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TNO report

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NH3 emission factors for road transport

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Summary

In this report a first set of NH_3 road transport emission factors is derived for all current 333 SRM[1] and CBS vehicle categories and all road and congestion types for the Netherlands, which can be included in the Dutch annual emission factor update for the Netherlands Pollutant Release and Transfer Register (PRTR).

So far the NH_3 emission factors have been available for the determination of nitrogen immissions, for example used in AERIUS, for Natura2000, nature preservation areas. Current emission factors establish the status quo. However, it is very likely that the focus on reducing NO_x emissions for diesel vehicles increases the risk of high NH_3 emissions. In particular, high SCR conversion rates and hot after-treatment systems may yield NH_3 slip.

Moreover, NH_3 is also associated with the aging of catalysts. Earlier emission measurements on Euro 1 and Euro 2 vehicles show lower values than more recent measurements. Both values are correct and consistent with the aging of catalyst. There is limited data available, therefore a simple aging formula is assumed.

To establish a first set of NH_3 road transport emission factors, NH_3 road transport emission data from various sources such as COPERT, the Dutch Emission Testing Programme and recent emission literature was used. As expected, the main sources of road transport emitted NH_3 appear to be passenger cars with three-way catalytic converter and SCR equipped heavy duty vehicles. On the basis of the available data it was decided to use the COPERT data as a basis and to extend it with more recently measured data for the aforementioned two main NH_3 emitting vehicle classes. Thus, NH_3 road transport emission factors were generated for all current 333 vehicles classes and all Dutch road and congestion types.

[1] The abbreviation SRM refers to the so-called ‘Standaard Rekenmethoden’ 1 and 2 which are Dutch standard methods to perform emission and air-quality calculations for certain road types.

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1 Introduction

Currently ammonia (NH_3) emission factors of vehicles are not included in the annual update of road transport emission factors by TNO.

From an earlier study on NH_3 emissions on Dutch motorways (see Ref. [12]), NH_3 road transport emission factors for a limited set of vehicle categories and limited to the SRM 2 motorway road types are known.

Goal of this short study was to provide a first set of NH_3 road transport emission factors for all vehicle categories and all SRM road types, which can be included in the annual emission factor update for the Netherlands Pollutant Release and Transfer Register (PRTR).

Such NH_3 road transport emission factors are of high importance for nitrogen emission and deposition studies and will be used in AERIUS, the nitrogen emission software tool of the Dutch Integrated Approach to Nitrogen.

Euro 6 and Euro VI vehicles are often equipped with SCR technology, which requires the injection of urea in the tail pipe. The slip of NH3, from the catalyst, meant to convert NH3 and NO_x to water and nitrogen, is a real risk for a further increase in NH_3 emission with the new vehicle technology entering the market. In particular high conversion rates and hot after-treatment systems may cause NH_3 slip.

To establish a first complete set of NH_3 road transport emission factors the following sources were used:

- Known NH_3 emission factors.
- Data from emission measurement programmes.
- Data from short literature survey.

2 NH_3 emission factor sources

2.1 Known NH_3 emission factors

The NH_3 emission factors from an earlier study on NH_3 emissions on Dutch motorways were based on the emission model COPERT (see Ref. [1]), together with expert opinion estimates to account for the various motorway types of SRM 2 (Standaard Rekenmethode 2) for which COPERT makes no distinctions. Furthermore, this set contains only 71 of the current (spring 2014) 333 vehicle types which TNO uses for the annual emission factor update.

As previously, it was decided to use COPERT again as a basis and to extend and update it with data from other sources. The previous limited set was used for checking.

2.2 Data from emission measurement programmes

NH_3 emissions are not regularly measured in the current national emission measurement programmes (for LD and HD), which TNO conducts for the Ministry of Infrastructure and Environment. Hence, the available data on NH_3 emission measurements is rather limited and a bit scattered and requires some interpretation.

Nevertheless, useful information on NH_3-slip from SCR equipped HD vehicles from a TNO report (see Ref. [15]) on the HD emissions programme is cited in paragraph 2.4.

2.3 Data from literature survey

A short literature survey into NH_3 emission measurements was performed via Science Direct (http://www.sciencedirect.com/) and resulted in a large number of interesting publications. From these the most relevant for further study were selected and have been listed in the Reference section of this report.

The most important publication is a recent study by Carslaw and Rhys-Tyler (see Ref. [2]), in which (a.o.) NH_3 emission factors of about 20 LD and 20 HD vehicle types have been measured in 2012 in London UK with remote emission sensing. As the emissions were measured in the exhaust plumes of the vehicles while passing by an extended[2] remote emission sensing instrument, these are emission measurements under real world driving conditions.

The NH_3 emission data from the other relevant publications - i.e. Heeb (Ref. [3-5]), Sjödin and Jerksjö (Ref. [6]), Yao (Ref. [7]) and others (Ref. [8-12]) – were, in terms of magnitude, in good agreement with the more comprehensive data in Carslaw and Rhys-Tyler (Ref. [2]).

[2] The in Ref. [2] used extended remote emission sensing instrument measured, apart from the usually by such an instrument measured emissions HC, CO, CO_2 and NO, also NO_2 and NH_3. Hence, it can be considered as a far more comprehensive vehicle exhaust emission measurement system giving a realistic picture of real world vehicle emissions.

It was therefore decided to extend and update the COPERT NH_3 emission factor data with the data published by Carslaw and Rhys-Tyler (Ref. [2]).

In the next chapter it is explained how this was done.

2.4 NH_3 emission factor estimations for SCRs

As a check for the measured NH_3 emission factors published by Carslaw and Rhys-Tyler (Ref. [2]) for HD vehicles equipped with an SCR NO_x abatement system, two theoretical estimations are given in the following.

After that, information on NH_3-slip from SCR equipped HD vehicles from a TNO report is cited as it is considered to give a fair order of magnitude estimate for this NH_3 emission source.

NH_3 emission factor estimate based on SCR urea-additive usage

The first estimation is based on the typical urea usage of SCR systems, which is known to lie in the range of 2 to 6 % in terms of the volume of urea-additive (AdBlue) used with respect to the volume of diesel fuel used. In Stelwagen and Ligterink [13] it is shown that the CO_2 emission, E_{UA}, from urea-additive can be expressed as:

$$E_{UA} = (\rho_{UA} / \rho_D) \bullet VF_{UA} \bullet M_D \bullet MF_U \bullet (44/60) \quad (1)$$

$\rho_{UA} = 1090$ kg/m^3 $\rho_D = 832$ kg/m^3

$VF_{UA} = 0.02 - 0.06$ m^3/m^3 $MF_U = 0.325$ kg/kg

Where M_D is the mass of diesel fuel used.

During combustion urea ($CO(NH_2)_2$) is converted into ammonia (NH_3) which reduces the nitric oxides (NO_x) to nitrogen (N_2) and water (H_2O). See for example Heeb et al. 2011 (Ref. [5]) for an overview of the involved reactions. However, a small amount of the formed NH_3 does not react with NO_x but escapes as NH_3 emissions in the exhaust. Hence, a small fraction, i.e. F_{UA}, of urea-additive is not used but emitted as NH_3. As each unused urea molecule leads to two emitted NH_3 molecules, equation (1) can be rewritten to express the amount of urea-additive based NH_3 emissions, also known as 'NH_3 slip', as:

$$E_{UA\_NH3} = (\rho_{UA} / \rho_D) \bullet F_{UA} \bullet VF_{UA} \bullet M_D \bullet MF_U \bullet (34/60) \quad (2)$$

As each kg of combusted diesel fuel is known to lead to 3.16 kg of emitted CO_2 (see Ref. [14]) this implies that equation (2) can be rewritten as:

$$E_{UA\_NH3} = (\rho_{UA} / \rho_D) \bullet F_{EU} \bullet VF_{UA} \bullet (E_D/3.16) \bullet MF_U \bullet (34/60) \quad (3)$$

Where E_D is the amount of diesel fuel based emitted CO_2. Estimating for now F_{EU} at 1 % and E_D at 1000 g/km it follows from equation (3) that the NH_3 slip from an SCR may be expected to be in the order of 46 mg/km.

In terms of order of magnitude this compares well to the (recalculated) measured values given for three buses with SCR as published by Carslaw and Rhys-Tyler (Ref. [2]). In Table 4 (page 15) the recalculated (from NH_3/CO_2 volume ratios to g/km) values are given as 45, 23 and 16 mg/km for resp. a Euro IV and two Euro V buses with SCR.

NH_3 emission factor estimate based on Euro V and VI SCR NH_3 standards

According to the Euro V and VI standards on NH_3 emission for SCR equipped vehicles, the amount of NH_3 in the vehicle exhaust may not exceed 25 respectively 10 parts per million (ppm). Assuming a CO_2 volume percentage of 5 % in the exhaust of a diesel vehicle at average load, and a CO_2 emission factor of 1000 g/km, these ppm NH_3 values roughly translates to NH_3 values in mg/km as:

$$E_{NH3} = E_{CO2} \bullet (17/44) \bullet 25E\text{-}6/0.05 \approx 193 \text{ mg/km} \quad (4a)$$

$$E_{NH3} = E_{CO2} \bullet (17/44) \bullet 10E\text{-}6/0.05 \approx 77 \text{ mg/km} \quad (4b)$$

In terms of order of magnitude this again compares well with the (recalculated) measured values as published by Carslaw and Rhys-Tyler (Ref. [2]).

NH_3 emission factors measured in the TNO HD Emission Testing Programme

In the TNO “In-Service Testing Programme for Heavy-Duty Vehicle and Engine emissions; 2006-2009” (see Ref [15]), the NH_3-slip of about ten Euro V vehicles equipped with SCR was measured using the European Stationary Cycle (ESC). Though this cycle is not very representative for most real world driving conditions, which are usually far more dynamic, these measurements are nevertheless considered to give a fair order of magnitude impression of NH_3-slip from SCRs.

The cycle averaged NH_3-slip appeared to range from 1 to 13 ppm for all engines. Translating this to mg/km values using equation (4) yields NH_3 emission factors roughly ranging from 10 to 100 mg/km. Again, this compares well to the estimates given before and the (recalculated) measured values as published by Carslaw and Rhys-Tyler (Ref. [2]).

3 Calculation methodology

3.1 Introduction

As said in paragraph 2.3 it was decided to extend and update the COPERT NH_3 emission factor data (Ref. [1]) with the data published by Carslaw and Rhys-Tyler (Ref. [2]). This was done in the following processing and calculation steps:

1. Manually copy and expand the COPERT NH_3 emission factor data (Ref. [1]) into Excel spreadsheet *"EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx".* The expansion included manual generation of comparison tables between the COPERT and the Carslaw and Rhys-Tyler data (from which the correction factors for the COPERT data were manually derived and used in Matlab script nh3ef2.m). The tables of this spreadsheet have been reproduced in Appendix II.

2. Manually copy and expand the Carslaw and Rhys-Tyler (Ref. [2]) NH_3 measurement data into Excel spreadsheet *"Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"*. In this spreadsheet the conversion (see equations therein) of the measured NH_3/CO_2 ratios to NH_3 emission factors was done using CO_2 emission factors from VERSIT+. The tables of this spreadsheet have been reproduced in Appendix III.

3. Manually translate the detailed VERSIT+ classes (i.e. the 333 classes as used for SRM) to the more global vehicle classes as used in COPERT. This resulted in the VERSIT+ to COPERT translation table *"Translation of VERSIT vehicle classes to COPERT classes and descriptions.xlsx"*, which has been reproduced in Appendix IV.

4. The final step was to automatically generate the full table with revised NH_3 emission factors for all 333 SRM VERSIT+ vehicle classes and three road types (i.e. urban, rural and highway) with the aid of Matlab script nh3ef2.m. The full table is an Excel spreadsheet *"NH3_Emission_Factors_for_SRM-.xlsx"*. It includes the basis COPERT data, the correction factors based on Carslaw and Rhys-Tyler and the revised data and has been reproduced in Appendix I.

In the following paragraphs the first two steps will be explained in more detail.

3.2 COPERT NH_3 basis emission factors

The COPERT data on NH_3 emissions is published in Ref. [1] in the form of tables with rather universal emission factors, in g/km, per generalised vehicle type and road types urban, rural and motorway. Additionally, for non-diesel passenger cars and light commercial vehicles a distinction is made per Euro emission class including the age of the vehicle in terms of a total mileage driven which has to be specified. For the latter, a Euro class dependent total mileage, supposed to be representative for the Dutch fleet, was estimated. Thus, the EMEP-EEA 2013 GB NH_3 emission factor tables were adapted and expanded for the Dutch situation.

The resulting detailed tables, which can be found in Excel spreadsheet *"EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"*, have been reproduced in Appendix II of this report.

Summarising tables have been reproduced in Table 1 and Table 2 on pages 12 and 13.

