Environmental, Health, and Safety Guidelines for Crude Oil and Petroleum Product Terminals

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment

Applicability

The EHS Guidelines for Crude Oil and Petroleum Product Terminals include information relevant to land and shore-based petroleum storage terminals receiving and dispatching bulk shipments of crude oil, gasoline, middle distillates, aviation gas, lube oil, residual fuel oil, compressed natural gas (CNG), liquid petroleum gas (LPG), and specialty products from pipelines, tankers, railcars, and trucks for subsequent commercial distribution. This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References
Annex A — General Description of Industry Activities

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with crude oil and petroleum product terminals that occur during the operation phases of a facility, along with recommendations for their management. Additional recommendations for the management of environmental issues common to the construction and decommissioning phase of infrastructure and industrial facilities are provided in the **General EHS Guidelines.**

1.1 Environment

Environmental issues in this industry sector include the following:

- Air emissions
- Wastewater
- Hazardous materials and oil
- Waste

Air Emissions

Volatile organic compounds (VOCs) emitted during crude oil and petroleum product terminal storage activities have the potential to be significant from both an environmental and an economic perspective. Emissions of VOCs may result from evaporative losses during storage (typically referred to as "breathing, storage, or flash losses" [2]), from operational activities such as filling, withdrawal, additive blending, and loading / unloading of transport links (referred to as "working losses"), and due to leaks from seals, flanges, and other types of equipment connections (known as "fugitive losses"). Additional emissions may occur from vapor combustion units and vapor recovery units. Recommendations to prevent and control the emission of VOCs from storage and working losses which apply to most bulk fuel storage tanks, as well as above-ground piping and pump systems, include the following[3,4]:

- Maintaining stable tank pressure and vapor space by:
  - Coordinating filling and withdrawal schedules, and implementing vapor balancing between tanks (a process whereby vapor displaced during filling activities is transferred to the vapor space of the tank being emptied or to other containment in preparation for vapor recovery);
  - Reducing breathing losses by using white or other reflective color paints with low heat absorption properties on exteriors of storage tanks for lighter distillates (e.g. gasoline, ethanol, and methanol) or by insulating tanks. The potential for visual impacts from tank colors should be considered;
- Where vapor emissions contribute or result in ambient air quality levels in excess of health-based standards, installation of secondary emissions controls such as vapor condensing and recovery units, catalytic oxidizers, vapor combustion units, or gas adsorption media;
- Use of gasoline supply and return systems, vapor recovery hoses, and vapor tight trucks / railcars / vessels during loading and unloading of transport vehicles;
- Use of bottom loading truck / rail car filling systems;
- Establishing a procedure for periodic monitoring of fugitive emissions from pipes, valves, seals, tanks and other infrastructure components with vapor detection equipment, and with subsequent maintenance or replacement of components as needed. The procedure should specify the

[2] Storage losses occur due to changes in temperature and pressure which cause vapor to be forced from the tank through vents and into the atmosphere.
[3] The applicability may depend on the type of product stored, the storage system, and the significance of potential impacts to ambient air quality.
[4] More detailed recommendations are provided in European Commission (EC): Integrated Pollution Prevention and Control Bureau: Reference Document on Best Available Techniques on Emissions from Storage, 2005.

monitoring frequency and locations, as well as the trigger levels for repairs.

Fixed Roof Tanks

- Based on the nature of materials being stored, minimizing storage and working losses through installation of internal floating roof and seals;[5]
- Further minimizing working losses during filling and emptying through vapor balancing and vapor recovery techniques[6] as described above;
- Maintaining the insulation of heavy fuel storage tanks (which is necessary together with a heating source to maintain fuel viscosity) in good condition in order to maintain the negligible levels of storage loss typically associated with this type of insulation.[7]
- Reducing the generation of dissolved gases by eliminating the pressure drop from the tank fill line.

