Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman, Quezon City 1116
Tel.Nos. (632)927-1517; 928-3725; Fax No.(632)920-2258
Website: www.emb.gov.ph Email: recordsco@emb.gov.ph

EMB MEMORANDUM CIRCULAR
No. 2021 - ____

SUBJECT : **GUIDELINES ON THE CALCULATION OF MOTOR VEHICLE EMISSIONS FOR THE CONDUCT OF EMISSIONS INVENTORY**

Pursuant to Republic Act No. 8749 also known as "*Philippine Clean Air Act of 1999"* and its Implementing Rules and Regulations under Department Administrative Order 2000-81, Part V, Rule XIV, Section 2 which mandates the Bureau to make an inventory of emissions from stationary, mobile and area sources within three (3) years from the date of effectivity of these Rules, and every three (3) years thereafter, the attached calculation for the Total Motor Vehicle Emissions is hereby adopted, subject to the following guidelines:

SECTION 1. OBJECTIVES

The issuance of this Memorandum Circular (MC) aims to:

(a) Provide guidelines on the estimation of emission contributions from Mobile Sources of Air Pollution;

(b) Provide localized Running Emission Factor for Mobile Sources utilizing the actual Emission Test Results from previously released approved Certificate of Conformity (COC);

(c) Assess the estimated annual mass emissions from motor vehicles; and

(d) Come up with the appropriate strategies for air quality management

SECTION 2. SCOPE

This Circular shall apply to all Mobile Sources of Air Pollution within the coverage of RA 8749.

SECTION 3. DEFINITION OF TERMS

(a) Certificate of Conformity (COC) - the Certificate issued by the DENR through the EMB toa vehicle manufacturer/assembler or importer certifying that a particularly new vehicle or vehicle type meets the requirements provided under RA 8749 and its Implementing Rules and Regulations;

(b) Compression Ignition Engine - an internal combustion engine in which atomized fuel temperature is raised through compression, resulting to an ignition, e.g. diesel engines;

(c) Diurnal Emission - associated with daily temperature change, vaporization and expansion of fuel vapor, a type of evaporative emission;

(d) Emissions - any measurable air contaminant, pollutant, gas stream or unwanted sound from a known source is passed into the atmosphere;

(e) Emission Factor - serves as a tool in conducting emission inventories used in quantifying and identifying the extent of air pollution emitted by a certain source;

(f) European Emission Standards - set of requirements defining the acceptable limits for exhaust emissions of new vehicles sold in EU member states. The standards are defined in a series of European Union Directives staging the progressive introduction of increasingly stringent standards;

(g) Evaporative Emissions – Occurs particularly in Gasoline-fueled Vehicles which is a non-tail pipe emission composed of hydrocarbons as a result of adding the Hot Soak, Diurnal and Evaporative running loses;

(h) Hot Soak Emission - vapors emitted when engine is turned off;

(i) Imported Used Vehicle - any imported used motor vehicle allowed by law;

(j) In-use Vehicle - any motor vehicle previously registered with the LTO;

(k) M / Passenger Vehicle Category - motor vehicles with at least four (4) wheels designed and constructed for the carriage of passengers;

(l) M1 Passenger Vehicle Category / M1 Vehicles- refers to the vehicles used for the carriage of passengers and comprising not more than eight (8) seats in addition to the driver's seat;

(m) M2, M3, N2, N3 / Heavy Duty Vehicle Category - motor vehicles whose gross vehicle weights are greater than 3,500 kilograms;

(n) Moped (L1) – a two-wheeled vehicle with an engine cylinder capacity in the case of a thermic engine *not* exceeding 50 cubic centimeter and whatever the means of propulsion a maximum design speed *not* exceeding 50km/h;

(o) Motorcycle (L3) – a two-wheeled vehicle with an engine cylinder capacity in the case of a thermic engine exceeding 50 cubic centimeter and whatever the means of propulsion a maximum design speed exceeding 50km/h;

(p) Motorcycle (L4) – a vehicle with three-wheels asymmetrically arranged in relation to the longitudinal media plane with an engine cylinder capacity in the case of a thermic engine exceeding 50 cubic centimeter and whatever the means of propulsion a maximum design speed exceeding 50km/h (motorcycles with side cars or tricycles);

(q) Motor Vehicle - any vehicle propelled by a gasoline or diesel engine or by any means other than human or animal power constructed and operated principally for the conveyance of a person or the transportation of goods;

(r) Motor Vehicle Cold Start Emission – air pollutants produced during the first 60 seconds or so after ignition which continue to represent the most toxic segment of the engine operating cycle since catalysts don't reach full efficiency until the engine exhaust gas heats up the catalyst to the high temperatures at which catalytic reactions are initiated within a catalytic converter;

(s) Motor Vehicle Hot Start Emission – air pollution produced when both engine and catalytic converter are near operating temperatures. A hot start thus requires that the previous trip be at least four (4) minutes long and soak length be no more than 45 minutes, after which the catalytic converter has cooled considerably since catalytic converters require extremely high temperatures to operate at intended efficiency, so they drop below their optimal temperatures much more quickly than the engines;

(t) N / Light Duty Vehicle Category - motor vehicles with at least four (4) wheels designed and constructed for the carriage of goods;

(u) N1 Light Duty Vehicle Category / N1 Vehicles - motor vehicles whose gross vehicles weights are equal to or less than 3,500 kilograms. This also refers to "Light Commercial Vehicles";

(v) Reference Mass (RW) - the mass of the vehicle in running order less the uniform mass of the driver of 75 kg and increased by a uniform mass of 100 kg;

(w) Type Approval - the official ratification of the compliance of a vehicle type with applicable national or international regulations;

(x) UN ECE Vehicle Regulation – one of the first International Agreement on vehicle regulations between UN member states which first focused on European countries and later on adapted by the Philippines; and

(y) Vehicle Regulations – are requirements that automobiles must satisfy in order to be approved for sale or use for a particular country or region.

SECTION 4. EMISSION FACTORS FOR MOBILE SOURCES

Emission factors (EF) are the average rate of emission of a pollutant per unit of activity data for a given category. When there is no emission factor reflecting the actual local situation, default values in manuals can be used. However, if the default factor is considered as inappropriate, it is preferable to obtain an emission factor that reflects the real situation by direct measurement.

ANNEX A shows the necessary Emission Factors to be used in calculating the Total Motor Vehicle Emission:

4.1 Incremental Cold Start Emission Factor
4.2 Incremental Hot Start Emission Factor
4.3 Evaporative Emission Factors (For Gasoline-fueled Engines only)
  4.3.1 Hot soak Emission Factor
  4.3.2 Diurnal Emission Factor
  4.3.3 Evaporative Running Losses
4.4 Motor Vehicle Running Emission Factor (Localized)

SECTION 5. MOTOR VEHICLE ACTIVITY RATES

Motor Vehicle data is a pre-requisite activity that collects data and information requirements from national, local government and other concerned agencies essential in determining air pollution estimates from Mobile Sources.

ANNEX B shows the required data and information of source to be used in the later calculation:

5.1 Number of Vehicles (N)
5.2 Distance Traveled (D)
5.3 Diesel Fuel Consumption (C)
5.4 Cold Start and Hot Start Trip per Day (T/D)
5.5 No. of days of vehicle in operation per year (AOD)
5.6 Sulfur Content of Diesel Fuel (SD)

SECTION 6. CALCULATION OF TOTAL MOTOR VEHICLE EMISSION

ANNEX C shows the detailed procedures in calculating the Emissions Inventory for Mobile Sources utilizing the prior established Emission Factors and other independent data for Motor Vehicles

The following are the steps in estimating emissions from Motor Vehicles:

DETERMINE EMISSIONS IN TONS/YEAR FOR EACH CONTRIBUTING FACTOR TO THE TOTAL VEHICLE EMISSIONS

6.1 Solve for Motor Vehicle Cold Start Emissions
6.2 Solve for Motor Vehicle Hot Start Emissions
6.3 Solve for Evaporative Emissions (For Gasoline-Fueled engines only)
    6.3.1 Hot Soak Emission
    6.3.2 Diurnal Emission
    6.3.3 Evaporative Running Losses
6.4 Solve for Motor Vehicle Running Emissions
6.5 Calculate Total Emissions in Tons/Year
6.6 Solve for Sulfur Dioxide Emissions (For Diesel-Fueled engines only)

SECTION 7. GUIDELINES FOR MOTOR VEHICLE COUNTING

The EMB-Regional Office (EMB-RO) shall be guided accordingly to utilize the Emissions Inventory for Mobile Source Survey Form

ANNEX D provides the suggested Mobile Source Survey Form utilizing the following methods in vehicle counting and data collection

7.1 Annual Average Weekday Traffic (AAWT)
7.2 Average Summer Daily Traffic (ASDT)
7.3 Average Daily Traffic (ADT)

SECTION 8. FREQUENCY OF VALIDATION AND UPDATING OF THE TOTAL MOTOR VEHICLE AIR POLLUTION FOR EMISSIONS INVENTORY

The EMB-Regional Office (EMB-RO) and its Airshed Governing Board members shall validate and update the Emissions Inventory every three (3) years. All designated Airsheds with more than three (3) years Emission Inventory shall update their assessments.

