Appendix B~~C~~: SIP Credit Calculations

Introduction

Ground Support Equipment Measures

LAWA Alternative Fuel Vehicle Incentive Measure

LAWA Zero Emission Bus Measure

JWA Parking Shuttle Bus Electrification Measure

JWA Jet Fuel Delivery Trucks Measure

Burbank Shuttle Bus Electrification

1. Introduction

Commercial airports are a major part of transportation and economic infrastructure in the South Coast Basin (Basin) but they also contribute to the adverse air quality in the Basin. Non-aircraft mobile source emissions associated with airport operations are covered under the MOUs between the South Coast and the commercial airports. These sources include airport ground support equipment (GSE), shuttles buses, trucks, on-road and off-road airport fleet vehicles, and passenger vehicles. The emissions for these sources are included in their respective aggregate categories in the AQMP's emissions inventories and they are not explicitly identified as airport specific emissions.

For the purpose of the MOUs with South Coast AQMD, the five commercial airports (i.e., LAX, John Wayne Airport, Burbank Airport, Ontario Airport, and Long beach Airport) developed their own Air Quality Improvement Programs (AQIPs) or Air Quality Improvement Measures (AQIM). A suite of measures and initiatives are presented in the airports AQIPs or AQIM aimed at reducing emissions from non-aircraft airport operations. The specific AQIP or AQIM measures that are potentially eligible for SIP credit are identified in the MOUs with the five commercial airports, as indicated in Chapter 4. These measures cover GSE, heavy-duty vehicles and trucks, and shuttle buses. This appendix describes how SIP creditable emissions reductions are estimated from the specific AQIP or AQIM measures covered under the MOUs, as indicated in the following sections.

2. Ground Support Equipment Measures

The GSE emissions inventory included in the 2016 AQMP reflects regulations adopted as of November 2015. Specific regulations affecting GSE are described in Chapter 1, Regulatory Background section. The CARB's OFFROAD emissions model (and corresponding emission factors), which the AQMP's GSE emissions are based on, reflect the full implementation of CARB's existing regulations.

CARB began efforts in reducing emissions from GSE with an MOU with commercial airlines operating in the five commercial airports in the South Coast AQMD in 2002 (GSE MOU, https://ww3.arb.ca.gov/msprog/offroad/gse/gse-mou-final.pdf). The GSE MOU included provisions for the early introduction of clean units, with requirements for a 2.65 grams per brake-horsepower hour HC+NOx fleet average in the Basin by December 31, 2010. Other major provisions included the introduction of electric or zero-emission vehicles into the fleet and the use of diesel oxidation catalysts and diesel particulate filters to significantly reduce particulate matter emissions from the diesel portion of the fleet. Although the GSE MOU expired on January 1, 2006, its adoption resulted in an earlier start in reducing GSE emissions in the Basin than the rest of the state and generally cleaner GSE fleets in the South Coast AQMD airports compared to the statewide averages. Currently, GSE emissions are covered under several regulations administered by CARB targeting in-use GSE fleets. Those programs include in-use off-road diesel vehicle rule (https://ww2.arb.ca.gov/our-work/topics/construction-earthmovingequipment), off-road large spark-ignition (gasoline and LPG) equipment (https://ww3.arb.ca.gov/msprog/offroad/orspark/orspark.htm) and new off-road compression-ignition (diesel) engines and equipment (https://ww3.arb.ca.gov/msprog/offroad/orcomp/orcomp.htm)

The OFFROAD model used in developing the GSE emissions in the 2016 AQMP utilizes equipment registration data from the CARB off-road in-use regulations. Statewide equipment population, model year distributions, fuel types, horse-power rating combined with equipment use characteristics, such as annual operating hours and load factors were used to estimate statewide emissions. The statewide emissions are allocated to each county in the state based on the commercial aircraft operations in each county. Future year emissions were projected with growth factors combined with fleet averaged emissions factor requirements in the regulations. Table C-1 presents the GSE NOx emissions in the Basin in the 2016 AQMP in tons per year (tpy). The emissions are shown for the base year (2017) and future milestone years (2023 and 2031) consistent with the airports AQIP/AQIM base year and future years emissions inventories. Table C-2 presents the 2016 AQMP GSE emissions in the Basin by fuel type (i.e., diesel, gasoline, natural gas, and LPG). As shown in Table C-2, NOx emissions are mostly from diesel powered equipment.

