EMFAC-HK

General Guidelines for
EMFAC-HK Model Input Data

References

- *Guideline on Modelling Vehicle Emissions*, April 2012.
  - http://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/air_guidelines.html

Outline

- General
- Exhaust Technology Group Indexes
- Implementation of Vehicle Emission Standards
- Vehicle Fleet compositions
- Speed Distributions
- Hourly temperature and relative humidity data

General

- Vehicle emissions are affected by traffic flow patterns, ambient temperature, relative humidity, and vehicle fleet composition.
- In modelling vehicle emissions, project proponents or environmental consultants should use model input data as representative of the situations under study as practicable.
- When site-specific information is absent, project proponents or environmental consultants should make reference to data obtained from areas bearing relevant similarities for making reasonable estimates for their environmental impact assessment studies.

alternative vehicle emission modelling methodologies

- can adopt alternative vehicle emission modelling methodologies if the alternatives can also serve the purpose of EIA.

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Key features of modelling methodology:

- based on driving patterns characterized by average vehicle speeds;

- taking into account vehicle emission design technologies and vehicle emission deterioration rate;

- other local factors.

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The model is a tool for estimating project specific fleet averaged vehicle emission factors and vehicle emissions for the following primary pollutants:

- hydrocarbons (TOG, THC, VOC, CH_4)
- carbon monoxide (CO)
- carbon dioxide (CO_2)
- nitrogen oxides (NOx) (NO + NO_2)
- particulate matters (PM_{30}, PM_{10} & $PM_{2.5}$)

Fuel-consumption-related pollutants

- Estimate emissions of fuel-consumption-related pollutants such as SOx and lead by a mass-balance approach based on fuel consumption data.
- can refer to PART 5, the particulate emission factor model from USEPA

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Modelling the following emissions:

- Running exhausts
- Starting exhausts (for petrol vehicles only)
- Evaporative emissions (for petrol vehicles only)

Model Choice

- EMFAC-HK V2.1 BC (base case)
  - works for calendar years 1997-2012
  - Contains no inspection and maintenance (I/M) program
- EMFAC-HK V2.1 I&M (inspection & maintenance case)
  - works for calendar years 2013-2040
  - Contains I/M programs using remote sensing and dynamometer testing for petrol/LPG vehicles

Modeling Mode
EMFAC vs Burden

- Burden mode
  - Calculates area-specific emissions in tonnes per weekday or tonnes per weekday-hour.
  - reports total emissions for each pollutant by vehicle class.
  - Emissions/day = emission factors corrected for ambient conditions and speeds x vehicle activity
  - Vehicle activity: number of vehicles, kilometers driven per day, and number of daily trips.
  - hourly or daily total output

Modeling Mode
EMFAC vs Burden (cont.)

- Emfac mode
  - generates emission factors in terms of grams of pollutant emitted per vehicle activity.
  - Vehicle activity: g/km or g/hr, or g/start, depending on the emission process.
  - The emission factors depend on basic scenario data
  - Includes options for calendar year and month.

* idling emissions should not be used.

Modeling Mode
EMFAC vs Burden (cont.)

- Emfac mode (cont.)
  - calculates a matrix of emission factors at specific values of temp (0oC to 40oC), RH (0% to 100%), and vehicle average speed (1.6km/h to 140 km/h) for each vehicle class/technology combination.
  - an additional input form allows users to customize their output and select specific temp, RH and average speed values.
  - generates files for use with the DTIM, AIRSHED, CALINE and URBEMIS.

Exhaust Technology Groups

- Default exhaust technology fractions provided in EMFAC-HK by model year and vehicle class
- Do not use the default exhaust technology fractions unless these fractions are representative of your environmental impact assessment studies.
- Should consider:
  - committed vehicle exhaust emission control programmes for the vehicle class; and
  - a realistic estimation of the vehicle fleet composition of the year, for which the environmental impacts are to be assessed.

Exhaust Technology Groups

- Vehicles of different exhaust emission standards are represented in the model by specific technology group indexes.
- The technology group indexes in the EMFAC-HK model are in Appendix III of the *Guideline*.

Vehicle Emission Controls

- EMFAC-HK includes, as default, all existing vehicle emission control programmes by vehicle class and model year.
- Vehicle emission control measures not included in the model, the additional assumptions adopted for working out the emissions should be technically sound, well supported and applicable to the situation.

