| Pipe/Hose Failure | 6 | 8.1 | 2,128 | 1.0 | 355 |
| Structural Failure | 4 | 5.4 | 362 | 0.2 | 91 |
| Tank Overflow | 1 | 1.4 | 50 | 0.0 | 50 |
| Valve Failure/Loose/Leak | 3 | 4.1 | 217 | 0.1 | 72 |
| **Total** | **616** | **100** | **225,665** | **100** | **360** |

## 3.4. BEHAVIOR ON LAND

Spilled oil or HS will migrate over the surface or percolate through the soil until it reaches the water table. Surface migration will follow the terrain, collecting in low spots that are often parts of local drainage systems, to a waterway. Oil or HS absorbed into the ground and reaching a water table can contaminate water supplies and migrate to a waterway as shown in Figure 3-1.

Oil or HS spilled on the ground will also migrate along artificial fill areas such as building foundations and pipeline trenches. These spills present a hazard to life and property because of the volatility of petroleum products and some chemicals. Basements of nearby buildings and sewer lines are likely areas where explosive vapor concentrations may develop.

## 3.5. IMPACTS OF AN OIL OR HAZARDOUS SUBSTANCE SPILL

An oil or HS spill can affect many areas during a spill, as well as long after a spill. Impacts during an oil spill can be easily seen, such as oil on the water, oiled piers, closed beaches, and dead fish or birds. Conversely, impacts during a chemical spill are not as easy to notice. Likewise, long-term impacts on the environment from an oil or HS spill are not immediately seen.

## 3.5.1. Types of Impacts

### 3.5.1.1. Physical Impacts

Physical impacts are related to the mechanical effects of the spilled product, such as the soiling of structures, craft, shoreline, and wildlife. The fouling, corroding, or deteriorating of water supply intake screens and equipment may also occur.

### 3.5.1.2. Economic Impacts

Economic impacts relate primarily to direct dollar costs of spill cleanup, and product and property loss. However, economic impacts also include secondary costs such as injuries related to the spill, reduction in value or enjoyable use of private property, loss of commercial fish or shellfish crop, and reduced tourist trade at a resort area. Additional secondary costs related to a spill come from future construction projects planned at a past spill site; if a spill was not cleaned up properly, construction could be delayed or could require additional cost to properly remove the contamination.

### 3.5.1.3.Chemical Impacts

Chemical impacts relate to changes in chemical content of the affected area. An oil spill could potentially increase hydrocarbon content or change oxygen regimen of the affected water. An HS spill could dramatically change the chemical content of the affected area, to potentially dangerous conditions. Additionally, additives in oils, other petroleum products, and hazardous chemicals may be toxic to marine plant and animal life.

### 3.5.1.4. Biological Impacts

Biological impacts relate to oil or HS spill interaction with plants and animals, including direct toxic effects, food chain interference, or behavioral modifications.

### 3.5.1.5. Social Impacts

Social impacts relate to interactions of oil or HS spills with human values and behavioral patterns, such as diminishment of the aesthetic value and enjoyable use of the spill-affected area and its adjoining areas.

The most recognizable social impact of oil or HS spills is public and private interest group activity. Interest groups often seek action and information on oil or chemical spills shortly after they occur. Every effort should be made to give accurate information to the public on a regularly scheduled basis.

