apcd air pollution control district SANTA BARBARA COUNTY

MEMORANDUM

TO: David Harris
FROM: Robin Cobbs
SUBJECT: GDF Emission Factors for Phase I EVR and Phase II EVR for UST and AST Systems
DATE: October 24, 2024
cc: Toxics Group

SUMMARY

The District updated our approved emission factors for gasoline dispensing facilities (GDF) with a new spillage emission factor for Phase II EVR as shown in Table 1. In addition, the District approved GDF emission factors for aboveground storage tank (AST) systems with Phase I EVR and Phase II EVR, as shown in Table 2. No other changes were made to our approved GDF emission factors.

In 2022, the California Air Resources Board (CARB) and the California Air Pollution Control Officers Association (CAPCOA) released the *Gasoline Service Station Industrywide Risk Assessment Technical Guidance* (2022 GDF HRA Guidelines). The 2022 GDF HRA Guidelines included emission factors from CARB's December 23, 2013 *Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities* (2013 GDF Emission Factors), including hose permeation emission factors. However, CARB's 2013 GDF Emission Factors do not reflect control technologies required by any Vapor Recovery regulations later than 2013.

On July 12, 2023, CARB amended three of their certification procedures to include a revised spillage emission rate: CP-201, *Certification Procedure for Vapor Recovery Systems at Gasoline Dispensing Facilities Using Underground Storage Tanks;* CP-206, *Certification Procedure for Vapor Recovery Systems at Gasoline Dispensing Facilities Using Aboveground Storage Tanks;* and CP-207, *Certification Procedure for Enhanced Conventional (ECO) Nozzles and Low Permeation Conventional Hoses for Use at Gasoline Dispensing Facilities*. The District revised our approved spillage emission factor for Phase II EVR systems to be consistent with the spillage performance standard listed in CP-201, CP-206, and CP-207. The only change in Table 1 from the prior District-approved emission factors (November 18, 2019) for UST with Phase I EVR and Phase II EVR is the revised spillage emission factor and updated references.

Table 1. GDF ROC Emission Factors for Underground Tanks with Phase I EVR and Phase II EVR

Subcategory	ROC Emission Factor	Units	Reference
Loading	0.15	(lb/1000 gal)	Section 3.1 of CP-201 (July 12, 2023)
Refueling with Breathing	0.38	(lb/1000 gal)	Section 4.1 of CP-201 (July 12, 2023)
Spillage	0.05	(lb/1000 gal)	Section 4.3 of CP-201 (July 12, 2023)
Hose Permeation – System Types:			District Internal Memo dated November 18, 2019 *Hose Permeation Emission Factors for Gasoline Dispensing Facilities*
Assist Controlled with EVR	0.47 0.001	(lb/year-per hose) (lb/day-per hose)	
Balance	3.74 0.010	(lb/year-per hose) (lb/day-per hose)	

The District-approved emission factors for ASTs with Phase I EVR, Phase II EVR, and standing loss controls are based on the performance standards in CP-206 and are shown in Table 2 below. These are new; the District did not previously have approved emission factors for AST systems with Phase I EVR and Phase II EVR.

Table 2. GDF ROC Emission Factors for Aboveground Tanks A6 System[1]
AST System with Phase I EVR and Phase II EVR

Subcategory	ROC Emission Factor	Units	Reference
Loading	0.15	(lb/1000 gal)	Section 4.1 of CP-206 (July 12, 2023)
Refueling with Breathing	0.38	(lb/1000 gal)	Section 5.1 of CP-206 (July 12, 2023)
Spillage	0.05	(lb/1000 gal)	Section 5.3 of CP-206 (July 12, 2023)
Standing Loss – AST System Types:			Section 3.1 of CP-206 (July 12, 2023)
New Installation	0.57	lb/1000 gal/ullage day	
Existing Installation	2.26	lb/1000 gal/ullage day	
Hose Permeation – System Types:			District Internal Memo dated November 18, 2019 *Hose Permeation Emission Factors for Gasoline Dispensing Facilities*
Assist Controlled with EVR	0.47 0.001	(lb/year-per hose) (lb/day-per hose)	
Balance	3.74 0.010	(lb/year-per hose) (lb/day-per hose)	

The District-approved emission factors for ASTs with Phase I EVR and Phase II with Vent Valves are shown in Table 3 below. These emission factors are not new, but the reference to the loading factor has been updated to reflect the latest version of CP-206.