Floating Roof Tanks [8]

- Installing decks, fittings, and rim seals according to design specifications of international standards to minimize evaporative losses.[9]
- Protecting rim seals from wind and weather damage and conducting regular maintenance;
- Consider the use of double seal systems for floating roof tanks where appropriate based on the nature of the material being stored, the size of the tank(s) in question, throughputs, location considerations, and meteorology.[10]
- Using sleeves to eliminate emissions from slotted guide poles;
- Minimize losses from tank roof landing events by limiting the number and durations of such events. Use practices that minimize the impact of tank roof landing events, such as keeping legs on a low setting or restricting activities to evenings when temperatures are cooler and the potential for ozone formation is lower. Consider cone bottom drain dry floor designs which reduce potential emissions when a tank roof is landed.

Variable Vapor Space Tanks

- When feasible, upgrading tank systems with variable vapor space tanks. These tanks use expandable vapor reservoirs to account for changes to vapor volume resulting from temperature and pressure changes and can function as integrated components of vapor systems for fixed roof tanks. Examples of variable vapor space tanks are lifter roof tanks and flexible diaphragm tanks. These systems minimize VOC emissions from storage losses.[11]

Pressurized tanks

- Consistent with manufacturer's recommended pressure / vacuum settings, low-pressure tanks which can emit working losses during filling operations should be equipped with a pressure / vacuum vent that is set to minimize breathing loss from temperature or pressure changes. High-pressure storage tanks have next to no evaporative or working losses.[12]

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5 American Petroleum Institute (API) Standard 2610: Design, Construction, Operation, and Maintenance of Terminal and Tank Facilities (2005)

6 Vapor recovery units typically employ adsorption, absorption, membrane separation, and / or condensation. EC (2005)

7 Environment Canada. Guide for Reporting to the National Pollutant Release Inventory, Appendix Six: Storage Tanks and their Evaporation Implications (2003)

8 Floating roof tanks emit VOCs through both storage and working losses. To minimize evaporative losses, both external and internal floating roof systems use decks, fittings, and rim seals to allow the roof to adjust in relation to the liquid level in the tank. Evaporative losses occur through the rim seal and deck fittings and residual liquid on the tank walls that is exposed during liquid withdrawal activities.

9 Examples include: API Standard 620: Design and Construction of Large, Welded, Low-pressure Storage Tanks (2002); API Standard 650: Welded Steel Tanks for Oil Storage (1998), and; European Union (EU) European Standard (EN) 12285-2:2005. Workshop fabricated steel tanks for the aboveground storage of flammable and non-flammable water polluting liquids (2005).

10 API Standard 2610 (2005)

11 Environment Canada (2003)

12 Environment Canada (2003)

Tank Cleaning

- Tank cleaning and degassing can generate significant quantities of VOCs. Tank degassing vapors should be routed to an appropriate emissions control device. Other practices include restricting activities to a season when the potential for ozone formation is reduced or to a time of the day when the potential for ozone formation is less;
- Tanks should be periodically inspected internally, and establishing an inspection frequency based on the condition of the tank at the previous internal inspection (typically 10 years or less).[13]

Wastewater

Crude oil and petroleum product terminal effluent consists of sewage and process wastewater. Process wastewater consists mainly of tank bottom draining and contaminated stormwater runoff, including water from tank leaks and spills that collects in hydrocarbon contaminated secondary containment areas. Other possible sources of wastewater include oil contaminated water from washing tanker trucks and railcars, and wastewater from vapor recovery processes.[14]

Recommendations for the treatment of sewage are discussed in the **General EHS Guidelines**. Recommendations for the prevention and control of process wastewater effluents are discussed below.

Stormwater

Contaminated stormwater quality and volumes may depend on site-specific considerations including overall housekeeping and spill prevention practices, rainfall, and total runoff area. Measures to minimize generation of oil contaminated stormwater runoff primarily include:

- Application of effective spill prevention and control;
- Implementation of secondary containment procedures that avoid accidental or intentional releases of contaminated containment fluids;
- Installation of stormwater channels and collection ponds with subsequent treatment through oil / water separators. Oil / water separators should be properly selected, designed, operated, and maintained.

