Air Permit Technical Guidance for New Source Review Loading Operations

APD-ID 3v1

Air Permits Division Texas Commission on Environmental Quality

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Technical Disclaimer

This Package Is Intended for Instructional Use Only

This document is intended as guidance to explain the specific requirements for new source review permitting of loading operations; it does not supersede or replace any state or federal law, regulation, or rule. References to abatement equipment technologies and sample calculations are not intended to represent minimum or maximum levels of Best Available Control Technology (BACT). Determinations of BACT are made on a case-by-case basis during the review of New Source Review permit applications. BACT determinations are always subject to adjustment in consideration of specific process requirements, air quality concerns, and recent developments in abatement technology. Additionally, specific health effects concerns may result in stricter abatement than required by the BACT determination.

The represented calculation methods are intended as an aid in the completion of acceptable submittals; alternate calculation methods may be equally acceptable if they are based upon, and adequately demonstrate, sound engineering assumptions or data.

These guidelines and any regulations discussed or referenced in this document are applicable as of the publication date of this package but are subject to revision during the application preparation and review period. It is the responsibility of applicants to remain abreast of any guideline or regulation developments that may affect their industries.

The electronic version of this document may not contain attachments/forms/tables that can be obtained electronically elsewhere on the Texas Commission on Environmental Quality (TCEQ) website.

Examples of boilerplate special conditions are available on the TCEQ Internet site. Special Conditions included in an actual permit are written by the permit reviewer to address specific permit requirements and operating conditions.

I. Overview

The purpose of this document is to assist the permit applicant in calculating emissions, planning air abatement methods, identifying applicable State and Federal Regulations, and preparing a permit application for a project to build or modify a loading rack for loading volatile liquids. This document will also be used as a resource by agency staff.

Loading operations are conducted at almost every terminal (gasoline and bulk or "for hire" terminals), refinery, petrochemical, and chemical complexes in the state. This document will describe acceptable methods of calculating emissions from these operations and specify acceptable methods of capturing and controlling loading losses. This document does not address emissions from unloading, since these are accounted for as emissions from the receiving vessel. This document does not comprehensively address vacuum trucks, although guidance on calculation methods are given.

The TCEQ encourages pollution prevention, specifically source reduction, as a means of eliminating or reducing air emissions from industrial processes. The applicant should consider opportunities to prevent or reduce the generation of emissions at the source whenever possible through methods such as product substitutions, process changes, or training. Considering such opportunities prior to designing or applying “end-of-pipe” controls can not only reduce the generation of emissions but may also provide potential reductions in subsequent control design requirements (e.g., size) and costs.

II. Process Description

Loading operations may be classified according to the type of vessel being loaded and the type of facility where a loading operation occurs. The types of vessels loaded can be categorized as tank trucks, railcars, marine vessels (barges and ships), and smaller containers such as drums or totes. Facilities that conduct loading operations include gasoline terminals, chemical manufacturing facilities, petroleum refineries, for-hire chemical or fuels storage terminals, marine terminals, and small chemical blending facilities. Permit requirements depend on both the type of vessel loaded and the type of facility where the loading is conducted.

A. Tank Trucks

Tank trucks are motor vehicles used to transport liquids or gases via roads. Some operate near atmospheric pressure, while others are rated to handle higher pressures to transport gases or higher vapor pressure liquids. Depending on the type of fluid transported, tank trucks must be certified to meet specifications from the Department of Transportation (DOT). [For example, see 49 Code of Federal Regulations (CFR) §173.33]. Tank trucks are commonly used to transport gasoline and other fuels from terminals to local gasoline stations. Vapor return lines can be attached to route vapors displaced from the loading operation to a control or recovery device. Different types of connections are used in the loading procedure. “Quick connects” are clamp type connections that are not bolted or flanged. “Quick connects” can be used with atmospheric trucks, but hard-piped connections that are bolted or flanged to the receiving vessel should be used with pressure trucks.

B. Railcars

Specially designed railcars are used to transport volatile liquids via trains. These railcars are also subject to DOT specifications in 49 CFR §173.31. In most cases, railcars are pressure stressed and use hard-piped and/or bolted connections. Some railcars are equipped with spew gauges for determining the liquid level inside the railcar.

C. Marine Vessels

Marine loading can be broken down into two categories: barge and ship. Barges and ships are used to transport volatile liquids via waterways. Shallow draft barges generally travel only in inland waterways and have compartment depths of approximately 10 to 12 feet. Ships travel in international waters and generally have much deeper compartments. Ocean-going barges also travel in international waters and have deeper compartments. For emission calculation purposes, ocean-going barges are considered as ships. Ocean-going barges and ships are subject to regulation by the U.S. Coast Guard and by international maritime agreements. Very large crude carriers (VLCCs) or ultra large crude carriers (ULCCs) will require a case-by-case review.

D. Other Containers

Containers such as drums and totes are used to handle smaller quantities of chemicals. They are frequently used at smaller chemical blending facilities that prepare special blends of chemicals. At small facilities, or at facilities handling materials with low vapor pressures, loading may be uncontrolled. For loading of larger quantities of higher vapor pressure materials, containers can be loaded under an enclosure so that the displaced vapors can be collected and routed to a control or recovery device.