HK Stds & Implementation Dates

<table>
<tr><td>HK Imple. Dates</td><td colspan="3">Pre - Euro</td><td colspan="2">Euro I</td><td colspan="3">Euro II</td></tr>
<tr><td colspan="2">Vehicle Class</td><td>Pre - ULP</td><td>ULP</td><td>Diesel</td><td>Petrol</td><td>Diesel</td><td>LPG</td><td>Petrol</td><td>Diesel</td></tr>
<tr><td colspan="2">Private Car</td><td rowspan="2">< 1.1.92</td><td rowspan="2">1.1.92</td><td rowspan="5">< 1.4.95</td><td rowspan="5" colspan="2">1.4.95</td><td rowspan="5">NA</td><td>1.4.97</td><td>1.4.98</td></tr>
<tr><td rowspan="2">Goods Vehicle</td><td><= 2.5 t</td><td rowspan="3">1.10.98</td></tr>
<tr><td>2.5 t - 3.5 t</td><td rowspan="2">< 1.4.95</td><td rowspan="2">NA</td></tr>
<tr><td rowspan="2">Light Bus</td><td><= 3.5 t</td></tr>
<tr><td>> 3.5 t</td><td colspan="2" rowspan="2">< 1.4.95</td></tr>
<tr><td colspan="2">Goods Vehicle & Other Bus > 3.5 t</td><td colspan="2">1.4.97</td></tr>
<tr><td colspan="2">Taxi</td><td>< 1.1.92</td><td>1.1.92</td><td>< 1.1.96</td><td>1.4.95</td><td>1.1.96</td><td>1.8.01</td><td>1.10.98</td><td>1.7.99</td></tr>
<tr><td colspan="2">Motorcycle</td><td colspan="3">< 1.10.99</td><td colspan="2">1.10.99</td><td colspan="3">NA</td></tr>
</table>

EPD. Guideline on Modelling Vehicle Emissions, Appendix II, 2 April 2012

HK Stds & Implementation Dates

<table>
<tr><td colspan="2">HK Imple. Dates</td><td colspan="3">Euro III</td><td colspan="3">Euro IV</td></tr>
<tr><td colspan="2">Vehicle Class</td><td>LPG</td><td>Petrol</td><td>Diesel</td><td>LPG</td><td>Petrol</td><td>Diesel</td></tr>
<tr><td colspan="2">Private Car</td><td rowspan="2">NA</td><td colspan="2">1.1.01</td><td rowspan="2">NA</td><td colspan="2">1.1.06</td></tr>
<tr><td rowspan="2">Goods Vehicle</td><td><= 2.5 t</td><td colspan="2" rowspan="2">1.1.02</td><td colspan="2" rowspan="2">1.1.07</td></tr>
<tr><td> > 2.5 t - 3.5 t</td><td>NA</td></tr>
<tr><td rowspan="2">Light Buses</td><td><= 3.5 t</td><td rowspan="2">1.8.03</td><td colspan="2">1.1.02</td><td colspan="3">1.1.07</td></tr>
<tr><td> > 3.5 t</td><td>1.10.01</td><td>1.8.03</td><td colspan="3">1.10.06</td></tr>
<tr><td colspan="2">Goods Vehicle & Other Bus > 3.5 t</td><td>NA</td><td colspan="2">1.10.01</td><td>NA</td><td colspan="2">1.10.06</td></tr>
<tr><td colspan="2">Taxi</td><td>1.8.03</td><td>1.1.01</td><td>NA (fr. 1.8.01)</td><td colspan="2">1.1.06</td><td>NA</td></tr>
<tr><td colspan="2">Motorcycle</td><td colspan="3">1.1.07</td><td colspan="3">NA</td></tr>
</table>