Further recommendations for the management of stormwater are discussed in the **General EHS Guidelines**.

Tank Bottom Water

Rainwater infiltration, condensation of moisture from tank vapor space, and water present in the product itself prior to delivery may all contribute to the presence of water inside product storage tanks. Water that separates and settles to the tank bottom should be periodically drained from the bottom of the tank, resulting in a liquid effluent of oily water. Measures to prevent the accumulation of tank bottom water include:[15]

- Regular maintenance to locate and repair / replace tank roof, seals, or other sources of water infiltration;
- Use of domes on floating roof tanks to reduce rainwater penetration;
- Use of meters (“sight glasses”) to determine water content in tank, as well as vortex eliminators / barriers to minimize product release during draw off.

[13] See API Standard 653 (1995) for specific guidance on inspection frequency.

[14] API Standard 1612. Guidance Document for the Discharge of Petroleum Distribution Terminal Effluents to Publicly Owned Treatment Works (1996)

[15] API Standard 2610 (2005)

Storm and Process Wastewater Treatment [16]

Depending on the type and quality of fuel product stored at the terminal, effluents from tank bottom water, stormwater, and other sources may contain separate phase and dissolved petroleum hydrocarbons such as benzene, tolulene, ethylbenzene, and xylene (BTEX) and oxygenates (e.g. MTBE). Wastewater may also contain metals and phenols, in addition to common wastewater contaminants including total suspended solids (TSS), and fecal coliforms.

As the major wastewater sources are tank bottom water and stormwater runoff, wastewater flows in this sector typically occur in batches, not lending themselves to on-site biological treatment. These types of effluents may need to be pre-treated via oil / water separators, with further on-site or off-site biological and chemical treatment and activated carbon systems,[17] depending on the volume of contaminants present, and whether the facility is discharging the wastewater into a municipal system or directly to surface waters. Additional guidance on wastewater treatment, including sanitary sewage discharge, is provided in the **General EHS Guidelines**.

Hazardous Materials and Oil

The storage and transfer of liquid materials in crude oil and petroleum product terminals creates the potential for leaks or accidentally releases from tanks, pipes, hoses, and pumps during loading and unloading of products. The storage and transfer of these materials also poses a risk of fire and explosion due to the flammable and combustible nature of the materials stored. In addition to the recommendations for hazardous materials and oil management in the **General EHS Guidelines**, measures to manage these types of hazards include:

- Storage tanks and components should meet international standards for structural design integrity and operational performance to avoid catastrophic failures during normal operation and during exposure to natural hazards and to prevent fires and explosions.[18] Applicable international standards typically include provisions for overfill protection, metering and flow control, fire protection (including flame arresting devises), and grounding (to prevent electrostatic charge).[19] Overfill protection equipment include level gauges, alarms, and automatic cutoff systems. Other standard equipment include the use of "breakaway" hose connections in fuel dispensing equipment which provide emergency shutdown of flow should the fueling connection be broken through movement;[20]
- Storage tanks should have appropriate secondary containment[21] as discussed in the **General EHS Guidelines**, including procedures for the management of containment systems. Secondary containment design needs depend on the type of tank, the nature and volume of the material(s) being stored, and site configuration, and includes:
    - o Depending on the size and location of the tanks, use of double bottom and double wall containment,

[16] Further good practice for effluent treatment is available in API Standard 4602: Minimization, Handling, Treatment and Disposal of Petroleum Products Terminal Wastewater, 1994.

[17] API Standard 1612 (1996)

[18] Examples include API Standard 620; API Standard 650, and; European Standard (EN) 12285-2:2005.

[19] Examples of industry practice for loading and unloading of tankers includes the latest edition of the International Safety Guide for Oil Tankers and Terminals (ISGOTT) and API 2610 (2005).

