

# COPERT 4 Training

## 2. General Methodology

# Vehicle Categories

Passenger Cars



Light Duty Vehicles



Heavy Duty Vehicles



Mopeds



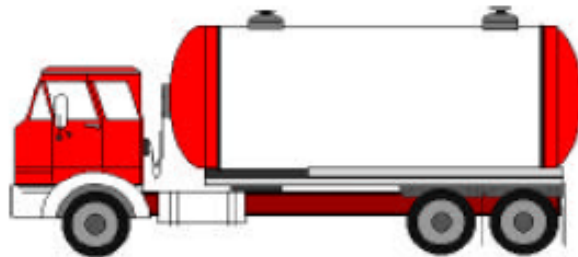
Motorcycles



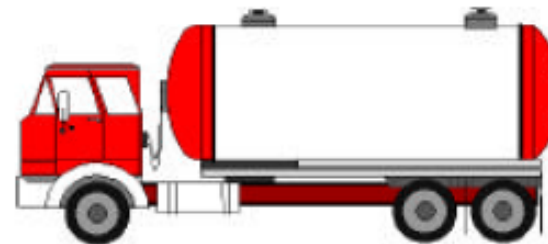
# Vehicle Categories

- Passenger Cars
  - Gasoline (<1.4 l, 1.4-2.0 l, >2.0 l)
  - Diesel (<2.0 l, >2.0 l)
  - LPG
- Light Duty Vehicles (Trucks & Vans)
  - Gasoline
  - Diesel
- Heavy Duty Vehicles
  - Gasoline
  - Diesel (11 weight categories)
- Power Two Wheelers
  - Mopeds (< 50 cc)
  - Motorcycles (2-stroke, <250 cc, 250-750 cc, >750 cc)

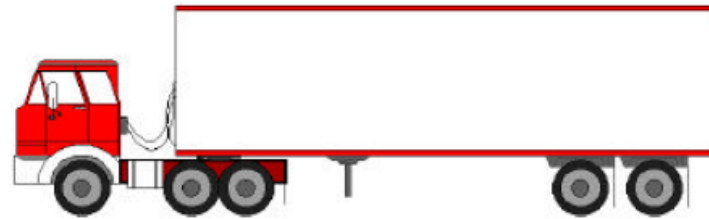
# Vehicle Categories – Heavy Duty Vehicles



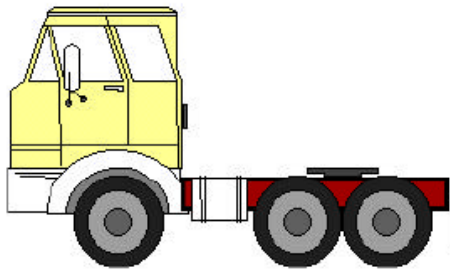
# Vehicle Categories – Rigid Trucks (Lorries)



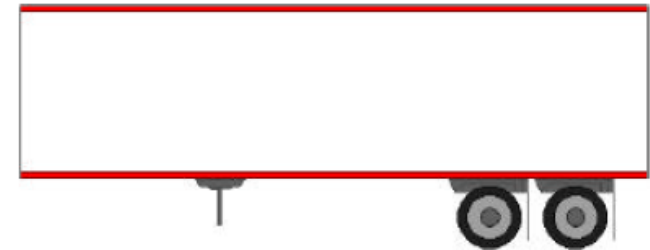
# Vehicle Categories – Articulated Vehicles



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Tractor

Semi-Trailer

**Definition.**

A road tractor coupled to a semi-trailer.

**Source of definition.**

Article 2 of Council Regulation 1172/98.