SECTION 9. EFFECTIVITY

This shall take effect fifteen (15) days after publication of EMB Central Office at the official website (www.emb.gov.ph)

ENGR. WILLIAM P. CUÑADO

ANNEX A

EMISSION FACTORS FOR MOBILE SOURCES

The emission inventory in the Philippines utilizes Emission Factors (EF) where certain numerical values relating the quantity of pollutants released from a source to some activity associated with those emissions are priorly established. Emission Factors serves as a tool in conducting emission inventories used in quantifying and identifying the extent of air pollution emitted by a certain source.

For motor vehicles, local emission factors were developed as combination of results from the study under the 1992 Vehicular Emission Control Program (VECP) funded by the Asian Development Bank (ADB) and the recommended Emission Factors from Emission Test Results gathered from previous approved Certificate of Conformity (COC).

$$E_M = E_C + E_H + E_E + E_R \qquad \textit{(Equation 1)}$$

Where:

E_M – *Total Motor Vehicle Emission (Tons/Year)*
E_C – *(a) Motor Vehicle Cold Start*
E_H – *(b) Motor Vehicle Hot Start Emission*
E_E – *(c) Evaporative Emissions*
E_R – *(e) Motor Vehicle Running Emission*

Where the basic formula pattern for each contributing Emission Source for the Total Mobile Vehicle Emission (except for sulfur emissions) is provided for by the following equation:

$$Qv = \Sigma (N \times D \times E) \qquad \textit{(Equation 2)}$$

Where:

Qv = total emissions in tons per year
N = number of units
D = distance traveled per year (km)
E = tons of pollutant emitted per km traveled

Table 1
General Parameters for Acquiring Total Motor Vehicle Emissions in Tons/Year

Parameter	Data
N numbers of vehicles	**For Top-Bottom Approach:** LTO registration records **If Bottom-Top Count:** Average Annual Daily Traffic (AADT) or ave. daily traffic data from MMDA/ Conduct Vehicle Counting Study per EMB RO
D distances traveled	**Direct method:** odometer survey **Indirect methods for daily distance estimate:** • (Daily fuel consumption) x (fuel consumption rate) • (Length of route) x (No. of trips per day) • (Hours on the road) x (average speed) • No. of days per year on the road
E emission factors	ADB emission factors (1992)
	Abstracted California Air Resources Board (CARB) Data
	EMB-Derived local Emission Factor

For the Emission estimates for the following:

(a) Motor Vehicle Cold Start Emission; and
(b) Motor Vehicle Hot Start Emission

The Emission Factors came from the VECP study funded by ADB in 1992 where Emission factors were developed for six (6) vehicle types and six (6) air pollutant gases. Vehicle speed and vehicle age were not considered and fuel consumption was not included. Hence the following table for Emission Factors should be used in the succeeding total emission calculations for items (a) and (b).

(a) In solving the **Motor Vehicle Cold Start Emission (E_C) in Tons/Year**, the following equation will be used using the Emission Factors from Table 2:

$$E_C = T/D \times EF_C \times AOD \times N \qquad \textit{(Equation 3)}$$

Where:

T/D – No. of vehicle type/trip
EF_C – Incremental cold start Emission Factors (Table 2)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

TABLE 2
INCREMENTAL COLD START EMISSION FACTORS
(grams/trip)

POLLUTANT	CARS		UV		MC/TC
	GAS	DIESEL	GAS	DIESEL	
THC	15.82	0.72	16.47	0.83	12.48
CO	131.18	4.11	129.23	4.02	69.99
NOx	4.30	0.31	4.50	1.10	0.87

(b) In solving the **Motor Vehicle Hot Start Emission (E_H) in Tons/Year**, the following equation will be used using the Emission Factors from Table 3:

$$E_H = T/D \times EF_H \times AOD \times N \qquad \textit{(Equation 4)}$$

Where:

T/D – No. of vehicle type/trip
EF_H – Incremental hot start Emission Factors (Table 3)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

TABLE 3
INCREMENTAL HOT START EMISSION FACTORS
(grams/trip)

POLLUTANT	CARS		UV		MC/TC
	GAS	DIESEL	GAS	DIESEL	
THC	10.98	0.18	10.88	0.16	4.22
CO	26.12	2.19	23.80	2.68	9.83
NOx	5.86	0.15	5.94	0.74	0.84

(c) Evaporative Emissions

In solving the **Evaporative Emissions (E_E) in Tons/Year for Gasoline-fueled Vehicles only**, the following equation will be used:

$$E_E = E_{EH} + E_{ED} + E_{ER} \quad \textit{(Equation 5)}$$

Where:

E_{EH} – Hot Soak Emission
E_{ED} – Diurnal Emission
E_{ER} – Evaporative Running Losses

Initially, the adapted California Air Resources Board data of Emission Factors for Evaporative Emissions in the form of Hydrocarbons are expressed in Total Organic Gases (TOG) which is a measure of Total Hydrocarbons (THC) plus the oxygenated alcohols, especially aldehydes which are chemically reactive and therefore considered ozone forming hydrocarbons *(USEPA, 2005)*. However, since the current emission standards in the Philippines for motor vehicles are adapted from UN ECE Regulations (DAO 2016-23 & DAO 2010-24) which measures only THC, the TOG values shall then be converted to THC only.

Following the Conversion Factors from the US EPA 420-R-05-015 also known as the "Conversion Factors for Hydrocarbon Emission Components or NR-002c" published in 2005, for non-tailpipe emissions such as Evaporative Emissions, the following relation between TOG and THC was established:

THC = TOG

This adapted assumption from US EPA *(2005)* then resulted to retaining the same values abstracted from the California Air Resources Board and renaming the hydrocarbons as THC instead of TOG for uniformity of data. To further elaborate Equation 5, the following equations and Emission factors for Evaporative Emission components are as follow:

i. Hot Soak Emission (E_{EH}) – vapors emitted when engine is turned off. In solving for Hot Soak Emission (E_{EH}) in Tons/Year, the following equation will be used utilizing the Emission Factors in Table 4:

$$E_{EH} = T/D \times EF_{EH} \times AOD \times N \quad \textit{(Equation 6)}$$

Where:

T/D – No. of vehicle type/trip
EF_{EH} – Hot Soak Emission Factors (Table 4)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

TABLE 4
HOT SOAK EMISSION FACTORS (grams/trip)
FOR GASOLINE-FUELED VEHICLES ONLY

POLLUTANT	CARS	UV	TRUCKS	MC/TC
THC	10.19	9.39	3.79	3.92

ii. Diurnal Emission (E_{ED}) – associated with daily temperature change, vaporization and expansion of fuel vapor. In solving for Diurnal Emission (E_{ED}) in Tons/Year, the following equation will be used utilizing the Emission Factors in Table 5:

$$\mathbf{E_{ED}} = N \times EF_{ED} \times AOD \qquad \textit{(Equation 7)}$$

Where:

N – No. of Registered Vehicle per Type
EF_{ED} – Diurnal Emission Factors (for gasoline fueled only in Table 5)
AOD – No. of days of vehicle in operation

TABLE 5
DIURNAL EMISSION FACTORS (grams/vehicle-day)
FOR GASOLINE – FUELED VEHICLES ONLY

POLLUTANT	CARS	UV	TRUCKS	MC/TC
THC	16.70	15.66	12.86	7.70

iii. Evaporative Running Losses (E_{ER}) – In solving for E_{ER} in Tons/Year, the following equation will be used utilizing the Emission Factors in Table 6:

$$\mathbf{E_{ER}} = N \times EF_{ER} \times D \times \text{conversion value} \qquad \textit{(Equation 8)}$$

Where:

N – No. of Registered Vehicle per Type
EF_{ER} – Evaporative Running Loses (for gasoline fueled only in Table 6)
D – Distance traveled

TABLE 6
EVAPORATIVE RUNNING LOSSES (g/km)
FOR GASOLINE – FUELED VEHICLES ONLY

POLLUTANT	CARS	UV
THC	0.38	0.36

(d) Motor Vehicle Running Emission

In solving for the ***Motor Vehicle Running Emissions (E_R)***, the following equation will be used:

E_R *= Process Rate also known as Number of registered Vehicles multiplied by Distance Travelled (Vehicle count in Table 8 x VKT in Table 9) x Motor Vehicle Running Emission Factor (Table A or B)*

-or-

$$\mathbf{E_R} = N \times D \times EF_R \qquad \textit{(Equation 9)}$$

Where:

N – No. of Registered Vehicle per Type
D – Distance traveled
EF_R – Motor Vehicle Running Emission Factor (Table A or B)

The Motor Vehicle Running Emission Factor (EF_R) to be used in solving came from the EMB-Derived Emission Factor from previously approved ***Certificates of Conformity*** (COCs) whose emission test results conformed with DAO 2015-04 also known as *"Implementation of*

Vehicle Emission Limits for Euro 4/IV, and In-Use Vehicle Emission Standards" and DAO 2016-23 which is also known as *"Adoption of Euro 4/IV Emission Limits/ Standards"* where the latter provided in details on the specifics of the adopted United Nations Economic Commission on Europe Regulations (UNECE Regulation) No. 83-05B for M1 and N1 vehicles and UNECE Regulation No. 49-04 for Heavy Duty Vehicles.

