EMISSIONS FACTORS FOR EQUIPMENT LEAK FUGITIVE COMPONENTS

Technical Disclaimer

This document is intended to help you accurately determine equipment leak fugitive emissions. It does not supersede or replace any state or federal law, rule, or regulation.

This guidance reflects the current understanding of how piping components work and how they generate emissions, how they are monitored or tested, and what data are available for emissions determination, may change over time as we continue our scientific studies and as new information becomes available. We welcome any data, information, or feedback that may improve our understanding of equipment leak fugitive emissions and thereby further improve determinations within the emissions inventory.

The calculation methods represented are intended as an emissions calculation aid; alternate calculation methods may be equally acceptable if they are based upon, and adequately demonstrate, sound engineering assumptions or data. If you have a question regarding the acceptability of a given emissions determination method, contact the Emissions Assessment Section at 512-239-1773.

Introduction

This document provides emission factor guidance for determining equipment leak fugitive emissions from piping components and associated equipment at industrial facilities. It does not address emissions from cooling towers, oil/water separators, material stockpiles, loading operations, or other sources not related to piping components. Use this guidance in conjunction with *2007 Emissions Inventory Guidelines*, Appendix A, Technical Supplement 3: Equipment Leak Fugitives.

Guidance Available in This Document

This document provides appropriate emission factors to be used when determining emissions from piping component fugitives. Specifically, the emission factors included are:

- Correlation equations – synthetic organic chemical manufacturing industry (SOCMI);
- Correlation equations – petroleum industry;
- Average emission factors – SOCMI;
- Average emission factors – oil and gas production;
- Average emission factors – refinery; and
- Average emission factors – petroleum marketing terminal.

Determining Emissions from Monitored Components

Quantifying Emissions Using Correlation Equations

Emissions determinations for monitored equipment leak fugitive emissions sources must be determined using site-specific monitoring data. Specifically, correlation equations must be used to determine emissions when a permit condition, TCEQ rule, or commission order requires the retention of screening value data.

Correlation equations use an instrument-measured VOC concentration screening value to determine a component-specific emission rate. Screening value data are collected using a portable monitoring instrument to sample air from potential leak interfaces on individual pieces of equipment. Screening data must be collected in accordance with EPA Reference Method 21, as detailed in 40 CFR 60, Appendix A and *Protocol for Equipment Leak Emission Estimates* (EPA-453/R-95-017), available at the EPA's Web site at <http://www.epa.gov/ttnchie1/publications.html>.

To determine emissions, the screening value data are used either in industry-specific correlation equations developed by the EPA or in correlation equations developed by a company for a specific process unit. The EPA has approved separate correlation equation sets for SOCMI components and petroleum industry components (that includes refineries, marketing terminals, and oil and gas production facilities).

The TCEQ accepts the use of correlation equations for screening values between zero and 100,000 parts per million. To determine emissions using correlation equations, you must consider each component's screening value (adjusted for the background concentration) as follows:

- Before using the screening value in the appropriate correlation equation, determine the screened stream's response factor and, if necessary, adjust the screening value according to the guidance in *Protocol for Equipment Leak Emission Estimates*.
- For each component with a nonzero and nonpegged screening value, enter the screening value into the applicable correlation equation to determine a mass emission rate. Sum the individual mass emission rates for each component to determine a total leak rate. Note that each individual screening value must be entered into the correlation equation to predict a component's leak rate. Averaged screening values should not be used to determine emissions.
- For each component with a screening value of zero, note that, although the correlations predict a leak rate of zero for screening values of zero, the EPA data suggest that this prediction is incorrect. For screening values of zero, the EPA has established a default zero leak rate that should be applied to each component whose screening value was zero.

- For each component with a pegged screening value, use the EPA-developed default 100,000 ppm pegged leak rate. Note that if a pegged value of 10,000 ppm is indicated (i.e., the instrument will not quantify the screening value between 10,000 ppm and 100,000 ppm), then use the default 100,000 ppm pegged leak rate—**not** the default 10,000 ppm rate.