[20] EC (2005)

[21] Secondary containment may include a wide variety of structures such as earthen berms, dikes, concrete retaining walls, booms, spill diversion ponds, retention ponds, and trenches, among others. Examples of good practice in the construction and maintenance of secondary containment can be found in United States Environment Protection Agency (US EPA) Spill Prevention, Control and Countermeasure (SPCC) Requirements.

impervious linings underneath tanks, or internal tank liners[22]

- Installation of impervious asphalt or concrete surfaces with polyethylene sheeting underneath in areas of potential petroleum leaks and spills, including below gauges, pipes, and pumps,[23] and below rail and truck loading / unloading areas
- Secondary containment in rail and truck tanker loading areas should be appropriate for the size of the railcar or truck, level, curbed, sealed, and draining to a sump connected to a spill retention area. The spill retention area should also be equipped with an oil / water separator to allow the routine discharge of collected rainwater[24]

- Storage tanks and components (e.g. roofs and seals) should undergo periodic inspection for corrosion and structural integrity and be subject to regular maintenance and replacement of equipment (e.g. pipes, seals, connectors, and valves);[25]
- Loading / unloading activities should be conducted by properly trained personnel according to pre-established formal procedures to prevent accidental releases and fire / explosion hazards. Procedures should include all aspects of the delivery or loading operation from arrival to departure, including wheel blocking to avoid vehicle movement, connection of grounding systems, verification of proper hose connection and disconnection, adherence to no-smoking and no-naked light policies for visiting drivers;
- For unloading / loading activities involving marine vessels and terminals, preparing and implementing spill prevention procedures for tanker loading and off-loading according to applicable international standards and guidelines which specifically address advance communications and planning with the receiving terminal;[26]
- Facilities should develop a spill prevention and control plan that addresses significant scenarios and magnitudes of releases. The plan should be supported by the necessary resources and training. Adequate spill response equipment should be conveniently available to address the most likely types of spills. Spill cleanup materials should be managed as discussed below;
- Where appropriate, spill control and response plans should be developed in coordination with the relevant local regulatory agencies;[27, 28]
- Above Ground Storage Tanks (ASTs) should be located in a secure area, protected from potential collisions by vehicles, vandalism, and other hazards. Additional guidance on ASTs is presented in the **General EHS Guidelines**.

Waste Management

Wastes generated at terminals may include tank bottom sludge, which must be periodically removed to maintain product quality or tank storage capacity, as well as spill cleanup materials and soils contaminated with oil. Typically, sludge is composed of water, residual product, and various solids including sand,

22 EC (2005)

23 US EPA. SPCC Requirements.

24 API Standard 2610 (2005).

25 Several methods exist for inspecting tanks. Visual inspection may reveal cracks and leaks in tanks. X-ray or ultrasonic analysis can be used to measure wall thickness and pinpoint crack locations. Hydrostatic testing may indicate leaks caused by pressure, while a combination of magnetic flux eddy current and ultrasonic analysis can be used to detect pitting. An example of good practice includes API Standard 653: Tank Inspection, Repair, Alteration, and Reconstruction (1995).

26 API Standard 2610 (2005). For details about basic precautions, including those related to fire safety, refer to the latest version of ISGOTT, which includes a Ship / Shore Safety Checklist for overall safety and spill prevention.

27 For relevant components for spill response and planning, see US EPA Code of Federal Regulations (CFR) 40 CFR Part 112: Oil Pollution Prevention and Response (2002).

28 EC (2005)

scale, and rust.[29] Tank sludge and spill cleanup materials should be managed via re-processing for product recovery or as a waste at a facility licensed to handle this type of material in an environmentally sound manner. Small quantities of oil contaminated soils should be managed via land treatment or as a waste at a facility licensed to handle this type of material. Larger quantities of affected soils and other environmental media, including sediment and groundwater, may require management according to guidance applicable to contaminated land provided in the **General EHS Guidelines**.

