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2019R02EN

# ROAD TUNNELS: VEHICLE EMISSIONS AND AIR DEMAND FOR VENTILATION

TECHNICAL COMMITTEE D.5 *ROAD TUNNELS*

WORLD ROAD ASSOCIATION
MONDIALE DE LA ROUTE
AIPCR PIARC

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*The study that is the subject of this report was defined in the PIARC Strategic Plan 2016 – 2019 and approved by the Council of the World Road Association, whose members are representatives of the member national governments. The members of the Technical Committee responsible for this report were nominated by the member national governments for their special competences.*

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*World Road Association (PIARC)*
*Arche Sud 5° niveau*
*92055 La Défense CEDEX, FRANCE*

*International Standard Book Number: 978-2-84060-500-3*

*Front cover © Peter Sturm*

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# AUTHORS/ ACKNOWLEDGEMENTS

This report has been prepared by the working group 4 of the Technical Committee D5 of the World Road Association (PIARC).

The contributors to the preparation of this report are:

Rune Brandt (Germany)
Jean-Francois Burkhart (France)
Gary Clark (United Kingdom)
Ignacio Del Rey (Spain)
Enrico Ferro (Italy)
Conor Fleming (Canada)
Norris Harvey (USA)
Frédéric Hervé (France)
Natalino Lucatelli (Italy)
Conrad Stacey (Australia)
Peter Sturm (Austria), WG leader
Marouane Yaghzar (France)
Franz Zumsteg (Switzerland)

The editors of this report are Peter Sturm (Austria) and Gary Clark (United Kingdom) for the English version, Frédéric Hervè (France) for the French version and Ignacio Del Rey (Spain) for the Spanish version. Quality control of the report was provided within the WG by Jean-Francois Burkhart (France).

In depth peer-review of the report was performed by Fathi Tarada (UK) and Nobuharu Isago (Japan).

The Technical Committee was chaired by Marc Tesson (France) and Jean-Claude Martin (France), Gary Clark, (United Kingdom), Rafael López Guarga (Spain) were respectively the French, English and Spanish-speaking secretaries.

EXECUTIVE SUMMARY

2019R02EN

# ROAD TUNNELS: VEHICLE EMISSIONS AND AIR DEMAND FOR VENTILATION

The design of a road tunnel ventilation system must consider fresh-air demand for maintaining in-tunnel air quality during normal and congested traffic operations and the control of smoke and hot gases in case of fire. The ventilation capacity to manage a fire incident frequently drives the ventilation sizing in highway and non-urban tunnels. Nevertheless, the fresh-air requirement for dilution during normal and congested operation, or special environmental constraints, can be dominant in tunnels with high traffic volumes and frequent congested traffic. This report provides emission rates and an assessment methodology to support the tunnel ventilation system designer in establishing the minimum fresh-air demand for adequate in-tunnel air quality and visibility thresholds.

The emission standards for new vehicles are becoming more stringent and the vehicle fleet is constantly being renewed. Therefore, the data for calculating vehicle emissions and the resulting fresh-air demand requires updating on a regular basis. This report provides the emission rates for exhaust pollutants (CO, $NO_X$ and PM), as well as the appropriate factors for non-exhaust particle emissions for passenger cars, light-duty commercial vehicles, and heavy-goods vehicles.

In recent years many international programmes have been undertaken to extend the existing database for emission rates for road vehicles. These programmes have provided updates to data for existing vehicles and have added factors for vehicles in accordance with upcoming emission standards. Factors representing driving situations in road tunnels have now been developed by PIARC for the purposes of this report and a dataset for tunnel ventilation design has been established. This dataset is intended for ventilation design purposes and differs from emission data used for environmental assessments. Specifically, in the derivation of factors relevant to tunnel ventilation system design, a conservative approach is taken where specific factors may lie within a range.

Data collection and methodologies to derive fresh-air volumes are similar to those described in PIARC's previous reports concerning emission estimations for ventilation design. However, the emission rates found in older reports are outdated. Vehicle legislation has enforced more stringent emission rates since their publication, and vehicle technology has rapidly advanced, resulting in lower emissions.

This report completely replaces the previous report on vehicle emissions and fresh-air demand published by PIARC in 2012 [1]. Previously reported emissions factors are outdated and should not be used for calculating the fresh-air demand in road tunnel ventilation design.

# CONTENTS

# 0. INTRODUCTION

Tunnel ventilation systems should provide adequate in-tunnel air quality during normal and congested traffic operations, support the management of portal emissions and self-evacuation and rescue efforts during emergency incidents. This report focuses on establishing the road tunnel ventilation capacity for normal and congested traffic operations. Separately, the tunnel ventilation capacity requirements for emergency ventilation (typically for the control of smoke and hot gases during fire) must also be assessed and the system designed accordingly.

The ventilation capacity for normal and congested traffic operation is established by the assessment of fresh-air volume required to dilute vehicle emissions to allowable in-tunnel air quality values as well as any specific requirements for portal and shaft emissions management.

Due to the continual renewal of the vehicle fleet, a steady tightening of emission laws and the introduction of alternative propulsion systems (hybrid vehicles, electric cars, etc.) design emissions data need regular updating. In this report, new design information and references are provided for calculating the required capacity of mechanical tunnel ventilation systems for normal and congested traffic operations. The emission rate data base is updated for existing road vehicles and extended for vehicles following future emission standards to allow for future emission projections. The data originate mainly from tests on chassis dynamometers and the application of on-board measurement devices and is intended to describe the real-world emission behaviour of on-road vehicles in road tunnels.

This report entirely replaces the 2012 R05 (revised version) PIARC report “Road Tunnels: Vehicle Emissions and Air Demand for Ventilation” [1] in terms of emission rates and related data. General definitions and methodology provided in previous reports, PIARC reports 2004 05.14.B [2] and 1995 05.02.B [3], are referenced. The main changes to the previous report concern the emission data up to 2030 for Euro 4, 5 and 6 vehicles as well as an update of the factors for non-exhaust particle emissions. Additional data for Light Commercial Vehicles (LCV) are provided for diesel and gasoline fuelled vehicles separately.

Two approaches to estimating vehicle emissions for a particular design year are detailed, both using 2018 as the base year for the emission rates:

- The standard approach is based on the emission estimations for the base year and the application of different influencing factors for year of operation, altitude of the tunnel, and vehicle mass (for HGV only).
- The fleet-specific approach allows an emission calculation, when the vehicle fleet data are known in detail, using specific tables for emission rates for single vehicle model years. This method is applied if the fleet composition is different to that assumed for the standard approach.

The emission rates given in this document serve ventilation calculation design purposes and tend to be conservative for CO and particulates (visibility) in terms of emission quantities compared to emission data used for the assessment of the environmental impact on air quality.

A large uncertainty exists for the quantification of non-exhaust particulate matter (PM) emissions (re-suspension of road dust, abrasion). The source strength strongly depends on the overall cleanliness of the tunnel, the types of vehicles and the goods transported through the tunnel as well as on the traffic operation mode (uni- or bi-directional traffic).

# 1. PREFACE

## 1.1. The Need for Ventilation for Normal Operation

During normal operation, including traffic congestion, the function of ventilation is to dilute pollutants to ensure adequate in-tunnel air quality.

## 1.2. Application

This report entirely replaces the 2012 R05 (revised version) PIARC report 'Road Tunnels: Vehicle Emissions and Air Demand for Ventilation' [1] with an updated set of emission rates and associated data for design years up to 2035.

For design years beyond 2035, there is significant uncertainty in the validity of the extrapolation of the emissions factors provided in this report. The uncertainty associated with the prevalence of new vehicle technology and alternative fuels makes the prediction of vehicle fleet composition beyond 2035 unreliable. In addition, the ageing effects on conventional vehicles with respect to their emissions characteristics is unknown.

## 1.3. Purpose of the Report

The aim of this document is to define a method for the calculation of the fresh-air demand and to provide current emission rates for tunnel ventilation design on an international basis. This report contains emission rates for internal combustion engine propelled vehicles for various emission standards for the base year 2018 and reduction factors for emission projections up to 2035.

## 1.4. Target Audience

The target audience for this report is tunnel ventilation system designers and operators.

# 2. FRESH-AIR DEMAND CALCULATION PROCEDURE

This section addresses the procedure for estimating air demand for a tunnel ventilation system with the goal of achieving admissible concentration limits for in-tunnel air quality.

## 2.1. POLLUTANTS

The emissions of CO, particulate matter and $NO_X$ - as the sum of NO and $NO_2$ (see section 4.3) - are considered the reference emissions of internal combustion driven vehicles for road tunnel ventilation design.

For environmental reasons, the ambient air quality at tunnel portals is often required to adhere to certain thresholds of pollutants, mainly $NO_2$. This can be achieved by portal air emissions management. Consequently, the requirements for in-tunnel air quality or ambient air quality at the tunnel portals may determine the capacity requirements of the ventilation system.

For pollutants affecting human health, exposure time-dependent threshold values can be imposed by jurisdictions. The pollution dosage depends on the travel time required to pass through the tunnel.

Typically, various traffic conditions are reviewed to determine the capacity of the ventilation system. These include normal operations based on projected traffic density and congested traffic. Vehicle emissions vary depending on the speed of the vehicle, roadway gradient and the spacing between vehicles, which also changes depending upon vehicle speeds.

However, the control of the ventilation system is established according to set points that normally do not depend on traffic conditions. Set points are generally lower than admissible concentration limits values, so tunnel ventilation is engaged prior to pollutant levels exceeding criteria. In this manner, criteria limits are not exceeded even considering the time-lag effects of traffic conditions. For extreme circumstances, tunnel closure threshold values that should never be exceeded are defined for safe operation of the tunnel.

## 2.2. CALCULATION OF FRESH-AIR DEMAND

The fresh-air demand (airflow rate) is determined by the allowable increase of emission concentrations within the airflow. Air enters the tunnel environment with ambient pollutant concentrations. As this air moves through the tunnel environment, tailpipe emissions increase the pollutant concentrations. The vitiated air must then be diluted within the tunnel environment prior to reaching admissible pollutant limits. Emission concentrations within the tunnel are the product of the emission rates and the inverse of the airflow.

The required airflow rate for emission dilution can simply be calculated by dividing the overall pollution generation rate by the allowable change in air pollutant concentration. This relationship is defined by the following equation:

*Equation 1*

$$Q = \frac{G_{\mathrm{tun}}}{C_{\mathrm{adm}} - C_{\mathrm{amb}}}$$

For visibility criteria, the same formula is used in which the concentration *C* is replaced by the extinction coefficient *K,* where:

Q = Required fresh-air flow rate [m³/s]

$G_{tun}$ = Total emissions generation rate of the pollutant of interest along the relevant tunnel chainage, [g/s] for gases, [m²/s] for visibility
$C_{adm}$ = Admissible concentration level [g/m³]
$C_{amb}$ = Pollutant concentration in the fresh-air (typically drawn from outside the tunnel) [g/m³]
$K_{adm}$ = Admissible level for extinction coefficient (visibility) [$m^{-1}$]
$K_{amb}$ = Ambient level for extinction coefficient (visibility) [$m^{-1}$]

## 2.3. Calculation of Emissions Generation Rate

The term emission rate is used to define a specific quantity of a pollutant (gas or aerosol) emitted by a road vehicle during its journey through a tunnel. The quantity of such a pollutant is a function of vehicle type, traffic and driving situation and in the case of non-exhaust particulates, the condition of the road surface. Emission rates are the key element to determine the amount of pollution released in a tunnel and hence the amount of fresh air needed for dilution of these emissions to acceptable concentrations.

The emission rate is a function of several factors including:

- the number and type of vehicles (PC, LCV, HGV),
- the emission standard the vehicle was registered under (e.g. Euro 4),
- vehicle speed which includes congested or fluid traffic,
- road gradient,
- other parameters influencing the power needed to propel the vehicles (e.g. weight).

In the context of this document the term emission rate – which is commonly used in emissions estimation – is used to describe the emission rate of a single vehicle under defined conditions.

The emission rates provided are based on the year 2018. Due to the continual renewal of the vehicle fleet, emission projections for future years must consider improvements in vehicle emission quantities. Therefore, reduction factors are provided for years projected later than 2018.

The total emission rate for a given year is determined by the addition of the emission rates for each vehicle type, under an assumed distribution of vehicle ages in the fleet.

This document defines two different approaches for determining emission rates for individual vehicle types. The standard approach uses predefined fleet averaged emission rates. This approach is for countries that follow similar implementation of emission standards and vehicle age profiles when compared to countries with known emission values (e.g. EU or North America). The fleet-specific approach is to establish the specific implementation of emission standards within the country of interest. Emission rates can then be determined if the age and distribution of the vehicle class (Euro standards) is known. The second approach can be more accurate but requires more detailed knowledge of the individual fleet distribution in terms of emission standard classes.

## 2.4. Traffic and Tunnel Data

Due to the numerous factors that influence emission rates, each possible traffic situation must be defined and considered in the calculation. Where local data are available, these should be considered for use by the designer. The main points for consideration are:

**Vehicle fleet**: for emission calculations, it is necessary to split the vehicle fleet into relevant groups: passenger cars (PC), light commercial vehicles (LCV) and heavy-goods vehicles (HGV). Very often, the number of HGV is given as a percentage of the total traffic volume. In addition, the heavy-duty fleet age distribution may vary depending on the type of traffic. On international routes (long haul

traffic) more modern vehicles are typically used, while for local distribution traffic in urban areas, older vehicles are common.

**Passenger cars (PC):** passenger cars (PC) can be powered by gasoline or diesel engines. Please note that exhaust emissions from electric and alternative fuel vehicles are not covered by this report.

**Light Commercial Vehicles (LCV):** this category concerns vehicles with a mass of typically up to 3.5 metric tonnes (t). If possible, this vehicle class should be considered separately as it has different certification limits to those for PC and HGV.

**Trucks, buses, Heavy-Goods Vehicles (HGV):** the number of trucks and buses is required to be known for emission calculations. Often these data are given as an average percentage of the total traffic flow, but this value is normally too high when applied to peak traffic flow. In the context of this report, trucks and buses are referred to as heavy-goods vehicles (HGV). HGV could comprise single trucks, lorry–trailer combinations, articulated trucks/semi-trailers or buses. The emission data provided in this document are for an average truck (fleet averaged combination of single lorries, lorry – trailer combination and semi-trailer). Mass-dependent factors are given for light trucks (15 t) and semi-trailers (32 t). Buses and coaches can be treated as light trucks (15 t).

**Passenger car units (PCU):** vehicles vary greatly in size and shape. The PCU represents an average vehicle that can be used to determine the maximum possible number of vehicles in the tunnel. One passenger car corresponds to one PCU. For the purposes of converting a truck/bus into PCU, the HGV may be assumed to occupy the space of 2 passenger cars in free-flowing traffic and up to 3 (in certain cases higher) passenger cars in slow moving traffic, including uphill grades.

With a given HGV fraction $a_{\mathrm{HGV}}$ the number of PCU is:

*Equation 2*

$$n_{\mathrm{PCU}} = (1 - a_{\mathrm{HGV}})n_{\mathrm{veh}} + a_{\mathrm{HGV}}f_{\mathrm{HGV}}n_{\mathrm{veh}}$$

Traffic speed $\leq$ 10 km/h: fHGV = 3

Traffic speed >10 km/h: fHGV = 2

Where:

$n_{\mathrm{PCU}}$ is the number of passenger car units

$n_{\mathrm{veh}}$ is the number of vehicles (PC, LCV, HGV)

$a_{\mathrm{HGV}}$ is the portion of HGV in the fleet

$f_{\mathrm{HGV}}$ is the number of HGV per PCU.

Vehicle density per lane km, D, is:

*Equation 3*

$$D_{\mathrm{PCU}} = D_{Veh}[(1 - a_{\mathrm{HGV}}) + a_{\mathrm{HGV}}f_{\mathrm{HGV}}]$$

Where:

$D_{\mathrm{PCU}}$ is the number of passenger car units per km

$D_{\mathrm{veh}}$ is the number of vehicles per km

*Table 1: Average peak traffic data*

| | | **Average peak traffic density (PCU/km) Traffic flow (PCU/h) per lane** | | | |
|---|---|---|---|---|---|
| | | **RURAL TUNNEL** | | | |
| | | **Unidirectional traffic** | | **Bi-directional traffic** | |
| | v [km/h] | PCU/km | PCU/h | PCU/km | PCU/h |
| **Fluid traffic** | 60 | 30 | 1800 | 23 | 1400 |
| **Congested traffic** | 10 | 70 | 700-850 | 60 | 600 |
| **Standstill** | 0 | 150 | - | 150 | - |
| | | **URBAN TUNNEL** | | | |
| | | **Unidirectional traffic** | | **Bi-directional traffic** | |
| | v [km/h] | PCU/km | PCU/h | PCU/km | PCU/h |
| **Fluid traffic** | 60 | 33 | 2000 | 25 | 1500 |
| **Congested traffic** | 10 | 100 | 1000 | 85 | 850 |
| **Standstill** | 0 | 165 | - | 165 | - |

In a heavily-used urban tunnel, peak density and flux of fluid traffic may be 10-20% higher than reported in Table 1.

**Emission-laws (emission standards):** emission laws and their implementation vary from country to country. For the detailed methodology (fleet specific approach) the emission rates used for the calculation must be matched to the emission standards of the individual model years of the vehicles.

**Design years:** over the past 40 years, emissions have reduced significantly. Due to continuing changes in emissions legislation, the design of the tunnel-ventilation system has to be based on the emission situation of the opening year and/or of the defined design year. Moreover, future operation must be considered as traffic parameters (volume, fleet composition, emissions, etc.) may change.

**Traffic density (D)**: projected traffic conditions such as the frequency of congestion (traffic lanes at peak capacity) or low vehicle counts, can influence the design ventilation capacity. Traffic density is the number of vehicles per unit distance per lane and is calculated according to equation (2).

**Congested and stopped traffic**: vehicle speeds around 10 km/h and stopped traffic typically define the normal ventilation capacity requirements. In longer tunnels or in tunnel networks, the ventilation equipment may be oversized if congested/stopped traffic is assumed over the entire tunnel length. Therefore, it is advisable to consider the option of preventing congested/stopped traffic over the full tunnel length by means of a traffic control system.

**Traffic speed (v)**: traffic speeds in tunnels are typically restricted by law. On a grade, trucks operate at a reduced speed, which is accounted for in the individual emission tables in this document.

**Scenario speed:** the term *scenario speed* describes a traffic situation at a certain travel speed achievable for passenger cars. For most cases (design scenarios), the scenario speed and the vehicle speed have the same values. However, for certain situations, vehicles might not reach the scenario speed (e.g. where HGV are restricted by law to a maximum vehicle speed or when considering road gradients). Emission tables for HGV contain emission rates for scenario speeds exceeding achievable vehicle speeds. For example, having a scenario speed for 120 km/h represents traffic at 120 km/h (for PC) but lower speeds (~90 km/h) for HGV. In such cases, the emission rate for HGV

given in the emission rate tables in this document remains constant with the value frozen at the level of the achievable velocity at this road gradient.

**Peak traffic flow**: the maximum traffic throughput per lane that can occur at velocities around 60 km/h. Average peak values are given in Table 1. In a heavily used urban tunnel, peak values in fluid traffic may be 10 to 20% higher. The hourly free flowing daily peak traffic volume is generally about 10% of the daily average traffic volume. In many cases, peak traffic is defined as the 30$^{th}$ largest trafficked hour per year.

**Tunnel gradient:** the influence of the gradient on the emission rates depends on the direction of traffic. Therefore, in case of bi-directional traffic both travel directions need to be taken into account. It should be noted that some unidirectional tunnels can be operated in reverse and/or bi-directional traffic mode.

# 3. EMISSION RATES

This section and its associated appendix (section 11) provide emission-rate tables for various vehicle types including passenger cars (PC), light commercial vehicles (LCV) and heavy goods vehicles (HGV). Emission rates are established for the base year 2018.

## 3.1. EMISSION STANDARDS (TRENDS)

Emission standards define the acceptable tail pipe emission quantities according to a specific test procedure. These values must be met by new vehicles. The introduction of emissions legislation has resulted in emissions reductions as new, lower emitting vehicles replace older, higher emitting vehicles.

Emission standards for Europe, Japan and the USA dominate the emissions legislation and have been adopted globally. The Euro standards have been implemented in Europe, in many countries of Asia (except Japan and South Korea) and in a few countries in South America, Africa and the Middle East. A different regulation exists in North America, which is also in use in Central America, some countries in South America, as well as in South Korea.

Due to air quality problems in some regions and megacities, different – more stringent – standards might be applied for road vehicles to be used in these areas. Before using the emissions tables provided in chapter 6, the emissions legislation in the region should be reviewed, including the timing when legislation was applied and the legislative history of the country for emissions. The applicability of the emission standards to the local situation should be confirmed.

Table 2 shows the evolution of the European Union emission standards for passenger cars with gasoline engines. Similar tables can be given for LCV and for HGV. Other regions might have different implementation years and/or different emission standards. Before using the emissions rates given in this report, the user should check and verify the appropriateness of the use of the factors for each individual project.

*Table 2: Emission standards for gasoline passenger cars according to Euro legislation*

| | Year of Implementation | CO | HC | $NO_X$ | $HC+NO_X$ | Particles |
|---|---|---|---|---|---|---|
| | | [g/km] | | | | |
| **ECE R 15/03** | 1979 | 21.5 | 1.8 | 2.5 | | smoke number |
| **ECE R15/04** | 1982 | 16.5 | | | 5.1 | smoke number |
| **PC Euro 1** | 1992 | 2.72 | | | 0.97 | 0.14 |
| **PC gasoline Euro 2** | 1997 | 2.2 | | | 0.5 | |
| **PC gasoline Euro 3** | 2000 | 2.3 | 0.2 | 0.15 | | |
| **PC gasoline Euro 4** | 2005 | 1.0 | 0.1 | 0.08 | | |
| **PC gasoline Euro 5** | 2008 | 1.0 | 0.100 | 0.060 | 0.068 (NMHC*) | 0.005 (DI**) |
| **PC gasoline Euro 6*** ** | 2014 | 1.0 | 0.100 | 0.060 | 0.068 (NMHC*) | 0.005 (DI**) |

* Non-Methane Hydrocarbons, ** Direct Injection, *** Euro 6 emission values changed only for diesel fuelled cars

US emission standards are quite different. Since the NLEV and the TIER II regulation (model year > 2004), emission standards for single model years have been replaced by fleet-averaged emission values, depending on the various types of vehicles sold by one manufacturer. Nevertheless, real world emission behaviour of the individual vehicles in Western Europe might be considered similar to those in North America. However, use of values for the Euro standards 5 and 6 should result in conservative estimated emission rates.

## 3.2. SOURCES OF DATA

As emission standards define the threshold values according to a specific test procedure and apply only for new vehicles, real world vehicle emissions differ significantly from the values given in the vehicle-emission standards. The emission rates contained within this document refer to real world situations. Nevertheless, the Euro standards classification is kept as an identifying feature for the various vehicle classes.

The base data for individual Euro standards are given in the appendix. PIARC data are derived from available emission data contained in the emission factor handbook (HBEFA) version 3.3 [8], selecting values appropriate for in-tunnel driving behaviour.

## 3.3. EMISSION DATABASE FOR TECHNOLOGY CLASSES A, B AND C

For simplification, emission generation rates have been grouped into three technology classes (A, B, C) with similar emission standard distributions in their fleets. Technology class A data follow a fleet distribution found in Western Europe or North America. These countries require vehicles to be checked regularly for technical issues, including exhaust emissions through regular vehicle inspections. For countries with a delayed introduction of stringent emission standards and/or for countries that do not adopt any regular vehicle-checking procedures, technology class B or C should be used.

Technology class B is used for countries which have adopted Euro or similar emission standards with a time shift compared to technology class A. Technology class C applies to countries which have adopted delayed emission standards but do not conduct any effective emission control (i.e. vehicle inspection programs) of vehicles (see section 6.4).

# 4. DESIGN AND OPERATIONAL POLLUTANT VALUES

## 4.1. INTRODUCTION

In the absence of national regulation, the admissible concentration and operation limits provided in the following sections are recommended.

Design values provide a basis for the determination of the required capacity of the tunnel ventilation system.

Operational values provide the limit levels for the different operating states, these comprise the following:

- Normal operations: where set points and threshold values defined in the design are used for the operation of the tunnel ventilation system in order to manage the pollution levels in the tunnel. These are different from design values and normally do not change with variations to traffic conditions. Set points are generally lower than the design values and are selected so that design conditions are not exceeded even considering the time-lag effects of the traffic conditions and flow inertia on the ventilation system.
- Maintenance operations: where specific limit levels are set for the protection of the health and safety of the maintenance workforce.

Closure conditions: threshold values that may not be exceeded i.e. if reached then an immediate tunnel closure is required to provide for the safety of tunnel users.

Operational values are based on measurements that are typically recorded as time averages over several minutes in order to avoid unnecessary actions as a result of short-term fluctuations. The specific action taken on reaching or approaching an operational limit is pre-determined and recorded in the operating procedures. These actions may depend on the duration as well as the magnitude of the level of pollution.

## 4.2. CARBON MONOXIDE (CO)

Table 3 gives design values for various traffic situations and the limits for tunnel operation states.

*Table 3: Design and Operation values for CO*

| Traffic situation | Design value | | Operation condition | Operation limits |
|---|---|---|---|---|
| Free flowing peak traffic 50 – 100 km/h | 70 ppm | | Normal operation* | < 100 ppm |
| Daily congested traffic, stopped on all lanes | 70 ppm | | Planned maintenance work in a tunnel under traffic** | 20 ppm |
| Exceptional congested traffic, stopped on all lanes | 90 ppm | | Threshold value for tunnel closure | 200 ppm |

* Intermediate set points and thresholds may be set at levels below the design values

** National workplace levels to be considered

To avoid excessive fresh-air demands for rarely occurring congestion conditions, a higher CO-concentration can be allowed. The 90 ppm value corresponds to the World Health Organisation (WHO) recommendation for short term-exposure (15 minutes) [4].

## 4.3. NITROGEN DIOXIDE ($NO_2$)

Nitrogen oxide (NO) and nitrogen dioxide ($NO_2$) are pollutants resulting from the combustion process. Most of the emitted nitrogen oxides ($NO_x$) consist of NO, which is oxidised into $NO_2$ in the presence of oxygen.

While in previous years $NO_x$ from combustion processes contained mostly NO (90 to 95% of the $NO_X$), the implementation of diesel vehicle exhaust gas after-treatment systems (oxygenation catalyst, DPF, SCR systems) tend to significantly increase the primary emitted $NO_2$ percentages [12]. In many European road tunnels, $NO_2$ can be up to 20 to 30% of $NO_x$ concentrations, which strongly depends on the share of diesel vehicles with exhaust gas after-treatment systems in the vehicle fleet and on the residence time of the $NO_x$ in the tunnel air. Only in tunnels with few passenger cars using diesel engines will the $NO_2$ contribution remain below 10%. Figure 1 shows, as an example, the $NO_2/NO_X$ relation as a function of total $NO_x$ concentrations for tunnels with a different share of diesel PC/LCV (red line 11%, green line 32% and blue line 57%). Note that the lines given in Figure 1 represent the best fit from data sets with significant scatter.

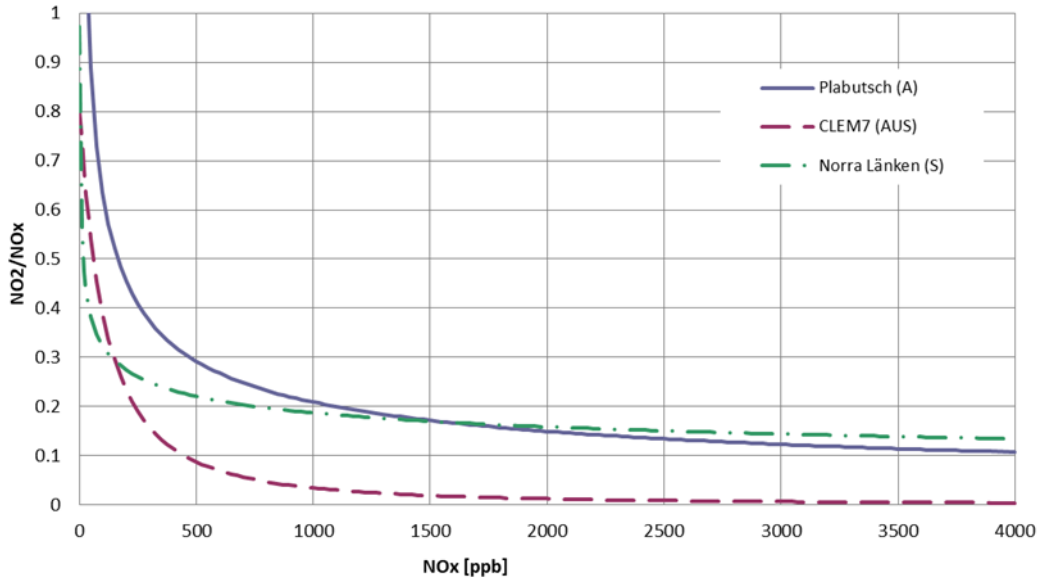


*Figure 1: $NO_2/NO_x$ ratio as a function of the $NO_x$ concentration for various tunnels [11]*

When calculating the $NO_2$ share it is recommended to apply individual values for the different vehicle types (PC gasoline, PC diesel, etc.). Values for base year 2018 emission standard A are given as an example in Table 4.

*Table 4 $NO_2$/NOx ratio for vehicle types*

| $NO_2/NO_X$ ratio | PC gasoline | PC diesel | LCV gasoline | LCV diesel | HGV |
|---|---|---|---|---|---|
| 2018 (base year) | 0.05 | 0.33 | 0.05 | 0.32 | 0.11 |
| 2030 | 0.05 | 0.31 | 0.05 | 0.31 | 0.21 |

NO by itself is not considered a harmful pollutant at commonly encountered levels. On the other hand, $NO_2$ is noxious and can irritate the lungs and lower the resistance to respiratory infections such as influenza. For short term exposure, the 2015 WHO Expert Consultation [6] reported evidence of a causal relationship between short term $NO_2$ exposure and respiratory health impact. The US National Institute for Occupational Safety and Health (NIOSH) proposes a value of 1 ppm as a 15-minute short-term limit [14]. Whilst it is acknowledged internationally that there are potential

health effects from exposure to $NO_2$, there is no clear consensus on the extent of these health effects for the general population, and no definitive guidance on generally applicable exposure limit levels. As a consequence, many countries have not set a $NO_2$ standard in road tunnels.

Where the tunnel ventilation system is also dimensioned for $NO_2$, PIARC proposed in 2000 [7] to permit an average in-tunnel concentration of 1.0 ppm $NO_2$ along the length of the tunnel at any one time as the design value.

Some countries have adopted values for different time frames. For many projects in North America the NIOSH and PIARC value of 1.0 ppm is used. France introduced a value of 0.4 ppm as an average over the tunnel length [15]. NSW (AUS) proposed a value of 0.5 ppm as a tunnel route average [13].

