Responses to Comments

on the

Initial Study/Mitigated Negative Declaration (IS/MND)

for the

Safeway Fuel Center

Petaluma, California

December 3, 2018

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and
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1. INTRODUCTION AND SUMMARY

Safeway proposes to develop a fuel station at 335 South McDowell Boulevard in Petaluma (Project) in the Washington Square Shopping Center. The fuel station will have 16 fuel positions (8 pumps with 2 fuel positions per pump) to accommodate the simultaneous fueling of SUVS, full-size pickup trucks, and passenger vehicles. The annual throughput of gasoline is asserted not to exceed 8.5 million gallons. The fuel dispensers will be served by two 20,000-gallon underground storage tanks that will be serviced by twice-daily truck deliveries of fuel, lasting 30 to 40 minutes. The Project also includes a 697-square foot convenience store, vehicle parking adjacent to the convenience store, landscaping, and an exit driveway.[1]

We submitted comments on the Initial Study/Mitigated Negative Declaration (IS/MND) on September 17, 2018.[2] The Applicant[3] and the BAAQMD[4] have provided responses to some of those comments. Based on our review and analysis of new information presented in these responses, we have revised our health risk assessment (HRA), which has been separately submitted. Our revised HRA continues to demonstrate that the Project will result in significant cancer risks at nearby sensitive receptors, including at residences along South McDowell Boulevard, at the North Bay Children's Center (60 feet away), and in the recreational playfield.

Our results are consistent with numerous scientific studies published in refereed journals that have linked residential proximity to gas stations and increased risk of adverse health outcomes, including increased risk for cancer, and specifically for leukemia in children. As we demonstrate below, there's no reason to quibble over the details of complex HRAs because numerous scientific studies, published in highly regarded scientific journals, have demonstrated that proximity to gas stations results in significant increases in cancer in surrounding populations.

A Negative Declaration can be prepared only when there is no substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment.[5] We have presented substantial unrefuted evidence that the proposed Safeway gas station will result in significant cancer risks in the surrounding community. An

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[1] City of Petaluma, Safeway Fuel Center Initial Study/Mitigated Negative Declaration (IS/MND), 335 South McDowell Boulevard, March 29, 2018, pp. 5–6; available at http://cityofpetaluma.net/cdd/major-projects.html.

[2] Phyllis Fox and Ray Kapahi, Comments on the Initial Study/Mitigated Negative Declaration (IS/MND) for the Safeway Fuel Center, September 17, 2018 (9/17/18 Fox/Kapahi Comments).

[3] Letter from Matthew D. Francois, Rutan & Tucker, LLP, to Heather Hines, City of Petaluma, Re: Safeway Fuel Center Project—Responses to Comments of Bay Area Air Quality Management District and Phyllis Fox/Ray Kapahi, October 10, 2018 (10/10/18 Rutan Letter).

[4] Letter from Damian Breen, BAAQMD, to Olivia Ervin, City of Petaluma, Re: Safeway Fuel Center Project—Air District Comments on Health Risks Assessments, November 8, 2018 (11/8/18 BAAQMD Letter).

[5] PRC § 21080(c)), 14 C.C.R. § 15070).

environmental impact report (EIR) must be prepared when there is substantial evidence in the record that supports a fair argument that significant effects may occur.[6] Our analysis below indicates that there is substantial evidence that the Project will result in significant cancer impacts, requiring that an EIR be prepared.

2. SCIENTIFIC RESEARCH CONFIRMS HEALTH IMPACTS ARE SIGNIFICANT

The health risk assessments (HRAs) prepared by the various parties—the Bay Area Air Quality Management District (BAAQMD), Safeway's consultants (Illingworth & Rodkin), and the affected community (Fox/Kapahi) are highly complex analyses prepared by parties with various interests in their outcomes. However, scientific research, conducted by parties with no interests in this case, have linked residential and school proximity to gas stations to an increased risk of adverse health outcomes[7]—including increased risk for cancer[8] and, specifically, leukemia in children.[9] We previously submitted the supporting scientific papers into the record and will not resubmit them here.

Living next to a gas station quadruples the risk of acute leukemia in children and increases the risk of developing acute non-lymphoblastic childhood leukemia by 7 times, compared with children who do not live near a gas station.[10] Moreover, a significant exposure-response relationship exists between the likelihood of childhood leukemia and the number of gasoline stations per square mile.[11] Thus, gas stations should not be located in areas where housing or vulnerable populations and activities exist or are proposed, including settings such as those near the Project, with residences across the street and schools within 300 feet.

A study by Johns Hopkins School of Public Health reports that even small spills at gas stations— "droplets of fuel"—cumulatively cause long-term environmental damage to soil and groundwater in residential areas close to the stations, resulting in significant public health

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6 PRC § 21080(d).

7 J. D. Brender et al., "Residential Proximity to Environmental Hazards and Adverse Health Outcomes," *American Journal of Public Health* 101, no. S1 (2011): S37–S52.

8 E. O. Talbot, "Risk of Leukemia as a Result of Community Exposure to Gasoline Vapors: A Follow-Up Study," *Environmental Research* 111, no. 4 (2011): 597–602.

9 P. Brosselin et al., "Acute Childhood Leukaemia and Residence Next to Petrol Stations and Automotive Repair Garages: The ESCALE Study (SFCE)," *Occupational and Environmental Medicine* 66, no. 9 (2009): 598–606; P. F. Infante, "Residential Proximity to Gasoline Stations and Risk of Childhood Leukemia," *American Journal of Epidemiology* 185, no. 1 (2017): 1–4; C. Steffen et al., "Acute Childhood Leukemia and Environmental Exposure to Potential Sources of Benzene and Other Hydrocarbons: A Case-Control Study," *Occupational and Environmental Medicine* 61, no. 9 (2004): 773–778; C. Steinmaus and M. Smith, "Parental, In Utero, and Early-Life Exposure to Benzene and the Risk of Childhood Leukemia: A Meta-Analysis," *American Journal of Epidemiology* 183, no. 1 (2016): 1–14.

10 Brosselin et al., 2009; Steffen et al., 2004.

11 H. H. Weng et al., "Childhood Leukemia and Traffic Air Pollution in Taiwan: Petrol Station Density as an Indicator," *Journal of Toxicology and Environmental Health A* 72, no. 2 (2009): 83–87.

risks.[12] Large filling stations can dispense as much as 1 million gallons fuel/month (12 million gallons/year).

3. CRITIQUE OF REVISED SAFEWAY HEALTH RISK ASSESSMENT

3.1. Validity of Meteorological Data

The revised HRA asserts that "The WRF model pulls in observations and archived meteorological data from the region around the Project site.…"[13] This is incorrect. The WRF meteorological data used by the Applicant's consultant was not based on observations recorded at or near the project site in Petaluma. Lakes Environmental, which prepared the WRF meteorological data used by the Applicant's consultant, confirmed to Mr. Kapahi that the WRF model is not set up to utilize direct input of any local meteorological data. See Exhibit 1, which is the email exchange with Lakes Environmental. The WRF model used in Safeway's analysis has a resolution that is regional and not site or source specific. Accordingly, it is not intended to be used, nor is it appropriate to be used, for a site-specific health risk assessment at this fine scale. The minimum resolution available with WRF model as used in the most recent HRA by I & R is in the range of 1 to 4 kilometers. Given this resolution, it is not possible to make accurate predictions within 50 to 100 meters.

3.2. Emission Factors

Diesel particulate emissions (DPM) are a major contributor to public health risks. Thus, it is critical that accurate emission factors for determining the emission rates of DPM be used. The emission factor for heavy-duty diesel delivery trucks used in Safeway's analysis is 0.03221 grams of PM2.5 per mile, based on a vehicle speed of 5 mph. The emission factor based on the EMFAC model for Sonoma County for calendar year 2019 is 0.063 grams/mile, or double what was used in the Applicant's calculation. A similar discrepancy appears for light-duty vehicles (LDA):

Vehicle Category	Used in the Safeway HRA (gram/mile) [pdf Page 29]	Listed in EMFAC Model (gram/mile)
LDA	0.024008	0.087806

Understating the emission rates of DPM by a factor of 4 directly leads to underestimating public health risks. We used EMFAC to estimate emissions of DPM,

12 M. Hilpert and P.N. Breysse, "Infiltration and Evaporation of Small Hydrocarbon Spills at Gas Stations," *Journal of Contaminant Hydrology*, v. 170, (2014): 39-52.

13 10/10/18 Rutan Letter, 10/10/18 I&R Memo, pdf 13.

recommended by the BAAQMD's CEQA Guidelines.[14] The following tables present the actual EMFAC results used in our analysis for heavy-heavy duty and light-duty vehicles.

EMFAC2014 (v1.0.7) Emission Rates
Region Type: County
Region: Sonoma
Calendar Year: 2019
Season: Annual
Vehicle Classification: EMFAC2007 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

Region	CalYr	VehClass	MdlYr	Speed	Fuel	VMT	ROG_RUN	TOG_RUN	CO_RUNE	NOx_RUN	CO2_RUNI	PM10_RUI	PM2_5_RUNEX
Sonoma	2019	HHDT	Aggregate	5	DSL	1269.665	0.907418	3.252055	8.000291	20.47671	4589.594	0.066444	0.06357
Sonoma	2019	HHDT	Aggregate	10	DSL	3926.696	0.76558	2.23991	5.770483	16.61248	3821.149	0.062739	0.060025
Sonoma	2019	HHDT	Aggregate	15	DSL	3971.48	0.550222	1.028745	3.089707	11.40913	2743.792	0.053964	0.051629
Sonoma	2019	HHDT	Aggregate	20	DSL	23007.28	0.363347	0.45624	1.60128	7.73209	2124.615	0.053474	0.051161

EMFAC2014 (v1.0.7) Emission Rates
Region Type: County
Region: Sonoma
Calendar Year: 2019
Season: Annual
Vehicle Classification: EMFAC2007 Categories
Units: miles/day for VMT, g/mile for RUNEX, PMBW and PMTW

Region	CalYr	VehClass	MdlYr	Speed	Fuel	VMT	ROG_RUN	TOG_RUN	CO_RUNE	NOx_RUN	CO2_RUNI	PM10_RUI	PM2_5_RUNEX
Sonoma	2019	LDA	Aggregate	5	DSL	18.65869	0.284867	0.324302	3.569349	0.28606	721.2901	0.091776	0.087806
Sonoma	2019	LDA	Aggregate	10	DSL	214.4412	0.207805	0.236572	2.663858	0.28083	604.4364	0.065939	0.063087
Sonoma	2019	LDA	Aggregate	15	DSL	930.7187	0.122855	0.139862	1.437057	0.28592	507.2989	0.04987	0.047712
Sonoma	2019	LDA	Aggregate	20	DSL	3035.568	0.071016	0.080847	0.693976	0.277533	417.1567	0.038615	0.036944

3.3. Exposure Duration

There are various guidelines for an appropriate exposure duration for use in an HRA, ranging from 30 years to 70 years. The Office of Environmental Health Hazard Assessment (OEHHA) recommends a 30-year exposure duration. This exposure duration is referenced by the Applicant and in BAAQMD's Comment letter dated November 8, 2018. However, the BAAQMD's own Guidance[15] on preparing risk assessments for gas stations requires the use of a 70-year exposure. See Exhibit 4, BAAQMD Air Toxics NSR Program Health Risk Assessment Guidelines (December 2016). These Guidelines were never revised, and therefore remain current. These Guidelines provide in relevant part:

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[14] BAAQMD, California Environmental Quality Act, Air Quality Guidelines, May 2017, pdf 61; available at: http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en.

[15] BAAQMD Health Risk Assessment Guidelines, December 2016; available at: http://www.baaqmd.gov/~/media/files/planning-and-research/permit-modeling/hra_guidelines_12_7_2016_clean-pdf.pdf.

> 2.2.1.3 Exposure Duration
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> Based on OEHHA's 2003 HRA Guidelines, the Air District will estimate cancer risk to residential receptors for gasoline dispensing facilities based on a 70-year lifetime exposure. Although 9-year and 30-year exposure scenarios may be presented for information purposes, risk management decisions will be made based on 70-year exposure duration for residential receptors. For worker receptors for gasoline dispensing facilities, risk management decisions will be made based on OEHHA's 2003 recommended exposure duration of 40 years. Cancer risk estimates for children at school sites will be calculated based on a 9-year exposure duration.

These Guidelines specifically state that the District's HRA Guidelines "…generally conform to the Health Risk Assessment Guidelines adopted by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) for use in the Air Toxics Hot Spots Program for all types of facilities *except gasoline dispensing facilities (GDFs)*."[16] Contrary to this guidance, the Applicant used 30 years. When the District provides guidance for a particular industry, that guidance needs to be followed rather than other general guidance. Safeway's use of a 30-year exposure duration understates the public risk. The 70-year exposure used in our analysis is more appropriate and is consistent with relevant guidance.

4. CRITIQUE OF BAAQMD COMMENT LETTER DATED NOVEMBER 8, 2018

The BAAQMD's comment letter dated November 8, 2018 ("BAAQMD Letter") is less than a single page in length and does not represent a serious effort by a regulatory agency charged with protecting human health from air emissions. The comments raised in the BAAQMD letter lack specificity, much less adequate reference to current regulatory guidance or practices. Each comment from the BAAQMD Letter is addressed and dismissed below.

4.1. Reliance on Santa Rosa Meteorological Data

The BAAQMD letter criticizes our earlier reliance on Santa Rosa meteorological data but offers no specific explanation as to why our methodology was inappropriate. Our prior comment letter explained why it was necessary to rely on Santa Rosa data, and further explained that the respective wind patterns for Santa Rosa and Petaluma mean that the actual health impacts would be more significant than we previously modeled. Nevertheless, we were able to obtain AERMOD-consistent Petaluma meteorological data as described more fully above. Consistent with our earlier prediction, use of Petaluma data reveals that the health risk impact is significantly higher than previously modeled. Thus, this criticism has no merit.

4.2. Benzene Emission Factor

The BAAQMD letter criticizes our benzene emission factor as "substantially higher than the Air District's standard benzene emission factor for gasoline dispensing facilities." Notably, the BAAQMD Letter does not assert that our emission factor is incorrect or inappropriate, much

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[16] BAAQMD September 2016 Guidelines, p. 1.

less cite any authority supporting this criticism. Contrary to this vague criticism, our benzene emission factor is consistent with CAPCOA guidance. To the extent the BAAQMD currently relies on a lower emission factor, that is a failure on the part of BAAQMD and not a deficiency in our analysis. See Table 1. As documented in Tables 1 and 2, recent research shows that actual benzene emissions from gas stations have been underestimated by CARB/CAPCOA and therefore would be substantially greater than those estimated in our analysis.

4.3. Residential Exposure Assumptions

The BAAQMD letter states that our "residential exposure assumptions" are "not consistent with the Air District's ***current*** HRA risk calculation ***procedures***" (emphasis added). Again, the BAAQMD letter is not specific as to which exposure assumptions are being addressed, what the "proper" assumption is, or any supporting reference. To the extent that the BAAQMD letter is criticizing our 70-year residential exposure duration, that duration is expressly required in the "BAAQMD Air Toxic NSR Program Health Risk Assessment Guidelines." The Introduction to these Guidelines clearly states that OEHHA guidelines are followed "for all types of facilities **except gasoline dispensing stations** (GDFs)."[17] Section 2.2.1.3 of that guidance further states, "Based on OEHHA's 2003 HRA Guidelines, the Air District will estimate cancer risk to residential receptors for gasoline dispensing facility based on a 70-year lifetime exposure."[18] Similarly, Section 2.2.1.2 requires exposure assumptions of "24 hours per day for 350 days per year." To the extent that BAAQMD's "current . . . procedures" are now deviating from its own published guidance, that represents a failure on the part of BAAQMD to protect Bay Area residents and not a valid criticism of our analysis.

Finally, it should be clarified that the BAAQMD's November 8 letter does not address the proposed gasoline station's DPM emissions, which are not regulated by BAAQMD. Further, the BAAQMD's review failed to include other carcinogens known to be present in gasoline vapors. The failure of the BAAQMD's November 8 letter to acknowledge these omissions, which we identified in our initial comments, is inexcusable given that DPM emissions represent a major source of human health risk from the Project.

In summary, emissions of carcinogens from the Safeway gasoline station would be much greater than those presented in the latest submittal by the Applicant. If these deficiencies are corrected, the Applicant's current risk analysis would yield cancer risks significantly greater than the cancer significance threshold of 10 per million.

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[17] BAAQMD, December 2016, p. 2 (emphasis added).

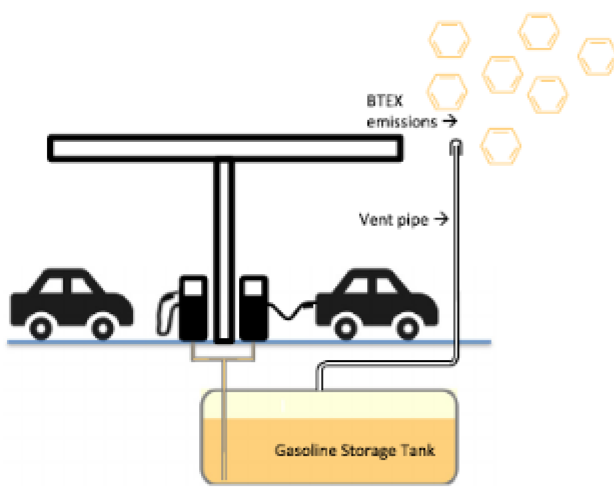
[18] BAAQMD, December 2016, p. 8.

5. RECENT RESEARCH DEMONSTRATES CANCER HEALTH RISKS OF THE PROJECT ARE SIGNIFICANT

5.1. Safeway Significantly Underestimated Benzene Emissions

Gasoline vapors from unburned fuel are released into the atmosphere at fuel stations from five sources: (1) storage tank loading; (2) storage tank breathing (due to changes in temperature); (3) vehicle refueling; (4) spillage; and (5) hose permeation. The loading, breathing, and refueling emissions are released through the vent pipe, shown in Figure 1, and are generally called "vent" emissions. Vent emissions are the major source of unburned fuel (gasoline, diesel) and benzene, accounting for 66% to 70%[19] of the total fuel vapors[20] and hence benzene. The balance of the benzene comes from spillage and hose permeation, both of which are emitted directly into the air.

Figure 1. Schematic of Typical Gas Station



The responses argue that we "overstate the amount of benzene emissions, citing higher emission factors from another air district, and then modeling even higher emissions than the cited values."[21] They further assert that their benzene emission factors are correct as they were "based on the latest California Air Resources Board ("CARB") guidance…and were the same factors used by BAAQMD to compute effects for the facility's permit…"[22] These assertions are unsupported and incorrect. The CARB guidance is known to underestimate VOC and benzene emissions from gas stations, as demonstrated below. The following discussion is based on

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[19] CARB, Revised Emission Factors for Phase 1 Gasoline Bulk Transfer at California Gasoline Dispensing Facilities, December 23, 2013, Table I-1; available at: https://www.arb.ca.gov/vapor/gdf-emisfactor/attachment_2%20-%2020%20nov%202013.pdf.

[20] Based on refueling of Phase II non-ORVR vehicles.

[21] 10/10/18 Francois Letter, p. 2.

[22] 10/10/17 I&R Memo, p. 3.

VOCs because all parties assumed the same benzene content in fuel vapors, 0.003 pounds per pound of VOC (lb/lb VOC).

Table 1 summarizes various estimates of VOC emissions from gasoline station sources. This table shows that the total VOC emission factor used by BAAQMD and Safeway, 0.67 lb/1000 gal, is at the lower end of the range of reported VOC emission factors.

Table 1. VOC Emission Factors for Gasoline Fueling Stations (lb VOC/1000 gal)[23]

Source	SCAQMD	Kapahi/ Fox	BAAQMD	Safeway	CARB Non-ORVR	CARB ORVR
Tank Filling	0.15	0.08			0.15	0.15
Vehicle Fueling	0.32	0.42	0.45	0.45	0.42	0.021
Breathing Losses	0.024	0.03			0.024	0.024
Spillage	0.24	0.42	0.22	0.22	0.24	0.24
Hose Permeation	0.009	0			0.009	0.009
TOTAL	0.743	0.95	0.67	0.67	0.843	0.444

The Applicant and BAAQMD also underestimated benzene emissions by omitting emission sources. Their HRAs are based only on "refueling" and spillage emissions. These analyses do not explain what is included in "refueling." However, the VOC emission factor that was used, 0.45 pounds per thousand gallons of gasoline (lb/1000 gal),[24] is too low to plausibly include tank filling (see Table 2) and appears to be based only on refueling of Phase II vehicles equipped with Onboard Refueling Vapor Recovery (ORVR) systems, assuming 100% of visiting vehicles are so equipped. However, based on CARB estimates[25] for 2018, 15% of the vehicles will not be equipped with ORVR. See Table 2. The Safeway and BAAQMD HRAs also omitted hose permeation emissions.[26] See Table 1. An underestimate in VOC emissions means an underestimate in benzene because benzene emissions are calculated by multiplying the VOC emissions by the benzene content in the fuel vapors. In sum, we know VOC and benzene emissions are grossly underestimated by BAAQMD and Safeway for three reasons.

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[23] SCAQMD = SCAQMD, Proposed Amended Rule 1401—New Source Review of Toxic Air Contaminants, August 2017, Table 2; BAAQMD & Safeway = 10/10 Rutan Letter, BAAQMD Evaluation Report, pdf 33; CARB ORVR & CARB Non-ORVR = CARB 2013.

[24] 10/10/18 Rutan Letter, Exhibit A, BAAQMD Evaluation Report, pdf 32.

[25] CARB, Revised Emission Factors for Phase II Vehicle Fueling at California Gasoline Dispensing Facilities, December 23, 2013, Table 1-2.

[26] 10/10/18 Rutan Letter, Exhibit A, BAAQMD Evaluation Report, pdf 32.

Table 2: CARB 2013 Revised and SCAQMD Proposed Controlled Gasoline Dispensing Emission Factors (lbs VOC/1,000 gal)[27]

Emission Source	SCAQMD Current Controlled Gasoline Emission Factor (lbs/1,000 gal)	CARB 2013 Revised Controlled Gasoline Emission Factor (lbs/1,000 gal)	SCAQMD Proposed Controlled Gasoline Emission Factor (lbs/1,000 gal)
Loading	0.42	0.15	Same as CARB
Breathing	0.025	0.024	Same as CARB
Refueling – Phase II with Non-ORVR vehicles	0.32*	0.42	Same as CARB
Refueling – Phase II with ORVR vehicles	NA	0.021	0.32* (remain unchanged from current emission factor)
Spillage	0.24	0.24	Same as CARB
Hose Permeation	None	0.009	Same as CARB

*SCAQMD staff is committed to continue working with CARB staff on the refueling emission factor for Phase II EVR with ORVR vehicles. Until then, SCAQMD staff is recommending using the current SCAQMD emission factor for refueling.

First, 100% of refueling vehicles would not be equipped with Phase II ORVR, as apparently assumed by BAAQMD and the Applicant.

Second, it is generally understood that CARB's 2013 revised controlled gasoline emission factor for Phase II refueling with ORVR, which the BAAQMD and Applicant apparently relied on, is a gross underestimate. The South Coast Air Quality Management District (SCAQMD) recently reviewed the CARB revised 2013 gasoline dispensing emission factors and concluded that the proposed Phase II ORVR refueling emissions factor of 0.021 lb/1000 gal is a gross underestimate that was not based on any measurements or other empirical evidence. SCAQMD concluded:[28]

> CARB's revised emission factor for refueling of ORVR vehicles is calculated assuming that the ORVR system and the Phase II EVR system work consecutively in series to control vapor emissions, allowing a compounding control efficiency of 99.75 percent from both control equipment. However, there is no empirical evidence supporting the assumption that all the vapors escaping from the ORVR system are directed to the fillpipe and can be captured by the Phase II EVR system.

Thus, the SCAQMD substituted 0.32 lb/1000 gal,[29] the original CARB estimate, yielding a refueling emission factor of 0.32 lbs/1000 gal and a vent emission factor of 0.49 lb/1000 gal.[30] In comparison, we used a vent emission factor of 0.58 lb/1000 gal.[31]

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[27] SCAQMD, Proposed Amended Rule 1401—New Source Review of Toxic Air Contaminants, August 2017, Table 2. Exhibit 2.

[28] *Ibid.*

[29] *Ibid.*

Third, all of the various estimates of gasoline station VOC emissions are based on either no actual measurements or very few measurements, but rather assume theoretical control efficiencies that have not been demonstrated in the field. Recent research published after CARB's, BAAQMD's, SCAQMD's, Safeway's, and our initial cancer risk analyses demonstrate that they all significantly underestimate VOC and benzene emissions, based on substantial actual measurements at two gas stations. This research, published in a refereed scientific journal, concludes as follows:[32]

> We present unique data on vent emissions from USTs at two gas stations. Emissions can be compared to vent losses assumed by CAPCOA (CAPCOA, 1997). For a gas station with Stage I and II vapor recovery technology and a P/V valve on the vent pipe of the UST (Scenario 6B), the CAPCOA study assumed loading losses of 0.084 and breathing losses of 0.025 lb/kgal dispensed. The total loss of gasoline through the vent pipe is the sum of the two and amounts to a vent emission factor EF_{vent}= 0.109 lb/kgal. Based on actual measurements in two fully functioning US gas stations, we obtained EF_{vent} values of 1.4 lb/kgal for GS-MW and 1.7 lb/kgal for GS-NW, more than one order of magnitude higher than the CAPCOA estimate. While the difference between our measurements and the CAPCOA estimates may appear surprising, it is important to consider that the CAPCOA estimates are based on relatively few measurements and some unsupported assumptions (Aerovironment, 1994), particularly with regard to uncontrolled emissions due to equipment failures or defects (Appendix A-5 (CAPCOA, 1997)).

We assumed vent VOC emissions of 0.53 lb VOC/1000 gal.[33] Safeway and BAAQMD assumed vent VOC emissions of 0.45 lb VOC/1000 gal.[34] As benzene emissions are directly proportional to VOC emissions (i.e., calculated by multiplying VOC emissions by the fraction of benzene) and all parties assumed the same benzene content in gasoline, 0.003 lb/lb VOC, we underestimated vent benzene emissions by about a factor of 2, and BAAQMD and Safeway underestimated vent benzene emissions by about a factor of 3, based on the Hilpert et al. study. Assuming our estimate of spillage VOC emissions is accurate, we underestimated total facility

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[30] Vent emission factor = loading + breathing + Phase II refueling = 0.15 + 0.024 +0.32 = 0.494 lb/1000 gal.