E. Types of Loading Facilities

Some loading operations are conducted directly at the production facility (e.g. petroleum refinery, large chemical manufacturing plant, small chemical blending installation.) Other loading operations take place at separate facilities called terminals. A terminal consists of storage tanks to store materials prior to transfer and loading racks to transfer the materials into tank trucks, railcars, or marine vessels. When materials with vapor pressures greater than 0.5 psia or higher are loaded, a control or recovery device will be used to abate emissions from the loading operations.

Terminals may be relatively small, containing only a few tanks and loading limited materials. For example, fuels terminals are used to store gasoline, diesel, ethanol, and special additives that are loaded into tank trucks and delivered to neighborhood gas stations. Other terminals can include hundreds of tanks that are authorized to store and load a wide range of chemicals, crude petroleum products, or fuels. Some terminals are owned and operated by the same entity that owns the materials handled. Others, known as “for-hire terminals” rent space in their tanks to outside entities. In these facilities, the terminal owner/operator does not own the stored material.

F. Loading Methods

In some loading operations, liquids are introduced into the bottom of vessel. This method is called “bottom fill.” Another method is called “submerged fill.” As the name indicates, the submerged fill liquid is introduced through a pipe or hose that extends below the level of liquid in the vessel being loaded. In “splash loading,” liquid is loaded from the top of the vessel above the liquid level. The splashing that occurs as the introduced liquid hits the liquid already present in the vessel contributes to increased saturation of the vapor space and higher emissions.

G. Vacuum trucks are used during maintenance operations for the removal of liquids from storage tanks, other vessels, and equipment, and from spills. Calculation of emissions and evaluation of controls for vacuum trucks depend upon the characteristics of the liquid transferred and on the mode of operation of the vacuum truck. If a positive displacement pump is used to move liquids into the vacuum truck, emissions can be calculated using Equation 1 in Section III. If an air mover is used to transfer liquids into the truck, the results of Equation 1 should be multiplied by a factor of 2. Some vacuum trucks operate by using a pump to draw a vacuum on the vacuum truck tank. The pump is then turned off and liquid is drawn into the tank using the vacuum in the tank. The tank is emptied prior to drawing another vacuum. In this mode of operation, no emissions would be generated during the vacuuming operation.

III. Basis for Emission Calculations

A. Basic Calculation

Emissions from loading operations are calculated using Equation 1 in AP-42 Chapter 5.2 dated June 2008:

$L_L = 12.46 \frac{SPM}{T}$ (Equation 1)

where

L_L = loading loss, pounds per 1,000 gallons (lbs/1,000 gal) of liquid loaded

S saturation factor (dimensionless)

P = true vapor pressure of liquid loaded, psia

M = molecular weight of the vapor in lb/lb-mol

T = temperature of liquid loaded in degrees Rankine (°R = °F + 460).

Short-term emissions should be estimated by using the worst-case combination of temperature and vapor pressure (typically the vapor pressure at the maximum expected temperature or 95°F, whichever is greater), and the design maximum pumping rate being used to fill the container. Annual emissions should be estimated by using the average annual temperature and vapor pressure of the compound and the maximum annual throughput of the compound.

B. Derivation of Loading Loss Equation

Loading losses from filling tank trucks, railcars, marine vessels (ships or barges), or other containers arise when vapors are displaced by the incoming liquid. The volume of vapor displaced is equal to the volume of incoming liquid. The ideal gas law can be used to estimate the number of moles of pollutant in the displaced vapor:

$n = PV/RT$ (Equation 2)

n = number of moles of pollutant

P = true vapor pressure of liquid loaded (psia)

V = volume of liquid loaded (gallons)

R = universal gas constant = 80.27 (psia gal)/(lb-mol R)

T = absolute temperature of liquid loaded (°R).

The mass in the vapor is calculated by multiplying the number of moles times the molecular weight.

$$L = (M)(n) \qquad \text{(Equation 3)}$$

L = Mass emissions from loading a volume of incoming liquid, V

M = molecular weight of the vapor in pounds per pound-mole (lb/lb-mol).

Mass emissions can be calculated by combining equations 2 and 3:

$$L = \frac{(P)(V)(M)}{(R)(T)} \text{ (Equation 4)}$$

Equation 4 can be used to calculate emissions in pounds for loading a volume of 1000 gallons of liquid as follows:

$$L_L = \frac{(P \text{ psia})(1000 \text{ gal})(M)}{(80.27 \text{ psia-gal/lb-mol R})(T)} \text{ (Equation 5).}$$

Simplifying by performing the arithmetic gives equation 6:

$$L_L = \frac{12.46(P)(M)}{T} \text{ (Equation 6).}$$

The equations derived above assume that the displaced vapors are fully saturated. The actual saturation is typically less than 100%, but in certain cases it can be higher. AP-42 Chapter 5.2, Equation 1, uses a factor “S” to account for the degree of saturation. With the addition of the saturation factor, Equation 6 becomes AP-42 Chapter 5.2, Equation 1.

