EMFAC-HK - Model Overview

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What is *EMFAC-HK*?

* A vehicle emission model that estimates emission rates and emission inventories for motor vehicles operating on roads in Hong Kong.

* Adaptation of the California Air Resources Board (CARB) EMission FACtors (EMFAC) with modifications to cater for local factors such as local vehicle fleet characteristics.

Reference Materials

* Software

* User's Manual

* Guideline on Modeling Vehicle Emissions

* EMFAC-HK Modelling Assumptions

https://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/emfac-hk.html

Model Overview

* Introduction

* Pollutants and Processes Modeled

* Overview of Basic Terminology

* Scenario Data

* Modeling Modes

* Editing Fundamental Data

Introduction

* **Emission**: 'product of an emission rate (e.g. grams per pollutant emitted over a mile or km) and vehicle activity (e.g. miles or km driven per day)'

  Emission Factor X Source Activity = Emissions

Introduction (cont.)

- Vehicle tailpipe emissions are sensitive to driving patterns (In EMFAC-HK, they are characterized by average vehicle speeds, ambient conditions, etc.)

- A common set of fleet-averaged vehicle emission factors, irrespective of driving patterns, are no longer accepted by advanced countries like the EU and the USA.

History Of *EMFAC-HK*

Version Number	Descriptions
1.2	Adapted from EMFAC2002 by CARB Used from 2005-2012
2.1	Adapted from EMFAC2009 by CARB Released on April 2012
2.5 & 2.5.1	Released on January 2013 with refinement on March
2.6	Released on January 2014
3.1 & 3.1.1	Released on January 2016 with refinement on February
3.3	Released on January 2017
3.4	Released on Februray 2018
4.1	Released on January 2019

Changes in EMFAC-HK V4.1

- ❖ Released on 2 January 2019
- ❖ Replaced EMFAC-HK V3.4
- ❖ Migrated to Intel Visual FORTRAN complier from Compaq Visual FORTRAN
- ❖ Base Year 2002-2016
- ❖ Updated implementation dates for Euro VI light buses more than 3.5t & buses between 3.5t and 9t and Euro 4 MC
- ❖ Introduced Euro IV diesel commercial vehicles phase-out program
- ❖ Updated Euro II/III franchised buses SCR retrofit program
- ❖ Updated base emission factors, speed correction factors and regime growth rates
- ❖ Disabled forecast algorithm in mitigating sharp anomalies in new sales
- ❖ Disabled 3-D array data online-editing in GUI
- ❖ Enforced speed fractions input normalization

Comparison of EMFAC-HK V3.4 & EMFAC-HK V4.1

Activity Related

V3.4	V4.1
2015 vehicle population distribution from TD (updated in 1/2017)	2016 vehicle population distribution from TD
2015 VKT from TD	2016 VKT from TD
2015 survey on vehicle classification on 100 road segments from TD and EPD in-house surveys	2016 survey on vehicle classification on 100 road segments from TD and EPD in-house surveys
EPD conducted surveys in 2012-15 on vehicle classifications to supplement TD's data (from 11 p.m. to 7 a.m.) and 64 additional road segments	EPD conducted surveys in 2012-16 on vehicle classifications to supplement TD's data (from 11 p.m. to 7 a.m.) and 64 additional road segments
2015 speed limits from TD & HyD	2016 speed limits from TD & HyD
2015 speed surveys from TD	2016 speed surveys from TD
2015 ambient temperature & relative humidity from HKO	2016 ambient temperature & relative humidity from HKO

Comparison of EMFAC-HK V3.4 & EMFAC-HK V4.1

Emission Factor Related

V3.4	V4.1
Updated Speed Correction Factors (SCF), zero mile emission factors (ZMEF) and deterioration rates (DR). Real-world vehicle emission data (242 vehicles with 120 of Euro IV-VI) are used to determine these factors or as references. International emission factors are used using local data as reference if few data are collected in some tech groups.	Same approach but having more real-world vehicle emission data (320 vehicles with 200 of Euro IV-VI).
Estimated occurrence of normal, high and super emitters for petrol cars and LPG taxis based on 2015 remote sensing data.	Estimated occurrence of normal, high and super emitters for petrol cars and LPG taxis based on 2016/17 remote sensing data.
No start emission for diesel vehicles.	Added start emissions for SCR diesel vehicles, aligning with CARB's EMFAC.