Likewise, the same also applied to DAO 2010-24 also known as the *"Revised Emission Limits/Standards for Motorcycles/Tricycles and Mopeds"* indicating the adopted transitory Emission Standards from European Economic Community Directive or EEC Directive No. 97/24/EC for Motorcycles, Tricycles and Mopeds where the Philippines is currently as EURO III standard for these vehicle categories.

These emission test results from the COCs utilizes UNECE Type Approval Testing procedure in compliance with Section 1, Part IX, Rule XXXI of DENR Administrative Order 2000-81 (Implementing Rules and Regulations of RA 8749). The local EF was recommended for adaption since it reflects a more accurate depiction of the actual exhaust emitted by Mobile Sources of air pollution in the Philippines to improve the precision of data apportionment for the Emissions Inventory.

TABLE A

LOCAL EMISSION FACTORS FOR MOTOR VEHICLE RUNNING EMISSION FROM APPROVED COC EMISSION TEST RESULTS (grams/km)

FOR M1 VEHICLES (EURO IV Passenger Vehicles with RW less than 3500 kg e.g. Cars)

		MONITORED POLLUTANT				
		CO	HC + NOx	HC	NOx	PM
GASOLINE	EURO IV Actual Average from COC	0.3101	-	0.0397	0.0222	-
	EURO II Actual Average from COC	0.4394	0.0685	-	-	-
DIESEL	EURO IV Actual Average from COC	0.2587	0.1802	-	0.1225	0.0186
	EURO II Actual Average from COC	0.2640	0.3270	-	-	0.0You know 287

FOR N1 VEHICLES (EURO IV Vehicle for Carriage of Goods with RW less than 3500 kg e.g. UV, Pick up)

CLASS I (RW ≤ 1305 KGS)		MONITORED POLLUTANT				
		CO	HC + NOx	HC	NOx	PM
GASOLINE	EURO IV Actual Average from COC	0.5610	-	-	-	-
	EURO II Actual Average from COC	0.2377	0.0449	-	-	-
DIESEL	EURO IV Actual Average from COC	0.1278	0.1718	-	0.1573	0.0116
	EURO II Actual Average from COC	0.0730	0.4100	-	-	0.0160

CLASS II (RW = 1305-1760 KGS)		MONITORED POLLUTANT				
		CO	HC + NOx	HC	NOx	PM
GASOLINE	EURO IV Actual Average from COC	0.5277	-	0.0391	0.0121	-
	EURO II Actual Average from COC	0.5489	0.1380	-	-	-
DIESEL	EURO IV Actual Average from COC	-	-	-	-	-
	EURO II Actual Average from COC	0.0980	0.0980	-	-	0.0001

CLASS III (RW>1760 KGS)		MONITORED POLLUTANT				
		CO	HC + NOx	HC	NOx	PM
GASOLINE	EURO IV Actual Average from COC	0.1591	-	0.0088	0.1279	-
	EURO II Actual Average from COC	0.4915	0.1456	-	-	0.0002
DIESEL	EURO IV Actual Average from COC	0.2469	0.3118	-	0.3664	0.0393
	EURO II Actual Average from COC	0.4762	0.6391	-	-	0.0791

FOR HEAVY DUTY VEHICLES (EURO IV Vehicles with Maximum Mass greater than 3500 kgs e.g. Truck, Bus)

		MONITORED POLLUTANT			
		CO	HC	NOx	PM
GASOLINE	n/a				
DIESEL	EURO IV Actual Average from COC	0.1751	0.0685	2.6318	0.0224
	EURO II Actual Average from COC	0.7578	0.3221	5.7326	0.1024

FOR L3 VEHICLES (EURO III for Vehicles with less than 4 Wheels, e.g: Motorcycles, Tricycles, Mopeds)

ENGINE CAPACITY < 150 CC		MONITORED POLLUTANT		
		CO	HC	NOx
GASOLINE	Actual Average	1.6575	0.3138	0.0990
DIESEL	n/a			
ENGINE CAPACITY ≥ 150 CC		MONITORED POLLUTANT		
		CO	HC	NOx
GASOLINE	Actual Average	0.9734	0.1922	0.0850
DIESEL	n/a			

Note: For other air pollution data from motor vehicles that does not fall with the current categories from the local Emission Factors (EF) of Table A, the following EF from the East Asia Guidelines in Table B is also adapted as well in solving the Motor vehicle Running Emissions:

TABLE B

Emission Factors from Guidelines for Developing Emission Inventory in East Asia, published on March 2011 by Study Committee for Methodologies of Developing Emission Inventory in East Asia under a project sponsored by the Ministry of the Environment, Japan

Table 3.3-2 Emission factor by target pollutant and by car type[8]

Car Type	Fuel Type	CO (g/kg fuel)			NMVOC (g/kg fuel)			NOx (g/kg fuel)		
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
Passenger car	Gasoline	132	50	350	14	5	40	14.5	6	35
	Diesel oil	4.7	2	11	1.1	0.5	2.5	11	9	14
	LPG	68	40	115	10	6	18	15.5	6	40
Small truck, small bus	Gasoline	155	80	300	14	5	40	24	14	40
	Diesel oil	11	8	15	1.75	1.5	2	15	13	19
Large truck, large bus	Diesel oil	8	6.5	10	1.6	1	2.5	37	30	45
	CNG (bus)	5.7	2.2	15	0.26	0.1	0.67	13	5.5	30
Motorbike	Gasoline	490	340	700	114	65	200	9.5	11	8

Car Type	Fuel Type	PM (g/kg fuel)			N_2O (g/kg fuel)			NH_3 (g/kg fuel)		
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
Passenger car	Gasoline	0.037	0.030	0.045	0.213	0.130	0.350	0.173	0.030	1.000
	Diesel oil	1.700	0.700	4.000	0.087	0.050	0.150	0.018	0.016	0.020
	LPG	0.000	0.000	0.000	0.194	0.090	0.420	0.173	0.150	0.200
Small truck, small bus	Gasoline	0.030	0.020	0.045	0.197	0.130	0.300	0.140	0.030	0.650
	Diesel oil	2.800	2.000	4.000	0.069	0.040	0.120	0.014	0.013	0.015
Large truck, large bus	Diesel oil	1.200	0.700	2.000	0.061	0.025	0.120	0.015	0.012	0.020
	CNG (bus)	0.020	0.010	0.036	n.a			n.a		
Motorbike	Gasoline	2.700	1.500	5.000	0.059	0.050	0.070	0.063	0.050	0.080

Car Type	Fuel Type	BC (g/kg fuel)	OC (g/kg fuel)
Passenger car	Gasoline	0.013	0.014
	Diesel oil	2.280	0.720
	LPG	0.000	0.000
Small truck, small bus	Gasoline	0.013	0.014
	Diesel oil	2.280	0.720
Large truck, large bus	Diesel oil	1.140	0.360
	CNG (bus)	0.000	0.000
Motorbike	Gasoline	1.450	1.550

Car Type	Fuel Type	$kgCO_2$/kg fuel	CH_4 (kg/TJ)	SO_2 (g/kg fuel)
All car types	Gasoline	3.180	33.000	20×S content (%)
	Diesel oil	3.140	3.900	20×S content (%)
	LPG	3.017	62.000	20×S content (%)
	CNG or LNG	2.750	3.900	20×S content (%)