Site Upgrade and Decommissioning

Contaminated soils and water may be encountered around fuel dispensers, piping, and tanks during excavation for repairs, upgrades or decommissioning. Depending on the type and concentration of contaminants present, small quantities of soils or liquids may need to be managed as a hazardous waste as described in the **General EHS Guidelines**. Larger quantities of affected soils and other environmental media, including sediment and groundwater, may require management according to guidance applicable to contaminated land provided in the **General EHS Guidelines**.

Terminals should have formal procedures to address and manage the planned or unplanned discovery of site upgrade and decommissioning waste, as well as to address the discovery of more extensive evidence of environmental contamination.[30]

Removal operations of any tanks and connected piping should include the following procedures:

- Residual fuel should be removed from the tank and all associated pipes and managed as a hazardous waste;
- Before commencing tank removal operations the tanks should be inerted so as to remove the risk of explosion. Proven inerting methods include hydrophobic foam fill, nitrogen foam fill, nitrogen gas purging, water fill, dry ice, combustion of gas, and cleaning-degassing;
- All vent pipes and risers associated with the tank should be dismantled and / or capped-off and clearly labeled;
- Tank dismantling should be carried out off-site, if the facility is currently used to store fuel and there is not sufficient space to carry out the dismantling work safely;
- If tanks and piping are left in situ, recommended closure methods should include cleaning and removing contents, inerting, and filling with sand and cement slurry, hydrophobic foams, or foamed concrete.

1.2 Occupational Health and Safety

Occupational health and safety issues associated with crude oil and petroleum product terminals primarily include the following:

- Chemical hazards
- Fire and explosions
- Confined spaces

Chemicals Hazards

Occupational exposures may be most likely related to the dermal contact with fuels and inhalation of fuel vapors during fuel loading and unloading. Exposure should be prevented through the implementation of occupational health and safety management programs and measures described in the **General EHS Guidelines** as applicable to hazardous materials management and chemical occupational health and safety hazards.

[29] US EPA Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313. Industry Guidance: Petroleum Terminals and Bulk Storage Facilities (2000).

[30] Host country regulations may require specific approaches to screening of soils during excavation as well as further assessment of contaminated media in retail petroleum sites (for examples see CETESB regulations in the State of Sao Paulo, Brazil).

Fire and Explosions

Fire and explosion hazards at crude oil and petroleum product terminals may result from the presence of combustible gases and liquids, oxygen, and ignition sources during loading and unloading activities, and / or leaks and spills of flammable products. Possible ignition sources include sparks associated with the buildup of static electricity[31], lightning, and open flames.[32] In addition to recommendations for hazardous materials and oil management, and emergency preparedness and response provided in the **General EHS Guidelines**, the following measures are specific to terminal facilities:

- Crude oil and petroleum product terminals storage facilities should be designed, constructed, and operated according to international standards[33] for the prevention and control of fire and explosion hazards, including provisions for distances between tanks in the facility and between the facility and adjacent buildings, provision of additional cooling water capacity for adjacent tanks, or other risk-based management approaches;[34]
- Implementing safety procedures for loading and unloading of product to transport systems (e.g. rail and tanker trucks, and vessels[35]), including use of fail safe control valves and emergency shutdown equipment;
- Prevention of potential ignition sources such as:
    - Proper grounding to avoid static electricity buildup and lightning hazards (including formal procedures for the use and maintenance of grounding connections)[36]
    - Use of intrinsically safe electrical installations and non-sparking tools[37]
    - Implementation of permit systems and formal procedures for conducting any hot work during maintenance activities,[38] including proper tank cleaning and venting
- Preparation of a fire response plan supported by the necessary resources and training, including training in the use of fire suppression equipment and evacuation. Procedures may include coordination activities with local authorities or neighboring facilities. Further recommendations for emergency preparedness and response are addressed in the **General EHS Guidelines**;
- Facilities should be properly equipped with fire suppression equipment that meets internationally recognized technical specifications for the type and amount of flammable and combustible materials stored at the facility.[39] Examples of fire suppression equipment include mobile / portable equipment such as fire extinguishers, and specialized vehicles, as well as

[31] Static electricity may be generated by liquids moving in contact with other materials, including pipes and fuel tanks during loading and unloading of product. In addition, water mist and steam generated during tank and equipment cleaning can be come electrically charged, in particular with the presence of chemical cleaning agents.