Comparison of EMFAC-HK V3.4 & EMFAC-HK V4.1

Modelling Methodology Related

V3.4	V4.1
Population Forecast: • All except franchised buses, taxis & public light buses (PLB) used a smoothing function to mitigate sharp new sales in population forecast.	Population Forecast: • Disabled the smoothing function in mitigating sharp new sales in population forecast.
Exhaust Tech Group description: No Euro 4 motorcycle (MC)	Exhaust Tech Group description: Added Euro 4 MC (TG278)

Comparison of EMFAC-HK V3.4 & EMFAC-HK V4.1

Policy Related

V3.4	V4.1
Updated Euro VI implementation dates according to legislative amendments	Plan to implement - • Euro 4 MC in 2020 • Euro VI light buses more than 3.5t and buses 3.5- 9t in 2021
LPG light buses are available	Based on the information from trade, no newly registered LPG light buses from 2021 (**for assessment purpose only**).
No program to phase out Euro IV DCV	Plan to progressively phase out Euro IV DCV by end 2023

Changes in Implementation Dates of Vehicle Emission Standards

EMFAC-HK V3.4

Vehicle Class\Fuel Type		Euro VI		
		LPG	Petrol	Diesel
Private Car			1.7.17	1.10.17[#]
Goods Vehicle	<= 3.5t	NA	1.1.18	
	>3.5 t		1.10.18	
Bus	<= 9 t	NA	No schedule	
	>9 t		1.10.18	
Light Bus	<= 3.5t		1.1.18	
	>3.5 t		No schedule	
Taxi			1.7.17	NA

EMFAC-HK V4.1

Vehicle Class\Fuel Type		Euro VI		
		LPG	Petrol	Diesel
Private Car			1.7.17	1.10.17[#]
Goods Vehicle	<= 3.5t	NA	1.1.18	
	>3.5 t		1.10.18	
Bus	<= 9 t	NA	1.1.2021 (tentative)	
	>9 t		1.10.18	
Light Bus	<= 3.5t		1.1.18	
	>3.5 t		1.1.2021 (tentative)	
Taxi			1.7.17	NA

Changes highlighted in red.

Emfac-HK homepage, Appendix III

Notes: # HK adopted California LEV III Standards on 1 October 2017 for diesel PC.

Changes in Implementation Dates of Vehicle Emission Standards

EMFAC-HK V3.4

Vehicle Class\ Fuel Type	Euro IV		
	LPG	Petrol	Diesel
Motorcycle	NA	No Schedule	

EMFAC-HK V4.1

Vehicle Class\ Fuel Type	Euro IV		
	LPG	Petrol	Diesel
Motorcycle	NA	1.7.2020 (tentative)	NA (from 1.7.2020 tentative)
Motor tricycle	No Schedule		

Changes highlighted in red.

Emfac-HK homepage, Appendix III

Addition of Exhaust Tech Group

Exhaust Tech Group Added:

Vehicle Class	Vehicle Emission Standards	Technology Group Index
Motorcycle	Euro 4	278

Comparison of EMFAC-HK V3.4 & EMFAC-HK V4.1

Graphical User Interface (GUI) Related

V3.4	V4.1
Main screen size is pretty long	Resized main screen for easier operation
For Population, Accrual, Trip & VKT editing: • Direct cell-by-cell editing in 2D grid • Multiple cells editing by copying, editing and pasting to and from external spreadsheets	For Population, Accrual, Trip & VKT editing: • Disabled direct cell-by-cell editing in 2D grid • Multiple cells editing by copying, editing and pasting to and from external spreadsheets Note: Nothing is changed from input file point of view.

Revision History Of *EMFAC-HK*

Visit EMFAC-HK webpage for full details:

https://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/emfac-hk.html

Pollutants

- Hydrocarbons (HC) – can be expressed as the following:

  - TOG (Total Organic Gases, regardless of reactivity)

  - VOC (Volatile Organic Compounds), also known as Reactive Organic Gases (ROG)

  - THC (Total HydroCarbons, compounds with H and C atoms only, carbonyls and halogens are not included)

  - CH4 (methane)

- Carbon monoxide (CO)

- Nitrogen oxides (NOx)

Pollutants (cont.)