[31] Vent emission factor = loading + breathing + Phase II refueling = 0.08 + 0.42 + 0.03 = 0.53 lb/1000 gal.

[32] M. Hilpert, A. M. Rule, B. Adria-Mora, and T. Tiberi, "Vent Pipe Emissions from Storage Tanks at Gas Stations: Implications for Setback Distances," *Science of the Total Environment*, v. 650, (2019): 2239-2250 (available online September 24, 2018). Exhibit 3.

[33] Vent VOC emissions assumed by appellants: tank filling + vehicle fueling + breathing loss = 0.08 + 0.42 +0.03 = 0.53 lb VOC/1000.

[34] 10/10/18 Rutan Letter, Exhibit A, BAAQMD Evaluation Report, pdf 32. Refueling VOC emissions = [(5695 lb VOC/yr)/(8500 x10^3 gal/yr)]0.67 = 0.45 lb VOC/10^3 gal.

benzene emissions by a factor of 2.[35] Assuming the BAAQMD's and Safeway's estimate of spillage VOC emissions is accurate, they underestimated total facility benzene emissions by a factor of 3.[36]

The underestimate in benzene emissions can be used to revise Safeway's estimated cancer risk. Safeway's revised HRA reported a total 30-year residential cancer risk of 6.1 per million. Of this total, 32% or 1.94 per million, is due to benzene emissions from fuel evaporation.[37] If we apply the most recent emission data for vent emissions from Hilpert et al., we estimate that total VOC emissions would be 2.5 times greater than current ARB/CAPCOA-recommended emission factors. This would increase the portion of the cancer risk due to benzene from 1.94 to 4.85 per million and the total 30-year residential cancer risk from 6.1 per million to 10 per million.[38] A cancer risk of 10 per million is significant. Thus, by correcting Safeway's analysis to account for its substantial underestimate in benzene emissions, the cancer risk to nearby residents is significant.

The actual cancer risk would be substantially higher for four reasons. First, both Safeway and appellants assumed the benzene content of gasoline is 0.003 lb/1000 gallons. The current proposed benzene content is 0.0455 lb/gal.[39] This would increase Safeway's residential cancer risk to 15 per million. Second, both HRAs are based only on benzene. Gasoline vapors contain other carcinogens, including ethyl benzene, formaldehyde, naphthalene, and acetaldehyde.[40] Naphthalene, for example, is a more potent carcinogen than benzene, with a cancer unit risk value of 3.4 E-5 $ug/m^3)^{-1}$ compared to 2.9 E-5 $ug/m^3)^{-1}$ for benzene.[41] Third, this revision based only on benzene excludes the increase in cancer risk from adjusting the exposure duration to 70 years (a 19% increase) and the increase from using the correct DPM emissions from cars and heavy-heavy-duty trucks, discussed elsewhere in these comments. Fourth, the omission of benzene from hose permeation and the inclusion of much higher benzene emissions from non-ORVR vehicles would further increase risk. Fifth, none of the HRAs included the

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35 Benzene underestimate based on Fox/Kapahi VOC emissions: [(1.4 + 1.7/2) + 0.42/0.95] = 1.97/0.95 = 2.07.

36 Benzene underestimate based on BAAQMD/Safeway VOC emissions: [(1.4 + 1.70/2) + 0.45/0.67] = 3.0.

37 10/10/18 Rutan Letter, 10/10/18 Memo from James A. Reyff, Illingworth & Rodkin, Inc. to Natalie Mattei, Albertsons Companies, Re: Safeway Fuel Center Health Risk Assessment—Updated Modeling Results Using U.S. EPA's AERMOD Dispersion Model, Table 1, pdf 19.

38 Revised 30-year residential cancer risk = 1.06 + 1.66 + 1.38 + 0.03 + 3(1.94) = 9.95 per million, which rounds up to 10 per million.

39 SCAQMD, August 2017, Table 3: current speciation = 0.30%; proposed speciation = 0.455%.

40 SCAQMD, August 2017, Table 3 and BAAQMD's CEQA Guidelines (BAAQMD, California Environmental Quality Act Air Quality Guidelines, May 2017) at p. 5-14 ("TAC emissions were evaluated for only those toxic compounds found in diesel or gasoline fuel including diesel PM, benzene, ethylbenzene, acrolein, etc."); available at: http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en.

41 OEHHA Hot Spots Unit Risk and Cancer Potentcy Values; available at: https://oehha.ca.gov/media/CPFs042909.pdf.

increase in cancer risk from increased traffic in the local area to access the gas station. These changes would increase Safeway's estimated residential cancer risk of 6.1 per million significantly above the 10 per million cancer significance threshold estimated here, based only on adjusting benzene exposures. Thus, cancer risks from the proposed gas station are highly significant.

5.2. Setback Distances

We relied on CARB's 2005 *Air Quality and Land Use Handbook* to confirm safe setback distances between the proposed gas station and nearby sensitive receptors to confirm our HRA results. The responses to comments argue that recommendations in this handbook[42] are "outdated" because they were developed using emission factors developed in 1999 and since then, advancements have occurred that would reduce emissions.[43] However, Hilpert et al.'s recent study, based on actual measurements, concludes the opposite. The Hilpert et al. study concluded that "current CARB setback distances might be adequate for gas stations in California but less so for the other 49 US states." Hilpert et al's AERMOD modeling identified exceedances of the 1-hour acute REL for benzene at a distance greater than the 300 ft setback recommended in the CARB guidance. They concluded that "modeled exceedance of the OEHHA acute REL in the winter season is already of concern, because that REL was developed for once per month or less exposure."[44]

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[42] CARB, *Air Quality and Land Use Handbook: A Community Health Perspective*, April 2005, p. 31; available at http://www.arb.ca.gov/ch/handbook.pdf.

[43] Responses, pp. 1-2.

[44] Hilpert et al. 2019, p. 2248.

<u>EXHIBIT 1</u>

From: **Lakes Support** <support@weblakes.com>
Date: Wed, Oct 17, 2018 at 11:31 AM
Subject: RE: MM5 Data Request for Quote | MET1812984
To: ray.kapahi@gmail.com <ray.kapahi@gmail.com>
Cc: Lakes Support <support@weblakes.com>

Ray,

Thank you for your email. I'm familiar with the order you're referencing, but that description did not come from us. We have a standard document provided to customers who request more information about our WRF data processing routines. While WRF is different from MM5 (which is what your order was for), neither model as we have them set up are utilizing direct input of station observations. Station data may be a component of the gridded data which serves as input to these models, but it is not a direct step.

Note: *The information contained in this e-mail is for clarification purposes only. We do not assume any responsibility or liability, explicitly or implied, for its accuracy.*

Cheers,
Michael T. Hammer, CCM | Senior Product Specialist
support@weblakes.com
Lakes Environmental Software
www.webLakes.com | Twitter | Facebook | LinkedIn

From: KapahiR <ray.kapahi@gmail.com>
Sent: Wednesday, October 17, 2018 11:19 AM
To: Lakes Software <info@weblakes.com>
Subject: Re: MM5 Data Request for Quote | MET1812984

Julie,

Thanks Julie. I am handling a case for Sonoma County where the applicant (Illingworth & Rodekin) refers to a met data set developed by Lakes. Their description differs from your description....

The Weather Research and Forecasting ("WRF") grid model was used to develop a 5-year data set (2013 through 2017) for meteorological conditions at the Project site. The WRF model pulls in observations and archived meteorological model data from the region around the

Project site, and uses the same physical equations that are used in weather forecasting to model the historical weather conditions at the specific project location. Development of this data set was performed by Lakes Environmental using the WRF model and the MMIF program to process data for input to the AERMOD meteorological data preprocessor, AERMET.

The above description indicates that data from stations around the project site were used to develop the met data set. So, is this an accurate description of the met data set developed by Lakes using the WRF model?

Thanks Julie.

Ray

On Wed, Oct 17, 2018 at 5:42 AM Lakes Software <info@weblakes.com> wrote:

Dear Ray,

Thank you so much for your inquiry. It's always good to hear from you!

Our MM5 process does not include direct input of local station data; input data to the model are based on global reanalyzed data which is a computational analysis performed on a combination of station observations, upper air soundings, and satellite data.

I've gone ahead and sent your quote through. If you have any additional questions, just let us know.

Have a wonderful day!

Kindest regards,

Julie Swatson | Senior Sales Associate
office: 519.746.5995 | fax: 519.746.0793
Lakes Environmental Software
www.webLakes.com | Twitter | Facebook | LinkedIn

<u>EXHIBIT 2</u>

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Draft Staff Report

Proposed Amended Rule 1401 – New Source Review of Toxic Air Contaminants

August 2017

Deputy Executive Officer
Planning, Rule Development, and Area Sources
Philip M. Fine, Ph.D.

Assistant Deputy Executive Officer
Planning, Rule Development, and Area Sources
Susan Nakamura

Planning and Rules Manager
Planning, Rule Development, and Area Sources
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Reviewed by:	William Wong – Principal Deputy District Counsel Barbara Baird – Chief Deputy District Counsel

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BACKGROUND

Rule 1401 – New Source Review of Toxic Air Contaminants (Rule 1401) was adopted in June 1990 and establishes health risk thresholds for new or modified permitted equipment or processes. Under Rule 1401, the health risk assessment conducted for new or modified permit units must not exceed a maximum individual cancer risk of one in one million, a cancer burden of 0.5, a chronic hazard index of one, and an acute hazard index of one. The methodology used to estimate health risks for SCAQMD's toxic regulatory program, including Rule 1401, is based on guidance from the Office of Environmental Human Health Assessment (OEHHA). OEHHA's Risk Assessment Guidelines are incorporated in the South Coast Air Quality Management District's (SCAQMD) Risk Assessment Procedures, which are required for implementing Rules 1401, 1401.1 and 212. The current version of the SCAQMD Risk Assessment Procedures is Version 8.0.

In March 2015, OEHHA revised its Risk Assessment Guidelines[1] (2015 OEHHA Guidelines) to incorporate requirements from the Children's Health Protection Act of 1999 (SB 25) which included the addition of child specific factors that increased the estimated cancer risk for long-term exposures for residential and sensitive receptors. The result is an increase in the estimated cancer risk of about 2.3 times, and higher for certain toxic air contaminants that have multiple exposure pathways such as inhalation, ingestion, and dermal. The 2015 OEHHA Guidelines do not change the toxic emission reductions already achieved by facilities in the South Coast Air Basin (Basin). The 2015 OEHHA Guidelines represent a change in the methodologies and calculations used to estimate health risk based on the most recent scientific data on exposure, childhood sensitivity, and breathing rates.

At the June 5, 2015 meeting, the SCAQMD Governing Board adopted amendments to Rule 1401 and incorporated the 2015 OEHHA Guidelines into SCAQMD's Risk Assessment Procedures (Version 8.0)[2]. SCAQMD staff evaluated permits received between October 1, 2009 and October 1, 2014 and found that most sources would not be required to install new or additional pollution controls as a result of the 2015 OEHHA Guidelines. The SCAQMD staff had concluded that based on an initial screening in June 2015, that some spray booths may have difficulties meeting the Rule 1401 risk thresholds using the 2015 OEHHA Guidelines so additional analysis was needed to better understand potential permitting impacts for spray booths. In addition, time was also needed to better assess and understand the impacts from gasoline dispensing facilities before use of the 2015 OEHHA Guidelines, and updates to emission factors and speciation profiles for gasoline dispensing facilities that the California Air Resources Board (CARB) was recommending. Therefore, provisions were included in the June 2015 amendment to Rule 1401[3] to allow spray booths and retail gasoline transfer and dispensing facilities to continue to use the then current

[1] Available on the internet at https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0

[2] SCAQMD's Risk Assessment Procedures for Rules 1401 and 212 (Version 8.0) can be found here: http://www.aqmd.gov/docs/default-source/planning/risk-assessment/riskassprocjune15.pdf and Attachment M can be found here: http://www.aqmd.gov/docs/default-source/permitting/attachment-m.pdf.

[3] SCAQMD's June 2015 Staff Report for Proposed Amended Rules 212 – Standards for Approving Permits and Issuing Public Notice, 1401 – New Source Review of Toxic Air Contaminants, 1401.1 – Requirements for New and Relocated Facilities Near Schools, and 1402 – Control of Toxic Air Contaminants from Existing Sources," can be found here: http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2015/2015-jun1-028.pdf?sfvrsn=9

SCAQMD Risk Assessment Procedures (Version 7.0)[4] to calculate the cancer risk until SCAQMD staff returns to the Board with specific regulations and/or procedures for these industries.

Staff has since completed the review of analyzing potential permitting impacts for spray booths and gasoline dispensing facilities. The results of the analysis is presented below under the section Proposed Amendments to Rule 1401. As discussed later in this staff report, implementation of the 2015 OEHHA Guidelines are expected to have minimal impacts to new or modified spray booth or gasoline dispensing facilities. As a result, Proposed Amended Rule 1401 will require these two source categories to begin using the SCAQMD's Risk Assessment Procedures (Version 8.1) which incorporates the 2015 OEHHA Guidelines for spray booths and gasoline dispensing facilities, revised emission factors and speciation profiles for gasoline dispensing facilities, and updated meteorological data. Currently, the SCAQMD's Risk Assessment Procedures (Version 8.0) requires all other permitted sources to use the 2015 OEHHA Guidelines and no changes except for updated screening tables using updated meteorological data are proposed for those sources.

PUBLIC PROCESS AND OUTREACH EFFORTS

Development of Proposed Amend Rule 1401 (PAR 1401) is being conducted through a public process. SCAQMD staff held three working group meetings at SCAQMD Headquarters in Diamond Bar on June 1, 2017, July 6, 2017, and July 20, 2017. The Working Group is composed of representatives from businesses, environmental groups, public agencies, and consultants. The purpose of the working group meetings are to discuss proposed concepts and to work through the details of staff's proposal. A Public Workshop was held on July 12, 2017.

PROPOSED AMENDMENTS TO RULE 1401

Currently, Rule 1401 allows the use of the previous SCAQMD Risk Assessment Procedures (Version 7.0) when determining risk for new and modified spray booths (e)(3)(A) and gasoline dispensing facilities (e)(3)(B). PAR 1401 will remove those provisions and instead require the use of the proposed SCAQMD Risk Assessment Procedures (Version 8.1) for all new and modified permitted equipment and processes. Version 8.1 of SCAQMD's Risk Assessment Procedures will replace Version 8.0 to reflect updates to emission factors for gasoline dispensing facilities, gasoline speciation profiles and meteorological data. Additionally, PAR 1401 will update the list of toxic air contaminants subject to the rule.

SPRAY BOOTHS

While previously issued permits are not subject to the proposed amendments to Rule 1401, they were used to predict potential impacts. To determine if the 2015 OEHHA Guidelines would impact future spray booth permits, the maximum individual cancer risk calculated in the previous permit evaluation was multiplied by 2.3 if the materials driving cancer risk had no multipathway factor (including most volatile organic compounds) or multiplied by six if the material driving cancer risk had a multipathway factor (including most toxic metals). The increase in the estimated cancer risk for a residential receptor is 2.3 times higher with the 2015 OEHHA Guidelines. If the receptor

[4] SCAQMD's Risk Assessment Procedures for Rules 1401, 1401.1 and 212 (Version 7.0) can be found here: http://www.aqmd.gov/docs/default-source/planning/risk-assessment/risk-assessment-procedures-v-7.pdf and Attachment L can be found here: http://www.aqmd.gov/docs/default-source/planning/risk-assessment/attachment-l.pdf.

is a worker there is generally no change in the estimated health risk. As a conservative approach, it is assumed that these permits had a residential receptor.

If the risk remained below the Rule 1401 risk thresholds of either 1 in-one-million without Best Available Control Technology for Toxics (T-BACT), or 10 in one million with T-BACT, then there would be no additional pollution controls required, and no permitting impact. If the calculated risk was higher than Rule 1401 thresholds, then it was deemed that a similar future spray booth permit could potentially be impacted. The objectives of the analysis were to answer the questions if spray booths were permitted with estimated health risks reflecting the 2015 OEHHA Guidelines: (1) would future spray booths that were not required to install pollution controls, potentially need to install pollution controls; or (2) would future spray booths that were required to install pollution controls, potentially need to upgrade pollution controls.

Analysis of Spray Booths

Staff evaluated spray booth permits issued from October 1, 2009 through October 1, 2014. Over the five-year permitting period, SCAQMD staff processed approximately 1,400 new or modified permits for spray booths. Out of the 1,400 spray booth permits, staff conducted a detailed review of a subset of 327 permits, which were randomly chosen. This sample size was selected to provide a 95 percent confidence level and a 5 percent margin of error in the analysis. Staff reviewed permit applications to better understand:

- Industry type and applicable coating rule(s);
- Compound(s) driving the carcinogenic risk; and
- Maximum individual cancer risk

Out of the 327 permits reviewed, automotive finishing accounted for almost one third of the applications. Wood coatings and other coatings each contributed to 23 percent of the applications, followed by metal coatings and aerospace coatings. Overall, the distribution of the industry type was very similar between the subset of reviewed permits and all the spray booth permits issued over the five-year period, indicating that the universe of spray booth application was well represented by the subset sample as indicated by Figure 1 below.

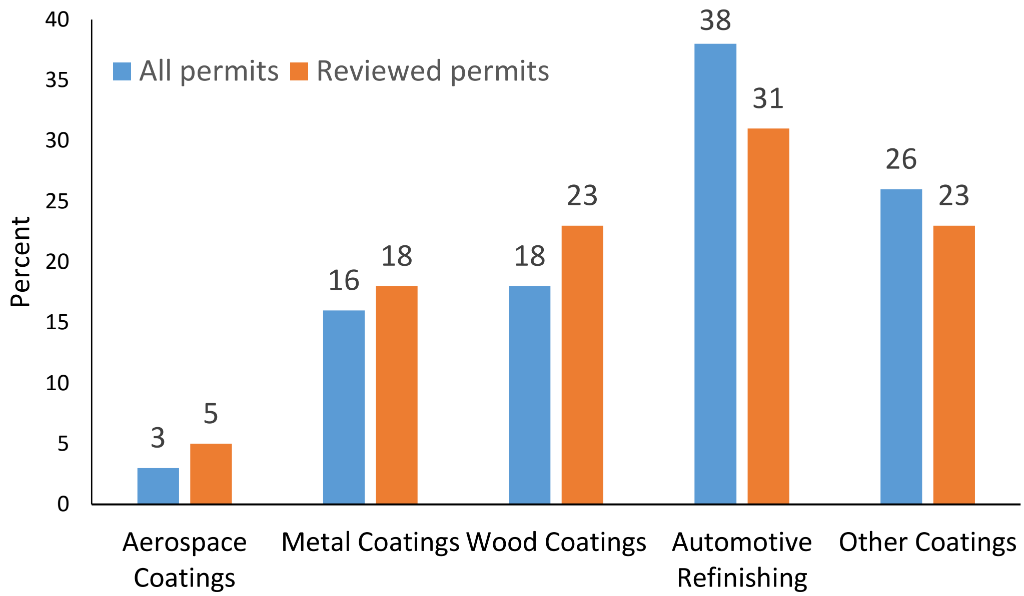

Figure 1: Industry Type Breakdown of Spray Booth Permit Applications

The spray booths can be categorized into two groups: with or without T-BACT. Figure 2 provides an overview of the potential impacts of the 2015 OEHHA Guidelines on spray booths. Majority of the spray booths (277 of 327) are not equipped with T-BACT, while 50 of the 327 spray booths are equipped with T-BACT. More details about the potential impacts on the two types of spray booths are discussed below.

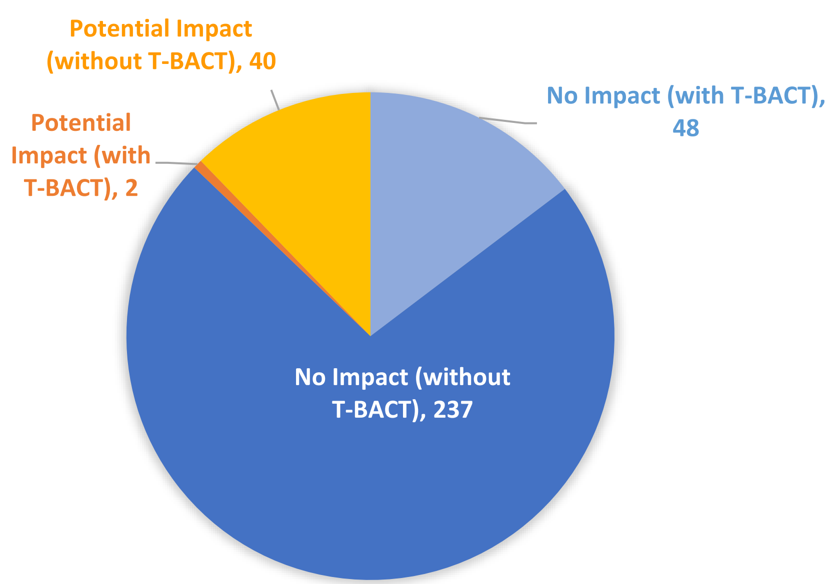

Figure 2: Potential Impacts of 2015 OEHHA Guidelines on Spray Booths

Impacts on Spray Booth Applications with T-BACT

Of the 327 permits reviewed, 50 were permitted with T-BACT. Of those 50 permits with T-BACT, 48 spray booths would have an estimated cancer risk that remained below the threshold of 10 in one million with the application of the 2015 OEHHA Guidelines. Among these spray booths, most of them use coatings containing hexavalent chromium or other metals. Thus, if 48 similar spray booths were permitted in the future using the proposed SCAQMD Risk Assessment Procedures (Version 8.1) that incorporates the 2015 OEHHA Guidelines, no additional pollution controls are expected.

Two spray booths had an estimated cancer risk above 10 in one million with the use of the 2015 OEHHA Guidelines. These two spray booths use aerospace coatings containing hexavalent chromium, and were permitted with high efficiency particulate air (HEPA) filters with an efficiency of 99.999 percent, which satisfies the T-BACT requirement. The permitted cancer risk was kept below 10 in a million with limits on the maximum allowable usage of hexavalent chromium and ethyl benzene. If these two spray booths were permitted using the proposed SCAQMD Risk Assessment Procedures (Version 8.1) which incorporates the 2015 OEHHA Guidelines, the cancer risk would exceed the threshold of 10 in one million assuming the same throughput and emission control technology (HEPA filters) are used. Thus, a new spray booth application with the same operating conditions as these two spray booths would have to either reduce their throughput or use a more effective control technology. An ultra-low penetration air (ULPA) filter provides a removal efficiency of 99.9999 percent or better, and is commercially available with a comparable cost as the HEPA filter. With the use of an ULPA filter, throughput would not need to be reduced. Nonetheless, a filter with a higher efficiency will likely increase the pressure drop across the filter. Depending on the design of the air system, a stronger fan/blower might be needed to accommodate a more efficient filter.

Impacts on Spray Booth Applications without T-BACT

Of the 327 permits reviewed, 277 are permitted without T-BACT. Staff estimates that with the application of the 2015 OEHHA Guidelines the estimated cancer risk for 237 (86 percent) permitted spray booths would remain below a health risk of 1 in one million so no further action, such as the addition of pollution controls or changes to the type or amount of materials identified in the permit, would be expected. These types of permit applications would not be impacted by incorporating the 2015 OEHHA Guidelines in the proposed SCAQMD Risk Assessment Procedures (Version 8.1) because the coatings applied have low or no toxics content.

Of the 277 spray booths without T-BACT, 40 spray booths (14 percent) exceeded the cancer risk threshold of 1 in one million when the 2015 OEHHA Guidelines were applied. An in-depth analysis was conducted on the permits issued for these 40 spray booths to better understand the volume and the content of toxic air contaminants in the coatings used. Four spray booths were found to be no longer in service and are not included in the analysis below, leaving 36 permits for spray booths analyzed. Staff collected safety data sheets, usage records, contacted coating suppliers, or conducted site visits to examine the potential impact of the 2015 OEHHA Guidelines.

Among the 36 spray booths that are in operation, ethyl benzene was the most prevalent toxic air contaminant used in coatings with 72 percent of the permits for spray booths use coatings with ethyl benzene. Formaldehyde is the next most common toxic air contaminant used in coatings, representing 8 percent of the permits for spray booths. For the other permits, the formulations had multiple toxic air contaminants, including ethyl benzene and formaldehyde (8 percent), ethyl benzene and nickel (6 percent), as well as ethyl benzene and others (6 percent).

As discussed in more detail below, the 36 permits for spray booths are not expected to be impacted by the 2015 OEHHA Guidelines because the facilities are either no longer using toxic air contaminants, the actual usage of materials containing toxic air contaminants is much lower than permitted levels, or the amount of toxic air contaminants assumed in the permit is higher than the actual amount in the material used. The results of the in-depth analysis is illustrated in Figure 3 below.

Permitted Spray Booths Without T-BACT – Use of Materials With Toxic Air Contaminants

Based on interviews with owner or operators with permitted spray booths, staff found that for 10 of the 36 permits for spray booths, the owner or operator switched coatings and are currently using coatings that do not contain toxic air containments. In some cases, the facility had opted to utilize a new coating while in the remaining cases, the coating had been reformulated. Reformulated coatings typically replace the mineral spirits that contains trace quantities of ethyl benzene with a hydrotreated petroleum distillate that performs the same function but does not contain ethyl benzene. Thus, it is expected that a considerable fraction of owners or operators that are applying for future permits for spray booths will be selecting coatings that do not contain toxic air contaminants as coatings that do not contain toxic air contaminants are available. It is assumed that for the 10 permitted spray booths that originally were using coatings with toxic air contaminants, that in the future these permit applications would not be impacted by incorporating the 2015 OEHHA Guidelines in the proposed SCAQMD Risk Assessment Procedures (Version 8.1) because operators are already making the decision to use coatings that do not contain toxic air contaminants.

Permitted Spray Booths Without T-BACT – Actual Material Usage

Based on interviews and site visits with owner and operators, staff found that the permitted usage of coatings was considerably higher than the actual usage in 16 of 36 permits for spray booths reviewed (25 percent). In many cases, the facility is given a maximum allowable limit on the number of gallons for the overall use and a maximum allowable limit on the number of gallons that can be used that contain a toxic air contaminant. Because the spray booths use multiple coatings within the same booth and most coatings do not contain a toxic air contaminant, the facility may use close to their overall use limit but not approach their limit for coatings that contain toxic air contaminants. Because their actual usage is considerably lower than their maximum allowable usage limit for specific coatings with toxic air contaminants, a lower permitted usage for specific coatings with toxic air contaminants will not impact their operations. By establishing maximum usage limits for coatings with toxic air contaminants that are closer to anticipated actual usage, it is expected that for the 16 permitted spray booths that in the future these permit applications would not be impacted by incorporating the 2015 OEHHA Guidelines in the proposed SCAQMD Risk Assessment Procedures (Version 8.1) because operators can accept a lower permitted usage limit for materials with toxic air contaminants.

