Texas Commission on Environmental Quality
Air Permits Division

New Source Review (NSR) Emission Calculations

This information is maintained by the Chemical NSR Section and is subject to change. Last update was made **June 2007**. These emission calculations represent current NSR guidelines and are provided for informational purposes only. The emission calculations are subject to change based on TCEQ case by case evaluation. Please contact the appropriate Chemical NSR Section management if there are questions related to the emission calculations.

Bulk Gasoline Terminal Calculations

LOADING LOSSES

Loading losses are comprised of the total vapors displaced and generated by loading liquid into a container. Assume:

1. Gasoline with 3 weight percent benzene content.
2. Annual volume loaded = $400{,}000 \frac{barrels}{year}$.
3. Maximum loading rate = $750 \ \frac{gallons}{\min}$.
4. Gasoline vapor pressure = 7.4 psia @ 68°F; 8.8 psia @ 90°F.

Calculate annual uncontrolled emissions in accordance with AP-42, Section 4.4 equation below:

$$\text{LL} = 12.46 \left(\frac{SPM}{T} \right) \text{ where:}$$

LL = loading loss, lb/1000 gallons of gasoline loaded.
S = See current AP 42 saturation factor.
P = True Vapor Pressure at maximum temperature, psia.
M = Molecular weight of gasoline vapor, $\frac{lb}{lb-mol}$.
T = Temperature of bulk gasoline loaded, degrees Rankine.
TPY = Emissions, tons per year.

Note: A saturation factor of 1.0 will normally be used for gasoline. This is based upon the increasingly prevalent practice of vapor-balanced unloading of the tank truck into the gasoline station storage tank, so that saturated vapors are displaced from the truck tank when the truck is next loaded.

$$LL(annual) = \frac{12.46(1.0)(7.4\,psia)(66\,lb/mol)}{(460+68)\,°R} = \frac{11.53\,lb\,VOC}{1000\,gallons\,loaded}$$

$$\text{Total annual emissions} = \left(\frac{400{,}000\,bbl}{yr}\right)\left(\frac{42\,gal}{bbl}\right)\left(\frac{11.53\,lb}{1000\,gal}\right)\left(\frac{ton}{2000\,lb}\right) = 96.85\,TPY$$

$$\text{LL (short-term)} = \frac{12.46(1.0)(8.8)(66\,lb/mol)}{(460+90)} = \frac{13.16\,lb\,VOC}{1000\,gallons}$$

$$\text{Total short-term emissions} = \left(\frac{750\,gal}{\min}\right)\left(\frac{60\,\min}{hr}\right)\left(\frac{13.16\,lb}{1000\,gal}\right) = 592.2\,\frac{lb}{hr}$$

CONTROL DEVICE EMISSIONS

Elevated Flare @ 98% Destruction Efficiency:

Annual emissions = (96.85 TPY) (0.987 collection efficiency) (0.02) = 1.91 TPY

$$\text{Short-term emissions} = \left(\frac{592.2\,lb}{hr}\right)(0.987)\ 0.02) = 11.69\,\frac{lb}{hr}$$

Enclosed Flare or CAS @ $\frac{0.09\,lb}{1000\,gallons\,loaded}$ (Reg. V):

$$\text{Annual emissions} = \left(\frac{400{,}000\,bbl}{yr}\right)\left(\frac{42\,gal}{bbl}\right)\left(\frac{0.09\,lb}{1000\,gal}\right)\left(\frac{60\,\min}{hr}\right) = 0.76\ \text{TPY}$$

$$\text{Short-term emissions} = \left(\frac{750\,gal}{\min}\right)\left(\frac{0.09\,lb}{1000gal}\right)\left(\frac{60\,\min}{hr}\right) = 4.05\,\frac{lb}{hr}$$

Enclosed Flare or CAS @ $\frac{10\,mg}{liter\,loaded}$ (MACT): Same as above using $\frac{0.083\,lb}{1000\,gallons}$

UNCOLLECTED LOADING LOSSES

Annual uncollected losses @ 98.7% collection efficiency = (96.85 TPY) (0.013) = 1.26 TPY

$$\text{Short-term uncollected losses @ 98.7\% coll. eff.} = \left(592.2\,\frac{lb}{hr}\right)(0.013) = 7.70\,\frac{lb}{hr}$$

BENZENE CALCULATIONS (Using Raoult's and Dalton's Laws)

Conditions (worst-case, short-term):

1. 3.0 Wt. percent benzene in gasoline.
2. Mol. Wt. benzene = 78 $\frac{lb}{lb-mol}$.
3. Mol. Wt. gasoline (liquid) = 92.2 $\frac{lb}{lb-mol}$.
4. Vapor Pressure of benzene @ 90F = 2.6 psia.
5. Mol. Wt. gasoline (vapor) = 66 $\frac{lb}{lb-mol}$.
6. Vapor Pressure of gasoline @ 90F = 8.8 psia.