The 2016 AQMP emissions inventory did not assign the GSE emissions to specific airports but, for the purpose of MOUs, assumptions were made to allocate the county level emissions to each commercial airport. Since there is only one commercial airport each in the Orange and San Bernardino Counties, the county level GSE emissions were assigned to the respective airports. For the three airports in the Los Angeles County (LAX, Burbank, Long Beach airports), the Federal Aviation Administration (FAA) terminal area forecast data (https://taf.faa.gov/) for the commercial aircraft operations was used to split the Los Angeles (LA) County GSE emissions among these three airports. Table C-3 presents the percentages of commercial aircraft operations among the three airports in LA County. The resulting airport specific GSE emissions by fuel type are presented in Table C-4. The future emissions inventories show significant declining trend due to the impact of existing regulations.

Table C-1. 2016 AQMP GSE NOx Emissions in the Basin (TPY)

Category	2017	2023	2031
Air Conditioner	6.05	1.85	1.11
Air Stand	32.04	16.62	6.49
Aircraft Tug	50.45	27.78	15.46
Baggage	51.84	24.98	19.80
Belt Loader	13.04	8.93	7.77
Bobtail	3.89	2.69	2.09
Cargo Loader	18.08	9.14	7.44
Cargo Truck	88.27	39.61	28.84
Cart	0.02	0.02	0.03
Catering Truck	20.48	9.32	4.42
Deicer	0.06	0.02	0.01
Forklift	14.80	9.82	5.84
Fuel Truck	1.76	0.84	0.32
Generator	136.79	69.52	26.96
Ground Power	93.94	48.93	18.37
Hydrant Truck	20.29	9.84	4.63
Lavatory Cart	0.02	0.02	0.02
Lavatory Truck	3.12	1.64	1.27
Lift	11.74	5.42	3.46
Maintenance. Truck	4.22	1.65	0.99
Other-C4	10.66	10.39	4.56
Other-GSE	44.81	23.75	18.95
Passenger Stand	2.39	1.08	0.53
Service Truck	28.58	13.10	6.28
Sweeper	0.68	0.42	0.28
Water Truck	0.42	0.18	0.07
All GSE	658.41	337.54	185.97

Table C-2. 2016 AQMP GSE NOx Emissions in the Basin by Fuel Type (TPY)

Fuel	2017	2023	2031
Natural Gas/LPG	35.31	22.50	10.68
Gasoline	171.97	87.70	59.18
Diesel	451.13	227.34	116.11
All Fuels	658.41	337.54	185.97

Table C-3. Commercial Aircraft Operations in the Los Angeles County *

Airport	2017		2023		2031	
LAX	681,578	(86.1%)	747,746	(85.7%)	872,191	(86.3%)
BUR	68,806	(8.7%)	83,472	(9.6%)	92,241	(9.1%)
LGB	41,102	(5.2%)	41,203	(4.7%)	45,652	(4.5%)
Total	791,486	(100.0%)	872,424	(100.0%)	1,010,084	(100.0%)

*Based on FAA Terminal Area Forecast, September, 2019**.** Percentage of each airport shown with respect to county total.