# Vehicle Technologies: Passenger Cars & Light Duty Vehicles

Passenger Cars	Light Duty Vehicles
PRE ECE (~1970 technology)	Conventional
ECE 15/00-01	LD Euro 1 - 93/59/EEC
ECE 15/02	LD Euro 2 - 96/69/EEC
ECE 15/03	LD Euro 3 - 98/69/EC Stage2000
ECE 15/04	LD Euro 4 - 98/69/EC Stage2005
Improved Conventional	LD Euro 5 - EC 715/2007
Open Loop	LD Euro 6 - EC 715/2007
PC Euro 1 - 91/441/EEC	
PC Euro 2 - 94/12/EEC	
PC Euro 3 - 98/69/EC Stage2000	
PC Euro 4 - 98/69/EC Stage2005	
PC Euro 5 - EC 715/2007 (2010 and	

# Vehicle Technologies: HDVs, Busses, & PTWs



<b>Heavy Duty Trucks/Buses</b>	<b>Mopeds/Motorcycles</b>
Conventional	Conventional
HD Euro I - 91/542/EEC Stage I	Euro 1 - 97/24/EC
HD Euro II - 91/542/EEC Stage II	Euro 2 - 97/24/EC
HD Euro III – 1999/96/EC	Euro 3 – 2002/51/EC (only motorcycles)
HD Euro IV - 2005/55/EC	
HD Euro V - 2005/55/EC	
HD Euro VI - 595/2009	



# Pollutants – 1(2)

Pollutants for which a detailed methodology exists, based on specific emission factors

<b>Group 1</b>
Carbon monoxide (CO)
Nitrogen oxides (NO <sub>x</sub> : NO and NO <sub>2</sub> )
Volatile organic compounds (VOCs)
Methane (CH <sub>4</sub> )
Non-methane VOCs (NMVOCs)
Nitrous oxide (N <sub>2</sub> O)
Ammonia (NH <sub>3</sub> )
Particulate matter (PM)
PM number and surface area

Pollutants which are estimated based on fuel consumption

<b>Group 2</b>
Carbon dioxide (CO <sub>2</sub> )
Sulphur dioxide (SO <sub>2</sub> )
Lead (Pb)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

# Pollutants - 2

Pollutants for which a simplified methodology is applied, mainly due to the absence of detailed data

## Group 3

Polycyclic aromatic hydrocarbons (PAHs) and persistent organic pollutants (POPs)

Polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzo furans (PCDFs)

Pollutants which are derived as a fraction of total NMVOC emissions.

## Group 4

Alkanes ( $C_nH_{2n+2}$ ):

Alkenes ( $C_nH_{2n}$ ):

Alkynes ( $C_nH_{2n-2}$ ):

Aldehydes ( $C_nH_{2n}O$ )