Table 3. GDF ROC Emission Factors for Aboveground Tanks A1 System[1]
AST System with Phase I EVR and Phase II with Vent Valves

Subcategory	ROC Emission Factor	Units	Reference
Loading	0.15	(lb/1000 gal)	Section 4.1 of CP-206 (July 12, 2023)
Refueling	0.525	(lb/1000 gal)	District Internal Memo dated May 20, 2003 *New GDF Emission Factors*
Breathing	0.42	(lb/1000 gal)	
Spillage	0.42	(lb/1000 gal)	
Hose Permeation – System Types:			District Internal Memo dated November 18, 2019 *Hose Permeation Emission Factors for Gasoline Dispensing Facilities*
Assist Controlled with EVR	0.47 0.001	(lb/year-per hose) (lb/day-per hose)	
Balance	3.74 0.010	(lb/year-per hose) (lb/day-per hose)	

The loading, breathing, refueling and spillage emission factors for all other AST and UST systems remain unchanged and are presented in Tables 7 and 8 of this memo for ease of reference. In addition, the hose permeation factor from Table 4 of this memo must be included for those systems. Note that the standing loss control emission factor is not required to be added to the Pre-EVR AST systems (i.e., A1 through A5 system types[1]).

[1] System types are defined in the District's spreadsheet *GDF-Emissions-ver.4.0.xlsx*. The A6 system is for an AST with Phase I EVR and Phase II EVR with Vent Valve and Standing Loss Control. A1-A5 systems are AST systems with no controls or Pre-EVR controls on Phase II.

BACKGROUND

From 1998 to 2003, the District used GDF emission factors from CAPCOA's 1997 *Gasoline Service Station Industrywide Risk Assessment Guidelines* (CAPCOA's 1997 GDF HRA Guidelines). In 2003, the District reviewed the references for the GDF emission factors in CAPCOA's 1997 GDF HRA Guidelines and found several discrepancies in the derivation of the factors. These discrepancies were documented in District's internal memorandum dated May 20, 2003 regarding *New GDF Emission Factors*, which also included the District's approved emission factors based on Section 5.2 of USEPA's AP-42 (1/95) and some of the factors in CAPCOA's 1997 GDF HRA Guidelines.

In 2005, CARB approved the first Phase II EVR system. In 2006, the District revised our approved GDF emission factors to include factors for Phase II EVR systems and to base the EVR emission factors on performance standards from CARB's February 9, 2005 CP-201. These revisions were documented in the District's internal memorandum dated November 22, 2006 (Corrected April 3, 2007) regarding *GDF Emission Factors for Phase I EVR and Phase II EVR*.

In 2019, the District reviewed CARB's 2013 GDF Emission Factors and revised our approved emission factors as follows: 1) Emission factors were added for hose permeation; and 2) the combined refueling and breathing emission factor was distributed for modeling purposes. Revised emission factors and documentation from the District's review are found in the District's internal memorandum dated November 18, 2019 regarding *GDF Emission Factors for Phase I EVR and Phase II EVR*. The derivation of the District's hose permeation emission factors are documented in the District's internal memorandum dated November 18, 2019 regarding *Hose Permeation Emission Factors for Gasoline Dispensing Facilities*.