Since a component's screening concentration may vary from one monitoring period to another, emissions for each period should be based upon each component's screening concentration for that period. These period-specific emission rates should then be summed to obtain an annual emissions rate. For example, if components are monitored quarterly, each component's quarterly screening value should be used to determine quarterly emissions, and then the quarterly emission rates summed to obtain the component's total annual emissions.

When determining a component's leak duration, it would be most conservative to assume that the component was leaking at the measured concentration for the entire period since last monitored. An acceptable engineering estimate would be that the component was leaking at the measured concentration for half the monitoring period, plus the time needed to repair the component. The EAS must approve any other method of determining leak durations before you use it.

When using the correlation equations to calculate emissions, the components must be monitored at least once during the year. Using monitoring data from a previous year to estimate future emissions is a difficult process. If this is done, sound engineering assumptions to support the calculations must be provided with the emissions inventory.

The correlation equations, default zero factors, and default pegged factors are found in Table 1, "Correlation Equations – SOCMI" and Table 4, "Correlation Equations – Petroleum Industry."

Unit-Specific Correlation Equations

If a regulated entity has developed its own set of unit-specific correlation equations for its equipment leak fugitive components, those equations may be used to determine emissions only if the equations, sampling procedures, and all related procedures and data comply with EPA Reference Method 21 and the guidance in *Protocol for Equipment Leak Emission Estimates*.

When using company-developed correlation equations, supply supporting documentation indicating the basis for these equations. Also, if the site-specific equations do not take into consideration components with screening values of zero, the EAS may require the use of the EPA's default zero leak rates. Likewise, if the site-specific equations do not include components with pegged screening values, the EAS may require the use of the EPA's pegged leak rates.

Quantifying Emissions from Components Monitored by an Audio/Visual/Olfactory (AVO) Inspection

For odorous or toxic inorganic compounds, an AVO inspection may be required by TCEQ rule, commission order, or permit condition. Generally, an AVO inspection program may only be applied to inorganic compounds that cannot be monitored by instrument. In limited instances, the AVO inspection program may be applied to extremely odorous organic compounds such as mercaptans.

If no monitoring or screening data exist for AVO-monitored components, then average emissions factors with AVO reduction credits applied can be used to determine emissions. To claim credit for this program, you must be able to produce, upon request, documentation that all elements of the program are in place and were followed.

Determining Emissions from Unmonitored Components

Quantifying Emissions Using Average Factors

Average emission factors are divided into four categories:

- SOCMI factors,
- oil and gas production factors,
- refinery factors, and
- factors for petroleum marketing terminals.

Within each category, factors vary depending upon specific component type (connectors, valves, pumps, etc.) and material in service (light liquid, heavy liquid, gas-vapor, or water–light liquid). For components in liquid service, you may need to choose between a "heavy liquid" factor and a "light liquid" factor. Use the "heavy liquid" factor if the stream's vapor pressure is less than or equal to 0.044 psia at 68°F. If the stream's vapor pressure is greater than 0.044 psia at 68°F, use the appropriate "light liquid" factor.

Note that the average factors generally determine total hydrocarbon emissions. Therefore, you may need to multiply the calculated emission rates by the stream's weight percentage of VOC compounds to determine total VOC emissions.

The EPA average emissions factors for the industry types described in the following sections can be found in *Protocol for Equipment Leak Emission Estimates* (EPA-453/R-95-017), available at the EPA Web site at <http://www.epa.gov/ttnchie1/publications.html>.

SOCMI Factors

Use the SOCMI factors to determine equipment leak emissions from chemical plants or chemical processes within refineries. SOCMI factors are divided into three categories: SOCMI average factors, "SOCMI with ethylene" factors, and "SOCMI without ethylene" factors.

Use the SOCMI average factors, which were developed to represent fugitive emission rates from all chemical plants, for streams containing between 11 percent and 85 percent ethylene. For streams containing more than 85 percent ethylene, use the "SOCMI with ethylene" factors. For streams containing less than 11 percent ethylene, use the "SOCMI without ethylene" factors.

These factors are found in Table 3, "Average Emission Factors – SOCMI."