When defining a design value for $NO_2$, the following issues should be considered:

- there are limited options for reliable sensors to measure $NO_2$ levels in road tunnels in the lower ppm ranges (<0.5 ppm);
- there may be significant difficulties in complying with standards if design values are too demanding, with consequences for design costs and subsequent energy consumption;
- the choice of a design value in tunnels has to be made with consideration of the actual ambient pollutant levels outside the tunnels and the characteristics of the vehicle fleet (engine emission treatment technologies).

The control of the environment in tunnels regarding the levels of $NO_2$ is a challenge due to measurement accuracy (see section 11.4).

The $NO_2$ levels in urban areas vary according to the season, temperature and time of day. In areas with heavy traffic, one-hour peak levels can exceed short-term air-quality standards. Background levels of $NO_X$ have to be determined carefully if this pollutant is considered in the ventilation design.

## 4.4. Particulate Matter (PM) Emissions and Visibility

The presence of particulates leads to reduced visibility inside the tunnel. Therefore, visibility criteria are intended to support the ability of a driver to stop safely. The tunnel ventilation system must provide visibility levels that exceed the minimum vehicle stopping distance at the design speed.

There are two primary sources of PM in a tunnel, exhaust emissions and non-exhaust emissions. Exhaust emissions consist of PM emanating from the tailpipe as a result of fuel combustion. Non-exhaust PM consists of tyre and brake wear, road surface abrasion and re-suspended dust.

Visibility is reduced by the scattering and absorption of light by PM suspended in the air. The reason for reduced visibility is the occurrence of light extinction by the scattering and absorption of radiation in the visible wave-length range. The amount of light scattering and/or absorption is highly dependent upon the material, diameter and the density of the particles. In general, sulphates, nitrates, organic compounds, soot and soil are the major components that scatter and absorb light in the atmosphere. Except for mineral based re-suspended and abrasion particles, most of these components are abundant in the size range up to 0.7 µm. This is approximately the wavelength of visible light. Due to the similarity between wave length and particle diameter, there is a significant effect on visibility impairment [5].

The principle for measuring visibility in a tunnel is based on the fact that a light beam decays in intensity as it passes through air. The level of decay can be used to determine the opacity of air and is expressed as an extinction coefficient K in $m^{-1}$. Opacity meters for tunnels typically use these effects to measure visibility within the tunnel.

The extinction coefficient is expressed as:

*Equation 4*

$$K = -\frac{1}{L}.\ln\left(\frac{I}{I_0}\right)$$

Where:

$I_0$ Intensity of the light source

I Intensity of the light at the receiver

L Beam length between source and receiver [m]

Table 5 gives a correlation between visibility conditions, extinction coefficient and light beam length for an acceptable light level of 20% of the light source intensity.

*Table 5: Visibility condition and extinction coefficient*

| **Visibility condition** | **Extinction coefficient K** | **Length of light beam L with I/Io=exp(-K L) =20%** |
|---|---|---|
| Slightly hazy | 0.003 $m^{-1}$ | 536 m |
| Hazy | 0.007 $m^{-1}$ | 230 m |
| Foggy | 0.009 $m^{-1}$ | 179 m |
| Uncomfortable | 0.012 $m^{-1}$ | 134 m |

At a driving speed of 80 km/h the stopping distance with normal braking is about 85 m. Hence, even a visibility of a K-value for tunnel closing (Table 6) is sufficient to stop safely at an obstacle.

Strong fluctuations in visibility can occur. For example, visibility can be degraded as diesel-trucks move as a group, high emitting (smoky) vehicles are in the tunnel, or when the ventilation control reacts too slowly to emission peaks.

The consideration of extinction levels for ambient air (background pollution) is in most cases not needed, as even peak concentration levels in ambient air normally have no impact on short range visibility which is relevant for in-tunnel conditions. Only rare events with high PM levels in the air (e.g. bush fires, sand storms, high pollution episodes) might have an impact on short range visibility.

Vehicle exhaust consists of very small particles mainly in the range of 0.01 to 0.20 µm ([3]). Particles in this range are very effective in light extinction. Diesel combustion is the main source of combustion-related particle emissions [3]. Therefore, HGV, LCV and PC with diesel engines are the primary contributors to PM in exhaust emissions. Diesel particle filters (DPF) significantly reduce these emissions in terms of mass as well as the number of particles. Recent studies indicate that gasoline-powered vehicles with direct fuel injection also contribute to particulate-matter (PM) emissions. In addition to tailpipe emissions, vehicles also emit particulate matter due to abrasion processes (road, tires, brake wear, etc.) and re-suspension of road dust. These types of emissions occur for all vehicles and are not restricted to the use of internal combustion engines as the propulsion system. Non-exhaust particulate emissions are mainly in the size from 1 µm and upwards. Hence, they contribute strongly to $PM_{2.5}$ and even more to $PM_{10}$ concentrations, but less to light extinction [3]. While the abrasion processes correlate with driving behaviour and vehicle speed, the quantity of suspended particles is also strongly related to the cleanliness of the tunnel and the traffic mode (uni- or bi-directional traffic).

In road tunnels, the two source types of emission, ‘exhaust’ and ‘non-exhaust’, are relevant. Although both fractions have different light extinction behaviour and therefore should be treated

differently, the following correlation between $PM_{2.5}$ mass concentration ($\mu$ in mg/m³) and light extinction coefficient ($K$ in $m^{-1}$) can be applied for diluted exhaust gases [2]:

Diluted exhaust gas (tunnel):

*Equation 5*

$$K = f_{vis}\,\mu$$

where the conversion factor $f_{\mathrm{vis}}$ has units $m^2/mg$.

A value of 0.0047 m²/mg is proposed for $f_{\mathrm{vis}}$ [1]. Recent measurements performed in the Landy tunnel (France) as well as in the Mt. Blanc tunnel (France/Italy) showed a correlation between opacity and mass ($PM_{10}$) in the range between 0.0033 m²/mg and 0.0067 m²/mg and confirm the range of mass and extinction correlations found in the various tunnel measurements reported in [3].

Table 6 gives design values for various traffic situations and the limits for tunnel operation states.

*Table 6: Design and Operation values for Visibility*

| Traffic situation | Design value | | Operation condition | Operation limits |
|---|---|---|---|---|
| Free flowing peak traffic 50 – 100 km/h | 0.005 $m^{-1}$ | | Normal operation* | 0.003 – 0.007 $m^{-1}$ |
| Daily congested traffic, stopped on all lanes | 0.007 $m^{-1}$ | | Planned maintenance work in a tunnel under traffic** | 0.003 $m^{-1}$ |
| Exceptional congested traffic, stopped on all lanes | 0.009 $m^{-1}$ | | Threshold value for tunnel closure | 0.012 $m^{-1}$ |

* Intermediate set points and thresholds may be set at levels below the design values

** National workplace levels to be considered

# 5. CALCULATION OF EMISSIONS GENERATION RATE

The calculation of the amount of emissions produced in the tunnel according to a specific traffic scenario is based on a simple mathematical approach using base emission rates (emission rates) multiplied by influencing factors and the number of vehicles, as described in this section. The resulting 'total emission rate' $G_{tun}$ is then used in equation (1) to determine the fresh-air demand (see section 2.2)

## 5.1. GENERAL FORMULA

The total emission rate in a tunnel $G_{tun}$ is calculated by adding the emission rates for each lane $G_{lane}$. $G_{lane}$ may be a summation of emission rates for discrete sections of constant road gradient and traffic speed. Figure 2 shows a sketch of a tunnel with two lanes and two sections, with constant road gradients in each section. In general, a section should cover a part of the tunnel in which the main parameters affecting emissions can be assumed to be constant.

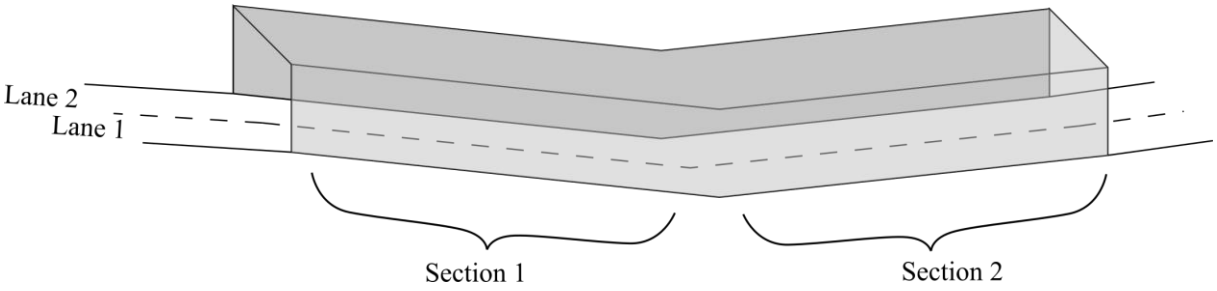


*Figure 2: A simple tunnel with two lanes and two sections of constant slope.*

The section emissions rate $G_{sec}$ is a summation of the *factored* emission rate per vehicle, $g_{fac}$, from each vehicle category $i$, weighted by the time-averaged number of vehicles of that category within that tunnel section, $n$. The factored emissions rate is derived from the base emission rate for a given vehicle type, and can account for vehicle age, tunnel altitude, and other parameters as explained in section 5.4.

*Equation 6*

$$G_{\mathrm{sec}} = \sum_{i=1}^{N_{\mathrm{cat}}} g_{\mathrm{fac},i} n_{veh,i}$$

Hence the general formula for the tunnel emission rate is:

*Equation 7*

$$G_{\mathrm{tun}} = \sum_{k=1}^{N_{\mathrm{lane}}} \sum_{j=1}^{N_{\mathrm{sec}}} G_{\mathrm{sec},j}$$

where $N_{sec}$ is the number of discrete sections and $N_{lane}$ is the number of lanes in the tunnel. Note that this summation can be reordered if appropriate, for example if the number of lanes changes within the tunnel. See section 11.3 for an example of this calculation.

The preliminary steps required to calculate the factored emissions rate and the volume of each vehicle category are described in the following sections.

## 5.2. VEHICLE CATEGORIES (VEHICLE AND FLEET CHARACTERISTICS)

For the purposes of vehicle emissions calculations, road vehicles are categorised in terms of their function and size as follows:

- Passenger car (PC)
- Light commercial vehicle (LCV)
- Heavy goods vehicle (HGV)

The LCV category typically includes vehicles with a mass of up to 3,500 kg (3.5 t). Where possible, this category should be considered separately as it can have different certification limits to the PC and HGV categories. In the context of this report, the HGV category comprises vehicles of over 3.5 t including trucks, truck-trailer combinations, articulated lorries, buses and coaches.

The primary vehicle categories above can be sub-categorized by fuel, e.g. gasoline (petrol) or diesel.

- PC Gasoline
- PC Diesel
- LCV Gasoline
- LCV Diesel
- HGV Diesel

In Europe, vehicles must adhere to the European emissions standard current at the time of manufacture, leading to further sub-categorization, e.g.

- PC Gasoline - Euro 5
- PC Gasoline - Euro 6

and so forth.

HGV emissions are highly dependent on vehicle mass. The emissions data provided in this report correspond to a fleet-averaged HGV (representing a combination of light trucks, regular trucks and semi-trailers) with a reference mass of 23 t. A mass factor is applied to account for other fleet-averaged HGV masses (see section 5.4.3).

Note that emissions calculations can be sensitive to the composition of the HGV fleet. The number of HGVs is often reported as an average percentage of the total traffic flow without any further information about sub categories and their respective masses. This information is needed so that a single effective average mass can be calculated for the HGV portion of the fleet. In addition, the usage of an average percentage of HGV within the daily average traffic volume might be overly-conservative when applied to peak traffic flow.

## 5.3. NUMBER OF VEHICLES (TUNNEL GEOMETRY / TRAFFIC CHARACTERISTICS)

The number of vehicles of a given category in a section of tunnel depends on the fleet composition, the traffic conditions, the length of roadway and the number of traffic lanes.

### 5.3.1. Traffic condition

The traffic condition may be expressed as either:

- traffic flux - the number of vehicles passing a reference point per unit time, or
- traffic density - the number of vehicles per unit distance

While traffic flux prediction is a specialist subject, indicative data on average peak values of traffic flow and density in the context of a road tunnel is provided in Table 1.

### 5.3.2. Calculation of number of vehicles

The number of vehicles of a particular category in a tunnel section is calculated as

*Equation 8*

$$n_{\mathrm{cat}} = D.L_{\mathrm{sec}}.a_{\mathrm{cat}}$$

where $L_{sec}$ is the section length, $D$ is the traffic density (vehicles/km), and $a_{cat}$ is the proportion of that vehicle category. The traffic density $D$ may be calculated from the PCU density using equation (2), or from the traffic flux, $q$ (veh/h), and speed, $v$ (km/h), as

*Equation 9*

$$D = \frac{q}{v}$$

## 5.4. Factored Vehicle Emissions Rate

The factored emissions rate for each vehicle category $g_{fac}$ in Equation 6 depends on fuel, traffic speed, road gradient, fleet age, design year and altitude, with possible further dependencies on vehicle mass and on the pollutant of interest. Hence, the factored emission rate is the base emission rate multiplied by the influence factors.

The procedure for calculating the factored emissions rate $g_{fac}$ begins with the selection or preparation of a fleet-averaged emissions database. The base emissions rate per vehicle category $g_{cat}$ is obtained for a particular vehicle category and pollutant as a function of vehicle speed and road gradient. The effects of time, vehicle mass and altitude are accounted for through influence factors $f_t$, $f_m$ and $f_a$ respectively. For particulate matter calculations, the equivalent emission rate of non-exhaust particulate matter $g_{\mathrm{non-ex}}$ is added.

The general form of the factoring process is:

*Equation 10*

$$g_{\mathrm{fac}} = g_{\mathrm{cat}}.f_{\mathrm{t}}.f_{\mathrm{m}}.f_{\mathrm{a}} + g_{\mathrm{non-ex}}$$

Note that the non-exhaust term is only relevant for particulate matter, and hence has a value of zero for other pollutants.

### 5.4.1. Fleet-averaged emissions database

The emissions database is a collection of tables which present the fleet-averaged vehicle emissions rate $g_{cat}$ as a function of vehicle speed and road gradient. The emissions tables are arranged by fuel, vehicle function and pollutant.

A standard fleet-averaged emissions database may be selected if its assumed fleet composition (the combination of vehicle functions, fuels and emission standards) is appropriate to the analysis at hand. Standard emissions databases are provided for certain Euro emissions profiles and certain countries (technology standards A, B and C) in section 6.

If no suitable standard database is available, a project-specific fleet-averaged emissions database can be prepared based on the 'detailed' database in section 11, where emission rates are presented for each Euro emission standard. This detailed database must be filtered by the profile of Euro standards in the fleet and a factor must also be applied to account for engine degradation. This process is demonstrated in Section 11.1.1.

### 5.4.2. Time factor ($f_t$)

The emissions databases have been derived for the year 2018. Use of data for future design years therefore requires a time factor. The time factor accounts for fleet renewal with vehicles constructed with more stringent emissions standards, and for the degradation of exhaust after-treatment systems during the lifetime of a vehicle. Where a standard emissions database has been chosen, vehicle-specific time factors should be applied to the corresponding emission tables.

Where a fleet-averaged database is generated from the detailed emissions database, the fleet distribution and the corresponding emission standards for projection years have to be defined by the designer.

### 5.4.3. Mass factor ($f_m$)

As discussed in section 5.2, HGV emissions highly depend on their mass. The emissions data provided in this report correspond to a fleet-averaged HGV (representing a combination of light trucks, regular trucks and semi-trailers, buses) with a reference mass of 23 t. Where the fleet-averaged HGV is lighter or heavier, the emissions are derived by applying a mass-dependent factor, $f_m$, which can be interpolated from the values for trucks (15 t) and semi-trailers (32 t).

### 5.4.4. Altitude factor ($f_a$)

The altitude influence on the different exhaust components varies with the type of engine. For example, passenger cars with catalytic converters behave quite differently to cars without such converters. There is insufficient data to determine appropriate altitude factors for all vehicle categories, and hence the factors suggested in this document should be applied in a conservative manner.

### 5.4.5. Non-exhaust emissions

Non-exhaust emissions apply for all type of propulsion systems. Non-exhaust emissions, discussed in detail in section 4.4, should be added to the exhaust emission rate as shown in Equation 10, for all vehicle types.

Particulate matter may be transmitted to the tunnel air by brake and tyre wear and resuspension of road dust. Due to limited research on this subject, these non-exhaust particulates are simply treated as an additional vehicle emission per unit distance. There is little knowledge on the speed dependency of the emission rates of non-exhaust PM. The emission rate of a heavy duty vehicle is much higher than that one of a passenger car.

Research shows that there is a significant difference in the emission rates between tunnels with uni- and bi-directional traffic [10]. This is due to the fact that for traffic heading in both directions in a tunnel the longitudinal air velocity is much lower and the residence time of PM therefore longer, hence the possibility of resuspension of deposited PM increases. In addition, vehicle generated turbulence – especially from HGVs – increases the likelihood of goods being lost from uncovered loads (e.g. gravel transportation, etc.)

# 6. DATABASE FOR THE STANDARD METHOD

The emission rates given in this section are based on the year 2018. Deviations from that year require application of time factors for future emissions. The base emission rate represents an 'average' vehicle on the road for the specific base year i.e. an 'average' passenger car consists of a certain percentage of vehicles according to Euro 1, Euro 2, etc. emission standards. The detailed percentage for a typical European fleet distribution ([8]) is given in Table 7.

*Table 7: Fleet composition used for base case emission rate calculations for base year 2018*

| type | year | pre EU1 | EU 1 | EU 2 | EU 3 | EU 4 | EU 5 | EU 6 |
|---|---|---|---|---|---|---|---|---|
| PC gasoline | 2018 | 2.2% | 2.3% | 2.6% | 2.1% | 17.0% | 35.7% | 38.2% |
| PC Diesel | | 0.2% | 1.3% | 2.2% | 5.9% | 16.8% | 36.0% | 37.5% |
| LCV gasoline | | 5.7% | 3.3% | 2.4% | 4.3% | 15.9% | 29.7% | 38.9% |
| LCV Diesel | | 1.7% | 1.7% | 3.0% | 8.3% | 20.5% | 33.6% | 31.1% |
| HGV Diesel | | 0.8% | 0.6% | 1.6% | 4.9% | 3.1% | 29.2% | 59.8% |

## 6.1. PASSENGER CARS

### 6.1.1. Base emission rates for technology class A

The base emission rate $g_{cat}$ quantifies the vehicle-specific tailpipe emission for a specific pollutant as a function of average vehicle speed and road gradient. The factor differs for gasoline and diesel fuelled cars.

*Table 8: Base emission rates for CO (EC Euro regulation), gasoline passenger cars*

| PC Gasoline CO [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| 10 | 7.7 | 8.8 | 9.7 | 11.0 | 12.0 | 14.1 | 16.6 |
| 20 | 8.4 | 10.2 | 12.6 | 15.5 | 22.7 | 35.4 | 50.2 |
| 30 | 7.7 | 9.3 | 11.1 | 13.7 | 17.3 | 22.8 | 31.1 |
| 40 | 8.3 | 10.3 | 12.9 | 16.4 | 22.3 | 33.2 | 48.9 |
| 50 | 8.9 | 11.8 | 14.0 | 18.2 | 23.8 | 33.1 | 46.7 |
| 60 | 8.5 | 11.4 | 13.3 | 18.2 | 25.3 | 37.8 | 59.2 |
| 70 | 9.9 | 13.3 | 17.9 | 25.6 | 36.4 | 60.4 | 109.0 |
| 80 | 12.5 | 16.2 | 21.1 | 31.0 | 49.8 | 89.1 | 166.2 |
| 90 | 11.7 | 15.7 | 22.7 | 35.6 | 67.5 | 146.1 | 264.3 |
| 100 | 15.5 | 20.9 | 31.6 | 50.4 | 85.9 | 209.4 | 415.7 |
| 110 | 26.7 | 33.2 | 47.4 | 78.1 | 148.6 | 326.2 | 791.2 |
| 120 | 47.2 | 54.9 | 74.1 | 130.7 | 259.8 | 604.4 | 1506.2 |
| 130 | 85.3 | 106.2 | 142.2 | 236.6 | 504.3 | 1318.7 | 2568.7 |

*Table 9: Base emission rates for NOx (EC Euro regulation), gasoline passenger cars*

| PC Gasoline $NO_x$ [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 10 | 1.2 | 1.3 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 |
| 20 | 1.3 | 1.6 | 2.0 | 2.4 | 2.9 | 3.4 | 4.2 |
| 30 | 1.3 | 1.6 | 2.1 | 2.7 | 3.4 | 4.3 | 5.4 |
| 40 | 1.4 | 1.8 | 2.4 | 3.1 | 4.1 | 5.1 | 6.2 |
| 50 | 1.3 | 1.7 | 2.3 | 3.2 | 4.3 | 5.5 | 7.1 |
| 60 | 1.3 | 1.8 | 2.5 | 3.6 | 5.1 | 6.9 | 8.6 |
| 70 | 1.3 | 1.9 | 2.7 | 4.0 | 5.9 | 8.3 | 10.1 |
| 80 | 1.4 | 2.1 | 3.2 | 5.2 | 7.4 | 9.8 | 12.3 |
| 90 | 1.6 | 2.4 | 3.7 | 6.4 | 9.9 | 11.8 | 14.6 |
| 100 | 1.9 | 3.0 | 4.4 | 7.7 | 12.1 | 15.3 | 17.8 |
| 110 | 2.6 | 3.8 | 6.0 | 9.2 | 13.9 | 18.3 | 22.5 |
| 120 | 3.4 | 5.0 | 8.2 | 12.2 | 16.3 | 21.7 | 26.4 |
| 130 | 4.4 | 7.2 | 13.0 | 17.9 | 19.8 | 24.7 | 29.7 |

*Table 10: Base emission rates for exhaust particles (opacity) (EC Euro regulation), gasoline passenger cars*

| PC Gasoline Opacity exhaust [$m^2$/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| 20 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 |
| 30 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 |
| 40 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 |
| 50 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 |
| 60 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 | 0.9 |
| 70 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.9 | 1.5 |
| 80 | 0.2 | 0.3 | 0.3 | 0.5 | 0.8 | 1.3 | 2.4 |
| 90 | 0.3 | 0.3 | 0.3 | 0.6 | 1.2 | 2.1 | 3.8 |
| 100 | 0.5 | 0.3 | 0.4 | 0.7 | 1.5 | 2.9 | 4.9 |
| 110 | 0.7 | 0.6 | 0.7 | 1.1 | 2.0 | 3.7 | 6.2 |
| 120 | 1.0 | 0.9 | 1.3 | 2.0 | 3.3 | 5.0 | 8.0 |
| 130 | 1.3 | 1.6 | 2.3 | 3.7 | 5.8 | 7.9 | 10.4 |

*Table 11: Base emission rates for CO (EC Euro regulation), diesel passenger cars*

| PC Diesel CO [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 10 | 0.8 | 0.9 | 1.1 | 1.3 | 1.5 | 1.8 | 2.0 |
| 20 | 0.9 | 1.0 | 1.3 | 2.8 | 3.3 | 3.6 | 4.1 |
| 30 | 0.9 | 1.2 | 1.4 | 2.4 | 3.0 | 3.5 | 3.9 |
| 40 | 0.9 | 1.2 | 1.4 | 2.0 | 2.7 | 3.2 | 3.7 |
| 50 | 1.0 | 1.1 | 1.4 | 1.8 | 2.6 | 3.1 | 3.6 |
| 60 | 1.0 | 1.1 | 1.2 | 1.6 | 2.4 | 3.0 | 3.6 |
| 70 | 1.0 | 1.1 | 1.2 | 1.6 | 2.1 | 2.8 | 3.4 |
| 80 | 0.9 | 1.1 | 1.2 | 1.6 | 2.1 | 2.4 | 3.2 |
| 90 | 0.9 | 1.0 | 1.2 | 1.5 | 1.9 | 2.1 | 2.9 |
| 100 | 1.0 | 1.1 | 1.2 | 1.3 | 1.6 | 1.9 | 2.7 |
| 110 | 1.2 | 1.2 | 1.2 | 1.4 | 1.5 | 1.7 | 2.5 |
| 120 | 1.3 | 1.3 | 1.2 | 1.4 | 1.8 | 2.0 | 2.8 |
| 130 | 1.4 | 1.4 | 1.2 | 1.4 | 2.0 | 2.4 | 2.9 |

*Table 12: Base emission rates for NOx (EC Euro regulation), diesel passenger cars*

| PC Diesel $NO_x$ [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| 10 | 7.7 | 9.0 | 10.3 | 12.2 | 14.5 | 16.9 | 19.9 |
| 20 | 7.9 | 9.5 | 11.6 | 14.7 | 18.4 | 23.1 | 28.4 |
| 30 | 8.0 | 10.1 | 12.8 | 17.3 | 22.4 | 29.3 | 36.9 |
| 40 | 8.0 | 10.2 | 13.5 | 19.0 | 25.8 | 34.8 | 45.8 |
| 50 | 8.0 | 10.4 | 14.2 | 20.6 | 29.2 | 40.2 | 54.7 |
| 60 | 8.4 | 11.3 | 16.2 | 23.9 | 35.2 | 51.0 | 71.6 |
| 70 | 8.7 | 12.4 | 18.7 | 28.9 | 43.6 | 63.0 | 87.8 |
| 80 | 7.6 | 11.9 | 20.0 | 34.0 | 56.7 | 88.8 | 126.6 |
| 90 | 8.3 | 13.3 | 24.5 | 43.9 | 70.0 | 108.6 | 171.6 |
| 100 | 9.6 | 14.2 | 27.0 | 50.9 | 86.7 | 131.1 | 204.2 |
| 110 | 13.3 | 21.9 | 37.9 | 68.5 | 114.3 | 178.8 | 247.4 |
| 120 | 19.3 | 32.4 | 53.2 | 86.2 | 142.7 | 239.2 | 316.1 |
| 130 | 25.4 | 47.9 | 77.1 | 120.9 | 191.6 | 291.5 | 373.4 |

*Table 13: Base emission rates for exhaust particles (opacity) (EC Euro regulation), diesel passenger cars*

| PC Diesel Opacity exhaust [m²/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| 10 | 1.1 | 1.2 | 1.3 | 1.5 | 1.6 | 1.8 | 2.0 |
| 20 | 1.1 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.7 |
| 30 | 1.1 | 1.4 | 1.6 | 2.0 | 2.3 | 2.7 | 3.1 |
| 40 | 1.2 | 1.4 | 1.8 | 2.3 | 2.8 | 3.4 | 4.0 |
| 50 | 1.2 | 1.5 | 2.0 | 2.7 | 3.4 | 4.2 | 4.8 |
| 60 | 1.3 | 1.6 | 2.1 | 2.8 | 3.8 | 4.9 | 6.0 |
| 70 | 1.3 | 1.8 | 2.5 | 3.2 | 4.3 | 5.3 | 7.0 |
| 80 | 1.3 | 1.9 | 2.8 | 3.8 | 5.3 | 6.6 | 8.6 |
| 90 | 1.5 | 2.2 | 3.2 | 4.6 | 6.5 | 8.2 | 9.7 |
| 100 | 2.0 | 2.6 | 3.8 | 5.6 | 7.6 | 9.4 | 10.6 |
| 110 | 2.7 | 3.5 | 4.7 | 6.6 | 8.9 | 10.5 | 11.7 |
| 120 | 3.4 | 4.6 | 6.3 | 7.9 | 9.6 | 11.2 | 12.5 |
| 130 | 4.3 | 6.2 | 8.1 | 9.9 | 11.1 | 12.6 | 14.1 |

### 6.1.2. Time and Altitude Factors

**Time factor - $f_t$:** The influence of continual fleet renewal and more stringent emission standards for new vehicles is taken into consideration by the time factor $f_t$.

*Table 14: Time factor for passenger cars, technology standard A*

| $f_t$ | CO | | NOx | | Opacity | |
|---|---|---|---|---|---|---|
| **Passenger cars** | **Gasoline** | **Diesel** | **Gasoline** | **Diesel** | **Gasoline** | **Diesel** |
| **2018** | 1 | 1 | 1 | 1 | 1 | 1 |
| **2020** | 0.91 | 0.92 | 0.85 | 0.87 | 0.98 | 0.76 |
| **2025** | 0.78 | 0.80 | 0.62 | 0.51 | 0.95 | 0.44 |
| **2030** | 0.71 | 0.74 | 0.50 | 0.32 | 0.93 | 0.33 |
| **2035** | 0.69 | 0.72 | 0.46 | 0.26 | 0.92 | 0.31 |

**Altitude factor** - $f_h$: For altitudes of up to 1,000 m above sea level, the altitude factor fh is 1.0. Table 15 shows the altitude factors valid for an altitude of 2,000 m. The altitude factors for altitudes between 1,000 m and 2,000 m can be derived through linear interpolation. For altitudes higher than 2,000 m, the data is sparse, but it can be assumed that the values in Table 15 apply even for higher altitudes.

*Table 15: Altitude factor for passenger cars, technology standard A*

| $f_h$ | CO | | $NO_X$ | | Opacity |
|---|---|---|---|---|---|
| **Passenger cars** | **Gasoline** | **Diesel** | **Gasoline** | **Diesel** | **Diesel** |
| 2018 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 2020 | 1.6 | 1.0 | 1.0 | 1.0 | 1.0 |
| 2025 and later | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

### 6.1.3. Non-exhaust emissions

*Table 16: Base EMission Factors for non-exhaust particulates (opacity) (EC Euro regulation), passenger cars*

| PC Opacity non-exhaust [m²/h] | | |
|---|---|---|
| **v [km/h]** | **Bi-directional** | **Unidirectional** |
| 0 | 0 | 0 |
| 10 | 1.1 | 0.7 |
| 20 | 2.2 | 1.3 |
| 30 | 3.4 | 2.0 |
| 40 | 4.5 | 2.6 |
| 50 | 5.6 | 3.3 |
| 60 | 6.7 | 3.9 |
| 70 | 7.8 | 4.6 |
| 80 | 9.0 | 5.3 |
| 90 | 10.1 | 5.9 |
| 100 | 11.2 | 6.6 |
| 110 | 12.3 | 7.2 |
| 120 | 13.4 | 7.9 |
| 130 | 14.6 | 8.6 |

## 6.2. Light-Duty Commercial Vehicles (LCV)

### 6.2.1. Base emission rates for technology class A

The base emission rate quantifies the vehicle specific tailpipe emission for specific pollutants as a function of average vehicle speed and road gradient.