C. Saturation Factor

The degree of saturation of the displaced vapors depends on the loading method, the geometry of the vessel, and the previous condition of the vessel being loaded. Bottom loading or submerged fill loading generally result in less than 100% saturation. Splash loading can lead to super-saturation (greater than 100%) due to the carry-over of liquid droplets. Loading of containers that are relatively shallow relative to their volume (such as tank trucks or barges) leads to higher saturation than deep containers (such as ships). The degree of saturation also depends on the previous cargo held by the vessel being loaded, since the initial vapors displaced contain residual vapors from the previous cargo. A vessel that has been cleaned prior to loading will have the lowest saturation, since there are no residual vapors, while a vessel that has been used in vapor balance service will be saturated with vapors from the previous cargo. BACT requires that most loading operations be carried out using bottom loading or submerged fill; splash loading is generally acceptable only for materials that are so viscous that bottom or submerged fill is technically infeasible.

TCEQ recommends use of the saturation factors in AP-42 Table 5.2-1 for all loading, including marine loading of gasoline and crude oil. The factors and equations suggested for marine loading of gasoline and crude oil in AP-42 were developed as averages from various tests and do not allow for input of the site-specific vapor pressure. Although use of these average factors may be appropriate for estimating emissions from a population of sources, calculations for air permitting purposes must be based on a reasonable worst-case estimate of emissions from a specific source. Therefore, use of the saturation factors for gasoline in AP-42 Chapter 5.2 Table 5.2-2 and equations (2) and (3) for crude oil is not accepted for permitting purposes.

Table 1. Saturation Factors For Calculating Liquid Loading Losses

Cargo Carrier	Mode of Operation	Saturation Factor (S)
Tank trucks and rail tank cars	Submerged loading: clean cargo tank	0.50
	Submerged loading: dedicated normal service	0.60
	Submerged loading: dedicated vapor balance service	1.00
	Splash loading: clean cargo tank	1.45
	Splash loading: dedicated normal service	1.45
Marine vessels	Submerged loading: ships and ocean-going barges	0.2
	Submerged loading: shallow draft barges	0.5

D. Collection Efficiency

The procedures discussed above are used to calculate uncontrolled emissions from loading operations. In many cases, emissions must be controlled to satisfy BACT or other regulatory requirements or to reduce impacts from a particular compound. Because of leaks in the collection system or from the vessel being loaded, some of the vapors displaced during loading escape capture and are emitted as loading fugitives. (Note that these “loading fugitives” are different than the fugitive emissions from equipment leaks described in Technical Guidance Document APDG 6422.) Collection efficiencies for the different categories of containers/vessels are discussed below.

(1) Tank Truck Loading

Collection efficiency for tank truck loading operations depends on the type of truck and connections used. If a pressure truck is used in atmospheric or pressure service, 100 percent collection efficiency may be obtained if the pressure truck is leak checked and certified annually in accordance with 49 CFR 180.407 DOT standards for pressure rating, and pressure stressed type connections are used.

Atmospheric trucks transporting compounds with a vapor pressure of 0.5 psia or greater need to be leak checked annually using the procedures in New Source Performance Standards (NSPS) 40 CFR 60 Subpart XX or Maximum Achievable Control Technology (MACT) 40 CFR 63 Subpart R. Vacuum loading can be used to increase collection efficiency. One hundred percent collection efficiency can be assumed for vacuum loading where a vacuum of -1.5 inches of water is maintained in the truck cavity and verified by continuous monitoring to ensure that the required vacuum is maintained throughout the loading process.

Accepted collection efficiencies for tank truck loading are as follows:

Annual Leak Checking per NSPS Subpart XX	98.7%
Annual Leak Checking per MACT Subpart R	99.2%
Vacuum Loading	100%
Pressure trucks	100%

(2) Railcar Loading

In most cases, railcars are pressure stressed, use hard-piped and/or bolted connections, and are subject to a leak checking program per DOT requirements. In these cases, collection efficiencies of 100% can be used. If no leak checking can be documented, or the use of hard-piped or bolted connections cannot be verified, or a spew gauge is used, assume 95% collection efficiency.

(3) Marine Loading

Traditionally, TCEQ has specified a collection efficiency of 95% for marine loading. This value had also been used for collection efficiency for tank trucks before EPA developed the specific collection efficiencies for testing under NSPS XX and MACT R. This lower, more conservative value was retained for marine loading because no data were available to indicate a higher value. Like tank trucks, shallow draft barges can claim a collection efficiency of 100% if loaded under vacuum with pressure monitoring to ensure that the vacuum is maintained throughout the loading operation. Ships and ocean-going barges are subject to specific U.S. Coast Guard requirements that require these vessels to maintain an inert atmosphere for safety purposes and thus preclude the use of vacuum loading to enhance collection efficiency. Discussions with the regulated community led to development of a test protocol to measure the collection efficiency from specific ships. After analysis of data from more than 60 such tests, TCEQ has adopted new guidance that assumes a collection efficiency of 99.9% provided the applicant agrees to follow additional monitoring, inspection, and recordkeeping requirements. See Appendix A for more details on the testing program. A collection efficiency of 95% must be used for shallow draft barges that do not use vacuum loading.