Permitted Spray Booths Without T-BACT – Toxic Air Contaminant Content in Safety Data Sheet

Based on interviews with owner or operators and coating formulators, staff found that for 10 of the spray booths, the Safety Data Sheet had overstated the quantity of toxic air contaminants in their coatings. Safety Data Sheets list the range (in percent by weight) of toxic air contaminants present in the coating formulation. In many cases the formulated coating lists the ethyl benzene content as between 0.5 and 5 percent. However, based on discussions with the coating formulator, the actual ethyl benzene content for the formulated product is actually between 0.2 and 2.5 percent. If these spray booths were to apply for new permits under the proposed SCAQMD Risk Assessment Procedures (Version 8.1), they might consider migrating to reformulated coatings / new coatings with lower or no ethyl benzene content. Alternatively, manufacturers might update the Safety Data Sheet to provide a more accurate estimate with products using ethyl benzene. By either using a more accurate percentage of toxic air contaminant in the coating formulation or using a coating with lower or no ethyl benzene, it is expected that for the 10 permitted spray booths that in the future these permit applications would not be impacted by incorporating the 2015 OEHHA Guidelines in the proposed SCAQMD Risk Assessment Procedures (Version 8.1).

Summary of Spray Booth Analysis

Based on the detailed review of 327 spray booth permit applications, the implementation of the 2015 OEHHA Guidelines in the proposed SCAQMD Risk Assessment Procedures (Version 8.1) will result in no impact for 99 percent of spray booth permits. Figure 3 below summarizes staff's findings for spray booths that were permitted without T-BACT. For spray booths that were permitted without T-BACT, it is expected that in the future permit applicants will either select a coating with no toxic air contaminants, use products that provide more accurate estimates of toxic air contaminants in the Safety Data Sheet, or accept a lower usage limit for coatings that contain toxic air contaminants rather than install T-BACT.

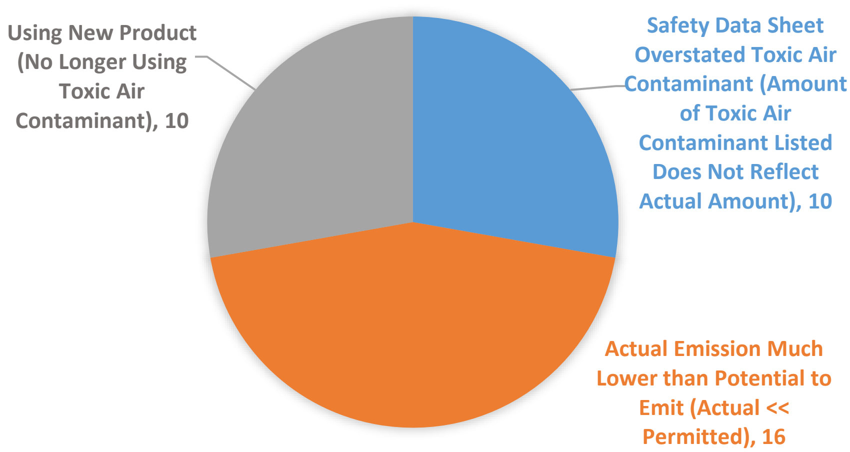

Figure 3: Summary Findings for 36 Spray Booths without T-BACT

Table 1 provides a summary findings for spray booths. Approximately 1 percent (two of the 327) of spray booth permits may need to use a high efficiency filter media such as ULPA filters, or consider reducing their throughput if the 2015 OEHHA Guidelines are utilized. For facilities that were permitted without T-BACT, it is expected that no additional pollution controls would be needed using the 2015 OEHHA Guidelines. Therefore, with a 95 percent confidence level, it is expected that approximately 1 percent of new spray booth permit applications will require additional pollution control equipment if the 2015 OEHHA Guidelines are utilized. With SCAQMD receiving, on average, 280 spray booth permit applications annually, approximately two spray booth permits annually could require higher level of air pollution controls. The expected additional air pollution control would be the replacement of HEPA filters with ULPA filters. It is concluded that the impact of the 2015 OEHHA Guidelines are minimal on spray booth permits. Therefore, staff recommends removing the exemption and referencing the proposed SCAQMD Risk Assessment Procedures (Version 8.1) for spray booths.

Table 1: Summary Findings for Spray Booths with T-BACT

Area of Analysis	Number of Permits	Will T-BACT or Upgrades to T-BACT be Needed?
Total number of spray booths reviewed	327	
Spray booths without T-BACT where the cancer risk with the 2015 OEHHA Guidelines would be:		
• ≤ 1 in one million after initial review	237	
• ≤ 1 in one million after in-depth review		
○ Use of materials with toxic air contaminants	10	No
○ Actual material usage	16	No
○ Toxic air contaminant content in Safety Data Sheet	10	No
○ No longer in operation	4	N/A
Spray booths with T-BACT where the cancer risk with the 2015 OEHHA Guidelines would be:		
• ≤ 10 in one million	48	No
• >10 in one million	2	Yes
Percent of spray booth permits that will need T-BACT or upgrades to T-BACT controls out of 327 permits reviewed	0.6%	

GASOLINE DISPENSING FACILITIES

In the amendments to Rule 1401 in June 2015, SCAQMD staff recommended that retail gasoline transfer and dispensing facilities continue to use the then current SCAQMD Risk Assessment Procedures (Version 7.0) because additional time was needed to better assess the potential impacts of the revised speciation profile that the California Air Resources Board (CARB) had provided in March 2015 and emission data on gasoline dispensing facilities. As part of this rule development process for PAR 1401, staff evaluated the potential impacts of the revised emission factors and gasoline speciation profiles and how they could affect new gasoline dispensing facilities combined with the use of the 2015 OEHHA Guidelines in proposed SCAQMD Risk Assessment Procedures (Version 8.1).

Gasoline Dispensing Emission Factors

Gasoline dispensing emission factors gasoline speciation profiles for air toxics are developed by the California Air Resources Board (CARB). In December 2013, CARB revised emission factors for gasoline dispensing facilities and are described in CARB's "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities." (CARB's 2013 Revised Emission Factors). The emission factors were revised for the processes of loading, breathing, and refueling, and new information was added for hose permeation. The emission factor for spillage remains unchanged. Each of these emission sources is briefly described below:

i) Loading - Emissions occur when a fuel tanker truck unloads gasoline to the storage tanks. The storage tank vapors, displaced during loading, are emitted through its vent pipe. A pressure/vacuum valve installed on the tank vent pipe significantly reduces these emissions.

ii) Breathing - Emissions occur through the storage tank vent pipe as a result of temperature and pressure changes in the tank vapor space.

iii) Refueling - Emissions occur during motor vehicle refueling when gasoline vapors escape either through the vehicle/nozzle interface or the onboard refueling vapor recovery (ORVR) system.

iv) Spillage - Emissions occur from evaporating gasoline that spills during vehicle refueling.

v) Hose Permeation - Emissions caused by the migration of liquid gasoline through the outer hose material and to the atmosphere through permeation.

One of the updates to the 2013 Revised Emission Factors was to add a new subcategory for refueling for Phase II fueling for vehicles equipped with ORVR. CARB's previous emission factors which were adopted in 1999 did not account for vehicles equipped with ORVR. Table 2 presents CARB's 2013 Revised Emission Factors and SCAQMD's proposed controlled gasoline emission factors for the process of loading, breathing, refueling, spillage and hose permeation. SCAQMD staff is recommending the use of CARB's Revised Controlled Gasoline Emission Factors for loading, breathing, spillage and hose permeation. SCAQMD staff, however, is recommending not to incorporate CARB's 2013 revised emission factors for refueling ORVR vehicles, but continuing the use of the current SCAQMD emission factor for refueling.

Table 2: CARB 2013 Revised and SCAQMD Proposed Controlled Gasoline Dispensing Emission Factors (lbs/1,000 gallon)

Emission Source	SCAQMD Current Controlled Gasoline Emission Factor (lbs/1,000 gal)	CARB 2013 Revised Controlled Gasoline Emission Factor (lbs/1,000 gal)	SCAQMD Proposed Controlled Gasoline Emission Factor (lbs/1,000 gal)
Loading	0.42	0.15	Same as CARB
Breathing	0.025	0.024	Same as CARB
Refueling – Phase II with Non-ORVR vehicles	0.32*	0.42	Same as CARB
Refueling – Phase II with ORVR vehicles	NA	0.021	0.32* (remain unchanged from current emission factor)
Spillage	0.24	0.24	Same as CARB
Hose Permeation	None	0.009	Same as CARB

*SCAQMD staff is committed to continue working with CARB staff on the refueling emission factor for Phase II EVR with ORVR vehicles. Until then, SCAQMD staff is recommending using the current SCAQMD emission factor for refueling.

Refueling Emission Factor for Phase II with ORVR Vehicles

The SCAQMD staff has reviewed the emission factor for refueling, and believes that CARB's 2013 revised emission factors may overestimate the emission reductions from refueling with Phase II with ORVR vehicles. CARB's approach to derive the refueling emission factor is to apply a 95 percent control efficiency for Phase II enhanced vapor recovery (EVR), and an additional 95 percent control efficiency for ORVR to provide an overall control efficiency for refueling of 99.75 percent. Based on SCAQMD staff's review of the Phase II EVR and ORVR technologies, these two pollution control technologies may not work in series to provide a 99.75 control efficiency. The technical basis of staff's determination is presented below.

Phase II EVR is a system designed to capture displaced vapors that emerge from inside a vehicle's fuel tank, when gasoline is dispensed into the tank. As shown in Figure 4, during refueling, vapors are pulled from the gasoline tank to the underground storage tank for a vehicle that is not equipped with ORVR that is fueled with Phase II EVR. Currently there are two systems certified for Phase II EVR: a balance system and a vacuum-assist system. The balance system transfers vapors from the vehicle and returns them to the underground storage tank based on the pressure differential. A vacuum-assist system relies on a vacuum to draw vapors from the vehicle fuel tank into the underground storage tank. CARB requires use of ORVR-compatible Phase II EVR systems that are designed to sense when an ORVR vehicle is being refueled and reduces the air to liquid ratio to near zero to avoid compatibility emission effects in the underground storage tank. CARB has determined that Phase II EVR systems have a control efficiency of 95 percent.

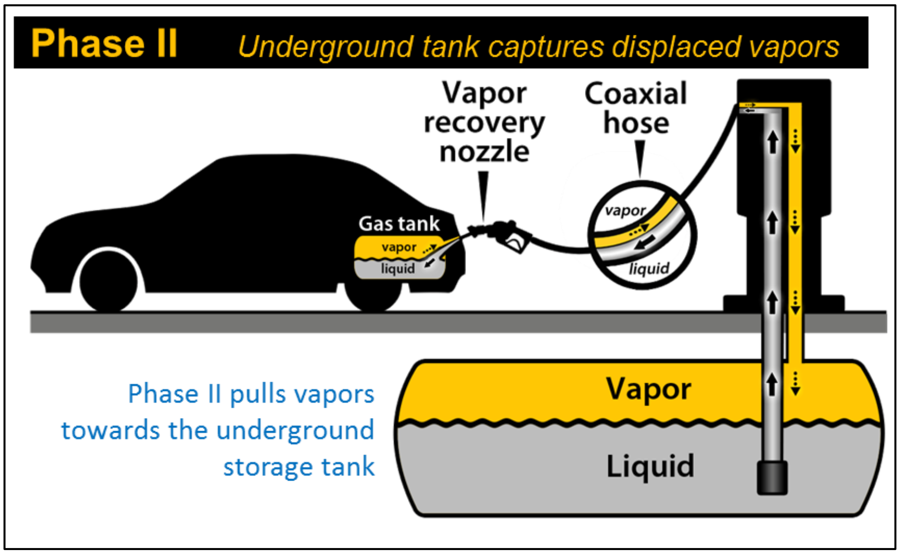

Figure 4: Phase II Vapor Recovery Underground Tank Captures Displaced Vapors

As shown in Figure 5, an ORVR system captures the gasoline vapors that are displaced during refueling and stores those vapors in a canister filled with activated carbon. When the vehicle engine is started, gasoline vapors stored in the canister are purged and burned in the engine. The carbon bed achieves an average control efficiency of 95% as determined by CARB.

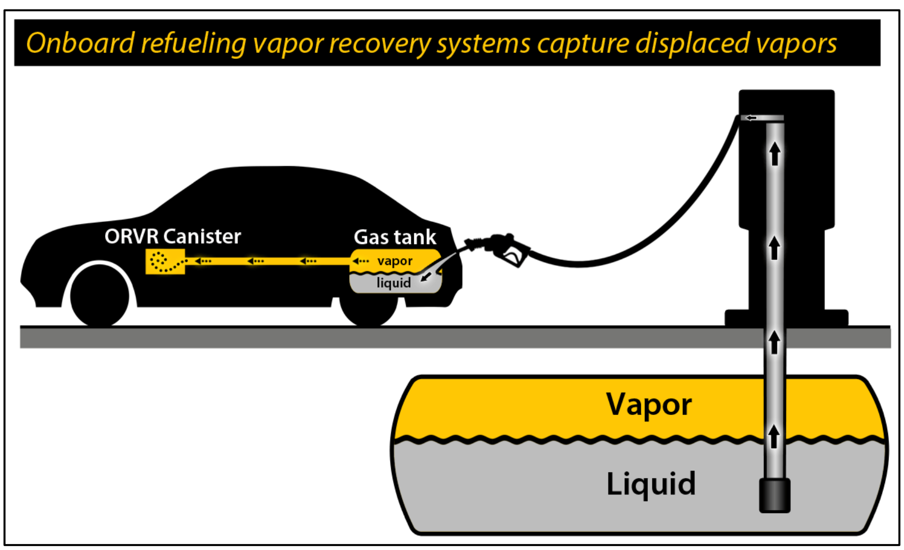

Figure 5: Onboard Refueling Vapor Recovery System Capture Displaced Vapors

Figure 6 provides a more detailed view of the fuel tank and the modified fillpipe on a vehicle equipped with ORVR. As shown in Figure 6, the ORVR system has mechanisms (i.e. a narrowed fillpipe to form a liquid barrier and a mechanical valve at the end of the fillpipe) to prevent vapor within a vehicle fuel tank from escaping via the fillpipe of the vehicle to the Phase II controls. The vapor that would have otherwise escaped through the fillpipe to the Phase II controls is instead directed to a carbon canister contained within the vehicle, which is the actual means of emission control of the ORVR system, to adsorb hydrocarbons contained in the displaced vapor.

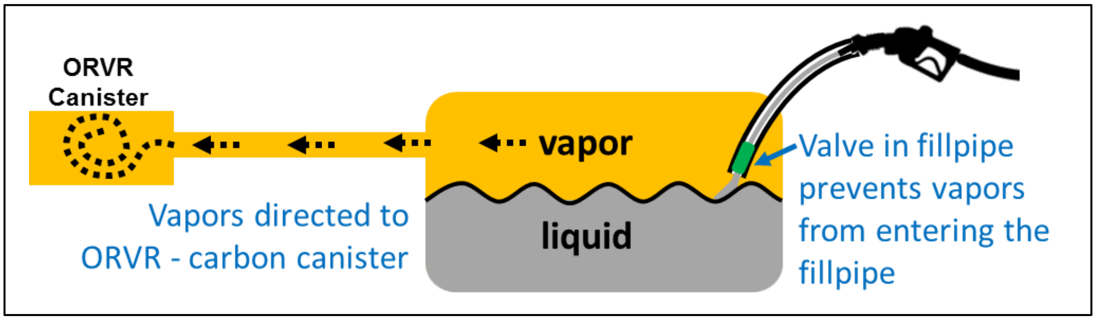

Figure 6: Detailed View of Fillpipe for Onboard Refueling Vapor Recovery System

CARB's revised emission factor for refueling of ORVR vehicles is calculated assuming that the ORVR system and the Phase II EVR system work consecutively in series to control vapor emissions, allowing a compounding control efficiency of 99.75 percent from both control equipment. However, there is no empirical evidence supporting the assumption that all the vapors escaping from the ORVR system are directed to the fillpipe and can be captured by the Phase II EVR system.

To further illustrate that emission reductions from the Phase II EVR system are not compounded, the United States Environmental Protection Agency (U.S. EPA) has conducted source test studies according to the Federal Test Procedure. The U.S. EPA tests were conducted using sealed housing emissions device (SHED), where emissions from both the fillpipe and the on-board canister were monitored. The U.S. EPA study tested 337 dispensing events, and the results are summarized in a report published by CARB in 2008 (Table 7)[5]. The fillpipe and on-board canister emissions together averaged to 0.25 pounds per 1,000 gallons, suggesting that the revised emission factor recommended by CARB underestimates the emissions from refueling ORVR vehicles. The table further shows a standard deviation of 1.15 which indicates the control efficiency of individual vehicle tested varies significantly from the average emissions of 0.25 pounds per 1,000 gallons.

Additional justifications can be found with the documents U.S. EPA issued on its rule to remove the federal Stage II program from the State Implementation Plans (SIP) requirements. On July 15, 2011, the U.S. EPA issued a proposed rule titled "*Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver*." The proposed rule allowed states to consider removing Stage II vapor recovery requirements when revising their SIPs, due to the national widespread use of ORVR. Subsequently, U.S. EPA issued the "*Guidance on Removing Stage II Gasoline Refueling Vapor Recovery Programs from State Implementation Plan*" in 2012. The Guidance document provides both policy and technical recommendations for states seeking to remove or phase-out

[5] Available on the internet at https://www.arb.ca.gov/vapor/archive/2008/orvrtestreport072408.pdf

existing Stage II program, based on the premise that the Stage II program would become largely-redundant due to the widespread use of ORVR.

On the federal level, the control efficiency of Stage II is in the range of 60-75 percent, much lower than the California Phase II program (95 percent). In addition, in areas where certain types of vacuum-assist Stage II control systems are used, the limited compatibility between ORVR and some configurations of this Stage II hardware may result in an area-wide emissions disbenefit. U.S. EPA's regulation stated that with the widespread use of the ORVR-equipped vehicles, Stage II programs have become largely redundant control systems with minimal reduction benefits beyond the ORVR system. SCAQMD and CARB have commented that Phase II EVR are still needed as discussed in more detail under their comment letters[6] submitted in response to U.S. EPA's proposed rule. U.S. EPA's guidance does, however provide additional insight regarding the application of emission reductions from Stage II control systems for vehicles equipped with ORVR further demonstrating that the control efficiency of the ORVR and/or the Stage II systems are only applied once to the respective gasoline throughput. See Appendix A for a detailed discussion.

Additional Refueling Emission Reductions for Phase II with ORVR Vehicles

Although the SCAQMD staff does not believe that it is technically correct to apply an additional 95% control efficiency on the remaining refueling emissions for a vehicle equipped with ORVR, there is evidence that vehicles equipped with ORVR do have emissions at the fillpipe. A study conducted by CARB in 2008[7] measured the gasoline vapor emissions at the vehicle fuel fillpipe of ORVR vehicles at a gasoline dispensing facility with no Phase II EVR system. Although the study demonstrated that the majority of the vapors escaping from the ORVR canister is not routed to the fillpipe, there is a small percentage of vapors that will escape the fillpipe that can be captured by the Phase II EVR system. As discussed below, the amount of vapors escaping the fillpipe that can be captured by the Phase II EVR system is much less than the 0.42 lbs/1,000 gallons that CARB used to estimate emission reductions from Phase II EVR systems for vehicles with ORVR.

The 2008 CARB study was conducted at an "ambient environment" at a gasoline dispensing facility for a rental vehicle company and based on 58 dispensing events. While the test was designed to evaluate fillpipe emissions, the study could not capture emissions from the on-board canister of the ORVR system. Therefore, it does not present total refueling emissions, which includes emissions from both the fillpipe and the on-board canister for ORVR vehicles. Results from the 2008 CARB study showed that fillpipe emissions from ORVR vehicles, which represent the vapors escaping via the fillpipe and not directed to the carbon canister, were 0.043 lb per 1,000 gallons dispensed for summer fuel and 0.094 lb per 1,000 gallons for winter fuel. The low fillpipe emissions for ORVR vehicles are consistent with the design of the ORVR system, which creates a seal in the vehicle fillpipe to route vapors to the onboard canister during dispensing. Moreover, these emissions are a very small fraction of the anticipated emissions escaping from the ORVR canister, which is approximately 0.42 lbs per 1,000 gallons (5 percent of the uncontrolled emission factor of 8.4 lbs per 1,000 gallons).

[6] Available on the internet at
https://www.regulations.gov/docketBrowser?rpp=50&so=DESC&sb=postedDate&po=0&dct=PS&D=EPA-HQ-OAR-2010-1076

[7] Available on the internet at https://www.arb.ca.gov/vapor/archive/2008/orvrtestreport072408.pdf

The SCAQMD staff believes that there is a small amount of vapor that the Phase II EVR system will control during refueling of an ORVR vehicle. SCAQMD staff has been in communication with CARB staff regarding the refueling emissions factor. Both agencies agree that additional time is needed to better understand emission reductions from Phase II EVR for ORVR vehicles. SCAQMD staff is recommending not to incorporate CARB's 2013 revised emission factor for Phase II refueling of ORVR vehicles, but to continue the use of SCAQMD's current emission factor of 0.32 lbs per 1,000 gallons for refueling. Staff is recommending the use of CARB's 2013 emission factors for all other categories (loading, breathing, spillage, and hose permeation). The SCAQMD staff is committed to continue working with CARB staff to refine the refueling emission estimates for Phase II controls with ORVR vehicles and will return to the Board with future revisions to refueling emission factors.

Need for Phase II Enhanced Vapor Recovery with ORVR

Although U.S. EPA has determined that the federal Stage II program had become largely-redundant due to the widespread use of ORVR, the Phase II requirements are still needed in California. In 2011, CARB prepared a comment letter[8] in response to U.S. EPA's proposed rule regarding gasoline vapor recovery control of ozone-precursor emissions titled *Air Quality: Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver*. Included in the comment letter is an analysis that supports the need for California's Phase II EVR requirements even with the widespread use of ORVR. It highlights that Phase II EVR is needed for non-ORVR vehicles to achieve the additional VOC reductions of 14.7 tons per day in the year of 2020, and 8.8 tons per day in the year 2028 and beyond. Also, California's Phase II program includes other emission control features, such as in-station diagnostics and standards for nozzle liquid retention, dripless nozzle and spillage, in addition to the control of the vapors displaced during vehicle refueling. Thus, it achieves greater emission reductions than the federal Stage II program requirements and the improvement it provides is essential to meeting mandated federal ambient air quality standards.

Furthermore, the impacts of removing California's Phase II program could be magnified in disadvantaged communities. Due to the lower socioeconomic status in disadvantaged communities, the turnover of the fleet is usually lower. Since vehicles manufactured before year 1998 are not equipped with ORVR, disadvantaged communities could have a higher fraction of non-ORVR vehicles than non-disadvantaged communities, and removal of the Phase II EVR system would put much of the emission disbenefit in the disadvantaged communities.

In addition to emission factors, CARB has also developed speciation profiles of various toxic air contaminants. Out of the toxic compounds emitted from gasoline facilities, benzene, ethylbenzene, and naphthalene have cancer toxicity values. The speciation profiles are different for vapor and liquid phases of gasoline for benzene, ethyl benzene, and naphthalene. Table 3 presents the current and proposed speciation profile in weight percent for the three toxic air contaminants. SCAQMD staff recommends using CARB's proposed gasoline speciation profile.

[8] Available on the internet at https://www.arb.ca.gov/vapor/carb%20response%20useap%20orvr%20widespread%20use%20nprm.pdf.

Table 3: Current and Proposed Weight Percent (lbs/1,000 gallon)

Pollutant (Form)	Current Speciation	Proposed Speciation
Benzene (vapor)	0.30%	0.455%
Ethyl benzene (vapor)	0.118%	0.107%
Naphthalene (vapor)	0%	0.0004%
Benzene (liquid)	1.00%	0.707%
Ethyl benzene (liquid)	1.64%	1.29%
Naphthalene (liquid)	0.14%	0.174%

Analysis of Permitting Impacts for Gasoline Dispensing Facilities Using SCAQMD Risk Assessment Procedures Version 8.1

The proposed SCAQMD Risk Assessment Procedures (Version 8.1) has been revised using the following updated items for gasoline: (1) 2015 OEHHA Guidelines for spray booths and gasoline dispensing facilities, (2) emission factors for gasoline dispensing facilities and gasoline speciation profiles (as discussed earlier), and (3) dispersion model and meteorological data. To assess the impacts of these updates on future gasoline dispensing facilities, staff evaluated gasoline dispensing facilities that applied for a new permit (i.e. permit to construct or permit to operate) from October 1, 2009 through December 31, 2016. If the recalculated risk of a previously issued permit using the proposed SCAQMD Risk Assessment Procedures (Version 8.1) would be higher than Rule 1401 thresholds, then it was deemed that a similar future gasoline dispensing facility permit would potentially be impacted.

Under SCAQMD's Risk Assessment Procedures (Version 7.0), the U.S. EPA's dispersion model ISCST3 (Industrial Source Complex – Short Term, Version 3) was incorporated in the Hotspots Analysis and Reporting Program (HARP) software for the health risk assessment. In the most recent version of HARP (HARP 2), the U.S. EPA dispersion model AERMOD is used to estimate the concentration of pollutants in place of the previously used ISCST3 model. In addition to the new dispersion model, the meteorological data used to estimate cancer risk has been updated. It is SCAQMD's policy to update the meteorological data used for dispersion modeling every three years. In previous years, the use of SCAQMD collected meteorological data was used exclusively. However, in the most recent update of meteorological data, it was discovered that the meteorological data at some SCAQMD sites did not meet the QA/QC criteria for dispersion modeling. Therefore, the SCAQMD meteorological sites were supplemented with Automated Surface Observing System (ASOS) sites. Designed to serve meteorological and aviation observing needs, ASOS sites are located at various airports in the Basin. ASOS data was retrieved from the National Centers for Environmental Information (https://www.ncei.noaa.gov/). Finally, the use of meteorological correction factors for gasoline dispensing facilities have been removed in favor of more precise dispersion factors provided for each meteorological station. Additional information about the updates of the meteorological modeling are included in Appendix VI of SCAQMD's Risk Assessment Procedures (Version 8.1).