The data of these summarising tables have been used as the basis for the NH_3 emission factors for all current 333 SRM vehicle classes. For this an interpretative translation had to be made from the more detailed VERSIT+ vehicle classes to the rather general vehicle types as used in COPERT. This was done with a translation table in the Matlab script nh3ef2.m[3]. The translation table has been reproduced in Appendix IV of this report.

The resulting basis NH_3 emission factors can be found in the first four columns (A to D) of Excel spreadsheet file *"NH3_Emission_Factors_for_SRM.xlsx"*. A snippet of the spreadsheet is given in Figure 3.1. The entire spreadsheet has been reproduced in Appendix I of this report.

	A	B	C	D
1	**NH3_Emission_Factors_for_SRM.xlsx**			
2	**3-7-2014 12:31**			
3	**Made with nh3ef2.m**			
4		**EMEP-EEA (2013), i.e. COPERT data**		
5	**VERSIT+ Vehicle Class**	**NH3 EF, Urban**	**NH3 EF, Rural**	**NH3 EF, M'way**
6		g/km	g/km	g/km
7	**BABBEUR0**	0.003	0.003	0.003
8	**BABCEEV5**	0.003	0.003	0.003
9	**BABCEUR4**	0.003	0.003	0.003
10	**BABCEUR6**	0.003	0.003	0.003
11	**BABDEEV5SCR**	0.003	0.003	0.003

Figure 3.1 Snippet of the COPERT basis NH_3 emission factors in Excel spreadsheet file *"NH3_Emission_Factors_for_SRM.xlsx"*

The snippet also immediately illustrates the 'basic' nature of the COPERT emission factors for in this case a bus (BABDEEVSCR) with an SCR (Selective Catalytic Reduction NO_x abatement system using urea (AdBlue)). As all SCR systems invoke some ammonia slip it is hard to believe that an NH_3 emission factor of only 3 mg/km, equal to that of other busses without SCR, is a realistic value for this bus type.

[3] The Matlab script nh3ef2.m was used for the generation of the entire set of new NH_3 emission factors. The first processing step therein was the generation of the COPERT basis NH_3 emission factors using the translation table as reproduced in Appendix IV.

3.3 Carslaw-Rhys-Tyler-VERSIT+ NH_3 emission factors

Carslaw and Rhys-Tyler (Ref. [2]) measured and published the NH_3 emissions in the form of NH_3 over CO_2 emission ratios. With the aid of VERSIT+, which was used to provide estimated CO_2 emission factors (in g/km), these ratios were converted to NH_3 emission factors expressed in g/km. For this, a translation was made from the vehicle types as described by Carslaw and Rhys-Tyler to the most appropriate VERSIT+ vehicle classes. Thus, the Carslaw-Rhys-Tyler NH3/CO2-emission ratio tables were expanded for the Dutch situation.

The resulting detailed tables, which can be found in Excel spreadsheet *"Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"*, have been reproduced in Appendix III of this report.

Summarising tables, also comparing the Carslaw-Rhys-VERSIT+ NH3 emission factors to those of COPERT and as published by Sjödin and Jerksjö (Ref. [6]), have been reproduced in Table 3 and Table 4 on pages 14 and 15.

The data of these summarising tables have been used to derive estimated correction factors to update the basis NH_3 emission factors based on COPERT to more realistic emission factors.

These correction factors and the resulting updated NH_3 emission factors for SRM can also be found in the Excel spreadsheet file *"NH3_Emission_Factors_for_SRM-.xlsx"*, i.e. in the last six columns (E to J). Snippets of this part of the spreadsheet are given in Figure 3.2 and Figure 3.3. The entire spreadsheet has been reproduced in Appendix I of this report.

	A	E	F	G
1	NH3_Emission_Factors_f			
2	3-7-2014 12:31			
3	Made with nh3ef2.m			
4		Literature based correction factors		
5	VERSIT+ Vehicle Class	Urban cor. fac.	Rural cor. fac.	M'way cor. fac.
6				
7	BABBEUR0	1	1	1
8	BABCEEV5	1	1	1
9	BABCEUR4	1	1	1
10	BABCEUR6	1	1	1
11	BABDEEV5SCR	6	6	6

Figure 3.2 Snippet of the literature based correction factors in Excel spreadsheet file *"NH3_Emission_Factors_for_SRM.xlsx"*

	A	H	I	J
1	**NH3_Emission_Factors_f**			
2	**3-7-2014 12:31**			
3	**Made with nh3ef2.m**			
4		**SRM 1 NH3 Emission Factors**		
5	**VERSIT+ Vehicle Class**	**NH3 EF, Urban (WT1)**	**NH3 EF, Rural (WT2)**	**NH3 EF, M'way (WT3)**
6		g/km	g/km	g/km
7	**BABBEUR0**	0.003	0.003	0.003
8	**BABCEEV5**	0.003	0.003	0.003
9	**BABCEUR4**	0.003	0.003	0.003
10	**BABCEUR6**	0.003	0.003	0.003
11	**BABDEEV5SCR**	0.018	0.018	0.018

Figure 3.3 Snippet of the updated NH_3 emission factors in Excel spreadsheet file *"NH3_Emission_Factors_for_SRM.xlsx"*

The snippets clearly illustrate how the basis NH_3 emission factors for the bus (BABDEEVSCR) with SCR are updated from 3 mg/km (see Figure 3.1) to a more realistic value of 18 mg/km.

The updated NH_3 emission factors have also been depicted in Figure 3.4 to Figure 3.15, see pages 16 to 21. These plots nicely illustrate for which vehicle and road types and how much the updated emission factors change with respect to the COPERT values.

Table 1 Summarising COPERT NH3 EFs for PCs and LCVs

NH3 Emission Factors Summary for Gasoline PCs and LCVs based on EMEP-EEA 2013 (COPERT)				
In: EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx				
Based on:				
EMEP-EEA, 2013				
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013				
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013				
Passenger cars on gasoline, CNG, E85				
From Tables 3-89 to 3-92 expanded for NL				
Emission standard	**Urban cold**	**Urban hot**	**Rural hot**	**Highway hot**
	g/km	g/km	g/km	g/km
pre-Euro	0.002	0.002	0.002	0.002
Euro 1	0.052	0.070	0.132	0.074
Euro 2	0.057	0.169	0.149	0.084
Euro 3	0.006	0.002	0.030	0.065
Euro 4	0.005	0.002	0.029	0.065
Euro 5 *)	0.005	0.002	0.029	0.065
Euro 6 *)	0.005	0.002	0.029	0.065
***)** Euro 5 & 6 are not given in EMEP-EEA (2013) but have been calculated here using the Euro 4 coefficients and cumulative mileages of 75000 resp. 50000 km.				
Light commercial vehicles (LCVs) on gasoline, CNG, E85				
From Tables 3-93 to 3-96 expanded for NL				
Emission standard	**Urban cold**	**Urban hot**	**Rural hot**	**Highway hot**
	g/km	g/km	g/km	g/km
pre-Euro	0.002	0.002	0.002	0.002
Euro 1	0.052	0.070	0.132	0.074
Euro 2	0.057	0.169	0.149	0.084
Euro 3	0.006	0.002	0.030	0.065
Euro 4	0.005	0.002	0.029	0.065
Euro 5 *)	0.005	0.002	0.029	0.065
Euro 6 *)	0.005	0.002	0.029	0.065
***)** Euro 5 & 6 are not given in EMEP-EEA (2013) but have been calculated here using the Euro 4 coefficients and cumulative mileages of 75000 resp. 50000 km.				

Table 2 Summarising COPERT EFs for Other LDV & HDV

NH3 Emission Factors Summary for Other LDV & HDV based on EMEP-EEA 2013 (COPERT)			
In: EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx			
Based on:			
EMEP-EEA, 2013			
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013			
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013			
Table 3-97	**Other vehicles bulk (hot + cold)**		
Bulk (hot + cold) ammonia (NH3) emission factors (g/km)			
Vehicle category	**Urban**	**Rural**	**Highway**
	g/km	g/km	g/km
Passenger cars			
Diesel cc < 2.0 l	0.001	0.001	0.001
Diesel cc > 2.0 l	0.001	0.001	0.001
LPG	nd	nd	nd
2-stroke	0.002	0.002	0.002
Light commercial vehicles			
Diesel	0.001	0.001	0.001
Heavy-duty vehicles			
Gasoline vehicle > 3.5 t	0.002	0.002	0.002
Diesel < 7.5 t	0.003	0.003	0.003
Diesel 7.5 t < W < 16 t	0.003	0.003	0.003
Diesel 16 t < W < 32 t	0.003	0.003	0.003
Diesel W > 32 t	0.003	0.003	0.003
Urban buses	0.003	-	-
Coaches	0.003	0.003	0.003
Motorcycles			
< 50 cm^3	0.001	0.001	0.001
> 50 cm^3 2-stroke	0.002	0.002	0.002
> 50 cm^3 4-stroke	0.002	0.002	0.002

Table 3 Comparison of NH3 EFs for LD

NH3 Emission Factors Comparison for Light Duty Vehicles						
In: Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx						
Based on:						
- Carslaw, D.C. and G. Rhys-Tyler, 2013						
- EMEP-EEA 2013 (COPERT)						
- Sjödin, A. and M. Jerksjö, 2008						
				Carslaw &	**COPERT**	**Sjödin &**
Light Duty Vehicles, Urban				**Rhys-Tyler**	**EMEP-EEA**	**Jerksjö**
Vehicle type	**Fuel/type**	**Euro class**	**VERSIT+ vehicle**	**NH3 EF calc**	**Urban** (hot/hot+cold)	**NH3 EF**
			class	g/km	g/km	g/km
Passenger car	Petrol	0	LPABEUR0	0.036	0.002	0.024
Passenger car	Petrol	1	LPABEUR1	0.079	0.070	0.110
Passenger car	Petrol	2	LPABEUR2	0.083	0.169	0.080
Passenger car	Petrol	3	LPABEUR3	0.062	0.002	0.041
Passenger car	Petrol	4	LPABEUR4	0.042	0.002	0.029
Passenger car	Petrol	5	LPABEUR5	0.024	-	-
Passenger car	Petrol hybrid	4	LPHBEUR4	0.009	-	-
Passenger car	Petrol hybrid	5	LPHBEUR5	0.019	-	-
Passenger car	Diesel	0	LPADEUR0	0.001	0.001	-
Passenger car	Diesel	1	LPADEUR1	0.001	0.001	-
Passenger car	Diesel	2	LPADEUR2	0.003	0.001	-
Passenger car	Diesel	3	LPADEUR3	0.003	0.001	-
Passenger car	Diesel	4	LPADEUR4	0.002	0.001	-
Passenger car	Diesel	5	LPADEUR5	0.002	-	-
London taxi	FX	2	LPADEUR2	0.003	0.001	-
London taxi	Met	2	LPADEUR2	0.001	0.001	-
London taxi	TX1	2	LPADEUR2	0.002	0.001	-
London taxi	Met	3	LPADEUR3	0.002	0.001	-
London taxi	TXII	3	LPADEUR3	0.002	0.001	-
London taxi	MV111	4	LPADEUR4	0.002	0.001	-
London taxi	TX4	4	LPADEUR4	0.002	0.001	-
London taxi	TX4	5	LPADEUR5	0.002	-	-
London taxi	MV113	5	LPADEUR5	0.002	-	-
Van (N1)		1	LBADEUR1LCH	0.003	0.001	-
Van (N1)		2	LBADEUR2LCH	0.002	0.001	-
Van (N1)		3	LBADEUR3LCH	0.002	0.001	-
Van (N1)		4	LBADEUR4LCH	0.003	0.001	-
Van (N1)		5	LBADEUR5LCH	0.002	-	-

Table 4 Comparison of NH3 EFs for HD

NH3 Emission Factors Comparison for Heavy Duty Vehicles					
In: Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx					
Based on:					
- Carslaw, D.C. and G. Rhys-Tyler, 2013					
- EMEP-EEA 2013 (COPERT)					
				Carslaw &	**COPERT**
Heavy Duty Vehicles, Urban				**Rhys-Tyler**	**EMEP-EEA**
Vehicle type	**Technology**	**Euro class**	**VERSIT+ vehicle class**	**NH3 EF calc** g/km	**Urban** (hot+cold) g/km
TfL bus	DPF	II	BABDEUR2DPF	0.000	0.003
TfL bus	DPF	III	BABDEUR3DPF	0.000	0.003
TfL bus	DPF	IV	BABDEUR4	0.004	0.003
TfL bus	EGR	V	BABDEUR5EGR	0.004	-
TfL bus	EGR	EEV	BABDEEV5EGR	-	-
TfL bus	SCR	IV	BABDEUR4SCR	0.045	0.003
TfL bus	SCR	V	BABDEUR5SCR	0.023	-
TfL bus	SCR	EEV	BABDEEV5SCR	0.016	-
TfL bus	SCR hybrid	V	BAHDEUR5SCR	-	-
Non-TfL bus		I	BABDEUR1	0.000	0.003
Non-TfL bus		II	BABDEUR2	0.000	0.003
Non-TfL bus		III	BABDEUR3	0.004	0.003
Non-TfL bus		IV	BABDEUR4	0.015	0.003
Non-TfL bus		V	BABDEUR5	0.004	-
HGV (3.5-12t)		II	MVADEUR2LCH	0.014	0.003
HGV (3.5-12t)		III	MVADEUR3LCH	0.006	0.003
HGV (3.5-12t)		IV	MVADEUR4LCH	0.007	0.003
HGV (3.5-12t)		V	MVADEUR5LCH	-	-
HGV (>12t)		II	MVADEUR2ZWA	0.013	0.003
HGV (>12t)		III	MVADEUR3ZWA	0.007	0.003
HGV (>12t)		IV	MVADEUR4ZWA	0.014	0.003
HGV (>12t)		V	MVADEUR5ZWA	-	-