Source: EMEP/EEA Guidebook, 2006 IPCC Guidelines

Table 3.3-5 Passenger car average emission factor

Type	Technology	CO	NMVOC	NOx	N_2O	NH_3	$PM_{2.5}$
Units		g/km	g/km	g/km	g/km	g/km	g/km $PM_{2.5}$= PM_{10}=TSP
Gasoline <1.4L	PRE ECE	39.2	3.65	1.89	0.010	0.0025	0.0024
Gasoline <1.4L	ECE 15/00-01	30.5	3.05	1.89	0.010	0.0025	0.0024
Gasoline <1.4L	ECE 15/02	22.8	2.94	2.06	0.010	0.0025	0.0024
Gasoline <1.4L	ECE 15/03	23.2	2.94	2.23	0.010	0.0025	0.0024
Gasoline <1.4L	ECE 15/04	13.6	2.51	2.02	0.010	0.0025	0.0024
Gasoline <1.4L	Open Loop	11.9	2.22	1.49	0.010	0.0025	0.0024
Gasoline <1.4L	PC Euro1 - 91/441/EEC	4.23	0.564	0.441	0.023	0.0731	0.0024
Gasoline <1.4L	PC Euro2 - 94/12/EEC	2.39	0.301	0.242	0.012	0.0958	0.0024
Gasoline <1.4L	PC Euro3 - 98/69/EE I	2.14	0.169	0.098	0.005	0.0276	0.0011
Gasoline <1.4L	PC Euro4 - 98/69/EE II	0.710	0.123	0.062	0.005	0.0276	0.0011
Gasoline 1.4 -2.0L	PRE ECE	39.2	3.80	2.47	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	ECE 15/00-01	30.5	3.19	2.47	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	ECE 15/02	22.8	3.081	2.33	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	ECE 15/03	23.2	3.08	2.43	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	ECE 15/04	13.8	2.66	2.58	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	Open Loop	6.68	1.73	1.26	0.010	0.0025	0.0024
Gasoline 1.4 -2.0L	PC Euro1 - 91/441/EEC	3.93	0.645	0.441	0.0023	0.0731	0.0024
Gasoline 1.4 -2.0L	PC Euro2 - 94/12/EEC	2.18	0.349	0.243	0.012	0.0958	0.0024
Gasoline 1.4 -2.0L	PC Euro3 - 98/69/EE I	1.96	0.193	0.098	0.005	0.0276	0.0011
Gasoline 1.4 -2.0L	PC Euro4 - 98/69/EE II	0.658	0.136	0.062	0.005	0.0276	0.0011
Gasoline >2.0L	PRE ECE	39.2	4.01	3.70	0.010	0.0025	0.0024
Gasoline >2.0L	ECE 15/00-01	30.5	3.41	3.70	0.010	0.0025	0.0024
Gasoline >2.0L	ECE 15/02	22.8	3.30	2.62	0.010	0.0025	0.0024
Gasoline >2.0L	ECE 15/03	23.2	3.30	3.44	0.010	0.0025	0.0024
Gasoline >2.0L	ECE 15/04	13.8	3.51	2.80	0.010	0.0025	0.0024
Gasoline >2.0L	PC Euro1 - 91/441/EEC	3.33	0.520	0.419	0.023	0.0731	0.0024
Gasoline >2.0L	PC Euro2 - 94/12/EEC	1.74	0.273	0.226	0.012	0.0958	0.0024
Gasoline >2.0L	PC Euro3 - 98/69/EE I	1.58	0.157	0.091	0.005	0.0276	0.0011
Gasoline >2.0L	PC Euro4 - 98/69/EE II	0.549	0.116	0.058	0.005	0.0276	0.0011
Diesel <2.0L	Conventional	0.713	0.162	0.561	0.000	0.0012	0.246
Diesel <2.0L	PC Euro1 - 91/441/EEC	0.449	0.051	0.691	0.003	0.0012	0.0877
Diesel <2.0L	PC Euro2 - 94/12/EEC	0.333	0.036	0.726	0.006	0.0012	0.0594
Diesel <2.0L	PC Euro3 - 98/69/EE I	0.097	0.020	0.780	0.010	0.0012	0.0412
Diesel <2.0L	PC Euro4 - 98/69/EE II	0.097	0.016	0.601	0.010	0.0012	0.0342
Diesel >2.0L	Conventional	0.713	0.162	0.890	0.000	0.0012	0.246
Diesel >2.0L	PC Euro1 - 91/441/EEC	0.449	0.0077	0.691	0.003	0.0012	0.0877
Diesel >2.0L	PC Euro2 - 94/12/EEC	0.333	0.110	0.726	0.006	0.0012	0.0594
Diesel >2.0L	PC Euro3 - 98/69/EE I	0.097	0.019	0.780	0.010	0.0012	0.0412
Diesel >2.0L	PC Euro4 - 98/69/EE II	0.097	0.016	0.601	0.010	0.0012	0.0342
LPG	Conventional	6.75	1.10	2.31	0.000	0.0100	n.a.
LPG	PC Euro1 - 91/441/EEC	3.80	0.771	0.444	0.000	0.0100	n.a.
LPG	PC Euro2 - 94/12/EEC	2.65	0.369	0.199	0.013	0.0120	n.a.
LPG	PC Euro3 - 98/69/EE I	2.22	0.206	0.115	0.005	0.0050	n.a.
LPG	PC Euro4 - 98/69/EE II	1.04	0.100	0.063	0.005	0.0050	n.a.
2-Stroke	Conventional	13.1	10.0	0.642	0.008	0.0019	n.a.
Hybrid Gas 1.4-2.0L	PC EURO 4 - 98/69/EC II	0.001	0.021	0.009	0.005	0.0276	n.a.

Source: EMEP/EEA Guidebook

Gasoline <3.5t	PC Euro3 - 98/69/EE I	5.06	0.189	0.129	0.028	0.0302	0.0011
Gasoline <3.5t	PC Euro4 - 98/69/EE II	2.01	0.128	0.064	0.013	0.0302	0.0011
Diesel <3.5t	Conventional	1.34	0.133	1.66	0.000	0.0012	0.356
Diesel <3.5t	PC Euro1 - 91/441/EEC	0.577	0.141	1.22	0.003	0.0012	0.117
Diesel <3.5t	PC Euro2 - 94/12/EEC	0.577	0.149	1.22	0.006	0.0012	0.117
Diesel <3.5t	PC Euro3 - 98/69/EE I	0.473	0.094	1.03	0.009	0.0012	0.0783
Diesel <3.5t	PC Euro4 - 98/69/EE II	0.375	0.035	0.831	0.009	0.0012	0.0409

Source: EMEP/EEA Guidebook

Table 3.3-7 Heavy duty trucks average emission factor

Type	Technology	CO	NMVOC	NOx	N_2O	NH_3	$PM_{2.5}$
Units		g/km	g/km	g/km	g/km	g/km	g/km $PM_{2.5}$=P M_{10} =TSP
Gasoline >3.5t	Conventional	59.5	5.25	6.60	0.006	0.0019	0.000
Rigid <=7.5 t	Conventional	1.85	1.07	4.70	0.029	0.0029	0.333
Rigid <=7.5 t	HD Euro I - 91/542/EEC I	0.657	0.193	3.37	0.005	0.0029	0.129
Rigid <=7.5 t	HD Euro II -91/542/EEC II	0.537	0.123	3.49	0.004	0.0029	0.061
Rigid <=7.5 t	HD Euro III -2000	0.584	0.115	2.63	0.003	0.0029	0.0566
Rigid <=7.5 t	HD Euro IV -2005	0.047	0.005	1.64	0.006	0.0029	0.0106
Rigid <=7.5 t	HD Euro V -2008	0.047	0.005	0.933	0.017	0.0029	0.0106
Rigid <=7.5 t	HD Euro VI	0.047	0.005	0.180	0.017	0.0029	0.0005
Rigid 12 -14 t	Conventional	2.13	0.776	8.92	0.029	0.0029	0.3344
Rigid 12 -14 t	HD Euro I - 91/542/EEC I	1.02	0.326	5.31	0.008	0.0029	0.201
Rigid 12 -14 t	HD Euro II -91/542/EEC II	0.902	0.207	5.50	0.008	0.0029	0.104
Rigid 12 -14 t	HD Euro III -2000	0.972	0.189	4.30	0.004	0.0029	0.0881
Rigid 12 -14 t	HD Euro IV -2005	0.071	0.008	2.65	0.012	0.0029	0.0161
Rigid 12 -14 t	HD Euro V - 2008	0.071	0.008	1.51	0.034	0.0029	0.0161
Rigid 12 -14 t	HD Euro VI	0.071	0.008	0.291	0.033	0.0029	0.0008
Rigid 20 -26 t	Conventional	1.93	0.486	10.7	0.029	0.0029	0.418
Rigid 20 -26 t	HD Euro I - 91/542/EEC I	1.55	0.449	7.52	0.008	0.0029	0.297
Rigid 20 -26 t	HD Euro II -91/542/EEC II	1.38	0.29	7.91	0.007	0.0029	0.155
Rigid 20 -26 t	HD Euro III -2000	1.49	0.278	6.27	0.004	0.0029	0.13
Rigid 20 -26 t	HD Euro IV -2005	0.105	0.010	3.83	0.012	0.0029	0.0239
Rigid 20 -26 t	HD Euro V - 2008	0.105	0.010	2.18	0.034	0.0029	0.0239
Rigid 20 -26 t	HD Euro VI	0.105	0.010	0.422	0.032	0.0029	0.0012
Rigid >32 t	Conventional	2.25	0.534	12.8	0.029	0.0029	0.491
Rigid >32 t	HD Euro I - 91/542/EEC I	1.90	0.510	9.04	0.012	0.0029	0.358
Rigid >32 t	HD Euro II -91/542/EEC II	1.69	0.326	9.36	0.012	0.0029	0.194
Rigid >32 t	HD Euro III -2000	1.79	0.308	7.43	0.007	0.0029	0.151
Rigid >32 t	HD Euro IV -2005	0.121	0.012	4.61	0.018	0.0029	0.0268
Rigid >32 t	HD Euro V - 2008	0.121	0.012	2.63	0.053	0.0029	0.0268
Rigid >32 t	HD Euro VI	0.121	0.012	0.507	0.049	0.0029	0.0013

