Booster Fuels, Inc.

Environmental Benefits of Mobile Refueling

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Section **Page**

List of Tables Page

List of Figures Page

List of Appendices Page

List of Attachments

1.0 EXECUTIVE SUMMARY

Booster Fuels operates a fleet of Mobile Fueling On-Demand (MFOD) gasoline delivery vehicles under a research and development operating permit issued by the South Coast Air Quality Management District (SCAQMD) [(see Attachment 1: Various Locations Permit Application Number 601539, dated April 20, 2018, which provides equipment details)]. Booster Fuel's MFOD operation provides a viable alternative to vehicle re-fueling at conventional retail gasoline service stations with advantages in terms of customer convenience. The MFOD comes to the customer rather than having the customer locate and drive to a retail service station. As explained further below, the MFOD supply chain and delivery procedures also provide for reduced emissions of volatile organic compounds (VOCs) as compared to retail gasoline transfer operations. These VOC reductions derive from the fact that trained professionals use next-generation gas nozzles as well as spill containment, as compared to a largely untrained public that operate "self-service" pumps with associated spillage and top-offs.

This study first quantifies the relative emission benefit of the MFOD dispensing process compared to retail gasoline transfer operations as regulated by the SCAQMD and the California Air Resources Board. Specifically, the VOC emissions associated with the transfer and dispensing of one thousand gallons of gasoline through MFOD gasoline delivery operated by trained staff is compared to the VOC emissions associated with gasoline transfer at retail, self-serve gasoline stations into vehicles equipped with ORVR systems. Based on SCAQMD emission factors, MFOD equipment and Booster Fuels work practices, Booster Fuels' MFOD operations reduce overall VOC emissions by 26 percent when compared to gasoline refueling at a conventional retail gasoline station.

Under the terms of the SCAQMD various locations research permit, no fuel may be dispensed into any motor vehicle that is not equipped with an Onboard Refueling Vapor Recovery (ORVR) system, except for motor vehicles used in emergency response (see condition 16). Condition 16 was imposed to assure compliance with District Rule 461 – *Gasoline Transfer and Dispensing,* which as applied to mobile gasoline fueling trucks, requires vapor recovery that achieves a minimum 95% volumetric efficiency (see Rule 461(c)(1)(C)). Such minimum volumetric control efficiency is achieved where vehicles are equipped with ORVR, as the MFOD is not equipped with Phase II gasoline vapor recovery. However, based on the emissions benefits that derive from the MFOD supply chain and delivery system, a 95% volumetric efficiency can still be achieved when up to 2.4 percent of the total gasoline dispended to vehicles that are *not* equipped with ORVR; i.e., for every 1,000 gallons of gasoline transferred from a Booster Fuels MFOD, 24 gallons of gasoline may be transferred into vehicles that are *not* equipped with ORVR.

2.0 OBJECTIVE

The objective of this technical analysis is two-fold: first, to quantitatively compare volatile organic compound (VOC) emissions that result from traditional gasoline dispensing facilities (GDF) to Booster Fuels MFOD operations. Second, to provide the basis for granting operational flexibility to

Booster Fuel's MFOD to allow for gasoline transfer into vehicles not equipped with ORVR technology.

3.0 METHOD

The South Coast Air Quality Management District has developed emission factors, expressed in terms of pounds of VOC per thousand gallons of gasoline dispensed, for the purposes of estimating VOC emissions from gasoline transfer operations. The District requires that these factors be applied when permitting new or modified gasoline dispensing facilities (GDFs) within the SCAQMD's jurisdiction. The emission factors were developed in part through collaboration with the California Air Resources Board (CARB) and the California Air Pollution Control Officers Association (CAPCOA) and are specific to equipment and gasoline transfer operations (i.e., transfer from a bulk carrier into a underground storage tank, transfer from the underground storage tank into a motor vehicle). The factors are specifically identified in Table 1. VOC emissions from gasoline dispensing are calculated from both a conventional GDF and Booster Fuels MFOD operations. In all cases, the calculations assume a thousand gallons of gasoline are transferred through the fueling process. In all scenarios, emission calculations commence after gasoline is transferred into a fuel tanker or Booster Fuel's trucks from the fuel terminal.