(4) Container Loading

When drums, totes, or similar containers are loaded there is generally not a means to directly route the recovered vapors to a control device. Therefore, when control of loading vapors is required, the loading operation must be performed in a total enclosure or a partial enclosure designed and operated with a face velocity of at least 200 feet per minute across all natural draft openings. Under these conditions, the collection efficiency can be assumed to be 100%.

(5) Speciation

Mixtures that have defined effects screening levels (ESL) such as gasoline and crude oil may not require additional speciation. For loading of other mixtures, emissions must be speciated based on the composition of the vapor, not the liquid. For mixtures that can be assumed to behave as ideal, Raoult's Law should be used to calculate the vapor composition, using the same procedures that are used for speciation of emissions from fixed-roof storage tanks.

III. Applicable Federal and State Requirements

A number of federal and state regulations address VOC loading operations. All permit applications must demonstrate that the facility will comply with all applicable rules and regulations. These include NSPS in 40 CFR Part 60, National Emission Standards for Hazardous Air Pollutants (NESHAPS) in 40 CFR Part 61, MACT standards in 40 CFR Part 63, and 30 Texas Administrative Code (TAC) Chapter 115. Some of the more common regulations affecting loading operations are listed below. For specific details, refer to the actual regulation.

Standards of Performance for New Stationary Sources (NSPS)

Title 40 CFR 60 Subpart XX - Standards of Performance for Bulk Gasoline Terminals sets emission limitations for bulk gasoline terminals. The standard itself is not applicable to other loading facilities, but it establishes a leak testing method (Method 27) for verifying that tank trucks into which volatile liquids are loaded are vapor tight. Loading operations using tanks that have been certified according to this subpart can claim a collection efficiency of 98.7%. The method can be used for tank trucks that would not be subject to the standard.

National Emission Standards for Hazardous Air Pollutants (NESHAP)

Title 40 CFR 61 Subpart BB - National Emission Standard for Benzene Emissions from Benzene Transfer Operations is applicable to facilities that load liquids with 70% by weight or more benzene. It includes a leak testing method for marine vessels.

NESHAP for Source Categories, Maximum Achievable Control Technology (MACT)

Title 40 CFR 63 Subpart G (HON) - National Emission Standards for Organic Hazardous Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater gives facility specific requirements for loading operations at Synthetic Organic Chemical Manufacturing Industry (SOCMI) facilities that are at major sources of hazardous air pollutants (HAP).

Title 40 CFR 63 Subpart R - National Emission Standards for Gasoline Distribution Facilities (Bulk Gasoline Terminals and Pipeline Breakout Stations) applies to gasoline distribution facilities located at sites that are major sources of HAP. It also contains a leak test method that can be used to claim a collection efficiency of 99.2%. The method can be used for tank trucks that would not be subject to the standard.

Title 40 CFR 63 Subpart Y - National Emission Standards for Marine Tank Vessel Loading Operations applies to marine vessel loading at terminals that are major sources of HAP. It also contains a leak test method for marine vessels that is considered BACT for ship and barge loading.

Title 40 CFR 63 Subpart CC - *National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries* contains facility-specific requirements for loading of gasoline at petroleum refineries that are major sources of HAP.

Title 40 CFR 63 Subpart EEEE (OLD) - National Emission Standards for Hazardous Air Pollutants: Organic Liquids Distribution (Non-Gasoline) contains requirements for organic liquids distribution operations loading materials other than gasoline at major sources of HAP.

Title 40 CFR 63 Subpart FFFF (MON) - National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing gives facility specific requirements for loading operations at facilities producing specified chemicals at major sources of HAP.

Title 40 CFR 63 Subpart BBBBBB - National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Distribution Bulk Terminals, Bulk Plants, and Pipeline Facilities applies to gasoline distribution facilities located at sites that are not major sources of HAP.

Title 30 TAC Chapter 115 Subchapter C: Volatile Organic Compound Transfer Operations

Division 1: Loading and Unloading of Volatile Organic Compounds limits VOC emissions from loading gasoline and other VOC into transport vessels and marine vessels in specified counties. Limits on marine vessel loading are effective only in the Houston-Galveston-Brazoria ozone nonattainment area.

Division 3: Control of Volatile Organic Compound Leaks from Transport Vessels requires annual leak checks for tanker trucks transporting gasoline or other VOC with vapor pressure greater than or equal to 0.5 psia in specified counties.

IV. BACT and Impacts Guidelines

In general, emissions from loading operations must be controlled when liquids with vapor pressures of 0.5 psia or greater are loaded. Collected vapors must be recovered or destroyed at an efficiency based on the control or recovery method used. Typical control devices include thermal oxidizers, vapor combustors, flares, carbon adsorption systems, vapor recovery units, and scrubbers. A control device efficiency of 99 – 99.9% is generally required for loading operations at chemical plants, although a flare with an efficiency of 98% may be used in some cases if properly justified in the application to the TCEQ. (Note that loading operations at coatings facilities or small chemical blending facilities may have a different level of BACT. For gasoline terminals, an emission level based on milligrams VOC per liter of gasoline loaded may be accepted as BACT.) These requirements apply regardless of the vessel that is being loaded (tank truck, railcar, container, or marine vessel).