Oil and Gas Production Factors

The oil and gas production factors are based on oil and gas production equipment leak emissions data gathered by the American Petroleum Institute and evaluated by the EPA. The oil and gas production factors include four different equipment service categories: gas, heavy oil (less than 20° API gravity), light oil (greater than 20° API gravity), and water/light oil (water streams in light oil service with a water content between 50 percent and 99 percent).

These factors are found in Table 4, "Average Emission Factors – Petroleum Industry."

Refinery Factors

Use refinery factors to determine equipment leak fugitive emissions from a refinery process. For a chemical process located within a refinery that is not specifically considered a refinery process (for example, an MTBE production unit), use the SOCMI factors rather than the refinery factors to calculate emissions.

These factors are found in Table 4, "Average Emission Factors – Petroleum Industry."

Petroleum Marketing Terminal Factors

Use the factors for petroleum marketing terminals to determine equipment leak fugitive emissions at gasoline-distribution facilities that are one step removed from local gasoline stations and other end users. Do not use these factors to determine equipment leak fugitive emissions from loading racks at chemical plants and refineries; instead, use the appropriate SOCMI or refinery factors.

The use of these factors must be accompanied by an AVO program performed monthly. To claim credit for this program, you must be able to produce, upon request, documentation that all elements of the program are in place and were followed. Because the petroleum marketing terminal factors include the appropriate reduction credit for the AVO inspection, no additional reductions may be taken.

If a monthly AVO inspection was not performed, use the refinery factors to determine emissions.

These factors are found in Table 4, "Average Emission Factors – Petroleum Industry."

References

Texas Commission on Environmental Quality. 2000. Air Permit Technical Guidance for Chemical Sources: Equipment Leak Fugitives. TCEQ Air Permits Division draft document. Available online at: <http://www.tceq.state.tx.us/goto/nsr_chemguidance>. Accessed December 18, 2007.

U.S. Environmental Protection Agency. 1996. Preferred and Alternative Methods for Estimating Fugitive Emissions from Equipment Leaks. Vol. 2, Emissions Inventory Improvement Program Document Series, chapter 4. Available online at: <www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html>. Accessed December 18, 2007.

U.S. Environmental Protection Agency. 1995. Protocol for Equipment Leak Emission Estimates. EPA-453/R-95-017. Available online at: <www.epa.gov/ttnchie1/publications.html>. Accessed December 18, 2007.

Table 1. Correlation Equations - SOCMI.

Equipment/Service	**Default Zero Emission Rate** [1] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-33.	**Screening Value Correlations** [2] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-26.	**Default 100,000 ppm Pegged Rate** [3] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-36.
Valves: Gas	1.46e-06	$4.12E\text{-}06 \times (SV)^{0.873}$	0.243
Valves: Light Liquid	1.08e-06	$1.41E\text{-}05 \times (SV)^{0.797}$	0.331
Pumps: Light Liquid [4]	1.65e-05	$4.19E\text{-}05 \times (SV)^{0.824}$	1.37
Connectors	1.34e-06	$6.72E\text{-}06 \times (SV)^{0.885}$	0.485

All factors are in units of (lb/hr)/component.

Notes:
1. Use for screening values of zero, adjusted for background.
2. Use for nonzero and nonpegged screening values.
3. Use for screening values which peg the monitoring instrument.
4. The light liquid pump factors can be applied to compressor seals, pressure relief valves, agitator seals, and heavy liquid pumps.

Table 2. Correlation Equations - Petroleum Industry.

Equipment/Service	Default Zero Emission Rate [1] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-34.	Screening Value Correlations [2] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-27.	Default 100,000 ppm Pegged Rate [3] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-37.
Valves: All	1.72e-05	$5.05E\text{-}06 \times (SV)^{0.746}$	0.309
Pumps: All	5.29e-05	$1.11E\text{-}04 \times (SV)^{0.610}$	0.353
Connectors : All	1.65e-05	$3.37E\text{-}06 \times (SV)^{0.735}$	0.0661
Flanges: All	6.83e-07	$1.02E\text{-}05 \times (SV)^{0.703}$	0.185
Open-ended Lines: All	4.41e-06	$4.85E\text{-}06 \times (SV)^{0.704}$	0.174
Others[4]	8.82e-06	$3.00E\text{-}05 \times (SV)^{0.589}$	0.243

All factors are in units of (lb/hr)/component.