[32] A number of products stored at terminal facilities are listed as "accumulator oils" including natural gasolines, kerosenes, white spirits, motor and aviation gasolines, jet fuels, naphthas, heating oils, clean diesel oils, and lubricating oils. Accumulator oils take longer to dissipate electric charges and hence represent a higher risk of ignition from static electricity.

[33] An example of good practice includes the US National Fire Protection Association (NFPA) Code 30: Flammable and Combustible Liquids. Further guidance to minimize exposure to static electricity and lightening is available in API Recommended Practice 2003: Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents (1998).

[34] Safety distances also can be derived from industry and trade association standards, insurance providers, and specific safety analyses.

[35] For an example refer to the latest edition of the International Safety Guide for Oil Tankers and Terminals (ISGOTT).

[36] For an example refer to the latest edition of ISGOTT.

[37] For an example refer to the latest edition of ISGOTT.

[38] Control of ignition sources is especially relevant in areas of potential flammable vapor-air mixtures such as within vapor space of tanks, within vapor space of rail / truck tankers during loading / unloading, near vapor disposal / recovery systems, near discharge vents of atmospheric tanks, in proximity to a leak or spill.

[39] Such as the US National Fire Protection Association (NFPA) or other equivalent standards.

automatic or manually operated fixed fire suppression systems.[40]

Confined Spaces

Confined space hazards, as in any other industry sector, can, in the worse case scenario, potentially lead to fatalities if not properly managed. Confined space entry by workers and the potential for accidents may vary among terminal facilities depending on design, on-site equipment, and infrastructure. Confined spaces in crude oil and petroleum product terminals may include storage tanks, some secondary containment areas, and stormwater / wastewater management infrastructure. Facilities should develop and implement confined space entry procedures as described in the **General EHS Guidelines**.[41]

1.3 Community Health and Safety

Community health and safety issues associated with the operation of terminal facilities may include potential public exposure to spills, fires, and explosions although the probability of large magnitude events directly associated with storage operations in well designed and managed facilities is usually low. Facilities should prepare an emergency preparedness and response plan that considers the role of communities and community infrastructure as appropriate. Additional information on the elements of emergency plans is provided in the **General EHS Guidelines.**

The likelihood of community exposure to chemical hazards may be greater during road, rail, or water transport activities associated with fuel delivery and distribution. Risk management strategies associated with the transport of hazardous materials by road are presented in the **General EHS Guidelines** (refer specifically to the sections on "Hazardous Materials Management" and "Traffic Safety"). Guidance applicable to transport by rail is provided **EHS Guidelines for Railways** while transport by sea is covered in the **EHS Guidelines for Shipping.**

Visual Impacts

One of the most significant visual changes attributable to crude oil and petroleum product terminals is the size of bulk storage tanks. Visual impacts should be prevented during the planning process for new facilities or managed during operations through the installation of natural visual barriers such as vegetation. The location and color of bulk storage facilities also should be selected with consideration of visual impacts.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emission and Effluent Guidelines

VOC emissions from terminal facilities should be controlled through the application of techniques described in Section 1.1 of these Guidelines. Stormwater runoff should be treated through an oil/water separation system able to achieve oil & grease concentration of 10 mg/L. Process effluent discharge quality should be established on a site-specific basis, taking into account the characteristics of the effluent of the receiving water use.

[40] API Standard 2610 (2005).

[41] Industry specific guidance for safe entry during tank cleaning and maintenance is provided in API Standard 2015: Safe Entry and Cleaning Petroleum Storage Tanks (2001), and the latest edition of ISGOTT.