In addition, tank trucks, railcars, and marine vessels into which liquids with vapor pressures of 0.5 psia or greater are loaded must be leak checked at least once per year or verified to be pressure rated. Railcars shall not be equipped with spew gauges, because a spew gauge compromises the vapor tightness of the railcar during the loading operation.

Regardless of the vapor pressure of the liquid loaded, all lines and connectors must be visually inspected for any defects prior to hookup. Lines and connectors that are visibly damaged must be removed from service. Loading operations shall cease immediately upon detection of any liquid leaking from the lines or connections. In addition, all loading must be conducted by submerged fill or bottom fill. Splash loading is not accepted as BACT with the exception of heavy liquids that are so viscous that the applicant demonstrates to the TCEQ that submerged or bottom fill is technically infeasible.

The minimum standard for atmospheric type tank trucks routed to control consists of annual leak checking according to NSPS Subpart XX standards. The same standard is used for chemicals other than gasoline even though these chemicals are not subject to the NSPS subpart. Tank trucks can also be leak checked according to the procedures in MACT Subpart R, which allows slightly higher collection efficiency. Loading liquids with vapor pressure less than 0.5 psia is not required to be controlled to meet BACT, but if such liquids are controlled, they should be loaded into tank trucks that have been leak checked in order to ensure that loading vapors are effectively captured.

In order to further reduce emissions or minimize off-property impacts, the applicant may use a vacuum loading system, which allows 100 percent collection.

Loading liquids with vapor pressure greater than or equal to 0.5 psia into containers such as barrels, totes, or pails must generally be performed in a total enclosure with the collected vapors routed to a control or recovery device. A partial enclosure designed and operated with a face velocity of at least 200 feet per minute across all natural draft openings can also be used. Exemptions from the requirement for collection and control may be made for loading into containers at small chemical blending facilities on a case-by-case basis.

Vapor balancing, in which vapors displaced from the loaded vessel are transferred back into the original vessel, is not considered a method of control because the vapors are not abated, just transferred. This practice is not accepted as BACT unless the displaced vapors are actually routed to control (for example, if the tank is vented to a control device). Vapor balance may be accepted as a means to reduce impacts, provided the vapors are ultimately controlled. (Note also that vapor balancing back to a truck as it is unloaded is not an acceptable method of control for the receiving vessel. As noted in the overview, unloading emissions are not otherwise addressed in this document.)

V. Sample Calculations

Example 1. The following example is based on truck loading 5,500,000 barrels (bbl) of gasoline (RVP-13) at a loading rack. It is submerged loading with dedicated normal service. The true average vapor pressure of the liquid loaded is 8.3 psia; the vapor molecular weight is 62 lb/lb-mol; and the annual temperature of the bulk liquid loaded is 70°F. Tank trucks are leak checked annually in accordance with the requirements of NSPS Subpart XX. Captured vapors are routed to a vapor recovery unit for 99% control.

Annual Loading Losses:

S = 0.6 for submerged loading, dedicated normal service

P = 8.3 psia

M = 62 lb/lb-mol

T = 530°R (70°F)

L_L = 12.46 (0.6)(8.3)(62)/530 = 7.26 lb/1000 gal liquid loaded

Total Uncontrolled Emissions =

$$\frac{7.26\ \text{lb}}{1000\ \text{gal}} \times \frac{5{,}500{,}000\ \text{bbl}}{\text{yr}} \times \frac{42\ \text{gal}}{\text{bbl}} \times \frac{\text{ton}}{2000\ \text{lb}} = 838.39\ \text{tons/yr}$$

Controlled Emissions = (838.39 tons/yr)(1 - 0.99) = 8.34 tons/yr

Loading fugitive emissions = (1 - 0.987) (838.39 tons/yr) = 10.90 tons/yr

Short-Term Uncontrolled Loading Losses:

Use the maximum filling rate and maximum true vapor pressure to calculate the maximum short-term emissions. At 95°F, the maximum vapor pressure is 11.0 psia. At this terminal, 50,000 gallons of gasoline can be loaded in one hour.

L_L = 12.46 (0.6)(11.0)(62)/555 = 9.19 lb/1000 gal

Uncontrolled Emissions =

$$\frac{9.19\ \text{lb}}{1000\ \text{gal}} \times \frac{50{,}000\ \text{gal}}{\text{hr}} = 459.33\ \text{lb/hr}$$

Controlled Emissions = (459.33 lb/hr)(1 - 0.99) = 4.59 lb/hr
Short-term Loading fugitive emissions = (1 - 0.987)(459.33 lb/hr) = 5.97 lb/hr

Example 2. The following example is based on railcar loading 3,000,000 gal/yr of ammonium sulfide. Hard-pipe connections are used with submerged loading, dedicated normal service. The annual vapor pressure of ammonium sulfide at 70°F is 1.29 psia. Its vapor molecular weight is 64 lb/lb-mol. There will be no loading fugitives since 100 percent collection efficiency is given for hard-piped loading of railcars.