* Carbon dioxide (CO_2)

* Particulate matter (PM)

  * PM estimates are provided either as total suspended particulate (30 microns or less) (TSP), respirable suspended particulate (10 microns or less in diameter) (RSP or PM_{10}), or fine suspended particulate (2.5 microns or less in diameter) (FSP or $PM_{2.5}$).

Exhaust
Evaporative (Evap)
EMISSIONS PROCESSES

Emission Processes

* Running Exhaust

* Starting Exhaust (diesel vehicles fitted with SCR and petrol/LPG vehicles only)

* Diurnal Evap (partial day, multi-day)

* Resting Loss Evap (partial day, multi-day)

* Hot Soak Evap

* Running Evap

Running Exhaust Emissions

* emissions that come out of the vehicle tailpipe while it is traveling on the road, including at speed, and idling that occurs as part of normal driving, such as at intersections.

Starting Exhaust Emissions

* tailpipe emissions that occur as a result of starting a vehicle fitted with a 3-way catalyst or SCR$^{\#}$ when the catalyst or SCR is cold.

* These emissions are independent of running exhaust emissions and can be thought of as a slug of emissions associated with starting a vehicle .

* The magnitude of these emissions is dependent on how long the vehicle has been sitting prior to starting.

$^{\#}$ SCR – selective catalytic reduction device

Diurnal Evaporative Emissions

* Hydrocarbon (HC) emissions that occur when rising ambient temperatures cause fuel evaporation from vehicles sitting throughout the day.

* These losses are from leaks in the fuel system, fuel hoses, connectors, and as a result of breakthrough of vapors from the carbon canister.

* If a vehicle is sitting for a period of time after running, emissions from the first 35 minutes are counted as hot soak and emissions from the remaining period are counted as diurnal emissions, provided that the ambient temperature is *increasing* during the remaining period of time.

Resting Loss Evaporative Emissions

* HC emissions from fuel permeation through rubber and plastic components while vehicle is sitting.

* Emissions are counted as resting loss emissions if the vehicle has not been operated for 35 minutes and vehicle is still stationary, but the ambient temperature is either constant or *decreasing*.

Hot Soak Evaporative Emissions

* HC emissions that occur immediately after a trip end due to fuel heating and the fact that the engine remains hot for a short time after being switched off.

* In older, carbureted vehicles these emissions are attributed to vapor losses from the carburetor float bowl. In newer, fuel-injected vehicles, these vapor losses come from leaky fuel injectors or from fuel hoses.

Running Losses Evaporative Emissions

* Evaporative HC emissions that occur when hot fuel vapors escape from the fuel system or overwhelm the carbon canister while the vehicle is operating.

BASIC TERMINOLOGY

Vehicle Fleet and Vehicle Class

Fuel Type

Technology Group

Model Year

Activity

Population

VKT

Trips

Vehicle Fleet / Vehicle Class

* "Vehicle Fleet"
  * "Vehicle fleet" refers to the mixture of all the different types of motor vehicles operating on roads in Hong Kong.
* "Vehicle Class"
  * The fleet is sub-divided into multiple categories called "vehicle classes" (for example, class 1, or private cars). These classes are based on the type of vehicle, but they also take weight class (e.g. >15 tonnes), fuel type (i.e. gas, diesel, or LPG), and usage into account.
  * EMFAC-HK contains 16 vehicle classes, plus 5 unused "placeholders" for a total of 21 vehicle classes.

Fuel Type

* Petrol vehicles (exhaust, evap)

* Diesel vehicles (exhaust)

* Liquefied Petroleum Gas (LPG) vehicles (exhaust)

EMFAC-HK Version 4.1
Vehicle Classification Chart (Classes 1-10)

Index	Vehicle Class Description	Fuel Type*	Gross Vehicle Weight (tonnes)	Code
1	Private Cars (PC)	ALL	ALL	PC
2	Taxi	ALL	ALL	TAXI
3	Light Goods Vehicles (<=2.5t)	ALL	≤ 2.5	LGV3
4	Light Goods Vehicles (2.5-3.5t)	ALL	2.5-3.5	LGV4
5	Light Goods Vehicles (3.5-5.5t)	ALL	3.5-5.5	LGV6
6	Medium & Heavy Goods Vehicles (5.5-15t)	ALL	5.5-15	HGV7
7	Medium & Heavy Goods Vehicles (≥15t)	ALL	≥ 15	HGV8
8	Public Light Buses	ALL	ALL	PLB
9	Private Light Buses (≤ 3.5t)	ALL	≤ 3.5	PV4
10	Private Light Buses (>3.5t)	ALL	> 3.5	PV5

* All: petrol, diesel, or LPG.