*Table 17: Base emission rates for CO (EC Euro regulation), gasoline Light-Duty vehicles*

| LCV Gasoline CO [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Gradient [%]** | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| 10 | 35.3 | 38.1 | 41.7 | 45.5 | 50.2 | 55.9 | 61.8 |
| 20 | 35.9 | 40.1 | 46.8 | 51.7 | 58.3 | 67.8 | 83.4 |
| 30 | 36.5 | 42.2 | 51.9 | 57.9 | 66.5 | 79.7 | 105.1 |
| 40 | 37.8 | 43.2 | 57.4 | 67.8 | 86.2 | 116.5 | 123.2 |
| 50 | 39.5 | 44.2 | 57.6 | 70.0 | 90.0 | 124.0 | 141.3 |
| 60 | 40.8 | 47.1 | 61.2 | 69.3 | 93.8 | 131.6 | 204.7 |
| 70 | 44.0 | 51.8 | 71.9 | 90.8 | 126.5 | 193.5 | 381.1 |
| 80 | 52.1 | 61.6 | 81.3 | 98.3 | 164.5 | 272.5 | 645.7 |
| 90 | 52.3 | 67.8 | 99.1 | 118.4 | 237.1 | 581.9 | 1380.3 |
| 100 | 68.8 | 94.8 | 137.0 | 148.0 | 329.6 | 953.7 | 2194.7 |
| 110 | 108.9 | 150.0 | 203.1 | 238.1 | 609.9 | 1709.1 | 3479.0 |
| 120 | 174.1 | 240.8 | 323.1 | 468.3 | 1164.6 | 2709.5 | 4329.6 |
| 130 | 246.5 | 329.6 | 514.5 | 1073.3 | 2406.5 | 3959.4 | 4641.6 |

*Table 18: Base emission rates for (EC Euro regulation), gasoline Light-Duty vehicles*

| LCV Gasoline $NO_X$ [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| 10 | 1.7 | 2.1 | 2.7 | 3.4 | 4.3 | 5.4 | 6.4 |
| 20 | 1.8 | 2.2 | 3.0 | 4.7 | 6.2 | 8.8 | 10.4 |
| 30 | 1.9 | 2.1 | 3.1 | 5.7 | 8.0 | 10.7 | 13.1 |
| 40 | 1.8 | 2.0 | 3.3 | 6.0 | 9.1 | 12.7 | 16.1 |
| 50 | 1.4 | 1.6 | 3.6 | 6.0 | 9.9 | 14.2 | 18.7 |
| 60 | 0.9 | 1.7 | 3.9 | 7.5 | 12.3 | 14.7 | 21.2 |
| 70 | 0.8 | 1.9 | 4.7 | 9.1 | 14.6 | 18.1 | 24.3 |
| 80 | 0.7 | 2.0 | 5.7 | 12.3 | 19.1 | 21.6 | 25.5 |
| 90 | 1.1 | 2.7 | 7.8 | 15.2 | 23.6 | 24.7 | 26.8 |
| 100 | 2.0 | 3.9 | 10.1 | 19.2 | 27.9 | 27.8 | 27.9 |
| 110 | 3.4 | 6.7 | 15.2 | 26.8 | 33.0 | 30.9 | 28.9 |
| 120 | 4.5 | 9.8 | 21.6 | 33.8 | 36.1 | 32.1 | 29.8 |
| 130 | 5.9 | 13.5 | 26.6 | 36.2 | 36.7 | 32.7 | 30.8 |

*Table 19: Base emission rates for exhaust particles (opacity) (EC Euro regulation), gasoline Light-Duty vehicles*

| LCV Gasoline Opacity exhaust [$m^2$/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| 20 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 |
| 30 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 | 0.8 |
| 40 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 0.9 | 1.1 |
| 50 | 0.1 | 0.1 | 0.2 | 0.2 | 0.4 | 0.8 | 1.5 |
| 60 | 0.1 | 0.1 | 0.2 | 0.3 | 0.6 | 1.2 | 2.4 |
| 70 | 0.2 | 0.2 | 0.3 | 0.6 | 1.2 | 2.4 | 5.1 |
| 80 | 0.5 | 0.5 | 0.7 | 0.9 | 2.0 | 4.3 | 9.6 |
| 90 | 0.8 | 0.9 | 1.0 | 1.2 | 3.1 | 7.1 | 13.6 |
| 100 | 1.1 | 1.2 | 1.4 | 2.0 | 5.2 | 9.5 | 18.8 |
| 110 | 1.4 | 1.8 | 2.2 | 3.9 | 7.3 | 14.6 | 26.1 |
| 120 | 1.7 | 2.3 | 3.0 | 5.2 | 9.4 | 22.0 | 32.7 |
| 130 | 2.3 | 2.9 | 3.9 | 6.5 | 13.8 | 30.2 | 40.4 |

*Table 20: Base emission rates for CO (EC Euro regulation), diesel Light-Duty vehicles*

| LCV Diesel CO [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| 10 | 0.9 | 1.0 | 1.2 | 1.5 | 1.6 | 1.8 | 2.1 |
| 20 | 1.0 | 1.2 | 1.5 | 1.8 | 1.9 | 2.1 | 2.3 |
| 30 | 1.0 | 1.3 | 1.6 | 2.0 | 2.2 | 2.4 | 2.6 |
| 40 | 1.1 | 1.3 | 1.7 | 2.0 | 2.3 | 2.5 | 2.9 |
| 50 | 1.1 | 1.4 | 1.7 | 2.1 | 2.5 | 2.8 | 3.0 |
| 60 | 1.0 | 1.4 | 1.7 | 2.1 | 2.7 | 3.0 | 3.4 |
| 70 | 1.1 | 1.6 | 1.8 | 2.3 | 3.0 | 3.3 | 3.8 |
| 80 | 1.4 | 1.7 | 1.9 | 2.5 | 3.3 | 3.6 | 4.2 |
| 90 | 1.7 | 2.0 | 2.1 | 2.6 | 3.5 | 3.9 | 5.1 |
| 100 | 2.0 | 2.3 | 2.2 | 2.8 | 3.9 | 4.6 | 5.7 |
| 110 | 2.4 | 2.6 | 2.5 | 3.0 | 4.4 | 5.4 | 6.2 |
| 120 | 2.8 | 3.0 | 3.4 | 4.2 | 5.4 | 6.0 | 6.6 |
| 130 | 2.9 | 3.6 | 4.2 | 5.1 | 6.0 | 6.4 | 6.8 |

*Table 21: Base emission rates for (EC Euro regulation), diesel Light-Duty vehicles*

| LCV Diesel $NO_x$ [g/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 |
| 10 | 5.2 | 6.0 | 7.3 | 9.0 | 11.3 | 13.7 | 16.0 |
| 20 | 5.3 | 6.6 | 8.7 | 11.7 | 15.9 | 27.7 | 34.9 |
| 30 | 5.4 | 7.2 | 10.1 | 14.4 | 20.4 | 34.0 | 44.6 |
| 40 | 4.9 | 6.9 | 10.2 | 15.7 | 23.8 | 40.2 | 54.3 |
| 50 | 4.5 | 6.5 | 10.4 | 17.1 | 27.2 | 41.4 | 58.6 |
| 60 | 4.0 | 7.7 | 10.7 | 18.5 | 37.9 | 57.5 | 81.5 |
| 70 | 4.5 | 9.0 | 16.6 | 29.6 | 48.6 | 73.6 | 104.4 |
| 80 | 4.9 | 9.4 | 20.0 | 43.2 | 75.6 | 108.6 | 146.2 |
| 90 | 8.5 | 15.8 | 30.4 | 58.0 | 102.4 | 144.9 | 181.8 |
| 100 | 12.2 | 23.8 | 43.1 | 76.3 | 122.2 | 169.6 | 210.5 |
| 110 | 20.1 | 40.2 | 68.9 | 110.5 | 156.2 | 199.6 | 235.1 |
| 120 | 32.8 | 62.3 | 101.1 | 147.1 | 192.1 | 227.7 | 252.9 |
| 130 | 54.7 | 92.5 | 136.9 | 183.3 | 224.2 | 245.3 | 258.7 |

*Table 22: Base emission rates for exhaust particles (opacity) (EC Euro regulation), diesel Light-Duty vehicles*

| LCV Diesel Opacity exhaust [m²/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 10 | 1.8 | 2.0 | 2.2 | 2.6 | 2.9 | 3.3 | 3.6 |
| 20 | 2.0 | 2.3 | 2.8 | 3.3 | 3.8 | 4.6 | 5.5 |
| 30 | 2.0 | 2.3 | 2.9 | 3.5 | 4.7 | 5.9 | 7.0 |
| 40 | 2.1 | 2.8 | 3.3 | 4.2 | 5.4 | 7.2 | 8.5 |
| 50 | 2.0 | 2.7 | 3.7 | 4.8 | 6.1 | 8.8 | 9.4 |
| 60 | 2.3 | 3.0 | 4.2 | 5.9 | 7.2 | 10.5 | 11.9 |
| 70 | 2.5 | 3.3 | 4.6 | 6.9 | 9.8 | 12.2 | 14.3 |
| 80 | 3.9 | 4.6 | 6.4 | 9.1 | 12.3 | 14.8 | 17.3 |
| 90 | 5.7 | 6.7 | 8.3 | 11.3 | 14.6 | 17.4 | 20.4 |
| 100 | 7.7 | 9.1 | 11.0 | 13.3 | 16.5 | 19.8 | 22.7 |
| 110 | 9.2 | 11.1 | 13.2 | 16.0 | 19.0 | 22.3 | 25.1 |
| 120 | 10.8 | 13.2 | 15.5 | 18.0 | 21.5 | 24.8 | 26.9 |
| 130 | 12.0 | 14.7 | 17.2 | 20.5 | 24.2 | 26.7 | 27.6 |

### 6.2.2. Time and Altitude factors

**Time factor - $f_t$:** The influence of continual fleet renewal and more stringent emission standards for new vehicles is taken into consideration by the factor ft (derived from [8]).

*Table 23: Time factor, LCV, technology standard A*

| $f_t$ | CO | | $NO_X$ | | Opacity | |
|---|---|---|---|---|---|---|
| LCV | Gasoline | Diesel | Gasoline | Diesel | Gasoline | Diesel |
| 2018 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2020 | 0.80 | 0.77 | 0.70 | 0.82 | 0.92 | 0.75 |
| 2025 | 0.57 | 0.43 | 0.32 | 0.49 | 0.82 | 0.38 |
| 2030 | 0.49 | 0.26 | 0.20 | 0.34 | 0.79 | 0.21 |
| 2035 | 0.48 | 0.25 | 0.19 | 0.29 | 0.78 | 0.17 |

**Altitude factor - $f_h$:** For this vehicle class, there is no identifiable influence for altitudes up to 2,000 m above sea level.

### 6.2.3. Non-exhaust emissions

Due to lack of data, base emission rates for passenger cars PM non-exhaust are taken (see section 6.1.3).

## 6.3. Heavy Goods Vehicles and Buses (HGV)

The base emission rate quantifies the vehicle-specific tailpipe emission for a specific pollutant as a function of average vehicle speed and road gradient. The factors only exist for diesel HGV. The base emission rates for diesel HGV given in the following tables refer to an average vehicle mass of 23 t (mix of lorries, lorry-trailer combinations, semi-trailers). Buses can be calculated using the HGV

tables, using a lower mass factor. A mass of 15 t is proposed for buses and coaches. In this case, the values must be adjusted to compensate for the reduced mass.

### 6.3.1. Base emission rates for technology class A

The base emission rates given in the following tables are related to an average vehicle mass of 23 t.

*Table 24: Base emission rates for CO (EC Euro regulation), diesel heavy goods vehicles*

| **HGV Diesel CO [g/h] 2018** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Gradient [%]** | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 |
| 10 | 11.7 | 14.1 | 17.3 | 21.0 | 24.3 | 28.0 | 31.3 |
| 20 | 10.0 | 11.4 | 17.8 | 22.3 | 26.2 | 30.6 | 35.2 |
| 30 | 8.7 | 10.1 | 18.3 | 23.9 | 30.6 | 37.8 | 42.3 |
| 40 | 5.8 | 8.7 | 18.8 | 26.9 | 37.3 | 48.1 | 55.1 |
| 50 | 4.1 | 6.2 | 19.3 | 29.4 | 43.2 | 56.8 | 64.8 |
| 60 | 3.5 | 6.1 | 19.8 | 34.9 | 53.3 | 62.3 | 67.7 |
| 70 | 3.6 | 6.1 | 20.3 | 40.3 | 63.1 | 67.8 | 70.6 |
| 80 | 3.6 | 6.1 | 20.7 | 45.8 | 73.3 | 77.2 | 76.6 |
| 90 | 3.6 | 6.1 | 22.2 | 47.0 | 75.7 | 83.1 | 82.4 |
| 100 | 3.6 | 6.1 | 22.3 | 49.6 | 78.1 | 88.6 | 88.0 |

*Table 25: Base emission rates for $NO_X$ (EC Euro regulation), diesel heavy goods vehicles*

| **HGV Diesel $NO_X$ [g/h] 2018** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Gradient [%]** | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 14.4 | 14.4 | 14.4 | 14.4 | 14.4 | 14.4 | 14.4 |
| 10 | 54.2 | 65.7 | 77.2 | 86.5 | 92.7 | 98.4 | 103.8 |
| 20 | 41.0 | 55.3 | 76.2 | 88.7 | 98.8 | 104.1 | 111.7 |
| 30 | 32.4 | 48.5 | 75.2 | 92.7 | 103.1 | 111.0 | 127.6 |
| 40 | 23.9 | 41.6 | 69.3 | 105.3 | 119.2 | 141.2 | 174.9 |
| 50 | 20.0 | 33.1 | 64.2 | 111.8 | 129.8 | 167.1 | 211.7 |
| 60 | 16.2 | 24.5 | 62.2 | 122.9 | 182.0 | 247.5 | 301.9 |
| 70 | 12.3 | 16.3 | 57.5 | 134.0 | 234.2 | 328.0 | 392.1 |
| 80 | 12.3 | 16.3 | 57.5 | 145.1 | 286.5 | 408.4 | 482.3 |
| 90 | 12.3 | 16.3 | 57.5 | 146.6 | 294.6 | 419.5 | 485.4 |
| 100 | 12.3 | 16.3 | 57.5 | 151.7 | 304.6 | 428.6 | 488.5 |

*Table 26: Base emission rates for exhaust particles (opacity) (EC Euro regulation), diesel heavy goods vehicles*

| HGV Diesel Opacity exhaust [m²/h] 2018 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Gradient [%] | | | | | | |
| v [km/h] | -6 | -4 | -2 | 0 | 2 | 4 | 6 |
| 0 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| 10 | 4.3 | 4.9 | 5.6 | 6.3 | 7.1 | 7.9 | 8.6 |
| 20 | 3.7 | 4.3 | 5.6 | 6.5 | 7.4 | 8.5 | 9.6 |
| 30 | 3.5 | 4.1 | 5.6 | 6.8 | 8.4 | 9.9 | 11.3 |
| 40 | 3.3 | 3.9 | 5.8 | 8.0 | 10.5 | 12.9 | 15.0 |
| 50 | 3.1 | 3.7 | 5.8 | 8.6 | 11.9 | 14.9 | 17.5 |
| 60 | 3.1 | 3.7 | 6.0 | 9.3 | 14.3 | 19.3 | 22.6 |
| 70 | 3.1 | 3.8 | 6.3 | 10.1 | 16.7 | 23.6 | 27.7 |
| 80 | 3.3 | 3.7 | 6.6 | 12.3 | 19.4 | 28.0 | 32.8 |
| 90 | 3.5 | 3.9 | 6.6 | 14.4 | 21.7 | 28.5 | 33.1 |
| 100 | 3.5 | 3.9 | 6.8 | 15.0 | 23.0 | 29.4 | 33.3 |

### 6.3.2. Mass factors

*Table 27: Mass factors ($f_m$)*

| Type | CO | $NO_X$ | Opacity |
|---|---|---|---|
| 15 t (e.g. single lorry, bus) | 0.9 | 0.9 | 0.9 |
| 23 t (average)* | 1.0 | 1.0 | 1.0 |
| 32 t (Lorry-trailer combination/semitrailer) | 1.2 | 1.2 | 1.2 |
| * average consists of 21% single lorries and 79% truck/trailer or semi-trailer combinations | | | |

### 6.3.3. Time and Altitude factors

**Time factor - $f_t$:** The influence of continual fleet renewal and more stringent emission standards for new vehicles is taken into consideration by the factor $f_t$

*Table 28: Time factor for years other than the base year, heavy goods vehicles, Technology standard A*

| Year | CO | $NO_X$ | Opacity |
|---|---|---|---|
| 2018 | 1 | 1 | 1 |
| 2020 | 0.89 | 0.71 | 0.96 |
| 2025 | 0.76 | 0.34 | 0.92 |
| 2030 | 0.72 | 0.22 | 0.91 |
| 2035 | 0.72 | 0.22 | 0.91 |

**Altitude factor - $f_h$:** For heavy-goods vehicles and altitudes below 2,000 m above sea level no identifiable altitude factor $f_h$ exists.

### 6.3.4. Non-exhaust emissions [10]

*Table 29: Base EMission rates for non-exhaust particulates (opacity) (EC Euro regulation) heavy goods vehicles*

| HGV Opacity non-exhaust [m²/h] | | |
|---|---|---|
| **v [km/h]** | **Bi-directional** | **Unidirectional** |
| 0 | 0 | 0 |
| 10 | 5.1 | 4.4 |
| 20 | 10.1 | 8.8 |
| 30 | 15.2 | 13.3 |
| 40 | 20.2 | 17.7 |
| 50 | 25.3 | 22.1 |
| 60 | 30.3 | 26.5 |
| 70 | 35.4 | 30.9 |
| 80 | 40.4 | 35.3 |
| 90 | 45.5 | 39.8 |
| 100 | 50.6 | 44.2 |

## 6.4. Base Emission Rates for Technology Class B and C

The base emission rates for technology class B can be derived by shifting the time factor by 5 years. For technology class C the corresponding time shift shall be 10 years. E.g. for the design year 2025, the time factor corresponding to year 2020 shall be applied.

In case the year of the resulting time factor is earlier than 2018, the emission rates shall be calculated on basis of the PIARC report 2012 [1].

## 6.5. Data Consistency

As there are insufficient specific source data for emissions in road tunnels, various data sets representing mainly driving on open roads are used. Consequently, the source data for emission rates are conditioned in order to be applicable in a plausible manner to tunnel ventilation design. These conditioning includes primarily data smoothing with respect to average travel speed and road gradient.

The application of the vehicle-specific emission data combined with the fleet distribution data given for technology class A and base year 2018 will therefore not necessarily lead to exactly the same values as found in the aggregated emission rate tables for technology class A. Any difference in the resulting fresh-air demands applying the two methods of calculation are expected to be insignificant for the tunnel ventilation design.

# 7. CONCLUSIONS

This document presents updated emission rates for the year 2018 and the procedure to calculate fresh-air demand for the design of road tunnel ventilation. The emission rates given in this document are based on vehicles adopting Euro standards. Correlation factors for regions with other emission standards are provided. With the updated and extended data base, it is possible to calculate the fresh-air demand for the ventilation system to provide adequate air quality for tunnel users. Emission projections are possible for years up to 2035.

Depending on the availability of vehicle fleet data, two methodologies for calculation of vehicle emissions are described. The first is presented as a standard approach based on emissions for the year 2018 and includes influence factors for year of operation, altitude of the tunnel, and vehicle mass (for HGV only). Alternatively, in cases where the vehicle fleet data are known in detail, calculations can be performed using the tables for emission rates for vehicle-class specific emission standards.

# 8. GLOSSARY

| | |
|---|---|
| Admissible concentration | The maximum allowable in-tunnel concentration of a pollutant |
| Altitude factor | Factor to adjust emissions for the influence of altitude (see 5.4.4) |
| Time factor | Factor to adjust emissions for the influence of fleet renewal and degradation of exhaust after-treatment systems of vehicles (see 5.4.2) |
| Mass factor | Factor to adjust emissions for the influence of fleet-averaged HGV mass (see 5.4.3) |
| CO | Carbon monoxide |
| Design Year | The year for which the ventilation system is designed |
| Base emission rate | The quantity of a pollutant (gas or aerosol) emitted by a road vehicle in a certain year as a function of speed and slope |
| Factored emission rate | Base emission rate multiplied by influence factors |
| Extinction coefficient | A measure of intensity loss of a light beam |
| HBEFA | Handbook of Emission Factors |
| HGV | Heavy goods vehicles |
| LCV | Light duty commercial vehicles |
| Maintenance operations | Tunnel system operation during periods of tunnel maintenance |
| Non-exhaust particulate matter | Traffic-related particulates that do not emanate from the vehicle tailpipe. Examples include brake dust and roadway dust. |
| Normal operation | Traffic conditions when tunnel is open to traffic |
| $NO_X$ | Oxides of Nitrogen |
| $NO_2$ | Nitrogen dioxide |
| Particulate matter | Particles in the air that can reduce visibility. These include both brake dust and suspended dust from the roadway and tailpipe emissions. |
| $PM_{2.5}$ | Suspended particles in the air, with an aerodynamic diameter up to 2.5 µm |
| $PM_{10}$ | Suspended particles in the air, with an aerodynamic diameter up to 10 µm |
| PC | Passenger cars |
| PCU | Passenger car units |
| Threshold values | The level that shall not be exceeded |
| Set point (ventilation control) | Set points are used for the operation of the tunnel ventilation system. These are different from the design values and normally do not differ with variations to traffic conditions. Set points are generally lower than the design values. |
| Fresh-air | Ambient air to dilute emissions inside the tunnel |
| Vehicle category | Defines the type of vehicles (PC gasoline, PC diesel, etc.) |
| WHO | World Health Organization |

# 9. LIST OF SYMBOLS

$a_{cat}$ the proportion of that vehicle category
$a_{HGV}$ portion of HGV in the fleet
$f_h$ altitude factor [-]
$f_{HGV}$ number of HGV per PCU
$f_m$ influence factors for vehicle gross masses [-]
$f_t$ influence factor for years differing from the base year [-]
$f_{vis}$ conversion factor for mass and visibility [m²/mg]
$g_{cat}$ base emissions rate per vehicle category
$g_{fac}$ factored emissions rate for each vehicle category
$g_{non-ex}$ factor for non-exhaust particulate matter
$n_i$ $i^{-th}$ tunnelsection
$n_{PCU}$ the number of passenger car units
$n_{veh}$ number of vehicles in tunnel [-]
$n_{veh,i}$ number of vehicles in section i
$q$ traffic flux (veh/h)
v vehicle speed [km/h]
$C_{adm}$ admissible concentration of pollutant [g/m³]
$C_{amb}$ ambient (background) concentration of pollutant [g/m³]
$D_{PCU}$ number of passenger car units per km
$D_{veh}$ number of vehicles per km
G total emissions generation rate of the pollutant of interest [g/s].
$G_{lane}$ emissions rate for a lane of traffic [g/s]
$G_{sec}$ emissions rate for a section of the tunnel [g/s]
$G_{tun}$ total emissions rate in a tunnel [g/s]
$I_0$ intensity of the light source
I intensity of the light at the receiver
K light extinction coefficient [$m^{-1}$]
$K_{adm}$ admissible extinction coefficient [$m^{-1}$]
$K_{amb}$ extinction coefficient in ambient air [$m^{-1}$]
L length of tunnel [km]
$L_{sec}$ section length [km]
$N_{lane}$ number of lanes in the tunnel
$N_{sec}$ number of sections within the tunnel
Q required fresh-air flow rate [m³/s]
μ $PM_{2.5}$ mass concentration [mg/m³]

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# 11. APPENDICES

## 11.1. EMISSION FACTORS BY EURO CLASSES (DETAILED METHODOLOGY)

### 11.1.1. Generation of fleet-averaged database

If no suitable fleet-averaged (standard) emissions database is applicable, e.g. due to a unique fleet composition, then a fleet-averaged database may be generated from the detailed emissions database in this section. The procedure begins with the preparation of a detailed fleet distribution in terms of vehicle function, fuel and Euro category. The emissions data for each Euro category of a given vehicle type (combination of function and fuel) are combined in a weighted sum operation.

An example unique fleet composition is presented in Table 30. The proportion of each vehicle type in the fleet is multiplied by the corresponding distribution of Euro emissions standards to generate a detailed fleet distribution. The example corresponding detailed fleet distribution is given in Table 31 along with sample degradation factors. The weighting factor is the product of the detailed vehicle type proportion and degradation factor.

*Table 30: Example unique fleet composition*

| Vehicle Type | | Proportion [%] | Euro standards distribution [%] | | |
|---|---|---|---|---|---|
| **Function** | **Fuel** | | **Euro IV** | **Euro V** | **Euro VI** |
| PC | Gasoline | 50 | 10 | 40 | 50 |
| PC | Diesel | 30 | 10 | 40 | 50 |
| LCV | Diesel | 10 | 10 | 40 | 50 |
| HGV | Diesel | 10 | 10 | 40 | 50 |

*Table 31: Example detailed fleet composition, with degradation factors for CO in the year 2025 (or other example pollutant)*

| Detailed Vehicle Type | | | Proportion in fleet | Weighting factor |
|---|---|---|---|---|
| **Function** | **Fuel** | **Euro Category** | | |
| PC | Gasoline | Euro IV | 0.05 | 0.1 |
| PC | Gasoline | Euro V | 0.20 | 0.3 |
| PC | Gasoline | Euro VI | 0.25 | 0.3 |
| PC | Diesel | Euro IV | etc. | etc. |
| PC | Diesel | Euro V | | |
| PC | Diesel | Euro VI | | |
| LCV | Diesel | Euro IV | | |
| LCV | Diesel | Euro V | | |
| LCV | Diesel | Euro VI | | |
| HGV (Bus) | Diesel | Euro IV | | |
| HGV (Bus) | Diesel | Euro V | | |
| HGV (Bus) | Diesel | Euro VI | | |

The weighting factor corresponding to each vehicle category in Table 31 is used for the weighted sum operation on the detailed emissions database.

### 11.1.2. Emission rates for vehicle classes according to Euro standards

The emission rates have been derived for the projection year 2018, assuming an implementation of the respective emission standard in the years as given in Table 2.