Annual Loading Losses

S = 0.6 for submerged loading, dedicated normal service

P = 1.29 psia

M = 64 lb/lb-mol

T = 530°R (70°F)

L_L = 12.46 (0.6)(1.29)(64)/530 = 1.16 lb/ 1000 gallon ammonium sulfide loaded

Annual emissions =

$$\frac{1.16\ \text{lb}}{1000\ \text{gal}} \times \frac{3{,}000{,}000\ \text{gal}}{\text{yr}} \times \frac{\text{ton}}{2000\ \text{lb}} = 1.74\ \text{tons/yr}$$

Short-Term Loading Losses

The maximum filling rate of 200 gal/min and the maximum vapor pressure of 2.34 psia at 100°F are used to calculate short-term emissions.

L_L = 12.46(0.6)(2.34)(64)/560 = 2.00 lb/1000 gal ammonium sulfide loaded

Short-term loading emissions =

$$\frac{2.00\ \text{lb}}{1000\ \text{gal}} \times \frac{200\ \text{gal}}{\text{min}} \times \frac{60\ \text{min}}{\text{hr}} = 24.0\frac{\text{lb}}{\text{hr}}$$

Emissions are routed to a thermal oxidizer with a destruction efficiency of 99.9%, giving controlled emissions as follows

Annual: (1.74 tons/yr)(1 - 0.999) = 0.002 ton/yr

Short-term: (24 lb/hr)(1 - 0.999) = 0.024 lb/hr

Be sure to account for the sulfur dioxide that will be formed from the burning of a sulfide and any additional nitrogen oxides from burning a nitrogen-bound vapor. Assume 100% conversion of sulfur to sulfur dioxide. Nitrogen compounds are not necessarily all converted to nitrogen oxides; be sure to provide support for the assumptions used.

Example 3. The following example is based on barge loading 2,500,000 barrels per year of furfural. Submerged loading with dedicated normal service is used. The true annual vapor pressure at 70°F is 0.035 psia. The molecular weight is 96.08 lb/lb-mol. Furfural is being loaded without controls since its maximum vapor pressure is 0.096 psia at 95°F which is < 0.5 psia.

Annual Loading Losses

S = 0.5 for submerged loading of shallow-draft barges

P = 0.035 psia

M = 96.08 lb/lb-mol

T = 530°R (70°F)

L_L = 12.46(0.5)(0.035)(96.08)/530 = 0.040 lb/1000 gal furfural loaded

Annual emissions =

$$\frac{0.04\ \text{lb}}{1000\ \text{gal}} \times \frac{2{,}500{,}000\ \text{bbl}}{\text{yr}} \times \frac{42\ \text{gal}}{\text{bbl}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} = 2.08\ \text{tons/yr}$$

Short-Term Loading Losses

The maximum filling rate of 1,000 bbl/hr and the maximum vapor pressure of 0.096 psia at 95°F are used to calculate short-term emissions.

L_L = 12.46(0.5)(0.096)(96.08)/555 = 0.104 lb/1000 gal furfural loaded

Short-term loading emissions =

$$\frac{0.104\ \text{lb}}{1000\ \text{gal}} \times \frac{1000\ \text{bbl}}{\text{hr}} \times \frac{42\ \text{gal}}{\text{bbl}} = 4.37\ \text{lb/hr}$$

Example 4. The following example is based on loading 3,000,000 barrels per year of crude oil onto a ship. Submerged loading with dedicated normal service is used. The annual true vapor pressure at 70°F is 7.6 psia. The molecular weight is 56.0 lb/lb-mol. The capture efficiency is 99.9%. Captured emissions are routed to a flare at 98% destruction.

Annual Loading Losses

S = 0.2 for submerged loading of ships

P = 7.6 psia

M = 56.0 lb/lb-mol

T = 530°R (70°F)

L_L = 12.46(0.2)(7.6)(56.0)/530 = 2.00 lb/1000 gal loaded

Annual emissions =

$$\frac{2.00\ \text{lb}}{1000\ \text{gal}} \times \frac{3{,}000{,}000\ \text{bbl}}{\text{yr}} \times \frac{42\ \text{gal}}{\text{bbl}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} = 126\ \text{tons/yr}$$

Controlled Emissions = (126 tons/yr)(1 - 0.98) = 2.52 tons/yr
Loading fugitive emissions = (1 - 0.999) (126 tons/yr) = 0.126 tons/yr

Short-Term Loading Losses

The maximum filling rate of 8,000 bbl/hr and the maximum vapor pressure of 10.0 psia at 95°F are used to calculate short-term emissions.