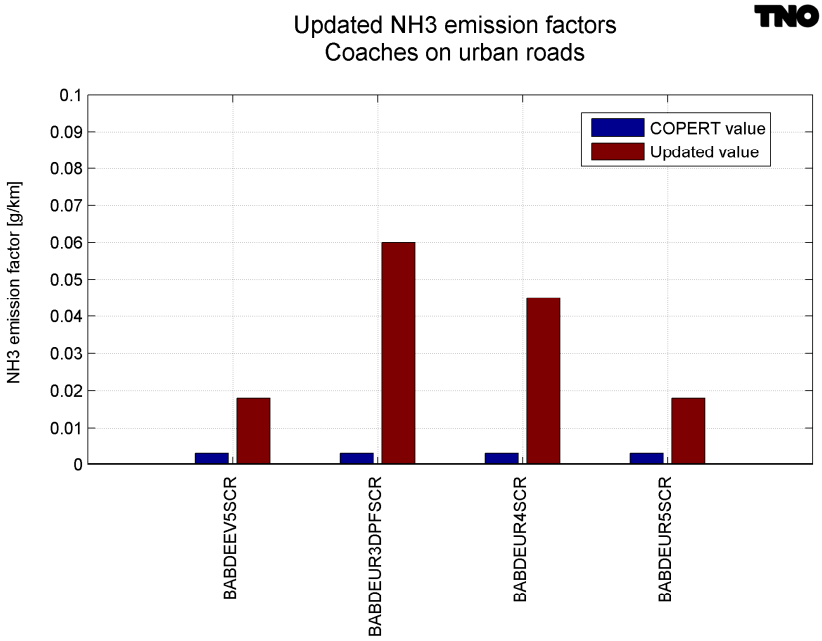

Figure 3.4 Updated NH_3 emission factors for coaches on urban roads

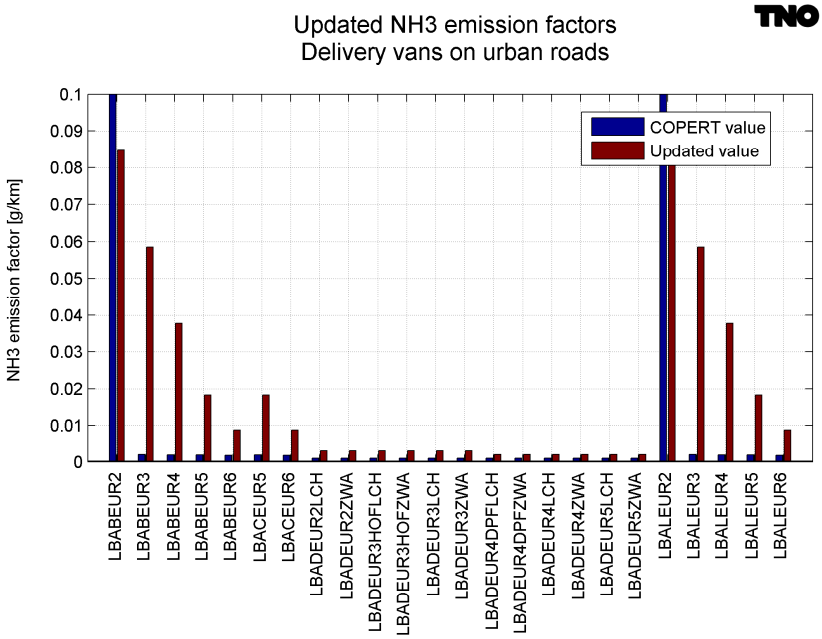

Figure 3.5 Updated NH_3 emission factors for delivery vans on urban roads

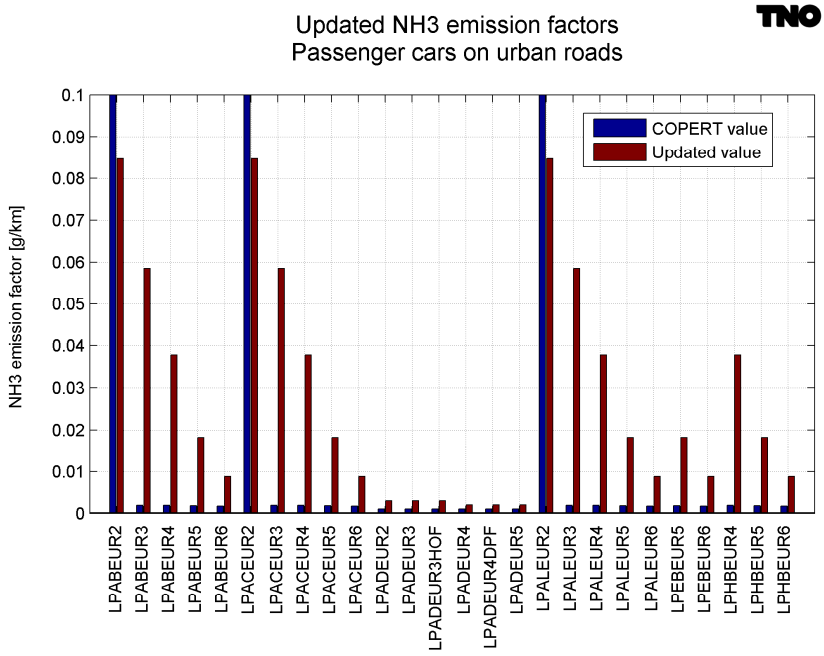

Figure 3.6 Updated NH_3 emission factors for passenger cars on urban roads

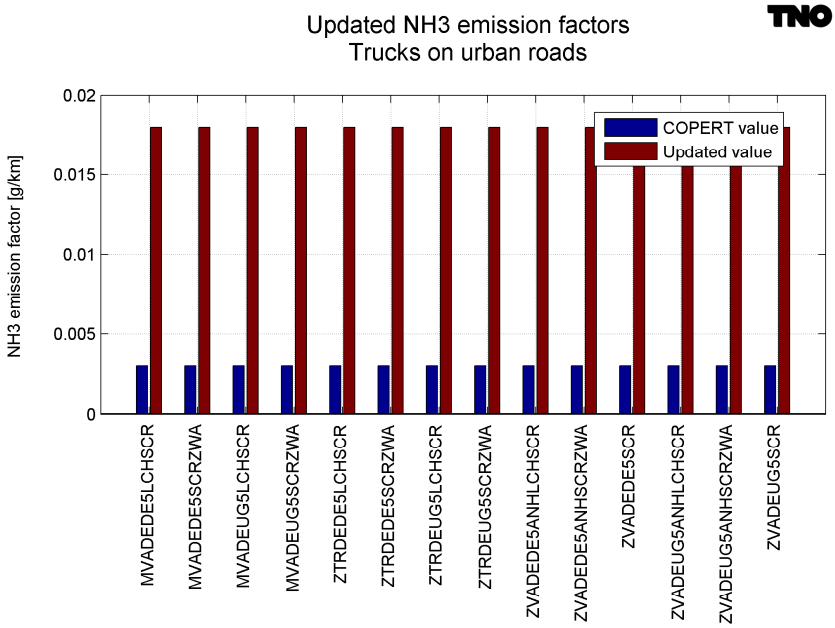

Figure 3.7 Updated NH_3 emission factors for trucks on urban roads

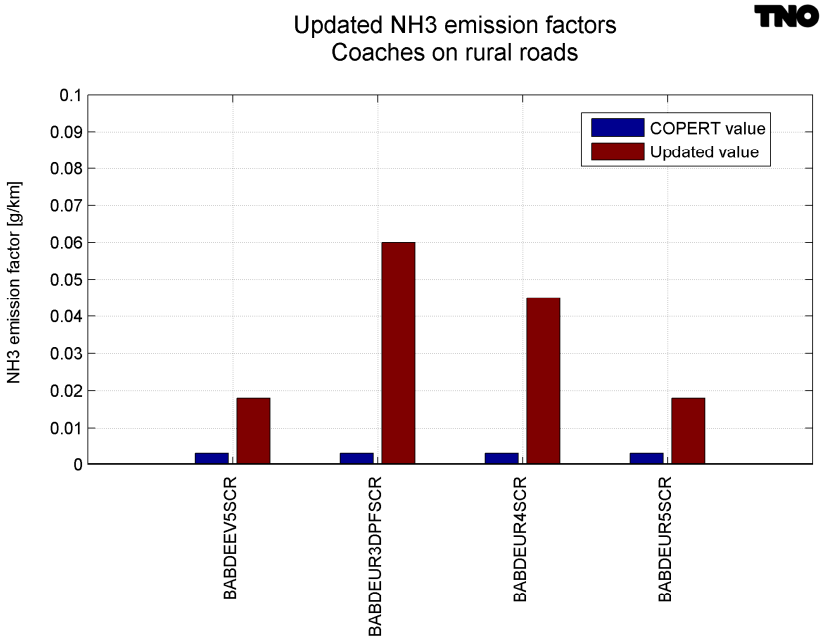

Figure 3.8 Updated NH_3 emission factors for coaches on rural roads

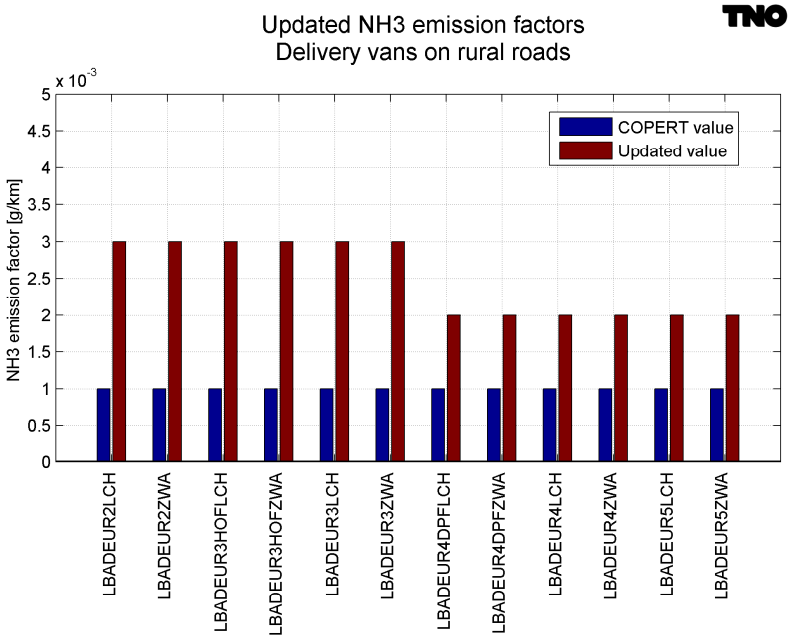

Figure 3.9 Updated NH_3 emission factors for delivery vans on rural roads

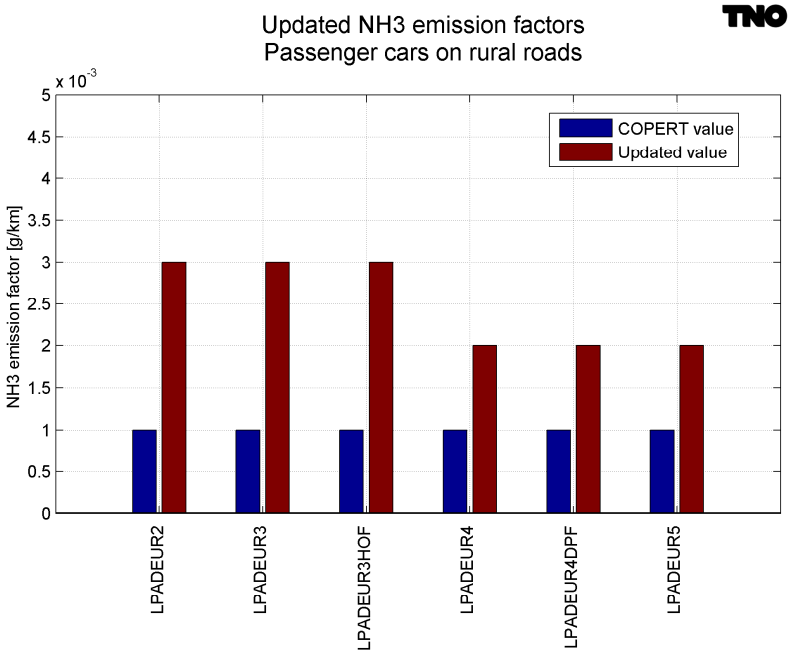

Figure 3.10 Updated NH_3 emission factors for passenger cars on rural roads

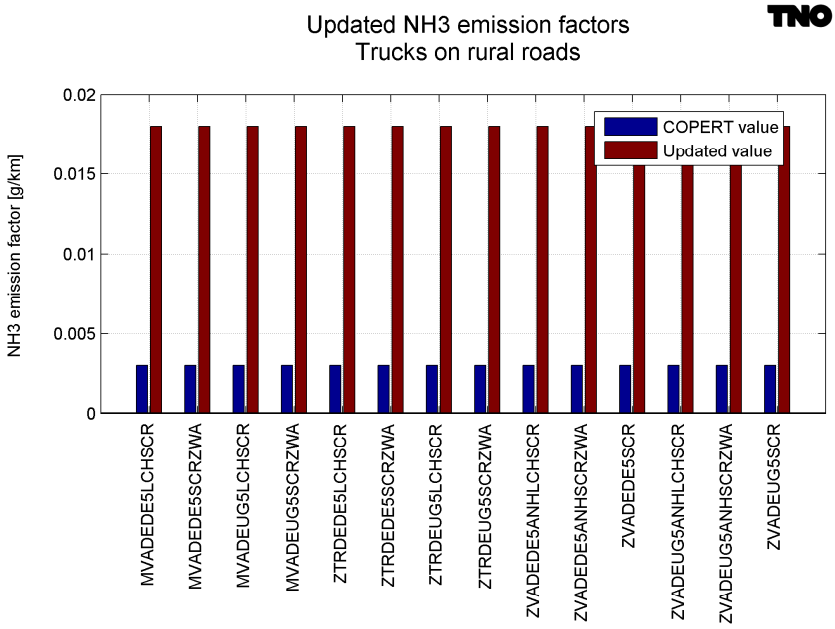

Figure 3.11 Updated NH_3 emission factors for trucks on rural roads

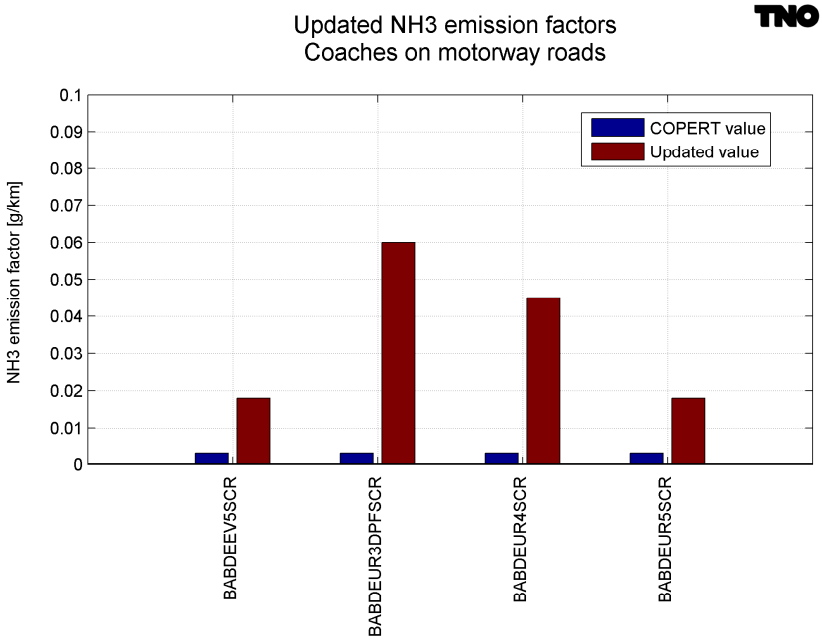

Figure 3.12 Updated NH_3 emission factors for coaches on motorway roads

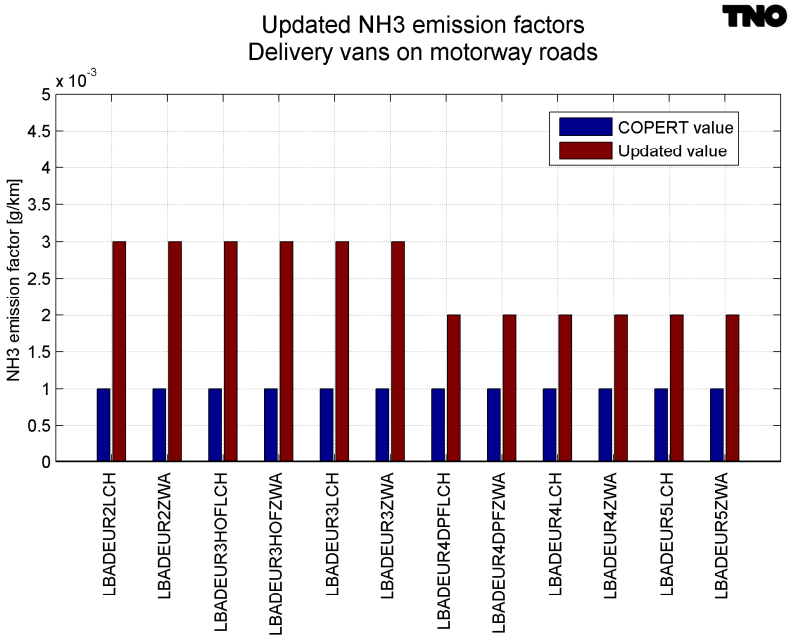

Figure 3.13 Updated NH_3 emission factors for delivery vans on motorway roads

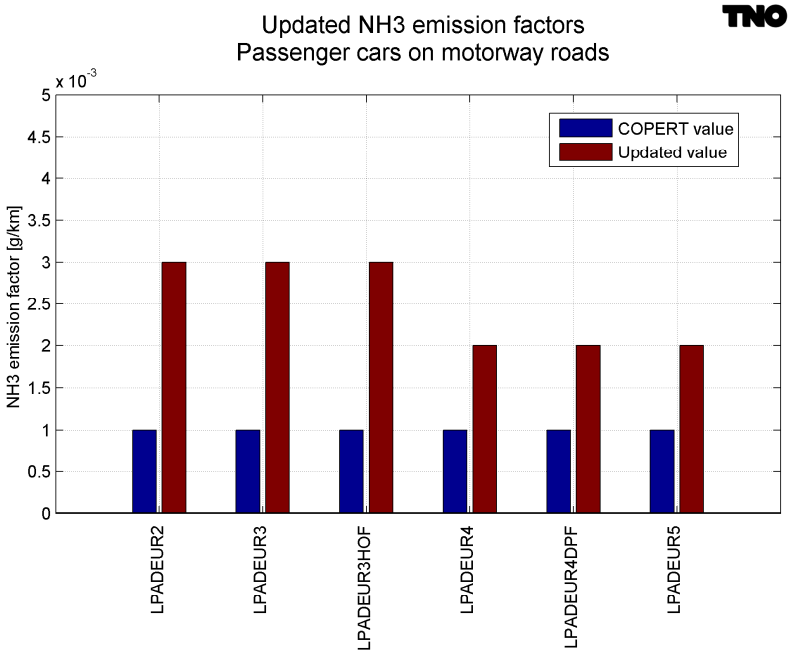

Figure 3.14 Updated NH_3 emission factors for passenger cars on motorway roads

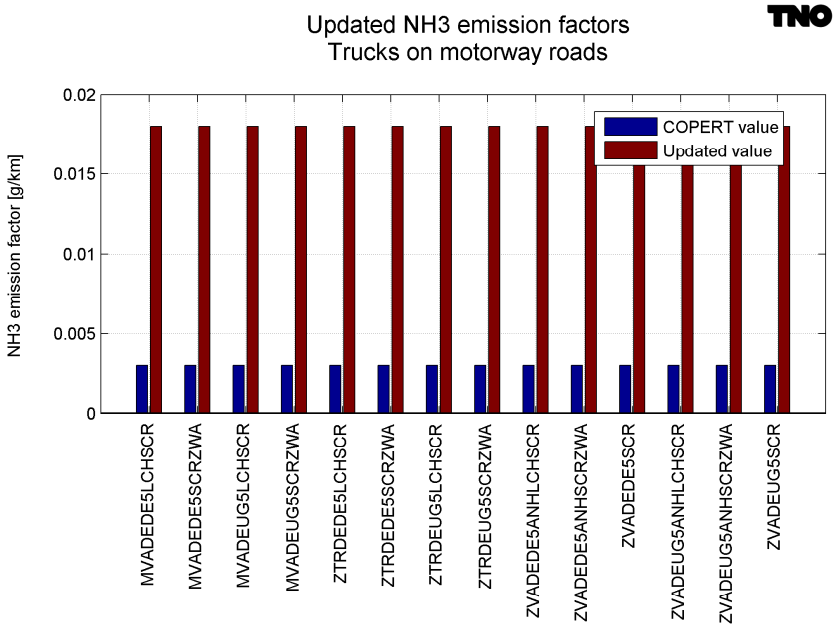

Figure 3.15 Updated NH_3 emission factors for trucks on motorway roads

4 Vehicle aging for Euro 1 & 2 petrol passenger cars