Impacts on New Gasoline Dispensing Facilities

Over the seven-year period, 140 new permits of gasoline dispensing facilities were processed. To identify gasoline dispensing facilities that would exceed the maximum individual cancer risk of ten in one million as they are equipped with T-BACT, staff gathered the following data from the permit applications:

- Industry type and application type (new, modified, relocated);
- Permitted throughput, usually expressed as million gallons per year;
- Distance to the nearest residential and commercial receptor;
- Location of the gasoline dispensing facilities; and
- Maximum individual cancer risk

Table 4 provides a summary of the permitted annual throughput for the gasoline dispensing facilities reviewed. Of the 140 new permits, the majority of the applications (64 percent) are permitted at less than one million gallons per year. They include aboveground storage tanks, mobile fuelers, as well as underground storage tanks serving commercial (non-retail) operations. Fifty gasoline dispensing facilities were permitted at an annual throughput above one million gallons per year. Most of these higher throughput facilities are retail service stations.

Table 4: Annual Throughput of Gasoline Dispensing Facilities Permitted between 2009 and 2016

Annual Throughput (MMGals/year)	Number of Gasoline Dispensing Facilities	Industry Type
<1	90	Aboveground storage tanks, mobile fuelers, and others
1-3	9	Aboveground storage tanks and retail gas stations
>3	41	Retail gas stations

Impacts on New Gasoline Dispensing Facilities Permitted Using a Tier 4 Analysis

Over the seven-year period from October 2009 to December 2016, three of the 140 new gasoline dispensing facilities had a maximum individual cancer risk above ten in one million based on Tier 2 screening and therefore, the applicant submitted a more refined site specific Tier 4 analysis (Detailed Risk Assessment) in order to demonstrate compliance with Rule 1401 at the requested throughput. To estimate the potential impacts on those applications, a percentage change, based on a comparison between the Tier 2 screening tables of SCAQMD Risk Assessment Procedures in Version 7.0 and Version 8.1, was applied. The percentage change is site-specific, depending on the facility location and distance to receptor. After applying the percentage change, the estimated health risk for the three gasoline dispensing facilities is expected to decrease and remained below the threshold of ten in one million. Therefore, it is expected that for new gasoline dispensing facilities permitted using Tier 4 analysis that in the future these permit applications would not be impacted by the proposed SCAQMD Risk Assessment Procedures (Version 8.1).

Impacts on New Gasoline Dispensing Facilities Permitted Using Tier 2 Analysis

The cancer risks for the rest of the permit applications (137 of 140) from 2009 to 2016 were determined using Tier 2 Screening Risk Assessment. In order to analyze the impacts to these permits from the use of the 2015 OEHHA Guidelines, staff used the screening tables (Tier 2) in the proposed SCAQMD Risk Assessment Procedures (Version 8.1) to estimate the cancer risk for the permits. Using the proposed SCAQMD Risk Assessment Procedures (Version 8.1), 132 of the 137 gasoline dispensing facilities had estimated cancer risks that remained below the Rule 1401 thresholds. Therefore, no impact is expected for 96 percent of the new permit applications, if these permits were to be processed with the proposed SCAQMD Risk Assessment Procedures (Version 8.1). Five of the 137 facilities had cancer risks that would exceed the threshold. The five facilities are retail service stations equipped with CARB certified Phase I and Phase II EVR systems, which are considered to be T-BACT. The five facilities are located in Whitter (Facility A), Burbank (Facility B), Riverside (Facility C), Perris (Facility D), and Perris (Facility E), respectively. Table 5 summarizes the potential impacts of the proposed SCAQMD Risk Assessment Procedures (Version 8.1). Note that for these five facilities, the permitted allowable throughput was based on Tier 2 Screening Risk Assessment as part of the permitting process. The permit applicants did not need to proceed to a higher tier (Tier 3: Screening Dispersion Modeling or Tier 4: Detailed Risk Assessment) for a more refined risk assessment. However, if Facility A, B[9], C, D and E were to apply for a new permit under the proposed SCAQMD Risk Assessment Procedures (Version 8.1), their allowable throughput would have decreased by 13%, 16%, 40%, 28% and 22%, respectively.

Table 5: Potential Impacts of the Proposed SCAQMD Risk Assessment Procedures (Version 8.1)

Facility	Maximum Individual Cancer Risk Estimated using Current SCAQMD Risk Assessment Procedures (Version 7.0) (per One Million)	Maximum Individual Cancer Risk Estimated using Proposed SCAQMD Risk Assessment Procedures (Version 8.1) (per One Million)
A	9.97	11.3
B	9.72	11.7
C	9.86	16.3
D	9.55	13.8
E	8.82	12.7

[9] Note that this facility is located within 500 feet of a school and permitted prior to the adoption of Rule 1401.1 - Requirements for New and Relocated Facilities near Schools. Under SCAQMD Rule 1401.1, the maximum individual cancer risk shall not exceed one in one million at any school within 500 feet of the toxic-emitting permit unit at the facility. Therefore, if a facility was to apply for a new or modified SCAQMD permit where Facility B is located, it would be subject to Rule 1401.1. The maximum individual cancer risk will be limited to less than one in one million at the school, and the permitted throughput will be substantially lower.

All retail service stations within SCAQMD's jurisdiction are already equipped with CARB certified Phase I and Phase II vapor recovery systems to control gasoline emissions. Phase I vapor recovery refers to the collection of gasoline vapors displaced from storage tanks when cargo tank trucks make gasoline deliveries. Phase II EVR systems control the vapors displaced from the vehicle fuel tanks during refueling. In addition, all gasoline is stored underground with valves installed on the tank vent pipes to further control gasoline emissions. Installation of additional emission control technology is not economical and very unlikely.

On the other hand, cancer risks decrease substantially with distance. Estimated cancer risks are higher when the facility is close to the receptor. For one million gallons of gasoline, the residential maximum individual cancer risk ranges from 2.6 to 5.2 in one million at 25 meters from receptor, and decreases considerably to a range of 0.31 to 0.76 in one million at 100 meters from the receptor. Among the five facilities listed in Table 5, the highest cancer risk is observed at Facility C. Using Facility C as the worst case scenario, the cancer risk calculated using the proposed SCAQMD Risk Assessment Procedures (Version 8.1) would remain below the threshold for the same throughput as previously permitted, if the distance between the emission source and the nearest downwind receptor was 54 meters instead of 41 meters. Thus, retail gasoline dispensing facilities that would like to be permitted with a relatively high throughput might need to give more consideration to its site design by positioning the emission source further away from the sensitive receptor.

Furthermore, while the use of Tier 1 and Tier 2 screening tables are useful to allow most facilities to demonstrate compliance with Rule 1401 without complicated dispersion modeling, there are other more refined modeling options available to applicants such as the use of Tier 3 and Tier 4 analyses. As previously discussed, three of the 140 new applicants demonstrated compliance through Tier 4 modeling. If the Tier 2 screening risk assessment results in a risk estimate that exceeds the risk limits or the permit applicant feels that a more detailed evaluation would result in a lower risk estimate, the applicant has the option of conducting a more detailed analysis using Tier 3 or 4.

Impacts on Modified Gasoline Dispensing Facilities

Staff also evaluated applications submitted for modifications from existing gasoline dispensing facilities to analyze the potential impact on future modified permits. Over the five-year permitting period from October 1, 2009 through October 1, 2014, SCAQMD staff processed approximately 1,200 modified permits for gasoline dispensing facilities. Out of the 1,200 modified permits, staff conducted a detailed review of a subset of 300 permits, which were randomly chosen. This sample size was selected to provide a 95 percent confidence level and a 5 percent margin of error in the analysis.

Of the 300 permits for existing gasoline dispensing facilities filing for a permit for modifications between 2009 and 2014, 267 (~89 percent) modifications were associated with no emission increase and were exempt from Rule 1401. The rest of the permit modifications (33 of 300) were associated with an emission increase and triggered Rule 1401. Of the 33 permit modifications that triggered Rule 1401, 28 gasoline dispensing facilities used Tier 2 analysis and 5 gasoline dispensing facilities used Tier 4 analysis. The approach used to analyze potential impacts to modified permits was the same for new permitted gasoline dispensing facilities.

For the 28 modified permits that used Tier 2 screening analysis, the estimated cancer risks for all 28 gasoline dispensing facilities remained below the Rule 1401 thresholds when using the proposed SCAQMD Risk Assessment Procedures (Version 8.1). For the 5 modified permits that used Tier 4 dispersion modeling, two gasoline dispensing facilities would have an increase in the estimated health risk, but estimated health risk is ≤ 10 in a million. Estimated health risk for the remaining three gasoline dispensing facilities is expected to decrease. Therefore, based on the evaluation of 300 modified permits, no impact to future modified gasoline dispensing facilities is expected with the proposed SCAQMD Risk Assessment Procedures (Version 8.1).

Summary of Analysis on Gasoline Dispensing Facilities

Based on the detailed review of 173 new or modified gasoline dispensing facilities triggering Rule 1401 requirements from October 2009 to December 2016, the implementation of the proposed SCAQMD Risk Assessment Procedures (Version 8.1) will result in no impact for 97 percent of permit applications. Note that these impacts were estimated assuming the emission factor of 0.42 lbs per 1,000 gallons for Phase II refueling of ORVR-equipped vehicles, as a conservative estimate of cancer risk. If the current emission factor of 0.32 lbs per 1,000 gallons are used, the emissions and the associated cancer risk would be lower, resulting in fewer impacts than those presented above.

With a 95 percent confidence level, approximately three percent of permit applicants may need to proceed to a higher tier analysis (Tier 3: Screening Dispersion Modeling or Tier 4: Detailed Risk Assessment), consider reducing their throughput, or new gasoline dispensing facilities could increase the distance between emission sources and the nearest receptor. With SCAQMD receiving, on average, about 27 permit applications annually, approximately one permit could be affected by the proposed SCAQMD Risk Assessment Procedures (Version 8.1) per year. Therefore, the impact of the proposed amendments on gasoline dispensing facilities is minimal. Therefore, staff recommends removing the exemption and referencing the proposed SCAQMD Risk Assessment Procedures (Version 8.1) for gasoline dispensing facilities.

LIST OF APPLICABLE TOXIC AIR CONTAMINANTS

Table 1 of Rule 1401 lists the toxic air contaminants that are subject to the rule and used to estimate health risks. The list consists of the compounds that OEHHA has provided acute, chronic, or carcinogenic health values. Periodically, OEHHA publishes new or updated health values and subsequently SCAQMD amends Table 1 to incorporate the new or updated information. Table 1 was last updated in 2010; in the interim, a number of health values have been published by OEHHA. Additionally, several compounds will be included on the list for clarity and consistency with California Air Resources Board's Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values which was last updated on February 23, 2017[10].

New Compounds

Caprolactum (Chemical Abstracts Service Number 105-60-2) – In 2013, OEHHA developed acute and chronic Reference Exposure Levels of 50 µg/m^3 and 2.2 µg/m^3 respectively. OEHHA states that exposure to caprolactum has been found to cause upper respiratory and eye irritation in both animals and humans; inflammation of the nasal and laryngeal epithelium in rodents; and reduced

[10] Available on the internet at: https://www.arb.ca.gov/toxics/healthval/contable.pdf

weight of offspring for pregnant rats administered high doses orally. According to OEHHA[11], the increased eye blink frequency with eye irritation are manifestations of the same underlying event of ocular trigeminal nerve activation. Thus, the acute reference exposure limit is based on eye blink frequency. The acute reference exposure limit of 50 µg/m^3 was established by applying a species uncertainty factor of 10 to the No Observed Adverse Effect Level (NOAEL) of 500 µg/m^3. The chronic value of 2.2 µg/m^3 was derived by the 95 percent lower confidence limit of the dose producing a 5 percent response rate for the nasal respiratory and olfactory changes and the non-keratinized laryngeal tissue changes found at terminal sacrifice. An uncertainty factor of 60 was applied because of interspecies and study length uncertainties.

The main use of caprolactum is in the polymerization process during the manufacture of Nylon-6. Nylon-6 is a widely used type of nylon and is found in textiles, engineered plastics, and films used in packaging and medical applications. Exposure to caprolactum may occur during the production and recycling of Nylon-6, and offgassing from carpeting and other textiles containing Nylon-6.

Permitted use of caprolactum will occur nearly exclusively in resin manufacturing facilities. As a Volatile Organic Compound, caprolactum emissions are already regulated in resin manufacturing facilities by SCAQMD Rule 1141 – Control of Volatile Organic Compound Emissions from Resin Manufacturing. The provisions in that rule require that volatile organic compound emissions, including caprolactum emissions, be reduced by 95 percent or more from blending, reaction, and processing operations. Therefore, the addition of acute and chronic health risk values are not expected to have any additional impacts on resin manufacturing operations as they already are required to control caprolactum emissions.

Carbonyl sulfide (Chemical Abstracts Service Number 463-58-1) – In 2017, OEHHA developed acute and chronic Reference Exposure Levels of 660 µg/m^3 and 10 µg/m^3 respectively[12]. OEHHA found that inhalation of carbonyl sulfide results in adverse health effects in the central nervous system. The NOAEL for carbonyl sulfide is 1,500,000 µg/m^3. The time-adjusted one hour NOAEL is 1,300,000 µg/m^3. The acute reference exposure limit was determined by applying an uncertainty factor of 2,000 to the time-adjusted one hour NOAEL resulting in an acute reference exposure limit of 660 µg/m^3. The uncertainty factor was based on limited information on acute toxicity and there were no pharmacokinetic modeling data available. For chronic exposures, the time-adjusted NOAEL was determined to be 130,000 µg/m^3. An uncertainty factor of 6,000 was applied resulting in a chronic reference exposure limit of 22 µg/m^3. The uncertainty factor was based on default factors for interspecies and intraspecies toxicokinetic and toxicodynamic differences.

For industrial uses, carbonyl sulfide is emitted from some refineries as an end product of sulfur combustion. It is also a potential grain fumigant replacing methyl bromide. In 2012, reported emissions of carbonyl sulfide in SCAQMD was just over 15,000 pounds annually with the largest facility reporting 7,706 pounds of annual emissions.

Refinery sources and potential fumigant sources of carbonyl sulfide are already closely controlled. Refineries reporting carbonyl sulfide emissions already determine health risks by accounting for

[11] Available on the internet at: https://oehha.ca.gov/media/downloads/crnr/caprolactam2013.pdf
[12] Available on the internet at: https://oehha.ca.gov/media/downloads/crnr/cosrel022117.pdf

contributions from carbonyl sulfide in the Air Toxics Hot Spots Program. Additionally, sulfur emissions are regulated as criteria pollutants necessitating the use of control equipment. The inclusion of acute and chronic non-cancer health values for carbonyl sulfide are not expected to require additional pollution controls as the sources of those emissions already are expected to have pollution control.

Compounds with Added Health Risk Values

Butadiene, 1,3- (Chemical Abstracts Service Number 106-99-0) – In 2013, OEHHA developed an acute reference exposure level of 660 $\mu g/m^3$ [13]. At the same time, OEHHA also updated the chronic inhalation health value to 2.0 $\mu g/m^3$. In 1992, OEHHA established a cancer inhalation unit risk value of 1.7x10-4 $(\mu g/m^3)^{-1}$. For permitted units, the cancer risk is generally orders of magnitude greater than the acute risk. Therefore the inclusion of an acute reference exposure level for 1,3- butadiene is not expected to have any additional impacts on permitted sources.

Methylene diphenyl diisocyanate – (Chemical Abstracts Service Number 101-68-8) – In 2016, OEHHA developed an acute reference exposure level of 12 ug/m^3 [14] and updated the chronic reference exposure level to $8.0x10^{-2}$ ug/m^3. The chronic reference exposure level is more than two magnitudes lower than the acute reference exposure level and thus the inclusion of an acute reference exposure level is not expected to have any additional impacts on permitted sources. In addition, a typographical error was corrected for this compound.

Toluene diisocyanates (Chemical Abstracts Service Number 26471-62-5), including toluene-2,4-diisocyante (Chemical Abstracts Service Number 584-84-9) and toluene-2,6-diisocyantate (Chemical Abstracts Service Number 91-08-7) – In 2016, OEHHA developed an acute reference exposure level of 2.0 $\mu g/m^3$ for the parent compound of toluene diisocyante and related compounds toluene-2,4-diisocyante and toluene-2,6-diisocyantate[15]. The chronic reference exposure level was also updated at the same time to 8x10-3 $\mu g/m^3$. However, the cancer inhalation unit risk, established in 1999, is 1.1x10-5 $(\mu g/m^3)^{-1}$ resulting in a cancer risk that is generally orders of magnitude greater than the acute risk. For permitted units, the inclusion of an acute reference exposure level for toluene diisocyantes is not expected to have any additional impacts.

Compounds Added for Clarification and Consistency

In two cases, a parent compound is listed in Table 1 of Rule 1401 while some associated compounds are not. To clarify the applicability of the compounds and to make Table 1 more consistent with CARB's Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (February 23, 2017), the following related compounds in Table 6 below will be added to Table 1 of Rule 1401:

[13] Available on the internet at: https://oehha.ca.gov/media/downloads/crnr/072613bentcrel.pdf
[14] Available on the internet at: https://oehha.ca.gov/media/downloads/air/report-hot-spots/finalmdirelmarch2016.pdf
[15] Available on the internet at: https://oehha.ca.gov/media/downloads/air/report-hot-spots/finaltdirelmarch2016.pdf

Table 6: Related Compounds Added for Clarification and Consistency

Compound	Chemical Abstracts Service Number	Already Listed Parent Compound
Barium chromate	10294-40-3	Chromium (hexavalent)
Calcium chromate	13765-19-0	Chromium (hexavalent)
Chromic trioxide	1333-82-0	Chromium (hexavalent)
Sodium dichromate	10588-01-9	Chromium (hexavalent)
Strontium chromate	7789-06-2	Chromium (hexavalent)
Zinc chromate	13530-65-9	Chromium (hexavalent)
Hexachlorocyclohexane, alpha	319-85-6	Hexachlorocyclohexanes (mixed or technical grade)
Hexachlorocyclohexane, beta	319-85-7	Hexachlorocyclohexanes (mixed or technical grade)

Similarly, in two other cases, a related compound is listed in Table 1 while the parent compound is not. The following parent compounds will be added to Table 1 of Rule 1401 as shown in Table 7 below.

Table 7: Parent Compounds Added for Clarification and Consistency

Parent Compound	Chemical Abstracts Service Number	Already Listed Related Compound
Fluorides	1101	Hydrogen fluoride
Vanadium	7440-62-2	Vanadium pentoxide

For both the newly added parent and related compounds, the effective date of rule applicability will be the same as the already listed compound.

Finally, a typographical error was corrected as the same compound, vinylidene chloride and dichloroethylene, 1,1- (Chemical Abstracts Service Number 75-35-4), is listed twice. To avoid confusion, the compound will remain listed twice but the dichloroethylene, 1,1- will refer back to vinylidene chloride.

AFFECTED INDUSTRIES

Implementation of PAR 1401 is expected to potentially increase the estimated cancer risks for spray booths and gasoline dispensing facilities. SCAQMD staff conducted an analysis to better understand the number of sources that could be potential affected by the proposal. Staff estimates two spray booth permits annually could require higher level of air pollution controls. The expected additional air pollution control would be the replacement of HEPA filters with ULPA filters. For gasoline dispensing facilities, one permit applications annually will have a lower permitted throughput, consider increasing their distance of emission sources to the nearest residential receptor, or proceed to a Tier 3 or Tier 4 analysis requiring dispersion modeling. Finally, five refineries will see a negligible increase in cancer risk because of the addition of carbonyl sulfide to the Rule 1401 Toxic Air Contaminant list.

SOCIOECONOMIC ASSESSMENT

PAR 1401 would require the use of the proposed SCAQMD Risk Assessment Procedures (Version 8.1), also referred to as Procedures, when determining health risks for all new and modified permitted equipment and processes at spray booths and gasoline dispensing facilities. The updates to the Procedures could potentially increase the calculated cancer risk for emission sources at the affected facilities. Based on staff's analysis of SCAQMD permits issued from October 1, 2009 through October 1, 2014, two spray booths and one gasoline dispensing facility per year could potentially incur costs to comply with PAR 1401[16]. Spray booths belong to various sectors of the economy such as manufacturing, wholesale, retail, services, and the affected gasoline dispensing facilities belong to the sector of retail services. As spray booths and gasoline dispensing facilities tend to be small businesses, the potentially affected facilities by the proposed amendments are also likely to be small businesses.

For the potentially affected spray booths with new or modified permits, an average of two facilities per year are expected to need to install ULPA filters in lieu of HEPA filters to comply with PAR 1401. The unit cost of ULPA filters is expected to be very similar to the unit cost of HEPA filters. However, ULPA filters require the use of higher horsepower blowers. For a typical size of spray booth, a 15 HP blower will be needed for ULPA filters as opposed to a 10 HP blower for HEPA filters. A 15 HP blower is more expensive than a 10 HP blower, and it also uses more electricity which would result in a higher operation cost. The incremental cost of a 15 HP blower over a 10 HP blower is estimated at $750 ($4,250 for a 15 HP blower *vs* $3,500 for a 10 HP blower). The incremental operating cost related to additional electrical usage is estimated at $595 annually ($0.13/kWh × 2.2 kW × 8 hours/day × 5 days/week × 52 weeks/year).[17] Based on a typical equipment life of five years, the present value of the total incremental costs of purchasing and operating a 15 HP blower is estimated to be up to $3,725 per facility [$750 + $595 × 5], or $7,450 for a total of two potentially affected spray booths.[18]

For the potentially affected gasoline dispensing facilities with new or modified permits, an average of one facility per year is expected to proceed to the more complicated Tier 3 or Tier 4 HRA unless the facility can lower its permitted throughput or increase the distance between the emission sources to the nearest receptor. For the purpose of the socioeconomic impact assessment, it is assumed that the affected facility would proceed to a Tier 4 HRA, which would require dispersion modeling to predict the atmospheric concentrations of gaseous and particulate pollutants using site-specific input parameters. Based on a vendor's price quote, the annual cost of dispersion modeling is estimated at $15,000 per gasoline dispensing facility.

Therefore, the overall compliance cost is estimated at $22,450 ($7,450+$15,000) per year based on the assumption that, each year after PAR 1401 adoption, there will be two spray booths and one gasoline dispensing facility applying for new or modified permits that will need to fulfill additional

[16] For new gasoline dispensing facilities, staff analyzed permits up to December 2016.

[17] $0.13/kWh represents the average commercial electricity rate in the City of Los Angeles (see http://www.electricitylocal.com/states/california/los-angeles/). Additionally, the blower is assumed to be operated at the 50-percent capacity to reach the typical five-year equipment life.

[18] The present value of $3,725 per spray booth is derived by assuming a zero discount rate. The amount would decrease if a greater discount rate is used. Notice this cost may recur every five years if ULPA filters would continue to be required for these facilities and the differences in the capital and operation costs would continue to remain the same between a 15 HP and a 10 HP blower.

requirements to comply with PAR 1401. It has been a standard socioeconomic practice that, when the annual compliance cost is less than one million current U.S. dollars, the Regional Economic Models Inc. (REMI)'s Policy Insight Plus Model is not used to simulate jobs and macroeconomic impacts. This is because the resultant impacts would be diminutive relative to the baseline regional economy.

CALIFORNIA ENVIRONMENTAL QUALITY ACT ANALYSIS

Pursuant to the California Environmental Quality Act (CEQA) and SCAQMD Rule 110, the SCAQMD, as lead agency for the proposed project, has reviewed the proposed amendments to Rule 1401 pursuant to: 1) CEQA Guidelines § 15002(k) – General Concepts, the three-step process for deciding which document to prepare for a project subject to CEQA; and 2) CEQA Guidelines § 15061 – Review for Exemption, procedures for determining if a project is exempt from CEQA. SCAQMD staff has determined that it can be seen with certainty that there is no possibility that the proposed amendments to Rule 1401 may have a significant adverse effect on the environment. Therefore, PAR 1401 is considered to be exempt from CEQA pursuant to CEQA Guidelines § 15061(b)(3) – Activities Covered by General Rule. A Notice of Exemption will be prepared pursuant to CEQA Guidelines § 15062 - Notice of Exemption. If the project is approved, the Notice of Exemption will be filed with the county clerks of Los Angeles, Orange, Riverside and San Bernardino counties.

DRAFT FINDINGS UNDER CALIFORNIA HEALTH AND SAFETY CODE SECTION 40727

Requirements to Make Findings

California Health and Safety Code Section 40727 requires that prior to adopting, amending or repealing a rule or regulation, the SCAQMD Governing Board shall make findings of necessity, authority, clarity, consistency, non-duplication, and reference based on relevant information presented at the public hearing and in the staff report.

Necessity

PAR 1401 is needed to update rule language relating to risk assessment calculations such that they are consistent with those specified in the state OEHHA Risk Assessment Guidelines adopted on March 6, 2015.

Authority

The SCAQMD Governing Board has authority to adopt amendments to Rule 1401 pursuant to the California Health and Safety Code Sections 39002, 39650 et. Seq., 40000, 40001, 40440, 40441, 40702, 40725 through 40728, 41508, 41700, 41706, 44360 through 44366, and 44390 through 44394.

Clarity

PAR 1401 is written or displayed so that its meaning can be easily understood by the persons directly affected by it.

Consistency

PAR 1401 is in harmony with and not in conflict with or contradictory to, existing statutes, court decisions or state or federal regulations.

Non-Duplication
PAR 1401 will not impose the same requirements as any existing state or federal regulations. The proposed amended rule is necessary and proper to execute the powers and duties granted to, and imposed upon, the SCAQMD.

Reference
By adopting PAR 1401, the SCAQMD Governing Board will be implementing, interpreting or making specific the provisions of the California Health and Safety Code Sections 39666 (District new source review rules for toxics), 41700 (prohibited discharges), and 44360 through 44366 (Risk Assessment).

Rule Adoption Relative to Cost-effectiveness
On October 14, 1994, the Governing Board adopted a resolution that requires staff to address whether rules being proposed for adoption are considered in the order of cost-effectiveness. The 2016 Air Quality Management Plan (AQMP) ranked, in the order of cost-effectiveness, all of the control measures for which costs were quantified. It is generally recommended that the most cost-effective actions be taken first. However, PAR 1401 is not a control measure that was included in the 2016 AQMP and was not ranked relative to other criteria pollutant control measures in the 2016 AQMP.