EMFAC-HK Version 4.1
Vehicle Classification Chart (Classes 11-21)

Index	Vehicle Class Description	Fuel Type*	Gross Vehicle Weight (tonnes)	Code
11	Non-franchised Buses (<6.4t)	ALL	< 6.4	NFB6
12	Non-franchised Buses (6.4-15t)	ALL	6.4-15	NFB7
13	Non-franchised Buses (>15t)	ALL	>15	NFB8
14	Single Deck Franchised Buses	ALL	ALL	FBSD
15	Double Deck Franchised Buses	ALL	ALL	FBDD
16	Motor Cycles	ALL	ALL	MC
17	Placeholder (P1)	--	--	P1
18	Placeholder (P2)	--	--	P2
19	Placeholder (P3)	--	--	P3
20	Placeholder (P4)	--	--	P4
21	Placeholder (P5)	--	--	P5

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Technology Groups

* represents vehicles from the same class but have distinct emission control technologies; have similar in-use deterioration rates; and, respond the same to repair.

* can represent vehicles whose emissions standards (i.e., pre-Euro, Euro-I) are the same, or those that have specific equipment installed on them (e.g., multi-port fuel injection, three-way catalyst, adaptive fuel controls, etc.) which makes them behave the same.

* Separate technology groups for exhaust and evap emissions

Exhaust Tech Group Indexes (Example Only)

Diesel Heavy Goods Vehicles with GVW >15 t (HGV8)

Vehicle Class	Fuel Type	Vehicle Emission	Tech Group Index
HGV8	Diesel	pre-Euro	153
HGV8	Diesel	pre-Euro DOC Retrofitted	155
HGV8	Diesel	Euro I	154
HGV8	Diesel	Euro II	157
HGV8	Diesel	Euro III	159
HGV8	Diesel	Euro IV	160
HGV8	Diesel	Euro IV - DPF	163
HGV8	Diesel	Euro IV - SCR	164
HGV8	Diesel	Euro V	161
HGV8	Diesel	Euro V - DPF	165
HGV8	Diesel	Euro V - SCR	166
HGV8	Diesel	Euro VI	162

Model Years

* model years tell the ages of the vehicles.

* within each vehicle class, each model year is represented by a combination of technology groups.

* model estimates emission rates for 1965 to 2040 model years.

Calendar Years

* EMFAC-HK estimates calendar years from 1997 to 2040.

* Only one calendar year/scenario can be run at a time

Age

* How old a vehicle of a particular model year is relative to the calendar year

* Difference between the calendar year and model year, plus 1

Activity

* for each vehicle class and fuel type, these terms are commonly referred to as vehicle activity:
    * Vehicle population
    * Accrual
    * Odometer
    * Vehicle Kilometers/Miles Travelled (VKT/VMT)
    * Trips

Population

* determined through an analysis of traffic census data. These data are used in developing vehicle age matrices for the base year, as well as forecast/backcast of population to other calendar years
  * EMFAC-HK v4.1: 2002-2016 base years

Accrual

* Vehicle accrual is the annual mileage a vehicle travelled against its age.

* Newer vehicles driven more than older ones

Vehicle Kilometers Traveled (VKT)

* represents total distance travelled on a weekday

* Estimate VKT based on vehicle population and vehicle accrual

* Modify the accrual rates to match the VKT estimates by vehicle class.

Starts/Trips

* Number of trips or starts is the number of times a vehicle is started for separate trips made per weekday

* Emissions of diesel vehicles fitted with SCR and petrol and LPG vehicles are affected by starts/trips.

Basic Data for a Scenario

* Geographic area (Hong Kong)
* Forecast Year (i.e., "Calendar" Year)
* Alternate Baseline Year (2013 or newer)
* Title
* Month or Season
* Model Years Included in calculation
* Emissions mode (Burden or EMFAC)
* Output formats, and
* Output options (frequency, pollutant form)

Mode Comparison

BURDEN

* Emissions estimates
* total emissions in tonnes per period (weekday or hour) for each pollutant, by vehicle class and the total vehicle fleet
* emission factors--corrected for ambient conditions and speeds--combined with vehicle activity to calculate emissions in tonnes per day

EMFAC

* Emission Factors (EFs) in terms of grams of pollutant emitted per vehicle activity
* Calculates matrix of EFs at specific values of T (0^oC to 40^oC), RH (0% to 100%), and vehicle speed (10 kph to 130 kph) for each vehicle class/technology combination.