Comparing the NH_3 emission factors, derived as described in Chapter 3, for Euro 1 and Euro 2 passenger cars on petrol to older TNO measured NH_3 emission factor data (see Ref. [12]), it was understood that vehicle aging effects for these specific vehicles[4] are responsible for the observed increase in NH_3 emission factor.

Hence, when studying NH_3 emissions for the Dutch national fleet over a longer period which includes the period of approximately 1991 to 2007, wherein Euro 1 and Euro 2 passenger cars on petrol came into play, these effects need to be taken into account. This can be achieved by using a lower or 'new' NH_3 EF start value in a certain start year and an a higher or 'aged' NH3 EF end value in a certain end year and interpolating between these two values. This procedure has been graphically illustrated in Figure 4.1 and Figure 4.2 and the 'new' and 'aged' values are in Table 5.

Table 5 Vehicle aging effects on NH_3 emission factors for Euro 1 & 2 passenger cars on petrol

VERSIT+ Vehicle Class	Road Type	NH3 EF New	NH3 EF Aged
		g/km	g/km
LPABEUR1	Urban (WT1)	0.023	0.070
LPABEUR1	Rural (WT2)	0.044	0.132
LPABEUR1	Motorway (WT3)	0.025	0.074
LPABEUR2	Urban (WT1)	0.028	0.085
LPABEUR2	Rural (WT2)	0.050	0.149
LPABEUR2	Motorway (WT3)	0.028	0.084

[4] Aging for these vehicles affects the performance of the three-way catalytic converter and thereby increases the NH_3 emission.