Incremental Cost-effectiveness
Health and Safety Code Section 40920.6 requires an incremental cost effectiveness analysis for Best Available Retrofit Control Technology (BARCT) rules or emission reduction strategies when there is more than one control option which would achieve the emission reduction objective of the proposed amendments, relative to ozone, CO, SOx, Nox, and their precursors. Since PAR 1401 applies to toxic air contaminants, the incremental cost effectiveness analysis requirement does not apply.

COMPARATIVE ANALYSIS

Health and Safety Code section 40727.2 requires a comparative analysis of the proposed amended rule with any Federal or District rules and regulations applicable to the same source. See Table 8 below.

Table 8: Comparative Analysis of PAR 1401 with Rules 212, 1401.1, 1402, and Federal Regulations

Rule Element	PAR 1401	Rule 212	Rule 1401.1	Rule 1402	Equivalent Federal Regulation
Applicability	New, relocated or modified permit unit	New or modified permit unit	New or relocated permit unit	Existing facilities subject to Air Toxics "Hot Spots" Information and Assessment Act of 1987 and facilities with total facility emissions exceeding any significant or action risk level	None
Requirements	Limits maximum individual cancer risk, cancer burden and chronic and acute hazards	Provide public notice to all nearby addresses projects that are located within 1,000 feet of a school, increase risk or nuisance, or increase criteria pollutants above specified thresholds	Limits cancer risk and chronic and acute hazards near schools	Submittal of health risk assessment for total facility emissions when notified. Implement risk reduction measures if facility-wide risk is greater than or equal to action risk level	None
Reporting	None	Verification that public notice has been distributed	None	Progress reports and updates to risk reduction plans	None
Monitoring	None	None	None	None	None
Recordkeeping	None	None	None	None	None

Appendix A – U.S. EPA Guidance on Removing Stage II Gasoline Refueling Vapor Recovery Programs from State Implementation Plan

On a federal level, the control efficiency of Stage II is in the range of 60- 75 percent, much lower than the California Phase II program (95 percent). In addition, in areas where certain types of vacuum-assist Stage II control systems are used, the limited compatibility between ORVR and some configurations of this Stage II hardware may result in an area-wide emissions disbenefit. U.S. EPA's regulation stated that with the widespread use of the ORVR-equipped vehicles, Stage II programs have become largely redundant control systems with minimal reduction benefits beyond the ORVR system. SCAQMD and CARB have commented that Phase II EVR is still needed as discussed in more detail under their comment letters[19] submitted in response to U.S. EPA's proposed rule titled "*Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver*." U.S. EPA's guidance does, however provide additional insight regarding the application of emission reductions from Stage II control systems for vehicles equipped with ORVR further demonstrating that the control efficiency of the ORVR and/or the Stage II systems are only applied once to the respective gasoline throughput (the same control efficiency was applied to both the throughput of Stage II and non-ORVR vehicles.

The U.S. EPA Guidance document provides two equations to calculate impacts on the refueling emission inventory whereas the results could be used by States to support SIP actions (Section 3.3). Equation 1 determines the overall stage II-ORVR increment, which identifies the annual area-wide emission control gain from Stage II installations as ORVR technology phases in, assuming both have the same efficiency. It also indicates the emission reduction potential loss (in year i) from removing Stage II. Equation 1 is shown below:

Equation 1

$$increment_i = (Q_{SII})(1-Q_{ORVRi})(\eta_{iuSII}) - (Q_{SIIva})(CF_i)$$

The first part of the equation identifies the overall Stage II-ORVR increment. The second part of the equation accounts the for vacuum-assist compatibility factor, which is not applicable in California because California's Phase II EVR system requires compatibility with ORVR. Equation 1 estimates the incremental emission control gain with the widespread use of ORVR vehicles by accounting for (1) fraction of gasoline throughput covered by Stage II vapor recovery system (Q_{SII}), the fraction of gasoline dispensed to non-ORVR vehicles ($1-Q_{ORVRi}$) and the in-use control efficiency of the stage II vapor recovery system (η_{iuSII})

Equation 2 determines the delta between the Stage II efficiency and the ORVR efficiency with both technologies in place. It considers the greater efficiency of ORVR relative to non-ORVR vehicles refueling at Stage II-equipped gasoline dispensing facilities. Equation 2 is shown below:

[19] Available on the internet at https://www.regulations.gov/docketBrowser?rpp=50&so=DESC&sb=postedDate&po=0&dct=PS&D=EPA-HQ-OAR-2010-1076

Equation 2

$$delta_i = (Q_{SII})(\eta_{iuSII}) - (Q_{SIIva})(CF_i) - (Q_{ORVRi})(\eta_{ORVR})$$

As demonstration in the two equations above, the control efficiency of the ORVR and / or the Stage II systems are only applied once to the respective gasoline throughput (the same control efficiency was applied to both the throughput of Stage II and non-ORVR vehicles in equation 1). If the two control equipment were to work in series, the control efficiency of the two would have been multiplied together, as the way it was determined by CARB:

ORVR, Phase II EVR = (non-ORVR UEF)*(1 - ORVR CE)*(1 - Ph II EVR CE)
= (8.4 lbs/kgal)*(1 - 0.95)*(1 - 0.95) = 0.021 lbs/kgal

Thus, SCAQMD staff's interpretation that the ORVR and Phase II vapor recovery system may not work in series is consistent with the methodology used by U.S. EPA to determine the impacts of removing the Stage II program.

Appendix B – Comments and Responses

CIOMA

California Independent Oil Marketers Association
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916.646.5999

July 19, 2017

Susan Nakamura
Assistant Deputy Executive Officer
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Via email at: snakamura@aqmd.gov

Re: Proposed Amended Rule 1401- New Source Review of Toxic Air Contaminants

Dear Ms. Nakamura:

These comments are presented on behalf of CIOMA, a part of the California Small Business Alliance, members that own and operate facilities that are affected by Proposed Amended Rule 1401- New Source Review of Toxic Air Contaminants.

The California Independent Oil Marketers Association (CIOMA) represents about 300 members, including nearly 90% of all the independent petroleum marketers in the state and about one quarter of the state's 10,000 service stations. Our members provide services to local governments, law enforcement, city and county fire departments, ambulances/emergency vehicles, school district bus fleets, construction firms, marinas, public and private transit companies, hospital emergency generators, trucking fleets, independent fuel retailers (small chains and mom-and-pop gas stations) and California agriculture, among others.

The District is proposing to make several changes to its evaluation procedures for new and modified gasoline dispensing facilities (GDFs) and has not disclosed key details critical to the rule development, which is proceeding on a severely compressed schedule with limited public input. CIOMA's major concerns regarding Proposed Amended Rule 1401 are as follows:

The Proposed Amended Rule 1401 rule development schedule has been aggressively compressed, with technical documents not being provided to stakeholders prior to the set hearing date.

The first working group meeting for Proposed Amended Rule 1401 was held on June 1, 2017; draft rule language and the Draft Staff Report was released on June 16, 2017. Stakeholders were also notified on June 16 of the dates of the second working group meeting and public workshop, scheduled for June 29 and July 12 respectively. Technical documents were 1-1

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requested by stakeholders at the first working group meeting and promised by Staff to be available at the second working group meeting.

The second working group meeting was rescheduled for July 6, **one day prior** to the set hearing scheduled for July 7. No technical documentation was provided by Staff at the second working group meeting; Staff stated that the gasoline station appendix would be available by mid-July and the Proposed Risk Assessment Procedures Version 8.1 would be available by August 2. A third working group meeting was scheduled for July 20 at the request of stakeholders due to the lack of available technical documentation to evaluate the proposed changes to Rule 1401.

The gasoline station appendix (Attachment N) was available via hard copy at the public workshop on July 12. Attachment N and its methodology (Appendix X) were emailed to the Proposed Amended Rule 1401 working group list on the night of July 15. Neither document has been posted online to the Proposed Rules page of the SCAQMD website. The Proposed Risk Assessment Procedures (Version 8.1) will not be released until August, when many members of Staff will be unavailable for questions or comment. 1-1

Staff is presenting the proposed rule **one day after** the third working group on July 21. The public hearing for Proposed Amended Rule 1401 is scheduled for September 1, 2017. With much of the technical documentation supporting the proposed changes in the rule being released within the last week, or not yet released, such a short timetable has not allowed for a robust public rulemaking process with proper stakeholder input.

SCAQMD plans to increase the emission factor for refueling activities at GDFs to the level identified by the California Air Resources Board (CARB) for vehicles not equipped with onboard refueling vapor recovery (ORVR) systems.

Staff is planning on increasing its emission factor for refueling activities at GDFs, and differing from CARB and the emissions factor SCAQMD used to develop its own emissions inventory for the AQMP. The majority of vehicles are equipped with ORVR, and for ORVR vehicles CARB identified an emission factor twenty times lower than non-ORVR vehicles. The District needs to provide more technical information for its own proposed emission factor, and identify why it appears to be disregarding ORVR entirely. Stakeholders are not able to determine the analysis behind Staff's increase in the emissions factor and divergence from CARB's determination for ORVR vehicles without access to the Proposed Risk Assessment Procedures (Version 8.1), which will not be available until August. 1-2

The Governing Board adoption hearing for Proposed Adopted Rule 1401 should be delayed from the September 1, 2017 date.

Conclusion

Due to the lack of availability of technical documents to stakeholders, the constricted rulemaking schedule pushed up against the SCAQMD August summer recess, and the need for 1-3

2

continued technical analysis due to the implications of the proposed changes, the date of the Governing Board adoption hearing for Proposed Adopted Rule 1401 should be delayed. Stakeholders have not had the proper opportunity to have access to key technical documents critical to proposed changes to the emission factor for refueling activities at GDFs, and will not have the opportunity to make comments in a timely fashion due to the rulemaking and staff schedule. The hearing should be delayed to ensure the proper public rulemaking process takes place and all analysis is completed in a thoughtful, transparent manner. 1-3

Please contact Samuel Bayless at bayless@cioma.com or (916) 646-5999 with any questions.

Sincerely,

Samuel Bayless
Regulatory Issues Specialist
California Independent Oil Marketers Association

CC:
Wayne Nastri, SCAQMD Executive Officer
Philip Fine, Ph.D., SCAQMD Deputy Executive Officer
Ben Benoit, Mayor Pro Tem, City of Wildomar
Joseph Lyou, Ph.D, Governor's Appointee /SCAQMD Governing Board
Judith Mitchell, Councilmember, City of Rolling Hills Estates
Shawn Nelson, Supervisor, Fourth District/County of Orange
Janice Rutherford, Supervisor, Second District/County of San Bernardino
Sheila Kuehl, Supervisor, Third District/County of Los Angeles
Ruthanne Taylor Berger, Board Assistant to Ben Benoit
Mark Abramowitz, Board Assistant to Dr. Joseph Lyou
Marisa Perez, Board Assistant to Judith Mitchell
Denis Bilodeau, Board Assistant to Shawn Nelson
Mark Taylor, Chief of Staff to Janice Rutherford
Andrew Silva, Board Assistant to Janice Rutherford
Diane Moss, Board Assistant to Sheila Kuehl

Response to Comment 1-1

In the first working group meeting, staff presented the proposed emission factors for gasoline dispensing facilities, and agreed to invite a subject matter expert from Engineering & Permitting to the next working group to provide a technical explanation.

Draft Proposed Amended Rule 1401 and the Preliminary Draft Staff Report were released on June 16, more than 75 days before the public hearing.

In the second working group meeting, staff presented more background information and the technical basis of the proposed emission factors (link), and provided clarification and justification for the proposal. To address the concerns on the potential impacts on gasoline dispensing facilities, both the Preliminary Draft of Appendix X - Methodology Used to Develop Tier 2 Screening Tables for Gasoline Transfer and Dispensing Facilities and the corresponding Attachment N screening tables from proposed SCAQMD Risk Assessment Procedures (Version 8.1) were released on July 15. A third working group meeting was held to walk the stakeholders through and answer any questions on these two documents.

On July 21, the proposed amendments to Rule 1401 and the associated impacts were presented to the Stationary Source Committee. Staff highlighted the key issues on the proposed emission factors of gasoline dispensing facilities and the rule development schedule. Both issues were thoroughly discussed among Committee members, staff, and stakeholders.

A Draft Staff Report, including additional information on the technologies of the ORVR and Phase II vapor recovery system, as well as the rationale behind using the current SCAQMD emission factor for refueling (0.32 lbs per 1,000 gallons) has been released on August 2. Staff is available to hold another working group meeting in August to address any questions or concerns that may arise.

In brief, the proposed rule language, the Preliminary Draft Staff Report, Draft Staff Report (which also includes the Socioeconomic Analysis) have been released following the rule development schedule, and additional technical justification has been provided to stakeholders in a timely manner upon request.

Response to Comment 1-2

As discussed in Response to Comment 1-1, additional background information and technical justification was provided in the second working group meeting on July 6. The sections relevant to gasoline dispensing facilities from Proposed Risk Assessment Procedures Version 8.1 were released on July 15 and a working group meeting was held on July 20 to address questions and concerns on the documents.

As discussed at the Working Group meetings, based on the available test data from CARB and EPA, SCAQMD staff concluded that the Phase II vapor recovery system and ORVR systems would each achieve a 95% control efficiency. However, there is no empirical evidence to support the assumption that all the vapors escaping from the ORVR system are directed to the fillpipe and can be captured by the Phase II EVR system. For more information, please refer to Response to Comment 2-2.

On the emission factor used for the refueling in gasoline dispensing facilities in the 2016 AQMP, please refer to Comment 2-6.

Response to Comment 1-3

PAR 1401 has followed a typical rule development schedule and has met the requirements of SCAQMD's public process for rulemaking. Upon request, additional technical justification has also been provided to stakeholders in a timely manner. Staff is available for follow up meetings to answer questions or provide clarifications before the Public Hearing.

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July 25, 2017

Ms. Kalam Cheung
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Re: Costco Wholesale Corporation Comments on SCAQMD Proposed Amended Rule 1401

Dear Ms. Cheung:

Costco Wholesale Corporation appreciates this opportunity to provide comments on the South Coast Air Quality Management District's Proposed Amended Rule (PAR) 1401 – New Source Review of Toxic Air Contaminants. As you know, for years Costco has stood at the forefront of emissions control efforts concerning California gasoline dispensing facilities (GDFs). Costco has worked closely with the District and the California Air Resources Board (ARB) over many years to develop and test cutting-edge in-station diagnostic (ISD) technologies designed to automatically detect vapor recovery system failures and avoid volatile organic compound (VOC) emissions through early detection and repair. In many cases, VOC emissions reduction technologies tested and adopted by Costco have gone well beyond what the regulations require. This is because Costco has made a commitment to conduct all of its operations in an environmentally responsible and sustainable manner, recognizing that in order for Costco to thrive, our world and shared environment must also thrive. 2-1

We believe that sound environmental policy requires use of the latest and best scientific data available. Accordingly, we commend the District for proposing amendments to District Rule 1401 that strive to incorporate the most up-to-date information available regarding the emissions performance of today's GDFs. As you know, advances in enhanced vapor recovery (EVR) technology in the past few decades have literally changed the face of GDF regulation. Onboard refueling vapor recovery (ORVR) technology, which results in capture of greater than 95% of all organic vapors from a passenger car gas tank during refueling, is required to be

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installed on new passenger cars and is now present on the vast majority of cars on California's roads. In addition, Phase I and II EVR technologies installed in gasoline underground storage tanks and gasoline pump nozzles, respectively, provide additional control of gasoline vapors displaced from USTs and vehicle gas tanks during refilling, further ensuring an extremely low VOC emissions profile at today's GDFs. Market penetration of these technologies has risen dramatically in just the last decade alone, meaning that estimates of GDF emissions today are now, thankfully, far lower than estimates from ten years ago.

Thus, Costco was very pleased to work with the District and ARB over that past decade not only to implement EVR at its California GDFs, but also to gather the data necessary to update the statewide VOC and toxics emissions factors applicable to GDFs. Prior GDF emission factors were adopted in 1999 and did not account for technological advances in Phase I, Phase II and ORVR technologies implemented over the next 15 years. For that reason, ARB invited several air districts and other stakeholders to collaborate in a multi-year study of GDF emissions using current technologies. As you know, on December 23, 2013 ARB released its "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" (ARB 2013 GDF Factors)[1] updating emissions factors for Phase I transfers and Phase II refueling, and adding new emissions sub-categories for Phase II refueling of ORVR-equipped vehicles and gasoline dispensing hose permeation. We understand the District participated closely in this process.

2-1

In relevant part, PAR 1401 seeks to update the District's new source review rule for toxic emissions sources by requiring the use of proposed SCAQMD Risk Assessment Procedures Version 8.1 in risk assessments for all new and modified spray booths and GDFs. This Version 8.1 also proposes to incorporate all of ARB's updates to GDF speciation profiles and emissions factors except for one: the factor for refueling of ORVR-equipped vehicles by Phase II-equipped pumps. ARB has determined that refueling of non-ORVR-equipped vehicles by Phase II nozzles results in VOC emissions of 0.42 pound/1,000 gallons of gasoline throughput, and that refueling of ORVR-equipped vehicles by Phase II nozzles results in a lower emissions profile of 0.021 pound/1,000 gallons gasoline throughput. Here, the District's Version 8.1 of the Risk Assessment Procedures proposes an emission factor of 0.42 pound/1,000 gallons gasoline throughput for refueling of ORVR vehicles **or** non-ORVR vehicles at a Phase II nozzle. This would assume that addition of ORVR control provides no emissions benefit **whatsoever** in reducing refueling emissions at a Phase II pump.

2-2

[1] The ARB 2013 GDF Factors document and its attachments are available on ARB's website at https://www.arb.ca.gov/vapor/gdf-emisfactor/gdf-emisfactor.htm.

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This would flatly contradict ARB's studied finding in the 2013 ARB GDF Factors document. As a result of its multi-year analysis and study of GDF VOC emissions, ARB concluded that, while ORVR systems average 95% capture efficiency of gas tank emissions during refueling (i.e., capture of vapors in the onboard carbon canister for routing to the engine), the **additional** use of a Phase II nozzle (which has its own 95% control efficiency) will prevent escape of most of these remaining uncaptured vapors into the atmosphere. *See* ARB 2013 GDF Factors, Attachment 1, p. 7 (95% control efficiency of Phase II provides additional benefit to 95% control of ORVR). 2-2

Empirical evidence of the significant compound effect of multiple vapor controls was established in a 2008 ARB empirical study of emissions from ORVR-equipped vehicles during refueling. ARB's study found that the addition of Phase II controls to ORVR control provided roughly an order of magnitude improvement in emission reduction, versus ORVR control **without** Phase II. *See* California Air Resources Board, *Measurement of Gasoline Vapor Emissions From Vehicles Equipped with On Board Vapor Recovery*, p. 15, Table 7 (July 24, 2008).[2] The table reproduced below from ARB's 2008 study summarized the data comparing the two emissions scenarios:

(*see next page…*)

[2] The 2008 ARB study can be found on ARB's website at http://www4.aqmd.gov/enewsletterpro/uploadedimages/000001/Celia/1401/orvrtestreport072408.pdf

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Table 7
Emissions data for ORVR Vehicles from ARB tests at gasoline dispensing facilities and from EPA/Manufacturer SHED tests

Emission Measurements	Emissions, lbs per 1000 gallons dispensed		
	CaRFG3 Summer Fuel 6.9 RVP	Federal Test Procedure Fuel, 9 RVP	CaRFG3 Winter Fuel, 11.9 RVP
ARB Test Procedure 201.2 at gasoline dispensing facilities			
Fillpipe, no Phase II, mean ± standard deviation (This study)	0.043 ± 0.08		0.094 ± 0.18
Average odometer reading, miles, for vehicles in this study, 2006 – 2007 model years	13,400		14,100
Fillpipe, with Phase II EVR (Average of two ARB studies.)[6]			0.01
Estimated reduction of fillpipe emissions for ORVR vehicle with Phase II control (winter fuel, RVP not specified)[7]			0.09
EPA/Manufacturers ORVR vehicle emissions measurement according to the Federal Test Procedure			
Fillpipe and on-board canister emissions ± std deviation (Average for 337 dispensing events)[8]		0.25 ± 1.15	
Average odometer reading, miles		19,100	
Number of vehicles failing the 0.2 gram/gallon ORVR standard = 17, or 5.3% of vehicles tested			

As ARB's data show, VOC fillpipe emissions during refueling of CaRFG Winter Fuel at a non-Phase II equipped nozzle were estimated to be roughly 0.1 pound/1,000 gallons gasoline throughput (data line 1), while VOC fillpipe emissions during refueling of CaRFG Winter Fuel at a Phase II-equipped nozzle were estimated at 0.01 pound/1,000 gallons gasoline throughput (data line 3). Thus, according to ARB, the addition of Phase II control when refueling an ORVR-equipped vehicle improved the overall VOC capture efficiency by 10 times over use of ORVR alone. This squarely contradicts the District's use of the same emissions factor (0.42) for ORVR + Phase II and for ORVR alone. 2-2

In September 2011, ARB again concluded in a White Paper responding to EPA's proposed "widespread use" finding and Stage II waiver that the use of ORVR together with Phase II control significantly reduced refueling emissions versus use of ORVR alone. ARB noted that emissions of hydrocarbon VOCs when refueling a non-ORVR vehicle from a Phase II pump were nearly 40 times higher (0.38 pound/1,000 gallons gasoline dispensed) than when ORVR control is added (0.01 2-3

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pound/1,000 gallons gasoline dispensed), as shown in the below excerpt from the White Paper:

Table 2

Emission Factors for Vehicle Fueling Operations
(pounds of hydrocarbon per thousand gallons dispensed)

Vapor Displaced From Vehicle Fuel Tank				Drip, Spill & Liquid Retention		Pressure Driven Emissions From Underground Storage Tank	
With Phase II		Without Phase II					
ORVR	Non-ORVR	ORVR	Non-ORVR	EVR	Non-EVR	EVR	Non-EVR
0.01	0.38	0.07	7.5	0.24	0.42	0.0045	0.044

See ARB White Paper, *Preliminary Analysis of U.S. EPA's Proposed Rule on Onboard Refueling Vapor Recovery Widespread Use Determination and California's Enhanced Vapor Recovery Requirements*, p. 6 (Sept. 8, 2011).[3] In its letter to EPA accompanying the White Paper, ARB argued against the removal of Phase II EVR requirements in California despite EPA's finding of ORVR "widespread use," noting that "(ORVR) and Stage II (Phase II) are ***both*** designed to control the vehicle refueling emissions and ***both*** are effective." *See* Letter from James Goldstene to EPA Air and Radiation Docket and Information Center, p. 1 (Sept. 8, 2011).[4] 2-3

To date, District staff have provided no empirical data or evidence to substantiate their rejection of the ARB 2013 GDF emission factor for ORVR/Phase II refueling, nor has the District provided evidence or data to refute ARB's empirical analyses. In the public workshops on this rule, District staff have repeatedly asserted that they are "confident" that the ARB emissions factor is based on "double counting" of emissions controls. Staff further assert that their conclusion is based on an "engineering disagreement" with ARB. But District staff have not presented any empirical emissions data to support these assertions, nor has ARB provided any public response to date as to the validity of District staff's claims. 2-4

We believe it is problematic from a policy perspective for the District to adopt an emission factor in direct contravention of an emissions factor set by ARB based on empirical evidence and years of analysis, particularly where the District is unable to

[3] The White Paper and accompanying ARB letter to EPA can be found on ARB's website at https://www.arb.ca.gov/vapor/carb%20response%20useap%20orvr%20widespread%20use%20nprm.pdf.

[4] See link above for copy of ARB letter to EPA.

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produce data or evidence of its own to justify the rejection of ARB's findings. When the District disagrees with ARB over engineering conclusions that are amenable to **empirical** determination – especially as to emissions factors that should have uniform statewide applicability – we believe it is incumbent on District staff to work out their differences with ARB and ultimately defer to evidence and data. 2-4

We also believe that it is potentially dangerous ground for District staff to take a position suggesting that Phase II controls have **zero** benefit to controlling refueling emissions versus use of ORVR alone. This position would have farther-reaching consequences for the District than just in this rulemaking. As the District knows, California opposed EPA's "widespread use" determination Indeed, in the 2016 Air Quality Management Plan, the District has **already** taken Basinwide credit for emissions reductions from GDFs by applying the suite of ARB 2013 GDF Factors (*see* 2016 AQMP, Appendix III, pp. III-1-15 to III-1-16),[5] putting the District in the position of potentially contradicting its own AQMP by only selectively adopting **some** but not all of the ARB 2013 GDF Factors. 2-5 2-6

As we have explained in the public workshops and working groups on PAR 1401, Costco wholeheartedly agrees with the District's adoption of the ARB 2013 GDF Factors, but simply believes that the available data from ARB supports adoption of **all** of the ARB factors, including the ORVR/Phase II factor. Costco agrees with District Staff's position that the GDF emissions factors themselves do not require actual rulemaking, so we believe this one remaining oversight can and should be remedied by District Staff – if not in conjunction with this rulemaking, then immediately following it.

Everyone – the District, regulated entities, and the public – has a strong interest in ensuring accurate emissions inventories from the thousands of GDFs across California. We all have a shared interest in ensuring evidence- and science-based rulemaking. Unlike many of the policy debates that can sometimes emerge from rulemaking, empirical issues like this can and should be resolved definitively and cooperatively, in order to avoid unnecessary administrative work fixing those issues later. As always, Costco remains committed to working with the District to address these issues quickly and efficiently, so that both the public and the regulated community have an accurate picture of the significant emissions reduction progress at gasoline pumps throughout the District. 2-7

[5] The District's AQMP, Appendix III, is available at http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/appendix-iii.pdf?sfvrsn=6.

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Thank you again for the opportunity to work together with the District on this important Rule revision.

Very truly yours,

Michael S. McDonough

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Response to Comment 2-1

As noted, staff from several districts including SCAQMD participated as part of the California Air Pollution Control Officer Association (CAPCOA) Vapor Recovery Subcommittee in the review of CARB's revised emission factors. At the time of release, CARB is also committed to continue its efforts to revise the newly released emission factors.

Response to Comment 2-2

SCAQMD staff agrees that the ORVR system averages a 95% control efficiency of gas tank emissions during refueling, but disagrees that the use of a Phase II nozzle could further control all emissions escaping from the ORVR system.

The ORVR system has mechanisms to prevent vapor within a vehicle fuel tank from escaping via the fillpipe of the vehicle (i.e. a narrowed fillpipe to form a liquid barrier and a mechanical valve at the end of the fillpipe). The vapor that would have otherwise escaped through the fillpipe is directed to a carbon canister, which is the actual means of emission control of the ORVR system, to adsorb hydrocarbons contained in the displaced vapor.