3.1 Traditional Gasoline Dispensing Facility

The VOC emissions from a conventional GDF assume that the GDF is in compliance with SCAQMD Rule 461, which reflects all applicable CARB regulations pertaining to stationary gasoline dispensing operations. The conventional GDF scenario begins with gasoline transfer from a fuel terminal into a tanker truck, after which the gasoline is transferred using Phase I vapor recovery into the GDF's underground storage tank (UST). A Phase I vapor recovery system collects vapors displaced from the UST into a certified leak-free mobile tank associated with the tanker truck.[1] After transfer into the UST, the gasoline is then dispensed using a Phase II vapor recovery system into a motor vehicle fuel tank. The Phase II vapor recovery system allows for capture of 95% of vapors displaced from the customer's fuel tank during motor vehicle refueling[2] (see Figure 1 below).

[1] "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities", California Air Resources Board, December 23, 2013.

[2] Same as [2]

Figure 1: Traditional Supply Chain for GDF[3]

The SCAQMD approved emission factors (EF) for permitting a GDF are shown in Table 1.

Table 1: South Coast AQMD Emission Factors

Emission Source	EF (lbs/kgal)[4]
Loading (Transfer to UST)	0.15
Breathing Losses (from UST)	0.024
Refueling (combined ORVR and non-ORVR vehicles)	0.32
Spillage	0.24
Hose Permeation	0.009

Note that the District has one emission factor for refueling and takes into account the amount of ORVR/non-ORVR vehicles as well as other variations such as the seasonal variations in gasoline RVP.

3.2 Mobile Fueling On Demand

The VOC emissions from Booster Fuels MFOD operations are quantified by estimating emissions at each step in the refueling process as illustrated in Figure 2 below. Gasoline is loaded from the fuel terminal into custom mobile refueling trucks then delivered to the end customer at the customer's location.

Figure 2: Booster Fuels Supply Chain[5]

3.2.1 Mobile Refueling - Scenario 1

For the purposes of this technical analysis, the following emission factors (Table 2) were used for refueling into ORVR and non-ORVR vehicles:

[3] Graphic from Booster Fuels presentation at the 2016 CAPCOA Fall Conference (November 1, 2016).

[4] Emission factors are from the South Coast Air Quality Management District "Risk Assessment Procedures for Rules 1401, 1401.1 and 212", Version 8.1, issued September 1, 2017. Based on telephone conversations with Randy Matsuyama, SCAQMD AQ Engineer II, we confirmed that these emission factors (lb VOC per 1,000 gallons (kgal)) are accepted by the District when issuing permits for new or modified GDF.

[5] Graphic from Booster Fuels presentation at the 2016 CAPCOA Fall Conference (November 1, 2016)

Table 2: Scenario 1 - Booster Fuels Refueling Emission Factors

Emission Sources	EF (lb/kgal)	Emission Factor (EF) Reference
Loading	0	Not applicable. No loading into UST occurs as part of Booster Fuels operation.
Breathing Losses	0	Not applicable. No loading into UST occurs as part of Booster Fuels operation.
Refueling Non-ORVR Vehicles	8.4	EF for GDF without ORVR and without Phase II controls from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.
Refueling ORVR Vehicles	0.42	EF for GDF without Phase II controls from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.
Spillage	0.12	EF from CARB'S CP-207 "Certification Procedure for Enhanced Conventional (ECO) Nozzles and Low Permeation Conventional Hoses for Use at Gasoline Dispensing Facilities", Adopted April 23, 2015.
Hose Permeation	0.009	EF from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.

Note CARB refueling emission factors were used to calculate the emissions from Booster Fuels' operations since the District does not have a separate emission factor for ORVR and non-ORVR vehicles.

3.2.2 Mobile Refueling - Scenario 2

The benefits of Booster Fuels' refueling procedure is not completely captured in Table 2 above, as the spillage emission factor does not take into account refueling performed by trained personnel. Booster Fuels' staff do not "top off" gas tanks. Refueling protocol requires that absorbent pads be placed on the ground directly below the nozzle when refueling. After refueling spent absorbent pads are stored in vapor tight containers and managed as hazardous waste. In an effort to be conservative the emission factor from CARB's CP-207 certification for ECO nozzles was used in Table 2 above. An alternative MFOD scenario is presented in Table 3 where the emission factor for spillage is zero.

Table 3: Scenario 2 - Booster Fuels Refueling Emission Factors

Emission Sources	EF (lb/kgal)	Emission Factor (EF) Reference
Loading	0	Not applicable. No loading into UST occurs as part of Booster Fuels operation.
Breathing Losses	0	Not applicable. No loading into UST occurs as part of Booster Fuels operation.
Refueling Non-ORVR Vehicles	8.4	EF for GDF without ORVR and without Phase II controls from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.
Refueling ORVR Vehicles	0.42	EF for GDF without Phase II controls from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.
Spillage	0	MFOD are equipped with next-generation Eco-nozzle, which limit spillage as compared to traditional Phase II gasoline dispensing nozzles. In addition, Booster Fuels personnel are trained to prevent spills and do not “top off” mobile gas tanks. Refueling protocol requires that absorbent pads be placed on the ground directly below the nozzle. After refueling, all spent absorbent pads are stored in vapor tight containers mounted on the MFOD and managed as hazardous waste.
Hose Permeation	0.009	EF from CARB's Monitoring and Laboratory Division, "Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities" released December 23, 2013.