REFUELING & BREATHING FOR UST AND AST SYSTEMS WITH PHASE II EVR

The District uses the combined refueling and breathing emission factor of 0.38 lb/1000 gal, as listed in Table 4-1 of CARB's CP-201 (July 12, 2023) and Table 5-1 of CP-206 (July 12, 2023). Table 4-1 of CP-201[2] states that the "Phase II Emission Factor Includes: Refueling and Vent Emissions Pressure-Related Fugitives." For modeling purposes, the District distributed the emissions between breathing and refueling, as the breathing emissions are vented through the stack and refueling results in fugitive emissions underneath the canopy. The District assigned a factor of 0.024 lb/1000 gal to the breathing process based on Table V-I, *Current and Revised TOG Pressure Driven Emission Factors for Gasoline Dispensing Facilities*, of CARB's 2013 GDF Emission Factors. The remaining factor of 0.356 lb/1000 gal (i.e., 0.38 lb/1000 gal - 0.024 lb/1000 gal) was assigned to the refueling process; the breathing and refueling factors are shown in Tables 5 and 6 of this memo. CARB's 2013 GDF Emission Factors presents a lower combined value for breathing and refueling than the standards required by CP-201. However, the District uses the combined emission factor from CP-201 since the CP-201 emission standard was not reduced.

STANDING LOSS FOR AST SYSTEMS WITH STANDING LOSS CONTROL

In addition to refueling and vent emissions, ASTs also release standing loss emissions (i.e., diurnal venting). "Standing Loss Control" is defined in CARB's D-200 (July 12, 2021), *Definitions for Vapor Recovery Procedures*, as "the control of vapors from ASTs when no Phase I or Phase II gasoline transfers are occurring." Standing loss control performance standards are listed in Table 3-1 and Section 3.1 of CP-206 (July 12, 2023), which includes one standard for new ASTs and a separate standard for existing (retrofitted) ASTs. The standing loss performance standards are in units of lbs/1000 gallons ullage/day. The average ullage, or headspace of the gasoline storage tank, is estimated to be the volume of the tank divided by two (i.e., half the total tank capacity). Therefore, the standing loss emissions are calculated as follows:

[2] Table 5-1 of CP-206 (July 12, 2023) for AST systems has similar language and states "Phase II Emission Factor Includes: Refueling and Vent Emissions." However, emissions from AST systems also include standing loss, which is considered separate from vent emissions.

AST Standing Loss Emissions from New Installations:

$$Em_{ROC\ Annual\ Standing\ Loss-New} = \left(0.57 \frac{lb}{1000\ gallon\ ullage - day}\right) * \left(\frac{1}{2} * \ Tank\ Capacity * \frac{1}{10^3}\right) * \left(365 \frac{days}{year}\right)$$

$$Em_{\ ROC\ Hourly\ Standing\ Loss-\ New} = \left(0.57 \frac{lb}{1000\ gallon\ ullage - day}\right) * \left(\frac{1}{2} * \ Tank\ Capacity * \frac{1}{10^3}\right) * \left(\frac{1\ day}{24\ hours}\right)$$

Where:

$Em_{ROC\ Annual\ Standing\ Loss-New}$

$$= Annual\ ROC\ Emissions\ from\ Standing\ Loss\ for\ New\ AST\ Install, \left(\frac{lb}{year}\right)$$

$Em_{\ ROC\ Hourly\ Standing\ Loss-\ New}$

$$= \ Maximum\ Hourly\ ROC\ Emissions\ from\ Standing\ Loss\ for\ New\ AST\ Install, \left(\frac{lb}{hour}\right)$$

Tank Capacity $= Volume\ or\ capacity\ of\ AST\ (gallons)$

$10^3 = Conversion\ factor\ from\ gallons\ to\ 1000\ gallons$

AST Standing Loss Emissions from Existing Installations (Retrofits):

$$Em_{ROC\ Annual\ Standing\ Loss-Retrofit} = \left(2.26 \frac{lb}{1000\ gallon\ ullage - day}\right) * \left(\frac{1}{2} * \ Tank\ Capacity * \frac{1}{10^3}\right) * \left(365 \frac{days}{year}\right)$$

$$Em_{\ ROC\ Hourly\ Standing\ Loss-\ Retrofit} = \left(2.26 \frac{lb}{1000\ gallon\ ullage - day}\right) * \left(\frac{1}{2} * \ Tank\ Capacity * \frac{1}{10^3}\right) * \left(\frac{1\ day}{24\ hours}\right)$$

Where:

$Em_{ROC\ Annual\ Standing\ Loss-Retrofit}$

$$= Annual\ ROC\ Emissions\ from\ Standing\ Loss\ for\ Existing\ AST\ Install, \left(\frac{lb}{year}\right)$$

$Em_{\ ROC\ Hourly\ Standing\ Loss-\ Retrofit}$

$$= \ Maximim\ Hourly\ ROC\ Emissions\ from\ Standing\ Loss\ for\ Existing\ AST\ Install, \left(\frac{lb}{hour}\right)$$

Tank Capacity $= Volume\ or\ capacity\ of\ AST\ (gallons)$

$10^3 = Conversion\ factor\ from\ gallons\ to\ 1000\ gallons$

SPILLAGE FOR UST AND AST SYSTEMS WITH PHASE II EVR

The previous District-approved emission factor for spillage was based on the April 23, 2015 CP-201 performance standard for spillage of 0.24 lb/1000 gal. However, CARB's July 12, 2023 CP-201, CP-206 and CP-207, amended the spillage performance standard to 0.05 lb/1000 gallon. Therefore, the District's approved Phase II EVR

emission factor for spillage for both UST and AST systems is based on CARB's performance standard for Phase II EVR systems in the July 12, 2023 CP-201, CP-206 and CP-207.

LOADING FOR UST AND AST SYSTEMS WITH PHASE I EVR

The District-approved EVR emission factor for loading is 0.15 lb/1000 gallon, from Section 3.1 and Table 3-1 of CARB's CP-201 (July 12, 2023) and Section 4.1 and Table 4-1 of CP-206 (July 12, 2023). Table 3-1 of CP-201 and Table 4-1 of CP-206 lists the Phase I EVR emission standard of 0.15 lb/1000 gallon, with the test procedure used to verify the emission factor as CARB's *Vapor Recovery Test Procedure TP-201.1A Emission Factor For Phase I Systems at Dispensing Facilities* (February 1, 2001). TP-201.1A evaluates emissions occurring only during loading, as described on Page 1 of the test procedure:

> "*The purpose of this test procedure, TP-201.1A, is to determine the emission factor (in units of pounds of hydrocarbon emitted per 1000 gallons of gasoline transferred from cargo tank to storage tank, lb/kgal) for installations of Phase I vapor recovery systems (VRS) at gasoline dispensing facilities (GDFs).*"

HOSE PERMEATION FOR UST AND AST SYSTEMS

The District-approved hose permeation emission factors are shown in Table 4 and documented in the District's internal memorandum dated November 18, 2019, *Hose Permeation Emission Factors for Gasoline Dispensing Facilities*. CARB's 2013 GDF Emission Factors presents a hose permeation emission factor of 0.009 lb/1000 gallon for GDFs without controls, GDFs with vapor recovery (Pre-EVR) and GDFs with EVR. In lieu of using CARB's throughput-based hose permeation factor for all hose types, the District developed hose permeation emission factors based on the specific hose type and the number of hoses at a facility, as shown in Table 4.

Table 4. Hose Permeation Emission Factors

System Type	ROC Emission Factor (lb/day-per hose)	ROC Emission Factor (lb/year-per hose)
Conventional, Assist Uncontrolled (Pre-EVR)	0.030	10.98
Assist Controlled (EVR for both Phase I and II)	0.001	0.47
Balance (All Balance System Types)	0.010	3.74

As the District's approved emission factors for hose permeation are based on the number of hoses instead of throughput, the user cannot directly enter the District's hose permeation emission factor into CARB's GDF HRA screening tool. In order to use CARB's GDF HRA screening tool, the user must calculate the annual emissions based on the number of hoses, and then divide by the permitted annual throughput. For example, to use CARB's screening tool, the throughput-based hose permeation factor for a balance station with 8 hoses and a throughput of 3 million gallons per year would be calculated as shown below:

HRA Screening Example – for CARB's GDF Screening Tool

Example: Facility with 8 Balance Hoses and a Throughput of 3,000,000 gal/yr

$$Em_{ROC\ Annual\ Hose\ Permeation} = \left(3.74 \frac{lb\ ROC}{year - hose}\right) * (8\ balance\ hoses)$$

$$= 29.92\ \frac{lb\ ROC}{year}; Specific\ to\ Example$$

$$EF_{Example\ ROC\ Annual\ Hose\ Permeation\ Factor} = Em_{ROC\ Annual\ Hose\ Permeation} * Annual\ Throughput$$

$$EF_{Example\ ROC\ Annual\ Hose\ Permeation\ Factor} = \left(29.92 \frac{lb\ ROC}{year}\right) \div \left(3{,}000{,}000 \frac{gal}{year}\right) * (10^3)$$

$$= \left(0.00997 \frac{lb\ ROC}{1000\ gallon}\right); Specific\ to\ Example$$

Where:

$$Em_{ROC\ Annual\ Hose\ Permeation} = Annual\ ROC\ Emissions\ from\ Hose\ Permeation\ \left(\frac{lb}{year}\right)$$

$$EF_{Example\ ROC\ Annual\ Hose\ Permeation\ Factor}$$
$$= Example\ ROC\ Emission\ Factor\ for\ Hose\ Permeation\ \left(\frac{lb}{1000\ gal}\right)$$

$$10^3 = Conversion\ factor\ from\ gallons\ to\ 1000\ gallons$$

Note that use of the throughput-based hose permeation factor in CARB's GDF HRA screening tool as explained above will overestimate the hourly emission rate for hose permeation. CARB's screening tool will calculate emissions from hose permeation based on the hourly dispensing throughput and the throughput-based hose permeation factor. However, as hose permeation contributes only one percent of the acute risk[3], the overestimation will have minimal impacts.

If a site-specific refined health risk assessment is performed, calculating the throughput-based hose permeation factor is not necessary. For a refined HRA, the annual emissions from hose permeation should be calculated directly from the factors in Table 4. For a refined HRA, hourly emissions for hose permeation should be calculated based on the daily emission rate from Table 4 divided by 24 hours. For example, the annual and hourly hose permeation emission calculations for a facility with 8 balance hoses are shown below:

<u>Site-Specific Refined HRA Example – Facility with 8 Balance Hoses</u>

Example: Facility with 8 Balance Hoses

$$Em_{ROC\ Annual\ Hose\ Permeation} = \left(3.74 \frac{lb\ ROC}{year - hose}\right) * (8\ balance\ hoses)$$

$$Em_{ROC\ Annual\ Hose\ Permeation} = 29.92\ \frac{lb\ ROC}{year}$$

$$Em_{ROC\ Hourly\ Hose\ Permeation} = \left(0.010 \frac{\text{lb ROC}}{\text{day} - \text{hose}}\right) * (8\ balance\ hoses) * \left(\frac{1\ day}{24\ hour}\right)$$

$$Em_{ROC\ Hourly\ Hose\ Permeation} = 0.00333\ \frac{lb\ ROC}{hour}$$

[3] Reference: CARB and CAPCOA's 2022 *Gasoline Service Station Industrywide Risk Assessment Technical Guidance.*

DISTRIBUTION OF EMISSIONS FOR HRA MODELING

ROC and toxic emissions are released in five processes at a gasoline dispensing facility (GDF):

1. Loading emissions occur at the pressure vent valve (PV valve) during gasoline delivery to the tanks (Phase I). The "loading" process is modeled as a point source at the PV valve.
2. Breathing emissions occur at the PV valve due to changes in temperature and pressure in the underground storage tank. Vent emissions at the PV valve also occur during Phase II refueling events for ASTs. In addition, ASTs release standing losses to the PV valve during times when no Phase I or Phase II gasoline transfers are occurring. For the purposes of modeling, all of these releases are grouped into the "breathing" process, which is modeled as a point source at the PV valve, with a slightly lower temperature than the "loading" process emissions.
3. Refueling emissions occur at the gas pump during vehicle fueling (Phase II). During the fueling process, gasoline vapors are emitted due to a poor seal between the nozzle and the vehicle. These emissions are grouped with the hose permeation emissions into the "refueling" process, and are modeled as a volume source.
4. Spillage emissions occur at the dispenser due to liquid gasoline spilled from the nozzle. The "spillage" process is modeled as a volume source.
5. Hose permeation emissions are caused by the migration of liquid gasoline through the outer GDF hose material and to the atmosphere through permeation. These emissions are grouped into the "refueling" process, which is modeled as a volume source.