#### *11.1.2.1. Passenger cars*

*Table 32: PC Gasoline CO*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 250.48 | 250.48 | 304.69 | 321.33 | 323.58 | 321.71 | 388.59 | 455.47 | 531.44 | 593.94 | 709.70 | 825.46 | 956.20 |
| Euro 1 | 2.20 | 21.85 | 21.85 | 39.24 | 50.78 | 46.25 | 56.71 | 86.31 | 87.20 | 126.96 | 158.36 | 216.03 | 252.35 | 344.10 |
| Euro 2 | 1.28 | 11.93 | 33.81 | 17.79 | 24.72 | 22.60 | 33.23 | 41.53 | 53.77 | 75.71 | 102.95 | 176.29 | 267.07 | 526.64 |
| Euro 3 | 1.20 | 9.38 | 25.44 | 13.06 | 16.88 | 14.94 | 20.98 | 25.13 | 32.32 | 43.52 | 60.76 | 103.64 | 156.86 | 300.38 |
| Euro 4 | 1.58 | 8.54 | 10.59 | 9.20 | 11.19 | 13.23 | 9.49 | 13.87 | 24.24 | 18.70 | 31.36 | 56.41 | 125.69 | 311.50 |
| Euro 5 | 0.78 | 4.21 | 8.57 | 5.23 | 7.26 | 9.44 | 9.44 | 15.15 | 17.39 | 20.41 | 33.20 | 55.97 | 102.12 | 182.92 |
| Euro 6 | 0.64 | 4.21 | 8.57 | 5.23 | 7.26 | 9.44 | 9.44 | 15.15 | 17.39 | 20.41 | 33.20 | 55.97 | 102.12 | 182.92 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 200.06 | 200.06 | 200.06 | 200.06 | 200.06 | 200.06 | 200.06 | 200.71 | 204.25 | 214.61 | 226.15 | 225.57 | 224.99 |
| Euro 1 | 2.20 | 11.45 | 11.45 | 12.59 | 13.32 | 12.82 | 14.29 | 14.29 | 15.85 | 20.06 | 26.24 | 32.29 | 38.10 | 43.10 |
| Euro 2 | 1.28 | 5.96 | 11.81 | 5.86 | 6.06 | 5.72 | 6.24 | 10.72 | 6.93 | 10.02 | 15.81 | 25.06 | 41.79 | 70.68 |
| Euro 3 | 1.20 | 4.71 | 8.64 | 4.36 | 4.21 | 3.84 | 3.93 | 6.66 | 4.27 | 6.13 | 9.58 | 14.94 | 24.17 | 41.61 |
| Euro 4 | 1.58 | 6.86 | 6.03 | 5.77 | 6.79 | 7.17 | 5.28 | 6.80 | 9.68 | 10.53 | 14.78 | 35.53 | 79.23 | 173.36 |
| Euro 5 | 0.78 | 2.22 | 3.09 | 2.44 | 3.00 | 3.79 | 3.68 | 4.94 | 7.87 | 6.18 | 9.61 | 19.00 | 35.67 | 64.01 |
| Euro 6 | 0.64 | 2.22 | 3.09 | 2.44 | 3.00 | 3.79 | 3.68 | 4.94 | 7.87 | 6.18 | 9.61 | 19.00 | 35.67 | 64.01 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 215.91 | 225.47 | 235.04 | 244.60 | 254.16 | 263.73 | 273.29 | 278.47 | 281.63 | 283.88 | 283.88 | 283.88 | 296.89 |
| Euro 1 | 2.20 | 13.19 | 16.31 | 19.43 | 20.59 | 22.17 | 21.46 | 21.96 | 22.46 | 31.22 | 41.04 | 58.80 | 74.14 | 85.57 |
| Euro 2 | 1.28 | 6.89 | 16.66 | 8.84 | 9.38 | 10.16 | 9.68 | 17.36 | 10.16 | 15.46 | 27.23 | 48.70 | 87.67 | 149.97 |
| Euro 3 | 1.20 | 5.42 | 12.61 | 6.58 | 6.60 | 6.83 | 6.17 | 10.84 | 6.21 | 9.35 | 15.96 | 28.79 | 52.34 | 91.19 |
| Euro 4 | 1.58 | 7.74 | 6.92 | 6.73 | 7.96 | 9.35 | 6.75 | 8.69 | 13.23 | 12.49 | 18.47 | 42.49 | 90.07 | 209.07 |
| Euro 5 | 0.78 | 2.96 | 4.10 | 3.00 | 3.79 | 5.10 | 4.93 | 6.42 | 9.51 | 8.28 | 13.04 | 22.48 | 38.44 | 76.54 |
| Euro 6 | 0.64 | 2.96 | 4.10 | 3.00 | 3.79 | 5.10 | 4.93 | 6.42 | 9.51 | 8.28 | 13.04 | 22.48 | 38.44 | 76.54 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 231.98 | 247.64 | 263.30 | 263.67 | 264.05 | 264.42 | 313.27 | 362.12 | 410.98 | 419.46 | 437.11 | 435.95 | 495.54 |
| Euro 1 | 2.20 | 17.05 | 21.71 | 26.36 | 30.81 | 32.64 | 30.34 | 50.13 | 43.21 | 58.09 | 80.19 | 105.88 | 122.47 | 147.47 |
| Euro 2 | 1.28 | 8.84 | 24.61 | 12.07 | 14.27 | 15.28 | 13.47 | 23.89 | 21.30 | 28.77 | 54.86 | 95.08 | 147.46 | 246.93 |
| Euro 3 | 1.20 | 6.98 | 18.61 | 8.96 | 10.05 | 10.27 | 8.62 | 14.41 | 11.72 | 16.55 | 32.67 | 57.28 | 89.19 | 148.02 |
| Euro 4 | 1.58 | 8.25 | 8.96 | 8.03 | 9.20 | 11.02 | 7.73 | 11.46 | 15.87 | 14.28 | 23.85 | 48.36 | 93.53 | 237.98 |
| Euro 5 | 0.78 | 3.35 | 5.62 | 3.87 | 5.37 | 6.54 | 6.76 | 9.54 | 11.86 | 12.07 | 19.59 | 31.92 | 54.52 | 105.86 |
| Euro 6 | 0.64 | 3.35 | 5.62 | 3.87 | 5.37 | 6.54 | 6.76 | 9.54 | 11.86 | 12.07 | 19.59 | 31.92 | 54.52 | 105.86 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 271.37 | 314.62 | 357.87 | 391.77 | 393.71 | 389.82 | 452.28 | 514.73 | 577.18 | 639.64 | 993.28 | 1801.71 | 2520.92 |
| Euro 1 | 2.20 | 27.95 | 44.91 | 61.88 | 86.64 | 71.89 | 87.96 | 146.11 | 180.06 | 212.58 | 217.98 | 406.94 | 672.68 | 1064.78 |
| Euro 2 | 1.28 | 15.00 | 61.03 | 30.49 | 42.91 | 35.58 | 57.74 | 76.48 | 106.34 | 168.66 | 226.18 | 407.94 | 768.83 | 1596.33 |
| Euro 3 | 1.20 | 11.66 | 46.80 | 22.32 | 30.10 | 23.79 | 35.66 | 46.25 | 62.90 | 100.25 | 133.09 | 234.11 | 416.32 | 884.97 |
| Euro 4 | 1.58 | 8.65 | 17.12 | 10.40 | 14.09 | 16.20 | 16.74 | 18.10 | 35.28 | 43.23 | 55.90 | 94.65 | 208.37 | 511.07 |
| Euro 5 | 0.78 | 4.55 | 12.71 | 6.80 | 10.32 | 12.69 | 13.14 | 23.26 | 32.94 | 49.04 | 66.11 | 116.58 | 191.06 | 376.97 |
| Euro 6 | 0.64 | 4.55 | 12.71 | 6.80 | 10.32 | 12.69 | 13.14 | 23.26 | 32.94 | 49.04 | 66.11 | 116.58 | 191.06 | 376.97 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 301.90 | 487.70 | 423.67 | 476.54 | 516.02 | 489.33 | 695.19 | 901.05 | 1106.92 | 1312.78 | 1679.97 | 2958.73 | 4509.94 |
| Euro 1 | 2.20 | 36.40 | 156.84 | 94.83 | 136.52 | 116.78 | 143.81 | 236.39 | 294.20 | 352.00 | 409.81 | 661.36 | 1512.12 | 2381.22 |
| Euro 2 | 1.28 | 19.10 | 86.35 | 48.76 | 68.51 | 56.81 | 86.50 | 158.75 | 218.13 | 359.53 | 482.48 | 1084.19 | 2272.21 | 3922.90 |
| Euro 3 | 1.20 | 14.91 | 68.16 | 35.15 | 48.00 | 37.74 | 54.62 | 97.05 | 129.61 | 211.43 | 280.54 | 620.11 | 1317.13 | 2399.13 |
| Euro 4 | 1.58 | 12.07 | 20.83 | 12.94 | 19.91 | 21.12 | 22.23 | 25.70 | 45.70 | 89.72 | 184.26 | 297.77 | 586.01 | 1327.45 |
| Euro 5 | 0.78 | 5.14 | 18.88 | 9.79 | 18.32 | 17.98 | 22.60 | 39.63 | 63.06 | 115.02 | 164.93 | 247.70 | 432.55 | 1068.23 |
| Euro 6 | 0.64 | 5.14 | 18.88 | 9.79 | 18.32 | 17.98 | 22.60 | 39.63 | 63.06 | 115.02 | 164.93 | 247.70 | 432.55 | 1068.23 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 261.67 | 333.22 | 608.80 | 500.38 | 601.41 | 671.44 | 612.62 | 990.80 | 1549.85 | 2191.81 | 2833.78 | 3509.32 | 5019.62 | 5997.20 |
| Euro 1 | 2.20 | 44.88 | 223.19 | 141.08 | 212.12 | 200.11 | 241.69 | 331.23 | 452.87 | 742.60 | 1032.33 | 1585.82 | 2522.02 | 2953.99 |
| Euro 2 | 1.28 | 23.47 | 133.19 | 71.06 | 112.52 | 96.62 | 143.03 | 262.45 | 443.78 | 792.36 | 1291.96 | 2722.74 | 4452.16 | 5268.84 |
| Euro 3 | 1.20 | 18.49 | 103.23 | 50.78 | 79.01 | 64.66 | 90.18 | 161.36 | 270.79 | 466.32 | 730.19 | 1599.33 | 2742.47 | 3430.98 |
| Euro 4 | 1.58 | 13.13 | 35.26 | 22.79 | 30.72 | 25.57 | 34.22 | 64.37 | 69.78 | 160.83 | 342.56 | 974.17 | 1769.09 | 2801.89 |
| Euro 5 | 0.78 | 6.87 | 27.27 | 13.79 | 28.56 | 26.03 | 39.14 | 79.42 | 125.93 | 192.20 | 302.46 | 554.01 | 1172.99 | 2284.00 |
| Euro 6 | 0.64 | 6.87 | 27.27 | 13.79 | 28.56 | 26.03 | 39.14 | 79.42 | 125.93 | 192.20 | 302.46 | 554.01 | 1172.99 | 2284.00 |

*Table 33: PC Gasoline $NO_X$*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.18 | 20.33 | 27.79 | 35.25 | 40.02 | 44.78 | 46.98 | 66.43 | 99.69 | 134.76 | 169.82 | 203.13 | 268.68 | 395.20 |
| Euro 1 | 0.76 | 15.54 | 18.67 | 20.52 | 25.13 | 25.96 | 25.33 | 32.66 | 49.39 | 62.46 | 77.14 | 91.82 | 132.20 | 174.75 |
| Euro 2 | 0.96 | 11.07 | 12.59 | 14.13 | 15.39 | 15.74 | 15.74 | 16.39 | 16.93 | 19.37 | 21.44 | 29.79 | 45.62 | 81.19 |
| Euro 3 | 0.30 | 2.01 | 2.28 | 2.54 | 2.74 | 2.74 | 2.74 | 2.76 | 2.84 | 3.17 | 3.52 | 4.99 | 7.65 | 13.72 |
| Euro 4 | 0.23 | 1.31 | 2.33 | 1.90 | 2.17 | 1.92 | 1.87 | 2.45 | 2.72 | 3.56 | 4.10 | 5.61 | 6.39 | 10.79 |
| Euro 5 | 0.08 | 0.65 | 0.81 | 0.96 | 1.14 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.38 |
| Euro 6 | 0.06 | 0.65 | 0.81 | 0.96 | 1.14 | 1.18 | 1.18 | 1.18 | 1.18 | 1.18 | 1.17 | 1.08 | 1.07 | 1.38 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.18 | 10.25 | 10.60 | 11.44 | 12.64 | 12.64 | 12.64 | 12.64 | 12.64 | 14.78 | 17.44 | 26.03 | 39.04 | 58.04 |
| Euro 1 | 0.76 | 9.66 | 10.60 | 10.61 | 11.10 | 11.10 | 11.10 | 11.10 | 11.67 | 17.72 | 25.85 | 40.25 | 55.40 | 70.55 |
| Euro 2 | 0.96 | 7.72 | 8.68 | 8.20 | 8.50 | 7.47 | 7.47 | 7.19 | 7.06 | 6.79 | 8.32 | 12.67 | 18.36 | 22.62 |
| Euro 3 | 0.30 | 1.41 | 1.58 | 1.47 | 1.50 | 1.30 | 1.30 | 1.21 | 1.19 | 1.13 | 1.38 | 2.10 | 3.08 | 3.84 |
| Euro 4 | 0.23 | 0.89 | 1.17 | 0.90 | 0.93 | 0.77 | 0.66 | 0.78 | 0.64 | 0.74 | 0.93 | 1.14 | 1.39 | 1.93 |
| Euro 5 | 0.08 | 0.49 | 0.55 | 0.55 | 0.62 | 0.57 | 0.57 | 0.60 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |
| Euro 6 | 0.06 | 0.49 | 0.55 | 0.55 | 0.62 | 0.57 | 0.57 | 0.60 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 | 0.69 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 1.18 | 11.97 | 11.97 | 16.38 | 16.38 | 16.62 | 18.00 | 21.10 | 22.51 | 31.40 | 44.39 | 57.39 | 87.29 | 150.31 |
| Euro 1 | 0.76 | 10.45 | 12.83 | 12.91 | 14.50 | 14.19 | 14.19 | 16.55 | 18.35 | 25.74 | 36.51 | 48.60 | 62.56 | 80.04 |
| Euro 2 | 0.96 | 8.47 | 9.83 | 10.22 | 10.55 | 10.19 | 10.19 | 10.11 | 10.69 | 10.08 | 12.01 | 15.70 | 20.81 | 31.71 |
| Euro 3 | 0.30 | 1.54 | 1.79 | 1.83 | 1.86 | 1.77 | 1.77 | 1.70 | 1.80 | 1.69 | 2.02 | 2.67 | 3.50 | 5.09 |
| Euro 4 | 0.23 | 1.02 | 1.46 | 1.16 | 1.22 | 1.03 | 0.93 | 1.12 | 1.05 | 1.20 | 1.58 | 1.82 | 1.98 | 3.14 |
| Euro 5 | 0.08 | 0.55 | 0.62 | 0.66 | 0.76 | 0.71 | 0.71 | 0.79 | 0.88 | 0.85 | 0.80 | 0.86 | 0.88 | 0.88 |
| Euro 6 | 0.06 | 0.55 | 0.62 | 0.66 | 0.76 | 0.71 | 0.71 | 0.79 | 0.88 | 0.85 | 0.80 | 0.86 | 0.88 | 0.88 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 1.18 | 15.95 | 20.10 | 24.26 | 25.39 | 26.53 | 24.57 | 38.22 | 51.19 | 66.11 | 82.50 | 120.40 | 170.53 | 280.17 |
| Euro 1 | 0.76 | 12.93 | 15.66 | 16.69 | 19.30 | 19.70 | 17.77 | 23.58 | 30.85 | 36.07 | 46.90 | 68.15 | 99.29 | 146.86 |
| Euro 2 | 0.96 | 9.77 | 11.26 | 12.19 | 13.06 | 13.09 | 13.09 | 13.29 | 14.20 | 13.94 | 15.28 | 21.18 | 32.51 | 62.10 |
| Euro 3 | 0.30 | 1.78 | 2.04 | 2.18 | 2.30 | 2.28 | 2.28 | 2.24 | 2.40 | 2.32 | 2.53 | 3.43 | 5.26 | 9.96 |
| Euro 4 | 0.23 | 1.15 | 1.85 | 1.46 | 1.62 | 1.42 | 1.33 | 1.66 | 1.70 | 1.97 | 2.13 | 2.83 | 3.12 | 5.70 |
| Euro 5 | 0.08 | 0.60 | 0.71 | 0.79 | 0.94 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.97 | 0.98 | 0.95 | 0.95 |
| Euro 6 | 0.06 | 0.60 | 0.71 | 0.79 | 0.94 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.97 | 0.98 | 0.95 | 0.95 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 1.18 | 23.99 | 37.18 | 50.37 | 60.21 | 70.05 | 77.52 | 113.28 | 156.92 | 209.64 | 260.10 | 299.49 | 361.03 | 378.27 |
| Euro 1 | 0.76 | 16.82 | 22.16 | 25.61 | 35.48 | 32.94 | 37.53 | 48.59 | 64.39 | 97.38 | 115.11 | 132.85 | 145.24 | 185.62 |
| Euro 2 | 0.96 | 12.07 | 13.70 | 15.97 | 17.76 | 18.98 | 18.98 | 20.12 | 21.50 | 31.95 | 39.97 | 48.00 | 60.04 | 92.39 |
| Euro 3 | 0.30 | 2.20 | 2.50 | 2.86 | 3.13 | 3.29 | 3.29 | 3.37 | 3.57 | 5.38 | 7.01 | 9.76 | 12.50 | 15.24 |
| Euro 4 | 0.23 | 1.53 | 2.90 | 2.40 | 3.01 | 2.57 | 2.52 | 3.82 | 4.64 | 6.18 | 8.30 | 9.89 | 10.87 | 15.62 |
| Euro 5 | 0.08 | 0.71 | 0.88 | 1.12 | 1.32 | 1.42 | 1.42 | 1.42 | 1.42 | 1.54 | 1.54 | 1.56 | 1.92 | 2.60 |
| Euro 6 | 0.06 | 0.71 | 0.88 | 1.12 | 1.32 | 1.42 | 1.42 | 1.42 | 1.42 | 1.42 | 1.54 | 1.56 | 1.92 | 2.60 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 1.18 | 27.14 | 48.35 | 69.56 | 84.20 | 98.85 | 136.59 | 174.33 | 210.44 | 254.73 | 296.95 | 339.16 | 381.38 | 423.60 |
| Euro 1 | 0.76 | 18.11 | 25.48 | 33.36 | 41.50 | 39.93 | 46.54 | 69.00 | 79.15 | 109.44 | 154.56 | 181.24 | 207.93 | 234.62 |
| Euro 2 | 0.96 | 13.06 | 15.14 | 17.66 | 19.92 | 21.90 | 21.90 | 24.67 | 26.97 | 35.89 | 57.99 | 81.95 | 105.90 | 114.34 |
| Euro 3 | 0.30 | 2.38 | 2.76 | 3.19 | 3.51 | 3.80 | 3.80 | 4.21 | 4.52 | 6.04 | 9.85 | 15.43 | 17.54 | 18.96 |
| Euro 4 | 0.23 | 1.79 | 3.55 | 3.15 | 3.89 | 3.65 | 3.67 | 5.80 | 8.06 | 8.57 | 11.70 | 13.66 | 16.68 | 21.80 |
| Euro 5 | 0.08 | 0.77 | 0.94 | 1.27 | 1.37 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 2.12 | 2.64 | 3.51 | 3.98 |
| Euro 6 | 0.06 | 0.77 | 0.94 | 1.27 | 1.37 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 2.12 | 2.64 | 3.51 | 3.98 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 1.18 | 33.39 | 66.91 | 95.57 | 126.07 | 135.61 | 159.61 | 205.41 | 251.21 | 297.02 | 342.82 | 388.62 | 434.42 | 480.22 |
| Euro 1 | 0.76 | 20.03 | 31.57 | 40.90 | 49.01 | 49.45 | 56.86 | 83.25 | 109.64 | 136.03 | 171.49 | 207.24 | 243.00 | 278.76 |
| Euro 2 | 0.96 | 14.34 | 17.53 | 20.26 | 22.22 | 25.42 | 25.42 | 32.94 | 38.67 | 44.41 | 69.44 | 99.26 | 129.09 | 158.91 |
| Euro 3 | 0.30 | 2.61 | 3.15 | 3.63 | 3.94 | 4.42 | 4.42 | 5.48 | 6.44 | 7.39 | 11.25 | 20.01 | 22.65 | 25.28 |
| Euro 4 | 0.23 | 2.04 | 4.25 | 4.08 | 5.23 | 5.16 | 5.21 | 8.02 | 9.99 | 11.96 | 14.37 | 19.75 | 23.86 | 24.48 |
| Euro 5 | 0.08 | 0.81 | 1.00 | 1.41 | 1.51 | 1.80 | 1.80 | 1.89 | 1.93 | 2.19 | 2.60 | 3.87 | 4.65 | 5.44 |
| Euro 6 | 0.06 | 0.81 | 1.00 | 1.41 | 1.51 | 1.80 | 1.80 | 1.89 | 1.93 | 2.19 | 2.60 | 3.87 | 4.65 | 5.44 |

*Table 34: PC Gasoline PM*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.07 | 0.15 | 0.06 | 0.14 | 0.12 | 0.20 | 0.19 | 0.26 | 0.42 | 0.59 | 0.94 | 1.77 | 2.86 |
| Euro 1 | 0.01 | 0.06 | 0.11 | 0.05 | 0.08 | 0.07 | 0.12 | 0.13 | 0.22 | 0.34 | 0.40 | 0.71 | 1.42 | 2.18 |
| Euro 2 | 0.01 | 0.06 | 0.13 | 0.06 | 0.10 | 0.09 | 0.17 | 0.18 | 0.27 | 0.36 | 0.56 | 1.05 | 2.21 | 3.52 |
| Euro 3 | 0.00 | 0.04 | 0.05 | 0.03 | 0.05 | 0.04 | 0.07 | 0.08 | 0.13 | 0.14 | 0.22 | 0.40 | 0.79 | 1.22 |
| Euro 4 | 0.00 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.04 | 0.08 | 0.07 | 0.15 | 0.26 | 0.50 | 0.64 |
| Euro 5 | 0.01 | 0.03 | 0.05 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.09 | 0.11 | 0.12 | 0.16 | 0.27 | 0.60 |
| Euro 6 | 0.00 | 0.03 | 0.05 | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.09 | 0.11 | 0.12 | 0.16 | 0.27 | 0.60 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.04 | 0.05 | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 | 0.15 | 0.34 | 0.59 | 0.70 |
| Euro 1 | 0.01 | 0.03 | 0.04 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.07 | 0.14 | 0.32 | 0.52 | 0.60 |
| Euro 2 | 0.01 | 0.03 | 0.05 | 0.03 | 0.04 | 0.04 | 0.05 | 0.07 | 0.07 | 0.06 | 0.13 | 0.31 | 0.51 | 0.59 |
| Euro 3 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.04 | 0.09 | 0.20 | 0.32 | 0.35 |
| Euro 4 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.09 | 0.18 | 0.24 | 0.24 |
| Euro 5 | 0.01 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.08 | 0.10 | 0.13 | 0.16 | 0.24 |
| Euro 6 | 0.00 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.08 | 0.10 | 0.13 | 0.16 | 0.24 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.04 | 0.07 | 0.04 | 0.05 | 0.07 | 0.07 | 0.06 | 0.05 | 0.07 | 0.16 | 0.38 | 0.69 | 0.98 |
| Euro 1 | 0.01 | 0.04 | 0.06 | 0.04 | 0.04 | 0.05 | 0.05 | 0.07 | 0.04 | 0.06 | 0.14 | 0.35 | 0.63 | 0.85 |
| Euro 2 | 0.01 | 0.04 | 0.07 | 0.04 | 0.04 | 0.05 | 0.06 | 0.05 | 0.04 | 0.06 | 0.15 | 0.38 | 0.71 | 1.01 |
| Euro 3 | 0.00 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.02 | 0.04 | 0.09 | 0.22 | 0.40 | 0.51 |
| Euro 4 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.04 | 0.09 | 0.20 | 0.31 | 0.34 |
| Euro 5 | 0.01 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.06 | 0.08 | 0.13 | 0.34 |
| Euro 6 | 0.00 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.06 | 0.08 | 0.13 | 0.24 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.06 | 0.10 | 0.05 | 0.07 | 0.09 | 0.09 | 0.13 | 0.10 | 0.12 | 0.24 | 0.52 | 0.97 | 1.61 |
| Euro 1 | 0.01 | 0.04 | 0.07 | 0.04 | 0.05 | 0.06 | 0.06 | 0.08 | 0.08 | 0.09 | 0.20 | 0.44 | 0.82 | 1.26 |
| Euro 2 | 0.01 | 0.05 | 0.09 | 0.05 | 0.06 | 0.07 | 0.07 | 0.10 | 0.08 | 0.10 | 0.25 | 0.55 | 1.09 | 1.84 |
| Euro 3 | 0.00 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.04 | 0.05 | 0.12 | 0.26 | 0.47 | 0.70 |
| Euro 4 | 0.00 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.02 | 0.04 | 0.10 | 0.20 | 0.33 | 0.40 |
| Euro 5 | 0.01 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.10 | 0.19 | 0.40 |
| Euro 6 | 0.00 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.10 | 0.19 | 0.40 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.08 | 0.22 | 0.10 | 0.20 | 0.18 | 0.30 | 0.39 | 0.47 | 1.00 | 1.65 | 2.13 | 3.49 | 5.52 |
| Euro 1 | 0.01 | 0.06 | 0.16 | 0.09 | 0.14 | 0.12 | 0.21 | 0.28 | 0.38 | 0.79 | 1.25 | 1.57 | 2.59 | 3.66 |
| Euro 2 | 0.01 | 0.07 | 0.24 | 0.11 | 0.18 | 0.16 | 0.29 | 0.37 | 0.53 | 1.18 | 1.88 | 2.43 | 4.16 | 6.05 |
| Euro 3 | 0.00 | 0.04 | 0.09 | 0.05 | 0.08 | 0.07 | 0.12 | 0.15 | 0.22 | 0.45 | 0.64 | 0.83 | 1.41 | 2.03 |
| Euro 4 | 0.00 | 0.01 | 0.04 | 0.01 | 0.03 | 0.04 | 0.06 | 0.07 | 0.16 | 0.23 | 0.28 | 0.44 | 0.77 | 0.98 |
| Euro 5 | 0.01 | 0.03 | 0.06 | 0.05 | 0.06 | 0.07 | 0.08 | 0.10 | 0.14 | 0.17 | 0.19 | 0.26 | 0.40 | 0.91 |
| Euro 6 | 0.00 | 0.03 | 0.06 | 0.05 | 0.06 | 0.07 | 0.08 | 0.10 | 0.14 | 0.17 | 0.19 | 0.26 | 0.40 | 0.91 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.01 | 0.09 | 0.36 | 0.16 | 0.32 | 0.26 | 0.44 | 0.83 | 1.03 | 2.09 | 3.00 | 3.77 | 5.36 | 9.13 |
| Euro 1 | 0.01 | 0.07 | 0.24 | 0.15 | 0.22 | 0.17 | 0.33 | 0.56 | 0.67 | 1.41 | 2.22 | 2.78 | 3.90 | 6.17 |
| Euro 2 | 0.01 | 0.08 | 0.36 | 0.19 | 0.30 | 0.24 | 0.47 | 0.83 | 1.03 | 2.23 | 3.62 | 4.61 | 6.67 | 9.58 |
| Euro 3 | 0.00 | 0.04 | 0.13 | 0.08 | 0.13 | 0.10 | 0.19 | 0.32 | 0.37 | 0.78 | 1.26 | 1.58 | 2.25 | 3.38 |
| Euro 4 | 0.00 | 0.02 | 0.06 | 0.03 | 0.07 | 0.06 | 0.10 | 0.13 | 0.24 | 0.47 | 0.62 | 0.86 | 1.27 | 1.53 |
| Euro 5 | 0.01 | 0.04 | 0.07 | 0.06 | 0.08 | 0.09 | 0.11 | 0.14 | 0.22 | 0.28 | 0.38 | 0.47 | 0.58 | 1.03 |
| Euro 6 | 0.00 | 0.04 | 0.07 | 0.06 | 0.08 | 0.09 | 0.11 | 0.14 | 0.22 | 0.28 | 0.38 | 0.47 | 0.58 | 1.03 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.01 | 0.12 | 0.54 | 0.28 | 0.54 | 0.39 | 0.78 | 1.44 | 2.45 | 4.93 | 7.41 | 10.17 | 12.37 | 15.96 |
| Euro 1 | 0.01 | 0.08 | 0.36 | 0.22 | 0.37 | 0.27 | 0.51 | 1.00 | 1.77 | 2.93 | 3.61 | 4.46 | 6.64 | 10.43 |
| Euro 2 | 0.01 | 0.10 | 0.57 | 0.29 | 0.55 | 0.39 | 0.76 | 1.56 | 2.83 | 4.66 | 5.87 | 7.32 | 10.46 | 13.59 |
| Euro 3 | 0.00 | 0.05 | 0.21 | 0.11 | 0.21 | 0.16 | 0.29 | 0.57 | 1.01 | 1.55 | 2.02 | 2.47 | 3.37 | 5.61 |
| Euro 4 | 0.00 | 0.02 | 0.09 | 0.06 | 0.12 | 0.09 | 0.17 | 0.28 | 0.40 | 0.77 | 1.00 | 1.22 | 1.79 | 2.35 |
| Euro 5 | 0.01 | 0.04 | 0.09 | 0.08 | 0.11 | 0.11 | 0.16 | 0.22 | 0.35 | 0.48 | 0.61 | 0.73 | 0.85 | 1.03 |
| Euro 6 | 0.00 | 0.04 | 0.09 | 0.08 | 0.11 | 0.11 | 0.16 | 0.22 | 0.35 | 0.47 | 0.60 | 0.74 | 0.85 | 1.03 |

*Table 35: PC Diesel CO*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 2.47 | 20.29 | 24.76 | 29.23 | 30.25 | 31.26 | 33.12 | 34.59 | 39.81 | 41.68 | 44.93 | 52.74 | 64.80 | 84.89 |
| Euro 1 | 2.15 | 10.01 | 12.84 | 14.63 | 16.52 | 17.68 | 19.73 | 20.41 | 21.08 | 21.75 | 22.41 | 23.83 | 25.24 | 32.79 |
| Euro 2 | 3.92 | 5.87 | 6.80 | 7.33 | 7.49 | 7.98 | 7.81 | 8.41 | 8.83 | 8.55 | 7.75 | 6.23 | 5.99 | 6.77 |
| Euro 3 | 0.67 | 2.66 | 2.47 | 2.29 | 2.10 | 1.91 | 1.72 | 1.54 | 1.35 | 1.40 | 1.47 | 1.50 | 1.57 | 1.79 |
| Euro 4 | 0.24 | 1.28 | 1.94 | 1.90 | 1.86 | 1.66 | 1.45 | 1.36 | 1.25 | 1.14 | 1.08 | 1.16 | 1.17 | 1.15 |
| Euro 5 | 0.02 | 0.87 | 2.61 | 2.08 | 1.56 | 1.32 | 1.08 | 1.06 | 1.04 | 0.96 | 0.88 | 0.79 | 0.71 | 0.63 |
| Euro 6 | 0.19 | 0.87 | 2.61 | 2.08 | 1.56 | 1.48 | 1.31 | 1.32 | 1.04 | 0.64 | 0.48 | 0.40 | 0.33 | 0.25 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 2.47 | 11.41 | 11.99 | 12.56 | 11.15 | 9.74 | 9.90 | 10.07 | 11.32 | 12.57 | 17.54 | 29.07 | 33.86 | 38.80 |
| Euro 1 | 2.15 | 5.89 | 7.29 | 6.47 | 7.01 | 5.58 | 5.92 | 6.25 | 7.56 | 8.87 | 12.62 | 20.73 | 23.31 | 26.35 |
| Euro 2 | 3.92 | 4.34 | 4.69 | 4.29 | 4.24 | 3.72 | 3.72 | 3.86 | 4.31 | 4.77 | 6.05 | 6.54 | 7.04 | 6.98 |
| Euro 3 | 0.67 | 1.53 | 1.42 | 1.31 | 1.19 | 1.08 | 0.97 | 0.92 | 0.64 | 0.59 | 0.60 | 0.70 | 0.86 | 0.85 |
| Euro 4 | 0.24 | 0.87 | 1.01 | 1.15 | 1.10 | 1.04 | 0.99 | 0.88 | 0.78 | 0.74 | 0.70 | 0.76 | 0.85 | 0.89 |
| Euro 5 | 0.02 | 0.50 | 0.57 | 0.64 | 0.65 | 0.76 | 0.86 | 0.79 | 0.71 | 0.67 | 0.68 | 0.73 | 0.76 | 0.81 |
| Euro 6 | 0.19 | 0.50 | 0.57 | 0.64 | 0.65 | 0.67 | 0.68 | 0.70 | 0.71 | 0.67 | 0.68 | 0.73 | 0.76 | 0.81 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 2.47 | 13.73 | 13.87 | 14.00 | 14.13 | 14.26 | 14.40 | 14.95 | 15.50 | 21.70 | 28.89 | 38.56 | 49.06 | 57.42 |
| Euro 1 | 2.15 | 7.01 | 7.90 | 8.79 | 8.54 | 8.29 | 8.49 | 9.29 | 10.10 | 14.87 | 20.09 | 26.24 | 31.95 | 35.99 |
| Euro 2 | 3.92 | 4.90 | 5.09 | 5.29 | 5.34 | 4.87 | 4.87 | 5.52 | 5.42 | 7.09 | 7.94 | 8.80 | 9.14 | 9.13 |
| Euro 3 | 0.67 | 1.72 | 1.84 | 1.95 | 1.90 | 1.60 | 1.31 | 1.23 | 0.97 | 0.88 | 0.83 | 0.95 | 1.08 | 1.17 |
| Euro 4 | 0.24 | 0.97 | 1.11 | 1.24 | 1.22 | 1.14 | 1.05 | 0.91 | 0.76 | 0.73 | 0.71 | 0.74 | 0.90 | 1.00 |
| Euro 5 | 0.02 | 0.57 | 0.68 | 0.80 | 0.81 | 0.85 | 0.82 | 0.71 | 0.59 | 0.63 | 0.59 | 0.55 | 0.53 | 0.50 |
| Euro 6 | 0.19 | 0.57 | 0.68 | 0.80 | 0.81 | 0.85 | 0.82 | 0.71 | 0.59 | 0.63 | 0.59 | 0.55 | 0.53 | 0.50 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 2.47 | 17.03 | 17.88 | 18.73 | 19.58 | 20.43 | 21.28 | 25.59 | 29.21 | 34.08 | 38.95 | 46.80 | 56.69 | 68.57 |
| Euro 1 | 2.15 | 8.62 | 10.98 | 11.77 | 12.41 | 13.04 | 14.35 | 15.66 | 19.60 | 22.27 | 24.95 | 26.98 | 28.50 | 32.98 |
| Euro 2 | 3.92 | 5.32 | 5.91 | 6.50 | 6.62 | 6.49 | 6.21 | 7.23 | 8.24 | 8.58 | 8.60 | 8.63 | 8.09 | 8.05 |
| Euro 3 | 0.67 | 2.18 | 2.14 | 2.10 | 2.05 | 2.01 | 1.96 | 1.78 | 1.49 | 1.41 | 1.28 | 1.27 | 1.35 | 1.46 |
| Euro 4 | 0.24 | 1.11 | 1.23 | 1.36 | 1.49 | 1.30 | 1.12 | 1.00 | 0.88 | 0.85 | 0.91 | 0.97 | 1.08 | 1.03 |
| Euro 5 | 0.02 | 0.70 | 0.86 | 1.03 | 1.11 | 0.89 | 0.79 | 0.70 | 0.62 | 0.56 | 0.51 | 0.47 | 0.37 | 0.27 |
| Euro 6 | 0.19 | 0.70 | 0.86 | 1.03 | 1.11 | 0.89 | 0.79 | 0.70 | 0.62 | 0.56 | 0.51 | 0.47 | 0.37 | 0.27 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 2.47 | 23.92 | 30.84 | 35.41 | 39.31 | 41.61 | 43.92 | 43.52 | 44.51 | 52.25 | 58.53 | 69.63 | 91.82 | 124.06 |
| Euro 1 | 2.15 | 11.99 | 14.68 | 17.83 | 20.44 | 22.19 | 24.73 | 24.30 | 24.26 | 24.22 | 26.06 | 28.68 | 36.14 | 47.26 |
| Euro 2 | 3.92 | 6.46 | 7.39 | 8.33 | 8.34 | 8.99 | 9.35 | 9.09 | 7.52 | 6.49 | 6.29 | 5.83 | 6.00 | 6.95 |
| Euro 3 | 0.67 | 3.08 | 2.87 | 2.66 | 2.45 | 2.24 | 2.03 | 1.82 | 1.61 | 1.49 | 1.73 | 1.68 | 1.82 | 2.01 |
| Euro 4 | 0.24 | 1.49 | 2.43 | 2.27 | 2.15 | 2.05 | 1.95 | 1.75 | 1.56 | 1.38 | 1.19 | 1.15 | 1.44 | 1.62 |
| Euro 5 | 0.02 | 1.04 | 3.12 | 2.71 | 2.29 | 2.05 | 1.81 | 1.48 | 1.52 | 1.37 | 1.30 | 1.22 | 1.14 | 1.14 |
| Euro 6 | 0.19 | 1.04 | 3.12 | 2.71 | 2.29 | 2.02 | 1.77 | 1.48 | 1.52 | 1.37 | 1.30 | 1.22 | 1.14 | 0.54 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 2.47 | 27.11 | 35.87 | 40.76 | 42.91 | 45.07 | 49.45 | 49.33 | 49.22 | 59.67 | 74.73 | 106.32 | 136.52 | 149.67 |
| Euro 1 | 2.15 | 13.24 | 16.59 | 19.81 | 22.42 | 23.43 | 25.40 | 26.76 | 28.12 | 29.48 | 30.84 | 40.57 | 52.97 | 71.75 |
| Euro 2 | 3.92 | 7.07 | 7.74 | 8.31 | 8.89 | 8.95 | 9.17 | 9.39 | 9.14 | 8.89 | 8.64 | 8.39 | 8.14 | 10.03 |
| Euro 3 | 0.67 | 3.26 | 3.04 | 2.83 | 2.61 | 2.39 | 2.17 | 1.95 | 1.73 | 1.64 | 1.86 | 1.84 | 2.01 | 2.18 |
| Euro 4 | 0.24 | 1.71 | 2.72 | 2.85 | 2.74 | 2.64 | 2.53 | 2.42 | 2.13 | 1.83 | 1.54 | 1.61 | 1.67 | 2.09 |
| Euro 5 | 0.02 | 1.32 | 3.40 | 3.19 | 2.78 | 2.59 | 2.40 | 2.22 | 1.83 | 1.44 | 1.05 | 0.91 | 0.78 | 0.64 |
| Euro 6 | 0.19 | 1.32 | 3.40 | 3.19 | 2.78 | 2.59 | 2.32 | 2.22 | 1.96 | 1.69 | 1.43 | 1.17 | 0.90 | 0.64 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 2.47 | 30.43 | 37.48 | 45.80 | 49.96 | 51.07 | 53.34 | 58.84 | 59.94 | 73.90 | 104.90 | 163.71 | 181.39 | 181.39 |
| Euro 1 | 2.15 | 14.55 | 17.38 | 21.55 | 23.17 | 25.27 | 24.07 | 26.13 | 28.18 | 30.23 | 39.23 | 60.38 | 77.56 | 86.97 |
| Euro 2 | 3.92 | 7.53 | 8.50 | 9.47 | 9.43 | 8.93 | 8.74 | 8.55 | 9.04 | 9.53 | 10.02 | 10.51 | 11.00 | 13.58 |
| Euro 3 | 0.67 | 3.75 | 3.49 | 3.22 | 2.95 | 2.69 | 2.42 | 2.15 | 1.89 | 1.78 | 2.00 | 2.04 | 2.11 | 2.32 |
| Euro 4 | 0.24 | 1.88 | 2.97 | 3.29 | 3.21 | 3.12 | 3.03 | 2.95 | 2.69 | 2.42 | 2.16 | 1.97 | 1.88 | 2.09 |
| Euro 5 | 0.02 | 1.45 | 3.99 | 3.58 | 3.18 | 2.93 | 2.68 | 2.44 | 2.19 | 1.94 | 1.69 | 1.39 | 1.08 | 0.77 |
| Euro 6 | 0.19 | 1.45 | 3.99 | 4.35 | 4.07 | 3.80 | 3.53 | 3.40 | 2.83 | 2.26 | 1.69 | 1.39 | 1.08 | 0.77 |