Source: EMEP/EEA Guidebook

Table 3.3-8 Large bus average emission factor

Technology	CO	NMVOC	NOx	N_2O	NH_3	$PM_{2.5}$
	g/km	g/km	g/km	g/km	g/km	g/km $PM_{2.5}$=PM_{10} =TSP
HD Euro I -91/542/EEC I	8.40	0.371	16.5	n.a.	n.a.	0.02
HD Euro II - 91/542/EEC II	2.70	0.313	15.0	n.a.	n.a.	0.01
HD Euro III - 2000	1.00	0.052	10.0	n.a.	n.a.	0.01
EEV	1.00	0.045	2.50	n.a.	n.a.	0.005
Conventional	5.71	1.99	16.5	0.029	0.0029	0.909
HD Euro I - 91/542/EEC I	2.71	0.706	10.1	0.012	0.0029	0.479
HD Euro II -91/542/EEC II	2.44	0.463	10.7	0.012	0.0029	0.22
HD Euro III -2000	2.67	0.409	9.38	0.001	0.0029	0.207
HD Euro IV -2005	0.223	0.022	5.42	0.012	0.0029	0.0462
HD Euro V -2008	0.223	0.022	3.09	0.032	0.0029	0.0462
HD Euro VI	0.223	0.022	0.597	0.040	0.0029	0.0023
Conventional	2.27	0.661	10.6	0.029	0.0029	0.47
HD Euro I - 91/542/EEC I	1.85	0.624	8.10	0.009	0.0029	0.362
HD Euro II -91/542/EEC II	1.60	0.416	8.95	0.008	0.0029	0.165
HD Euro III -2000	1.91	0.399	7.51	0.004	0.0029	0.178
HD Euro IV -2005	0.150	0.021	4.51	0.012	0.0029	0.0354
HD Euro V -2008	0.150	0.021	2.57	0.034	0.0029	0.0354
HD Euro VI	0.150	0.021	0.496	0.033	0.0029	0.0018

Source: EMEP/EEA Guidebook

Table 3.3-9 Motorcycle average emission factor

Technology	CO	NMVOC	NOx	N_2O	NH_3	$PM_{2.5}$
	g/km	g/km	g/km	g/km	g/km	g/km
						$PM_{2.5}=PM_{10}$ =TSP
<50cm^3	13.8	13.8	0.020	0.001	0.0010	0.188
<50cm^3	5.60	2.82	0.020	0.001	0.0010	0.0755
<50cm^3	1.30	1.66	0.260	0.001	0.0010	0.0376
<50cm^3	1.00	1.31	0.260	0.001	0.0010	0.0114
4-stroke <250cm^3	32.8	2.06	0.225	0.001	0.0010	0.014
4-stroke <250cm^3	13.6	1.08	0.445	0.001	0.0010	0.014
4-stroke <250cm^3	7.17	0.839	0.317	0.001	0.0010	0.0035
4-stroke <250cm^3	3.03	0.465	0.194	0.001	0.0010	0.0035
4-stroke 250-750 cm^3	25.7	1.68	0.233	0.001	0.0010	0.014
4-stroke 250-750 cm^3	13.8	1.19	0.477	0.001	0.0010	0.014
4-stroke 250-750 cm^3	7.17	0.918	0.317	0.001	0.0010	0.0035
4-stroke 250-750 cm^3	3.03	0.541	0.194	0.001	0.0010	0.0035
4-stroke >750 cm^3	21.1	2.75	0.247	0.001	0.0010	0.014
4-stroke >750 cm^3	10.1	1.50	0.579	0.001	0.0010	0.014
4-stroke >750 cm^3	7.17	0.994	0.317	0.001	0.0010	0.0035
4-stroke >750 cm^3	3.03	0.587	0.194	0.001	0.0010	0.0035

Source: EMEP/EEA Guidebook

ANNEX B

GATHERING OF MOTOR VEHICLE DATA

Collection of latest data related to Motor Vehicles are vital in producing a more accurate Emissions Inventory for Mobile Air Pollution Sources. EMB ROs shall gather information requirements from national, local government and other concerned agencies essential in determining air pollution estimates or in case of data unavailability, perform their own conservative count on the required parameters.

ANNEX B shows the required data and information of source to be used in the calculation:

5.1 Number of Vehicles (N)
5.2 Distance Traveled (D)
5.3 Diesel Fuel Consumption (C)
5.4 Cold Start and Hot Start Trip per Day (T/D)
5.5 No. of days of vehicle in operation per year (AOD)
5.6 Sulfur Content of Diesel Fuel (SD)

Table 7
MOTOR VEHICLE DATA REQUIREMENTS

DATA PARAMETER	SOURCE	TO BE USED IN FORMULA	SAMPLE VALUE(S) FOR CALCULATION
Number of Vehicles (N)	i) Land Transporation Office (LTO) ii) Must be the Latest Statistical Report of Registered Motor Vehicles by Type and Fuel Used for the specific Region	All Emission Equations	See Table 8
Distance Traveled (D)	i) Measured in Vehicle Kilometers Travelled (VKT) ii) Can be acquired through Direct method: odometer survey iii) Can also be acquired through Indirect methods for daily distance estimate: • (Daily fuel consumption) x (fuel consumption rate) • (Length of route) x (No. of trips per day) • (Hours on the road) x (average speed)	i) Evaporative Running Losses *(See Annex A, equation 8)* ii) Motor Vehicle Running Emission *(See Annex C, equation 9)*	See Table 9 *(Abstracted from VECP project of ADB)*
Diesel Fuel Consumption (C)	i) Department of Energy (DOE) ii)Volume of Diesel Consumed for the specific Region	Sulfur Dioxide Emission *(See Annex C, equation 11)*	12,679,610 Barrels *(NCR consumption for Year 2000)*
Cold Start and Hot Start Trip per Day (T/D)	i) Can be surveyed per Region	i) Motor Vehicle Cold Start Emission	See Table 10, Table 11 and Table 12

	ii) Utilized Trips/Day in succeeding calculations were assumptions based on observation and anecdotal information form operators of taxis (diesel-dueled cars), UVs and tricycles. Gasoline fueled cars were assumed to have 2 cold starts, one (1) in the morning and one (1) in the evening	*(See Annex A, equation 3)* ii) Motor Vehicle Hot Start Emission *(See Annex A, equation 4)* iii) Evaporative Emissions – Hot Soak *(See Annex A, equation 6)*	
No. of days of vehicle in operation per year (AOD)	i) Can be acquired through Survey per each Region per type of vehicle (By fuel then by category)	i) Motor Vehicle Cold Start Emission *(See Annex A, equation 3)* ii) Motor Vehicle Hot Start Emission *(See Annex A, equation 4)* iii) Evaporative Emissions – Hot Soak *(See Annex A, equation 6)* iv) Evaporative Emissions – Diurnal Emission *(See Annex A, equation 6)*	240 days/year
Sulfur Content of Diesel Fuel (SD)	i) Department of Trade and Industry- Bureau of Product Standards (DTI-BPS) ii) DAO 2015-04	i Sulfur Dioxide Emission *(See Annex C, equation 11)*	0.3% *(Sulfur content limit of diesel fuel set by DTI-BPS)* 50 ppm for EURO IV 500 ppm for EURO II *(DAO 2015-04)*

Table 8
SAMPLE NUMBER OF MOTOR VEHICLES REGISTERED BY TYPE AND FUEL USED
(NCR, 2000)

CARS	Gasoline	471,100
	Diesel	20,028
UV	Gasoline	211,964
	Diesel	322,298
BUS	Gasoline	1,047
	Diesel	11,121
TRUCKS	Gasoline	4,752
	Diesel	62,370
MT/TC	Gasoline	167,848
TOTAL	Gasoline	856, 711
	Diesel	415, 817

Source: Land Transportation Office, 2000

Table 9
DISTANCE TRAVELLED PER VEHICLE TYPE PER YEAR
(IN THOUSAND KILOMETERS PER VEHICLE)

TYPE OF FUEL	CAR	UV	TRUCKS	BUSES	MC/TC
Gasoline	12	30	50	50	10
Diesel	30	40	50	50	--

Source: Abstracted from ADB Project, 2000

Table 10
COLD START EMISSION TRIPS PER DAY *(T/D)*

In calculating the cold start emissions, the number of vehicle trips were assumed as follows:		
CAR	Gasoline	2 Trips
	Diesel	1 Trip
UV	Gasoline	1 Trip
	Diesel	1 Trip
MC/TC	Gasoline	1 Trip

Table 11
HOT START EMISSION TRIPS PER DAY *(T/D)*

In calculating the hot start emissions, the number of vehicle trips were assumed as follows:		
CAR	Gasoline	1 Trip
	Diesel	2 Trips
UV	Gasoline	4 Trips
	Diesel	5 Trips
MC/TC	Gasoline	10 Trips

Table 12
HOT SOAK EMISSION-VAPORS EMITTED WHEN ENGINE IS TURNED OFF IN TRIPS PER DAY *(T/D)*

For Hot-Soak Emissions, the number of trips of vehicles were assumed to be as follows:		
CAR	Gasoline	1 Trip
UV	Gasoline	4 Trips
TRUCKS	Gasoline	2 Trips
MC/TC	Gasoline	10 Trips

ANNEX C

CALCULATION OF TOTAL MOTOR VEHICLE EMISSION

The following guideline shows the detailed procedures in calculating the Emissions Inventory for Mobile Sources utilizing the prior established Emission Factors and other collected statistical data for Motor Vehicles. Sample computations are shown to provide a pattern in solving the Total Emission Estimates.