Table C-4. GSE NOx Emissions by Airport Based on 2016 AQMP (TPY)

Airport	2017				2023				2031			
	Diesel	**Gasoline**	**NG/LPG**	**Total**	**Diesel**	**Gasoline**	**NG/LPG**	**Total**	**Diesel**	**Gasoline**	**NG/LPG**	**Total**
LAX	319.7	126.7	25.9	472.3	160.4	64.2	16.4	241.0	82.6	43.7	7.8	134.1
BUR	32.3	12.8	2.6	47.7	18.0	7.2	1.8	27.0	8.7	4.6	0.8	14.1
LGB	19.3	7.7	1.6	28.5	8.8	3.5	0.9	13.2	4.3	2.3	0.4	7.0
SNA	35.3	10.8	2.3	48.4	17.8	5.6	1.5	24.8	9.1	3.7	0.7	13.5
ONT	44.5	14.0	3.0	61.4	22.4	7.2	1.9	31.5	11.4	4.9	0.9	17.2
Total	451.1	172.0	35.3	658.4	227.3	87.7	22.5	337.5	116.1	59.2	10.7	186.0

During the AQIP/AQIM development process, the airport authorities collected information on GSE equipment operated in their respective airports for 2017 and provided emissions inventories using the methodology employed to develop the 2016 AQMP inventories. The airport specific inventories for the 2017 and future year Business-As-Usual (BAU) scenarios showed lower emissions than the AQMP inventories due to high penetration of electric equipment in the airports located in the basin (except for Ontario Airport).

All five commercial airports have included a GSE measure in their AQIPs/AQIM and have committed to reduce emissions from GSE by achieving specific GSE performance targets for their GSE fleets. Table C-5 lists the GSE performance targets for the five airports. The performance targets reflect the unique mix of GSE fleet at each airport. The airports provided their estimates of future BAU emissions before implementation of their GSE measures, emission reductions from implementation of their GSE measures based on their respective performance targets (compared to BAU), and the remaining GSE emissions in 2023 and 2031, as shown in Tables C-6a and C-6b. Since the information on airport specific operating hours of each piece of GSE may not be available, the statewide average operating hours for each class of GSE from the OFFROAD model are used in estimating GSE emissions in all airports.

The potential SIP credits from the GSE measures for all airports except ONT are calculated based on the differences between the AQMP inventory and AQIP/AQIM emissions given in Tables C-6a and C-6b, since the same methodologies were used for calculating emissions in the AQMP and in the AQIP/AQIM. For the Ontario airport, the potential SIP credits are calculated by applying the percent reduction between BAU emissions and AQIP emissions to the AQMP emissions. The Ontario airport is the only exception in that its AQIP specific GSE emissions inventory is higher than the AQMP apportioned emissions from statewide emissions inventory. The Ontario airport has shown a wide range of growth and decline in aircraft operations in the past decades~~...~~. From 1990 through 2004, there were about 120,000 commercial aircraft operations annually in ONT. Starting on 2005, operations in ONT steadily decreased for almost a decade. There were 118,345 and 67,123 commercial operations in 2005 and 2014, respectively, and those started increasing in 2015. The number of operations in ONT in 2017 was 78,866. This fluctuation may have led to a larger number of GSE to accommodate its peak level aircraft operations over the last 10 years. The higher number of GSE in combination with the statewide average operating hours might have caused the overestimation of GSE emissions for ONT.

Table C-5. GSE Performance Targets by Airport
(NO_x ~~or HC + NOx~~ g/bhp-hr)

Airport	2023	2031
~~LAX~~LAX[1]	1.8	1.0
BUR	1.~~92~~66	0.~~82~~74
LGB	0.93	0.44
SNA	1.7	0.9
ONT	2.2	1.0

[1] LAX uses a hydrocarbons + NOx combined emission factor.

Table C-6a~~,~~. 2023 NOx Emissions Benefits for GSE Measures (TPY)

Airport	BAU Emissions	AQIP Reductions	AQIP Emissions	AQMP Emissions	SIP Credits
LAX	150.69	56.17	94.32	241.03	146.71
BUR	17.46	0.65	16.81	27.00	10.19
LGB	13.23	0.93	12.30	13.22	0.92
SNA	15.07	4.80	10.27	24.80	14.53
ONT	91.10	22.66	68.44	31.49	7.83
Total					180.16

Table C-6b. 2031 NOx Emissions Benefits for GSE Measures (TPY)