L_L = 12.46(0.2)(10.0)(56.0)/555 = 2.51 lb/1000 gal loaded

Short-term loading emissions =

$$\frac{2.51\ \text{lb}}{1000\ \text{gal}} \times \frac{8000\ \text{bbl}}{\text{hr}} \times \frac{42\ \text{gal}}{\text{bbl}} = 843\ \text{lb/hr}$$

Controlled Emissions = (843 lb/hr)(1 - 0.98) = 16.86 lbs/hr

Loading fugitive emissions = (1 - 0.999) (843 lb/hr) = 0.843 lbs/hr

VI. Example Permit Conditions

Example Special Conditions may be found at the following website: https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/bpc_loading.pdf

Appendix A: Ship Loading Collection Efficiency

On September 21, 2016, TCEQ instituted new guidance regarding marine loading collection efficiencies for ocean-going marine vessels. The revised guidance allowed regulated entities to claim collection efficiencies of 99.0 to as high as 99.9 percent provided the entity agreed to specified conditions for monitoring, testing, and recordkeeping. Since that time, additional testing has been completed and submitted to TCEQ for review in compliance with the applicable NSR permits. After review of the data submitted, TCEQ has concluded that higher collection efficiencies are achieved with identification and repair of leaks at the beginning of the loading cycle. TCEQ now allows a collection efficiency of 99.9 percent to be claimed in an NSR authorization with attached special conditions. Additionally, the use of 99.9 percent capture efficiency is acceptable for sources authorized under Permit by Rule (PBR) provided the regulated entity certifies to following the additional monitoring, inspection, and recordkeeping requirements indicated in the attached special conditions.

This document summarizes the background and development of the revised guidance. Note that the guidance applies only to ocean-going marine vessels. Shallow draft, inland barges were not tested under the program. These vessels can use vacuum loading for 100% collection; for non-vacuum loading a collection efficiency of 95% is still applied.

Ships are classified as “mobile sources” and so are not generally subject to the regulatory authority of TCEQ. For example, TCEQ cannot regulate emissions from a ship’s propulsion engines while the ship is moving on the water. However, a ship becomes “stationary” when it is attached to a dock for purposes such as loading. Loading emissions from a ship at dock were initially evaluated only for impacts; these emissions became subject to full new source review around 2001.

The concept of collection efficiency is not relevant unless the emissions are routed to a control device. Because of leaks in the collection system or from the vessel being loaded, some of the vapors displaced during loading escape capture and are emitted as loading fugitives. When TCEQ first required that emissions from ship loading be quantified, a collection efficiency of 95% was assumed because that was the value used for tank trucks at that time. EPA later upgraded the collection efficiency for tank trucks based on test data from required annual vapor tightness testing of these trucks. TCEQ chose not to apply the higher values to ships due to the absence of specific test data for ships.

The use of the lower value for collection efficiency for ships became an issue with stakeholders because of the shortage of VOC credits in the Houston-Galveston-Brazoria ozone nonattainment area. Inland, shallow draft barges can use vacuum loading for 100 percent collection, but ships and ocean-going barges are subject to specific U.S. Coast Guard requirements (and international maritime treaties) that require these vessels to maintain an inert atmosphere for safety purposes and thus preclude the use of vacuum loading to enhance collection efficiency.

Discussions with the regulated community eventually led to the development of a test protocol to measure the collection efficiency from specific ships. The test protocol was initially developed by URS (now part of AECOM). The protocol calls for identifying potential leak sites on the ship. These potential leak sites are screened via EPA Method 21 while the ship is being loaded. Optical gas imaging devices are also used if possible, but because they are not intrinsically safe some captains will not allow their use on a ship. Initially, for any leaks of 500 parts by million by volume (ppmv) or greater identified by the Method 21 screening, leak rates were then measured using a Hi Flow sampler in a manner similar to what is done to develop site-specific correlations for equipment leak fugitives. This technique is also known as bagging.

The measured emission rates for all identified leaks were then multiplied by the loading duration (assuming that the leak occurred throughout the loading duration) to get a total leak rate for the loading event. Total loading emissions were calculated using Equation 1 in AP-42 Chapter 5.2 dated June 2008. The fractional collection efficiency was then calculated as one minus the measured uncollected fugitives divided by the total uncontrolled losses.

The first testing under the protocol was conducted in June of 2013. This initial test was conducted throughout the entire 63 hours of the loading operation. Testing during night hours proved to be difficult and dangerous with the low lighting and wet, slippery conditions. The protocol was thus adjusted to require testing only for a minimum of six hours, preferably near the end of the loading operation when there would be less available head space in the vessel and vapors would be most highly saturated.

The initial Hi Flow testing resulted in many readings below the 4.3 g/hr detection limit of the instrument. These measurements were assumed to be equal to one half the detection limit (2.2 g/hr). The protocol was subsequently revised to require Hi Flow testing only for leaks with a screening value greater than 2,500 ppmv. Components with a screening value less than 500 ppmv are assumed to not leak, and those with screening values between 500 and 2,500 ppmv are assumed to leak at a rate of 2.2 g/hr.

Between June 2013 and December 2019, TCEQ received 81 test reports from ten different regulated entities. The test data are summarized in Table A-1. The maximum collection efficiency achieved was 100%: three tests reported no leaks above 500 ppmv during the testing period. The lowest collection efficiency reported was 99.5%. In this test, however, initial screening indicated high leak rates on three components. These components were repaired by ship personnel during the testing and the readings were not included in the results. Had testing not been conducted on this ship, the leaking components would not likely have been identified and repaired, resulting in a collection efficiency closer to 99.1%. The average collection efficiency achieved was greater than 99.9%.