Mole percent benzene in liquid = $\frac{3.0(92.2)}{78}$ = 3.55 mole percent in liquid.

Partial pressure of benzene in gasoline vapor = 2.6 (0.0355) = 0.0923 psia.

Mole fraction benzene in vapor = $\frac{0.0923}{8.8}$ = 0.010.

Wt. fraction benzene in vapor = $\frac{0.010(78)}{66}$ = 0.012.

Short-term uncollected benzene loading losses = 7.7 $\frac{lb}{hr}$ (0.012) = 0.09 $\frac{lb}{hr}$.

Annual uncollected benzene loading losses should be calculated similarly, but using annual average benzene concentration in gasoline, temperature and vapor pressures.

Note: For additional loading operations details, see the document entitled “Air Quality Permit Technical Guidance for Chemical Sources: Storage Tanks and Loading Operations.”

EQUIPMENT FUGITIVES

For purposes of calculations, assume the gasoline terminal consists of the following equipment components:

18 - light liquid pumps
780 - light liquid flanges
150 - light liquid valves
30 - pressure relief devices
18 - capped open-ended lines

Set up a table showing the number of components, fugitive emission factor and calculated fugitive emissions using the AVO LDAR. The fugitive components are multiplied by a factor which includes the control efficiency, to calculate the controlled fugitive emissions.

Equipment	PMT Factor	Controlled Emissions
18 - LL pumps	1.19×10^{-3}	$0.0214\left(\frac{lb}{hr}\right)$
780 - LL flanges	1.76×10^{-5}	$0.0137\left(\frac{lb}{hr}\right)$
150 - LL valves	9.48×10^{-5}	$0.0142\left(\frac{lb}{hr}\right)$
30 - gas PRVs	2.65×10^{-4}	$0.0080\left(\frac{lb}{hr}\right)$
18 - capped lines	0.00	$0.0000\left(\frac{lb}{hr}\right)$

Total Emissions = $0.0573\frac{lb}{hr}$.

Controlled benzene fugitives @ 3 wt. percent benzene in gasoline = $\left(\frac{0.0573lb}{hr}\right)(0.03)$

$= 0.0017\frac{lb}{hr}$.

Note: For additional information on equipment fugitives, see Technical Guidance Package for Chemical Sources, Equipment Leak Fugitives.

STORAGE TANK EMISSIONS

For purposes of calculating storage tank emissions, short term emissions from a fixed roof tank will be calculated in accordance with the equation below:

$$L\max = \frac{Lw \times FRm}{N \times Tcg}$$

where:

L_{max} = maximum short term emission rate, $\frac{lbs}{hr}$

L_W = working loss calculated using AP-42 at maximum liquid surface temperature, $\frac{lbs}{yr}$

Note: Units are $\frac{lbs}{yr}$, not $\frac{lbs}{hr}$. L_W is calculated using a turnover factor, K_N of 1.0.

FR_m = maximum filling rate, $\frac{gallons}{hr}$

N = number of turnovers per year, dimension less

T_{cg} = tank capacity, gallons

To calculate a typical maximum short term emission rate, the following variables will be used:

$L_W = 300{,}000 \ \frac{lbs}{yr}$

$FR_m = 200 \ \frac{gallons}{hr}$

$N = 50 \ \frac{turnovers}{yr}$ (dimension less)

T_{cg} = 560,000 gallons

Using the above information, the maximum short term emission rate in $\frac{lbs}{hr}$ can be calculated as follows:

$$L_{MAX} = \frac{300{,}000 \times 200}{50 \times 560{,}000} = 2.14 \ \frac{lbs}{hr} \text{ maximum hourly emission}$$

So maximum hourly benzene emissions would then be = $2.14 \ \frac{lb}{hr}$ x 0.012 = $0.03 \ \frac{lb}{hr}$.

Short term emissions from floating roof tanks are calculated by using the appropriate equations from AP-42 and using a maximum throughput, Q_{MAX}, calculated by the following equation:

$$Q_{MAX} = PR_M \times 8760$$

where:

Q_{MAX} = maximum throughput, $\frac{bbls}{year}$

PR_m = maximum pumping rate (higher of the maximum fill rate or the maximum withdrawal rate), $\frac{bbls}{hr}$ (NOTE: units are $\frac{bbls}{hour}$ not $\frac{gallons}{hour}$. A pumping rate in $\frac{gallons}{hr}$ must be divided by 42 to get $\frac{bbls}{hr}$.)

8760 = total hours per year, $\frac{hours}{year}$

Q_{MAX} is then used in the appropriate AP-42 equation to arrive at the maximum withdrawal losses.

Note: For additional information on Storage Tanks, see the document entitled "Air Quality Permit Technical Guidance for Chemical Sources: Storage Tanks and Loading Operations."