

Massachusetts

2011 Periodic Emissions Inventory of VOC, NO_x, CO, SO₂, PM₁₀, PM_{2.5} and NH₃

February 2018

SECTION 3

STATIONARY AREA SOURCES

(continued)

3.2 GASOLINE DISTRIBUTION LOSSES

Description

Evaporative VOC emissions result from vapor losses at all stages in the gasoline distribution process. Bulk terminals and bulk plants, which are intermediate distributive points between refineries and outlets, have been inventoried as point sources. Also included in this section are emissions from petroleum vessel unloading/ballasting/transit and portable fuel containers (PFCs). Vehicle Refueling - Stage II emissions are estimated in the On-Road Mobile Section. The following are the gasoline operations that emit VOC.

1. Tank Truck Unloading into Underground Tanks (Stage I)
2. Vehicle Refueling (Stage II) (*estimated in On-road Mobile Section*)
3. Underground Tank Breathing
4. Tank Trucks in Transit Losses
5. Bulk Plants/Terminals (EPA estimate)
6. Gasoline Pipelines (EPA estimate)
7. Petroleum Vessel Unloading/Ballasting/Transit
8. Portable Fuel Containers (PFCs)
9. Aviation Gasoline Distribution

Methodology

EPA's emission inventory guidances (Volume 1¹ and EIIP Volume III -Area Sources Chapter 11 Gasoline Marketing)² state that the most appropriate approach for determining VOC emissions from gasoline distribution is to use gasoline sales or consumption as the activity factor, multiplied by AP-42 emission factors.³ MassDEP used the MA Department of Revenue (MA-DOR) Excises Unit⁴ monthly gasoline sales reports for 2011.

MassDEP followed the EIIP recommended procedure for calculating VOC emissions from gasoline distribution by multiplying the gasoline sales by the appropriate EPA AP-42 emission factors and adjusting for rule effectiveness (RE). MassDEP applied RE to categories that were subject to regulatory control and seasonally adjusted the emissions for a typical summer day. The following is the formula for VOC emissions estimation from gasoline distribution categories.

Uncontrolled Emissions = Gasoline sales * emission factor * seasonal adjustment/activity days per year.

The formula for applying Rule Effectiveness (RE) is:

Net Emissions = Uncontrolled Emissions * [1- (Control efficiency) (RE)]

3.2-1 TANK TRUCK UNLOADING (STAGE I)

VOC emissions from tank truck unloading are generally determined by the type of filling method at the service station. The following are the three methods: splash, submerged and balanced (submerged with vapor recovery system). The Massachusetts regulation 310 CMR 7.24⁵ which took effect July 1, 1991, stipulated that all stationary service station tanks with a capacity between 250 to 40,000 gallons must have submerged fill, and a Stage I vapor recovery system with a control efficiency of at least 95% of the gasoline vapors.

In order to estimate the proportion of gasoline distribution subject to the Stage I regulation, MassDEP used its Stage II Background Document⁶ that had a service station cut-off point of 10,000 gallons throughput per month. In this document MassDEP estimated that less than 1% of the stations (0.17%) were below that throughput and were exempt from the Stage II Regulation. MassDEP used this same percentage as the estimate of smaller gas stations exempt from the Stage I regulation. MassDEP applied the rule effectiveness formula that addressed the vapor recovery system estimated at 95% control efficiency (CE), a rule effectiveness (RE) of 84% and a rule penetration (RP) of 99.8%.

AP-42 Table 5.2-7 and EIIP Table 11.3-1 provided the uncontrolled emission factor of 7.3 lb/10³ gallons for submerged-fill.

¹ "Procedures for the Preparation of Emission Inventories for Precursors of Ozone." Volume 1: General Guidance for Stationary Sources. EPA. 450/4-91-016 OAQPS RTP NC, May 1991.