SAMPLE EMISSION CALCULATION IN TONS/YEAR FOR EACH CONTRIBUTING FACTOR TO THE TOTAL VEHICLE EMISSIONS

(a) Solving for Motor Vehicle Cold Start Emissions
(b) Solve for Motor Vehicle Hot Start Emissions
(c) Solve for Evaporative Emissions (For Gasoline-Fueled engines only)
  (c.1) Hot Soak Emission
  (c.2) Diurnal Emission
  (c.3) Evaporative Running Losses
(d) Solve for Motor Vehicle Running Emissions
(e) Calculate Total Emissions in Tons/Year
(f) Solve for Sulfur Dioxide Emissions (For Diesel-Fueled engines only)

Illustrative Sample Calculations:

(a) SOLVING FOR MOTOR VEHICLE COLD START EMISSIONS

$$E_C = T/D \times EF_C \times AOD \times N \qquad \textit{(Equation 3)}$$

Where:

T/D – No. of vehicle type/trip
EF_C – Incremental cold start Emission Factors (Table 2)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

E_C = *No. of vehicle type/trip (Table 10) x*
Incremental cold start Emission Factors (Table 2) x
No. of days of vehicle in operation (Table 7) x
No. of Registered Vehicle per Type (Table 8)

Sample 1:

Find ***Motor Vehicle Cold Start Emissions (E_C)*** of Gasoline Cars for THC pollutant:

Solution:

Using values from Equation 3,

E_C = *2 trips/day (See Table 10) x 15.82 grams/trip (See Table 2) x 240 days/year (See Table 7) x 471, 100 vehicle units (See Table 8) x conversion values*

$$E_C = 2\frac{trips}{day} \times 15.82\ \frac{grams}{trip} \times 240\frac{days}{year} \times 471{,}100\ \times \frac{1\ ton}{1{,}000{,}000\ grams} = 3,577.34\ \frac{tons}{year}$$

Total HC Concentration for Cold Start Emission of Gasoline Cars for year 2000 is at

$$\boldsymbol{3,\ 577.34\ \frac{tons}{year}}$$

Sample 2:

Find ***Motor Vehicle Cold Start Emissions (E_C)*** of Diesel Cars for NOx pollutant:

Solution:

Using values from Equation 3,

E_C = *2 trips/day (See Table 10) x 0.31 grams/trip (See Table 2) x 240 days/year (See Table 7) x 471, 100 vehicle units (See Table 8) x conversion values*

$$E_C = 2\ \frac{trips}{day} \times\ 0.31\ \frac{grams}{trip} \times 240\ \frac{days}{year} \times 471{,}100\ \times \frac{1\ ton}{1{,}000{,}000\ grams} = 70.1\ \frac{tons}{year}$$

Total NOx Concentration for Cold Start Emission of Diesel Cars for year 2000 is at

$$\boldsymbol{70.1\ \frac{tons}{year}}$$

(b) SOLVING FOR MOTOR VEHICLE HOT START EMISSIONS

$$\mathbf{E_H} = \text{T/D x } EF_H \text{ x AOD x N} \qquad \textit{(Equation 4)}$$

Where:

T/D – No. of vehicle type/trip
EF_H – Incremental hot start Emission Factors (Table 3)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

E_H = *No. of vehicle type/trip (Table 11) x Incremental hot start Emission Factors (Table 3) x No. of days of vehicle in operation (Table 7) x No. of Registered Vehicle per Type (Table 8)*

Sample 1:

Find ***Motor Vehicle Hot Start Emissions (E_H)*** of Gasoline Cars for THC pollutant:

Solution:

Using values from Equation 4,

E_H = *1 trip/day (See Table 11) x 10.98 grams/trip (See Table 3) x 240 days/year (See Table 7) x 471, 100 vehicle units (See Table 8) x conversion values*

$$E_H = 1\ \frac{trip}{day} \times\ 10.98\ \frac{grams}{trip} \times 240\ \frac{days}{year} \times 471{,}100\ \times \frac{1\ ton}{1{,}000{,}000\ grams} = 1{,}241.44\ \frac{tons}{year}$$

Total HC Concentration for Hot Start Emission of Gasoline Cars for year 2000 is at

$$\boldsymbol{1,\ 241.44\ \frac{tons}{year}}$$

(c) SOLVING FOR EVAPORATIVE EMISSIONS (FOR GASOLINE ENGINE ONLY)

$$E_E = E_{EH} + E_{ED} + E_{ER} \qquad \textit{(Equation 5)}$$

Where:

E_{EH} – Hot Soak Emission
E_{ED} – Diurnal Emission
E_{ER} – Evaporative Running Losses

E_E = *Hot Soak Emission (E_{EH}) +*
Diurnal Emission (E_{ED}) +
Evaporative Running Losses (E_{ER})

(c.1) Hot Soak Emission

$$\mathbf{E_{EH}} = \text{T/D x } EF_{EH} \text{ x AOD x N} \qquad \textit{(Equation 6)}$$

Where:

T/D – No. of vehicle type/trip
EF_{EH} – Hot Soak Emission Factors (Table 4)
AOD – No. of days of vehicle in operation
N – No. of Registered Vehicle per Type

E_{EH} = *No. of vehicle type/trip(Table 12) x*
Hot Soak Emission Factors (for gasoline fueled only in Table 4) x
No. of days of vehicle in operation (Table 7) x
No. of Registered Vehicle per Type(Table 8)

Sample 1:

Find ***Motor Vehicle Hot Soak Emission-vapors (E_{EH})*** of Cars for Hydrocarbon (HC) pollutant:

Solution:

Using values from Equation 6,

E_{EH} = *1 trips/day (See Table 12) x 10.19 grams/trip (See Table 4) x 240 days/year (See Table 7) x 471, 100 vehicle units (See Table 8) x conversion values*

$$E_{EH} = 1\,\frac{trip}{day} \times\ 10.19\,\frac{grams}{trip} \times 240\,\frac{days}{year} \times 471{,}100\ \times \frac{1\ ton}{1{,}000{,}000\ grams} = 1,\ 152\,\frac{tons}{year}$$

Total HC Concentration for Hot Soak Evaporative Emission of Cars for year 2000 is at

$$\boldsymbol{1,\ 152\ \frac{tons}{year}}$$

(c.2) Diurnal Emission

$$\mathbf{E_{ED}} = \mathrm{N} \times \mathrm{EF_{ED}} \times \mathrm{AOD} \qquad \textit{(Equation 7)}$$

Where:

N – No. of Registered Vehicle per Type
EF_{ED} – Diurnal Emission Factors (for gasoline fueled only in Table 5)
AOD – No. of days of vehicle in operation

$\boldsymbol{E_{ED}}$ = *No. of Registered Vehicle per Type (Table 8) x*
Diurnal Emission Factors (for gasoline fueled only in Table 5) x
No. of days of vehicle in operation (Table 7)

Sample 1:

Find ***Motor Vehicle Diurnal Emission-vapors (E_{ED})*** of Cars for HC pollutant:

Solution:

Using values from Equation 7,

$\boldsymbol{E_{ED}}$= *167, 848 vehicle units (See Table 8) x 7.7 grams/vehicle-day (See Table 5) x 240 days/year (See Table 7) x x conversion values*

$$\boldsymbol{E_{ED}} = 167{,}848 \times 7.7\,\frac{grams}{trip} \times 240\,\frac{days}{year} \times \frac{1\ ton}{1{,}000{,}000\ grams} = 310.18\,\frac{tons}{year}$$

Total HC Concentration for Diurnal Evaporative Emission of Cars for year 2000 is at

$$\boldsymbol{310.18\ \frac{tons}{year}}$$

(c.3) Evaporative Running Losses Emission

$$\mathbf{E_{ER}} = \mathrm{N} \times \mathrm{EF_{ER}} \times \mathrm{D} \times \text{conversion value} \qquad \textit{(Equation 8)}$$