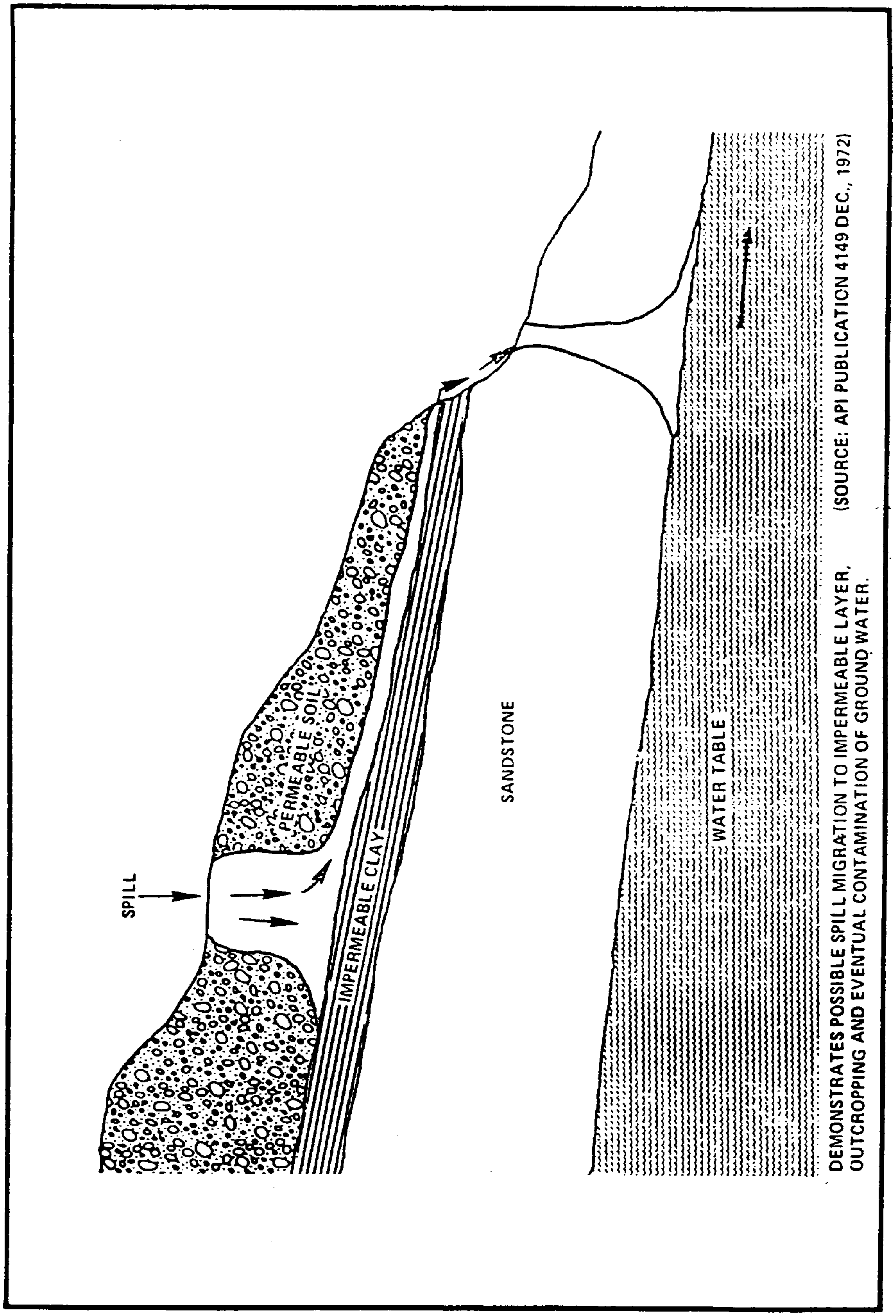


**Figure 3-1**
**Possible Migration Path of Oil and Hazardous Substance Spilled on Land**

### 3.5.2. Factors Affecting Impact

The factors affecting the impact of an oil or HS spill are directly influenced by the quantity, frequency, type, condition, and the location of the spill.

In general, the greater the quantity of material spilled the greater the impact. However, for some HS, the impact is just as great for a small quantity spill. Keep in mind, small but frequent spills do not allow an affected area to recover and can have the cumulative effect of one large spill.

Different types of oils will have different impacts. Light oils such as gasoline and jet fuels will percolate into soil more readily and spread more quickly than heavy oils, thus endangering ground water supplies. Aboveground spills of light fuels evaporate rapidly and leave little undesirable residue; however, they constitute a flammability hazard under many circumstances. Heavy fuels are more visible. They easily contaminate the materials they contact and affect the aesthetic value of the area. Certain fuel additives such as lead could complicate and increase the amount of effort required to clean up a spill site.

Different types of HS may produce various impacts as well. Depending on the type of HS spilled, it may cause permanent damage to the effected area, such as equipment, or flooring. This may substantially impact operation, and possibly lead to a halt in operation.

Compressed gases are not generally a threat to navigable waters, but a release may be toxic to humans or pose a fire or explosion hazard. Many HS are flammable, and if handled improperly, or spilled, may ignite. A reactive substance spill may cause a fire or violent reaction if spilled in water. In addition, a poison spilled may cause serious injury.

The condition of the material is another factor that affects the impact of a spill. For example, as oil is exposed to the environment the light fractions evaporate leaving a residual mass, of heavier organics. Usually this is less harmful to the environment, but it creates physical and economic impacts. In addition, the chemical composition of the HS may alter, which may lead to hazardous impacts.

The location of the spill will influence its impact. For oil and petroleum products, small quantities of gasoline spilled in open harbor waters without commercial fish will evaporate readily and have minimal effects. However, if the spill is surrounded by sensitive areas such as estuaries, recreational beaches, commercial and recreational fishing, then the impacts are greater. For HS, the location of the spill greatly influences the impact. An HS spilled in an open area may evaporate, or be absorbed into the surface with minimal impacts. If, on the other hand, the HS is spilled on an important surface, or equipment, the impact may cause failure, deteriorate the item, or ultimately halt operation.