² Emission Inventory Improvement Program (EIIP). Guidance for Emission Inventory Development Volume III, Chapter 11 "Gasoline Marketing (Stage I & II)" EPA 454/R-97-004A OAQPS MD-14. STAPPA/ALAPCO/EPA, Revised Final, January 2001. http://www.epa.gov/ttn/chief/eiip/techreport/volume03/iii11_apr2001.pdf

³ "AP-42 Compilation of Air Pollutant Emission Factors" Volume 1. Stationary Point and Area Sources. 4th Ed. OAQPS RTP.NC. Supplement D September 1991. AP-42 5th Edition, January 1995, Supplement A, February 1996, Supplement C, 1997. <http://www.epa.gov/ttn/chief/ap42/ch05/>

⁴ Massachusetts Department of Revenue (DOR) Excises Unit "Motor Fuels Monthly Summary Report 2008."

⁵ Massachusetts Air Pollution Control Regulations. 310 CMR 7.24.3&6, August 3, 2001.

⁶ Massachusetts DEP, Division of Air Quality Control. "Stage II Gasoline Vapor Recovery Program." Background Information and Technical Support Document for Public Hearings on the Proposed Amendments to 310 CMR 7.00 MGL c.111 Section 142A-142E, 1/1989

MassDEP apportioned gasoline distribution to counties based on vehicle miles traveled supplied by the Massachusetts Department of Transportation (MassDOT) and reported in Section 4 (On-Road Mobile Sources) of this report. The summer gasoline sales from MA-DOR amounted to 25.6% of the annual total. The summer months or peak ozone season covers June through August at 13 weeks or 92 days if activity is 7 days/week, and 78 days if activity is 6 days/week (6 days/week was used because delivery usually does not occur on Sundays).

BALANCED SUBMERGED FILL (STAGE I)

Massachusetts gasoline sales 2011 = 2,781,376,741 gallons

Balanced submerged fill = 2,781,376,741 gallons * 7.3 lb/10³ gallons

Pre-Control Emissions = 20,030,405 lb /2000 lb/ton = 10,152.03 TPY.

Post Control Emissions = Pre-control emissions [1-(CE)(RP)(RE)]

Post Control Emissions = 10,152.03 * [1- (0.95) (0.84) (0.998)]
 = 10,152.03 * [1- 0.796]
 = 10,152.03 * [0.20]
 = 2,030.41 TPY * 0.256 /78days = 6.66 TPSD.

Emissions are apportioned to county in Table 3.2-1.

3.2-2 VEHICLE RE-FUELING (STAGE II)

MassDEP estimated the Stage II refueling emissions as an on-road mobile source in Section 4 of this report. EPA recommended in Section 4.2-2.2 of the Volume 1 guidance that Stage II emissions should be estimated using the EPA Onroad MOBILE model (MOVES) which incorporates RVP, RFG and temperature.

3.2-3 UNDERGROUND TANK BREATHING

MassDEP used the same MA-DOR gasoline sales figure as use to estimate emissions for Stage I to estimate emissions for underground gasoline storage tanks (presented in Table 3.2-1).

Emission Factor (EIIP Table 11.3-1, AP-42 Table 5.2-7) = 1.0 lb/10³ gal
 2,781,376,741gallons. * 1.0 lbs/10³ gallons/2000 lbs = 1,390.7 TPY VOC

Summer day adjustment (same as Stage I):
 1,390.7 TPY * 0.256 /92 days = 3.87 TPSD.

3.2-4 TANK TRUCKS IN TRANSIT

Evaporative losses from tank trucks in transit are generally caused by leaking delivery trucks and temperature/pressure changes in the tank. Emissions occur under two modes of transfer: (1) tank trucks loaded with fuel and (2) tank trucks returning with vapor.