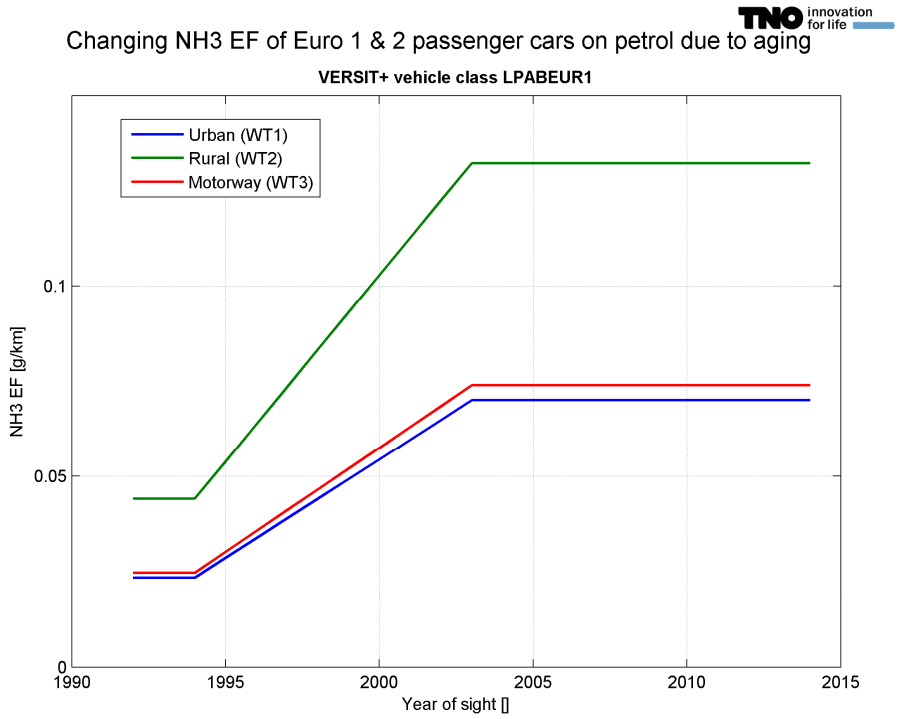

Figure 4.1 Aging effects on NH_3 emission factor for Euro 1 passenger cars on petrol

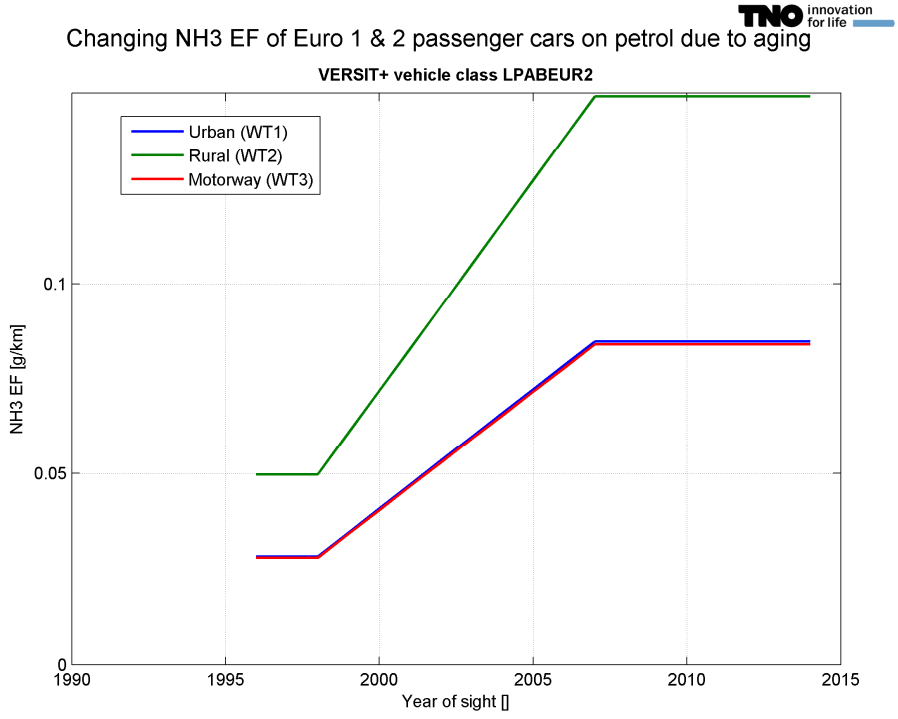

Figure 4.2 Aging effects on NH_3 emission factor for Euro 2 passenger cars on petrol

5 Conclusions

From the short study, as performed to provide a first set of NH_3 road transport emission factors for all vehicle categories and all road types and congestion levels, the following conclusions are drawn.

- A methodology was designed to provide a first set of NH_3 emission factors based on data from emission model COPERT (Ref. [1]) as a basis updated with recent measured data found in the literature (esp. Carslaw and Rhys-Tyler, Ref. [2]).

- Comparing COPERT data to recent measured NH_3 emission data it appears that COPERT underestimates especially: 1) the NH_3 emissions from non-diesel passenger cars and light commercial vehicles (i.e. those with three-way catalyst) under urban driving conditions; 2) the NH_3 emissions of heavy duty vehicles with an SCR NO_x abatement system.

- Based on this comparison a set of correction factors could be estimated to update the basis NH_3 emission factors for the Netherlands.

- Hence, a first set of NH_3 emission factors for all current 333 vehicle classes for urban, rural and motorway roads could be provided. For this set, the COPERT NH_3 emission factor values formed a basis, which was partially updated with values based on the literature (esp. Carslaw and Rhys-Tyler, Ref. [2]).

- The currently available data gives no insight on the necessity for, nor on the way how to expand the average motorway emission factors to account for all seven motorway emission factors for the different speed limits and congestion levels.

- Hence, it is proposed from 2015 to make no such distinction and to use the average motorway NH_3 emission factors also for all seven motorway subtypes.

6 Signature

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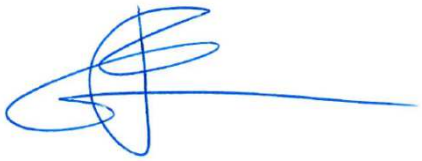

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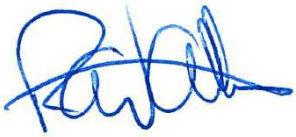
Projectleader

Release:



Ir. R.A.W. Albers MPA
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Appendix I NH_3 Emission Factors

All 333 NH_3 emission factors for based on data from “EMEP-EEA Emission Inventory Guidebook 2013, 1.a.3.b Road transport GB2013”, alias COPERT (see Ref. [1]), together with data from recent measurements, i.e. especially Carslaw and Rhys-Tyler (2013, see Ref. [2]), have been listed in the Excel spreadsheet file *“NH3_Emission_Factors_for_SRM.xlsx”*. This spreadsheet has been reproduced in this appendix on the following pages.

Table A1.1 Part 1 of 4 of “NH3_Emission_Factors_for_SRM.xlsx”

NH3_Emission_Factors_for_SRM.xlsx									
3-7-2014 12:31									
Made with nh3ef2.m									
	EMEP-EEA (2013), i.e. COPERT data			Literature based correction factors			SRM 1 NH3 Emission Factors		
VERSIT+ Vehicle Class	NH3 EF, Urban	NH3 EF, Rural	NH3 EF, M'way	Urban cor. fac.	Rural cor. fac.	M'way cor. fac.	NH3 EF, Urban (WT1)	NH3 EF, Rural (WT2)	NH3 EF, M'way (WT3)
	g/km	g/km	g/km				g/km	g/km	g/km
BABBEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABCEEV5	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABCEUR4	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABCEUR6	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEEV5SCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
BABDEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR1	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR2	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR2DPF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR2HOF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR3	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR3DPF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR3DPFSCR	0.003	0.003	0.003	20	20	20	0.060	0.060	0.060
BABDEUR3HOF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR4	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR4EGR	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR4SCR	0.003	0.003	0.003	15	15	15	0.045	0.045	0.045
BABDEUR5EGR	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABDEUR5SCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
BABDEUR6	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
BABLEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
LBAB1982	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1983	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1984	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1985	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1986	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1987	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1988	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1989	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1990	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1991	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAB1992	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBABEUR1	0.070	0.132	0.074	1	1	1	0.070	0.132	0.074
LBABEUR2	0.169	0.149	0.084	0.5	1	1	0.085	0.149	0.084
LBABEUR3	0.002	0.030	0.065	30	1	1	0.058	0.030	0.065
LBABEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LBABEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LBABEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LBABPR82	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBABR3WC	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBACEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LBACEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LBAD1982LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1982ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1983LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1983ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1984LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1984ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1985LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1985ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1986LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1986ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1987LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1987ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1988LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1988ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1989LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1989ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1990LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1990ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1991LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1991ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1992LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBAD1992ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUA6LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUA6ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUC6LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUC6ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUR1LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUR1ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADEUR2LCH	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR2ZWA	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR3HOFLCH	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR3HOFZWA	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR3LCH	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR3ZWA	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LBADEUR4DPFLCH	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADEUR4DPFZWA	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADEUR4LCH	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADEUR4ZWA	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADEUR5LCH	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADEUR5ZWA	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LBADPR82LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBADPR82ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001

Table A1.2 Part 2 of 4 of “NH3_Emission_Factors_for_SRM.xlsx”

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Made with nh3ef2.m									
	EMEP-EEA (2013), i.e. COPERT data			Literature based correction factors			SRM 1 NH3 Emission Factors		
VERSIT+ Vehicle Class	NH3 EF, Urban	NH3 EF, Rural	NH3 EF, M'way	Urban cor. fac.	Rural cor. fac.	M'way cor. fac.	NH3 EF, Urban (WT1)	NH3 EF, Rural (WT2)	NH3 EF, M'way (WT3)
	g/km	g/km	g/km				g/km	g/km	g/km
LBAE	0.000	0.000	0.000	1	1	1	0.000	0.000	0.000
LBAL1982	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1983	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1984	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1985	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1986	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1987	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1988	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1989	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1990	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1991	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBAL1992	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBALEUR1	0.070	0.132	0.074	1	1	1	0.070	0.132	0.074
LBALEUR2	0.169	0.149	0.084	0.5	1	1	0.085	0.149	0.084
LBALEUR3	0.002	0.030	0.065	30	1	1	0.058	0.030	0.065
LBALEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LBALEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LBALEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LBALPR82	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBALR3WC	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LBEDEUR5	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LBEDEUR6	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LMFBEUR0	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LMFBEUR1	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1982LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1982MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1982ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1983LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1983MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1983ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1984LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1984MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1984ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1985LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1985MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1985ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1986LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1986MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1986ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1987LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1987MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1987ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1988LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1988MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1988ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1989LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1989MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1989ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1990LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1990MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1990ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1991LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1991MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1991ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1992LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1992MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAB1992ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABEUR1	0.070	0.132	0.074	1	1	1	0.070	0.132	0.074
LPABEUR2	0.169	0.149	0.084	0.5	1	1	0.085	0.149	0.084
LPABEUR3	0.002	0.030	0.065	30	1	1	0.058	0.030	0.065
LPABEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LPABEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LPABEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LPABO3WCLCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABO3WCMED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABPR82LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABPR82MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABPR82ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPABR3WC	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPACEUR1	0.070	0.132	0.074	1	1	1	0.070	0.132	0.074
LPACEUR2	0.169	0.149	0.084	0.5	1	1	0.085	0.149	0.084
LPACEUR3	0.002	0.030	0.065	30	1	1	0.058	0.030	0.065
LPACEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LPACEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LPACEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LPAD1982LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1982MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1982ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1983LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1983MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1983ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1984LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1984MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1984ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001

Table A1.3 Part 3 of 4 of “NH3_Emission_Factors_for_SRM.xlsx”

NH3_Emission_Factors_for_SRM.xlsx									
3-7-2014 12:31									
Made with nh3ef2.m									
	EMEP-EEA (2013), i.e. COPERT data			Literature based correction factors			SRM 1 NH3 Emission Factors		
VERSIT+ Vehicle Class	NH3 EF, Urban	NH3 EF, Rural	NH3 EF, M'way	Urban cor. fac.	Rural cor. fac.	M'way cor. fac.	NH3 EF, Urban (WT1)	NH3 EF, Rural (WT2)	NH3 EF, M'way (WT3)
	g/km	g/km	g/km				g/km	g/km	g/km
LPAD1985LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1985MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1985ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1986LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1986MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1986ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1987LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1987MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1987ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1988LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1988MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1988ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1989LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1989MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1989ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1990LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1990MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1990ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1991LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1991MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1991ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1992LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1992MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAD1992ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADEUA6	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADEUC6	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADEUR1	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADEUR2	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LPADEUR3	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LPADEUR3HOF	0.001	0.001	0.001	3	3	3	0.003	0.003	0.003
LPADEUR4	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LPADEUR4DPF	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LPADEUR5	0.001	0.001	0.001	2	2	2	0.002	0.002	0.002
LPADPR82LCH	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADPR82MED	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPADPR82ZWA	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPAE	0.000	0.000	0.000	1	1	1	0.000	0.000	0.000
LPAL1982LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1982MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1982ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1983LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1983MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1983ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1984LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1984MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1984ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1985LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1985MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1985ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1986LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1986MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1986ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1987LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1987MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1987ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1988LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1988MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1988ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1989LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1989MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1989ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1990LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1990MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1990ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1991LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1991MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1991ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1992LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1992MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPAL1992ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALEUR1	0.070	0.132	0.074	1	1	1	0.070	0.132	0.074
LPALEUR2	0.169	0.149	0.084	0.5	1	1	0.085	0.149	0.084
LPALEUR3	0.002	0.030	0.065	30	1	1	0.058	0.030	0.065
LPALEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LPALEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LPALEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LPALO3WCLCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALO3WCMED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALPR82LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALPR82MED	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALPR82ZWA	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPALR3WC	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
LPEBEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LPEBEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065

Table A1.4 Part 4 of 4 of “NH3_Emission_Factors_for_SRM.xlsx”

NH3_Emission_Factors_for_SRM.xlsx									
3-7-2014 12:31									
Made with nh3ef2.m									
	EMEP-EEA (2013), i.e. COPERT data			Literature based correction factors			SRM 1 NH3 Emission Factors		
VERSIT+ Vehicle Class	NH3 EF, Urban	NH3 EF, Rural	NH3 EF, M'way	Urban cor. fac.	Rural cor. fac.	M'way cor. fac.	NH3 EF, Urban (WT1)	NH3 EF, Rural (WT2)	NH3 EF, M'way (WT3)
	g/km	g/km	g/km				g/km	g/km	g/km
LPEDEUR5	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPEDEUR6	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPHBEUR4	0.002	0.029	0.065	20	1	1	0.038	0.029	0.065
LPHBEUR5	0.002	0.029	0.065	10	1	1	0.018	0.029	0.065
LPHBEUR6	0.002	0.029	0.065	5	1	1	0.009	0.029	0.065
LPHDEUR5	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
LPHDEUR6	0.001	0.001	0.001	1	1	1	0.001	0.001	0.001
MVABEUR0LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
MVADEDE5LCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
MVADEDE5SCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
MVADEUG5EGRLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUG5EGRZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUG5LCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
MVADEUG5SCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
MVADEUR0LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR0ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR1LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR1ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR2LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR2ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3DPFLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3DPFZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3HOFLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3HOFZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR3ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR4LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR4ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR6LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVADEUR6ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
MVALEUR0LCH	0.002	0.002	0.002	1	1	1	0.002	0.002	0.002
ZTRBEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEDE5LCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZTRDEDE5SCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZTRDEUG5EGRLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUG5EGRZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUG5LCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZTRDEUG5SCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZTRDEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR1	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR2	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR3	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR3DPF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR3HOF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR4	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR6LCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRDEUR6ZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZTRLEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEDE5ANHLCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEDE5ANHSCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEDE5SCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEUG5ANHEGRLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUG5ANHEGRZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUG5ANHLCHSCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEUG5ANHSCRZWA	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEUG5EGR	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUG5SCR	0.003	0.003	0.003	6	6	6	0.018	0.018	0.018
ZVADEUR0	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR0ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR0ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR1	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR1ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR1ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR2	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR2ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR2ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHDPFLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHDPFZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHHOFLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHHOFZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3DPF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR3HOF	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR4	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR4ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR4ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR6	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR6ANHLCH	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003
ZVADEUR6ANHZWA	0.003	0.003	0.003	1	1	1	0.003	0.003	0.003

Appendix II NH_3 Emission factors from EMEP-EEA GB 2013, alias COPERT

The summarising and detailed NH_3 emission factor tables, which can be found in Excel spreadsheet *"EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"*, have been reproduced in this appendix.