Airport	BAU Emissions	AQIP Reductions	AQIP Emissions	AQMP Emissions	SIP Credits
LAX	121.31	86.16	35.15	134.09	98.94
BUR	16.72	8.65	8.07	14.14	6.07
LGB	10.54	4.04	6.50	6.99	0.49
SNA	9.98	3.92	6.06	13.52	7.46
ONT	79.84	46.03	33.81	17.22	9.93
Total					122.90

3. LAWA Alternative Fuel Vehicle Incentive Measure

Under its AQIM, LAWA has allocated $500,000 to incentivize replacement of 23 heavy duty vehicles/trucks with near zero emission (0.02 g/bhp-hr NOx standard) vehicles/trucks. The program is scheduled to be completed by 2021. LAWA has already selected 23 vehicles for awarding the incentive funding. The model years for the 23 vehicles range from 1999 to 2016, with GVWR of 14001 pounds or more, fueled with diesel, gasoline and natural gas, and with the combined total VMTs of 588,335 miles annually.

The emissions for the 23 existing vehicles (to be replaced) was estimated ~~using their~~assuming they are 2020 model~~-~~ year ~~and GVWR specific emission factors from EMFAC2014. By 2023, older~~ vehicles~~ among~~ /trucks as baseline for the ~~23 vehicles would need to be replaced with newer model year vehicles to comply with the existing regulations. Assuming 2022 model year replacement vehicles, the~~purpose of SIP credit calculation. The projected emissions for these vehicles were estimated to be 0.~~91~~51 tons per year in 2023 and ~~1.55~~0.77 tons per year in 2031 based on ~~EMFAC~~EMFAC2104 emission factors for ~~corresponding model years and vehicle classes~~2020 model year vehicles/trucks for LA County and the VMTs provided by LAWA.

For each vehicle category, total NOx emissions were divided by total VMTs to obtain g/mile emission factors. These emission factors multiplied by annual VMT for each vehicle would yield annual emissions for each vehicle/truck. Refer to Attachment A for more details. The remaining emissions for the new near-zero emissions were calculated based on the CARBCARB's Carl Moyer program guidelines (https://ww3.arb.ca.gov/msprog/moyer/guidelines/2017gl/2017_gl_appendix_d.pdf), which provide the near-zero vehicles NOx emission factors of 0.10 g/mile and 0.18 g/mile for vehicles with 14,001-33,000 pounds, and over 33,000 pounds GVWR, respectively. Deterioration rates are assumed to be of 0.005 g/mile per 10,000 miles for vehicles 14,001-33,000 pounds of GVWR and 0.004 for vehicles over 33,000 pounds of GVWR, respectively. Applying these emission factors and vehicles' respective annual miles, assuming they are in operation for 3.5 years by 2023 and 11.5 years by 2031, the 23 new vehicles would emit 0.12 and 0.25 tons of NOx annually in total in 2023 and 2031, respectively.

As a result, the potential SIP credit for the NOx emission reductions is expected to be 0.7839 tons per year in 2023 and 1.30 tons0.52tons per year in 2031, with an average emission reduction rate of 1.210.60 g/mile in 2023 and 2.220.80 g/mile in 2031. The emission calculations are summarized in Table C-7.

Table C-7. NOx Emissions Benefits for LAWA Alternative Fuel Vehicle Incentive Measure

	2023	2031
Total annual VMTs for replaced vehicles (million)	0.59	0.59
Emissions of existing vehicles (TPY)	0.2951	0.4577
Emissions of new near-zero vehicles (TPY)	0.12	0.25
SIP credits (TPY)	0.1739	0.2152