*Table 36: PC Diesel $NO_X$*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.57 | 13.30 | 21.07 | 19.58 | 26.62 | 23.79 | 28.48 | 33.97 | 46.44 | 54.02 | 64.06 | 80.88 | 103.85 | 141.45 |
| Euro 1 | 4.88 | 12.06 | 19.38 | 17.71 | 22.36 | 20.34 | 24.43 | 28.74 | 39.27 | 48.44 | 56.28 | 75.13 | 100.50 | 140.75 |
| Euro 2 | 5.67 | 13.63 | 20.55 | 19.37 | 24.44 | 22.80 | 25.50 | 30.92 | 43.37 | 47.22 | 58.14 | 79.96 | 107.19 | 148.08 |
| Euro 3 | 4.37 | 12.39 | 20.41 | 17.96 | 25.91 | 21.33 | 26.99 | 30.48 | 41.20 | 49.84 | 56.24 | 83.27 | 116.43 | 162.67 |
| Euro 4 | 5.96 | 13.97 | 17.54 | 17.54 | 20.59 | 20.59 | 21.24 | 28.15 | 29.06 | 42.84 | 45.84 | 58.50 | 84.84 | 133.33 |
| Euro 5 | 3.45 | 16.41 | 23.25 | 22.68 | 28.82 | 27.81 | 31.46 | 38.07 | 43.11 | 55.20 | 65.87 | 79.55 | 107.94 | 156.69 |
| Euro 6 | 1.61 | 7.14 | 13.46 | 11.79 | 15.63 | 13.54 | 17.34 | 19.99 | 25.59 | 32.17 | 37.27 | 45.47 | 59.22 | 72.08 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.57 | 7.99 | 7.99 | 8.01 | 8.06 | 5.51 | 5.88 | 6.47 | 6.47 | 6.50 | 7.84 | 11.77 | 17.80 | 26.90 |
| Euro 1 | 4.88 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 9.75 | 14.78 | 22.47 |
| Euro 2 | 5.67 | 8.32 | 8.32 | 8.13 | 8.23 | 6.01 | 6.23 | 6.77 | 5.29 | 6.86 | 8.69 | 12.59 | 18.68 | 27.87 |
| Euro 3 | 4.37 | 8.07 | 8.07 | 8.56 | 9.26 | 8.32 | 8.95 | 9.54 | 8.13 | 8.50 | 10.39 | 19.65 | 28.91 | 38.16 |
| Euro 4 | 5.96 | 7.69 | 7.69 | 7.69 | 7.69 | 7.69 | 7.69 | 7.75 | 7.75 | 7.75 | 8.44 | 14.02 | 23.30 | 38.16 |
| Euro 5 | 3.45 | 11.22 | 11.22 | 11.23 | 12.10 | 11.18 | 11.64 | 11.86 | 10.07 | 11.00 | 11.93 | 15.04 | 20.21 | 28.71 |
| Euro 6 | 1.61 | 4.37 | 4.37 | 4.96 | 5.55 | 5.12 | 5.84 | 6.08 | 5.30 | 6.17 | 7.91 | 10.58 | 15.38 | 20.18 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.57 | 9.42 | 13.41 | 10.79 | 11.74 | 8.89 | 9.83 | 11.90 | 10.92 | 14.83 | 18.62 | 27.20 | 39.63 | 58.11 |
| Euro 1 | 4.88 | 8.38 | 12.14 | 9.48 | 10.21 | 7.75 | 8.34 | 9.96 | 8.83 | 12.31 | 15.40 | 22.78 | 34.09 | 51.34 |
| Euro 2 | 5.67 | 10.04 | 13.29 | 10.82 | 11.78 | 9.20 | 9.93 | 11.70 | 10.52 | 14.46 | 18.14 | 26.70 | 39.57 | 59.15 |
| Euro 3 | 4.37 | 9.58 | 13.27 | 10.67 | 12.75 | 10.74 | 11.79 | 12.96 | 11.61 | 13.07 | 16.69 | 29.51 | 41.28 | 52.32 |
| Euro 4 | 5.96 | 10.59 | 11.74 | 10.29 | 11.47 | 9.96 | 10.67 | 13.05 | 11.58 | 12.99 | 14.25 | 21.47 | 37.83 | 67.94 |
| Euro 5 | 3.45 | 12.44 | 15.35 | 14.04 | 16.22 | 14.70 | 15.87 | 16.97 | 16.72 | 18.55 | 19.12 | 25.11 | 35.93 | 56.32 |
| Euro 6 | 1.61 | 4.95 | 8.11 | 6.02 | 7.06 | 6.56 | 7.45 | 7.75 | 7.68 | 8.48 | 11.17 | 17.46 | 24.54 | 29.44 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.57 | 11.34 | 16.81 | 14.71 | 17.27 | 15.57 | 16.92 | 21.14 | 25.43 | 29.03 | 36.99 | 50.99 | 68.59 | 93.67 |
| Euro 1 | 4.88 | 10.19 | 15.41 | 13.10 | 15.18 | 13.17 | 14.42 | 17.60 | 21.15 | 24.61 | 31.79 | 44.93 | 62.59 | 88.82 |
| Euro 2 | 5.67 | 11.75 | 16.76 | 14.67 | 16.79 | 15.04 | 16.12 | 19.68 | 22.76 | 26.91 | 35.05 | 49.21 | 69.02 | 98.37 |
| Euro 3 | 4.37 | 10.99 | 16.36 | 13.60 | 16.96 | 14.66 | 16.42 | 19.18 | 21.36 | 24.16 | 29.85 | 47.33 | 68.09 | 94.27 |
| Euro 4 | 5.96 | 11.90 | 14.09 | 12.68 | 15.67 | 13.60 | 14.88 | 18.72 | 18.21 | 24.33 | 23.50 | 35.55 | 56.05 | 92.21 |
| Euro 5 | 3.45 | 13.99 | 18.86 | 17.46 | 21.29 | 19.73 | 22.24 | 25.37 | 26.04 | 32.79 | 34.41 | 44.82 | 62.41 | 93.84 |
| Euro 6 | 1.61 | 5.87 | 10.52 | 8.23 | 10.71 | 9.15 | 10.98 | 12.23 | 14.69 | 16.45 | 20.18 | 29.91 | 39.52 | 49.90 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.57 | 15.67 | 25.29 | 25.65 | 35.15 | 34.68 | 44.90 | 50.76 | 68.38 | 89.32 | 106.55 | 124.52 | 154.08 | 192.69 |
| Euro 1 | 4.88 | 14.36 | 23.92 | 23.46 | 31.47 | 29.98 | 38.30 | 44.00 | 59.58 | 80.77 | 96.27 | 119.06 | 153.88 | 202.05 |
| Euro 2 | 5.67 | 16.03 | 25.45 | 24.81 | 34.27 | 32.12 | 39.61 | 45.89 | 63.24 | 87.29 | 96.62 | 120.74 | 156.61 | 218.97 |
| Euro 3 | 4.37 | 14.73 | 26.01 | 23.65 | 34.74 | 30.70 | 41.13 | 47.13 | 64.84 | 95.32 | 108.40 | 144.93 | 190.15 | 255.30 |
| Euro 4 | 5.96 | 16.74 | 22.07 | 20.80 | 26.76 | 27.12 | 30.87 | 39.91 | 51.30 | 64.67 | 86.60 | 110.39 | 129.38 | 198.57 |
| Euro 5 | 3.45 | 19.22 | 28.96 | 28.84 | 37.58 | 38.25 | 44.99 | 55.09 | 71.07 | 87.84 | 108.58 | 150.94 | 187.14 | 247.92 |
| Euro 6 | 1.61 | 8.81 | 17.92 | 16.56 | 21.88 | 20.86 | 26.38 | 33.55 | 43.46 | 49.72 | 61.30 | 75.42 | 97.32 | 122.35 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.57 | 18.02 | 31.53 | 33.06 | 45.25 | 46.48 | 61.54 | 73.07 | 94.61 | 123.05 | 160.04 | 187.03 | 208.81 | 235.60 |
| Euro 1 | 4.88 | 16.76 | 29.88 | 30.55 | 41.18 | 41.32 | 53.77 | 64.73 | 85.84 | 114.79 | 150.61 | 181.73 | 211.93 | 247.52 |
| Euro 2 | 5.67 | 18.39 | 30.36 | 31.62 | 42.56 | 44.01 | 56.28 | 64.66 | 87.97 | 119.44 | 148.22 | 178.70 | 223.72 | 285.71 |
| Euro 3 | 4.37 | 17.72 | 32.29 | 32.23 | 46.59 | 43.41 | 58.58 | 76.46 | 100.25 | 142.21 | 181.72 | 239.53 | 280.60 | 338.39 |
| Euro 4 | 5.96 | 19.33 | 27.02 | 26.53 | 36.14 | 35.82 | 46.02 | 56.88 | 83.34 | 95.28 | 122.30 | 185.39 | 249.69 | 307.35 |
| Euro 5 | 3.45 | 22.22 | 35.50 | 37.01 | 49.53 | 51.40 | 64.54 | 78.86 | 112.50 | 139.73 | 169.37 | 228.34 | 298.78 | 352.71 |
| Euro 6 | 1.61 | 10.46 | 22.95 | 22.57 | 30.18 | 30.59 | 38.50 | 48.11 | 66.95 | 78.52 | 88.54 | 118.60 | 172.83 | 220.68 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.57 | 21.41 | 37.03 | 42.56 | 57.44 | 61.27 | 81.73 | 101.80 | 130.79 | 161.92 | 206.92 | 231.79 | 251.26 | 270.20 |
| Euro 1 | 4.88 | 19.61 | 36.35 | 38.73 | 52.36 | 54.19 | 71.81 | 91.74 | 126.14 | 155.20 | 195.55 | 235.90 | 257.76 | 278.04 |
| Euro 2 | 5.67 | 21.34 | 37.46 | 39.81 | 53.83 | 56.56 | 75.02 | 92.74 | 124.48 | 159.25 | 214.77 | 254.55 | 287.55 | 329.95 |
| Euro 3 | 4.37 | 20.33 | 39.07 | 42.18 | 61.05 | 60.17 | 81.05 | 108.48 | 158.90 | 198.62 | 255.46 | 329.54 | 369.49 | 427.44 |
| Euro 4 | 5.96 | 23.05 | 32.50 | 32.88 | 50.98 | 49.75 | 64.44 | 78.34 | 121.67 | 168.45 | 215.43 | 262.41 | 354.99 | 429.06 |
| Euro 5 | 3.45 | 25.87 | 43.20 | 45.90 | 66.87 | 68.05 | 88.82 | 110.40 | 161.07 | 215.95 | 250.44 | 313.54 | 386.73 | 433.42 |
| Euro 6 | 1.61 | 12.55 | 28.26 | 29.04 | 40.44 | 43.19 | 56.56 | 66.55 | 90.66 | 127.68 | 146.40 | 164.30 | 226.67 | 289.01 |

*Table 37: PC Diesel PM*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 3.20 | 3.28 | 3.36 | 3.98 | 4.59 | 4.71 | 4.76 | 6.94 | 9.11 | 11.60 | 16.65 | 23.37 | 32.16 |
| Euro 1 | 0.58 | 2.28 | 2.78 | 2.93 | 4.35 | 4.44 | 5.10 | 5.13 | 6.79 | 8.45 | 10.11 | 13.48 | 17.65 | 22.54 |
| Euro 2 | 0.56 | 1.83 | 2.10 | 2.37 | 3.21 | 3.48 | 3.24 | 3.93 | 4.73 | 5.53 | 6.79 | 9.18 | 11.18 | 12.02 |
| Euro 3 | 0.09 | 0.67 | 0.96 | 1.07 | 1.42 | 1.49 | 1.70 | 1.86 | 2.39 | 2.60 | 3.06 | 3.39 | 4.70 | 7.10 |
| Euro 4 | 0.16 | 0.89 | 1.06 | 1.19 | 1.46 | 1.54 | 1.62 | 1.90 | 2.16 | 2.69 | 3.51 | 3.91 | 4.47 | 5.44 |
| Euro 5 | 0.02 | 0.06 | 0.07 | 0.08 | 0.10 | 0.10 | 0.11 | 0.12 | 0.13 | 0.15 | 0.16 | 0.17 | 0.18 | 0.19 |
| Euro 6 | 0.05 | 0.06 | 0.07 | 0.08 | 0.10 | 0.10 | 0.11 | 0.12 | 0.13 | 0.15 | 0.16 | 0.17 | 0.18 | 0.19 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 1.99 | 1.91 | 1.62 | 1.92 | 1.73 | 1.84 | 1.89 | 2.01 | 3.13 | 5.21 | 9.36 | 13.64 | 19.11 |
| Euro 1 | 0.58 | 1.58 | 1.56 | 1.62 | 1.92 | 1.73 | 1.84 | 1.89 | 2.01 | 3.13 | 5.21 | 8.01 | 10.09 | 13.44 |
| Euro 2 | 0.56 | 1.36 | 1.32 | 1.43 | 1.65 | 1.58 | 1.62 | 1.68 | 1.83 | 2.67 | 4.24 | 6.13 | 7.31 | 8.95 |
| Euro 3 | 0.09 | 0.36 | 0.47 | 0.38 | 0.42 | 0.29 | 0.29 | 0.35 | 0.26 | 0.36 | 0.50 | 0.74 | 1.03 | 1.63 |
| Euro 4 | 0.16 | 0.69 | 0.71 | 0.71 | 0.79 | 0.78 | 0.82 | 0.81 | 0.83 | 0.85 | 0.99 | 1.19 | 1.52 | 1.83 |
| Euro 5 | 0.02 | 0.06 | 0.05 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.09 | 0.12 | 0.14 |
| Euro 6 | 0.05 | 0.06 | 0.05 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.09 | 0.12 | 0.14 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 2.38 | 2.29 | 2.08 | 2.50 | 2.48 | 2.46 | 3.06 | 3.03 | 4.40 | 6.58 | 11.78 | 17.05 | 24.61 |
| Euro 1 | 0.58 | 1.81 | 1.86 | 2.08 | 2.50 | 2.48 | 2.46 | 2.75 | 3.03 | 4.40 | 6.54 | 9.71 | 12.59 | 17.35 |
| Euro 2 | 0.56 | 1.66 | 1.53 | 1.76 | 2.07 | 2.11 | 2.13 | 2.49 | 2.50 | 3.49 | 4.97 | 6.99 | 8.48 | 10.21 |
| Euro 3 | 0.09 | 0.46 | 0.60 | 0.55 | 0.68 | 0.55 | 0.56 | 0.67 | 0.67 | 0.89 | 1.10 | 1.48 | 2.05 | 3.41 |
| Euro 4 | 0.16 | 0.73 | 0.80 | 0.82 | 0.98 | 0.92 | 0.99 | 1.05 | 1.16 | 1.23 | 1.28 | 1.58 | 2.17 | 3.01 |
| Euro 5 | 0.02 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.12 | 0.14 | 0.15 |
| Euro 6 | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.12 | 0.14 | 0.15 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 2.96 | 3.12 | 2.89 | 3.20 | 3.60 | 3.30 | 4.14 | 4.83 | 5.52 | 7.61 | 13.73 | 20.45 | 28.36 |
| Euro 1 | 0.58 | 2.14 | 2.41 | 2.65 | 2.96 | 3.60 | 3.87 | 4.14 | 4.83 | 5.52 | 7.61 | 11.28 | 15.33 | 19.98 |
| Euro 2 | 0.56 | 1.74 | 1.90 | 2.12 | 2.43 | 2.81 | 2.59 | 3.24 | 3.99 | 4.17 | 5.51 | 7.57 | 9.69 | 11.05 |
| Euro 3 | 0.09 | 0.57 | 0.76 | 0.77 | 1.00 | 0.94 | 0.97 | 1.21 | 1.45 | 1.68 | 2.19 | 2.50 | 3.36 | 5.23 |
| Euro 4 | 0.16 | 0.78 | 0.90 | 0.98 | 1.18 | 1.19 | 1.24 | 1.44 | 1.54 | 1.91 | 2.01 | 2.34 | 3.30 | 4.32 |
| Euro 5 | 0.02 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.12 | 0.14 | 0.16 | 0.18 |
| Euro 6 | 0.05 | 0.06 | 0.06 | 0.07 | 0.09 | 0.08 | 0.09 | 0.10 | 0.11 | 0.12 | 0.12 | 0.14 | 0.16 | 0.18 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 3.86 | 4.45 | 4.16 | 5.30 | 6.44 | 8.93 | 11.42 | 13.91 | 16.39 | 19.66 | 22.41 | 27.39 | 37.44 |
| Euro 1 | 0.58 | 2.65 | 3.39 | 3.37 | 4.58 | 5.80 | 6.44 | 8.45 | 10.45 | 13.05 | 15.65 | 17.19 | 19.86 | 24.97 |
| Euro 2 | 0.56 | 2.08 | 2.46 | 2.61 | 4.21 | 4.12 | 4.79 | 4.67 | 6.13 | 7.59 | 9.05 | 10.38 | 11.35 | 12.39 |
| Euro 3 | 0.09 | 0.82 | 1.18 | 1.38 | 1.84 | 2.01 | 2.32 | 2.45 | 3.08 | 4.04 | 4.66 | 5.62 | 6.72 | 8.85 |
| Euro 4 | 0.16 | 0.96 | 1.19 | 1.36 | 1.79 | 1.95 | 2.13 | 2.47 | 3.17 | 3.87 | 4.57 | 5.43 | 5.62 | 6.01 |
| Euro 5 | 0.02 | 0.07 | 0.07 | 0.09 | 0.11 | 0.12 | 0.13 | 0.14 | 0.16 | 0.17 | 0.18 | 0.19 | 0.19 | 0.20 |
| Euro 6 | 0.05 | 0.07 | 0.07 | 0.09 | 0.11 | 0.12 | 0.13 | 0.14 | 0.16 | 0.17 | 0.18 | 0.19 | 0.19 | 0.20 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 4.10 | 5.45 | 5.45 | 6.47 | 7.49 | 10.41 | 13.34 | 16.26 | 19.19 | 24.92 | 30.65 | 37.28 | 43.91 |
| Euro 1 | 0.58 | 2.82 | 3.94 | 4.24 | 5.59 | 6.94 | 7.88 | 8.82 | 11.78 | 16.93 | 19.69 | 22.46 | 23.69 | 27.50 |
| Euro 2 | 0.56 | 2.16 | 2.62 | 2.90 | 4.46 | 4.94 | 6.06 | 7.17 | 8.28 | 9.60 | 10.92 | 11.35 | 12.40 | 14.26 |
| Euro 3 | 0.09 | 1.01 | 1.42 | 1.69 | 2.23 | 2.48 | 2.80 | 3.27 | 3.92 | 5.26 | 7.15 | 8.11 | 8.97 | 10.32 |
| Euro 4 | 0.16 | 1.07 | 1.38 | 1.59 | 2.22 | 2.49 | 2.98 | 3.08 | 3.92 | 4.92 | 5.24 | 5.91 | 6.16 | 6.66 |
| Euro 5 | 0.02 | 0.07 | 0.08 | 0.10 | 0.12 | 0.14 | 0.15 | 0.16 | 0.18 | 0.18 | 0.19 | 0.20 | 0.21 | 0.25 |
| Euro 6 | 0.05 | 0.07 | 0.08 | 0.10 | 0.12 | 0.14 | 0.15 | 0.16 | 0.18 | 0.18 | 0.19 | 0.20 | 0.21 | 0.25 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.63 | 5.31 | 7.19 | 7.71 | 8.56 | 9.40 | 11.92 | 14.43 | 19.99 | 25.55 | 31.11 | 36.87 | 42.62 | 48.38 |
| Euro 1 | 0.58 | 3.31 | 4.92 | 5.04 | 6.37 | 7.70 | 10.41 | 13.12 | 16.67 | 18.87 | 22.12 | 25.38 | 28.63 | 31.89 |
| Euro 2 | 0.56 | 2.36 | 3.37 | 3.46 | 5.24 | 5.46 | 7.50 | 7.88 | 9.42 | 11.22 | 12.15 | 13.37 | 14.85 | 16.19 |
| Euro 3 | 0.09 | 1.13 | 1.62 | 1.98 | 2.72 | 2.86 | 3.37 | 4.21 | 5.81 | 6.57 | 8.65 | 9.89 | 10.37 | 11.40 |
| Euro 4 | 0.16 | 1.17 | 1.55 | 1.83 | 2.56 | 2.95 | 3.68 | 4.44 | 5.20 | 5.81 | 5.83 | 6.17 | 6.34 | 7.00 |
| Euro 5 | 0.02 | 0.08 | 0.09 | 0.11 | 0.13 | 0.15 | 0.16 | 0.17 | 0.19 | 0.20 | 0.21 | 0.21 | 0.24 | 0.27 |
| Euro 6 | 0.05 | 0.08 | 0.09 | 0.11 | 0.13 | 0.15 | 0.16 | 0.17 | 0.19 | 0.20 | 0.21 | 0.22 | 0.24 | 0.25 |