Table 1 contains the revised emission factors for GDFs with underground storage tanks and EVR for both Phase I and Phase II, while Table 5 shows the distribution of these factors for modeling purposes.

Table 5. Distribution for HRA Modeling – GDF ROC Emission Factors for Underground Tanks with Phase I EVR and Phase II EVR

Subcategory	ROC Emission Factor	Units
Loading	0.15	(lb/1000 gal)
Breathing	0.024	(lb/1000 gal)
Refueling	0.356	(lb/1000 gal)
Spillage	0.05	(lb/1000 gal)
Hose Permeation – System Types:		
Assist Controlled with EVR	0.47 0.001	(lb/year-per hose) (lb/day-per hose)
Balance	3.74 0.010	(lb/year-per hose) (lb/day-per hose)

Table 2 contains the revised emission factors for GDFs with aboveground storage tanks and EVR for both Phase I and Phase II, while Table 6 shows the distribution of these factors for modeling purposes.

Table 6. Distribution for HRA Modeling – GDF ROC Emission Factors for Aboveground Tanks with Phase I EVR and Phase II EVR

Subcategory	ROC Emission Factor	Units
Loading	0.15	(lb/1000 gal)
Breathing	0.024	(lb/1000 gal)
Standing Loss – AST System Types:		
New Installation	0.57	lb/1000 gal/ullage day
Existing Installation	2.26	lb/1000 gal/ullage day
Refueling	0.356	(lb/1000 gal)
Spillage	0.05	(lb/1000 gal)
Hose Permeation – System Types:		
Assist Controlled with EVR	0.47 0.001	(lb/year-per hose) (lb/day-per hose)
Balance	3.74 0.010	(lb/year-per hose) (lb/day-per hose)

DISTRICT-APPROVED GDF EMISSION FACTORS FOR NO CONTROL AND PRE-EVR

The loading, breathing, refueling and spillage emission factors for other systems (e.g., no control and Pre-EVR) remain unchanged and are presented in Tables 7 and 8. Emissions from hose permeation must be added according to Table 4. The derivation of the loading, breathing, refueling and spillage factors is presented in the District's internal memorandum dated May 20, 2003, *New GDF Emission Factors*. These unchanged emission factors are based on CAPCOA's 1997 GDF HRA Guidelines and Section 5.2 of EPA's AP-42 (January 1995).

Table 7. GDF ROC Emission Factors for Aboveground Storage Tanks – No Controls and Pre-EVR

Aboveground Tanks	Loading (lb/1000 gal)	Breathing (lb/1000 gal)	Refueling (lb/1000 gal)	Spillage (lb/1000 gal)	Hose Permeation
No Control	8.40	2.10	8.40	0.61	By No. of Hoses & Hose Type – **See Table 4**
Phase I only	0.42	2.10	8.40	0.61	
Phase I and II w/o Vent Valve	0.42	2.10	0.42	0.42	
Phase I and II w/Vent Valve	0.42	0.525	0.42	0.42	

Table 8. GDF ROC Emission Factors for Underground Storage Tanks – No Controls and Pre-EVR

Underground Tanks	Loading (lb/1000 gal)	Breathing (lb/1000 gal)	Refueling (lb/1000 gal)	Spillage (lb/1000 gal)	Hose Permeation
No Control	8.40	1.00	8.40	0.61	By No. of Hoses & Hose Type – **See Table 4**
Phase I only	0.42	1.00	8.40	0.61	
Phase I with Vent Valve	0.42	0.25	8.40	0.61	
Phase I and II w/o Vent Valve	0.42	1.00	0.42	0.42	
Phase I and II w/Vent Valve	0.42	0.25	0.42	0.42	
Phase I EVR and II w/Vent Valve	0.15	0.25	0.42	0.42	

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