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.1 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[42] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[43] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[44] Indicative Occupational Exposure Limit Values published by European Union member states,[45] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[46].

Occupational Health and Safety Monitoring

The working environment should be occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[47] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[42] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[43] Available at: http://www.cdc.gov/niosh/npg/
[44] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[45] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/
[46] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[47] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

3.0 References and Additional Sources

American Petroleum Institute (API) Recommended Practice 2003. Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents. Washington, DC: API (1998).

API. 2005. Standard 2610: Design, Construction, Operation, and Maintenance of Terminal and Tank Facilities. Washington, DC: API.

API. 2002. Standard 620: Design and Construction of Large, Welded, Low-pressure Storage Tanks. Washington, DC: API.

API. 2001. Publication 1612: Guidance Document for the Discharge of Petroleum Distribution Terminal Effluents to Publicly Owned Treatment Works (1996). Washington, DC: API.

API. Standard 2015: Safe Entry and Cleaning Petroleum Storage Tanks. Washington, DC: API.

API. 1998. Standard 650: Welded Steel Tanks for Oil Storage. Washington, DC: API.

API. 2001. Standard 653: Tank Inspection, Repair, Alteration, and Reconstruction. Washington, DC: API.

API. 1994. Standard 4602: Minimization, Handling, Treatment and Disposal of Petroleum Products Terminal Wastewater. Washington, DC: API.

Environment Canada, 2003. Guide for Reporting to the National Pollutant Release Inventory. Appendix 6: Storage Tanks and their Evaporation Implications. Gatineau, QC: Environment Canada.

European Commission (EC). 2005. Integrated Pollution Prevention and Control Bureau: Reference Document on Best Available Techniques on Emissions from Storage.

European Commission. 1996. Integrated Pollution Prevention and Control (IPPC). EU Council Directive 96/61/EC. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996L0061:EN:HTML

European Commission. 1996. Seveso II Directive - Prevention, Preparedness and Response. EU Council Directive 96/82/EC. Available at http://ec.europa.eu/environment/docum/01624_en.htm

European Union (EU). 2005. European Standard (EN) 12285-2:2005. Workshop fabricated steel tanks - Part 2: Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids.

European Union. 1994. European Parliament and Council Directive 94/63/EC of 20 December 1994 on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0063:EN:HTML

International Safety Guide for Oil Tankers and Terminals (ISCOTT). 2006. London: Witherbys Publishing.

US EPA. 2002. Code of Federal Regulations. 40 CFR Part 112. Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities. Available at http://www.epa.gov/oilspill/pdfs/0703_40cfr112.pdf

US EPA Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313. Industry Guidance: Petroleum Terminals and Bulk Storage Facilities (2000). Washington, DC: US EPA. Available at http://epa.gov/tri/guide_docs/2000/00petro4.pdf

US EPA. 2000. Industrial Guidance, Petroleum Terminals and Bulk Storage Facilities. Washington, DC: US EPA.

US EPA. 2002. 40 CFR 112. Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities. Washington, DC: US EPA. Available at http://www.epa.gov/earth1r6/6sf/sfsites/oil/bulk.htm

US EPA. AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. Washington, DC: US EPA.

US EPA. 1995. APR 42, Fifth Edition, Chapter 7, Liquid Storage Tanks. Washington, DC: US EPA.

US National Fire Protection Association (NFPA). Code 30: Flammable and Combustible Liquids.

Annex A: General Description of Industry Activities

Crude oil and petroleum product terminals are designed to receive and dispatch bulk shipments of gasoline, middle distillates, aviation gas, lube oil, compressed natural gas (CNG), liquid petroleum gas (LPG), and specialty products from pipelines, ships, railcars, and trucks. Crude oil and petroleum product terminals are often located at the sea coast but may also be situated inland.

Typical activities during the operations of terminal facilities include receiving and unloading of products from ships, rail tankers, trucks, and pipelines; storage and handling of product in on-site tanks; mixing or product blending activities; and loading products to transportation vehicles and other links, such as pipelines, rail tankers, trucks, and ships, for distribution to customers.