### *11.1.2.2. Light duty commercial vehicles*

*Table 38: LCV Gasoline CO*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 278.82 | 607.42 | 725.52 | 720.61 | 821.01 | 823.18 | 825.36 | 921.85 | 962.99 | 1004.13 | 1045.27 | 1153.66 | 1783.72 | 3551.75 |
| Euro 1 | 10.90 | 66.94 | 95.45 | 123.96 | 160.63 | 162.35 | 140.54 | 249.39 | 303.66 | 426.21 | 458.98 | 612.23 | 1580.94 | 5302.01 |
| Euro 2 | 5.76 | 34.58 | 141.05 | 64.68 | 84.77 | 83.49 | 75.30 | 136.44 | 151.73 | 219.24 | 229.97 | 303.95 | 768.10 | 2496.28 |
| Euro 3 | 1.08 | 8.11 | 48.90 | 16.72 | 24.22 | 24.41 | 23.02 | 49.52 | 42.62 | 69.75 | 94.82 | 135.75 | 314.66 | 990.40 |
| Euro 4 | 3.80 | 11.61 | 32.17 | 15.00 | 18.74 | 24.14 | 22.19 | 45.10 | 25.35 | 48.37 | 75.56 | 154.11 | 312.49 | 660.14 |
| Euro 5 | 3.78 | 8.61 | 14.70 | 12.29 | 14.72 | 16.50 | 17.08 | 26.42 | 35.84 | 46.77 | 77.19 | 170.49 | 346.29 | 726.90 |
| Euro 6 | 4.11 | 8.35 | 14.29 | 11.93 | 14.29 | 15.99 | 16.63 | 25.64 | 34.81 | 45.51 | 75.03 | 165.83 | 337.11 | 708.26 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 278.82 | 477.03 | 486.02 | 495.02 | 512.78 | 530.89 | 549.01 | 567.13 | 585.25 | 538.30 | 491.35 | 444.41 | 397.46 | 358.82 |
| Euro 1 | 10.90 | 32.66 | 35.20 | 37.74 | 35.86 | 34.33 | 34.10 | 35.66 | 37.22 | 40.93 | 47.25 | 65.23 | 127.91 | 293.61 |
| Euro 2 | 5.76 | 17.12 | 18.39 | 19.67 | 18.48 | 17.97 | 18.19 | 25.04 | 19.11 | 20.95 | 24.19 | 31.92 | 61.08 | 137.19 |
| Euro 3 | 1.08 | 3.34 | 3.76 | 4.17 | 3.99 | 4.75 | 5.97 | 10.03 | 5.09 | 7.89 | 11.28 | 15.36 | 29.72 | 64.89 |
| Euro 4 | 3.80 | 9.96 | 9.43 | 8.90 | 8.93 | 9.46 | 11.06 | 18.63 | 15.76 | 22.77 | 39.22 | 83.91 | 155.68 | 239.86 |
| Euro 5 | 3.78 | 7.47 | 7.52 | 7.58 | 8.13 | 9.07 | 9.08 | 9.92 | 21.55 | 23.71 | 47.58 | 99.15 | 177.96 | 255.88 |
| Euro 6 | 4.11 | 7.24 | 7.30 | 7.35 | 7.89 | 8.80 | 8.80 | 9.62 | 20.90 | 23.00 | 46.17 | 96.23 | 172.72 | 248.31 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 278.82 | 514.45 | 537.04 | 559.63 | 564.10 | 568.56 | 617.14 | 665.71 | 714.94 | 732.45 | 749.96 | 767.47 | 784.98 | 802.49 |
| Euro 1 | 10.90 | 38.78 | 45.87 | 52.96 | 57.55 | 52.40 | 54.94 | 58.34 | 61.75 | 70.46 | 113.70 | 175.03 | 315.17 | 701.50 |
| Euro 2 | 5.76 | 20.36 | 24.02 | 27.68 | 30.12 | 27.48 | 28.17 | 29.81 | 31.44 | 35.98 | 55.09 | 80.88 | 151.11 | 340.54 |
| Euro 3 | 1.08 | 4.15 | 20.42 | 5.97 | 6.84 | 7.20 | 8.85 | 13.95 | 7.77 | 13.07 | 23.32 | 35.43 | 73.35 | 161.63 |
| Euro 4 | 3.80 | 10.38 | 14.60 | 10.75 | 11.37 | 12.01 | 12.72 | 14.98 | 16.40 | 26.08 | 47.64 | 99.81 | 193.54 | 278.12 |
| Euro 5 | 3.78 | 7.84 | 10.48 | 8.98 | 9.68 | 10.87 | 10.71 | 12.51 | 22.80 | 27.32 | 57.40 | 120.95 | 220.38 | 299.50 |
| Euro 6 | 4.11 | 7.61 | 10.17 | 8.71 | 9.40 | 10.54 | 10.39 | 12.15 | 22.12 | 26.50 | 55.70 | 117.30 | 213.80 | 290.76 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 278.82 | 562.74 | 636.11 | 691.48 | 746.84 | 745.37 | 791.93 | 838.48 | 957.89 | 1112.97 | 1268.05 | 1423.13 | 1578.22 | 1733.30 |
| Euro 1 | 10.90 | 48.87 | 63.03 | 77.19 | 100.92 | 73.97 | 86.01 | 101.08 | 116.15 | 154.23 | 217.72 | 314.30 | 603.36 | 1610.27 |
| Euro 2 | 5.76 | 26.23 | 103.21 | 40.53 | 52.22 | 38.67 | 45.30 | 80.11 | 59.70 | 77.82 | 111.11 | 159.32 | 298.99 | 769.34 |
| Euro 3 | 1.08 | 5.59 | 33.48 | 9.44 | 12.86 | 10.42 | 13.52 | 28.42 | 15.31 | 26.43 | 49.87 | 75.02 | 138.92 | 338.99 |
| Euro 4 | 3.80 | 10.80 | 24.80 | 12.00 | 13.85 | 14.96 | 17.54 | 29.46 | 19.59 | 33.84 | 60.25 | 111.68 | 218.39 | 364.22 |
| Euro 5 | 3.78 | 8.27 | 12.25 | 10.22 | 11.48 | 13.52 | 13.29 | 19.54 | 26.56 | 33.42 | 64.69 | 129.56 | 246.35 | 404.10 |
| Euro 6 | 4.11 | 8.02 | 11.92 | 9.92 | 11.14 | 13.12 | 12.88 | 18.94 | 25.77 | 32.45 | 62.76 | 125.76 | 239.17 | 392.96 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 278.82 | 654.57 | 824.11 | 753.97 | 950.92 | 912.49 | 995.38 | 1169.54 | 1446.09 | 1722.64 | 2228.65 | 3103.31 | 4519.13 | 7812.77 |
| Euro 1 | 10.90 | 89.64 | 383.86 | 200.39 | 281.56 | 247.11 | 302.94 | 429.90 | 451.97 | 1092.34 | 1512.58 | 2713.96 | 5866.35 | 13493.95 |
| Euro 2 | 5.76 | 46.96 | 199.27 | 105.38 | 145.58 | 132.58 | 144.99 | 232.71 | 264.68 | 563.02 | 749.57 | 1349.06 | 2866.98 | 6569.31 |
| Euro 3 | 1.08 | 12.84 | 71.12 | 29.71 | 44.62 | 43.15 | 47.16 | 85.11 | 101.76 | 208.99 | 288.01 | 488.68 | 1091.19 | 2761.36 |
| Euro 4 | 3.80 | 12.63 | 42.11 | 20.77 | 27.11 | 33.62 | 29.01 | 62.33 | 84.38 | 118.53 | 198.23 | 362.58 | 718.93 | 1466.37 |
| Euro 5 | 3.78 | 9.57 | 19.99 | 14.89 | 19.69 | 21.15 | 25.69 | 39.94 | 64.37 | 92.06 | 135.79 | 346.16 | 719.00 | 1497.34 |
| Euro 6 | 4.11 | 9.28 | 19.47 | 14.46 | 19.15 | 20.57 | 24.96 | 38.84 | 62.80 | 89.95 | 132.50 | 338.01 | 702.29 | 1461.57 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 278.82 | 698.89 | 965.42 | 824.51 | 1125.17 | 989.07 | 1193.62 | 1377.61 | 1561.60 | 2568.57 | 4668.82 | 6853.59 | 8666.44 | 10982.17 |
| Euro 1 | 10.90 | 113.66 | 488.30 | 303.25 | 428.61 | 375.83 | 532.32 | 844.34 | 1052.52 | 3090.13 | 5962.06 | 8833.99 | 12380.07 | 14356.63 |
| Euro 2 | 5.76 | 59.19 | 279.67 | 159.98 | 232.40 | 201.68 | 270.68 | 445.87 | 554.46 | 1498.07 | 2410.20 | 4342.43 | 6207.01 | 8818.56 |
| Euro 3 | 1.08 | 16.94 | 95.98 | 48.22 | 77.20 | 68.51 | 89.63 | 161.19 | 222.51 | 611.63 | 904.84 | 1677.05 | 2741.75 | 4297.42 |
| Euro 4 | 3.80 | 20.20 | 66.91 | 27.34 | 47.44 | 50.00 | 46.88 | 101.37 | 206.53 | 397.66 | 627.21 | 1228.57 | 1947.02 | 2910.60 |
| Euro 5 | 3.78 | 10.64 | 31.20 | 18.85 | 32.87 | 28.54 | 42.40 | 79.81 | 138.68 | 309.23 | 438.17 | 974.30 | 1829.10 | 2975.39 |
| Euro 6 | 4.11 | 10.33 | 30.46 | 18.31 | 32.05 | 27.79 | 41.30 | 77.90 | 135.48 | 303.37 | 430.00 | 953.53 | 1785.99 | 2897.56 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 278.82 | 734.35 | 858.00 | 981.66 | 1100.47 | 1219.27 | 1605.50 | 2427.55 | 3249.61 | 4760.69 | 7286.88 | 10475.98 | 12042.40 | 12444.96 |
| Euro 1 | 10.90 | 141.38 | 304.27 | 467.15 | 513.86 | 560.56 | 827.17 | 1636.41 | 2642.18 | 6861.05 | 11755.82 | 15370.42 | 16230.42 | 16754.67 |
| Euro 2 | 5.76 | 77.28 | 432.82 | 247.88 | 424.68 | 308.42 | 424.84 | 873.54 | 1399.18 | 3556.23 | 5894.64 | 7903.43 | 8278.98 | 8632.46 |
| Euro 3 | 1.08 | 22.45 | 147.33 | 77.81 | 139.29 | 110.63 | 164.82 | 319.81 | 553.11 | 1488.71 | 2465.96 | 3550.14 | 3981.33 | 4364.36 |
| Euro 4 | 3.80 | 22.01 | 101.79 | 38.53 | 88.62 | 70.62 | 109.04 | 199.44 | 430.34 | 968.18 | 1538.45 | 2486.92 | 2953.75 | 3034.55 |
| Euro 5 | 3.78 | 13.64 | 50.44 | 27.60 | 58.10 | 45.09 | 76.85 | 182.45 | 367.71 | 861.10 | 1337.67 | 2434.18 | 3373.60 | 3722.82 |
| Euro 6 | 4.11 | 13.24 | 49.23 | 26.90 | 56.61 | 43.88 | 75.00 | 178.17 | 360.45 | 841.89 | 1306.77 | 2373.50 | 3282.98 | 3619.13 |

*Table 39: LCV Gasoline NOx*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.66 | 22.19 | 35.89 | 49.60 | 50.91 | 52.22 | 74.84 | 97.46 | 139.10 | 183.70 | 229.84 | 314.51 | 399.44 | 437.39 |
| Euro 1 | 1.69 | 35.56 | 40.73 | 45.90 | 46.75 | 47.60 | 50.84 | 54.09 | 69.50 | 75.53 | 102.80 | 155.49 | 211.74 | 211.74 |
| Euro 2 | 0.60 | 12.55 | 16.77 | 16.43 | 18.26 | 16.68 | 14.56 | 19.11 | 24.04 | 26.57 | 36.22 | 54.78 | 75.42 | 75.42 |
| Euro 3 | 0.34 | 3.15 | 3.41 | 3.67 | 3.69 | 3.58 | 3.35 | 3.12 | 3.52 | 3.93 | 5.43 | 8.16 | 11.45 | 11.45 |
| Euro 4 | 0.17 | 1.69 | 2.07 | 2.45 | 2.72 | 2.50 | 2.59 | 2.67 | 3.38 | 3.78 | 4.23 | 4.68 | 5.14 | 5.14 |
| Euro 5 | 0.06 | 0.47 | 0.60 | 0.72 | 0.77 | 0.83 | 0.96 | 1.09 | 1.25 | 1.42 | 1.58 | 1.58 | 1.58 | 1.99 |
| Euro 6 | 0.07 | 0.46 | 0.58 | 0.70 | 0.75 | 0.80 | 0.93 | 1.06 | 1.22 | 1.30 | 1.38 | 1.46 | 1.54 | 1.93 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.66 | 8.66 | 10.41 | 12.17 | 11.12 | 8.13 | 5.14 | 4.26 | 3.38 | 5.02 | 4.34 | 7.52 | 15.60 | 39.14 |
| Euro 1 | 1.69 | 18.33 | 19.04 | 19.74 | 17.87 | 13.46 | 9.05 | 7.83 | 6.61 | 11.34 | 30.35 | 56.70 | 67.80 | 67.80 |
| Euro 2 | 0.60 | 6.45 | 6.70 | 6.95 | 6.37 | 4.79 | 3.20 | 2.74 | 2.28 | 3.75 | 10.64 | 19.58 | 23.32 | 23.32 |
| Euro 3 | 0.34 | 1.98 | 1.96 | 1.93 | 1.90 | 1.44 | 0.98 | 1.19 | 1.41 | 1.63 | 1.84 | 3.05 | 3.59 | 3.59 |
| Euro 4 | 0.17 | 0.94 | 0.97 | 1.00 | 0.95 | 0.71 | 0.47 | 0.46 | 0.45 | 0.61 | 1.04 | 1.22 | 1.57 | 1.84 |
| Euro 5 | 0.06 | 0.26 | 0.27 | 0.29 | 0.30 | 0.24 | 0.18 | 0.18 | 0.18 | 0.26 | 0.43 | 0.48 | 0.61 | 0.69 |
| Euro 6 | 0.07 | 0.25 | 0.27 | 0.28 | 0.29 | 0.24 | 0.18 | 0.18 | 0.18 | 0.25 | 0.42 | 0.46 | 0.59 | 0.67 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.66 | 12.06 | 11.54 | 11.03 | 10.52 | 10.00 | 10.96 | 13.54 | 16.13 | 20.78 | 25.43 | 51.34 | 91.82 | 156.06 |
| Euro 1 | 1.69 | 23.06 | 21.25 | 19.44 | 17.63 | 15.82 | 14.32 | 14.68 | 15.04 | 23.24 | 42.66 | 69.42 | 82.33 | 82.33 |
| Euro 2 | 0.60 | 8.07 | 11.75 | 9.04 | 9.59 | 5.55 | 5.09 | 6.42 | 5.08 | 7.80 | 14.94 | 24.54 | 28.10 | 28.10 |
| Euro 3 | 0.34 | 2.31 | 2.33 | 2.35 | 2.39 | 1.68 | 1.63 | 1.57 | 1.89 | 2.22 | 2.54 | 3.80 | 4.19 | 4.19 |
| Euro 4 | 0.17 | 1.13 | 1.23 | 1.33 | 1.36 | 0.87 | 0.91 | 0.96 | 0.83 | 1.19 | 1.49 | 1.71 | 2.41 | 2.66 |
| Euro 5 | 0.06 | 0.31 | 0.48 | 0.39 | 0.34 | 0.29 | 0.33 | 0.37 | 0.33 | 0.48 | 0.59 | 0.67 | 0.92 | 1.00 |
| Euro 6 | 0.07 | 0.30 | 0.34 | 0.38 | 0.33 | 0.29 | 0.32 | 0.36 | 0.32 | 0.46 | 0.57 | 0.65 | 0.90 | 0.98 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.66 | 16.70 | 18.20 | 19.70 | 21.21 | 22.71 | 33.68 | 44.65 | 58.05 | 84.82 | 107.54 | 164.26 | 233.69 | 317.84 |
| Euro 1 | 1.69 | 28.54 | 28.55 | 28.56 | 28.58 | 28.59 | 31.27 | 33.95 | 36.15 | 45.37 | 67.56 | 107.20 | 162.83 | 162.83 |
| Euro 2 | 0.60 | 10.06 | 13.87 | 12.12 | 13.63 | 10.08 | 8.57 | 11.86 | 12.50 | 15.84 | 22.91 | 36.41 | 54.41 | 54.41 |
| Euro 3 | 0.34 | 2.71 | 2.83 | 2.95 | 3.09 | 2.54 | 2.46 | 2.37 | 2.72 | 3.06 | 3.41 | 5.23 | 7.62 | 7.62 |
| Euro 4 | 0.17 | 1.38 | 1.59 | 1.79 | 2.05 | 1.49 | 1.60 | 1.70 | 1.84 | 2.29 | 2.71 | 3.05 | 3.38 | 3.72 |
| Euro 5 | 0.06 | 0.38 | 0.58 | 0.53 | 0.52 | 0.50 | 0.57 | 0.64 | 0.70 | 0.89 | 1.04 | 1.17 | 1.30 | 1.43 |
| Euro 6 | 0.07 | 0.37 | 0.44 | 0.51 | 0.50 | 0.49 | 0.56 | 0.62 | 0.68 | 0.82 | 0.95 | 1.09 | 1.22 | 1.39 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.66 | 29.26 | 52.64 | 76.01 | 88.09 | 100.16 | 132.41 | 164.66 | 226.12 | 287.58 | 348.66 | 406.87 | 424.58 | 424.58 |
| Euro 1 | 1.69 | 42.87 | 49.91 | 56.96 | 60.90 | 64.84 | 70.93 | 77.02 | 94.81 | 112.60 | 130.40 | 173.53 | 220.82 | 220.82 |
| Euro 2 | 0.60 | 15.23 | 19.68 | 20.48 | 23.87 | 23.22 | 30.40 | 39.83 | 44.75 | 51.53 | 56.42 | 61.30 | 77.90 | 77.90 |
| Euro 3 | 0.34 | 3.58 | 3.88 | 4.18 | 4.45 | 4.20 | 4.19 | 4.17 | 5.05 | 5.93 | 6.80 | 9.24 | 12.07 | 12.10 |
| Euro 4 | 0.17 | 2.04 | 2.61 | 3.19 | 3.64 | 3.58 | 3.65 | 3.71 | 4.21 | 4.77 | 5.06 | 5.62 | 5.74 | 7.10 |
| Euro 5 | 0.06 | 0.57 | 0.87 | 0.96 | 1.08 | 1.20 | 1.38 | 1.55 | 1.79 | 2.01 | 2.08 | 2.14 | 2.20 | 2.76 |
| Euro 6 | 0.07 | 0.56 | 0.74 | 0.93 | 1.16 | 1.17 | 1.34 | 1.50 | 1.74 | 1.84 | 1.94 | 2.04 | 2.14 | 2.68 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.66 | 39.07 | 86.37 | 108.61 | 137.70 | 156.93 | 169.48 | 205.30 | 241.12 | 276.94 | 312.76 | 348.58 | 348.58 | 348.58 |
| Euro 1 | 1.69 | 52.11 | 61.04 | 69.96 | 74.64 | 79.33 | 78.60 | 101.30 | 122.98 | 144.66 | 166.34 | 188.03 | 209.71 | 225.40 |
| Euro 2 | 0.60 | 18.49 | 23.67 | 24.59 | 26.51 | 28.42 | 37.92 | 47.42 | 56.93 | 62.33 | 67.73 | 70.25 | 74.94 | 74.94 |
| Euro 3 | 0.34 | 4.13 | 4.44 | 4.76 | 4.81 | 4.87 | 5.12 | 5.37 | 6.71 | 8.06 | 9.40 | 10.64 | 11.71 | 11.71 |
| Euro 4 | 0.17 | 2.40 | 3.20 | 3.99 | 4.23 | 4.43 | 4.51 | 4.59 | 5.16 | 5.26 | 6.09 | 6.76 | 7.42 | 7.77 |
| Euro 5 | 0.06 | 0.69 | 1.02 | 1.22 | 1.41 | 1.58 | 1.74 | 1.89 | 2.07 | 2.25 | 2.42 | 2.60 | 2.84 | 2.95 |
| Euro 6 | 0.07 | 0.67 | 0.92 | 1.18 | 1.37 | 1.53 | 1.68 | 1.84 | 2.03 | 2.20 | 2.36 | 2.53 | 2.75 | 2.87 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.66 | 49.02 | 102.35 | 141.54 | 181.67 | 214.58 | 250.15 | 285.72 | 285.72 | 285.72 | 285.72 | 285.72 | 285.72 | 285.72 |
| Euro 1 | 1.69 | 59.01 | 72.35 | 76.50 | 89.19 | 101.87 | 103.84 | 127.97 | 149.54 | 171.10 | 192.66 | 214.23 | 235.79 | 259.19 |
| Euro 2 | 0.60 | 21.12 | 25.31 | 27.33 | 31.77 | 36.21 | 45.83 | 55.44 | 65.06 | 79.08 | 80.95 | 82.82 | 84.69 | 91.25 |
| Euro 3 | 0.34 | 4.57 | 4.89 | 5.21 | 5.55 | 5.89 | 6.24 | 6.59 | 8.32 | 10.04 | 11.77 | 11.98 | 12.20 | 12.52 |
| Euro 4 | 0.17 | 2.83 | 3.74 | 4.22 | 4.69 | 5.09 | 5.35 | 5.62 | 5.84 | 6.07 | 6.69 | 7.31 | 7.93 | 8.69 |
| Euro 5 | 0.06 | 0.79 | 1.13 | 1.46 | 1.63 | 1.85 | 1.98 | 2.11 | 2.34 | 2.56 | 2.80 | 2.91 | 2.98 | 3.00 |
| Euro 6 | 0.07 | 0.77 | 1.09 | 1.42 | 1.59 | 1.80 | 1.92 | 2.05 | 2.27 | 2.49 | 2.72 | 2.83 | 2.89 | 2.91 |

*Table 40: LCV Gasoline PM*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.08 | 0.10 | 0.12 | 0.17 | 0.19 | 0.20 | 0.43 | 0.52 | 0.61 | 1.02 | 2.13 | 3.17 | 4.17 |
| Euro 1 | 0.01 | 0.06 | 0.07 | 0.08 | 0.13 | 0.12 | 0.13 | 0.30 | 0.39 | 0.48 | 0.78 | 1.60 | 2.27 | 2.92 |
| Euro 2 | 0.01 | 0.06 | 0.08 | 0.10 | 0.17 | 0.17 | 0.19 | 0.44 | 0.57 | 0.69 | 1.16 | 2.46 | 3.60 | 4.68 |
| Euro 3 | 0.00 | 0.03 | 0.04 | 0.04 | 0.07 | 0.07 | 0.08 | 0.18 | 0.21 | 0.25 | 0.42 | 0.85 | 1.21 | 1.51 |
| Euro 4 | 0.00 | 0.01 | 0.02 | 0.02 | 0.04 | 0.04 | 0.06 | 0.14 | 0.17 | 0.19 | 0.32 | 0.63 | 0.85 | 1.02 |
| Euro 5 | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.04 | 0.09 | 0.15 | 0.22 | 0.37 | 0.69 | 0.87 | 1.05 |
| Euro 6 | 0.00 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.04 | 0.08 | 0.15 | 0.22 | 0.36 | 0.67 | 0.85 | 1.03 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.05 | 0.05 | 0.05 | 0.06 | 0.08 | 0.11 | 0.13 | 0.22 | 0.31 | 0.40 | 0.60 | 0.79 | 1.04 |
| Euro 1 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.07 | 0.06 | 0.15 | 0.24 | 0.33 | 0.45 | 0.56 | 0.75 |
| Euro 2 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.06 | 0.08 | 0.08 | 0.16 | 0.23 | 0.31 | 0.42 | 0.54 | 0.73 |
| Euro 3 | 0.00 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.05 | 0.10 | 0.15 | 0.21 | 0.27 | 0.34 | 0.44 |
| Euro 4 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.09 | 0.15 | 0.20 | 0.26 | 0.31 | 0.40 |
| Euro 5 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.09 | 0.17 | 0.24 | 0.29 | 0.34 | 0.46 |
| Euro 6 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.09 | 0.16 | 0.23 | 0.28 | 0.33 | 0.45 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.06 | 0.06 | 0.06 | 0.07 | 0.09 | 0.13 | 0.16 | 0.25 | 0.34 | 0.43 | 0.77 | 1.11 | 1.46 |
| Euro 1 | 0.01 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.10 | 0.18 | 0.27 | 0.35 | 0.58 | 0.80 | 1.05 |
| Euro 2 | 0.01 | 0.04 | 0.04 | 0.04 | 0.05 | 0.07 | 0.09 | 0.15 | 0.22 | 0.28 | 0.35 | 0.62 | 0.90 | 1.29 |
| Euro 3 | 0.00 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.05 | 0.05 | 0.11 | 0.17 | 0.22 | 0.36 | 0.49 | 0.62 |
| Euro 4 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.09 | 0.15 | 0.21 | 0.31 | 0.40 | 0.49 |
| Euro 5 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.10 | 0.18 | 0.26 | 0.35 | 0.44 | 0.54 |
| Euro 6 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.10 | 0.17 | 0.25 | 0.34 | 0.42 | 0.52 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.07 | 0.08 | 0.08 | 0.09 | 0.13 | 0.15 | 0.24 | 0.35 | 0.45 | 0.56 | 1.11 | 1.68 | 2.24 |
| Euro 1 | 0.01 | 0.05 | 0.05 | 0.05 | 0.07 | 0.06 | 0.09 | 0.16 | 0.25 | 0.35 | 0.44 | 0.85 | 1.20 | 1.60 |
| Euro 2 | 0.01 | 0.05 | 0.06 | 0.06 | 0.08 | 0.08 | 0.12 | 0.23 | 0.34 | 0.44 | 0.55 | 1.11 | 1.69 | 2.41 |
| Euro 3 | 0.00 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.09 | 0.15 | 0.20 | 0.26 | 0.46 | 0.66 | 0.88 |
| Euro 4 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.04 | 0.07 | 0.12 | 0.17 | 0.22 | 0.36 | 0.49 | 0.64 |
| Euro 5 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.05 | 0.12 | 0.20 | 0.27 | 0.40 | 0.54 | 0.68 |
| Euro 6 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.05 | 0.12 | 0.19 | 0.27 | 0.39 | 0.52 | 0.66 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 0.01 | 0.09 | 0.15 | 0.21 | 0.28 | 0.32 | 0.33 | 0.77 | 1.42 | 2.11 | 3.31 | 4.50 | 6.14 | 10.37 |
| Euro 1 | 0.01 | 0.08 | 0.11 | 0.13 | 0.24 | 0.21 | 0.25 | 0.58 | 1.10 | 1.54 | 2.38 | 3.22 | 4.18 | 6.40 |
| Euro 2 | 0.01 | 0.10 | 0.14 | 0.18 | 0.33 | 0.31 | 0.37 | 0.89 | 1.59 | 2.29 | 3.70 | 5.11 | 6.80 | 11.74 |
| Euro 3 | 0.00 | 0.05 | 0.06 | 0.07 | 0.13 | 0.12 | 0.14 | 0.32 | 0.53 | 0.74 | 1.19 | 1.64 | 2.17 | 3.30 |
| Euro 4 | 0.00 | 0.02 | 0.03 | 0.05 | 0.09 | 0.08 | 0.10 | 0.25 | 0.35 | 0.50 | 0.83 | 1.16 | 1.48 | 2.10 |
| Euro 5 | 0.00 | 0.01 | 0.02 | 0.03 | 0.07 | 0.06 | 0.09 | 0.18 | 0.29 | 0.49 | 0.85 | 1.22 | 1.50 | 2.06 |
| Euro 6 | 0.00 | 0.01 | 0.02 | 0.03 | 0.06 | 0.05 | 0.09 | 0.17 | 0.29 | 0.48 | 0.83 | 1.19 | 1.46 | 2.01 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.01 | 0.12 | 0.22 | 0.33 | 0.60 | 0.62 | 0.68 | 1.41 | 2.54 | 3.71 | 5.73 | 7.79 | 9.84 | 13.11 |
| Euro 1 | 0.01 | 0.11 | 0.17 | 0.23 | 0.47 | 0.37 | 0.55 | 1.09 | 2.01 | 2.70 | 3.83 | 5.37 | 6.57 | 7.71 |
| Euro 2 | 0.01 | 0.13 | 0.24 | 0.35 | 0.70 | 0.58 | 0.88 | 1.80 | 3.25 | 4.75 | 6.55 | 9.23 | 11.88 | 18.59 |
| Euro 3 | 0.00 | 0.06 | 0.09 | 0.13 | 0.24 | 0.21 | 0.27 | 0.57 | 1.06 | 1.49 | 2.13 | 3.16 | 4.65 | 6.15 |
| Euro 4 | 0.00 | 0.04 | 0.06 | 0.09 | 0.15 | 0.16 | 0.19 | 0.43 | 0.78 | 1.24 | 1.59 | 2.36 | 4.13 | 5.91 |
| Euro 5 | 0.00 | 0.02 | 0.04 | 0.06 | 0.14 | 0.10 | 0.20 | 0.39 | 0.69 | 1.24 | 1.60 | 2.59 | 4.10 | 5.60 |
| Euro 6 | 0.00 | 0.02 | 0.04 | 0.06 | 0.14 | 0.10 | 0.19 | 0.38 | 0.67 | 1.20 | 1.56 | 2.53 | 4.01 | 5.48 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 0.01 | 0.16 | 0.33 | 0.50 | 0.74 | 0.99 | 1.45 | 3.04 | 5.26 | 6.47 | 8.41 | 13.32 | 18.08 | 18.25 |
| Euro 1 | 0.01 | 0.14 | 0.27 | 0.40 | 0.55 | 0.70 | 1.14 | 2.18 | 3.95 | 4.53 | 5.81 | 9.31 | 12.62 | 12.90 |
| Euro 2 | 0.01 | 0.19 | 0.41 | 0.63 | 0.88 | 1.12 | 1.87 | 3.65 | 6.56 | 8.17 | 10.51 | 16.95 | 21.63 | 22.02 |
| Euro 3 | 0.00 | 0.08 | 0.14 | 0.20 | 0.29 | 0.38 | 0.59 | 1.12 | 1.99 | 2.43 | 3.32 | 4.99 | 6.31 | 7.38 |
| Euro 4 | 0.00 | 0.04 | 0.09 | 0.15 | 0.22 | 0.28 | 0.45 | 0.79 | 1.36 | 1.70 | 2.19 | 3.23 | 3.78 | 3.96 |
| Euro 5 | 0.00 | 0.03 | 0.08 | 0.13 | 0.17 | 0.21 | 0.38 | 0.86 | 1.71 | 2.68 | 3.82 | 4.97 | 6.11 | 8.38 |
| Euro 6 | 0.00 | 0.03 | 0.08 | 0.13 | 0.17 | 0.21 | 0.37 | 0.84 | 1.67 | 2.61 | 3.73 | 4.85 | 5.97 | 8.17 |