Table A2.1 Sheet 'PCs & LCVs' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

NH3 Emission Factors Summary for Gasoline PCs and LCVs based on EMEP-EEA 2013 (COPERT)				
In: EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx				
Based on:				
EMEP-EEA, 2013				
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013				
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013				
Passenger cars on gasoline, CNG, E85				
From Tables 3-89 to 3-92 expanded for NL				
Emission standard	**Urban cold**	**Urban hot**	**Rural hot**	**Highway hot**
	g/km	g/km	g/km	g/km
pre-Euro	0.002	0.002	0.002	0.002
Euro 1	0.052	0.070	0.132	0.074
Euro 2	0.057	0.169	0.149	0.084
Euro 3	0.006	0.002	0.030	0.065
Euro 4	0.005	0.002	0.029	0.065
Euro 5 *)	0.005	0.002	0.029	0.065
Euro 6 *)	0.005	0.002	0.029	0.065
***)** Euro 5 & 6 are not given in EMEP-EEA (2013) but have been calculated here using the Euro 4 coefficients and cumulative mileages of 75000 resp. 50000 km.				
Light commercial vehicles (LCVs) on gasoline, CNG, E85				
From Tables 3-93 to 3-96 expanded for NL				
Emission standard	**Urban cold**	**Urban hot**	**Rural hot**	**Highway hot**
	g/km	g/km	g/km	g/km
pre-Euro	0.002	0.002	0.002	0.002
Euro 1	0.052	0.070	0.132	0.074
Euro 2	0.057	0.169	0.149	0.084
Euro 3	0.006	0.002	0.030	0.065
Euro 4	0.005	0.002	0.029	0.065
Euro 5 *)	0.005	0.002	0.029	0.065
Euro 6 *)	0.005	0.002	0.029	0.065
***)** Euro 5 & 6 are not given in EMEP-EEA (2013) but have been calculated here using the Euro 4 coefficients and cumulative mileages of 75000 resp. 50000 km.				

Table A2.2 Sheet 'Other LD & HD' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

NH3 Emission Factors Summary for Other LDV & for HDV & MC based on EMEP-EEA 2013 (COPERT)			
In: EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx			
Based on:			
EMEP-EEA, 2013			
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013			
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013			
Table 3-97	**Other vehicles bulk (hot + cold)**		
Bulk (hot + cold) ammonia (NH3) emission factors (g/km)			
Vehicle category	**Urban**	**Rural**	**Highway**
	g/km	g/km	g/km
Passenger cars			
Diesel cc < 2.0 l	0.001	0.001	0.001
Diesel cc > 2.0 l	0.001	0.001	0.001
LPG	nd	nd	nd
2-stroke	0.002	0.002	0.002
Light commercial vehicles			
Diesel	0.001	0.001	0.001
Heavy-duty vehicles			
Gasoline vehicle > 3.5 t	0.002	0.002	0.002
Diesel < 7.5 t	0.003	0.003	0.003
Diesel 7.5 t < W < 16 t	0.003	0.003	0.003
Diesel 16 t < W < 32 t	0.003	0.003	0.003
Diesel W > 32 t	0.003	0.003	0.003
Urban buses	0.003	-	-
Coaches	0.003	0.003	0.003
Motorcycles			
< 50 cm^3	0.001	0.001	0.001
> 50 cm^3 2-stroke	0.002	0.002	0.002
> 50 cm^3 4-stroke	0.002	0.002	0.002

Table A2.3 Sheet 'Table 3-89' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-89	**Passenger cars - gasoline, CNG, E85 - urban cold**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline, CNG and E85 passenger cars under cold urban conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	All	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	50.0	1.52E-06	0.765	175000	0.052	√
Euro 1	> 150	11.7	2.92E-06	0.351	175000	0.010	
Euro 2	0-150	51.0	1.70E-06	0.853	150000	0.057	√
Euro 2	> 150	14.6	3.89E-06	0.468	150000	0.015	
Euro 3	0-30	5.4	1.77E-06	0.819	125000	0.006	√
Euro 3	> 30	4.8	4.33E-06	0.521	125000	0.005	
Euro 4	0-30	5.4	1.77E-06	0.819	100000	0.005	√
Euro 4	> 30	4.8	4.33E-06	0.521	100000	0.005	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.4 Sheet 'Table 3-90' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-90	**Passenger cars - gasoline, CNG, E85 - urban hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline, CNG and E85 passenger cars under hot urban conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	All	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	All	70.0	0.00E+00	1.000	175000	0.070	√
Euro 2	All	143.0	1.47E-06	0.964	150000	0.169	√
Euro 3	0-30	1.9	1.31E-06	0.862	125000	0.002	√
Euro 3	> 30	1.6	4.18E-06	0.526	125000	0.002	
Euro 4	0-30	1.9	1.31E-06	0.862	100000	0.002	√
Euro 4	> 30	1.6	4.18E-06	0.526	100000	0.002	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.5 Sheet 'Table 3-91' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-91	**Passenger cars - gasoline, CNG, E85 - rural hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline, CNG and E85 passenger cars under hot rural conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	All	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	131.0	5.94E-08	0.999	175000	0.132	√
Euro 1	> 150	100.0	8.95E-07	0.978	175000	0.113	
Euro 2	0-150	148.0	5.95E-08	0.999	150000	0.149	√
Euro 2	> 150	90.7	9.08E-07	0.992	150000	0.102	
Euro 3	0-30	29.5	5.90E-08	0.994	125000	0.030	√
Euro 3	> 30	28.9	8.31E-07	0.908	125000	0.029	
Euro 4	0-30	29.5	5.90E-08	0.994	100000	0.029	√
Euro 4	> 30	28.9	8.31E-07	0.908	100000	0.029	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.6 Sheet 'Table 3-92' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-92	**Passenger cars - gasoline, CNG, E85 - highway hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline, CNG and E85 passenger cars under hot highway conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	All	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	73.3	5.94E-08	0.998	175000	0.074	√
Euro 1	> 150	56.2	8.86E-07	0.968	175000	0.063	
Euro 2	0-150	83.3	5.94E-08	0.999	150000	0.084	√
Euro 2	> 150	51.0	9.05E-07	0.988	150000	0.057	
Euro 3	0-30	64.6	5.95E-08	0.999	125000	0.065	√
Euro 3	> 30	63.4	9.02E-07	0.985	125000	0.070	
Euro 4	0-30	64.6	5.95E-08	0.999	100000	0.065	√
Euro 4	> 30	63.4	9.02E-07	0.985	100000	0.068	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.7 Sheet 'Table 3-93' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-93	**LCVs - gasoline - urban cold**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline LCVs under cold urban conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	> 0	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	50.0	1.52E-06	0.765	175000	0.052	√
Euro 1	> 150	11.7	2.92E-06	0.351	175000	0.010	
Euro 2	0-150	51.0	1.70E-06	0.853	150000	0.057	√
Euro 2	> 150	14.6	3.89E-06	0.468	150000	0.015	
Euro 3	0-30	5.4	1.77E-06	0.819	125000	0.006	√
Euro 3	> 30	4.8	4.33E-06	0.521	125000	0.005	
Euro 4	0-30	5.4	1.77E-06	0.819	100000	0.005	√
Euro 4	> 30	4.8	4.33E-06	0.521	100000	0.005	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.8 Sheet 'Table 3-94' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-94	**LCVs - gasoline - urban hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for					**cumulative mileages**		
gasoline LCVs under hot urban conditions.							
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	> 0	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	> 0	70.0	0.00E+00	1.000	175000	0.070	√
Euro 2	> 0	143.0	1.47E-06	0.964	150000	0.169	√
Euro 3	0-30	1.9	1.31E-06	0.862	125000	0.002	√
Euro 3	> 30	1.6	4.18E-06	0.526	125000	0.002	
Euro 4	0-30	1.9	1.31E-06	0.862	100000	0.002	√
Euro 4	> 30	1.6	4.18E-06	0.526	100000	0.002	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle							
							aging.
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.9 Sheet 'Table 3-95' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-95	**LCVs - gasoline - rural hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for gasoline LCVs under hot rural conditions.					**cumulative mileages**		
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	> 0	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	131.0	5.94E-08	0.999	175000	0.132	√
Euro 1	> 150	100.0	8.95E-07	0.978	175000	0.113	
Euro 2	0-150	148.0	5.95E-08	0.999	150000	0.149	√
Euro 2	> 150	90.7	9.08E-07	0.992	150000	0.102	
Euro 3	0-30	29.5	5.90E-08	0.994	125000	0.030	√
Euro 3	> 30	28.9	8.31E-07	0.908	125000	0.029	
Euro 4	0-30	29.5	5.90E-08	0.994	100000	0.029	√
Euro 4	> 30	28.9	8.31E-07	0.908	100000	0.029	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle aging.							
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.10 Sheet 'Table 3-96' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013							
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013							
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013							
Table 3-96	**LCVs - gasoline - highway hot**				**NH3 EFs calculated for typical**		
Parameters for equation (44) to calculate NH3 emission factors for gasoline LCVs under hot highway conditions.					**cumulative mileages**		
Emission standard	**Sulphur content**	**Base EF**	**a**	**b**	**CMileage**	**NH3 EF**	**Applicable**
	ppm	mg/km	1/km		km	g/km	**for NL**
pre-Euro	All	2.0	0.00E+00	1.000	200000	0.002	√
Euro 1	0-150	73.3	5.94E-08	0.998	175000	0.074	√
Euro 1	> 150	56.2	8.86E-07	0.968	175000	0.063	
Euro 2	0-150	83.3	5.94E-08	0.999	150000	0.084	√
Euro 2	> 150	51.0	9.05E-07	0.988	150000	0.057	
Euro 3	0-30	64.6	5.95E-08	0.999	125000	0.065	√
Euro 3	> 30	63.4	9.02E-07	0.985	125000	0.070	
Euro 4	0-30	64.6	5.95E-08	0.999	100000	0.065	√
Euro 4	> 30	63.4	9.02E-07	0.985	100000	0.068	
Equation (44) as used to calculate NH3 EFs							
EF_NH3 = [a * CMileage + b] * EF_base							
CMileage or cumulative mileage is the total distance driven by a vehicle in km and accounts for vehicle aging.							
Typical CMileage values have been estimated for the Dutch situation.							
Sulphur content of Dutch gasoline is typically 10 ppm or less.							