4. LAWA Zero Emission Bus Measure

LAWA's Clean Fleet Program – Zero-Emission Bus Program targets LAWA's own bus fleet to be 20% of zero emission vehicles by 2023 and 100% by 2031. LAWA's bus fleet accumulates 3.25 million miles annually. With the implementation of the program, it will eliminate exhaust emissions equivalent to 0.65 million miles of conventional buses in 2023 and 3.25 million miles in 2031. In the 2016 AQMP inventory, the urban bus emissions from the Basin portion of the Los Angeles County are 5.12 and 1.68, tons per day for 2023 and 2031, respectively and the corresponding VMTs are 514,000 and 431,000, respectively. The fleet average emission factors, defined as bus emissions divided by VMTs, are 8.95 g/mile and 3.49 g/mile, respectively for 2023 and 2031 using EMFAC 2014. Applying the average emission factor to the LAWA's shuttle bus VMT, the resulting SIP creditable emission reductions are 6.4 and 12.5 TPY for 2023 and 2031, respectively. In June, 2019, CARB adopted the Zero-Emission Airport Shuttle Regulation which requires airport shuttle fleets to be 33% zero-emissions by December 31, 2027 and 66% zero-emissions by December 2031. Taking this regulatory development into account, the SIP creditable emission reductions for 2031 should be adjusted by a factor of 0.67. Table C-8 summarizes this information and the corresponding emission benefits for this measure. The SIP creditable emission reductions are much higher than the estimates in LAWA's AQIM measure since the AQIM emissions were based on EMFAC 2017, while the 2016 AQMP was based on EMFAC 2014. The EMFAC 2017 introduced significant updates on urban bus emissions which resulted in lower emissions than its precedent EMFAC2014.

Table C-8. NOx Emissions Benefits for LAWA Zero Emission Bus Program

	2023	2031
Urban bus emissions for LA County in 2016 AQMP (tons per day)	5.12	1.68
Daily urban bus VMTs in LA County in 2016 AQMP (miles/day)	514,000	431,000
LA County urban bus emission factor in 2016 AQMP (g/mile)	8.95	3.49
Airport's bus fleet total annual VMT (million miles/year)	3.25	3.25
Annual VMT affected by the AQIM measure (million miles/year)	0.65	3.25
SIP Credits (TPY)	6.40	~~12.50~~8.25

5. JWA Parking Shuttle Bus Electrification Measure

JWA is operating a fleet of 12 shuttle buses and is proposing to convert ~~6~~a minimum of 50% of the buses to electric by 2023 and ~~10~~a minimum of 80% of the buses to electric by 2031.The estimated annual mileages for the bus fleet are 0.65 million in 2023 and 0.69 million in 2031.

Implementation of this measure will eliminate exhaust emissions equivalent to 0.33 million miles of conventional bus in 2023 and 0.57 million miles in 2031. In the 2016 AQMP inventory, the urban bus emissions from Orange County are 0.52 and 0.23 tons/day in 2023 and 2031, respectively. The corresponding VMTs are 126,000 and 124,000, respectively, which lead to the average NOx emission factor for the urban buses to be 3.74 g/mile and 1.68 g/mile in 2023 and 2031, respectively. Note this is based on EMFAC 2014, which was the platform to estimate on-road mobile source emissions in the 2016 AQMP. The resulting SIP creditable emission reductions are 1.34 and 1.06 TPY for 2023 and 2031, respectively. The SIP creditable emission reduction for 2031 needs to be adjusted due to the zero emission airport shuttle regulation with an adjustment factor of 0.60. Table C-9 summarizes this information and the corresponding emission benefits for this measure. The potential SIP creditable emission reductions are higher than the JWA estimate of the AQIP benefit because the AQIP benefit was developed based on EMFAC 2017, which has lower emission rates for urban buses than EMFAC 2014.

Table C-9. NOx Emissions Benefits for JWA Parking Shuttle Bus Electrification

	2023	2031
Urban bus emissions for Orange County in 2016 AQMP (tons per day)	0.52	0.23
Daily urban bus VMTs in Orange County in 2016 AQMP (miles/day)	126,000	124,000
Orange County urban bus emission factor (g/mile)	3.74	1.68
Airport's bus fleet total annual VMT (million miles/year)	0.65	0.69
Annual VMT affected by AQIP measure (million miles/year)	0.33	0.57
SIP Credits (tpy)	1.34	~~1.06~~0.64