Where:

N – No. of Registered Vehicle per Type
EF_{ER} – Evaporative Running Loses (for gasoline fueled only in Table 6)
D – Distance traveled

$\boldsymbol{E_{ER}}$ = *No. of Registered Vehicle per Type(Table 8) x*
Evaporative Running Loses (for gasoline fueled only in Table 6) x
Distance traveled(Table 9) x conversion

Sample 1:

Find ***Motor Vehicle Running Loses (E_{ER})*** of Cars for HC pollutant:

Solution:

Using values from Equation 8,

E_{ER}= *471,100 vehicle units (See Table 8) x 0.38 grams/km (See Table 6) x 12,000 km/year distance travlled (9) x conversion values*

$$E_{ER} = 471{,}100 \times 0.38\ \frac{grams}{km} \times 12{,}000\ \frac{km}{year} \times \frac{1\ ton}{1{,}000{,}000\ grams} = 2{,}148.22\ \frac{tons}{year}$$

Total HC Concentration for Diurnal Evaporative Emission of Cars for year 2000 is at

$$\boldsymbol{2{,}142.22\ \frac{tons}{year}}$$

Sample 1:

c) Solving for the ***Total Evaporative Emissions*** from items (c.1), (c.2) and (c.3) for Gasoline Cars for Carbon Monoxide (CO) pollutant:

E_E *= Hot Soak Emission (E_{EH}) + Diurnal Emission (E_{ED}) + Evaporative Running Losses (E_{ER})* *(Equation 5)*

E_E *= 1, 152 tons/year (See Result from sample 1 of (c.1) Hot Soak Emission) + 310.18 tons/year (See Result from sample 1 of (c.2) or Diurnal Emission) + 2, 142.22 tons/year (See Result from sample 1 of (c.3) Evaporative Running Losses)*

$$E_E = 1{,}152\ \frac{tons}{year} + 310.18\ \frac{tons}{year} \times 2{,}142.22\ \frac{tons}{year} = 3{,}604.4\ \frac{tons}{year}$$

Total Evaporative Emissions for Gasoline Cars for the year 2000 is at

$$\boldsymbol{3{,}604.4\ \frac{tons}{year}}$$

(d) SOLVING FOR MOTOR VEHICLE RUNNING EMISSIONS

For solving the **Motor Vehicle Running Emission (E_R) in Tons/Year**, the following equation will be used using the Emission Factors from Table A:

$$\mathbf{E_R} = N \times D \times EF_R \qquad \textit{(Equation 9)}$$

Where:

N – No. of Registered Vehicle per Type
D – Distance travelled
EF_R – Motor Vehicle Running Emission Factor (Table A or B)

E_R *= Process Rate also known as Number of registered Vehicles multiplied by Distance Travelled (N*D) x Motor Vehicle Running Emission Factor (EF)*

Sample 1:

Find ***Motor Vehicle Running Emissions (E_R)*** of Euro IV, Gasoline-fueled Cars for Carbon Monoxide (CO) pollutant:

E_R = *Process Rate also known as Number of registered Vehicles multiplied by Distance Travelled (Vehicle count in Table 8 x VKT in Table 9) x Motor Vehicle Running Emission Factor (Table A or Table B)* *(Equation 9)*

Solution:

Using values from Equation 9,

E_R = *471,000 Vehicles unit for Cars (See Table 8) x 12,000 km/year(See Table 9) x 0.0397 grams/km (See Table A) x conversion value*

$$E_R = 471{,}000\ cars \times\ 12{,}000 \frac{km}{year} \times 0.0397 \frac{grams}{km} \times \frac{1\ ton}{1{,}000{,}000\ grams} = 224.43\ \frac{tons}{year}$$

Total Motor Vehicle Running Emission for Euro IV Gasoline Cars for the year 2000 is at

$$\boldsymbol{224.43\ \frac{tons}{year}}$$

(e) SOLVING FOR MOTOR VEHICLE TOTAL EMISSIONS (EXHAUST & EVAPORATIVE)

For Solving the ***Motor Vehicle Total Emissions (E_M) in Tons/year*** including exhaust and evaporative values, the following equation will be used:

$$E_M = E_C + E_H + E_E + E_R \qquad \textit{(Equation 1)}$$

Where:

E_M – *Total Motor Vehicle Emission (Tons/Year)*
E_C – *(a) Motor Vehicle Cold Start*
E_H – *(b) Motor Vehicle Hot Start Emission*
E_E – *(c) Evaporative Emissions*
E_R – *(e) Motor Vehicle Running Emission*

Sample 1:

Find ***Motor Vehicle Total Emissions (E_M)*** of Gasoline-fueled Cars for THC pollutant:

E_M = *Motor Vehicle Cold Start (Equation 3) +*
Motor Vehicle Hot Start Emission (Equation 4) +
Evaporative Emissions (Equation 5) +
Motor Vehicle Running Emission (Equation 9) *(Equation 1)*

Solution:

Using values from Equation 1,

E_M = *3,577.34 tons/ year (See results from Equation 3) + 1,241.44 tons/ year (See results from Equation 4) + 3,604.4 tons/year (See results from Equation 5)+ 224.43 tons/year (See results from Equation 9)*

$$E_M = 3{,}577.34\ \frac{tons}{year} + 1{,}241.44\ \frac{tons}{year} + 3{,}604.4\ \frac{tons}{year} + 224.43\ \frac{tons}{year} = 8{,}647.61\ \frac{tons}{year}$$

Total HC concentration for Motor Vehicle Total Emissions (E_M) of Gasoline-fueled Cars ***for year 2000 is at***

$$\boldsymbol{8{,}647.61\ \frac{tons}{year}}$$

(f) SOLVING FOR SULFUR DIOXIDE EMISSIONS (FOR DIESEL ENGINES ONLY)

The quantity of SO_2 emissions from diesel-fueled vehicles depends on the sulfur content of the diesel fuel used. In these calculations, the following assumptions will be used:

1) 0.3% Sulfur Content limit of diesel fuel set by the Department of Trade and Industry-Bureau of Products Standards (DTI-BPS) is being met and that this is the Sulfur content of diesel available from gasoline stations;

2) One (1) pound of sulfur is converted in the combustion process to about two pounds (2 lbs) of Sulfur Dioxide emitted into the atmosphere based on the stoichiometry and;

3) To calculate the SO_2 emissions from each type of vehicle, estimate first the total sulfur content of diesel fuel by multiplying the total volume of diesel fuel consumed (in gallons) by the diesel fuel density at 7.05lbs/gal. And by Sulfur content in the diesel fuel which is 0.3% sulfur by weight. Then, calculate the total SO_2 emissions from the total diesel fuel consumed by multiplying the total sulfur content of the diesel fuel by 2. The SO_2 emission from diesel-fueled UV are obtained by using the ratio of the number of registered diesel-fueled UV over the total number of all registered diesel-fueled vehicles.

For Solving **SO_2 Emissions (E_S) of Diesel-fueled motor vehicle engines in Tons/Year**, the value of **Total Sulfur Content of Diesel Consumed (T_S)** and **Total SO_2 Emissions of All Diesel fueled engines (E_{ST})** should first be known using the following equations:

Total Sulfur Content (T_S) *= Volume of Diesel Consumed (in Gallons) x Density of Diesel Fuel x Sulfur Content of Diesel Fuel* *(Equation 10)*

Total SO_2 Emission from All Vehicle (E_{ST}) *= Total Sulfur Content (T_S) x 2* *(Equation 11)*

SO_2 Emissions (E_S) *= Total SO Emission from All Vehicle (E_{ST}) x Ratio of Registered Number of Diesel Vehicles of specific type over Total Number of Diesel vehicles* *(Equation 12)*

Sample 1:

Find **SO_2 Emissions (E_S)** of Diesel-fueled Utility Vehicles (UV):

(f.1) Total Sulfur Content

Total Sulfur Content (T_S) *= Volume of Diesel Consumed (Table 7) x Density of Diesel Fuel (constant value at 7.05 lbs/gal) x Sulfur Content of Diesel Fuel (Table 7)* *(Equation 10)*

Solution:

Using values from Equation 10,

T_S = *12,679,610 barrels/year (See Table 7) x conversion values x 7.05 lbs/gal (Constant Value) x 0.003 (See Table 7)*

$$T_S = 12{,}679{,}610\ \frac{barrels}{year} \times\times\ 42\ \frac{gallons}{barrel} \times 7.05\ \frac{lbs}{gallon} \times 0.003 = 11{,}263{,}297{,}56\ \frac{lbs}{year}$$

Total Sulfur Content of Diesel Consumed is at

$$\boldsymbol{11{,}263{,}297{,}56\ \frac{lbs}{year}}$$

(f.2) Total Sulfur Content

Total SO_2 Emission from All Vehicle (E_{ST})= *Solved Total Sulfur Content (T_S) x 2* *(Equation 11)*