Table A2.11 Sheet 'Table 3-97' of "EMEP-EEA, 2013, Tables 3-89 to 3-97, expanded for NL.xlsx"

EMEP-EEA, 2013			
EMEP-EEA Emission Inventory Guidebook 2013, 1.A.3.b Road transport GB2013			
http://www.eea.europa.eu/publications/emep-eea-guidebook-2013			
Table 3-97	**Other vehicles bulk (hot + cold)**		
Bulk (hot + cold) ammonia (NH3) emission factors (g/km)			
Vehicle category	**Urban**	**Rural**	**Highway**
	g/km	g/km	g/km
Passenger cars			
Diesel cc < 2.0 l	0.001	0.001	0.001
Diesel cc > 2.0 l	0.001	0.001	0.001
LPG	nd	nd	nd
2-stroke	0.002	0.002	0.002
Light commercial vehicles			
Diesel	0.001	0.001	0.001
Heavy-duty vehicles			
Gasoline vehicle > 3.5 t	0.002	0.002	0.002
Diesel < 7.5 t	0.003	0.003	0.003
Diesel 7.5 t < W < 16 t	0.003	0.003	0.003
Diesel 16 t < W < 32 t	0.003	0.003	0.003
Diesel W > 32 t	0.003	0.003	0.003
Urban buses	0.003	-	-
Coaches	0.003	0.003	0.003
Motorcycles			
< 50 cm^3	0.001	0.001	0.001
> 50 cm^3 2-stroke	0.002	0.002	0.002
> 50 cm^3 4-stroke	0.002	0.002	0.002

Appendix III NH_3 Emission factors from Carslaw & Rhys-Tyler 2013 expanded with VERSIT+

The summarising and detailed NH_3 emission factor tables, which can be found in Excel spreadsheet *"Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"*, have been reproduced in this appendix.

Table A3.1 Sheet 'Summary' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

NH3 Emission Factors Summary for Light and Heavy Duty Vehicles based on Carslaw & Rhys-Tyler 2013

In: Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx

Based on:

Carslaw, D.C. , G. Rhys-Tyler, 2013

New insights from comprehensive on-road measurements of NOx, NO2 and NH3 from vehicle emission remote sensing in London UK

Atmospheric Environment 81 (2013) 339-347.

Light Duty Vehicles, Urban

From Table 2 expanded with VERSIT+ to convert the NH3 emission ratios (NH3/CO2) to NH3 emission factors in g/km

Vehicle type	Fuel/type	Euro class	n	VERSIT+ vehicle class	NH3 EF calc g/km
Passenger car	Petrol	0	204	LPABEUR0	0.036
Passenger car	Petrol	1	392	LPABEUR1	0.079
Passenger car	Petrol	2	2848	LPABEUR2	0.083
Passenger car	Petrol	3	5593	LPABEUR3	0.062
Passenger car	Petrol	4	8843	LPABEUR4	0.042
Passenger car	Petrol	5	1998	LPABEUR5	0.024
Passenger car	Petrol hybrid	4	154	LPHBEUR4	0.009
Passenger car	Petrol hybrid	5	605	LPHBEUR5	0.019
Passenger car	Diesel	0	15	LPADEUR0	0.001
Passenger car	Diesel	1	62	LPADEUR1	0.001
Passenger car	Diesel	2	363	LPADEUR2	0.003
Passenger car	Diesel	3	2610	LPADEUR3	0.003
Passenger car	Diesel	4	5836	LPADEUR4	0.002
Passenger car	Diesel	5	4577	LPADEUR5	0.002
London taxi	FX	2	877	LPADEUR2	0.003
London taxi	Met	2	80	LPADEUR2	0.001
London taxi	TX1	2	4148	LPADEUR2	0.002
London taxi	Met	3	148	LPADEUR3	0.002
London taxi	TXII	3	4050	LPADEUR3	0.002
London taxi	MV111	4	594	LPADEUR4	0.002
London taxi	TX4	4	4719	LPADEUR4	0.002
London taxi	TX4	5	185	LPADEUR5	0.002
London taxi	MV113	5	329	LPADEUR5	0.002
Van (N1)		1	26	LBADEUR1LCH	0.003
Van (N1)		2	93	LBADEUR2LCH	0.002
Van (N1)		3	2603	LBADEUR3LCH	0.002
Van (N1)		4	5347	LBADEUR4LCH	0.003
Van (N1)		5	4412	LBADEUR5LCH	0.002

Heavy Duty Vehicles, Urban

From Table 3 expanded with VERSIT+ to convert the NH3 emission ratios (NH3/CO2) to NH3 emission factors in g/km

Vehicle type	Technology	Euro class	n	VERSIT+ vehicle class	NH3 EF calc g/km
TfL bus	DPF	II	161	BABDEUR2DPF	0.000
TfL bus	DPF	III	631	BABDEUR3DPF	0.000
TfL bus	DPF	IV	89	BABDEUR4	0.004
TfL bus	EGR	V	106	BABDEUR5EGR	0.004
TfL bus	EGR	EEV	63	BABDEEV5EGR	-
TfL bus	SCR	IV	257	BABDEUR4SCR	0.045
TfL bus	SCR	V	266	BABDEUR5SCR	0.023
TfL bus	SCR	EEV	65	BABDEEV5SCR	0.016
TfL bus	SCR hybrid	V	158	BAHDEUR5SCR	-
Non-TfL bus		I	11	BABDEUR1	0.000
Non-TfL bus		II	84	BABDEUR2	0.000
Non-TfL bus		III	318	BABDEUR3	0.004
Non-TfL bus		IV	159	BABDEUR4	0.015
Non-TfL bus		V	203	BABDEUR5	0.004
HGV (3.5-12t)		II	50	MVADEUR2LCH	0.014
HGV (3.5-12t)		III	196	MVADEUR3LCH	0.006
HGV (3.5-12t)		IV	307	MVADEUR4LCH	0.007
HGV (3.5-12t)		V	230	MVADEUR5LCH	-
HGV (>12t)		II	17	MVADEUR2ZWA	0.013
HGV (>12t)		III	130	MVADEUR3ZWA	0.007
HGV (>12t)		IV	223	MVADEUR4ZWA	0.014
HGV (>12t)		V	191	MVADEUR5ZWA	-

Table A3.2 Sheet 'Comp LD' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

NH3 Emission Factors Comparison for Light Duty Vehicles						
In: Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx						
Based on:						
- Carslaw, D.C. and G. Rhys-Tyler, 2013						
- EMEP-EEA 2013 (COPERT)						
- Sjödin, A. and M. Jerksjö, 2008						
				Carslaw &	**COPERT**	**Sjödin &**
Light Duty Vehicles, Urban				**Rhys-Tyler**	**EMEP-EEA**	**Jerksjö**
Vehicle type	**Fuel/type**	**Euro class**	**VERSIT+ vehicle**	**NH3 EF calc**	**Urban** (hot/hot+cold)	**NH3 EF**
			class	g/km	g/km	g/km
Passenger car	Petrol	0	LPABEUR0	0.036	0.002	0.024
Passenger car	Petrol	1	LPABEUR1	0.079	0.070	0.110
Passenger car	Petrol	2	LPABEUR2	0.083	0.169	0.080
Passenger car	Petrol	3	LPABEUR3	0.062	0.002	0.041
Passenger car	Petrol	4	LPABEUR4	0.042	0.002	0.029
Passenger car	Petrol	5	LPABEUR5	0.024	-	-
Passenger car	Petrol hybrid	4	LPHBEUR4	0.009	-	-
Passenger car	Petrol hybrid	5	LPHBEUR5	0.019	-	-
Passenger car	Diesel	0	LPADEUR0	0.001	0.001	-
Passenger car	Diesel	1	LPADEUR1	0.001	0.001	-
Passenger car	Diesel	2	LPADEUR2	0.003	0.001	-
Passenger car	Diesel	3	LPADEUR3	0.003	0.001	-
Passenger car	Diesel	4	LPADEUR4	0.002	0.001	-
Passenger car	Diesel	5	LPADEUR5	0.002	-	-
London taxi	FX	2	LPADEUR2	0.003	0.001	-
London taxi	Met	2	LPADEUR2	0.001	0.001	-
London taxi	TX1	2	LPADEUR2	0.002	0.001	-
London taxi	Met	3	LPADEUR3	0.002	0.001	-
London taxi	TXII	3	LPADEUR3	0.002	0.001	-
London taxi	MV111	4	LPADEUR4	0.002	0.001	-
London taxi	TX4	4	LPADEUR4	0.002	0.001	-
London taxi	TX4	5	LPADEUR5	0.002	-	-
London taxi	MV113	5	LPADEUR5	0.002	-	-
Van (N1)		1	LBADEUR1LCH	0.003	0.001	-
Van (N1)		2	LBADEUR2LCH	0.002	0.001	-
Van (N1)		3	LBADEUR3LCH	0.002	0.001	-
Van (N1)		4	LBADEUR4LCH	0.003	0.001	-
Van (N1)		5	LBADEUR5LCH	0.002	-	-

Table A3.3 Sheet 'Comp HD' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

NH3 Emission Factors Comparison for Heavy Duty Vehicles					
In: Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx					
Based on:					
- Carslaw, D.C. and G. Rhys-Tyler, 2013					
- EMEP-EEA 2013 (COPERT)					
				Carslaw &	**COPERT**
Heavy Duty Vehicles, Urban				**Rhys-Tyler**	**EMEP-EEA**
Vehicle type	**Technology**	**Euro class**	**VERSIT+ vehicle class**	**NH3 EF calc** g/km	**Urban** (hot+cold) g/km
TfL bus	DPF	II	BABDEUR2DPF	0.000	0.003
TfL bus	DPF	III	BABDEUR3DPF	0.000	0.003
TfL bus	DPF	IV	BABDEUR4	0.004	0.003
TfL bus	EGR	V	BABDEUR5EGR	0.004	-
TfL bus	EGR	EEV	BABDEEV5EGR	-	-
TfL bus	SCR	IV	BABDEUR4SCR	0.045	0.003
TfL bus	SCR	V	BABDEUR5SCR	0.023	-
TfL bus	SCR	EEV	BABDEEV5SCR	0.016	-
TfL bus	SCR hybrid	V	BAHDEUR5SCR	-	-
Non-TfL bus		I	BABDEUR1	0.000	0.003
Non-TfL bus		II	BABDEUR2	0.000	0.003
Non-TfL bus		III	BABDEUR3	0.004	0.003
Non-TfL bus		IV	BABDEUR4	0.015	0.003
Non-TfL bus		V	BABDEUR5	0.004	-
HGV (3.5-12t)		II	MVADEUR2LCH	0.014	0.003
HGV (3.5-12t)		III	MVADEUR3LCH	0.006	0.003
HGV (3.5-12t)		IV	MVADEUR4LCH	0.007	0.003
HGV (3.5-12t)		V	MVADEUR5LCH	-	-
HGV (>12t)		II	MVADEUR2ZWA	0.013	0.003
HGV (>12t)		III	MVADEUR3ZWA	0.007	0.003
HGV (>12t)		IV	MVADEUR4ZWA	0.014	0.003
HGV (>12t)		V	MVADEUR5ZWA	-	-

Table A3.4 Sheet 'Table 1' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

Carslaw, D.C. , G. Rhys-Tyler, 2013

New insights from comprehensive on-road measurements of NOx, NO2 and NH3 from vehicle emission remote sensing in London UK

Atmospheric Environment 81 (2013) 339-347.

Table 1

Summary characteristics of the four sampling locations in London. The vehicle summaries give the total count by major vehicle type. VSP is the estimated vehicle specific power based on Jimenez-Palacios (1998).

	Aldersgate St.	Queen Victoria St.	A40 slip Road	Greenford Road
Latitude	51°31'8.21"N	51°30'42.87"N	51°32'39.56"N	51°31'11.03"N
Longitude	0°5'49.44"W	0°5'9.14"W	0°22'56.48"W	0°21'16.75"W
Mean speed (km/h)	28.3	29.1	60.2	40.1
Mean VSP (kW/t)	3.8	4.6	5.4	2.9
Cars	2844	6423	7105	18139
Vans	2403	5599	1868	3565
Taxi	4246	10796	30	67
Bus	1347	704	40	492
HGV 3.5t-12t	74	294	101	324
HGV >12t	47	98	219	204

Table A3.5 Sheet 'Table 2' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

Carslaw, D.C. , G. Rhys-Tyler, 2013

New insights from comprehensive on-road measurements of NOx, NO2 and NH3 from vehicle emission remote sensing in London UK

Atmospheric Environment 81 (2013) 339-347.

Table 2

Emission ratios (species/CO2) for different light duty vehicles types. The volume ratios have been multiplied by 10,000.
The uncertainties are shown as the 95% confidence interval in the mean. n is the sample size.
The uncertainties in the NO2/NOx ratio were calculated based on the mean uncertainties calculated for NO2 and NOx.