EPA AP-42 Table 5.2-5 and EIIP Table 11.3 provide emission factors for both modes and suggest that they should be combined into a composite emissions factor. MassDEP used the average of the extreme and typical values and calculated an emission factor of 0.1425 lbs/10³ gallons. EPA-EIIP suggests that bulk plants account for approximately 25% of the national distribution. Bulk plants require that gasoline must be

distributed twice, once from terminals to bulk plants and once from bulk plants to gas stations. MassDEP estimated that bulk plants accounted for 5% of the gasoline distribution in Massachusetts (based on EPA EIIP guidance⁷). This low estimate is a result of Massachusetts being one of the smallest states in the country in which there is very little need for the intermediary transfer of gasoline (bulk plants) between terminals and gas stations.

MassDEP therefore added 5% to total gasoline distribution in order to account for the additional distribution. The VOC emission calculations are as follows:

Emission Factor - AP-42 Table 5.2-5.

Loaded - typical - 0 to 0.1 Average = 0.005

- extreme - 0 to 0.08 Average = 0.04

Composite Average = 0.0225

Unloaded - typical - 0 to 0.11 Average = 0.055

- extreme - 0 to 0.37 Average = 0.185

Composite Average = 0.120

Composite Total = 0.1425 lb/10³ gallons

Gasoline sales = 2,781,376,741 gallons * 1.05 = 2,920,445,578 gallons transferred

* 0.1425 lbs/10³ gallons = 416,163 lbs /2000 lbs = 208.1 tons VOC

Summer day Adjustment

208.1 TPY * 0.256 = 53.3 TPY /78 days = 0.68 TPSD

3.2-5 PETROLEUM VESSEL UNLOADING/BALLASTING/TRANSIT

Evaporative VOC emissions from ocean-going petroleum ships and barges result from loading, unloading, ballasting, and transit losses. EIIP Volume III (Area Sources) Chapter 12 'Marine Vessel Loading, Ballasting, and Transit' states that loading losses are the primary source of evaporative emissions from marine vessel operations. However, loading loss does not fully apply to Massachusetts because of the absence of petroleum refineries. Most of the petroleum vessel loss in Massachusetts is involved with the unloading and ballasting of ships and barges and breathing losses in transit.

Ballasting losses are also a source of evaporative VOC emissions associated with unloading petroleum liquids at marine terminals. Ballasting VOC emissions are generated from the empty cargo tanks when the vapors are displaced to the atmosphere as the cargo tank is loaded with sea-water in order to improve the stability of the empty ship. The US Coast Guard provided a ballasting estimate of 25 percent of the ship's capacity. This estimate falls within the 15% to 40% estimate presented in Section 5.2.2.1.2 of EPA AP-42 5th Edition.

The Army Corps of Engineers publication, Waterborne Commerce of the US 2011⁸ provided data showing a small amount of shipment and outbound movement of gasoline from some ports in Massachusetts. EPA AP-42 does not give an emission factor for petroleum unloading, but provides one for ballasting of ships, which is associated with unloading.

⁷ Emission Inventory Improvement Program Technical Report Series Volume 3, Area Sources, Chapter 11 Gasoline Marketing. April 2001. See: <http://www.epa.gov/ttn/chiep/eiip/techreport/volume03/index.html>

⁸ "Waterborne Commerce of the United States, 2011, Part 1, Waterways and Harbors of the Atlantic Coast. Department of the Army Corps of Engineers, Water Resource Support Center, New Orleans, LA. <http://www.navigationdatacenter.us/wcsc/pdf/wcusatl11.pdf>

EPA AP-42 5th Edition Table 5.2-6 presents the transit loss emission factors in pounds of VOC per week per thousand gallons transported. MassDEP converted the emission factors to lbs/day. The US Coast Guard confirmed that tanker ships dock on any day of the week throughout the year and generally spend one day/night in port.

The Waterborne Commerce of the US 2011 report includes data for the amount of fuel unloaded from vessels from each port in the state. The New England Section of this report provided freight traffic for each port in short tons for the following petroleum fuels: gasoline, jet fuel, kerosene, distillate oil, residual oil, and naphtha.