BURDEN Mode Output Options

* Detailed Planning Inventory (CSV) - a comma-separated file (with a "csv" extension) which can be read by any spreadsheet program e.g. MS Excel. It contains emission estimates for all 16-vehicle classes by fuel type. It is recommended that new users select this as an output option to get an idea of the entire emissions.

BURDEN Mode Output (cont.)

* **MVEI7G (BCD) File** - This is also a comma-separated file but it has a "bcd" extension. This file is in the same format. This file has the same information as "Detailed Planning Inventory" but in columnar format, which makes it suitable for sorting using spreadsheets.

BURDEN Mode Output (cont.)

* Weighted Model Year Activity Output (*.WT) Gives the activity components like population, VKT, Trips, Accrual Rate and Odometer by model year.

BURDEN Mode Output (cont.)

* **Detailed Outputs (BDN) File** - gives the Burden output for each vehicle class and emissions process by Model year and Tech groups in a columnar, record-style format, which makes it suitable for importing to a spreadsheet or database. This format is useful for the air pollution modeling and planning communities.

Burden Report Output Types

Report Type	Description	Format	File Extension
Detailed Planning Inventory (CSV)	Contains emission estimates for all 16-vehicle classes by fuel type.	comma-separated	*.CSV
MVEI7G (BCD) File	Emissions Database for Planning.	comma-separated	*.BCD.CSV
Detailed Outputs (BDN)	Gives the Burden output by Model year, Tech groups and Speed bin.	comma-separated	*.BDN.CSV
Weighted Model Year Activity Output (WT)	Gives the Activity components like population, VKT, trips, accrual, and odometer by model year.	No delimiters	*.WT

Detailed Planning Inventory (*.csv)

HK_2030_Burden.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Title : Hong Kong SAR Annual CYr 2030 Default Title																				
2	Version : Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta																				
3	Run Date : 2015/11/10 11:18:08																				
4	Scen Year: 2030 -- All model years in the range 1986 to 2030 selected																				
5	Season : Annual																				
6	Area : Hong Kong SAR																				
7	I/M Stat : HK I/M CY2013+ program in effect																				
8	Emissions: Tonnes Per Day																				
9	••																				
10		PC-NCAT	PC-CAT	PC-DSL	PC-LPG	PC-TOT	TAXI-NCAT	TAXI-CAT	TAXI-DSL	TAXI-LPG	TAXI-TOT	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV<=2.5t	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5	LGV2.5-3.5
11	Vehicles	3	790870	277	0	791151	0	0	0	18204	18204	0	2	1003	0	1005	0	1058	53842	0	54900
12	VKT	51	22087438	5777	0	22093266	0	0	0	7670384	7670384	14	96	74300	0	74410	7	67137	3550588	0	3617731
13	Trips	4	1186420	416	0	1186840	0	0	0	72821	72821	1	7	4013	0	4021	1	4231	215391	0	219622
14	VOC Emissions																				
15	Run Exh	0.00009	0.06256	0.0004	0	0.06305	0	0	0	0.16034	0.16034	0.00002	0.00007	0.00114	0	0.00123	0.00001	0.00285	0.05605	0	0.05891
16	Start Ex	0.00004	0.05779	0	0	0.05783	0	0	0	0.03817	0.03817	0.00002	0.00003	0	0	0.00005	0.00001	0.00116	0	0	0.00117
17	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
18																					
19	Diurnal	0.00003	0.30319	0	0	0.30322	0	0	0	0	0	0.00001	0	0	0	0.00001	0	0.00067	0	0	0.00067
20	Hot Soak	0.00002	0.19507	0	0	0.19509	0	0	0	0	0	0.00001	0.00001	0	0	0.00002	0	0.00137	0	0	0.00137
21	Running	0.00009	0.30161	0	0	0.30171	0	0	0	0	0	0.00004	0.00002	0	0	0.00007	0.00001	0.00436	0	0	0.00437
22	Resting	0.00004	0.51523	0	0	0.51527	0	0	0	0	0	0.00001	0	0	0	0.00001	0	0.00105	0	0	0.00105
23	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
24	Carbon Monoxide Emissions																				
25	Run Exh	0.00122	3.85113	0.00243	0	3.85477	0	0	0	10.43512	10.43512	0.00014	0.00112	0.01836	0	0.01961	0.00006	0.17308	0.8737	0	1.04684
26	Start Ex	0.00021	1.34459	0	0	1.3448	0	0	0	0.18225	0.18225	0.00004	0.00025	0	0	0.0003	0.00002	0.03595	0	0	0.03597
27	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
28	Oxides of Nitrogen Emissions																				
29	Run Exh	0.00016	0.36871	0.00086	0	0.36973	0	0	0	2.0571	2.0571	0.00006	0.00007	0.02986	0	0.02999	0.00003	0.00139	1.50595	0	1.50736
30	Start Ex	0.00003	0.01248	0	0	0.01251	0	0	0	0.05446	0.05446	0	0.00003	0	0	0.00003	0	0.00057	0	0	0.00058
31	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
32	Carbon Dioxide Emissions (000)																				
33	Run Exh	0.00001	4.84702	0.00124	0	4.84827	0	0	0	1.78523	1.78523	0	0.00002	0.02227	0	0.02229	0	0.01223	1.06443	0	1.07666
34	Start Ex	0	0.08693	0	0	0.08694	0	0	0	0.00572	0.00572	0	0	0	0	0	0	0.00031	0	0	0.00031
35	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
36	PM10 Emissions																				
37	Run Exh	0	0.06703	0.00008	0	0.06712	0	0	0	0	0	0	0	0.00023	0	0.00023	0	0.00024	0.01329	0	0.01353