Solution:

Using solved values from Equation 10, the new Equation 11,

E_{ST} = *11,263,297.56 lbs/year(Solved from Equation 10) x 2 x conversion values*

$$E_{ST} = 11{,}263{,}297.56\ \frac{lbs}{year} \times\ 2 \times \frac{1\ ton}{2210\ lbs} = 10{,}193.029\ \frac{tons}{year}$$

Total SO_2 Emission from all diesel-fueled vehicles is at

$$\boldsymbol{10{,}193.029\ \frac{tons}{year}}$$

(f.3) Total Sulfur Content

SO_2 Emissions (E_S) *= Total SO Emission from All Vehicle (E_{ST}) x Ratio of Registered Number of Diesel Vehicles of specific type (Table 8) over Total Number of Diesel vehicles (Table 8)* *(Equation 12)*

Solution:

Using solved values from Equation 11, the new Equation 12,

E_S = *10,193.029 tons/year (Solved from Equation 12) x [322,298 diesel UV vehicle units (Table 8) / 415,817 diesel vehicle units (Table 8)]*

$$E_S = 10{,}193.029\ \frac{tons}{year} \times \frac{322{,}298\ diesel\ UV\ vehicles}{415{,}817\ total\ diesel\ vehicles} = 7{,}900.57\ \frac{tons}{year}$$

SO_2 Emission from UV diesel-fueled vehicles is at

$$\boldsymbol{7{,}900.57\ \frac{tons}{year}}$$

Note: Practice Solving the SO_2 Emission from UV diesel-fueled vehicles for the following:

- *Diesel Fuel Consumption = 5,000,000 Barrels/Year*
- *Sulfur Content of Fuel is at 50 ppm (from DAO 2015-04) which is equivalent to 50 ppm / $(10)^6$ x 100 = 0.005%*
- *lbs of Fuel from Sulfur from 5,000,000 barrels/year x 31.5 gallons/barrel x 7.05 lbs/gal x 0.005*

ANNEX D

GUIDELINES FOR MOTOR VEHICLE COUNTING

Annual Average Daily Traffic, abbreviated AADT, is a measure used primarily in transportation planning and transportation engineering. Traditionally, it is the total volume of vehicle traffic of a highway or road for a year divided by 365 days. AADT is a useful and simple measurement of how busy the road is.

For the Data Collection to measure AADT on individual road segments, traffic data is collected either by an automated traffic counter or hiring an observer to record traffic. There are two different techniques of measuring the AADTs for road segments.

I. Continuous count data collection method
II. Manual method

The following are the types of Continuous Count data collection methods namely:

1) Annual average weekday traffic (AAWT) is similar to AADT but only includes Monday to Friday data. Public holidays are often excluded from the AAWT calculation.

2) Average summer daily traffic (ASDT) is a similar measure to the annual average daily traffic. Data collecting methods of the two are exactly the same, however the ASDT data is collected during summer only. The measure is useful in areas where there are significant seasonal traffic volumes carried by a given road.

3) Average daily traffic or ADT, and sometimes also mean daily traffic, is the average number of vehicles two-way passing a specific point in a 24-hour period, normally measured throughout a year.

**Note: ADT is not as highly referred to as the engineering standard of AADT which is the standard measurement for vehicle traffic load on a section of road, and the basis for most decisions regarding transport planning, or to the environmental hazards of pollution related to road transport*

In relation thereto, The EMB-Regional Offices (EMB-ROs) are guided accordingly to utilize the following Emissions Inventory for Mobile Source Survey Form using the methods of data collection provided:

MOBILE SOURCE SURVEY FORM

Region:
Province:
City:
Name of Road : **Length of Road:** **Type of Survey:** ADT
Month of Survey: **Time of Survey:** **Weather:**

I. CARS 4-Door, 2-Door, 5-Door(wagon/hatchback)

VEHICLE TYPE				1	2	3
CARS	Fuel Type	Fuel Blend	Vehicle Use	Vehicle Count (NO. OF VEHICLES)	No. of Trips/day	VKT (vehicle km traveled)
CARS	Gasoline	10% ethanol	Private (Personal)			
			Private (Company)			
			Public(Taxi/Rental)			
			Government			
	Diesel	2% CME	Private (Personal)			
			Private (Company)			
			Public(Taxi/Rental)			
			Government			
	LPG		Public(Taxi/Rental)			
	Hybrids		Private (Personal)			

II. UTILITY VEHICLES (SUV, PUVs, JEERNEYS, PICK-UP, LIGHT TRUCKS, DELIVERY VAN, ARMORED VAN, MULTICAB etc.)

VEHICLE TYPE				1	2	3
UV	Fuel Type	Fuel Blend	Vehicle Use	Vehicle Count (NO. OF VEHICLES)	No. of Trips/day	VKT (vehicle km traveled)
PUV (Jeepney)	Diesel	2% CME	Public Transport			
PUV (Van)	Diesel	2% CME	Public Transport			
PUV (Van)	Gasoline	2% CME	Public Transport			
Multicab	Gasoline	10% ethanol	Public Transport			
School Service (VAN)	Diesel	2% CME	Public Transport			
	Gasoline	10% ethanol	Public Transport			
small PUV Taxi	Gasoline	10% ethanol	Public Transport			
SUV/Crossovers	Diesel	2% CME	Private (Personal)			
			Private (Company)			
			Public(Taxi/Rental)			
			Government			
SUV/Crossovers	Gasoline	10% ethanol	Private (Personal)			
			Private (Company)			
			Public(Taxi/Rental)			
			Government			
Jeepney	Diesel	2% CME	Private			
Pick-up	Diesel	2% CME	Private (Personal)			
			Private (Company)			
			Public(Taxi/Rental)			
			Government			
Delivery Van	Diesel	2% CME	Private (Company)			
Armored Van	Diesel	2% CME	Private (Company)			
			Government			

III. TRUCKS (4 ,6, 10, 18, 22 Wheelers , Delivery trucks, armored trucks etc.)

VEHICLE TYPE				1	2	3
UV	Fuel Type	Fuel Blend	Vehicle Use	Vehicle Count (NO. OF VEHICLES)	No. of Trips/day	VKT (vehicle km traveled)
Trucks (Cargo carriers)	Diesel	2% CME	Private (Company)			
			Government			
Armored Trucks	Diesel	2% CME	Private (Company)			
			Government			

IV. BUS

UV	Fuel Type	Fuel Blend	Vehicle Use	Vehicle Count (NO. OF VEHICLES)	No. of Trips/day	VKT (vehicle km traveled)
Bus	Diesel	2% CME	Private (Company)			
			Government			

V. MC/TC

UV	Fuel Type	Fuel Blend	Vehicle Use	Vehicle Count (NO. OF VEHICLES)	No. of Trips/day	VKT (vehicle km traveled)
MC	Gasoline	10% ethanol	Private (Company)			
			Government			
	Diesel	2% CME	Private (Company)			
TC	Gasoline	10% ethanol	Private (Company)			
			Government			

NOTE:

*1. **Annual average weekday traffic (AAWT)** is similar to AADT but only includes Monday to Friday data. Public holidays are often excluded from the AAWT calculation.*

*2. **Average summer daily traffic (ASDT)** is a similar measure to the annual average daily traffic. Data collecting methods of the two are exactly the same, however the ASDT data is collected during summer only. The measure is useful in areas where there are significant seasonal traffic volumes carried by a given road .*

*3. **Average daily traffic** or **ADT**, and sometimes also **mean daily traffic**, is the average number of vehicles two-way passing a specific point in a 24-hour period, normally measured throughout a year.*

MOBILE SOURCE SURVEY FORM

ON ROAD VEHICLES

	CARS				UV			TRUCK		BUS	MC/TC
	Gas	Diesel	LPG	Hybrids	Gas	Diesel	Hybrids	Gas	Diesel	Diesel	Gas
Audi											
Bentley											
BMW											
BYD											
Cherry											
Chevrolet											
Chrysler											
Cooper											
Daewoo											
Dodge											
Ducati											
Euro											
Ferrari											
Ford											
Foton											
Fuzo											
GMC											
Greatwall											
Haima											
Haojue											
Harley Davidson											
Higer											
Hino											
Honda											
Hyundai											
International											
Isuzu											
Jeep											
JinLong											
Joylong											
Kawasaki											
Kia											
King Long											
KTM											
Lambourghini											
Lexus											
Mahindra											
Man											
Mazda											
Mercedez											
Mitsubishi											
Motorstar											
Nissan											
Piaggio											
Porsche											
Proton											
Puegot											
Racal											
Renault											
Rusi											
Sino											
Skygo											
Subaru											
Suzuki											
Tata											
Toyota											
Vespa											
Volkswagen											
Volvo											
Yamaha											
Yutong											