4.0 ANALYSIS

Applying these VOC emission factors, we now estimate the VOC emissions associated with gasoline refueling quantified assuming 1,000 gallons of gasoline transfer at a retail GDF and separately from a MFOD. When compared, these data illustrate the VOC emission reduction associated with Booster Fuels MFOD operations. For this initial comparison, we assume that 1,000 gallons of gasoline is transferred only into vehicles equipped with ORVR; these VOC emissions data are presented in Table 4 below:

Table 4: VOC Emissions Assuming 100% ORVR Vehicles

	Conventional GDF		MFOD Scenario 1		MFOD Scenario 2	
	Percent Fuel	Emissions (lbs)	Percent Fuel	Emissions (lbs)	Percent Fuel	Emissions (lbs)
Loading (Transfer to UST)	100%	0.15	0%	0.00	0%	0.00
Breathing from UST	100%	0.02	0%	0.00	0%	0.00
Refueling Non-ORVR Vehicles	0%	0	0%	0	0%	0
Refueling ORVR Vehicles	100%	0.32	100%	0.42	100%	0.42
Spillage	100%	0.24	100%	0.12	100%	0.00
Hose Permeation	100%	0.01	100%	0.01	100%	0.01
Total Emissions (lbs)	--	0.74	--	0.55	--	0.43
Emissions Benefit	--	--	--	0.19	--	0.31

In this baseline comparison, it can be seen that the Booster Fuels MFOD operation achieves between 0.19 and 0.31 pound VOC reduction for every 1,000 gallons of gasoline dispensed into vehicles equipped with ORVR, or an overall VOC reduction of 26 to 42 percent.

Based on the research permit issued by the SCAQMD, Booster Fuels may only transfer fuel into vehicles equipped with ORVR (see Condition 16). To provide operational flexibility, the VOC emission calculation as described in Table 4 has been modified in Table 5 and 6 to include a small percentage of gasoline transfer into non-ORVR vehicles such that there is no increase in VOC emissions as compared to the transfer of gasoline at a retail GDF. This emissions analysis was performed for Scenarios 1 and 2 and is provided in Tables 5 and 6. The analysis shows that between 24 and 39 gallons out of 1,000 gallons dispensed may be dispensed by MFOD vehicles into non-ORVR cars and light duty trucks with no increase in VOC emissions when compared to refueling at a retail GDF. Therefore, Condition 16 may be modified to allow for transfer of up to 3.9% of gasoline into vehicles not equipped with ORVR; this will assure continued compliance of MFOD operations with Rule 461 requirements.

Strict regulation would impact the flexibility of Booster Fuels to dispense into gasoline vehicles without ORVR. The result may require Booster Fuels to apply company policies that prevent mobile refueling of fleets that are not completely ORVR. This would limit the environmental benefits of Booster Fuels mobile refueling operation. Potential impacts include: more trips to the gas station, more miles driven for fuel, and increased emissions from refueling vehicles equipped with ORVR at gas stations.

Table 5: VOC Emissions including Refueling Non-ORVR Vehicles Scenario 1

	Conventional GDF		MFOD Scenario 1	
	Percent Fuel	Emissions (lbs/kgal)	Percent Fuel	Emissions (lbs/kgal)
Loading (Transfer to UST)	100%	0.15	0%	0.00
Breathing from UST	100%	0.02	0%	0.00
Refueling Non-ORVR Vehicles	2.4%	0.01	2.4%	0.20
Refueling ORVR Vehicles	97.6%	0.31	97.6%	0.41
Spillage	100%	0.24	100%	0.12
Hose Permeation	100%	0.01	100%	0.01
Total Emissions (lbs)	--	0.74	--	0.74

Note that the same emission factor applies to GDF refueling non-ORVR or ORVR equipped vehicles (see Table 1).