SCAQMD staff carefully reviewed the 2008 ARB study referenced by the commenter. The 2008 CARB study was conducted at an "ambient environment" (i.e. at a gasoline dispensing facility for a rental vehicle company). While the test was designed to evaluate fillpipe emissions, the study could not capture emissions from the on-board canister of the ORVR system. As the commenter correctly pointed out, the top part of Table 7 lists the fillpipe emissions of refueling ORVR vehicles. SCAQMD agrees that for emissions that pass through the fillpipe, they would be controlled by the Phase II-equipped nozzle.

The key to the different interpretations of the 2008 ARB study between the commenter and SCAQMD staff is that the study focuses on fillpipe emissions. As discussed above, the 2008 emission tests were conducted at the fillpipe exhaust where exhaust from the ORVR canister is not detected. Therefore, the 2008 study does not present total refueling emissions, which include emissions from both the fillpipe and the on-board canister for ORVR vehicles. Indeed, the bottom part of Table 7 lists the source test results from EPA/manufactures ORVR vehicle emissions measurement according to the Federal Test Procedure. Unlike the 2008 CARB study, which was conducted in ambient conditions, the EPA tests were conducted using a sealed housing emissions device (SHED), where emissions from both the fillpipe and the on-board canister were monitored. The EPA study tested for 337 dispensing events. The fillpipe and on-board canister emissions together averaged to 0.25 lbs per 1,000 gallons. The table further shows a standard deviation of 1.15 which indicates the control efficiency of individual vehicle tested varies significantly from the average emissions of 0.25 lbs. per 1,000 gallons.

The SCAQMD staff believes that there is a small amount of vapor that the Phase II EVR system will control during refueling of an ORVR vehicle. SCAQMD staff has been in communication with CARB staff regarding the refueling emissions factor. Both agencies agree that additional time is needed to better understand emission reductions from Phase II EVR for ORVR vehicles. SCAQMD staff is recommending not to incorporate CARB's 2013 revised emission factor for Phase II refueling of ORVR vehicles, but to continue the use of SCAQMD's current emission factor of 0.32 lbs per 1,000 gallons for refueling. Staff is recommending the use of CARB's 2013 emission factors for all other categories (loading, breathing, spillage, and hose permeation).

SCAQMD staff is committed to continue working with CARB staff to refine the emission estimates for Phase II refueling with ORVR vehicles and will return to the Board with future revisions to refueling emission factors.

Response to Comment 2-3

SCAQMD staff agrees that "(ORVR) and Stage II (Phase II) are both designed to control the vehicle refueling emissions and both are effective." As discussed in the staff report, Phase II EVR is needed for non-ORVR vehicles to achieve the additional VOC reductions of 14.7 tons per day in the year of 2020, and 8.8 tons per day in the year 2028 and beyond. Also, California's Phase II program includes other emission control features, such as in-station diagnostics (ISD) and standards for nozzle liquid retention, dripless nozzle and spillage, in addition to the control of the vapors displaced during vehicle refueling. Thus, it achieves greater emission reductions than the federal Stage II program requirements, and the improvement it provides is essential to meet mandated federal ambient air quality standards. While both the ORVR and Phase II vapor recovery systems are effective, they target different fleets (ORVR vehicles vs. non-ORVR vehicles respectively) and different processes (ORVR controls refueling and evaporative emissions as compared to Phase II EVR, which controls emissions at the fillpipe as well as nozzle operations such as spillage, drips, and liquid retention, and provides early diagnostic information via ISD).

Response to Comment 2-4

Staff released the proposed emission factors for gasoline dispensing facilities in the first working group meeting, and provided the technical justification in the second working group.

Furthermore, as discussed in Response to Comment 2-3, the 2008 CARB study only measured fillpipe emissions, while the EPA SHED study captured both fillpipe and on-board canister (from the ORVR vehicles) emissions. It is also important to point out that CARB's Phase II emission factor includes pressure driven losses from the storage tanks at a GDF. Whereas, the EPA SHED study does not include such emissions.

As discussed in Comment 2-2, SCAQMD staff is committed to working with CARB staff on the refueling emission factor. Until then, SCAQMD staff is recommending not to incorporate CARB's 2013 revised emission factor for Phase II refueling of ORVR vehicles, but to continue the use of SCAQMD's current refueling emission factor of 0.32 lbs per 1,000 gallons.

Response to Comment 2-5

See Response to Comment 2-3.

Response to Comment 2-6

An emission inventory is a live document that gets updated when new information is available. For each AQMP, the emission inventory is developed using the best available information at the time of the development. For the 2016 AQMP, the emission inventory was "frozen" in late 2015 to allow time for conducting the modeling analyses. At that time, SCAQMD staff was having ongoing discussions with CARB staff on the concerns regarding the emission factors for refueling and spillage.

Information necessary to produce the emission inventory for the South Coast Air Basin is obtained from the SCAQMD and other governmental agencies, including CARB, the California Department of Transportation (Caltrans), and the Southern California Association of Governments (SCAG). While SCAQMD is responsible for developing the emission inventory for stationary sources, CARB is the agency responsible for developing the emissions inventory for gasoline dispensing facilities.

In addition, the attainment of the 2008 ozone standard mainly relies on NOx reductions. Even if the VOC emission reductions from Phase II refueling were overestimated, the change in VOC would not have resulted in significant impacts on the ozone concentrations in the design sites in the attainment year. More details about the ozone modeling approach and the ozone isopleths can be found in in the 2016 AQMP (Appendix V - Modeling and Attainment Demonstration, Attachment 4 8-hour Ozone Isopleths for 2031).

Response to Comment 2-7

SCAQMD staff agrees with the comment that this rulemaking should move forward and that once CARB and SCAQMD staff agree on an emission factor for refueling, the emission factor in the Risk Assessment Procedures can be updated at a later time. SCAQMD staff is committed to continue working with CARB staff to refine the emission factor for Phase II refueling.

EXHIBIT 3

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Vent pipe emissions from storage tanks at gas stations: Implications for setback distances

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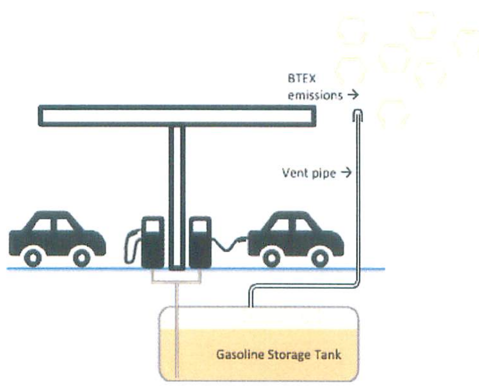
HIGHLIGHTS

- At gas stations, fuel vapors are released from storage tanks through vent pipes.
- We measured vent pipe flow rates and tank pressure at high temporal resolution.
- Vent emission factors were >10 times higher than previous estimates.
- Modeling was used to examine exceedance of benzene short-term exposure limits.

GRAPHICAL ABSTRACT



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ABSTRACT

At gas stations, fuel vapors are released into the atmosphere from storage tanks through vent pipes. Little is known about when releases occur, their magnitude, and their potential health consequences. Our goals were to quantify vent pipe releases and examine exceedance of short-term exposure limits to benzene around gas stations. At two US gas stations, we measured volumetric vent pipe flow rates and pressure in the storage tank headspace at high temporal resolution for approximately three weeks. Based on the measured vent emission and meteorological data, we performed air dispersion modeling to obtain hourly atmospheric benzene levels. For the two gas stations, average vent emission factors were 0.17 and 0.21 kg of gasoline per 1000 L dispensed. Modeling suggests that at one gas station, a 1-hour Reference Exposure Level (REL) for benzene for the general population (8 ppb) was exceeded only closer than 50 m from the station's center. At the other gas station, the REL was exceeded on two different days and up to 160 m from the center, likely due to non-compliant bulk fuel deliveries. A minimum risk level for intermediate duration (>14–364 days) benzene exposure (6 ppb) was exceeded at the elevation of the vent pipe opening up to 7 and 8 m from the two gas stations. Recorded vent emission factors were >10 times higher than estimates used to derive setback distances for gas stations. Setback distances should be revisited to address temporal variability and pollution controls in vent emissions.

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1. Introduction

In the US, approximately 143 billion gal (541 billion L) of gasoline were dispensed in 2016 at gas stations (EIA, 2017) resulting in release of unburned fuel to the environment in the form of vapor or liquid (Hilpert et al., 2015). This is a public health concern, as unburned fuel chemicals such as benzene, toluene, ethyl-benzene, and xylenes (BTEX) are harmful to humans (ATSDR, 2004). Benzene is of special concern because it is causally associated with different types of cancer (IARC, 2012). Truck drivers delivering gasoline and workers dispensing fuel have among the highest exposures to fuel releases (IARC, 2012). However, people living near or working in retail at gas stations, and children in schools and on playgrounds can also be exposed, with distance to the gas stations significantly affecting exposure levels (Terres et al., 2010; Jo & Oh, 2001; Jo & Moon, 1999; Hajizadeh et al., 2018). A meta-analysis (Infante, 2017) of three case-control studies (Steffen et al., 2004; Brosselin et al., 2009; Harrison et al., 1999) suggests that childhood leukemia is associated with residential proximity to gas stations.

Sources of unburned fuel releases at gas stations include leaks from storage tanks, accidental spills from the nozzles of gas dispensers (Hilpert & Breysse, 2014; Adria-Mora & Hilpert, 2017; Morgester et al., 1992), fugitive vapor emissions through leaky pipes and fittings, vehicle tank vapor releases when refueling, and leaky hoses, all of which can contribute to subsurface and air pollution (Hilpert et al., 2015). Routine fuel releases also occur through vent pipes of fuel storage tanks but are less noticeable because the pipes are typically tall, e.g., 4 m. These vent pipes are put in place to equilibrate pressures in the tanks and can be located as close as a few meters from residential buildings in dense urban settings (Fig. 1).

Unburned fuel can be released from storage tanks into the environment through "working" and "breathing" losses (Yerushalmi & Rastan, 2014). A working loss occurs when liquid is pumped into or out of a tank. For a storage tank, this can happen when it is refilled from a tanker truck or when fuel is dispensed to refuel vehicles (Statistics Canada, 2009) if the pressure in the storage tank exceeds the relief pressure of the pressure/vacuum (P/V) valve (EPA, 2008). P/V valve threshold pressures are typically set to around +3 and −8 in. of water column (iwc) (7.5 and −20 hPa). However, P/V valves are not always used, particularly in cold climates, as valves may fail under cold weather conditions (Statistics Canada, 2009).

Breathing losses occur when no liquid is pumped into or out of a tank because of vapor expansion and contraction due to temperature and barometric pressure changes or because pressure in the storage tank may increase when fuel in the tank evaporates (Yerushalmi & Rastan, 2014; EPA, 2008). Although delayed or redirected by the P/V valve, breathing emissions can be significant and represent an environmental and health concern (Yerushalmi & Rastan, 2014).

Fig. 1. The three vent pipes (enclosed by the red ellipse) on the right side of the convenience store of a gas station are <10 m away from the residential building. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Stage I vapor recovery systems, put in place to prevent working losses while delivering fuel to a station, collect the vapors displaced while loading a storage tank, redirecting them into the delivery truck. Stage II vapor recovery systems minimize working losses while delivering gas from the storage tank to the customer's car. During Stage II vapor recovery, gasoline vapors can be released through the vent pipe, if the sum of the flow rates of the returned volume and of the fuel evaporating within the storage tank is greater than the volume of liquid gasoline dispensed (Statistics Canada, 2009). We refer to this scenario as pressure while dispensing (PWD). In theory, a properly designed Stage II vapor recovery system should not have working losses, although in practice this is not typically the case (McEntire, 2000).

Regulations on setback distances for gas stations are based on lifetime cancer risk estimates. Several studies have assessed benzene cancer risk near gas stations (Atabi & Mirzahosseini, 2013; Correa et al., 2012; Cruz et al., 2007; Edokpolo et al., 2015; Edokpolo et al., 2014; Karakitsios et al., 2007). Based on cancer risk estimations, the California Air Resources Board (CARB) recommended that schools, day cares, and other sensitive land uses should not be located within 300 ft. (91 m) of a large gas station (defined as a facility with an annual sales volume of 3.6 million gal = 13.6 million L or greater) (CalEPA/CARB, 2005). This CARB recommendation has not been adopted by all US states, and within states setback distances can depend on local government. Notably, CARB regulations do not account for short term exposure limits and health effects. An important limitation of existing regulations is the use of average gasoline emission rates estimated in the 90s that do not consider excursions (CAPCOA, 1997).

The main objective of this study is to evaluate fuel vapor releases through vent pipes of storage tanks at gas stations based on vent emission measurements conducted at two gas stations in the US in 2009 and 2015, including the characterization of excursions at a high temporal resolution (~minutes) and meteorological conditions at an hourly temporal resolution. In addition, we performed hourly simulations of atmospheric transport of emitted fuel vapors to inform regulations on setback distances between gas stations and adjacent sensitive land uses by comparing modeled benzene concentrations to four 60-min benzene exposure limits: an acute Reference Exposure Level (REL) for infrequent (once per month or less) exposure (WHO, 2010) and Emergency Response Planning Guidelines ERPG-1, ERPG-2 and ERPG-3 (AIHA, 2016). Finally we compared simulated benzene levels to a Minimal Risk Level (MRL) for benzene for intermediate exposure duration (14 to 364 days) (ATSDR, 2018) because that duration window includes our duration of data collection. See Table 1 for the various benzene exposure limits and issuing agencies.

2. Methods

Although we provide SI unit conversions, we report some measures in English engineering units (ft, gal, and lb) as regulatory agencies such as CARB use these units.

2.1. Sites

Data for this study were obtained from vent release measurements conducted at two gas stations as part of technical assistance to the gas stations to quantify fuel vapor losses through the vent pipes of their storage tanks. A motivation for conducting the measurements was to perform a cost-benefit analysis to compare the economic losses due to the lost fuel versus the cost of technologies that reduce the emissions. The exact location of the two gas stations is not revealed for confidentiality reasons. The gas station managers and staff who authorized the

Table 1
Benzene exposure limits, to which we compared simulation results. For unit conversion, we assumed a temperature of 25 °C, i.e., 1 ppm = 3194 g/m^3 (CAPCOA, 1997).

Agency	Name	Value (ppb)	Value (g/m^3)	Exposure duration
California Office of Environmental Health Hazard Assessment (OEHHA)	REL	8	26	1 h
American Industrial Hygiene Association (AIHA)	ERPG-1	50	159,700	1 h
AIHA	ERPG-2	150	479,100	1 h
AIHA	ERPG-3	1000	3,194,000	1 h
Agency for Toxic Substances and Disease Registry (ATSDR)	MRL	6	19	14 to 364 days

ERPG = Emergency Response Planning Guidelines. The primary focus of ERPGs is to provide guidelines for short-term exposures to airborne concentrations of acutely toxic, high-priority chemicals.

collection and analysis of these data have not been involved in the current manuscript.

The first gas station, "GS-MW," was located in the US Midwest and is a 24-hour operation. The study was conducted from December 2014 to January 2015 for 20 full days, and fuel sales V_{sales} were about 450,000 gal (1.7 million L) per month. Fuel deliveries to the gas station usually took place during the nighttime. The second gas station, "GS-NW," was located on the US Northwest coast and closed at night. Hours of operation were between 6:00 am and 9:30 pm on weekdays and between 7 am and 7 pm on weekends. That study was conducted in October 2009 for 18 full days, and fuel sales were V_{sales} ~700,000 gal (2.6 million L) per month.

Both gas stations are considered to be high-volume, because they dispense >3.6 million gal of gasoline (both regular and premium) per year (CalEPA/CARB, 2005), and fuel was stored in underground storage tanks (USTs), which is typical in the US. Both gas stations had Stage II vapor recovery installed using the vacuum-assist method. In that method, gasoline vapors, which would be ejected into the atmosphere as a working loss during refueling of customer vehicle tanks, are collected at the vehicle/nozzle interface by a vacuum pump. The recovered vapors are then directed via a coaxial hose back into the combined storage tank ullage (head space) of the gas station. Stage I vapor recovery was also used at both gas stations during fuel deliveries. Both sites had a 3-inch diameter (7.5 cm) single above-grade vent pipe with below-grade manifold that connected the vent lines from several USTs; the cracking pressures of the P/V valves were set to +3 and −8 iwc (+7.5 and −20 hPa).

2.2. Vent emission measurements

To quantify evaporative fuel releases through the vent pipe of a storage tank, the volumetric flow of the mixture of gasoline vapor and air was measured in the vent pipe. A dry gas diaphragm flow meter (American Meter Company, Model AC-250) was used. For each cubic foot (28 L) of gas flowing through the meter, a digital pulse was generated. Every minute, the number of pulses was read out and stored together with date and time on a data logger. Gas flow meters were obtained from a distributor calibrated and equipped with temperature compensation and a pulse meter.

To determine the time-dependent volumetric flow rate $Q(t)$ of the gasoline vapor/air mixture through the vent pipe, the time series of measured flow volumes were integrated over an averaging period (15 or 60 min) and divided by the duration of that period. I.e., $Q(t)$ is given by the number of pulses registered by the gas flow meter in a time window multiplied by 1 cubic foot and divided by the averaging time. The 15-minute averaging time was chosen to visualize time-dependent data, while the 60-minute averaging time was chosen because air pollution simulations were performed at that resolution.

Gas pressure p in the ullage of the storage tank was measured to assess vent emission patterns. For instance, releases can occur when the pressure exceeds the cracking pressure of the P/V valve in the vent pipe (the dry gas flow meter was fitted with a P/V valve on the outlet). Pressure was measured with a differential pressure sensor (Cerabar PMC 41, Endress + Hauser) every 4 s, and 2-minute average values were stored. The sensor range was scaled from −15 to +15 iwc (−37 to +37 hPa), with a full scale accuracy of 0.20%. We also obtained 15- and 60-minute averaged tank pressure data $p(t)$ where averages represent the means of the 2-minute average pressure measurements taken during each time window.

2.3. Descriptive analysis

For the 60-minute flow rate, we calculated medians and inter quartile ranges (IQRs). To illustrate diurnal fluctuations in vapor emissions, we created box plots for the 60-minute flow rate distribution that occurred during each hour of the day. Spearman correlation coefficients between the time series for pressure and flow rate were calculated to evaluate whether pressure can be used to infer vent emissions.

To estimate the mass flow rate of gasoline m_{gas} that is released through the vent pipe in the form of a mixture of gasoline vapors and fresh air, we assumed, following the protocol of a study by the California Air Pollution Control Officers Association (CAPCOA) that assessed risks from fuel emissions from gas station (Appendix D-2 (CAPCOA, 1997)), that the density of gasoline vapors in this mixture is given by $_{gas}^{(v)}$ = 0.3 × 65 lb / 379 ft^3 = 0.824 kg/m^3, i.e., the molar percentages of gasoline and air were 30% and 70%, respectively. Then the volumetric flow rate Q can be converted into a mass flow rate of the vaporized gasoline:

$$m_{gas} \quad {}_{gas}^{v}\ Q \qquad (1)$$

To arrive at vent emission factors, we first calculated the mean volumetric flow rate $\overline{Q}$, and then the mean mass flow rate $\overline{m}_{gas} \quad {}_{gas}^{v}\ \overline{Q}$. From the latter, one can calculate the vent emission factor

$$EF_{vent} \quad \overline{m}_{gas}\ V_{sales} \qquad (2)$$

For EF_{vent}, CARB uses units of pounds of emitted gasoline vapors (also called total organic gases (TOG)) per 1000 gal dispensed, or more briefly lb/kgal where kgal stands for kilogallons.

As we were not able to measure benzene levels in the tank ullage, we assumed like the CAPCOA study (Section C) that the density of the mixture of gasoline vapors and fresh air was $_{mix}^{(v)}$ =1.05 lb/ft^3 = 1.682 kg/m^3 and that the emitted gasoline vapor/air mixture contained 0.3% of benzene by weight (CAPCOA, 1997). Therefore, the mass flow rate of benzene through the vent pipe was estimated as follows:

$$m_{benz} \quad 0\ 003 \quad {}_{mix}^{v}\ Q \qquad (3)$$

2.4. Air pollution modeling

We used the AERMOD Modeling System developed by the US Environmental Protection Agency (EPA) to model the dispersion of benzene vapors released into the environment through vent pipes of fuel storage tanks and from other sources (Cimorelli et al., 2005). AERMOD simulates atmospheric pollutant transport at a 1-hour temporal resolution. 3D polar grids were created with the gas station in the origin and potential receptors at different radial distances (up to 170 m) and angles (10°

increments). The grids were placed at the ground level ($z = 0$ m), in the breathing zone ($z = 2$ m), and at the 2nd floor level ($z = 4$ m) where the vent pipe emissions were assumed to occur. The topography was simplified for modeling purposes consistent with the CAPCOA study (CAPCOA, 1997), i.e., the terrain was assumed to be flat with no buildings present. Vent pipe emissions were modeled as a capped point source. Chemical reactions of benzene were not modeled, as residence times of atmospheric benzene are on the order of hours or even days (ATSDR, 2007), i.e. much longer than the travel time of benzene vapors across the 340-m diameter model domain.

For the period of time when vent emission measurements were made, we obtained meteorological data at a 1-hour temporal resolution that are representative for the geographic locations of the two gas stations. Table SI-1 provides descriptive statistics of that data. The time series were used in AERMOD to model the transport of benzene in the temporally varying turbulent atmosphere. We also used the 1-hour average time series of benzene emission rates (Eq. (3)) as an input into AERMOD.

To evaluate at each grid point whether OEHHA's acute REL or AIHA's ERPG levels were exceeded at least once, we determined maximum 1-hour average benzene concentrations that were simulated for about three weeks. To evaluate how often the OEHHA REL was exceeded at each grid point in the breathing zone, we created plots indicating the number of exceedances and the day when the maximum benzene level was observed.

To facilitate comparison to published benzene measurements around gas stations, we determined for each simulated radial distance from a gas station the mean of the average concentrations simulated for each ten degree increment on the radius around the gas station.

3. Results: vent releases

3.1. Times series of tank pressure and ow rate

Fig. 2 shows the time-series data for the volumetric flow rate Q of the gasoline vapor/air mixture through the vent pipe and tank pressure p that we collected at the two gas stations. At GS-MW, little vapor was typically released in the late night and in the very early morning, while releases were generally much higher during the daytime and evenings, presumably when more fuel was dispensed (Fig. 2a). Occasionally, no vapor releases occurred for several hours. While we do not have access to time of fuel delivery records, field visits indicate that time periods with no releases coincide with fuel deliveries. For instance, fuel delivery likely occurred on January 6 at 7 pm (see Fig. 3a; an amplification of data shown in Fig. 2a). As a result, the UST pressure dropped by about 10 hPa, far below the cracking pressure of the P/V valve. The decreased gas pressure in the ullage increased until the cracking pressure of the P/V valve was reached. A very small vapor release (~2 L/min) was observed briefly on the next day at 2 am. The vapor flow rate becomes relatively large again, ~12 L/min, only after 6 am, i.e., 11 h after fuel delivery.

Fig. 3b amplifies a major vapor release at GS-MW. The UST pressure significantly exceeded the cracking pressure of the P/V valve and rose rapidly up to 37 hPa, which coincides with vapors being released at a high flow rate (15-min average) of about 470 L/min.

At GS-NW, vapor releases followed a quite different pattern (Fig. 2b). Contrary to GS-MW, vapor releases occurred in a cyclical pattern, and tended to be higher in the late night and in the very early morning when the gas station was closed.

3.2. Statistics of vapor emissions

The average volumetric flow rate $\overline{Q}$ through the vent pipe for the entire period of time during which measurements were taken was $\overline{Q} = 7.9$ L/min for GS-MW and $\overline{Q} = 15.4$ L/min for GS-NW, which is consistent with the higher sales volume V_{sales} of GS-NW. These emissions consist of a mixture of gasoline vapors and air. Using Eq. (1), the volumetric flow rates were converted into average mass flow rates of gasoline: $\overline{m}_{gas} = 0.39$ kg/h for GS-MW and $\overline{m}_{gas} = 0.76$ kg/h for GS-NW. Using Eq. (2), we determined a vent emission factor $EF_{vent} = 0.17$ kg per 1000 L = 1.4 lb/kgal for GS-MW and $EF_{vent} = 0.21$ kg per 1000 L = 1.7 lb/kgal for GS-NW.

The medians (IQRs) for the 60-minute averaged flow rate Q (L/min) were 6.1 (1.9, 10.9) for GS-MW and 16.0 (12.7, 18.4) for GS-NW. For GS-MW, the mean is larger than the median, indicating a more skewed distribution of flow rates when compared to GS-NW. Also the first quartile is much lower than the median for GS-MW, indicating that there are periods of time during which little emissions occurred. Conversely, GS-NW was releasing emissions more consistently.

Fig. 4a shows boxplots illustrating the distribution of flow rate Q for each hour of the day at GS-MW. Less vapor was released between 10 pm and 4 am, even though the gas station was in operation, albeit at lower activity levels. The flow rate Q at GS-NW (Fig. 4b) had fewer outliers, and the highest outlier was an order of magnitude lower than the highest one at GS-MW. Emissions were highest between 1 and 3 am, when the gas station was closed.

The Spearman correlation coefficients between tank pressure p and vent flow rate Q were $r = 0.58$ for GS-MW and $r = 0.85$ for GS-NW. Thus, vent releases are moderately and strongly correlated with tank pressure, respectively. Table 2 summarizes statistical properties of vent emissions at the two gas stations.

4. Results: air pollution modeling

4.1. Emission sources and rates

Vent pipe emissions of benzene were modeled at a 1-hour temporal resolution as described in Section 2.4. However, they are not the sole source of gasoline emissions at gas stations. Accidental spills from nozzles regularly occur near the dispensers, "refueling losses" can occur when gasoline vapors are released from the vehicle tank during refueling due to the rising liquid levels in the tanks, fuel vapors are released from permeable dispensing hoses, and "fugitive" or leakage emissions occur with driving force derived from storage tank pressure. In Section A of Supporting material, we detail how these other emission sources were modeled. Table 3 summarizes estimated mean emission rates. Note that the vent pipe losses are much greater than other losses.

4.2. Predicted benzene levels

Fig. 5 shows for both gas stations and at each grid point the maximum 1-hour average benzene concentration observed during the simulated periods in time. Benzene levels depend significantly on elevation within a 50-meter radius around the centers of the gas stations. Close to the centers of the gas stations, benzene levels are higher at the 4-m elevation and at ground level due to vent pipe emissions, which represent the largest emission source (Table 3). Further than 50 m away from the center, the vertical concentration differences become less obvious due to dispersion causing vertical mixing of benzene vapors.