6. JWA Jet Fuel Delivery Trucks Measure

JWA's Jet Fuel Delivery Trucks measure proposes to eliminate commercial jet fuel delivery trucks by installing a jet fuel pipeline. The construction is expected to be completed by the end of 2019, which will eliminate commercial aviation jet fuel delivery trucks from tank farms near the refineries to the airport. The project is expected to be fully operational by 2023. The eliminated heavy duty diesel truck (HHDT) VMTs are estimated at 633,632 annually for both 2023 and 2031. In the 2016 AQMP inventory, the Orange County HHDT NOx emissions are 2.74 and 2.64

tons per day for 2023 and 2031, respectively, with corresponding VMTs of 1,138,000 and 1,477,000. The SIP creditable emission factors are 2.18 and 1.62 g/mile for 2023 and 2031, respectively using EMFAC 2014. The resulting potential SIP creditable emission reductions are 1.52 and 1.13 TPY for 2023 and 2031, respectively, as shown in Table C-10.

Table C-10. NOx Emissions Benefits for JWA Jet Fuel Delivery Truck Measure

	2023	2031
HHDT NOx in Orange County in 2016 AQMP (tons per day)	2.72	2.64
HHDT daily VMT in Orange County in 2016 AQMP (miles/day)	1,138,000	1,477,000
Orange County HHDT emission factor (g/mile)	2.18	1.62
Airport's Fuel trucks total annual VMT (million miles/year)	0.63	0.63
Annual VMT Affected by AQIP measure (million miles/year)	0.63	0.63
SIP Credits (tpy)	1.52	1.13

7. Burbank Shuttle Bus Electrification

The Burbank airport operates a fleet of 13 passenger vans. It's estimated that the fleet accumulates 1.3 million miles annually. The airport is proposing to electrify 50% of its fleet by 2023 and 100 % by 2031. The emissions for this fleet are estimated using medium duty vehicle (MDV) emission factors. The measure would eliminate 0.65 million miles MDV NOx emissions in 2023 and 1.3 million miles in 2031. In the 2016 AQMP, the Los Angeles County MDV emissions are 4.39 and 2.01 tons per day for 2023 and 2031, respectively, with corresponding daily VMTs of 26,730 and 25,308. The SIP creditable emission factors are 0.15 and 0.07 g/mile for 2023 and 2031, respectively using EMFAC 2014. The resulting potential SIP creditable emission reductions are 0.11 and 0.10 TPY for 2023 and 2031, respectively, as shown in Table C-11. The SIP creditable emission reduction for 2031 needs to be adjusted due to the zero emission airport shuttle regulation with an adjustment factor of 0.67.

Table C-11. NOx Emissions Benefits for Burbank Airport Shuttle Electrification

	2023	2031
MDV NOx in LA County in 2016 AQMP (tons per day)	4.39	2.01
MDV daily VMT in LA County in 2016 AQMP (miles/day)	26,730	25,308
LA County MDV emission factor (g/mile)	0.15	0.07
Airport's shuttle fleet annual VMT (million miles/year)	1.30	1.30
Annual VMT Affected by AQIP measure (million miles/year)	0.65	1.30
SIP Credits (tpy)	0.11	0.~~10~~07

Attachment A

Methodology for Calculating Emission Reductions Achieved from the AQIP/AQIM Measures Specified in the MOUs with Commercial Airports

Under the MOUs with the five commercial airports, beginning in June 2021, the airports will provide annual reports to the South Coast AQMD on their progress in implementing the SIP creditable AQIP/AQIM measures specified in the MOUs. The annual reports will provide detailed equipment/vehicle data as well as annual emissions inventories for these measures. This attachment provides a description of methodologies for calculating emission reductions achieved based on the reported data from the airports and supplemental information provided by South Coast AQMD to calculate SIP credits.

A) GSE Measures

Annually, the airports will provide a list of GSEs subject to GSE measures to South Coast AQMD. The reported data will include equipment type, fuel type, engine model year, power rating, engine tier level, and activity data (annual operating hours) as specified in the MOUs. From the reported data, annual emissions will be calculated for each piece of equipment using the corresponding emission factors and load factors from the CARB's OFFROAD model. The summation of emissions from all reported GSEs from all airports will represent the emissions associated with the implementation of all GSE measures for all five airports each year. The difference between the 2016 AQMP inventory and the total GSE emissions calculated for all five airports would show the progress towards meeting the SIP credit associated with the GSE measures for 2023 and 2031. This 2016 AQMP GSE emissions inventory from 2020 to 2031 is shown in Table 1. In this table, the summer planning inventory values are presented. For GSE NOx emissions, the summer planning and annual average inventory values are the same.