*Table 41: LCV Diesel CO*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 8.66 | 28.47 | 34.93 | 39.13 | 41.88 | 44.63 | 50.10 | 55.57 | 61.04 | 66.51 | 71.98 | 77.46 | 109.97 | 132.19 |
| Euro 1 | 5.70 | 18.79 | 22.45 | 25.65 | 27.75 | 29.86 | 33.15 | 36.43 | 39.72 | 43.01 | 46.30 | 49.58 | 71.01 | 86.57 |
| Euro 2 | 1.86 | 5.93 | 7.65 | 8.22 | 9.52 | 9.50 | 8.84 | 9.50 | 10.16 | 10.06 | 11.11 | 14.78 | 21.04 | 25.96 |
| Euro 3 | 0.34 | 2.17 | 2.17 | 2.17 | 1.76 | 1.34 | 0.93 | 0.89 | 0.84 | 0.80 | 0.91 | 1.02 | 1.11 | 1.26 |
| Euro 4 | 0.11 | 0.64 | 0.79 | 0.95 | 0.91 | 0.88 | 0.85 | 0.81 | 0.78 | 0.75 | 0.72 | 0.71 | 0.71 | 0.88 |
| Euro 5 | 0.04 | 0.16 | 0.20 | 0.25 | 0.24 | 0.23 | 0.22 | 0.21 | 0.18 | 0.16 | 0.14 | 0.14 | 0.18 | 0.22 |
| Euro 6 | 0.05 | 0.23 | 0.29 | 0.35 | 0.31 | 0.27 | 0.25 | 0.24 | 0.23 | 0.22 | 0.20 | 0.19 | 0.25 | 0.31 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 8.66 | 18.25 | 19.42 | 20.60 | 21.62 | 22.26 | 22.91 | 23.55 | 32.16 | 44.74 | 52.77 | 60.80 | 70.25 | 71.51 |
| Euro 1 | 5.70 | 12.23 | 12.94 | 13.64 | 14.40 | 15.05 | 15.44 | 15.57 | 21.66 | 30.17 | 35.68 | 41.19 | 47.92 | 47.92 |
| Euro 2 | 1.86 | 3.86 | 5.14 | 4.28 | 4.52 | 3.85 | 3.43 | 5.01 | 6.90 | 7.95 | 9.00 | 12.84 | 15.16 | 15.16 |
| Euro 3 | 0.34 | 0.92 | 0.92 | 0.92 | 0.75 | 0.58 | 0.41 | 0.35 | 0.29 | 0.38 | 0.42 | 0.45 | 0.43 | 0.60 |
| Euro 4 | 0.11 | 0.44 | 0.52 | 0.61 | 0.61 | 0.62 | 0.56 | 0.50 | 0.43 | 0.37 | 0.41 | 0.48 | 0.56 | 0.64 |
| Euro 5 | 0.04 | 0.11 | 0.12 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.12 | 0.11 | 0.10 | 0.12 | 0.14 | 0.16 |
| Euro 6 | 0.05 | 0.16 | 0.17 | 0.18 | 0.19 | 0.19 | 0.16 | 0.13 | 0.11 | 0.11 | 0.15 | 0.17 | 0.20 | 0.23 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 8.66 | 20.59 | 23.66 | 26.72 | 28.32 | 32.55 | 36.79 | 41.02 | 45.26 | 49.49 | 57.85 | 65.05 | 77.54 | 90.03 |
| Euro 1 | 5.70 | 13.84 | 15.73 | 17.63 | 18.74 | 20.79 | 22.85 | 24.90 | 26.96 | 33.38 | 39.05 | 44.46 | 52.10 | 59.73 |
| Euro 2 | 1.86 | 4.33 | 4.95 | 5.57 | 6.00 | 5.12 | 4.55 | 6.37 | 8.57 | 10.71 | 12.35 | 14.28 | 15.01 | 18.29 |
| Euro 3 | 0.34 | 1.18 | 1.18 | 1.18 | 0.98 | 0.77 | 0.57 | 0.50 | 0.43 | 0.50 | 0.56 | 0.61 | 0.68 | 0.94 |
| Euro 4 | 0.11 | 0.49 | 0.57 | 0.65 | 0.62 | 0.60 | 0.55 | 0.50 | 0.45 | 0.40 | 0.42 | 0.47 | 0.55 | 0.68 |
| Euro 5 | 0.04 | 0.13 | 0.14 | 0.15 | 0.15 | 0.14 | 0.13 | 0.11 | 0.10 | 0.10 | 0.11 | 0.12 | 0.15 | 0.18 |
| Euro 6 | 0.05 | 0.18 | 0.20 | 0.22 | 0.21 | 0.20 | 0.17 | 0.15 | 0.14 | 0.14 | 0.15 | 0.18 | 0.21 | 0.25 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 8.66 | 24.32 | 28.64 | 32.97 | 34.00 | 35.03 | 37.83 | 40.63 | 45.61 | 49.39 | 53.43 | 62.88 | 87.34 | 106.17 |
| Euro 1 | 5.70 | 16.25 | 19.05 | 21.86 | 22.63 | 23.40 | 25.21 | 27.01 | 30.98 | 33.55 | 36.52 | 42.18 | 58.17 | 70.17 |
| Euro 2 | 1.86 | 5.03 | 6.74 | 6.96 | 7.90 | 7.37 | 7.22 | 8.46 | 9.90 | 10.70 | 11.86 | 13.36 | 18.00 | 21.76 |
| Euro 3 | 0.34 | 1.68 | 1.68 | 1.68 | 1.43 | 1.17 | 0.92 | 0.80 | 0.69 | 0.66 | 0.76 | 0.86 | 1.00 | 1.12 |
| Euro 4 | 0.11 | 0.58 | 0.67 | 0.75 | 0.71 | 0.68 | 0.64 | 0.60 | 0.56 | 0.53 | 0.49 | 0.54 | 0.59 | 0.77 |
| Euro 5 | 0.04 | 0.15 | 0.18 | 0.21 | 0.20 | 0.19 | 0.18 | 0.17 | 0.15 | 0.12 | 0.12 | 0.12 | 0.15 | 0.19 |
| Euro 6 | 0.05 | 0.21 | 0.25 | 0.30 | 0.26 | 0.22 | 0.21 | 0.21 | 0.21 | 0.17 | 0.16 | 0.17 | 0.22 | 0.27 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 8.66 | 32.10 | 38.18 | 43.81 | 48.44 | 53.76 | 63.94 | 74.11 | 84.28 | 94.45 | 104.62 | 114.79 | 139.24 | 155.11 |
| Euro 1 | 5.70 | 21.31 | 24.49 | 28.80 | 32.66 | 35.95 | 42.39 | 48.83 | 55.28 | 61.72 | 68.16 | 74.60 | 92.51 | 103.28 |
| Euro 2 | 1.86 | 6.82 | 8.11 | 9.34 | 10.56 | 11.32 | 11.58 | 11.83 | 12.09 | 12.21 | 15.23 | 21.27 | 27.98 | 31.74 |
| Euro 3 | 0.34 | 2.10 | 2.10 | 2.10 | 1.76 | 1.43 | 1.10 | 1.04 | 0.98 | 0.94 | 1.03 | 1.12 | 1.27 | 1.47 |
| Euro 4 | 0.11 | 0.73 | 0.92 | 1.11 | 1.05 | 0.98 | 0.95 | 0.91 | 0.87 | 0.84 | 0.84 | 0.85 | 0.88 | 0.99 |
| Euro 5 | 0.04 | 0.18 | 0.23 | 0.29 | 0.28 | 0.26 | 0.25 | 0.23 | 0.22 | 0.20 | 0.19 | 0.17 | 0.20 | 0.24 |
| Euro 6 | 0.05 | 0.25 | 0.33 | 0.41 | 0.38 | 0.35 | 0.33 | 0.32 | 0.30 | 0.28 | 0.26 | 0.24 | 0.29 | 0.34 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 8.66 | 36.48 | 40.24 | 46.20 | 51.45 | 60.68 | 69.91 | 79.14 | 88.37 | 97.60 | 118.13 | 136.73 | 152.54 | 163.61 |
| Euro 1 | 5.70 | 24.16 | 26.17 | 30.35 | 34.91 | 40.71 | 46.51 | 52.31 | 58.11 | 63.91 | 76.52 | 88.64 | 99.09 | 106.13 |
| Euro 2 | 1.86 | 7.62 | 8.55 | 9.93 | 11.08 | 12.76 | 14.44 | 16.12 | 17.79 | 19.47 | 23.42 | 29.78 | 33.46 | 35.87 |
| Euro 3 | 0.34 | 2.19 | 2.19 | 2.19 | 1.89 | 1.58 | 1.27 | 1.15 | 1.02 | 1.08 | 1.14 | 1.21 | 1.33 | 1.43 |
| Euro 4 | 0.11 | 0.88 | 1.10 | 1.33 | 1.22 | 1.12 | 1.02 | 0.92 | 0.81 | 0.71 | 0.84 | 0.96 | 1.02 | 1.10 |
| Euro 5 | 0.04 | 0.21 | 0.28 | 0.36 | 0.34 | 0.32 | 0.30 | 0.28 | 0.27 | 0.25 | 0.23 | 0.21 | 0.23 | 0.26 |
| Euro 6 | 0.05 | 0.30 | 0.40 | 0.50 | 0.47 | 0.44 | 0.42 | 0.39 | 0.37 | 0.35 | 0.32 | 0.30 | 0.33 | 0.36 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 8.66 | 40.80 | 43.02 | 48.22 | 58.42 | 62.51 | 76.18 | 89.84 | 103.51 | 127.68 | 145.37 | 161.04 | 172.11 | 176.13 |
| Euro 1 | 5.70 | 26.99 | 28.31 | 31.43 | 39.71 | 42.98 | 51.04 | 59.11 | 67.18 | 84.14 | 96.32 | 104.07 | 110.80 | 113.79 |
| Euro 2 | 1.86 | 8.57 | 8.91 | 10.12 | 12.07 | 13.53 | 15.57 | 17.61 | 19.65 | 25.37 | 29.67 | 32.68 | 34.93 | 35.43 |
| Euro 3 | 0.34 | 2.20 | 2.20 | 2.20 | 1.99 | 1.77 | 1.55 | 1.34 | 1.12 | 1.26 | 1.39 | 1.52 | 1.64 | 1.68 |
| Euro 4 | 0.11 | 1.08 | 1.33 | 1.59 | 1.48 | 1.37 | 1.26 | 1.15 | 1.04 | 1.00 | 0.95 | 1.04 | 1.10 | 1.13 |
| Euro 5 | 0.04 | 0.25 | 0.34 | 0.44 | 0.41 | 0.39 | 0.36 | 0.34 | 0.32 | 0.29 | 0.27 | 0.24 | 0.26 | 0.27 |
| Euro 6 | 0.05 | 0.35 | 0.49 | 0.62 | 0.60 | 0.58 | 0.54 | 0.50 | 0.46 | 0.42 | 0.38 | 0.35 | 0.37 | 0.38 |

*Table 42: LCV Diesel $NO_x$*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.52 | 20.27 | 27.20 | 34.12 | 37.24 | 40.37 | 47.34 | 72.81 | 95.08 | 140.19 | 198.08 | 275.20 | 334.58 | 396.81 |
| Euro 1 | 5.88 | 18.39 | 24.42 | 30.45 | 33.35 | 36.24 | 42.66 | 64.75 | 84.58 | 124.70 | 175.51 | 245.68 | 300.06 | 358.48 |
| Euro 2 | 5.53 | 16.66 | 22.06 | 27.46 | 30.02 | 32.58 | 37.57 | 57.57 | 74.33 | 109.45 | 152.33 | 214.87 | 265.96 | 321.26 |
| Euro 3 | 4.12 | 13.63 | 18.84 | 24.05 | 25.43 | 26.81 | 29.96 | 48.62 | 63.37 | 90.22 | 116.01 | 169.66 | 207.21 | 237.30 |
| Euro 4 | 3.62 | 10.80 | 13.48 | 16.16 | 18.34 | 20.53 | 21.54 | 33.41 | 55.30 | 73.92 | 89.04 | 125.63 | 168.63 | 216.89 |
| Euro 5 | 3.60 | 9.80 | 12.79 | 15.78 | 17.09 | 18.40 | 19.68 | 32.27 | 47.24 | 60.90 | 83.04 | 122.46 | 169.67 | 214.02 |
| Euro 6 | 1.28 | 3.42 | 4.43 | 5.44 | 5.88 | 6.32 | 6.71 | 10.98 | 15.80 | 20.39 | 27.79 | 41.13 | 57.11 | 72.35 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **v [km/h]** | **0** | **10** | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | **130** |
| **standard** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** | **g/h** |
| Pre Euro | 6.52 | 10.87 | 11.35 | 11.83 | 10.30 | 8.78 | 8.20 | 10.33 | 12.46 | 19.58 | 26.70 | 44.03 | 68.56 | 105.83 |
| Euro 1 | 5.88 | 9.85 | 10.24 | 10.63 | 9.28 | 7.93 | 7.40 | 9.25 | 11.09 | 17.33 | 23.56 | 38.41 | 59.55 | 91.73 |
| Euro 2 | 5.53 | 9.12 | 9.44 | 9.76 | 8.53 | 7.30 | 6.83 | 8.51 | 10.19 | 15.60 | 21.01 | 33.46 | 51.42 | 79.37 |
| Euro 3 | 4.12 | 7.63 | 8.18 | 8.74 | 7.99 | 7.24 | 6.59 | 7.41 | 8.22 | 13.57 | 18.91 | 20.43 | 27.24 | 49.98 |
| Euro 4 | 3.62 | 6.23 | 6.34 | 6.44 | 6.21 | 5.97 | 5.35 | 5.65 | 5.96 | 9.77 | 13.59 | 23.73 | 39.81 | 67.27 |
| Euro 5 | 3.60 | 5.88 | 5.87 | 5.86 | 5.30 | 4.74 | 4.23 | 4.59 | 4.94 | 9.46 | 13.99 | 24.68 | 41.57 | 69.36 |
| Euro 6 | 1.28 | 2.07 | 2.07 | 2.06 | 1.86 | 1.67 | 1.49 | 1.60 | 1.71 | 3.23 | 4.76 | 8.27 | 13.80 | 22.85 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.52 | 13.00 | 14.78 | 16.56 | 15.20 | 13.83 | 17.10 | 20.37 | 25.67 | 41.67 | 61.30 | 95.97 | 134.63 | 186.08 |
| Euro 1 | 5.88 | 11.77 | 13.33 | 14.89 | 13.59 | 12.28 | 15.31 | 18.33 | 22.70 | 36.73 | 53.86 | 84.34 | 118.00 | 162.60 |
| Euro 2 | 5.53 | 10.83 | 12.22 | 13.62 | 12.46 | 11.31 | 13.87 | 16.43 | 20.42 | 32.64 | 47.61 | 73.89 | 103.04 | 140.81 |
| Euro 3 | 4.12 | 8.98 | 10.37 | 11.77 | 11.09 | 10.42 | 12.29 | 14.16 | 14.58 | 26.59 | 33.60 | 43.86 | 67.27 | 112.37 |
| Euro 4 | 3.62 | 7.11 | 7.76 | 8.42 | 8.18 | 7.94 | 9.44 | 10.93 | 10.29 | 16.52 | 25.18 | 45.27 | 73.01 | 110.12 |
| Euro 5 | 3.60 | 6.78 | 7.33 | 7.87 | 7.48 | 7.10 | 8.40 | 9.70 | 10.30 | 17.31 | 27.55 | 48.91 | 76.46 | 112.09 |
| Euro 6 | 1.28 | 2.38 | 2.56 | 2.75 | 2.61 | 2.48 | 2.91 | 3.34 | 3.52 | 5.87 | 9.31 | 16.46 | 25.63 | 37.65 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.52 | 16.19 | 19.82 | 23.45 | 23.89 | 24.33 | 26.87 | 38.53 | 52.74 | 81.64 | 117.03 | 171.39 | 225.68 | 295.65 |
| Euro 1 | 5.88 | 14.73 | 17.91 | 21.10 | 21.50 | 21.91 | 24.06 | 34.31 | 46.98 | 72.38 | 103.35 | 150.88 | 198.47 | 261.03 |
| Euro 2 | 5.53 | 13.35 | 16.22 | 19.09 | 19.52 | 19.96 | 21.86 | 30.42 | 41.71 | 63.74 | 90.72 | 131.28 | 171.54 | 226.03 |
| Euro 3 | 4.12 | 10.81 | 13.73 | 16.66 | 16.33 | 16.01 | 17.60 | 26.16 | 30.24 | 48.43 | 63.30 | 94.89 | 142.09 | 184.24 |
| Euro 4 | 3.62 | 8.53 | 10.12 | 11.71 | 12.20 | 12.68 | 12.25 | 19.68 | 24.73 | 32.56 | 46.01 | 75.79 | 115.25 | 160.13 |
| Euro 5 | 3.60 | 8.08 | 9.47 | 10.87 | 10.98 | 11.09 | 11.54 | 18.11 | 20.84 | 33.61 | 48.62 | 79.97 | 118.26 | 160.76 |
| Euro 6 | 1.28 | 2.83 | 3.30 | 3.77 | 3.80 | 3.83 | 3.96 | 6.15 | 7.02 | 11.31 | 16.36 | 26.91 | 39.76 | 54.07 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.52 | 24.91 | 37.41 | 49.90 | 56.64 | 63.39 | 91.79 | 120.19 | 163.13 | 218.23 | 292.37 | 365.39 | 415.33 | 461.96 |
| Euro 1 | 5.88 | 22.67 | 33.93 | 45.19 | 51.15 | 57.11 | 82.90 | 108.68 | 150.62 | 196.48 | 263.40 | 331.10 | 374.25 | 415.54 |
| Euro 2 | 5.53 | 20.56 | 30.74 | 40.91 | 46.02 | 51.13 | 73.35 | 95.57 | 131.69 | 169.94 | 234.80 | 299.31 | 343.64 | 386.70 |
| Euro 3 | 4.12 | 16.60 | 25.49 | 34.38 | 39.43 | 44.48 | 61.25 | 78.02 | 117.80 | 151.82 | 178.56 | 219.23 | 253.87 | 290.53 |
| Euro 4 | 3.62 | 13.68 | 18.54 | 23.41 | 27.68 | 31.96 | 43.53 | 55.09 | 84.84 | 122.81 | 152.38 | 186.85 | 225.01 | 265.48 |
| Euro 5 | 3.60 | 12.59 | 17.15 | 21.70 | 25.54 | 29.38 | 41.28 | 53.18 | 86.73 | 116.71 | 132.16 | 174.66 | 223.93 | 263.47 |
| Euro 6 | 1.28 | 4.38 | 5.92 | 7.46 | 8.75 | 10.05 | 14.03 | 18.02 | 29.26 | 38.51 | 43.96 | 58.73 | 75.79 | 89.73 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.52 | 30.82 | 63.16 | 76.82 | 90.47 | 95.04 | 134.78 | 174.51 | 249.61 | 307.99 | 373.89 | 428.32 | 471.70 | 507.01 |
| Euro 1 | 5.88 | 28.09 | 57.44 | 69.47 | 81.50 | 85.90 | 121.89 | 157.88 | 230.05 | 279.89 | 338.44 | 388.18 | 426.06 | 456.28 |
| Euro 2 | 5.53 | 25.22 | 51.26 | 62.29 | 73.32 | 76.27 | 107.71 | 139.15 | 199.82 | 247.16 | 305.24 | 354.59 | 391.44 | 420.10 |
| Euro 3 | 4.12 | 20.50 | 44.23 | 54.23 | 64.23 | 69.12 | 92.16 | 115.20 | 172.16 | 205.70 | 228.74 | 260.76 | 289.03 | 310.16 |
| Euro 4 | 3.62 | 16.62 | 31.32 | 38.97 | 46.63 | 47.89 | 68.12 | 88.35 | 121.13 | 167.68 | 208.36 | 239.79 | 268.84 | 291.86 |
| Euro 5 | 3.60 | 14.98 | 30.98 | 37.77 | 44.57 | 45.13 | 62.41 | 79.70 | 122.32 | 168.28 | 192.00 | 230.85 | 268.50 | 288.62 |
| Euro 6 | 1.28 | 5.20 | 10.61 | 12.89 | 15.16 | 15.39 | 21.14 | 26.90 | 41.53 | 57.05 | 64.40 | 78.17 | 92.06 | 99.18 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.52 | 36.91 | 78.80 | 99.29 | 119.78 | 137.47 | 184.57 | 231.66 | 334.11 | 389.11 | 442.30 | 488.02 | 521.70 | 533.88 |
| Euro 1 | 5.88 | 33.61 | 72.38 | 90.50 | 108.62 | 123.29 | 166.44 | 209.58 | 308.43 | 355.23 | 401.64 | 440.78 | 470.55 | 481.42 |
| Euro 2 | 5.53 | 30.31 | 63.73 | 79.73 | 95.74 | 109.59 | 148.51 | 187.43 | 276.31 | 321.05 | 364.37 | 401.51 | 428.92 | 438.85 |
| Euro 3 | 4.12 | 24.59 | 54.46 | 70.01 | 85.57 | 96.89 | 125.93 | 154.98 | 213.89 | 243.33 | 264.53 | 290.82 | 310.37 | 317.33 |
| Euro 4 | 3.62 | 18.85 | 40.62 | 52.04 | 63.45 | 67.90 | 96.84 | 125.78 | 174.30 | 212.51 | 252.97 | 285.21 | 306.64 | 314.04 |
| Euro 5 | 3.60 | 17.57 | 38.77 | 49.64 | 60.51 | 63.74 | 89.99 | 116.25 | 162.37 | 211.60 | 246.46 | 275.91 | 297.07 | 303.24 |
| Euro 6 | 1.28 | 6.08 | 13.27 | 16.94 | 20.61 | 21.68 | 30.51 | 39.35 | 55.15 | 72.19 | 83.77 | 93.76 | 102.06 | 104.73 |

*Table 43: LCV Diesel PM*

| gradient [%]: 0 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 6.31 | 8.41 | 8.89 | 10.25 | 11.60 | 15.24 | 18.88 | 24.18 | 29.47 | 33.57 | 37.72 | 42.82 | 49.35 |
| Euro 1 | 0.63 | 3.17 | 4.45 | 4.35 | 5.07 | 5.78 | 7.88 | 9.98 | 13.37 | 16.76 | 22.77 | 26.92 | 28.00 | 29.50 |
| Euro 2 | 0.54 | 2.10 | 2.66 | 2.89 | 3.36 | 3.82 | 4.96 | 6.10 | 7.89 | 9.68 | 11.15 | 12.10 | 13.59 | 15.81 |
| Euro 3 | 0.10 | 0.83 | 1.29 | 1.36 | 1.57 | 1.77 | 2.14 | 2.52 | 3.21 | 3.91 | 5.31 | 7.55 | 8.48 | 9.43 |
| Euro 4 | 0.16 | 1.05 | 1.22 | 1.36 | 1.66 | 1.97 | 2.24 | 2.52 | 3.42 | 4.32 | 4.69 | 5.47 | 6.21 | 7.19 |
| Euro 5 | 0.02 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.14 | 0.20 | 0.25 | 0.31 |
| Euro 6 | 0.02 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.09 | 0.14 | 0.21 | 0.31 |

| gradient [%]: -6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 4.77 | 5.10 | 5.25 | 5.40 | 5.49 | 6.50 | 7.50 | 13.64 | 19.12 | 24.14 | 25.29 | 26.44 | 27.05 |
| Euro 1 | 0.63 | 2.27 | 2.49 | 2.51 | 2.54 | 2.60 | 3.12 | 3.65 | 6.99 | 10.28 | 13.66 | 14.67 | 15.68 | 15.64 |
| Euro 2 | 0.54 | 1.62 | 1.69 | 1.76 | 1.83 | 1.87 | 2.19 | 2.51 | 4.62 | 6.47 | 8.10 | 8.42 | 8.75 | 8.91 |
| Euro 3 | 0.10 | 0.40 | 0.61 | 0.56 | 0.50 | 0.32 | 0.37 | 0.43 | 0.53 | 0.71 | 0.96 | 1.64 | 2.32 | 3.63 |
| Euro 4 | 0.16 | 0.79 | 0.79 | 0.82 | 0.86 | 0.88 | 0.94 | 1.00 | 1.27 | 1.91 | 2.78 | 3.73 | 4.67 | 5.12 |
| Euro 5 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.09 | 0.14 | 0.18 | 0.23 |
| Euro 6 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 | 0.09 | 0.14 | 0.18 | 0.23 |

| gradient [%]: -4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 5.11 | 5.99 | 6.20 | 7.24 | 7.25 | 8.01 | 8.76 | 14.85 | 21.82 | 27.06 | 28.93 | 30.80 | 30.42 |
| Euro 1 | 0.63 | 2.43 | 3.00 | 2.98 | 3.48 | 3.42 | 3.87 | 4.33 | 7.66 | 11.94 | 16.42 | 17.67 | 18.92 | 18.88 |
| Euro 2 | 0.54 | 1.73 | 2.02 | 2.10 | 2.40 | 2.39 | 2.65 | 2.92 | 4.99 | 7.27 | 9.12 | 9.74 | 10.37 | 9.93 |
| Euro 3 | 0.10 | 0.50 | 0.79 | 0.66 | 0.78 | 0.61 | 0.70 | 0.79 | 1.06 | 1.38 | 2.01 | 3.47 | 4.93 | 6.54 |
| Euro 4 | 0.16 | 0.84 | 0.91 | 0.93 | 1.13 | 1.09 | 1.23 | 1.37 | 1.48 | 2.19 | 3.05 | 4.06 | 5.08 | 5.88 |
| Euro 5 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.07 | 0.12 | 0.17 | 0.21 | 0.26 |
| Euro 6 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.07 | 0.12 | 0.17 | 0.21 | 0.26 |

| gradient [%]: -2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 5.74 | 6.90 | 7.14 | 8.33 | 9.53 | 10.37 | 11.21 | 17.57 | 24.97 | 30.57 | 32.16 | 33.76 | 39.31 |
| Euro 1 | 0.63 | 2.88 | 3.52 | 3.47 | 4.09 | 4.72 | 5.14 | 5.56 | 9.04 | 14.00 | 19.53 | 20.88 | 22.24 | 23.68 |
| Euro 2 | 0.54 | 1.89 | 2.30 | 2.35 | 2.78 | 3.20 | 3.42 | 3.64 | 5.86 | 8.33 | 10.19 | 10.50 | 10.81 | 12.13 |
| Euro 3 | 0.10 | 0.63 | 1.01 | 0.94 | 1.02 | 1.10 | 1.32 | 1.54 | 2.00 | 2.50 | 3.50 | 5.48 | 7.47 | 8.47 |
| Euro 4 | 0.16 | 0.90 | 1.10 | 1.19 | 1.36 | 1.53 | 1.74 | 1.95 | 2.38 | 2.67 | 3.66 | 4.69 | 5.72 | 6.19 |
| Euro 5 | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.08 | 0.13 | 0.18 | 0.23 | 0.28 |
| Euro 6 | 0.02 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.08 | 0.13 | 0.18 | 0.23 | 0.28 |

| gradient [%]: 2 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 7.12 | 9.54 | 12.21 | 13.35 | 14.50 | 17.74 | 23.23 | 28.72 | 34.39 | 38.97 | 44.95 | 50.67 | 55.82 |
| Euro 1 | 0.63 | 3.65 | 5.21 | 6.68 | 7.05 | 7.41 | 9.63 | 13.51 | 17.39 | 20.46 | 26.46 | 32.10 | 34.51 | 36.89 |
| Euro 2 | 0.54 | 2.37 | 3.02 | 4.15 | 4.49 | 4.83 | 5.87 | 7.70 | 9.52 | 11.13 | 12.47 | 14.53 | 16.60 | 18.47 |
| Euro 3 | 0.10 | 1.01 | 1.55 | 1.86 | 2.15 | 2.44 | 3.44 | 4.44 | 5.44 | 6.44 | 7.82 | 8.75 | 9.81 | 10.96 |
| Euro 4 | 0.16 | 1.20 | 1.43 | 1.69 | 2.06 | 2.43 | 2.62 | 3.67 | 4.73 | 5.59 | 5.76 | 6.46 | 7.45 | 8.54 |
| Euro 5 | 0.02 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.08 | 0.10 | 0.14 | 0.19 | 0.23 | 0.28 | 0.37 |
| Euro 6 | 0.02 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.08 | 0.10 | 0.13 | 0.18 | 0.23 | 0.28 | 0.36 |

| gradient [%]: 4 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 8.12 | 11.79 | 15.52 | 18.48 | 22.64 | 26.80 | 30.96 | 36.12 | 41.28 | 46.74 | 52.43 | 57.61 | 61.74 |
| Euro 1 | 0.63 | 4.24 | 6.53 | 8.76 | 9.97 | 13.02 | 16.06 | 19.11 | 22.12 | 25.12 | 30.22 | 34.88 | 37.91 | 40.42 |
| Euro 2 | 0.54 | 2.68 | 3.87 | 5.02 | 6.10 | 7.45 | 8.81 | 10.16 | 11.70 | 13.23 | 14.97 | 16.81 | 18.50 | 19.82 |
| Euro 3 | 0.10 | 1.22 | 1.94 | 2.41 | 2.89 | 3.61 | 4.34 | 5.07 | 6.63 | 8.20 | 9.38 | 10.22 | 11.20 | 11.98 |
| Euro 4 | 0.16 | 1.32 | 1.62 | 2.14 | 2.62 | 3.20 | 3.78 | 4.37 | 5.33 | 6.29 | 6.94 | 7.91 | 8.84 | 9.64 |
| Euro 5 | 0.02 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.08 | 0.08 | 0.14 | 0.20 | 0.25 | 0.30 | 0.36 | 0.40 |
| Euro 6 | 0.02 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.08 | 0.08 | 0.14 | 0.20 | 0.24 | 0.29 | 0.35 | 0.40 |

| gradient [%]: 6 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 1.59 | 8.92 | 13.73 | 17.69 | 21.16 | 24.52 | 29.58 | 34.63 | 41.62 | 48.61 | 54.15 | 59.45 | 63.51 | 64.99 |
| Euro 1 | 0.63 | 4.67 | 8.14 | 10.38 | 11.92 | 13.31 | 17.43 | 21.55 | 25.92 | 30.29 | 33.12 | 36.18 | 38.62 | 39.66 |
| Euro 2 | 0.54 | 2.97 | 4.45 | 5.89 | 6.83 | 7.71 | 9.51 | 11.31 | 13.54 | 15.78 | 17.57 | 19.28 | 20.58 | 21.09 |
| Euro 3 | 0.10 | 1.41 | 2.41 | 2.96 | 3.70 | 4.24 | 5.28 | 6.31 | 7.91 | 9.51 | 10.29 | 11.18 | 11.87 | 12.13 |
| Euro 4 | 0.16 | 1.36 | 1.95 | 2.50 | 3.18 | 3.35 | 4.34 | 5.33 | 6.24 | 7.15 | 8.10 | 9.08 | 9.77 | 10.02 |
| Euro 5 | 0.02 | 0.05 | 0.05 | 0.06 | 0.08 | 0.08 | 0.09 | 0.11 | 0.18 | 0.25 | 0.32 | 0.39 | 0.42 | 0.43 |
| Euro 6 | 0.02 | 0.05 | 0.05 | 0.06 | 0.08 | 0.08 | 0.09 | 0.11 | 0.18 | 0.25 | 0.29 | 0.34 | 0.38 | 0.42 |

### *11.1.2.3. Heavy Goods Vehicles*

The emission rates for HGV are normalized to an average vehicle mass of 23 t.