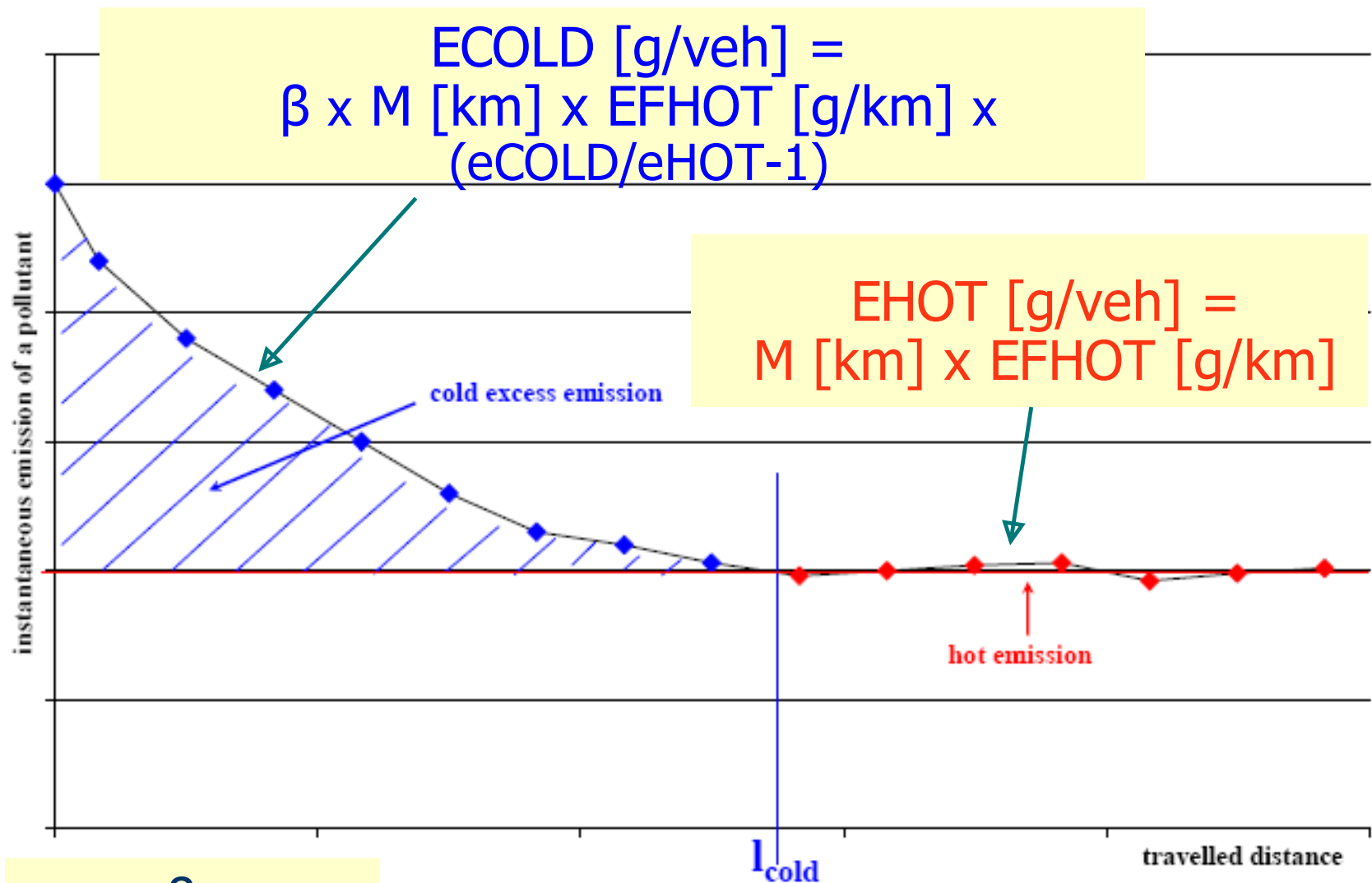
Ketones ( $C_nH_{2n}O$ )

Cycloalkanes ( $C_nH_{2n}$ )

Aromatic compounds



# General Concept for Exhaust Emissions/Consumption



$\beta = \frac{I_{\text{COLD}}}{I_{\text{TOTAL}}}$

# What are exhaust emissions dependent on?

- Activity
  - Number of vehicles [veh.]
  - Distance travelled [km/period of inventory]
- Hot Emissions
  - Technology / Emission Standard
  - Mean travelling speed [km/h]
- Cold Emissions
  - Technology / Emission Standard
  - Mean travelling speed [km/h]
  - Ambient temperature [Celsius]
  - Mean trip distance [km]