Table 1. NOx Emissions from Airport Ground Support Equipment in 2016 AQMP Summer Planning Inventory (tons per day)

Year	NOx Emissions	Year	NOx Emissions
2020	1.287	2026	0.707
2021	1.152	2027	0.653
2022	1.027	2028	0.608
2023	0.925	2029	0.556
2024	0.842	2030	0.536
2025	0.769	2031	0.510

Emissions from an individual piece of GSE can be calculated using the following equation:

$$E_i = EF_i \times HP_i \times LF_i \times A_i \times U$$

Where:

E_i is mass emissions in any desired unit for equipment *i*

EF_i is emission factor in gram per brake-horse power hour for equipment *i*

HP_i is the equipment's horse power rating.

LF_i is the equipment's load factor (from CARB's OFFROAD model)

Ai is the equipment's annual operating hour.

U is a unit conversion factor for the desired mass emission unit.

Emission factor can be calculated using the following equation:

$EF_i = [EF_{zh} + (DR \times Accumulated\ Hours)] \times FCF$

Where:

EF_{zh} = Zero-hour emission factor in gram per brake-horse power hour for equipment *i* (from CARB's OFFROAD model)

DR = Deterioration rate (from CARB's OFFROAD model)

Accumulated Hours = Annual Hours x Age of Equipment (capped at 12,000 hours)

FCF = Fuel Correction Factor (from CARB's OFFROAD model).

Detailed information can be found in the following links to CARB's websites: https://ww3.arb.ca.gov/regact/2010/offroadlsi10/offroadappd.pdf and https://ww3.arb.ca.gov/msei/ordiesel/ordas_ef_fcf_2017_v7.xlsx

Example:

Calendar Year: 2022
Equipment Type: Diesel-Powered Aircraft Tug
Model Year: 2003
Engine Size: 265 horsepower (hp)
Annual Operating Hour: 301 hours/year
NOx EF_{zh} = 5.53 g/hp-hr
DR = 0.0001
FCF = 0.93
NOx Emission Factor EF_i = [5.53 + (0.0001 x 20 x 301)] x 0.93 = 5.70 g/hp-hr
Load Factor = 0.54
E_i (NOx Emissions) = 5.7 g/hp-hr x 0.54 x 265 hp x 301 hours/year = 245,517 g/year
It can be expressed as 0.27 tons/year, or 1.48 pounds/day

B) LAWA Alternative Fuel Vehicle Incentive Measure

LAWA will provide data for replaced trucks/vehicles and replacement trucks/vehicles including vehicle type, model year and annual mileage. The NOx emission factors in gram/mile for the replaced vehicles should be obtained from EMFAC2014 for the Los Angeles County. The emission factors of the replacement vehicles with specific engine model year and emission standard can be found from Tables D-1 and D-2 of the CARB Carl

Moyer Program Guideline at
(https://ww3.arb.ca.gov/msprog/moyer/guidelines/2017gl/2017_gl_appendix_d.pdf).

For example, for a Medium-Heavy Duty low-NOx replacement truck (14,001 – 33,000 lbs GVWR) meeting the 0.02 g/bhp-hr standard, its emission factor is 0.10 gram/mile with a deterioration rate of 0.005 g/mile per 10,000 miles. For a Heavy-Heavy Duty low-NOx replacement truck with GVWR greater than 33,000 lbs meeting the same standard, its emission factor would be 0.18 g/mile with a deterioration rate of 0.004 g/mile per 10,000 miles. The emission reduction for each replacement truck/vehicle can be calculated based on the following equation:

$E_i = \Delta EF_i \times VMT_i \times U$

Where:

E_i is mass emissions in any desired unit for replacement truck/vehicle i

ΔEF_i is the difference between the emission factors for the replaced and replacement vehicles, in gram/mile

VMT_i is annual VMT of the replacement vehicle (assume the same VMT for both replaced and replacement vehicles)

U is a unit conversion factor for the desired mass emission unit.