Materials loaded during the tests included crude oil, gasoline, gasoline blendstock, aviation gasoline, and naphtha with a reported range of vapor pressures from 1.6 to 11.0 psia. Ships tested ranged in size from 131,200 barrels to 802,158 barrels, with a median size of 330,000 barrels. They ranged in age from one to 37 years. No correlations were found between material loaded, ship size, or ship age and collection efficiency.

Initially, TCEQ allowed the use of collection efficiency higher than 95% only with up-front tests and the commitment to conduct further tests. As test results indicated collection efficiencies consistently greater than 99%, regulated entities were allowed to claim 99% collection efficiency without up-front testing but with a commitment to test 5 ships per year for 6 years.

With the guidance that was published on the TCEQ website on September 21, 2016, regulated entities were allowed to choose from one of four different categories of collection efficiencies. Collection efficiencies higher than 99% could be claimed only with an agreement to conduct ship tests, with more testing required for higher efficiencies. While the initial tests were conducted for research purposes, the tests required to support the claim of collection efficiencies higher than 99% were considered to be compliance tests. The monitoring requirements for Category 1 also applied to the other categories.

In Category 1, collection efficiency of 99.0% could be claimed without any testing requirements, provided that the regulated entity committed to additional monitoring requirements, including conducting audio, olfactory, and visual checks for leaks at least once every 8 hours for on-shore equipment and on board the ship during the loading operation.

In Category 2 collection efficiency up to 99.49% could be claimed with a requirement to conduct one test within 12 months of the first loading operation.

In Category 3 collection efficiency of 99.5 to 99.89% could be claimed with a requirement to conduct one test per year for 3 years.

In Category 4 collection efficiency of 99.9% could be claimed with a requirement to conduct 3 tests per year for 5 years.

The new guidance allows a claim of 99.9% as long as the regulated entity commits to the monitoring requirements specified below, including conducting audio, olfactory, and visual checks for leaks at least once every 8 hours for on-shore equipment and on board the ship during the loading operation. These checks can be made by the regulated entity or by ship personnel. The use of optical gas imaging devices to supplement the audio, olfactory, and visual checks is encouraged.

Minimum Monitoring Requirements for Marine Loading of Inerted Vessels

1. The following additional requirements apply to loading of a VOC which has a vapor pressure equal to or greater than 0.5 pounds per square inch absolute (psia) under actual storage conditions onto inerted marine vessels (ships).

   A. Before loading, the owner or operator of the marine terminal shall verify that the marine vessel has passed an annual vapor tightness test as specified in 40 CFR §63.565(c) (September 19, 1995) or 40 CFR §61.304(f) (October 17, 2000) within the previous twelve months, and received a recent, completed Standard Tanker Chartering Questionnaire form (Q88) or equivalent.

   B. The pressure at the vapor collection connection of an inerted marine vessel must be maintained such that the pressure in a vessels' cargo tanks do not go below 0.2 pounds per square inch gauge (psig) or exceed 80% of the lowest setting of any of the vessel's pressure relief valves. The lowest vessel cargo tank or vent header pressure relief valve setting for the vessel being loaded shall be recorded. Pressure shall be continuously monitored while the vessel is being loaded. Pressure shall be recorded at fifteen-minute intervals.

   C. VOC loading rates shall be recorded during loading. The loading rate must not exceed the maximum permitted loading rate.

   D. During loading, the owner or operator of the marine terminal or of the marine vessel shall conduct audio, olfactory, and visual checks for leaks within the first hour of loading and once every 8 hours thereafter for on-shore equipment and on board the ship.

      (1) If a liquid leak is detected during loading and cannot be repaired immediately (for example, by tightening a bolt or packing gland), then the loading operation shall cease until the leak is repaired.

      (2) If a vapor leak is detected by sight, sound, smell, or hydrocarbon gas analyzer during the loading operation, then a "first attempt" shall be made to repair the leak. Loading operations need not be ceased if the first attempt to repair the leak is not successful provided that the first attempt effort is documented by the owner or operator of the marine vessel and a copy of the repair log is made available to a representative of the marine terminal.

      (3) If the attempt to repair the leak is not successful and loading continues, emissions from the loading operation for that ship shall be calculated assuming a collection efficiency of 99%.

(4) An optical gas imaging instrument as defined in 30 TAC 115.358 may be used in addition to the audio, olfactory, and visual checks to identify leaks. [If requested by the regulated entity and approved by TCEQ in the permit review, the OGI instrument may be used instead of the audio, olfactory, and visual checks. The applicant requesting use of the OGI instrument must include a proposed protocol for the OGI. The protocol must include identification of the materials to be loaded, confirmation that the OGI instrument to be used will be sensitive to those materials, and calibration procedures to ensure that leaks will be detected.]

Date and time of each inspection shall be noted in the operator's log or equivalent. Records shall be maintained at the plant site of all repairs and replacements made due to leaks. These records shall be made available to representatives of the Texas Commission on Environmental Quality (TCEQ) upon request.