At GS-MW, the 1-hour acute REL of 26 g/m^3 was exceeded 160 m away from the center of the gas station, at the location ($x = 158$ m, $y = 28$ m) both at ground level and in the breathing zone. At grid points with a distance >50 m from the center of the gas station, the REL was exceeded at most once (Fig. SI-1a). However, the exceedance at different grid points did not occur on the same day (Fig. SI-1b). Within the 20 days during the measurement campaign, exceedances occurred on the 4th and 13th of January.

At GS-NW, the furthest REL exceedance occurred at 50 m from the center of the gas station at the grid point ($x = -38$ m, $y = 32$ m) as

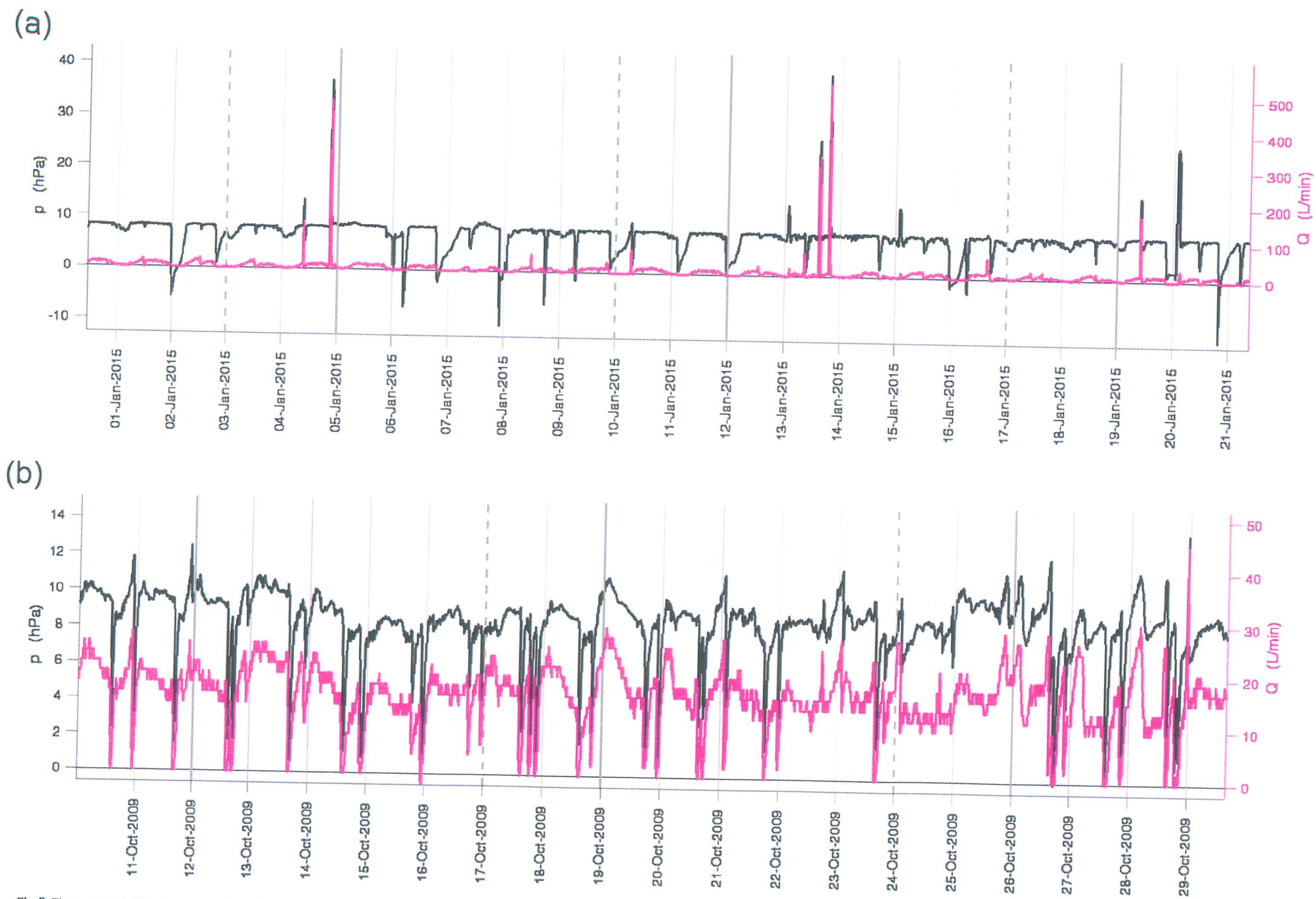

Fig. 2. Time series of ullage pressure p (left ordinate) and volumetric flow rate Q (right ordinate) for (a) GS-MW and (b) GS-NW. Horizontal tick marks indicate midnights. The vertical dashed and thick solid gray lines enclose weekends.

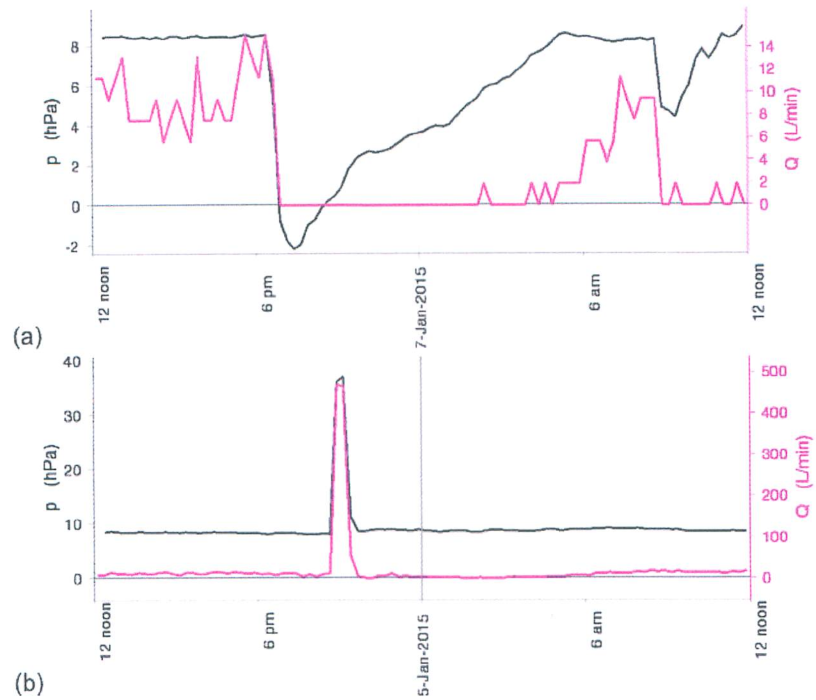

Fig. 3. Amplifications of time series data (15-minute averages) for GS-MW. (a) Tank pressure p became negative after fuel delivery. As a result, vent emission ceased for several hours. (b) A major vapor release (burst) likely occurred when the cracking pressure of the P/V valve was significantly exceeded at around 9 pm during a non-compliant bulk fuel delivery.

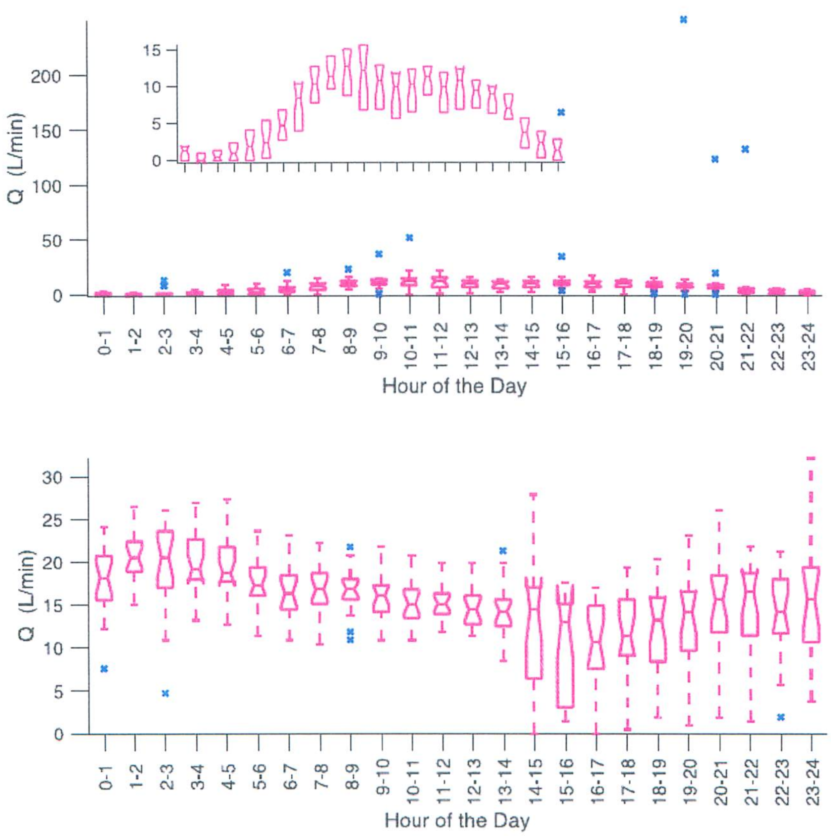

Fig. 4. Distribution of vent emissions Q observed for each hour of the day at (a) GS-MW [insert shows the IQRs of Q] and (b) GS-NW gas stations. In (a), outliers make it difficult to recognize variations in median hourly emissions. We therefore plotted in the inset only the IQRs. Boxes indicate median and IQR, whiskers values within 1.5 the IQR, and asterisks outliers.

Table 2
Summary of gas station characteristics and vent emissions.

	GS-MW	GS-NW	Units
Sales volume V_{sales}	450,000	700,000	gal/month
Volumetric flow rates (of gasoline vapor/air mixture)			
Mean $\overline{Q}$	7.9	15.4	L/min
Median (IQR) of 60-min average	6.1 (1.9, 10.9)	16.0 (12.7, 18.4)	L/min
Maximum of 60-min average	250	32.1	L/min
Vent emission factor EF_{vent}	1.4	1.7	lb/kgal
Mass flow rates of gasoline (w/o air)			
Mean $\overline{m}_{gas}$	0.39	0.76	kg/h
Maximum of 60-min average	12.3	1.6	kg/h
Correlation coefficient			
Between Q and p	0.58	0.85	–

shown in Fig. SI-2a. At a distance of 40 m, the REL was exceeded three times at one grid point (260° angle), and at 35 m four times at two grid points (250° and 260° angles) (Fig. SI-2b). At a distance of 20 m, the REL was exceeded at 30 (out of 36) grid points, and on nine different days.

Average benzene levels are shown in Fig. 6 for both gas stations. The MRL is exceeded at the elevation of the vent pipe opening, $z = 4$ m, up to 7 m away from for GS-MW and up to 8 m from GS-NW. Fig. 7 shows the average benzene concentration as a function of distance at an elevation of 2 m. Close to the center, benzene levels first increase and then decrease.

5. Discussion

5.1. Vent emission factors

We present unique data on vent emissions from USTs at two gas stations. Emissions can be compared to vent losses assumed by CAPCOA (CAPCOA, 1997). For a gas station with Stage I and II vapor recovery technology and a P/V valve on the vent pipe of the UST (Scenario 6B), the CAPCOA study assumed loading losses of 0.084 and breathing losses of 0.025 lb/kgal dispensed. The total loss of gasoline through the vent pipe is the sum of the two and amounts to a vent emission factor $EF_{vent}=$ 0.109 lb/kgal. Based on actual measurements in two fully functioning US gas stations, we obtained EF_{vent} values of 1.4 lb/kgal for GS-MW and 1.7 lb/kgal for GS-NW, more than one order of magnitude higher than the CAPCOA estimate. While the difference between our measurements and the CAPCOA estimates may appear surprising, it is important to consider that the CAPCOA estimates are based on relatively few measurements and some unsupported assumptions (Aerovironment, 1994), particularly with regard to uncontrolled emissions due to equipment failures or defects (Appendix A-5 (CAPCOA, 1997)).

5.2. Pressure measurements

Tank ullage pressure p was moderately to strongly positively correlated with vent flow rate Q, likely because exceedance of the cracking pressure of the P/V valve causes a vent release. Thus pressure measurements can be used to infer vent releases. Real-time detection of equipment failures and leaks via so-called in-station diagnostics systems is based on our observed correlations between p and Q.

Table 3
Mean benzene emission rates m_{benz} for the two gas stations.

Emission source	Benzene emissions (mg/s)	
Gas station	GS-MW	GS-NW
Vent pipe	0.80	1.55
Spillage	0.39	0.65
Refueling	0.41	0.69
Hose permeation	0.06	0.10
Total	1.67	2.90

5.3. Diurnal uctuations in vent emissions

Diurnal vent emissions were quite different at the two gas stations. At GS-MW, a 24-hour operation, vent emissions were high during the daytime, presumably due to PWD. Emissions ceased at night, likely because less gasoline was dispensed and fuel deliveries with relatively cool product were frequent. Evaporative losses could also have been lower at night because the cooler delivered fuel would cause slight contraction of the liquid phase with corresponding growth in the ullage volume while at the same time lowering the vapor pressure of gasoline in the UST.

At GS-NW, vent pipe releases occurred most of the time, during the daytime when fuel was dispensed (PWD) and at night when the gas station was closed. Vent releases were higher when the gas station was closed, suggesting that during the day-time Stage II vapor recovery resulted in the injection of vapors into the storage tank that were not completely equilibrated with the liquid gasoline. During night-time, the gradual equilibration of unsaturated air in the ullage of the UST with gasoline vapors could then have caused exceedance of the cracking pressure of the P/V valve and consequently vapor release. It seems counterintuitive that less nighttime emissions occurred at the gas station where fuel was dispensed. However, while fuel is being dispensed, the outgoing liquid creates additional ullage volume, and depending on excess air ingestion rate, a negative pressure could result that lowers vent pipe emissions.

Dispensing fuel to customer vehicles and the associated Stage II vapor recovery system interact with vent emissions and can even cause vent emission during PWD, because the vacuum-assist method can negatively interfere with Onboard Refueling Vapor Recovery (ORVR) installed in customer vehicles (EPA, 2004). However, Stage II vapor recovery is not obsolete. It can be used in conjunction with ORVR to minimize exposure of gas station customers and workers to benzene due to working losses (Cruz-Nunez et al., 2003), particularly when customer vehicles are not equipped with ORVR (e.g., older vehicles, boats, motorcycles) or small volume gasoline containers are refueled. Enhanced Stage II vapor recovery technology can significantly reduce vapor emissions both at the nozzle and from UST vent pipes (CARB, 2013).

5.4. Fuel deliveries and accidental vent releases

Based on observations and interpretation of time series of the tank pressure data, it is likely that the peak vent emissions (e.g., Fig. 3b) were partly due to non-compliant bulk fuel drops where the Stage I vapor recovery system either was not correctly hooked up by the delivery driver or to hardware problems with piping and/or valves. This

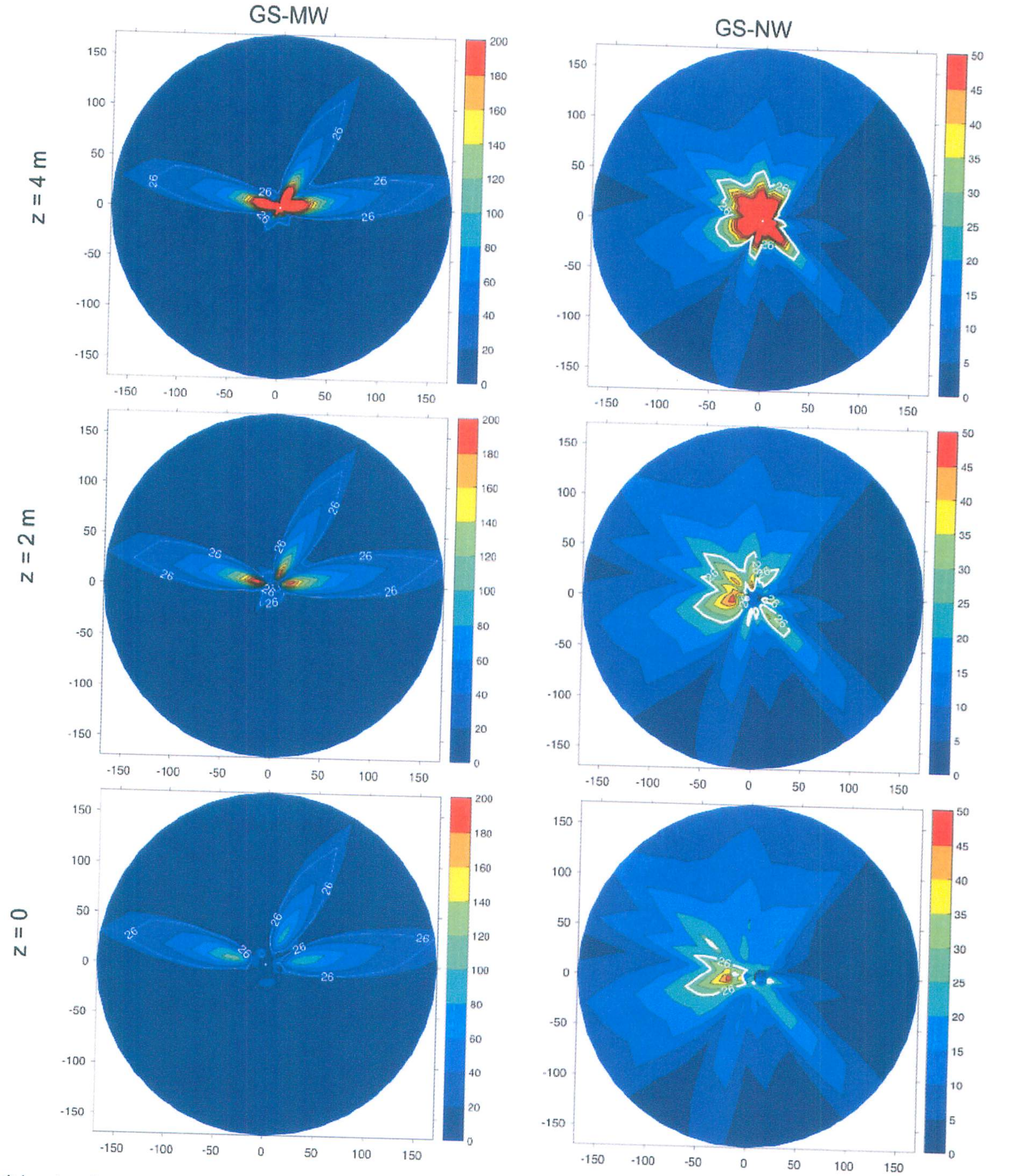

Fig. 5. Modeled maximum benzene concentrations for GS-MW and GS-NW at three different elevations z. The x- and y-axes indicate horizontal coordinates in meters. The color indicates benzene levels in units of g/m^3. Left column: time series of benzene emission rates were used. Right column: average benzene emission rate was used in the modeling. The white isoline indicates OEHHA's acute REL of 26 g/m^3 = 8 ppb.

conjecture is consistent with typical US storage tank volumes (~10,000 to 30,000 gal). Assuming that Phase I vapor recovery did not work at all and that 10,000 gal (~38,000 L) of fuel were delivered, the working loss (volume of gasoline vapor/air mixture released to the atmosphere through the vent pipe) is 38,000 L. It is also reasonable to assume that delivery lasted less than 1 h. According to Table 2, the maximum hourly flow rate through the vent pipe was 250 L/min at GS-MW, which would result in a maximum cumulative vapor release of 15,000 L within this hour. The measured maximum cumulative release underestimates the assumed working loss of 38,000 L. This could be due to a fuel delivery, which involved dropping fuel from multiple compartments of a tanker truck, with the vapor return hose not being correctly hooked up for only some of the emptied compartments.

At GS-MW, UST pressure decreased after fuel delivery (causing vent emissions to cease for several hours) during the climatic conditions prevalent during the observation period, behavior not observed at GS-NW. In practice, it is possible to observe both positive and negative pressure excursions, even during the same fuel delivery (when multiple fuel

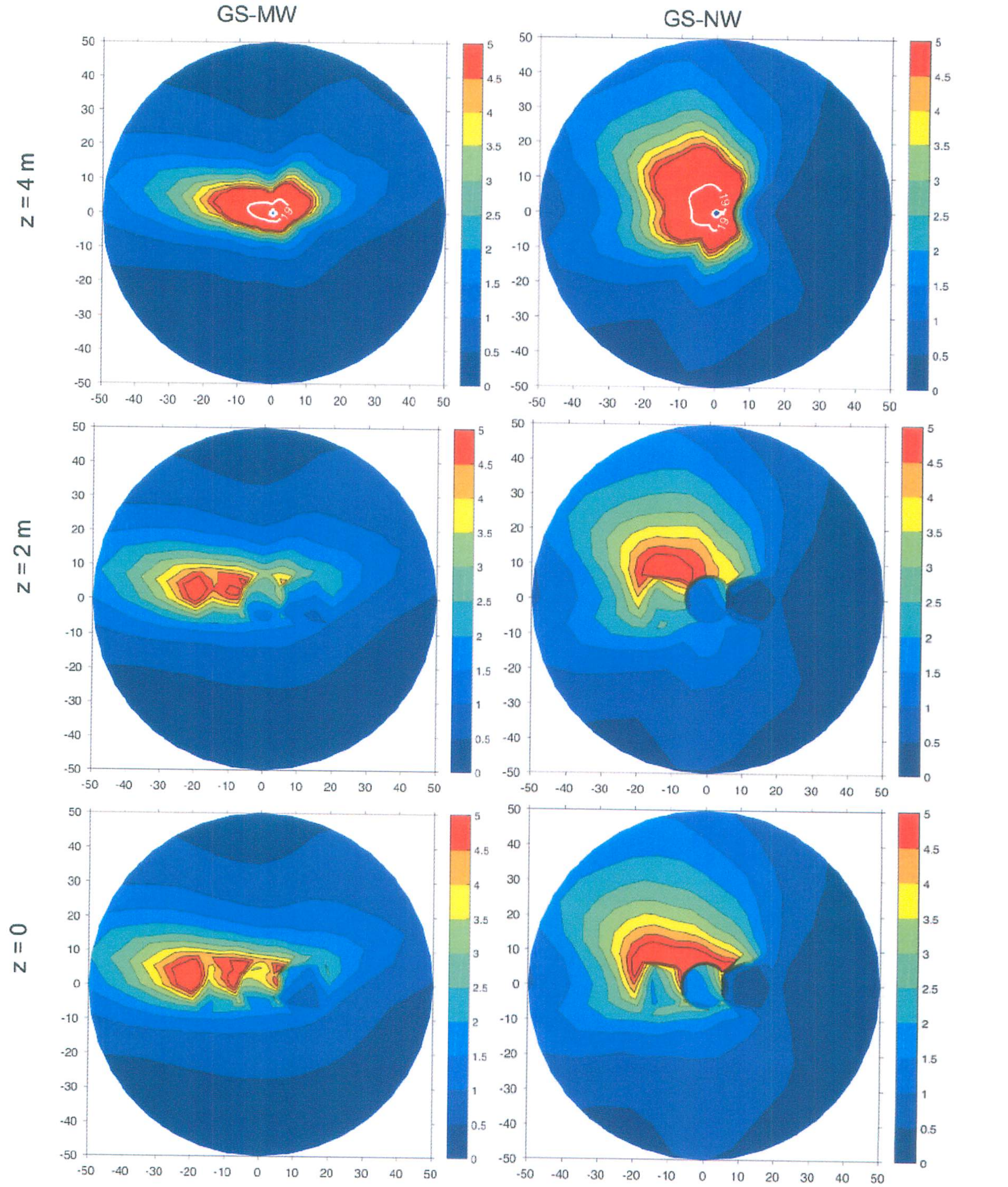

Fig. 6. Modeled average benzene concentrations for GS-MW and GS-NW at three different elevations *z*. The *x*- and *y*-axes indicate horizontal coordinates in meters. The color indicates benzene levels in g/m^3 and the white isoline the MRL of 19 g/m^3 = 6 ppb.

compartments of tanker trucks are unloaded), when Stage I vapor recovery is in place (personal observation by TT).

5.5. Exceedance of 1-hour exposure limits

AERMOD air pollution modeling suggests that at GS-MW the 1-hour acute REL was exceeded at one grid point 160 m (525 ft) from the center of the gas station once in 20 days (Fig. 5). This distance is larger than the 300-ft (91 m) setback distance recommended by CARB for a large gasoline dispensing facility (CalEPA/CARB, 2005). Assuming the gas station's fence line is <225 ft. (69 m) from its center (where the vent pipe was assumed to be located), our study shows that sensitive land uses at a distance further than 300 ft from the fence line of the gas station would represent a health concern despite compliance with the CARB guidelines because of non-compliance with the acute REL.

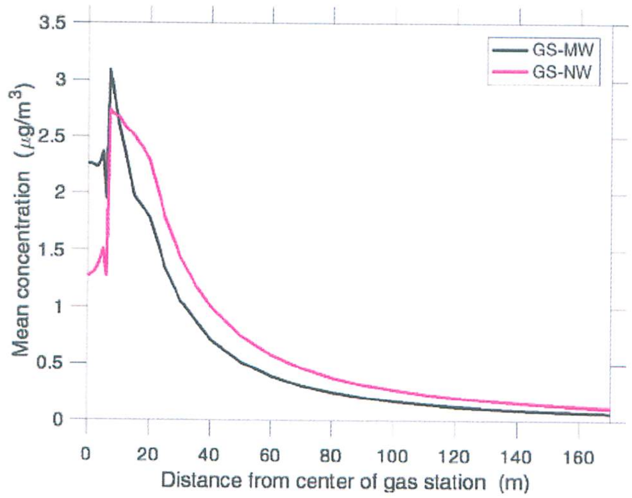

Fig. 7. Mean benzene concentrations as a function of distance from the center of the gas stations.

At any location further than 50 m from the gas station's center, the REL was exceeded at most once during the 20-day measurement campaign (Fig. SI-1a). However, exceedance occurred at several locations, and on two different days (Fig. SI-1b). E.g., at a distance of 120 m from the center, the REL was exceeded at three grid points, and the number of grid points increased with closer proximity to the gas station. This suggests that it was not just a single worst-case scenario or a single accidental vapor release that led to REL exceedance; rather exceedance may occur more frequently than is anticipated. Prevalent wind directions during the measurement campaign explained the directional patterns of exceedances (see the wind rose in Fig. SI-3a).