# Methodology: Total Emissions

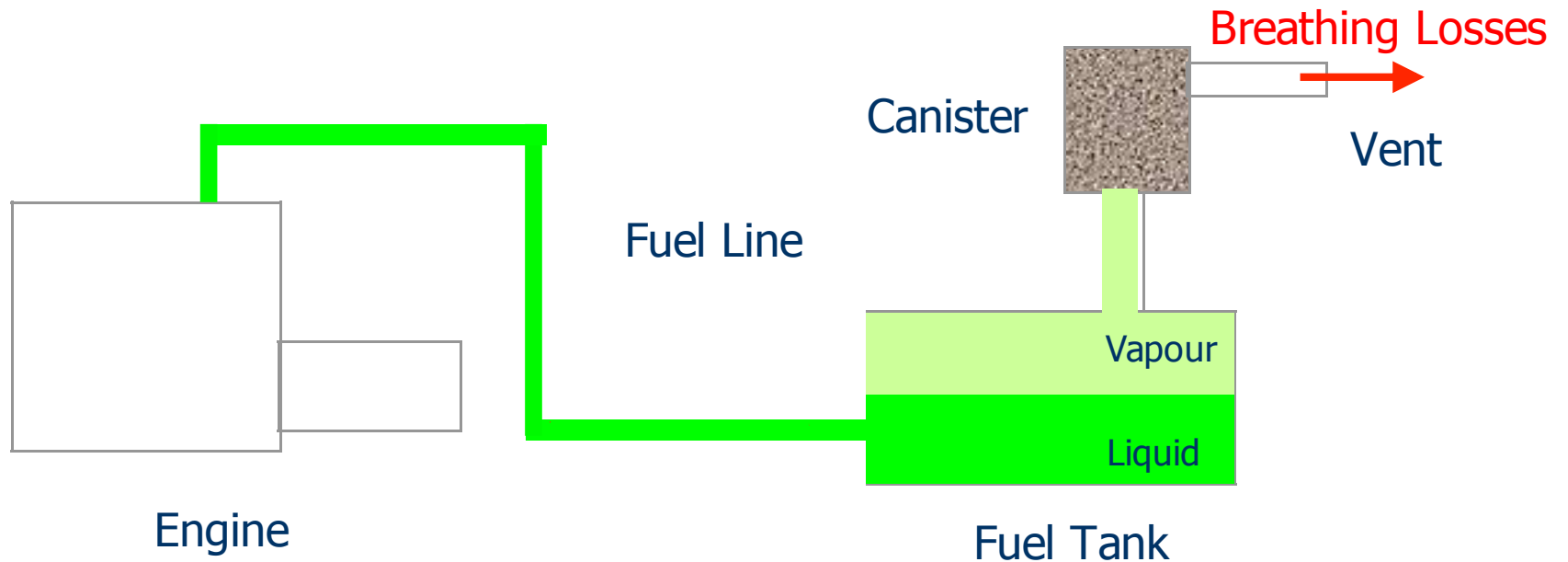
- Total Exhaust Emissions:  $EEXH = EHOT + ECOLD$ 
  - Hot (stabilized engine temperature):  $EHOT = N \cdot M \cdot eHOT$
  - Cold-start emissions:  $ECOLD = \square \cdot N \cdot M \cdot eHOT \cdot (eCOLD/eHOT-1)$

- Non-Exhaust Emissions

- NMVOC from Fuel Evaporation:  $EEVAP = EDIURNAL + ESOAK + ERUNNING$
- PM from tyre and brake attrition:  $EHOT = N \cdot M \cdot ePM$



# Non-exhaust emissions (evaporation)



Permeation / Leakages

Mechanisms causing evaporation emissions

- Diurnal emissions
- Hot soak emissions
- Running losses

**Parked vehicle**

**Engine running**

Only relevant for Gasoline!

# What is evaporation dependant on

- Vehicle technology
- Tank (vehicle) size
- Canister (vehicle) size
- Vehicle mileage (adsorption potential)
- **Temperature variation**
- **Fuel vapour pressure (kPa)**
- Fuel tank fill level
- Parking time distribution
- Trip duration



# Non-exhaust PM

- Particulate Matter due to road transport is also produced by:
  - Tyre abrasion
  - Brake abrasion
  - Road wear (not included in COPERT 4)
- Emission rates depend on:
  - Vehicle category (car, truck, motorcycle)
  - Number of axles/wheels (trucks)
  - Vehicle load
  - Vehicle speed