Table 6: VOC Emissions including Refueling Non-ORVR Vehicles Scenario 2

	Conventional GDF		MFOD Scenario 2	
	Percent Fuel	Emissions (lbs/kgal)	Percent Fuel	Emissions (lbs/kgal)
Loading (Transfer to UST)	100%	0.15	0%	0.00
Breathing from UST	100%	0.02	0%	0.00
Refueling Non-ORVR Vehicles	3.9%	0.01	3.9%	0.33
Refueling ORVR Vehicles	96.1%	0.31	96%	0.40
Spillage	100%	0.24	100%	0.00
Hose Permeation	100%	0.01	100%	0.01
Total Emissions (lbs)	--	0.74	--	0.74

Note that the same emission factor applies to GDF refueling non-ORVR or ORVR equipped vehicles (see Table 1).

5.0 QUALITATIVE BENEFITS

In addition to the quantitative benefits of the Booster Fuels' MFOD operations as described in Section 4.0 of this report, there are also qualitative benefits that derive from this innovative technology, which include:

- In general, there is a net increase in the vehicle miles traveled (VMT) in a specified time period due to travel to a conventional GDF for re-fueling. Studies have indicated that when a mobile refueling service is available to a customer, VMT decreases by 1.46[6] per refueling event. This has a net benefit in terms of reduction of tailpipe emissions that include both criteria pollutants, air toxics, and greenhouse gases within the urban environment.

[6] Based on "Traffic Impact Analysis for Booster Fuels" a study performed by Hexagon Transportation Consultants, Inc. on October 25, 2016.

- When requested by a customer, Booster Fuels provides tire inflation services, which improves fuel economy and provides other emission reduction and economic benefits[7].
- Conventional GDF operations require investments in terms of land use relative to a mobile refueling service, which makes this a more attractive option in highly urbanized communities where real estate is a premium commodity. The need for underground storage tanks is eliminated by Booster Fuels' MFOD operation, which prevents the possibility of a leaking storage tank to contaminant soil, ground water or surface waters.
- Re-fueling at conventional GDFs tend to occur during peak travel hours (i.e. as people travel to and from their place of employment) which at times requires that vehicles idle as drivers wait for an open pump station. Utilizing a service like Booster Fuel's MFOD eliminates waiting at the GDF and additional exhaust emissions from vehicle idling. This is a net benefit to the customer and the environment.
- The environmental benefits of Booster Fuels' MFOD operation will increase as the market for mobile refueling increases. Less miles will be driven by company trucks to deliver fuel, which will reduce overall VMT and congestion.

6.0 CONCLUSION

This analysis demonstrates that a mobile refueling service has a net benefit to the environment and the customer. Relative to Booster Fuel's MFOD operations, there is a 26 to 42% VOC emissions reduction relative to conventional GDF operations. Additionally, the analysis confirms that up to 3.9 percent of gasoline can be dispensed from a MFOD into non-ORVR vehicles, and still assure compliance with District Rule 461 and provide commensurate air quality impacts comparable to a conventional GDF.

[7] See *Maintaining Proper Tire Inflation Pressure At Glance at Clean Freight Strategies, 2011,* U.S. Environmental Protection Agency, https://bit.ly/2GDxfFP.

APPENDIX A. EMISSION CALCULATIONS

APPENDIX B. DEFINITIONS AND ACRONYMS

Definitions

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

Hose Permeation Losses – Emissions occur when liquid gasoline or gasoline vapors diffuse through the dispensing hose outer surface to the atmosphere.

Loading Losses– 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.

Onboard Refueling Vapor Recovery (ORVR) – is a vehicle fuel vapor emission control system that captures volatile organic compounds displaced during refueling.

Non-ORVR – is a vehicle not equipped with onboard refueling vapor recovery.

Phase I Vapor Recovery – A vapor recovery system that collects vapors displaced from an UST when a cargo tank truck delivers gasoline to a GDF.

Phase II Vapor Recovery – A vapor recovery system that collects vapors displaced during the transfer of gasoline from a GDF to a vehicle, fuel container, or gasoline-powered equipment; and the storage of gasoline at a GDF.

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

Spillage – Emissions occur from evaporating gasoline that spills during vehicle refueling.

Acronyms

CAPCOA – California Air Pollution Control Officers Association

CARB – California Air Resources Board

EF – Emission Factor

GDF – Gasoline Dispensing Facility

MFOD – Mobile Fueling On-Demand

ORVR – Onboard Refueling Vapor Recovery

RVP – Reid Vapor Pressure

SCAQMD – South Coast Air Quality Management District

UST – Underground Storage Tank

VMT – Vehicle-Miles Traveled

VOC – Volatile Organic Compound

Attachment 1: South Coast AQMD Various Locations Research Permit