At GS-NW, despite its higher sales volume, the REL was exceeded only closer than 50 m from the gas station's center. However, exceedance occurred much more frequently (Fig. SI-2), likely because of the higher sales volume of GS-NW. Again, the wind rose for GS-NW (Fig. SI-3b) explains spatial patterns of REL exceedance.

None of AIHA's three ERPG levels were exceeded, meaning that individuals, except perhaps sensitive members of the public, would not have experienced more than mild, transient adverse health effects.

5.6. Average benzene levels

The initial increase in average benzene levels when moving away from the gas stations' centers (Fig. 7) is likely due to the vent emissions (at 4 m) which represent the largest benzene source, and which require a certain transport distance until they reach the 2-m level through dispersion. Further away from the gas station, benzene levels are higher for GS-NW than for GS-MW likely because of the higher sales volume of GS-NW. However, close to the center, benzene levels are higher at GS-MW. This can be attributed to the higher wind speeds at GS-NW (Table SI-1), which result in greater initial dilution of emitted pollutants in the incoming airstream and also in greater subsequent pollutant dispersion.

Modeled average benzene concentrations are generally lower (~10 g/m^3 or less) than those measured in the surroundings of gas stations, likely because our simulations do not account for traffic-related air pollution (TRAP). For instance, a study published by the Canadian petroleum industry found average benzene concentrations of 146 and 461 ppb (466 and 1473 g/m^3) at the gas station property boundary in summer and winter, respectively (Akland, 1993), values orders of magnitudes higher than ours. A South Korean study examined outdoor and indoor benzene concentrations at numerous residences within 30 m and between 60 and 100 m of gas stations and found median outdoor benzene concentrations of 9.9 and 6.0 g/m^3, respectively (Jo & Moon, 1999), while we simulated benzene levels on the order of 1 g/m^3 (Fig. 7). In a study on atmospheric BTEX levels in an urban area in Iran, the three highest BTEX levels were measured near gas stations (~150 m away); the measured benzene levels (64 ± 36, 31 ± 28, 52 ± 26 g/m^3) were again much higher than ours simulated at that distance, likely due to TRAP. Our modeled average benzene levels at a distance of about 50 m are on the same order as background benzene levels of 1.0 g/m^3 that were measured in 2010 in the National Air Toxics Trend Sites (NATTS) network of 27 stations located in most major urban areas in the US (Strum & Scheffe, 2016). However, our modeled levels at a distance of 170 m were 0.07 at GS-MW and 0.12 at GS-NW, a non-negligible addition to urban background levels.

At both gas stations, the MRL was exceeded at the level of the vent pipe opening in the vicinity of the gas stations, up to 7 m away from the vent pipe at GS-MW and 8 m at GS-NW. Therefore there might be an appreciable risk of adverse noncancer health effects for individuals living at the 2nd-floor level relatively close to high-volume gas stations such as GS-MW and GS-NW.

5.7. Limitations

A limitation of our study is that data were collected only in fall and winter. Results cannot be easily extrapolated to other seasons, because vent pipe emissions are seasonally dependent, e.g., due to seasonally dependent gasoline formulations and meteorological conditions. However, modeled exceedance of the OEHHA acute REL in the winter season is already of concern, because that REL was developed for once per month or less exposures.

Another limitation is that we did not directly measure benzene levels in the vent pipe, and instead made assumptions about vapor composition that were also made in the CAPCOA study (CAPCOA, 1997) of gas station emissions. In practice it may be difficult to obtain permission from gas station owners to measure benzene levels directly.

In part because we did not want to reveal the locations of the gas stations, we did not use site-specific topography information in the air dispersion modeling and instead assumed flat terrain. While this simplification results in less accurate air pollution predictions for the two sites, using a "generic" gas station is perhaps more representative of other gas station sites, and is consistent with an approach used in a previous study (CAPCOA, 1997).

Finally, our study did not predict benzene levels in indoor environments. Even though indoor air pollution levels may substantially differ from outdoor levels due to indoor sources (e.g., smoking, photocopying) (El-Hashemy & Ali, 2018), our study can still inform exposure levels in indoor environments as outdoor sources may be the main contributors to indoor air pollution, e.g., in buildings situated in urban areas and close to industrial zones or streets with heavy traffic (Jones, 1999). This is relevant to workers and customers in C-stores or other fast-food/gasoline station combination facilities.

6. Conclusions

Our study is to the best of our knowledge the first one to (1) report hourly vent emission data for gasoline storage tanks in the peer-reviewed literature and (2) use these data in hourly simulations of atmospheric benzene vapor transport. This allowed us to examine potential exceedance of short-term exposure limits for benzene. Prior studies including CAPCOA's (CAPCOA, 1997) could not do so as average emission rates were used (only meteorological data was used at an hourly resolution).

Our findings support the need to revisit setback distances for gas stations, which are based on >2-decade old estimates of vent emissions (Aerovironment, 1994). Also, CARB setback distances are based on a binary decision, related to whether the gasoline sales volume V_{sales} is >3.6 million gal per year. Our data support, however, that setback distances should be a continuous function of sales volume V_{sales} and also include the type of controls installed at the facility. Setback distances should also address health outcomes other than cancer. OEHHA's acute REL for benzene could be used to inform setback distances as it accounts for non-cancer adverse health effects of benzene and its metabolites (Budroe, 2014). ATSDR's MRL could also be considered since it is a health-based limit.

We note that CARB recommended their setback distances in 2005, presumably assuming pollution prevention technology yielding a 90% reduction in benzene emissions (CalEPA/CARB, 2005). Since then, CARB further promoted use of second-generation vapor recovery technology (Enhanced Vapor Recovery, EVR) to reduce emissions further. EVR includes technology that is supposed to prevent fuel vapors in overpressurized tanks from being expelled into the atmosphere (CARB, 2017). To that end, "bladder tanks" have been proposed, into which the gasoline vapor/air mixture is directed as the pressure in the combined ullage space of the storage tank increases, and from which the mixture is redirected into the fuel storage tanks if the ullage pressure becomes negative (when fuel is dispensed). The challenge with such a system is to ensure that the bladder tank capacity is not exceeded by the fuel evaporation rate. Alternatively, fuel vapor release can be reduced by processing the fuel/air mixture through either a semi-permeable membrane which selectively exhausts clean air and returns enriched fuel vapor (Semenova, 2004) or an activated carbon filter which adsorbs hydrocarbons (and water vapor) and exhausts air into the atmosphere, or by combusting the fuel/air mixture which would otherwise be released through the P/V valve. Therefore, current CARB setback distances might be adequate for gas stations in California but less so for the other 49 US states, and other countries—depending on pollution prevention technology requirements.

The larger areal extent of modeled REL exceedance at GS-MW is due to "accidental" releases of gasoline vapors. Even though regulations appear generally not to be driven by accidental releases, at GS-NW such releases likely led on two different days to REL exceedances at distances beyond CARB's recommended setback distances. Policies should address accidental fuel vapor releases that depending on pollution prevention technology (here Stage I vapor recovery) and its proper functioning can occur on a frequent basis (twice at GS-MW within about three weeks).

In future work, potential exceedance of other shorter-term exposure limits should be examined, e.g., the 15-minute short-term exposure limits (STELs) and the 8-hour time-weighted averages (TWAs) used for occupational exposures.

Acknowledgements

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Competing nancial interest declaration

TT directs a company (ARID), which develops technologies for reducing fuel emissions from gasoline-handling operations. AMR, BAM and MH have no conflicts of interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scitotenv.2018.09.303.

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<u>EXHIBIT 4</u>

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

BAAQMD

Air Toxics NSR Program

Health Risk Assessment Guidelines

December 2016

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
375 BEALE STREET, SUITE 600
SAN FRANCISCO, CA 94105

BAAQMD Air Toxics NSR Program

Health Risk Assessment Guidelines

1. INTRODUCTION

This document describes the Bay Area Air Quality Management District's guidelines for conducting health risk assessments. Any health risk assessment (HRA) that is required pursuant to Regulation 2 Permits, Rule 1 General Requirements or Rule 5 New Source Review of Toxic Air Contaminants shall be conducted in accordance with these Air District HRA Guidelines.

In accordance with Regulation 2-5-402, the Air District HRA Guidelines generally conform to the Health Risk Assessment Guidelines adopted by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) for use in the Air Toxics Hot Spots Program for all types of facilities except gasoline dispensing facilities (GDFs). In addition, these guidelines are in accordance with State "Risk Management Guidance for Stationary Sources of Air Toxics" developed by the California Air Resources Board (ARB) and the California Air Pollution Control Officers Association (CAPCOA).

The Air District is delaying implementation of OEHHA's 2015 HRA Guidelines for gasoline dispensing facilities while further research is conducted on the potential impacts of OEHHA's 2015 HRA Guidelines on gasoline dispensing facilities. The Air District HRA Guidelines for gasoline dispensing facilities are described in Section 2.2.

The Air District will periodically update these Air District HRA Guidelines to clarify procedures or incorporate other revisions to regulatory guidelines.

2. PROCEDURES

The procedures described below constitute the Regulation 2-5-603 Health Risk Assessment Procedures.

2.1 Procedures for All Facilities Other Than Gasoline Dispensing Facilities

All HRAs for facilities other than gasoline dispensing facilities shall be completed by following the procedures described in the OEHHA Health Risk Assessment Guidelines for the Air Toxics Hot Spots Program adopted by OEHHA on March 6, 2015 and using the recommended breathing rates described in the ARB/CAPCOA Risk Management Guidance for Stationary Sources of Air Toxics adopted by ARB on July 23, 2015.

The OEHHA HRA Guidelines contain several sections which identify (a) the overall methodology, (b) the exposure assessment assumptions and procedures, and (c) the health effects data (cancer potency factors and reference exposure levels).

A summary of OEHHA's HRA Guidelines and an index of the relevant documents are located at:

http://www.oehha.ca.gov/air/hot_spots/index.html

OEHHA's risk assessment methodology (February 2015) is located at:

http://www.oehha.ca.gov/air/risk_assess/index.html

The exposure assessment and stochastic technical support document (August 2012) is located at:

http://www.oehha.ca.gov/air/exposure_assess/index.html

The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures (May 2009) is located at:

http://www.oehha.ca.gov/air/hot_spots/tsd052909.html

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (June 2008) is located at:

http://www.oehha.ca.gov/air/hot_spots/rels_dec2008.html

The ARB/CAPCOA Risk Management Guidance for Stationary Sources of Air Toxics (July 23, 2015) provides guidance on managing potential health risks from sources subject to California air toxics programs and updates the Risk Management Policy for Inhalation Risk Assessments. It is located at:

http://www.arb.ca.gov/toxics/rma/rmaguideline.htm

Sections 2.1.1 through 2.1.6 below clarify and highlight some of the exposure assessment procedures including exposure assumptions (e.g., breathing rate and exposure duration), health effect values, and calculation procedures to be used for conducting Air District HRAs.

2.1.1 Clarifications of Exposure Assessment Procedures

This section clarifies and highlights some of the exposure assessment procedures that should be followed when conducting an Air District HRA.

2.1.1.1 Breathing Rate

On July 23, 2015, ARB adopted "Risk Management Guidance for Stationary Sources of Air Toxics", which includes an updated Risk Management Policy for Inhalation Risk Assessments. For the HRA methodology used in the Air Toxics NSR Program, the Air District has conformed with these State guidelines and adopted the exposure assessment recommendations made by ARB and CAPCOA. The policy considers the new science while providing a reasonable estimate of potential cancer risk for use in risk assessments for risk management decisions. This policy recommends using a combination of the 95^{th} percentile and 80^{th} percentile daily breathing rates as the minimum exposure inputs for risk management decisions. Specifically, the policy recommends using the 95^{th} percentile rate for age groups less than 2 years old and the 80^{th} percentile rate for age groups that are greater than or equal to 2 years old.

To assess potential inhalation exposure to offsite workers, OEHHA recommends assuming a breathing rate of 230 L/kg-8 hours. This value represents the 95^{th} percentile 8-hour breathing rate based on moderate activity of 16-70 years-old age range.

To assess exposure to children at schools and daycare facilities, OEHHA recommends using the 95^{th} percentile moderate intensity breathing rates from Table 5.8 of OEHHA's HRA Guidelines. As a default, the Air District recommends using the breathing rate for 2<16 years (520 L/kg-8 hours) for children at schools. For a more refined analysis, the Air District will allow the use of breathing rates for other age ranges that are tailored to the ages of the children in the specific school under evaluation.

2.1.1.2 Exposure Frequency

Based on OEHHA recommendations, the Air District will estimate cancer risk to residential receptors assuming exposure occurs 24 hours per day for 350 days per year. For a worker receptor, exposure is assumed to occur 250 days per year. However, for some professions (e.g., teachers) a different schedule may be more appropriate. For children at school sites, exposure is assumed to occur 180 days (or 36 weeks) per year.

2.1.1.3 Exposure Duration

Based on OEHHA recommendations, the Air District will estimate cancer risk to residential receptors based on a 30-year exposure duration. Although 9-year and 70-

year exposure scenarios may be presented for information purposes, risk management decisions will be made based on 30-year exposure duration for residential receptors.

For worker receptors, risk management decisions will be made based on OEHHA's recommended exposure duration of 25 years.

As a default, cancer risk estimates for children at school sites will be calculated based on a 9-year exposure duration, such as for a K-8 school. However, this exposure duration may be refined based on the specific school under evaluation (i.e. 6 years for a K-5 elementary school, 4 years for a 9-12 high school, or 3 years for a 6-8 middle school). For any analyses using an alternative to the 9-year default duration for school children, the breathing rate assumptions must also be adjusted in accordance with the ages of the children in the school.

2.1.2 Health Effects Values

Chemical-specific health effects values have been consolidated and are presented in Regulation 2, Rule 5, Table 2-5-1 Toxic Air Contaminant Trigger Levels for use in conducting HRAs. The Air District has added the 8-hour reference exposure levels (RELs) adopted by OEHHA to this table. The Air District will periodically update this table to include OEHHA's revisions to health effects values.

2.1.3 Cancer Risk Calculations

In accordance with OEHHA's 2015 HRA Guidelines, cancer risk estimates should incorporate age sensitivity factors (ASFs) and fraction of time at home (FAH) adjustment factors. Air District HRAs should follow OEHHA's recommended cancer risk calculation procedures as presented in Section 8.2 of OEHHA's 2015 HRA Guidelines.

For residential exposures, the cancer risk calculations should include the most sensitive age groups: from third trimester of pregnancy to 30 years of age for a 30-year exposure duration. For worker receptors, assume working begins at age 16 years.

2.1.3.1 Fraction of Time at Home (FAH)

For the initial cancer risk estimate, assume the fraction of time at home factors are equal to one (FAH = 1.0) for the following age groups: 3rd trimester to < 2 years and 2 to < 16 years. Use this initial analysis to assess if there are any schools within cancer risk isopleths of one in a million or greater. If there are no schools within one in a million or greater cancer risk isopleths, the cancer risk analysis may be refined by using the appropriate age-specific FAH factors as identified in Table 8.4 of the 2015 OEHHA Guidelines:

- FAH = 0.85 for age group: 3rd trimester to < 2 years;
- FAH = 0.72 for age group: 2 to < 16 years;

- FAH = 0.73 for age group: 16 to 70 years.

2.1.3.2 Short Term Projects

In the 2015 HRA Guidelines, OEHHA recommends using actual project duration for short term projects, but cautions that the risk manager should consider a lower cancer risk threshold for very short term projects, because a higher exposure over a short period of time may pose a greater risk than the same total exposure spread over a much longer period of time. To ensure that short-term projects do not result in unanticipated higher cancer impacts due to short-duration high-exposure rates, the Air District recommends that the cancer risk be evaluated assuming that the average daily dose for short-term exposure lasts a minimum of three years for projects lasting three years or less. For residential exposures, the cancer risk calculations should include the most sensitive age groups (beginning with the third trimester of pregnancy) and should use the 95th percentile breathing rates. The Air District recommends following OEHHA guidelines for other aspects of short term projects. In summary, the Air District recommends:

- use of actual emission rates over a minimum 3-year duration for cancer risk assessments involving projects lasting 3 years or less, and
- use of actual project duration for cancer risk assessments on projects lasting longer than 3 years.

2.1.4 Noncancer Health Impacts

In accordance with OEHHA's 2015 HRA Guidelines, noncancer health impacts should be calculated using the hazard index approach. Air District HRAs should follow OEHHA's recommended calculation procedures for noncancer health impacts, as presented in Section 8.3 of OEHHA's 2015 HRA Guidelines.

Regarding Section 8.3.5 of OEHHA's 2015 HRA Guidelines, the Air District does not require inclusion of the contribution of background criteria pollutants to respiratory health effects for Air District HRAs.

2.1.5 Spatial Averaging

Typically, HRA results for an individual receptor have been based on air dispersion modeling results at a single point or location. In the 2015 OEHHA Guidelines (Section 4.7.3), OEHHA provides a refinement option that takes into account that people move around within their property or workplace and do not normally remain at a single fixed point for the entire exposure duration. This spatial averaging refinement may be used for any chronic analysis in an Air District HRA. Spatial averaging is not appropriate for an acute analysis.

After the points of interest have been identified by the air dispersion modeling analysis, the ground level air concentration for each maximum impact point may be refined by using the arithmetic mean of the receptor concentrations identified within a spatial average grid instead of the single maximum impact point concentration. The modeler shall generally center the spatial average grid around the maximum impact point, but the modeler shall also consider facility boundaries, possible receptor locations, and predominant wind direction. This grid shall be of an appropriate shape, shall be no larger than 400 square meters, and shall have a receptor spacing within the grid of no less than 5 meters. Grid shape, size, and location are subject to Air District approval.

2.1.6 Stochastic Risk Assessment

For a stochastic, multipathway risk assessment, the potential cancer risk should be reported for the full distribution of exposure from all exposure pathways included in the risk assessment. For risk management decisions, the potential cancer risk from a stochastic, multipathway risk assessment should be based on the 95th percentile cancer risk.

2.2 Procedures for Gasoline Dispensing Facilities

Any HRA for a gasoline dispensing facility shall be completed by following the procedures described in the OEHHA Health Risk Assessment Guidelines for the Air Toxics Hot Spots Program that were adopted by OEHHA on October 3, 2003 and any State risk assessment and risk management policies and guidelines in effect as of June 1, 2009.

The 2003 OEHHA Health Risk Assessment Guidelines contain several sections which identify (a) the overall methodology, (b) the exposure assessment assumptions and procedures, and (c) the health effects data (cancer potency factors, chronic reference exposure levels, and acute reference exposure levels).

A summary of OEHHA's 2003 Health Risk Assessment Guidelines and an index of the relevant documents are located at:

http://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk

OEHHA's 2003 risk assessment methodology is located at:

http://oehha.ca.gov/media/downloads/crnr/hraguidefinal.pdf

The exposure assessment and stochastic technical support document (Part IV of OEHHA's Risk Assessment Guidelines) is located at:

http://oehha.ca.gov/media/downloads/crnr/stoch4f.pdf

The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures (June 2009) is located at:

http://oehha.ca.gov/media/downloads/crnr/tsdcancerpotency.pdf

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (June 2008) is located at:

http://oehha.ca.gov/media/downloads/crnr/noncancertsdfinal.pdf

Sections 2.2.1 through 2.2.4 below clarify and highlight some of the exposure assessment procedures including exposure assumptions (e.g., breathing rate and exposure duration) and health effect values to be used for conducting HRAs for gasoline dispensing facilities.

2.2.1 Clarifications of Exposure Assessment Procedures

This section clarifies and highlights some of the exposure assessment procedures that should be followed when conducting an HRA for a gasoline dispensing facility.

2.2.1.1 Breathing Rate

On October 9, 2003, a statewide interim Risk Management Policy for inhalation-based residential cancer risk was adopted by the California Air Resources Board (ARB) and Cal/EPA's OEHHA (http://www.arb.ca.gov/toxics/rmpolicy.pdf). For the HRA methodology used in the Air Toxics NSR Program for gasoline dispensing facilities, the Air District has conformed with these State guidelines and adopted the interim exposure assessment recommendations made by ARB and OEHHA. The Air District will continue to use this interim recommendation for gasoline dispensing facilities even though newer guidance has been adopted by ARB and OEHHA. The interim policy recommended, where a single cancer risk value for a residential receptor is needed or prudent for risk management decision-making, the potential cancer risk estimate for the inhalation exposure pathway be based on the breathing rate representing the 80th percentile value of the breathing rate range of values (302 L/kg-day).

To assess potential inhalation exposure to offsite workers, OEHHA recommended assuming a breathing rate of 149 L/kg-day. This value corresponds to a 70 kg worker breathing 1.3 m^3/hour (breathing rate recommended by USEPA as an hourly average for outdoor workers) for an eight-hour day.

For children, OEHHA recommended assuming a breathing rate of 581 L/kg-day to assess potential risk via the inhalation exposure pathway. This value represents the upper 95% percentile of daily breathing rates for children.

2.2.1.2 Exposure Time and Frequency

Based on OEHHA's 2003 HRA Guidelines, the Air District will estimate cancer risk to residential receptors for gasoline dispensing facilities assuming exposure occurs 24 hours per day for 350 days per year. For a worker receptor, exposure is assumed to occur 8 hours per day for 245 days per year. However, for some professions (e.g., teachers) a different schedule may be more appropriate. For children at school sites, exposure is assumed to occur 10 hours per day for 180 days (or 36 weeks) per year.

2.2.1.3 Exposure Duration

Based on OEHHA's 2003 HRA Guidelines, the Air District will estimate cancer risk to residential receptors for gasoline dispensing facilities based on a 70-year lifetime exposure. Although 9-year and 30-year exposure scenarios may be presented for information purposes, risk management decisions will be made based on 70-year exposure duration for residential receptors. For worker receptors for gasoline dispensing facilities, risk management decisions will be made based on OEHHA's 2003 recommended exposure duration of 40 years. Cancer risk estimates for children at school sites will be calculated based on a 9-year exposure duration.

2.2.2 Health Effects Values

Chemical-specific health effects values have been consolidated and are presented in Regulation 2, Rule 5, Table 2-5-1 Toxic Air Contaminant Trigger Levels for use in conducting HRAs. Toxicity criteria summarized in Table 2-5-1 represent health effects values that were adopted by OEHHA/ARB as of March 31, 2016.

2.2.3 Cancer Risk Calculations

In accordance with OEHHA's revised health risk assessment guidelines (specifically, OEHHA's Technical Support Document (TSD) for Cancer Potency Factors, adopted June 1, 2009), calculation of cancer risk estimates for gasoline dispensing facilities should incorporate age sensitivity factors (ASFs).

The revised TSD for Cancer Potency Factors provides updated calculation procedures used to consider the increased susceptibility of infants and children to carcinogens, as compared to adults. The calculation procedure below includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommended weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. These weighting factors should be applied to all carcinogens emitted from gasoline dispensing facilities. For estimating cancer risk for residential receptors, the incorporation of the ASFs results in a cancer risk adjustment factor of 1.7. For estimating cancer risk for student receptors, an ASF of 3 should be applied. For estimating cancer risk for worker receptors, an ASF of 1 should be applied.

The cancer risk adjustment factors for gasoline dispensing facilities were developed based on the following:

Receptor	Age Groups	ASF	Duration	Cancer Risk Adjustment Factor
Resident	Third trimester to age 2 years	10	2.25/70	0.32
	Age 2 to age 16 years	3	14/70	0.6
	Age 16 to 70 years	1	54/70	0.77
				1.7
Student	Age 2 to age 16 years	3	9 years	***3***
Worker	Age 16 to 70 years	1	40 years	***1***

Since the exposure duration for a student receptor (9 years), and worker receptor (40 years), falls within a single age group, the student cancer risk adjustment factor is 3 and the worker cancer risk adjustment factor is 1.

Cancer risk adjustment factors should be used to calculate all cancer risk estimates for gasoline dispensing facilities.

Below is the equation for calculating cancer risk estimates for gasoline dispensing facilities:

Cancer Risk = Dose * Cancer Risk Adjustment Factor * Cancer Potency Factor

2.2.4 Noncancer Health Impacts

In accordance with OEHHA’s 2003 HRA Guidelines, noncancer health impacts should be calculated using the hazard index approach. Air District HRAs should follow OEHHA’s recommended calculation procedures for noncancer health impacts, as presented in Section 8.3 of OEHHA’s 2003 HRA Guidelines, using the RELs identified in Table 2-5-1.

Regarding Section 8.3.A of OEHHA’s 2003 HRA Guidelines, the Air District does not require inclusion of the contribution of background criteria pollutants to respiratory health effects for Air District HRAs.

3. Assessment of Acrolein Emissions

CARB has issued advisories regarding acrolein emissions data determined using CARB Method 430 (M430): http://www.arb.ca.gov/ei/acrolein.htm. The CARB advisories state that acrolein emissions data determined using CARB Method 430 are suspect and should be flagged as non-quantitative. Although acrolein emission factor data is available for several types of stationary combustion sources, this data was developed based on source tests that utilized CARB Method 430 or equally inaccurate test methods; therefore, the validity of this acrolein emission factor data is suspect. In addition, the tools the Air District needs to implement and enforce acrolein emission limits are not available due to the lack of an ARB approved acrolein test method for stationary sources.

In consideration of this information, the Air District has determined that acrolein emissions may be included in Air District HRAs for screening or informational purposes, but the Air District will exclude acrolein emissions from the final HRA results on which risk management decisions will be based.

References

1 *"Air Toxics "Hot Spots" Program Risk Assessment Guidelines, The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments," OEHHA, August, 2003*

2 *"Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part IV. Technical Support Document for Exposure Assessment and Stochastic Analysis", OEHHA, September, 2000*

3 *"Air Toxics Hot Spots Program Risk Assessment Guideline; Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures", OEHHA, May, 2009*

4 *"Air Toxics Hot Spots Program Risk Assessment Guidelines; Technical Support Document for the Derivation of Noncancer Reference Exposure Levels", OEHHA, June, 2008*

5 *"Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values", California Air Resources Board, updated March 28, 2016*

6 *"Air Toxics Hot Spots Program Risk Assessment Guidelines; Guidance Manual for Preparation of Health Risk Assessments", OEHHA, February, 2015*

7 *"Air Toxics Hot Spots Program Risk Assessment Guidelines; Technical Support Document for Exposure Assessment and Stochastic Analysis", OEHHA, August, 2012*

8 *"Risk Management Guidance for Stationary Sources of Air Toxics", Air Resources Board and California Air Pollution Control Officers Association, July 23, 2015*