Example:

Replaced Truck: Medium-Heavy Duty Diesel Truck
Model Year: 2000
Vehicle Type: T6 Instate Heavy, Diesel
Replacement Year: 2020
Annual VMT: 17,255 miles/year
NOx EF: NOx Emissions / VMT
NOx Emissions in Los Angeles County: 22,012 gram (EMFAC 2014 2020 model year, T6 Instate Heavy category)
VMT in Los Angeles County: 27,861 miles (EMFAC2014 2020 model year, T6 Instate Heavy category)
NOx Emission Factor: 22,012/27,861 = 0.79 g/mile,

Replacement Truck: Near-Zero CNG truck that meets the 0.02 g/bhp-hr standard.
Model Year: 2020
Vehicle Type: T6 Instate Heavy, Diesel
Annual VMT: 17,255 miles/year
NOx Emission Factor: 0.1 g/mile + (0.005 g/mile x 1.0 year x 17,255 mile/year /10,000) = 0.109 g/mile
Emission Factor Difference: ΔEFi: 0.79 – 0.109 = 0.68 g/mile
Emission Reductions: 0.68 g/mile x 17,255 miles/year = 11,750 g/year or 0.013 ton/year

C) Shuttle Bus Electrification Measures

For the MOU measures for shuttle bus electrification, the emission reductions can be calculated as:

$E = EF \times VMT \times U$

Where

E is mass emissions in any desired unit

EF is EMFAC2014 emission factor in gram/mile. NOx emission factor is calculated by dividing total NOx emissions (County/vehicle specific) by the VMT of the corresponding vehicles (e.g., urban buses)

VMT is annual vehicle miles impacted by the MOU measures

U is a unit conversion factor for the desired mass emission unit.

Example:

Replacement Year: 2023, JWA Shuttle Buses
Fleet Information Base: Orange County, urban bus
Orange County Urban Bus NOx Emissions from EMFAC2014: 0.52 tons/day
Orange County Urban Bus VMT from EMFAC2014: 126,000 miles/day
NOx Emission Factor: 0.52 ton/day / 126,000 miles/day x 907184 g/ton = 3.74 g/mile
Annual VMT of the JWA Shuttle Bus Fleet: 649,000 miles/year
Electric Shuttle Bus Fleet VMT: 0.5 x 649,000 miles = 324,500 miles
Annual Emission Reduction: 3.74 g/mile x 324,500 miles/year =1,213,630 g/year or 1.34 tons/year.

D) JWA Jet Fuel Delivery Trucks Measure

For the JWA jet fuel delivery trucks measure, the emission reductions can be calculated as:

$E = EF \times VMT \times U$

Where

E is mass emissions in any desired unit

EF is EMFAC2014 emission factor in gram/mile. NOx emission factor is calculated by dividing total NOx emissions from the Orange County Heavy-Heavy Duty diesel trucks by the corresponding VMT

VMT is annual vehicle miles impacted by the MOU measure

U is a unit conversion factor for the desired mass emission unit.

Example:

Benefit Year: 2023
Fleet Information Base: Orange County, Heavy-Heavy Duty Diesel Truck (HHDT)
Orange County HHDT NOx Emissions from EMFAC2014: 2.74 tons/day
Orange County HHDT VMT from EMFAC2014: 1,138,000 miles/day
NOx Emission Factor: 2.74 ton/day / 1,138,000 miles/day x 907184 g/ton = 2.18 g/mile
Annual VMT of the JWA Fuel Delivery Trucks: 633,632 miles/year
Eliminated Fuel Delivery Truck VMT by the Measure: 633,632 miles/year
Annual Emission Reduction: 2.18 g/mile x 633,632 miles/year = 1,381,318 g/year or 1.52 tons/year.