*Table 44: HGV Diesel CO*

| gradient [%]: 0 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 76.91 | 81.12 | 85.98 | 98.57 | 106.25 | 112.49 | 118.73 | 124.97 | 124.97 | 124.97 |
| Euro 1 | 15.77 | 40.00 | 41.86 | 47.79 | 51.93 | 56.97 | 61.06 | 65.15 | 69.24 | 68.89 | 75.53 |
| Euro 2 | 12.67 | 29.75 | 31.17 | 39.26 | 39.53 | 43.56 | 51.14 | 58.71 | 66.29 | 66.98 | 75.39 |
| Euro 3 | 10.52 | 45.17 | 46.13 | 49.61 | 53.10 | 56.35 | 62.08 | 67.81 | 73.54 | 73.40 | 80.12 |
| Euro 4 | 1.92 | 34.97 | 37.31 | 38.76 | 45.23 | 50.09 | 62.26 | 74.43 | 86.61 | 86.79 | 88.45 |
| Euro 5 | 2.62 | 30.89 | 32.99 | 34.76 | 40.35 | 45.04 | 56.35 | 67.67 | 78.98 | 78.90 | 80.01 |
| Euro 6 | 0.81 | 4.45 | 4.80 | 5.28 | 5.75 | 5.87 | 6.61 | 7.35 | 8.09 | 10.58 | 13.08 |

| gradient [%]: -6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 48.68 | 43.87 | 39.06 | 29.00 | 22.09 | 17.26 | 17.10 | 17.10 | 17.10 | 17.10 |
| Euro 1 | 15.77 | 24.82 | 22.39 | 19.95 | 14.96 | 11.64 | 9.52 | 9.31 | 9.31 | 9.31 | 9.31 |
| Euro 2 | 12.67 | 17.84 | 16.34 | 14.84 | 11.25 | 9.16 | 8.45 | 8.45 | 8.45 | 8.45 | 8.45 |
| Euro 3 | 10.52 | 32.25 | 30.11 | 27.98 | 24.19 | 22.87 | 21.56 | 20.25 | 20.25 | 20.25 | 20.25 |
| Euro 4 | 1.92 | 16.64 | 14.30 | 11.96 | 5.87 | 2.46 | 1.96 | 2.34 | 2.34 | 2.34 | 2.34 |
| Euro 5 | 2.62 | 15.36 | 12.95 | 10.54 | 5.44 | 2.47 | 1.86 | 2.29 | 2.29 | 2.29 | 2.29 |
| Euro 6 | 0.81 | 2.13 | 1.30 | 1.30 | 0.79 | 0.37 | 0.25 | 0.34 | 0.34 | 0.34 | 0.34 |

| gradient [%]: -4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 57.43 | 48.47 | 44.02 | 39.58 | 31.70 | 31.53 | 31.35 | 31.35 | 31.35 | 31.35 |
| Euro 1 | 15.77 | 29.46 | 24.10 | 22.16 | 20.21 | 16.80 | 16.30 | 15.81 | 15.81 | 15.81 | 15.81 |
| Euro 2 | 12.67 | 21.46 | 17.34 | 16.07 | 14.80 | 13.08 | 12.73 | 12.38 | 12.38 | 12.38 | 12.38 |
| Euro 3 | 10.52 | 37.31 | 32.73 | 31.44 | 30.15 | 24.87 | 24.70 | 24.54 | 24.54 | 24.54 | 24.54 |
| Euro 4 | 1.92 | 20.95 | 16.83 | 13.72 | 10.62 | 6.04 | 6.08 | 6.13 | 6.13 | 6.13 | 6.13 |
| Euro 5 | 2.62 | 18.66 | 14.65 | 12.12 | 9.58 | 5.63 | 5.66 | 5.69 | 5.69 | 5.69 | 5.69 |
| Euro 6 | 0.81 | 2.75 | 2.04 | 1.97 | 1.54 | 0.93 | 0.88 | 0.83 | 0.83 | 0.83 | 0.83 |

| gradient [%]: -2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 67.64 | 64.07 | 67.18 | 67.20 | 67.20 | 77.11 | 87.02 | 96.93 | 102.58 | 103.63 |
| Euro 1 | 15.77 | 34.81 | 32.10 | 36.35 | 33.34 | 32.29 | 36.82 | 38.63 | 45.87 | 47.73 | 47.73 |
| Euro 2 | 12.67 | 25.35 | 23.02 | 28.17 | 24.14 | 23.59 | 26.56 | 29.53 | 32.46 | 34.37 | 34.37 |
| Euro 3 | 10.52 | 42.40 | 40.97 | 45.76 | 44.51 | 45.00 | 46.70 | 48.41 | 53.73 | 56.04 | 56.04 |
| Euro 4 | 1.92 | 27.13 | 24.61 | 25.01 | 22.24 | 21.03 | 24.07 | 27.11 | 31.86 | 34.52 | 34.52 |
| Euro 5 | 2.62 | 23.88 | 21.54 | 22.20 | 19.81 | 18.47 | 21.27 | 24.07 | 27.77 | 29.81 | 29.81 |
| Euro 6 | 0.81 | 3.56 | 3.19 | 3.15 | 3.10 | 2.84 | 2.85 | 2.86 | 3.16 | 3.76 | 3.76 |

| gradient [%]: 2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 83.16 | 89.12 | 97.40 | 111.02 | 120.06 | 138.55 | 157.04 | 175.53 | 177.26 | 179.00 |
| Euro 1 | 15.77 | 43.35 | 46.41 | 55.20 | 57.82 | 63.22 | 74.53 | 85.85 | 97.17 | 111.46 | 125.75 |
| Euro 2 | 12.67 | 33.99 | 37.26 | 49.48 | 53.12 | 60.91 | 73.96 | 87.01 | 100.06 | 100.83 | 101.59 |
| Euro 3 | 10.52 | 46.65 | 45.78 | 52.68 | 59.58 | 66.11 | 75.57 | 85.03 | 94.49 | 93.66 | 92.83 |
| Euro 4 | 1.92 | 42.35 | 46.69 | 55.16 | 71.08 | 83.45 | 105.60 | 127.75 | 149.89 | 153.22 | 156.55 |
| Euro 5 | 2.62 | 37.53 | 41.64 | 49.98 | 64.67 | 77.21 | 98.99 | 120.77 | 142.54 | 148.33 | 154.12 |
| Euro 6 | 0.81 | 5.02 | 5.49 | 5.40 | 5.85 | 6.29 | 6.74 | 6.74 | 7.39 | 7.75 | 8.11 |

| gradient [%]: 4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 89.28 | 94.42 | 106.99 | 127.24 | 138.32 | 165.27 | 192.22 | 242.30 | 261.63 | 267.54 |
| Euro 1 | 15.77 | 46.78 | 49.65 | 62.31 | 70.04 | 78.86 | 94.91 | 110.95 | 132.08 | 160.41 | 188.75 |
| Euro 2 | 12.67 | 38.62 | 42.69 | 58.06 | 66.65 | 79.65 | 87.33 | 95.01 | 106.30 | 114.05 | 121.80 |
| Euro 3 | 10.52 | 49.00 | 48.30 | 65.72 | 67.53 | 76.20 | 83.17 | 90.14 | 99.95 | 108.86 | 117.77 |
| Euro 4 | 1.92 | 51.06 | 57.66 | 70.95 | 97.31 | 116.47 | 128.48 | 140.48 | 160.21 | 170.66 | 181.11 |
| Euro 5 | 2.62 | 45.47 | 51.42 | 64.37 | 88.37 | 106.77 | 115.46 | 124.15 | 140.59 | 150.33 | 160.06 |
| Euro 6 | 0.81 | 5.55 | 5.81 | 5.67 | 6.42 | 7.16 | 7.90 | 8.65 | 9.39 | 10.13 | 10.88 |

| gradient [%]: 6 |
|---|

| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 26.75 | 95.24 | 102.63 | 122.02 | 151.43 | 172.61 | 210.14 | 247.67 | 290.06 | 301.11 | 303.60 |
| Euro 1 | 15.77 | 51.00 | 54.84 | 71.96 | 86.63 | 104.47 | 122.94 | 141.40 | 162.33 | 183.26 | 204.19 |
| Euro 2 | 12.67 | 43.62 | 48.60 | 63.84 | 76.28 | 91.32 | 94.87 | 98.43 | 109.88 | 121.33 | 132.78 |
| Euro 3 | 10.52 | 50.45 | 51.46 | 68.60 | 73.59 | 85.04 | 89.72 | 94.40 | 108.32 | 122.25 | 136.17 |
| Euro 4 | 1.92 | 59.30 | 69.26 | 82.73 | 115.00 | 135.19 | 139.49 | 143.78 | 164.10 | 184.41 | 204.73 |
| Euro 5 | 2.62 | 52.40 | 61.62 | 73.45 | 102.20 | 121.74 | 123.51 | 125.27 | 130.12 | 134.97 | 139.83 |
| Euro 6 | 0.81 | 5.92 | 6.02 | 5.84 | 6.42 | 7.01 | 7.69 | 8.38 | 9.42 | 11.84 | 14.27 |

*Table 45: HGV Diesel $NO_X$*

| gradient [%]: 0 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 184.91 | 199.47 | 221.12 | 289.27 | 323.77 | 436.54 | 549.32 | 662.09 | 704.20 | 754.62 |
| Euro 1 | 32.60 | 129.19 | 139.65 | 152.18 | 196.71 | 217.45 | 307.06 | 396.67 | 486.28 | 524.77 | 558.21 |
| Euro 2 | 40.58 | 152.82 | 164.58 | 179.31 | 232.96 | 259.07 | 358.71 | 458.34 | 557.98 | 598.32 | 628.93 |
| Euro 3 | 42.08 | 141.68 | 149.55 | 167.47 | 196.11 | 219.30 | 292.72 | 366.13 | 439.55 | 439.58 | 450.11 |
| Euro 4 | 7.51 | 147.83 | 157.06 | 172.43 | 198.39 | 210.30 | 211.42 | 212.53 | 213.65 | 207.79 | 211.77 |
| Euro 5 | 11.71 | 133.33 | 140.22 | 148.38 | 163.43 | 170.03 | 162.79 | 155.55 | 148.31 | 142.88 | 143.88 |
| Euro 6 | 1.75 | 27.93 | 23.57 | 19.21 | 18.95 | 18.44 | 17.17 | 15.89 | 14.62 | 15.38 | 16.89 |

| gradient [%]: -6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 80.72 | 59.46 | 50.28 | 41.10 | 36.87 | 32.65 | 28.42 | 28.42 | 28.42 | 28.42 |
| Euro 1 | 32.60 | 60.37 | 47.11 | 40.27 | 33.43 | 30.03 | 26.64 | 23.24 | 23.24 | 23.24 | 23.24 |
| Euro 2 | 40.58 | 69.63 | 54.60 | 47.10 | 39.59 | 35.74 | 31.88 | 28.03 | 28.03 | 28.03 | 28.03 |
| Euro 3 | 42.08 | 69.92 | 55.13 | 45.69 | 36.26 | 33.27 | 30.28 | 27.28 | 27.28 | 27.28 | 27.28 |
| Euro 4 | 7.51 | 57.84 | 41.51 | 31.02 | 20.53 | 16.63 | 12.74 | 8.84 | 8.84 | 8.84 | 8.84 |
| Euro 5 | 11.71 | 58.20 | 42.32 | 31.81 | 21.29 | 17.51 | 13.72 | 9.94 | 9.94 | 9.94 | 9.94 |
| Euro 6 | 1.75 | 45.61 | 35.39 | 28.34 | 21.29 | 17.27 | 13.26 | 9.24 | 9.24 | 9.24 | 9.24 |

| gradient [%]: -4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 104.02 | 82.92 | 75.09 | 67.27 | 55.64 | 44.01 | 38.17 | 38.17 | 38.17 | 38.17 |
| Euro 1 | 32.60 | 75.51 | 62.34 | 56.43 | 50.52 | 41.79 | 33.07 | 29.65 | 29.65 | 29.65 | 29.65 |
| Euro 2 | 40.58 | 87.38 | 72.52 | 66.10 | 59.69 | 49.93 | 40.16 | 35.74 | 35.74 | 35.74 | 35.74 |
| Euro 3 | 42.08 | 86.49 | 72.01 | 63.31 | 54.60 | 45.27 | 35.95 | 35.95 | 35.95 | 35.95 | 35.95 |
| Euro 4 | 7.51 | 76.98 | 59.79 | 50.53 | 41.27 | 32.97 | 24.67 | 13.83 | 13.83 | 13.83 | 13.83 |
| Euro 5 | 11.71 | 74.81 | 58.32 | 49.12 | 39.93 | 31.86 | 23.78 | 14.33 | 14.33 | 14.33 | 14.33 |
| Euro 6 | 1.75 | 50.87 | 46.98 | 42.22 | 37.45 | 28.97 | 20.48 | 11.26 | 11.26 | 11.26 | 11.26 |

| gradient [%]: -2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 138.89 | 136.11 | 133.34 | 135.48 | 127.35 | 129.46 | 166.10 | 166.10 | 166.10 | 166.10 |
| Euro 1 | 32.60 | 98.40 | 95.61 | 92.82 | 95.92 | 89.17 | 88.15 | 97.21 | 97.21 | 97.21 | 97.21 |
| Euro 2 | 40.58 | 115.13 | 112.22 | 109.30 | 112.34 | 104.19 | 102.45 | 102.68 | 102.68 | 102.68 | 102.68 |
| Euro 3 | 42.08 | 110.31 | 108.76 | 107.20 | 97.34 | 90.38 | 86.52 | 90.52 | 90.52 | 90.52 | 90.52 |
| Euro 4 | 7.51 | 107.01 | 106.26 | 105.52 | 93.65 | 86.19 | 85.28 | 74.50 | 74.50 | 74.50 | 74.50 |
| Euro 5 | 11.71 | 101.57 | 100.06 | 98.54 | 87.04 | 79.22 | 77.53 | 64.94 | 64.94 | 64.94 | 64.94 |
| Euro 6 | 1.75 | 45.30 | 45.01 | 44.71 | 42.46 | 40.20 | 37.94 | 34.43 | 34.43 | 34.43 | 34.43 |

| gradient [%]: 2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 236.22 | 279.07 | 330.16 | 464.23 | 540.28 | 786.48 | 1032.68 | 1278.88 | 1331.88 | 1391.00 |
| Euro 1 | 32.60 | 165.33 | 195.72 | 231.20 | 327.52 | 381.79 | 584.25 | 786.71 | 989.17 | 1033.96 | 1068.58 |
| Euro 2 | 40.58 | 196.15 | 231.02 | 270.46 | 382.36 | 446.82 | 675.29 | 903.76 | 1132.24 | 1180.53 | 1221.76 |
| Euro 3 | 42.08 | 176.83 | 201.37 | 242.09 | 316.08 | 369.02 | 541.75 | 714.49 | 887.22 | 905.25 | 925.83 |
| Euro 4 | 7.51 | 175.81 | 187.79 | 187.41 | 197.36 | 204.70 | 292.41 | 380.12 | 467.83 | 478.34 | 490.97 |
| Euro 5 | 11.71 | 147.80 | 151.96 | 141.97 | 141.01 | 140.82 | 189.27 | 237.73 | 286.18 | 292.75 | 302.77 |
| Euro 6 | 1.75 | 15.26 | 13.90 | 15.59 | 17.27 | 18.96 | 20.64 | 22.33 | 24.01 | 24.60 | 26.54 |

| gradient [%]: 4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 294.63 | 361.28 | 452.06 | 657.39 | 782.91 | 1095.58 | 1408.24 | 1720.91 | 1755.41 | 1797.04 |
| Euro 1 | 32.60 | 207.37 | 257.40 | 320.29 | 467.27 | 560.05 | 833.54 | 1107.02 | 1380.51 | 1410.15 | 1436.63 |
| Euro 2 | 40.58 | 244.62 | 300.54 | 367.67 | 532.00 | 635.63 | 942.34 | 1249.06 | 1555.77 | 1584.99 | 1615.66 |
| Euro 3 | 42.08 | 217.14 | 256.76 | 320.61 | 438.38 | 518.88 | 766.12 | 1013.37 | 1260.61 | 1307.04 | 1329.02 |
| Euro 4 | 7.51 | 186.56 | 186.96 | 186.59 | 221.50 | 254.61 | 392.52 | 530.42 | 668.33 | 682.83 | 685.88 |
| Euro 5 | 11.71 | 147.80 | 141.89 | 129.92 | 143.58 | 160.99 | 244.46 | 327.94 | 411.42 | 419.74 | 433.46 |
| Euro 6 | 1.75 | 11.03 | 10.42 | 9.84 | 11.72 | 19.68 | 27.65 | 35.61 | 43.58 | 46.83 | 47.19 |

| gradient [%]: 6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 40.56 | 357.45 | 449.13 | 576.89 | 839.35 | 1021.53 | 1333.56 | 1645.59 | 1957.62 | 1972.03 | 1985.99 |
| Euro 1 | 32.60 | 251.81 | 321.72 | 409.13 | 598.93 | 729.74 | 1025.36 | 1320.98 | 1616.60 | 1628.43 | 1640.18 |
| Euro 2 | 40.58 | 294.65 | 370.73 | 461.17 | 668.72 | 808.58 | 1140.26 | 1471.95 | 1803.63 | 1821.45 | 1819.82 |
| Euro 3 | 42.08 | 258.84 | 314.63 | 397.51 | 552.49 | 662.91 | 948.75 | 1234.59 | 1520.43 | 1528.78 | 1546.77 |
| Euro 4 | 7.51 | 184.95 | 188.13 | 205.39 | 278.48 | 344.11 | 489.20 | 634.28 | 779.37 | 785.14 | 788.72 |
| Euro 5 | 11.71 | 142.38 | 133.01 | 133.67 | 171.34 | 205.11 | 303.52 | 401.93 | 500.34 | 503.95 | 505.90 |
| Euro 6 | 1.75 | 10.11 | 9.89 | 10.02 | 14.10 | 18.60 | 27.19 | 35.77 | 44.35 | 43.98 | 44.47 |

*Table 46: HGV Diesel PM*

| gradient [%]: 0 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 11.44 | 11.84 | 12.35 | 14.28 | 15.34 | 16.16 | 16.99 | 18.83 | 20.68 | 21.10 |
| Euro 1 | 5.53 | 8.03 | 8.28 | 8.52 | 9.47 | 9.81 | 10.20 | 10.59 | 12.58 | 14.58 | 15.20 |
| Euro 2 | 1.43 | 2.84 | 2.87 | 3.82 | 4.04 | 4.39 | 5.20 | 6.00 | 7.87 | 9.74 | 10.25 |
| Euro 3 | 1.29 | 4.49 | 4.69 | 4.57 | 5.63 | 5.75 | 6.03 | 6.31 | 7.93 | 9.55 | 10.04 |
| Euro 4 | 0.20 | 0.95 | 0.92 | 1.03 | 1.25 | 1.42 | 1.63 | 1.85 | 2.27 | 2.69 | 2.74 |
| Euro 5 | 0.10 | 1.03 | 1.01 | 1.08 | 1.32 | 1.49 | 1.69 | 1.88 | 2.34 | 2.79 | 2.89 |
| Euro 6 | 0.01 | 0.13 | 0.14 | 0.14 | 0.16 | 0.17 | 0.18 | 0.19 | 0.24 | 0.28 | 0.30 |

| gradient [%]: -6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 7.90 | 6.70 | 6.13 | 5.56 | 4.99 | 4.88 | 4.78 | 5.78 | 6.22 | 6.87 |
| Euro 1 | 5.53 | 6.33 | 5.56 | 5.38 | 4.79 | 4.20 | 4.18 | 4.16 | 4.17 | 4.17 | 4.18 |
| Euro 2 | 1.43 | 1.91 | 1.74 | 1.81 | 1.90 | 1.99 | 2.01 | 2.03 | 2.34 | 2.38 | 2.41 |
| Euro 3 | 1.29 | 3.82 | 3.73 | 3.60 | 3.78 | 3.95 | 3.96 | 3.98 | 4.32 | 4.66 | 5.01 |
| Euro 4 | 0.20 | 0.52 | 0.34 | 0.33 | 0.27 | 0.22 | 0.20 | 0.19 | 0.18 | 0.18 | 0.19 |
| Euro 5 | 0.10 | 0.53 | 0.33 | 0.30 | 0.22 | 0.15 | 0.13 | 0.12 | 0.09 | 0.10 | 0.11 |
| Euro 6 | 0.01 | 0.06 | 0.05 | 0.05 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| gradient [%]: -4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 8.93 | 7.86 | 7.38 | 6.90 | 6.90 | 6.90 | 6.90 | 6.94 | 7.45 | 8.38 |
| Euro 1 | 5.53 | 7.01 | 6.37 | 6.14 | 5.82 | 4.88 | 4.95 | 5.01 | 5.30 | 5.42 | 5.13 |
| Euro 2 | 1.43 | 2.14 | 1.89 | 2.13 | 2.13 | 2.22 | 2.33 | 2.44 | 2.38 | 2.40 | 2.45 |
| Euro 3 | 1.29 | 4.09 | 4.07 | 3.80 | 3.99 | 4.17 | 4.22 | 4.28 | 4.59 | 4.90 | 5.21 |
| Euro 4 | 0.20 | 0.60 | 0.42 | 0.44 | 0.38 | 0.30 | 0.26 | 0.32 | 0.20 | 0.20 | 0.20 |
| Euro 5 | 0.10 | 0.63 | 0.43 | 0.42 | 0.35 | 0.25 | 0.20 | 0.26 | 0.11 | 0.11 | 0.12 |
| Euro 6 | 0.01 | 0.08 | 0.07 | 0.07 | 0.04 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |

| gradient [%]: -2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 10.19 | 9.70 | 9.96 | 10.22 | 10.04 | 10.74 | 11.43 | 14.15 | 14.52 | 15.52 |
| Euro 1 | 5.53 | 7.67 | 7.64 | 7.94 | 8.23 | 8.28 | 8.37 | 8.45 | 10.29 | 10.19 | 10.09 |
| Euro 2 | 1.43 | 2.41 | 2.23 | 2.73 | 2.71 | 2.77 | 3.03 | 3.28 | 3.84 | 3.16 | 3.35 |
| Euro 3 | 1.29 | 4.38 | 4.58 | 5.03 | 5.48 | 5.67 | 5.64 | 5.62 | 6.62 | 6.95 | 6.83 |
| Euro 4 | 0.20 | 0.74 | 0.61 | 0.65 | 0.63 | 0.60 | 0.67 | 0.74 | 0.50 | 0.46 | 0.50 |
| Euro 5 | 0.10 | 0.80 | 0.65 | 0.67 | 0.65 | 0.61 | 0.67 | 0.74 | 0.43 | 0.39 | 0.45 |
| Euro 6 | 0.01 | 0.10 | 0.10 | 0.09 | 0.08 | 0.07 | 0.08 | 0.09 | 0.04 | 0.04 | 0.04 |

| gradient [%]: 2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 12.49 | 13.21 | 14.34 | 17.03 | 18.81 | 22.02 | 25.22 | 28.43 | 31.64 | 33.30 |
| Euro 1 | 5.53 | 8.21 | 8.28 | 9.60 | 10.97 | 11.88 | 15.68 | 19.48 | 23.27 | 27.07 | 28.76 |
| Euro 2 | 1.43 | 3.40 | 3.79 | 5.18 | 6.11 | 7.18 | 9.16 | 11.14 | 13.13 | 15.11 | 15.25 |
| Euro 3 | 1.29 | 4.60 | 4.66 | 5.16 | 6.56 | 7.20 | 8.65 | 10.11 | 11.56 | 13.01 | 13.48 |
| Euro 4 | 0.20 | 1.17 | 1.25 | 1.47 | 1.99 | 2.37 | 2.71 | 3.05 | 3.39 | 3.73 | 4.07 |
| Euro 5 | 0.10 | 1.27 | 1.33 | 1.52 | 2.05 | 2.42 | 2.88 | 3.33 | 3.78 | 4.23 | 4.68 |
| Euro 6 | 0.01 | 0.15 | 0.16 | 0.17 | 0.20 | 0.23 | 0.25 | 0.27 | 0.41 | 0.42 | 0.43 |

| gradient [%]: 4 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 13.61 | 14.48 | 16.33 | 20.29 | 22.52 | 29.82 | 37.11 | 44.41 | 46.00 | 47.76 |
| Euro 1 | 5.53 | 8.71 | 9.04 | 10.95 | 13.44 | 15.02 | 23.17 | 31.31 | 39.46 | 40.17 | 41.51 |
| Euro 2 | 1.43 | 3.96 | 4.70 | 6.39 | 7.98 | 9.68 | 12.74 | 15.80 | 18.86 | 19.24 | 19.55 |
| Euro 3 | 1.29 | 4.80 | 5.12 | 5.71 | 7.56 | 8.45 | 11.67 | 14.89 | 18.11 | 17.93 | 18.40 |
| Euro 4 | 0.20 | 1.39 | 1.55 | 1.86 | 2.58 | 3.10 | 3.46 | 3.82 | 4.18 | 4.35 | 4.34 |
| Euro 5 | 0.10 | 1.50 | 1.63 | 1.91 | 2.64 | 3.15 | 3.69 | 4.24 | 4.78 | 4.91 | 5.11 |
| Euro 6 | 0.01 | 0.18 | 0.18 | 0.20 | 0.25 | 0.27 | 0.35 | 0.43 | 0.52 | 0.53 | 0.53 |

| gradient [%]: 6 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| v [km/h] | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| standard | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h | g/h |
| Pre Euro | 6.62 | 14.76 | 16.09 | 18.83 | 24.26 | 27.76 | 36.11 | 44.47 | 52.83 | 53.57 | 54.47 |
| Euro 1 | 5.53 | 9.10 | 10.11 | 12.82 | 16.48 | 19.36 | 29.09 | 38.82 | 48.56 | 48.86 | 49.22 |
| Euro 2 | 1.43 | 4.62 | 5.60 | 7.31 | 9.50 | 11.49 | 15.05 | 18.61 | 22.17 | 22.24 | 22.57 |
| Euro 3 | 1.29 | 4.92 | 5.61 | 6.35 | 8.59 | 9.88 | 14.14 | 18.41 | 22.67 | 23.06 | 22.96 |
| Euro 4 | 0.20 | 1.59 | 1.82 | 2.10 | 2.93 | 3.44 | 3.72 | 4.00 | 4.28 | 4.29 | 4.30 |
| Euro 5 | 0.10 | 1.70 | 1.90 | 2.18 | 3.02 | 3.56 | 4.06 | 4.55 | 5.05 | 5.04 | 5.06 |
| Euro 6 | 0.01 | 0.19 | 0.20 | 0.23 | 0.28 | 0.32 | 0.43 | 0.54 | 0.64 | 0.65 | 0.65 |

### 11.1.3. Influence of degradation of exhaust gas After treatment systems

The emission rates for the single vehicle categories and emission standard classes given in this section are valid for vehicles on the road in good operating condition. Since exhaust gas after-treatment systems degrade with vehicle age, the tailpipe emissions tend to rise.

The former emission rate report [1] included factors for engine degradation. This is not appropriate for the current data, as the detailed emission data sets are based on the year 2018, where either the degradation of old engine technology is already at its maximum (Euro 0 to Euro 4) or no statistically valid information about engine degradation is currently available (Euro 5 and 6).

## 11.2. Influence of Cold Start

Vehicles operating in road tunnels normally operate under hot stabilized engine conditions. The emission rates given in this report describes the emission behaviour under these operating conditions. However, for certain installations, it might be necessary to consider the emission behaviour of vehicles under cold-start conditions. Cold-start emissions significantly exceed the emission quantities for hot stabilized conditions. Various emission databases like “emission rate handbook” [8] or Moves [9] provide factors on additional emissions to take cold start into account.

## 11.3. EXAMPLE CALCULATION

### 11.3.1. Introduction

The fresh-air demand calculation method is demonstrated for simplified conditions – a single-lane tunnel with constant road gradient and a fleet comprising gasoline and diesel passenger cars and HGV.

### 11.3.2. Input data

#### *11.3.2.1. Tunnel*

A single, one-lane bore of a unidirectional rural tunnel is considered, as summarised in Table 47.

*Table 47: geometric tunnel parameters*

| Length [km] | Gradient [%] | Altitude [m] |
|---|---|---|
| 10 | +4 | 1000 |

#### *11.3.2.2. Fleet and traffic conditions*

A fleet corresponding to technology class A is assumed (see Table 7). Three vehicle categories exist in this example – gasoline and diesel passenger cars and heavy goods vehicles. The proportion of each vehicle category is presented in Table 48. The traffic flux is 1000 veh/h and the speed is 60 km/h. The average mass of HGV is 25 t.

*Table 48: Traffic conditions*

| $q$ [veh/h] | Speed [km/h] | $a_{HGV}$ | $a_{PC\ gas}$ | $a_{PC\ diesel}$ | m HGV [t] |
|---|---|---|---|---|---|
| 1000 | 60 | 0.1 | 0.54 | 0.36 | 25 |

**Example for conversion of number of vehicles to PCU:**

1000 vehicles ($n_{\mathrm{veh}} = 1000$), 10% of which are HGV ($a_{\mathrm{HGV}} = 0.1$), moving at 60 km/h ($f_{\mathrm{HGV}} = 2$) is equivalent to 1100 PCUs ($n_{\mathrm{PCU}} = 1100$).

### 11.3.3. Calculation

#### *11.3.3.1. Time-mean number of vehicles*

Equation 8 and Equation 9 are used to calculate the time-mean number of vehicles in the tunnel.

*Table 49: number of vehicles in the tunnel*

| $n_{PC\ gas}$ | $n_{PC\ diesel}$ | $n_{HGV}$ |
|---|---|---|
| 90 | 60 | 16.7 |

#### *11.3.3.2. Emissions rates*

Base emissions rates, modification factors and factored emissions rates (Equation 7) for each vehicle category are presented for the assumed design year of 2025 in Table 50 below. Note that for calculations involving particulate matter (PM), the non-exhaust emissions should be included here.

*Table 50: CO Base emission rates and factored emission rates*

| | PC gasoline | | PC diesel | | HGV | |
|---|---|---|---|---|---|---|
| **g_base** [g/h-veh] | 37.8 | Table 8 | 3.1 | Table 11 | 62.3 | Table 24 |
| Altitude factor, f_h | 1.0 | Table 15 | 1.0 | Table 15 | 1.0 | Ch. 6.3.3 |
| Time factor, f_t | 0.78 | Table 14 | 0.80 | Table 14 | 0.76 | Table 28 |
| Mass factor, f_m | - | - | - | - | 1.044 | Table 27 |
| **g_fac** [g/h-veh] | 29.48 | | 2.48 | | 49.45 | |

As this example consists of one section only, the section emissions rate $G_{sec}$ equals the total emissions rate in the tunnel $G_{tun}$.

*Table 51: Total co emission rate per vehicle type in the tunnel*

| **Vehicle category** | **$G_{tun}$ [g/h]** |
|---|---|
| PC gasoline | 2654 |
| PC diesel | 149 |
| HGV | 824 |
| Total | 3627 |

### *11.3.3.3. Fresh-Air Demand*

Pollutant concentration can be converted from ppm to g/m³ through multiplication by the pollutant density. For this example, an admissible concentration of CO of 70 ppm and an approximate density of $\rho_{CO} \approx 1.2$ kg/m³ is assumed.

$$C\left[\frac{\mathrm{g}}{\mathrm{m}^3}\right] = \frac{C[\mathrm{ppm}] \cdot \rho}{1000}$$

*Table 52: admissible CO concentration*

| | | |
|---|---|---|
| $C_{adm}$ | 70 ppm CO | 0.084 g CO/m³ |

In this example, ambient concentrations for CO and $NO_X$ as well as the extinction value for visibility are neglected.

Using Equation 1, the fresh-air demand for CO is calculated as:

$$\dot{Q}_{\mathrm{CO}} = \frac{3627}{0.084 - 0} = 43179\ \frac{\mathrm{m}^3}{\mathrm{h}} = 12\frac{\mathrm{m}^3}{\mathrm{s}}$$

The corresponding fresh-air demand for nitrogen dioxide $NO_2$ with an assumed average oxidation rate of 20 % and a design value of 1 ppm is:

$$\dot{Q}_{\mathrm{NO2}} = \frac{3441 \cdot 0.2}{0.002 - 0} = 344100\ \frac{\mathrm{m}^3}{\mathrm{h}} = 96\frac{\mathrm{m}^3}{\mathrm{s}}$$

Finally, the fresh-air demand to meet an opacity design value of $K = 0.005$ m$^{-1}$ is:

$$\dot{Q}_{\mathrm{OP}} = \frac{1590}{0.005 \cdot 3600} = 88\frac{\mathrm{m}^3}{\mathrm{s}}$$

The design value for the required volume flow is $96\frac{\mathrm{m}^3}{\mathrm{s}}$

## 11.4. $NO_2$ MEASUREMENT TECHNIQUES FOR TUNNELS

Generally speaking, several types of sensors exist to measure $NO_2$ concentrations but none of them provides a perfect solution. Sensors such as the ones utilised in industry or ambient monitoring – Differential Optical Absorption Spectroscopy (DOAS), Chemiluminescence, Cavity Attenuated Phase Shift (CAPS) – are able to measure the levels of $NO_2$ encountered in tunnels (from 0.1 ppm and above), but cannot reasonably be installed in tunnels due to their expensive cost or to the extremely high maintenance that is required to ensure their reliability. There are two types of sensors that can be installed in tunnels: firstly the electrochemical cells and secondly sensors based on optical measurements (absorption of $NO_2$ with a monochromatic blue LED as the light source or Differential Optical Absorption Spectroscopy – DOAS). The optical sensors have a minimum detectable concentration, a measurement range and an accuracy that fit very well with road tunnel atmospheres. Moreover, these sensors have an auto-calibration procedure and their maintenance is limited to an annual intervention, which is a crucial advantage for road tunnel operators. Thus, in tunnels where $NO_2$ is a criterion for the activation of ventilation, the use of optical sensors is the best option, but due to their high price, it can be stated that their use will be restricted to cases with a lot at stake concerning air quality (long tunnels, high levels of traffic, risk of congestion, etc.). In the other cases, electrochemical sensors can be used. If their technical characteristics are clearly lower than those of optical sensors, recent improvements of this technology now allow a satisfactory monitoring of $NO_2$ levels in tunnels for a low cost of investment. But in return a very regular maintenance must be provided to ensure the quality of the measurement. More information can be found in the information document provided by CETU [15]. In France, where there is a threshold value concerning $NO_2$, a dozen tunnels are equipped with optical sensors. The results are good, even if it is still early to draw conclusions because these installations are recent. On the other hand, $NO_2$ electrochemical sensors are installed in dozens of tunnels, with various results, heavily dependent on the level of maintenance provided.

The European Committee for Electrotechnical Standardisation (CENELEC) launched working group CLC/TC/TC216/WG5 in 2018, to write a new standard EN 50545-2. The proposed new standard will define “general performance requirements and test methods for gaseous and airborne pollution measurements in tunnels”.




*World Road Association (PIARC)*

*La Grande Arche, Paroi Sud, 5e étage, F-92055 La Défense cedex*

*ISBN 978-2-84060-500-3*

*Front cover © Peter Sturm*