Notes:
1. Use for screening values of zero, adjusted for background.
2. Use for nonzero and nonpegged screening values.
3. Use for screening values which peg the monitoring instrument.
4. The other equipment type should be applied to any equipment type other than connectors, flanges, open-ended lines, pumps, or valves.

Table 3. Average Emission Factors - SOCMI.

Equipment/Service	**SOCMI Average** [1] Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-12.	**SOCMI Without Ethylene** [1] TCEQ- derived factors.	**SOCMI With Ethylene** [1] TCEQ- derived factors.
Valves: Gas/Vapor	0.0132	0.0089	0.0258
Light Liquid	0.0089	0.0035	0.0459
Heavy Liquid	0.0005	0.0007	0.0005
Pumps: Light Liquid	0.0439	0.0386	0.144
Heavy Liquid	0.019	0.0161	0.0046
Flanges/Connectors : Gas	0.0039	0.0029	0.0053
Light Liquid	0.0005	0.0005	0.0052
Heavy Liquid	0.00007	0.00007	0.00007
Compressors	0.5027	0.5027	0.5027
Relief Valve (Gas/Vapor)	0.2293	0.2293	0.2293
Open-ended Lines [2]	0.0038	0.004	0.0075
Sampling Connections	0.033	0.033	0.033

Notes: 1. All factors are in units of (lb/hr)/component.
2. The 28 Series quarterly LDAR programs require open-ended lines to be equipped with a cap, blind flange, plug, or a second valve. If so equipped, open-ended lines may be given a 100% control credit.

Table 4. Average Emission Factors - Petroleum Industry.

Equipment/Service	Petroleum Marketing Terminal [1]	Oil and Gas Production Operations [2]				Refinery [3]
		Gas	Heavy Oil <20° API	Light Oil >20° API	Water/ Light Oil	
Valves		0.00992	0.0000185	0.0055	0.000216	
Gas/Vapor	0.0000287	0.00992				0.059
Light Liquid	0.0000948					0.024
Heavy Liquid	0.0000948					0.000510
Pumps		0.00529	0.0011300	0.02866	0.00005290	
Light Liquid	0.00119					0.251
Heavy Liquid	0.00119					0.046
Flanges/Connectors		0.000860	0.00000086	0.000243	0.00000617	0.000550
Gas/Vapor	0.000092604	0.000860				
Light Liquid	0.00001762					
Heavy Liquid	0.00001720					
Compressors		0.0194	0.0000683	0.0165	0.0309	1.399
Relief Valve Gas/Vapor		0.0194	0.0000683	0.0165	0.0309	0.35
Open-ended Lines [4]		0.00441	0.0003090	0.00309	0.0006	0.0051
Sampling Connections [5]						0.033
Connectors		0.000440	0.0000165	0.0004630	0.000243	
Other [6]		0.0194	0.0000683	0.0165	0.0309	
Gas/Vapor	0.000265					
Light/heavy Liquid	0.000287					
Process Drains		0.0194	0.0000683	0.0165	0.0309	0.07

All factors are in units of (lb/hr)/component.

Notes:
1. Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-14.
2. Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-15.
3. Factors taken from EPA document EPA-453/R-95-017; November, 1995; pp. 2-13.
4. The 28 Series quarterly LDAR programs require open-ended lines to be equipped with a cap, blind flange, plug, or a second valve. If so equipped, open-ended lines may be given a 100% control credit.
5. Factor for Sampling Connections is in terms of pounds per hour per sample taken.
6. For Petroleum Marketing Terminals, ”Other” includes any component except fittings, pumps, and valves. For Oil & Gas Production Operations, “Other” includes diaphragms, dump arms, hatches, instruments, meters, polished rods, and vents.