HK_2030_Burden

MVEI7G CSV file (*.bcd.csv)

Weighted Model Year Activity Output (*.WT)


```
HK_2030_Burden.wt   ×
|....0....|....1.0....|....2.0....|....3.0....|....4.0....|....5.0....|....6.0....|....7.0....|....8.0....|....9.0....|...1
 1  --------------------------------------------------------------------------------------------------
 2   Calendar Year: 2030
 3     Model Years: 1986 to 2030
 4          Title: Hong Kong SAR Annual CYr 2030 Default Title
 5           Area: Hong Kong
 6        SubArea: Average
 7        Program: Emfac-HK V3.09 beta V3.0.9.beta 151008 Sp: Beta Version Pr: Emfac-HK HK3.0.9.beta
 8       Run Date: 2015/11/10 11:18:08
 9
10   SCEN  VEH                   VEH POP          VKT           TRIPS         ACCRUAL        ODOMETER
11   YEAR  CLS TECH  MYR         (number)      (km/day)      (per day)    (km/yr/veh)       (km/veh)
12
13   2030    1 NCAT 1986              0.          3.31            0.          6198.         352005.
14   2030    1 NCAT 1987              0.          3.43            0.          6228.         345808.
15   2030    1 NCAT 1988              0.          5.28            0.          6259.         339580.
16   2030    1 NCAT 1989              0.          8.41            1.          6289.         333321.
17   2030    1 NCAT 1990              1.         11.29            1.          6322.         327032.
18   2030    1 NCAT 1991              1.         18.92            2.          6355.         320710.
19   2030    1 NCAT 1992              0.          0.00            0.             0.             0.
20   2030    1 NCAT 1993              0.          0.00            0.             0.             0.
21   2030    1 NCAT 1994              0.          0.00            0.             0.             0.
22   2030    1 NCAT 1995              0.          0.00            0.             0.             0.
23   2030    1 NCAT 1996              0.          0.00            0.             0.             0.
24   2030    1 NCAT 1997              0.          0.00            0.             0.             0.
25   2030    1 NCAT 1998              0.          0.00            0.             0.             0.
26   2030    1 NCAT 1999              0.          0.00            0.             0.             0.
27   2030    1 NCAT 2000              0.          0.00            0.             0.             0.
28   2030    1 NCAT 2001              0.          0.00            0.             0.             0.
29   2030    1 NCAT 2002              0.          0.00            0.             0.             0.
30   2030    1 NCAT 2003              0.          0.00            0.             0.             0.
31   2030    1 NCAT 2004              0.          0.00            0.             0.             0.
32   2030    1 NCAT 2005              0.          0.00            0.             0.             0.
33   2030    1 NCAT 2006              0.          0.00            0.             0.             0.
34   2030    1 NCAT 2007              0.          0.00            0.             0.             0.
35   2030    1 NCAT 2008              0.          0.00            0.             0.             0.
36   2030    1 NCAT 2009              0.          0.00            0.             0.             0.
37   2030    1 NCAT 2010              0.          0.00            0.             0.             0.
38   2030    1 NCAT 2011              0.          0.00            0.             0.             0.
39   2030    1 NCAT 2012              0.          0.00            0.             0.             0.
40   2030    1 NCAT 2013              0.          0.00            0.             0.             0.
41   2030    1 NCAT 2014              0.          0.00            0.             0.             0.
```