EPD. Guideline on Modelling Vehicle Emissions, Appendix II, 2 April 2012

Proposed HK Stds & Implementation Dates

<table>
<tr><td colspan="2">HK Imple. Dates</td><td colspan="3">Euro V</td><td colspan="3">Euro VI</td></tr>
<tr><td colspan="2">Vehicle Class</td><td>LPG</td><td>Petrol</td><td>Diesel</td><td>LPG</td><td>Petrol</td><td>Diesel</td></tr>
<tr><td colspan="2">Private Car</td><td rowspan="3">NA</td><td colspan="2">1.6.12</td><td rowspan="3">NA</td><td colspan="2" rowspan="2">1.9.15</td></tr>
<tr><td rowspan="2">Goods Veh <=3.5 t</td><td><= 1.305 t</td><td rowspan="2">1.6.12</td><td rowspan="2">31.12.12</td></tr>
<tr><td>> 1.305 t - 3.5 t</td><td colspan="2">1.9.16</td></tr>
<tr><td rowspan="3">Light Bus</td><td><= 1.305 t</td><td colspan="3" rowspan="3">1.6.12</td><td colspan="3">1.9.15</td></tr>
<tr><td>>1.305 t-3.5 t</td><td colspan="3">1.9.16</td></tr>
<tr><td>> 3.5 t</td><td colspan="3">2016</td></tr>
<tr><td colspan="2">Goods Vehicle & Other Bus > 3.5 t</td><td>NA</td><td colspan="2">1.6.12</td><td>NA</td><td colspan="2">2016</td></tr>
<tr><td colspan="2">Taxi</td><td colspan="2">1.6.12</td><td>NA</td><td colspan="2">1.9.15</td><td>NA</td></tr>
<tr><td colspan="2">Motorcycle</td><td colspan="6">NA</td></tr>
</table>

EPD. Guideline on Modelling Vehicle Emissions, Appendix II, 2 April 2012

Vehicle Fleet Compositions

- The latest vehicle age distribution data is posted on EPD's website:
  - http://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/air_guidelines.html
- Justify any other necessary assumptions

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Supporting Data for Modelling

Supporting Data for Modelling:

- Engine-specific;
- Local fleet composition and characteristics;
- Project specific (traffic pattern, ambient conditions).

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Supporting Data - Engine Specific

- Zero mile emission factors (ZMEF) – hard-coded in the model and provided in the GUI in the form of different technology group indexes for selection (Appendix III of the Guideline);
- Engine emission deterioration rates (DRs) – hard-coded in the model;
- Correction factors – hard-coded in the model;

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Supporting Data - Local Fleet Specific

- Vehicle age distribution for each vehicle class (the one for 2010 posted on EPD's website);
- Annual mileage distribution vs. vehicle age (default distribution is provided in the model);
- Daily trips per vehicle (default distribution is provided in the model);
- Distribution of high emitters vs. vehicle age (hard-coded in the model)

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Supporting Data – Project Specific (I)

- Fleet composition in respect of vehicle emission standards and the retrofit of after-exhaust treatment devices for each model year (first registration year) – existing distribution posted on EPD's website;

- Diurnal variation of vehicle kilometer travelled (VKT); and

- Diurnal variation of total daily trips

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Supporting Data – Project Specific (II)

- Distribution of VKT fractions for each average speed bin;

- Ambient temperature and relative humidity.

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Project Specific Input Data (cont.)

- **Diurnal Variation of VKT**
  - Should use site-specific figures
  - In the absence of site specific figures, estimate based on the traffic data in TD's Annual Traffic Census (ATC)

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Project Specific Input Data
VKT Distribution for Vehicle Speed Bins

References:

- Speed vs. volume/capacity ratio (like those published in report of Comprehensive Transport Study)

- diurnal variation of traffic flow from ATC

- Posted speed limits on roads obtained from Highway Dept. or TD

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Project Specific Input Data
VKT Distribution for Vehicle Speed Bins

Mandatory requirements:

- Maximum speed
  - buses and goods vehicles > 5.5 tonne: 70 km/hr
  - Public light buses: 80 km/hr

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Project Specific Input Data
VKT Distribution for Vehicle Speed Bins

For peak hour, references:

- Conduct surveys
- Info from TD, like Car Journey Time Survey for Monitoring Traffic Congestions
- Roads with similar traffic patterns
- Speed vs. volume/capacity ratio
- Traffic models