Storage Tanks

A typical terminal has between 10 and 30 tanks. A typical tank is between 50 and 15,000 cubic meters (m^3). In general, tanks are separated to avoid damaging other tanks should they catch fire. The separation distance is dependent on the particular type and amount of fuel product. Individual secondary containment for tanks is used to further minimize the risk of heating adjacent tanks in the event of a fire. Storage of petroleum products takes place in various sized tanks, typically installed above ground.

Fixed Roof Tanks

Fixed roof storage tanks are typically cylindrical in shape and can be either horizontal or vertical in orientation. In general, they have a painted steel shell with a permanent roof that may be flat or in a cone / domed shape. Fixed roof tanks may also be fitted with internal floating roofs to minimize emissions of volatile organic compounds (VOCs).

Floating Roof Tanks

Floating roof tanks may have external and internal floating roofs. The former has no fixed roof while the latter has both a fixed and a floating roof. In both cases, the floating roof consists of a deck, fittings, and rim seals, and typically involves a pontoon and double-deck system. The roof rises and falls with the liquid level in the tank to minimize VOC emissions.

Variable Vapor Space Tanks

Variable vapor space tanks use expandable vapor reservoirs to account for changes to vapor volume resulting from temperature and pressure changes. Variable vapor space tanks often function as integrated components of vapor systems for fixed roof tanks. Examples of variable vapor space tanks are lifter roof tanks and flexible diaphragm tanks. These systems minimize VOC emission from storage losses.[48]

Pressurized Tanks

Pressure tanks are generally used for storing liquids and gases under pressure. They are available in several sizes and shapes, depending on the operating pressure of the tank. Pressurized storage tanks may be used for compressed natural gas (CNG) and liquefied petroleum gas (LPG).[49]

Operational Activities

Loading / Unloading

Terminal operations mainly consist of unloading / loading the product from supply links (e.g. vessels, pipelines, rail, and truck tankers) to storage tanks, and onward to distribution links, typically rail and truck tankers.

48 Environment Canada (2003)
49 Ibid.

Crude oil and petroleum product terminals generally employ above ground piping systems, consisting of pipelines, hoses / loading arms, valves, instrumentation connections, meters, and pump stations, to transfer the product between tanks and transport links. Other equipment includes vapor recovery systems and components of secondary containment zones in the loading bays for rail / tank trucks. Depending on the product, handling systems involving gravity, pump, compressor, and inert gas techniques are employed to move the product in and out of tanks. The design, construction, and operation of these systems are subject to international standards.[50] Terminals involving tanker ships have distinct loading and unloading considerations and equipment.

Additive Blending

During storage, a product sample is typically analyzed to ensure quality control. Various additives may be employed to increase product performance and other characteristics. For example, an additive to increase conductivity is typically added to jet kerosene while it is in the fuel storage tank. Other additives, such as gasoline oxygenates, including MTBE, may be employed at the time of loading to a truck or rail tanker for distribution.

Tank Drainage and Cleaning

Products may be contaminated with water from ship storage holds or from accumulation during storage due to condensation. Water is regularly drained from tanks using manual and automatic systems, and diverted to a retention unit and an oil / water separator. Recovered product is then pumped back into the original storage tank, and separated water is treated prior to discharge.

In addition to water drainage, the interior of tanks should be clean and corrosion free to avoid product contamination. Tanks are typically cleaned and inspected according to an established maintenance schedule based on the characteristics of the product being stored. For most petroleum products, an internal inspection interval based on the condition of the tank at the previous internal inspection is suitable (typically 10 years). For jet kerosene products, the inspection and cleaning regime for tanks should be performed with greater regularity due to the high purity requirements of the product. Tanks used for jet kerosene are typically cleaned every second year.

[50] An example is API Standard 2610 (2005).

Figure A.1: Typical Terminal Systems and Operations