MassDEP converted the petroleum freight in short tons to gallons using the product density of each fuel given in EPA AP-42 5th Edition Table 7.1-2. EPA AP-42 presented the conversion factor in pounds per gallons and MassDEP used the inverse of this factor to convert from short tons to pounds to gallons as shown in Table 3.2-2.

3.2-6 PORTABLE FUEL CONTAINERS

MassDEP adopted the EPA estimates of portable fuel containers (PFCs) as presented in their website.⁹ PFCs are used to store and transport fuel from gasoline service stations to residential homes and businesses. Emissions from PFC use are categorized as follows.

- **Permeation Emissions** is evaporation after fuel has been stored long enough in a can for fuel molecules to infiltrate and saturate the can material.
- **Diurnal Emissions** result when stored fuel vapors escape to the outside of a gas can through any possible openings while the gas can. They are subjected to daily cycle of increasing and decreasing ambient temperatures. Diurnal emissions are dependent on the closed or open-storage condition of a gas can.
- **Transport Emissions** arise when fuel escapes (e.g., spills, etc.) from gas cans that are in transit.
- **Equipment Refueling Emissions** result at pump when fuel escapes (e.g., spillage, vapor displacement) during the refueling of nonroad equipment. However, these emissions are accounted for in EPA's NONROAD model thus avoiding any double counting.

The EPA approach to estimating PFC emissions is to use its NONROAD2008 model which has a database of national gasoline usage and equipment population apportioned to states and counties for 2011. The NONROAD model also provides gasoline dispensing rates by season. EPA estimated that summer throughput of gasoline dispensing ranges between 35% and 40% for commercial and residential PFCs. Other factors that EPA includes are vapor displacement and spillage during refilling equipment at the pump, adjustments for evaporation and permeation, fuel RVP, and ambient temperature. EPA's PFC estimates for Massachusetts are given in Table 3.2-3.

3.2-7 AVIATION GASOLINE DISTRIBUTION

Aircraft gasoline refueling emissions occur when vapor-laden air in a partially empty aircraft fuel tank is displaced to the atmosphere when the tank is refilled. EPA Volume 1 guidance document states that the quantity of vapor displaced depends on the fuel temperature, fuel vapor pressure, aircraft fuel tank

⁹ <http://ftp.epa.gov/EmisInventory/2011nei/doc/>

temperature, and fuel dispensing rate. Smaller aircraft such as those with piston engines primarily use aviation gasoline (Av.gas) at smaller airports in the state.

Av.gas consumption in Massachusetts was obtained from the latest 2011 Department of Energy, State Energy Data Report.¹⁰ The emission factors for this category were obtained from EPA-ERTAC¹¹ for the following processes: 1.Av.gas Stage I, 2. Av.gas Stage II and 3. Av.gas Underground Tank Breathing and Emptying.

The Av.gas consumption data was apportioned to counties using the composite landing and take off cycles (LTO's) for airports available from EPA's aircraft database.¹² The VOC emissions for this category are presented in Table 3.2-4.

The annual and summer day emissions for all the sources in this Gasoline Distribution Category are presented in Table 3.2-5.

3.2-8 GASOLINE BULK PLANTS/TERMINALS AND PIPELINES

EPA estimated emissions for these two categories for the first time and MassDEP has adopted the estimates into this inventory. Gasoline Bulk Plants/Terminals and Pipeline emissions are included in Table 3.2-1. Emissions were obtained from EPA's website:

<ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>.

¹⁰ U.S. Department Energy (DOE) Energy Information Administration, State Energy Data, Table 11

¹¹ "Transportation Sector Energy Consumption Estimates 1960-2011 <http://www.eia.doe.gov/emeu/states/seds.html>

¹² EPA ftp site for nonpoint source emissions for 2011, av_gasoline_distribution_stage1.zip. See: <ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>