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Project Specific Input Data

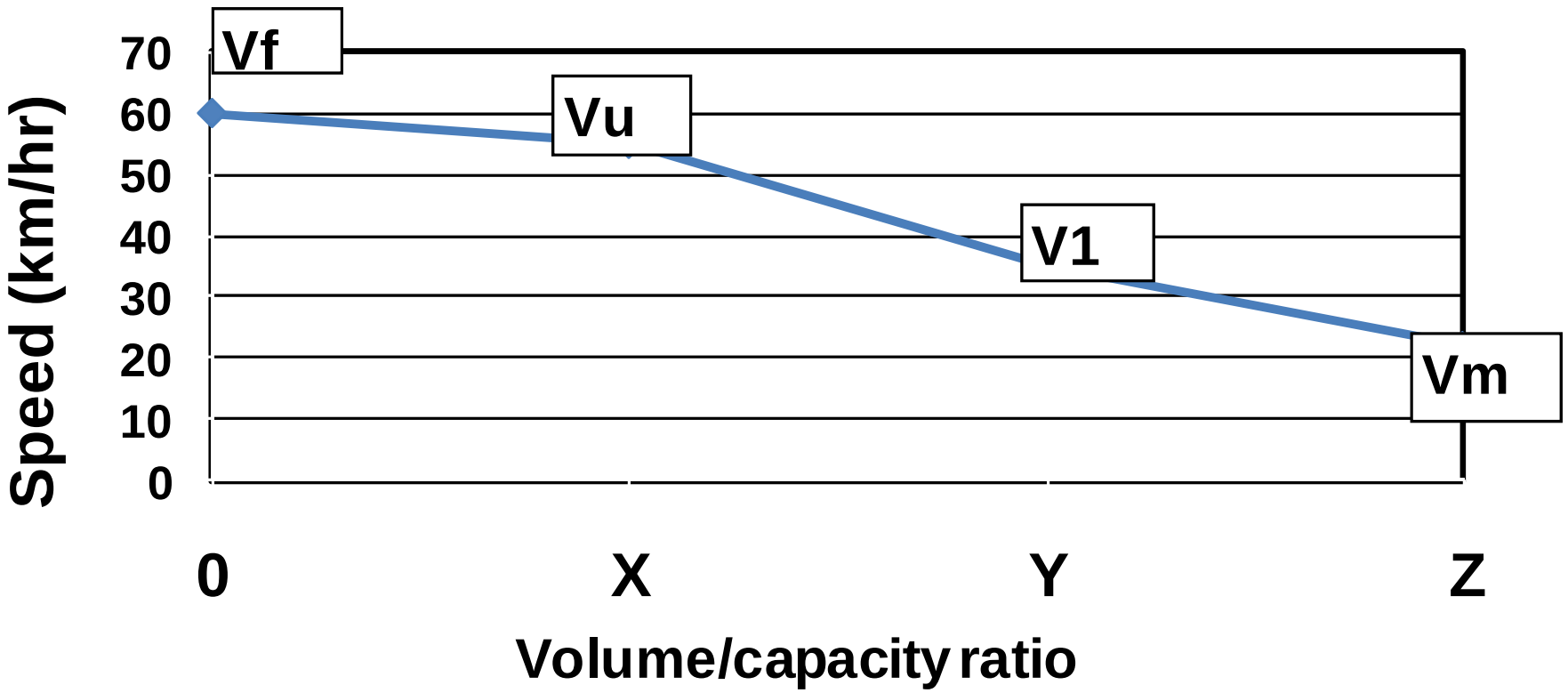
VKT Distribution for Vehicle Speed Bins

For non-peak hour, references:

- Conduct surveys

- roads with similar traffic patterns
- speed vs. volume/capacity ratio, or
- the speed limits of the concerned roads (for speed limit > 50 km/hr)

Link Speed Flow Curves



Link Speed Flow Curves (CTS-3)

Road Type	Vf	Vu	V1	Vm	X	Y	Z
Rural Road A	60	55	35	22	0.4	1.0	1.2
Rural Trunk Road	75	70	45	30	0.4	1.0	1.2
Urban Local Distributor	30	30	12	5	0.1	1.0	1.2
Urban District Distributor	40	40	22	11	0.1	1.0	1.2
Urban Primary Distributor	50	50	27	16	0.2	1.0	1.2
Urban Trunk Road	70	70	45	30	0.4	1.0	1.2
Expressway	90	85	65	40	0.4	1.0	1.2

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Project Specific Input Data
Ambient Temperature & Relative Humidity

- At least one year of recent hourly ambient temperature and relative humidity data.

- Source: a weather station either nearest or having similar characteristics as the study area;

- 90% valid data in the data set.


Thank you.
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Central
6X
TAXI
TAXI