## 3.6. TYPICAL SPCC DEFICIENCIES

### 3.6.1. Oil and Hazardous Substance Storage and Transfer Deficiencies

The equipment and structures that provide primary storage and distribution of oil and HS are high-risk locations for a spill. The equipment and structures include storage tanks, transfer pipeline, loading and unloading racks, and related items such as pipe supports, tank overflow prevention devices, and corrosion protection systems. Table 3-4 identifies typical storage and transfer deficiencies which can result in a spill.

**Table 3-4**
**Typical Storage and Transfer Deficiencies**

| |
|---|
| Inadequate containment structures |
| Leaks from underground storage tanks |
| Tank leaks due to corrosion or worn parts |
| Tank leaks through seams and rivets |
| Tank overfilling due to level instrument failure |
| Leaks from heating coils in tanks containing heavy fuel |
| Tanks and piping damage by collision with mobile equipment |
| Tank and piping damage from inadequate supports |
| Pipeline fracture due to improper installation |
| Leaks from hose and piping ruptures |
| Leaks in pipes, valves, and fittings |
| Leaks from damaged loading connections |
| Leaks from loading arms, especially joints and gaskets |
| Susceptible to wind/weather damage or flooding |

To remedy the deficiencies presented in Table 3-4, 40 CFR 112.7 requires the construction of adequate storage and transfer areas and regular inspection of these areas to assure that the structures and equipment will indeed serve their purpose of controlling and minimizing the impact of a spill. Chapters 4 and 5 of this manual provide the guidance needed to evaluate and correct deficiencies in storage and transfer areas.

### 3.6.2. Spill Control Equipment Deficiencies

Although an area may already have SPCC measures in place, the equipment could be insufficient in many ways. Table 3-5 lists common deficiencies of spill control measures or equipment that have been installed at oil or HS areas.

**Table 3-5**
**Typical Deficiencies In Spill Control Equipment**

| |
|---|
| Improper segregation of “clean” and “dirty” runoff |
| Improper storm water retainment |
| Inadequate drainage control structures |
| Inadequate containment volume |
| Insufficient sump capacity |
| Leaks in containment dikes |
| Dike drain valve unintentionally left open |
| Inadequate treatment unit design and installation |
| Breach in curbs, drains, and spill collection system |
| Level sensor failure |
| Breaches in security allowing sabotage or vandalism |
| Insufficient lighting at oil and HS areas |
| Overfill prevention equipment failure |

To remedy the deficiencies presented in Table 3-5, 40 CFR 112.7 requires the construction of adequate spill containment structures to contain a potential full-capacity spill; the monitoring of drainage and treatment of contaminated drainage; and the implementation of security measures such as valve locks, area lighting and area fencing. In addition, 40 CFR 112.7 requires regular inspection of spill containment structures and drainage equipment to assure that the structures and equipment will indeed serve their purpose of controlling and minimizing the impact of a spill. Chapters 7, 8 and 9 of this manual provide the guidance needed to evaluate and correct deficiencies in area spill containment structures, drainage control equipment, and security measures.

### 3.6.3. Operational Deficiencies

Spills can result from the improper operation and maintenance of storage and transfer areas, spill containment, drainage control, and security equipment and structures. Examples of operational deficiencies are presented in Table 3-6.

**Table 3-6**
**Typical Operational Deficiencies**

| |
|---|
| Improper storage procedures |
| Spills from the unattended draining of tank water |
| Operators incorrectly setting loading meters, and as a result, overfilling the tank |
| Overfilling tank trucks, tank cars, barges, and tankers |
| Incompatible material mixing from improper identification of fill ports |
| Improper maintenance of tank, pipe, valves, fittings, and instrumentation and controls |
| Spills from quick-connect coupling operation |
| Spills from line flushing |
| Leaks from pump seals due to lack of maintenance |
| Plugging of drainage system by debris |
| Inadequate material handling and equipment |
| Improper operation of drainage control structures |
| Improper operation of stormwater treatment units |

Finally, 40 CFR 112.7 requires that personnel be instructed and briefed on proper spill prevention procedures and requirements; area personnel use standardized written operating procedures; inspections are routinely performed to insure proper operation of equipment; and records are maintained to document the successful implementation of these personnel requirements. Chapters 4 through 9 of this manual provide the guidance needed to evaluate and correct deficiencies in operation and maintenance of storage and transfer areas, spill containment, drainage control, and security equipment and structures. Chapter 10 in this manual provides guidance in identifying SPCC deficiencies during inspections.