Detailed Output File (*.BDN.CSV)

EMFAC Mode Output Options

* Impact Rate Detail (RTL). This file generates detailed emission factors for each vehicle class and technology group by speed bin. 9 different emission factor tables are provided, described in next slide. This file has an "RTL" extension, but is in a CSV format. Hence, any spreadsheet program can read this file. It is recommended that new users output this file to get a feel for the type of information generated in *EMFAC* mode.

EMFAC Mode Output Options (cont.)

* Impact Rate Detail (RTL). The tables contained in the RTL file include:
    * Table 1: Running Exhaust Emissions (grams/km)
    * Table 2: Starting Emissions (grams/trip)
    * Table 4: Hot Soak Emissions (grams/trip)
    * Table 5a: Partial Day Diurnal Loss Emissions (grams/hour)
    * Table 5b: Multi-Day Diurnal Loss Emissions (grams/hour)
    * Table 6a: Partial Day Resting Loss Emissions (grams/hour)
    * Table 6b: Multi-Day Resting Loss Emissions (grams/hour)
    * Table 7: Estimated Travel Fractions
    * Table 8: Evaporative Running Loss Emissions (grams/minute)

EMFAC Report Output Types

Report Type	Description	Format	File Extension
Impact Rate Detail (RTL)	generates detailed emission factors by activity (i.e., g/km, g/trip) for each vehicle class and technology group by speed bin.	comma-separated	*.RTL.CSV

EMFAC Impact Rate Detail Format (*.RTL)

Other Output Options

* Output Frequency (BURDEN mode Only)

    * Daily (average weekday), or

    * hourly (values for all 24-hours, and includes daily total). Note: hourly generates 25 times more output, which can lead to very large output files.

* Output Particulate As...

    * User selects either total PM (or TSP), PM_{10} (or RSP), or $PM_{2.5}$ (or FSP)

* Output Hydrocarbon As..

    * User selects either TOG, THC, VOC, or CH4

EDITING FUNDAMENTAL DATA

Exhaust Tech Fractions

Evap Tech Fractions

Population (Calendar or Alternate Baseline)

Accrual

Trips

VKT

RVP

Speed Fractions

Temperature

Relative Humidity

Editing Fundamental Data – Tech / IM

* **Extra I&M benefits**

* **Exhaust Technology Fraction**
  - *Apply to model year / model year range*
  - *Apply to other vehicle classes*
  - *Technology specific*

* **Evaporative Technology Fractions**
  - *Petrol vehicles only*

Editing Fundamental Data - Activity

! SEQUENCE of edits

Edits applied proportionally

*✱ **Population (Alt. Base Year or Calendar Year)***
- *Edits applied proportionally*
- *Edits by vehicle, fuel, and age*
- *Age distributions*

*✱ **Accrual** (defn.) annual distance driven*
- *Population weighted accrual rates*
- *Edits by vehicle class, fuel and age*

*✱ **Trips** based on the number of engine on to off events*

- *Edits by vehicle class, fuel and hour (hourly model!)*

*✱ **VKT***
- *Edits by vehicle class, fuel and hour*

Editing Fundamental Data - Profile/Speeds

* **Reid Vapour Pressure (RVP)** *(evap emissions for petrol vehicles only)*

* **Speed Fractions**

  - Edits by vehicle class, hour and speed bin

  - Apply changes to this hour / vehicle class

  - Apply to others

Editing Fundamental Data - Temperature/RH Profiles

✳ **Temperature** / Relative Humidity (RH)

   ✳ *Edits by hour*

   ✳ *Modify for range of hours*

   ✳ *Only annual average can be edited via GUI*

   ✳ *Monthly average can be customized via INP file*

Thank you.