Vehicle type	Fuel/type	Euro class	n	NOx	± Δ	NO2	± Δ	NO2/NOx (%)	± Δ	NH3	± Δ
Passenger car	Petrol	0	204	85.1	10.7	0.5	0.4	0.6	0.4	5.0	1.0
Passenger car	Petrol	1	392	54.1	6.5	0.7	0.3	1.3	0.6	9.3	1.2
Passenger car	Petrol	2	2848	39.3	2.4	0.5	0.1	1.4	0.4	9.4	0.4
Passenger car	Petrol	3	5593	15.3	1.0	0.3	0.1	2.1	0.5	7.8	0.3
Passenger car	Petrol	4	8843	10.3	0.7	0.4	0.1	4.1	0.7	5.4	0.2
Passenger car	Petrol	5	1998	4.8	0.7	0.4	0.1	8.4	3.0	3.4	0.4
Passenger car	Petrol hybrid	4	154	1.6	1.0	0.2	0.4	12.9	27.8	1.9	0.6
Passenger car	Petrol hybrid	5	605	7.0	3.2	1.1	0.4	15.0	8.9	4.5	0.5
Passenger car	Diesel	0	15	47.0	8.7	7.2	2.0	15.3	5.0	0.2	0.2
Passenger car	Diesel	1	62	55.7	7.4	7.6	1.5	13.7	3.3	0.2	0.2
Passenger car	Diesel	2	363	65.5	4.1	5.7	0.5	8.7	0.9	0.4	0.2
Passenger car	Diesel	3	2610	62.9	1.5	10.3	0.4	16.3	0.8	0.4	0.0
Passenger car	Diesel	4	5836	47.7	0.9	13.5	0.4	28.4	0.9	0.3	0.0
Passenger car	Diesel	5	4577	49.9	1.0	12.6	0.4	25.2	0.9	0.3	0.0
London taxi	FX	2	877	90.1	2.8	3.9	0.3	4.3	0.3	0.4	0.1
London taxi	Met	2	80	149.4	20.3	11.9	2.1	8.0	1.8	0.1	0.5
London taxi	TX1	2	4148	95.7	1.3	5.6	0.2	5.9	0.2	0.3	0.0
London taxi	Met	3	148	52.5	3.1	3.6	0.5	6.9	1.0	0.2	0.1
London taxi	TXII	3	4050	52.7	1.0	6.3	0.2	11.9	0.4	0.2	0.0
London taxi	MV111	4	594	64.1	1.3	11.9	0.9	18.6	1.5	0.2	0.0
London taxi	TX4	4	4719	49.2	0.7	6.0	0.3	12.3	0.5	0.2	0.0
London taxi	TX4	5	185	79.7	7.4	15.8	2.0	19.9	3.2	0.3	0.1
London taxi	MV113	5	329	62.9	3.1	23.6	1.2	37.6	2.7	0.3	0.0
Van (N1)		1	26	74.8	14.6	9.3	2.8	12.5	4.5	0.3	0.2
Van (N1)		2	93	68.6	7.7	5.6	1.4	8.2	2.2	0.2	0.1
Van (N1)		3	2603	69.8	1.6	8.4	0.4	12.0	0.7	0.3	0.0
Van (N1)		4	5347	53.5	1.0	14.2	0.4	26.6	0.9	0.3	0.0
Van (N1)		5	4412	54.5	1.2	13.3	0.4	24.4	0.9	0.3	0.0

VERSIT+ Conversion to Emission Factors in g/km

using 2010 and WT1 (urban) from basislijst_SRM_EF_v20140212.xlsx

VERSIT+ classes and EFs			Carslaw-Rhys-VERSIT+ EFs	
VERSIT+ vehicle class	**CO2 EF** g/km	**NOx EF** g/km	**NOx EF calc** g/km	**NH3 EF calc** g/km
LPABEUR0	184.3	1.337	1.073	0.036
LPABEUR1	219.3	0.520	0.815	0.079
LPABEUR2	227.4	0.318	0.613	0.083
LPABEUR3	206.4	0.145	0.218	0.062
LPABEUR4	201.9	0.053	0.145	0.042
LPABEUR5	181.7	0.042	0.062	0.024
LPHBEUR4	119.0	0.053	0.014	0.009
LPHBEUR5	107.1	0.042	0.055	0.019
LPADEUR0	185.3	0.798	0.642	0.001
LPADEUR1	172.5	1.058	0.703	0.001
LPADEUR2	208.6	0.800	0.975	0.003
LPADEUR3	190.6	0.796	0.889	0.003
LPADEUR4	209.1	0.431	0.783	0.002
LPADEUR5	184.6	0.632	0.713	0.002
LPADEUR2	208.6	0.800	1.311	0.003
LPADEUR2	208.6	0.800	2.215	0.001
LPADEUR2	208.6	0.800	1.403	0.002
LPADEUR3	209.1	0.431	0.776	0.002
LPADEUR3	209.1	0.431	0.799	0.002
LPADEUR4	209.1	0.431	1.004	0.002
LPADEUR4	209.1	0.431	0.747	0.002
LPADEUR5	184.6	0.632	1.109	0.002
LPADEUR5	184.6	0.632	0.950	0.002
LBADEUR1LCH	250.9	0.983	1.364	0.003
LBADEUR2LCH	232.4	1.221	1.135	0.002
LBADEUR3LCH	194.0	1.035	0.983	0.002
LBADEUR4LCH	225.9	0.569	0.941	0.003
LBADEUR5LCH	184.6	0.632	0.775	0.002

Equations used for conversion of Carslaw-Rhys emission ratios into Carslaw-Rhys-VERSIT+ emission factors

NOx EF calc = NOx * CO2_EF * (((30*(NOx-NO2) + 46*NO2)/NOx)/44) / 10000

NH3 EF calc = NH3 * CO2_EF * (17/44) / 10000

Table A3.6 Sheet 'Table 3' of "Carslaw & Rhys-Tyler, 2013, Tables 1-3, expanded with VERSIT.xlsx"

Carslaw, D.C. , G. Rhys-Tyler, 2013
New insights from comprehensive on-road measurements of NOx, NO2 and NH3 from vehicle emission remote sensing in London UK
Atmospheric Environment 81 (2013) 339-347.

Table 3
Emission ratios (species/CO2) for different heavy duty vehicles types. The volume ratios have been multiplied by 10,000.
The uncertainties are shown as the 95% confidence interval in the mean. n is the sample size.
The uncertainties in the NO2/NOx ratio were calculated based on the mean uncertainties calculated for NO2 and NOx.

Vehicle type	Technology	Euro class	n	NOx	± Δ	NO2	± Δ	NO2/NOx	± Δ	NH3	± Δ
								(%)			
TfL bus	DPF	II	161	81.9	6.0	16.2	3.6	19.7	4.6	0.0	0.1
TfL bus	DPF	III	631	122.1	5.1	17.1	1.8	14.0	1.6	0.0	0.1
TfL bus	DPF	IV	89	160.2	13.9	25.5	6.1	15.9	4.1	0.1	0.1
TfL bus	EGR	V	106	92.5	10.1	18.1	2.8	19.6	3.8	0.1	0.2
TfL bus	EGR	EEV	63	119.7	12.6	16.7	3.2	13.9	3.0	-0.1	0.2
TfL bus	SCR	IV	257	104.6	7.8	0.2	0.2	0.2	0.2	1.2	0.8
TfL bus	SCR	V	266	93.3	6.1	13.4	1.9	14.4	2.2	0.6	0.4
TfL bus	SCR	EEV	65	86.1	11.9	28.3	7.5	32.9	9.8	0.4	0.4
TfL bus	SCR hybrid	V	158	84.8	5.4	4.3	0.9	5.1	1.1	0.2	0.1
Non-TfL bus		I	11	155.4	29.4	18.2	7.2	11.7	5.2	0.0	0.4
Non-TfL bus		II	84	104.1	8.7	23.8	4.9	22.9	5.1	0.0	0.2
Non-TfL bus		III	318	119.5	6.8	24.5	2.6	20.5	2.5	0.1	0.1
Non-TfL bus		IV	159	108.0	9.1	3.7	1.0	3.4	1.0	0.4	0.5
Non-TfL bus		V	203	90.2	7.7	13.3	2.7	14.8	3.3	0.1	0.1
HGV (3.5-12t)		II	50	142.1	18.2	29.9	9.5	21	7.2	0.8	0.7
HGV (3.5-12t)		III	196	111.4	8.4	20.2	3.7	18.2	3.6	0.3	0.1
HGV (3.5-12t)		IV	307	119.2	6.9	9.0	1.6	7.5	1.4	0.3	0.1
HGV (3.5-12t)		V	230	117.5	9.2	9.1	1.4	7.7	1.3	1.4	1.8
HGV (>12t)		II	17	153.4	21.6	18.0	12.4	11.7	8.2	0.4	0.4
HGV (>12t)		III	130	127.7	10.4	30.8	5.4	24.1	4.7	0.2	0.2
HGV (>12t)		IV	223	126.8	7.8	3.9	0.9	3.1	0.7	0.3	0.3
HGV (>12t)		V	191	116.1	8.2	4.4	0.8	3.7	0.7	0.2	0.2

Equations used for conversion of Carslaw-Rhys emission ratios into Carslaw-Rhys-VERSIT+ emission factors

NOx EF calc = NOx * CO2_EF * (((30*(NOx-NO2) + 46*NO2)/NOx)/44) / 10000

NH3 EF calc = NH3 * CO2_EF * (17/44) / 10000

VERSIT+ Conversion to Emission Factors in g/km
using 2010 and WT1 (urban) from basislijst_SRM_EF_v20140212.xlsx

VERSIT+ classes and EFs			Carslaw-Rhys-VERSIT+ EFs	
VERSIT+ vehicle class	**CO2 EF** g/km	**NOx EF** g/km	**NOx EF calc** g/km	**NH3 EF calc** g/km
BABDEUR2DPF	976.0	12.25	6.02	0.000
BABDEUR3DPF	1059.0	10.77	9.47	0.000
BABDEUR4	979.0	8.29	11.60	0.004
BABDEUR5EGR	1004.0	5.78	6.99	0.004
BABDEEV5EGR	-	-	-	-
BABDEUR4SCR	979.0	7.73	6.99	0.045
BABDEUR5SCR	1004.0	4.49	6.88	0.023
BABDEEV5SCR	1004.0	4.49	6.93	0.016
BAHDEUR5SCR	-	-	-	-
BABDEUR1	1017.2	13.48	11.45	0.000
BABDEUR2	976.0	12.25	7.77	0.000
BABDEUR3	1059.0	10.77	9.57	0.004
BABDEUR4	979.0	8.29	7.34	0.015
BABDEUR5	1004.0	4.81	6.66	0.004
MVADEUR2LCH	458.5	5.43	4.94	0.014
MVADEUR3LCH	505.3	5.71	4.21	0.006
MVADEUR4LCH	623.0	6.29	5.27	0.007
MVADEUR5LCH	-	-	-	-
MVADEUR2ZWA	828.1	9.94	9.20	0.013
MVADEUR3ZWA	912.5	10.24	8.97	0.007
MVADEUR4ZWA	1221.0	11.93	10.73	0.014
MVADEUR5ZWA	-	-	-	-

Appendix IV Translation of VERSIT+ vehicle classes to COPERT vehicle classes and descriptions

The translation of the VERSIT+ vehicle classes to COPERT vehicle classes and descriptions, which can be found in Excel spreadsheet *"Translation of VERSIT vehicle classes to COPERT classes and descriptions.xlsx"*, has been reproduced in this appendix.

Translation of VERSIT+ vehicle classes to COPERT classes and descriptions

In: Translation of VERSIT vehicle classes to COPERT classes and descriptions.xlsx

The translation as described below is used in Matlab script nh3ef2.m.

VERSIT+ class (1st 4 characters) *)	Used Summarising COPERT Table **)	COPERT description	Correction factor
BABB	Other LD & HD	Urban buses	1
BABC	Other LD & HD	Urban buses	1
BABD	Other LD & HD	Urban buses	1
BABL	Other LD & HD	Urban buses	1
LBAB	PCs & LCVs	LCV	1
LBAC	PCs & LCVs	LCV	1
LBAD	Other LD & HD	LCV	1
LBAE	none	LCV	0
LBAL	PCs & LCVs	LCV	1
LBED	Other LD & HD	LCV	0.5
LMFB	Other LD & HD	MC, > 50 cm³ 2-stroke	1
LPAB	PCs & LCVs	PC	1
LPAC	PCs & LCVs	PC	1
LPAD	Other LD & HD	PC, Diesel cc < 2.0 l	1
LPAE	none	PC	0
LPAL	PCs & LCVs	PC	1
LPEB	PCs & LCVs	PC	0.5
LPED	Other LD & HD	PC, Diesel cc < 2.0 l	0.5
LPHB	PCs & LCVs	PC	1
LPHD	Other LD & HD	PC, Diesel cc < 2.0 l	1
MVAB	Other LD & HD	HDV, Gasoline	1
MVAD	Other LD & HD	HDV, Diesel <	1
MVAL	Other LD & HD	HDV, Gasoline	1
ZTRB	Other LD & HD	HDV, Diesel 7	1
ZTRD	Other LD & HD	HDV, Diesel 7	1
ZTRL	Other LD & HD	HDV, Diesel 7	1
ZVAD	Other LD & HD	HDV, Diesel 7	1

Notes

*) For PCs and LCVs in addition to the 1st 4 characters of the VERSIT+ class also the Euro class (char 5-8) was used.

**) 'PCs & LCVs' and 'Other LD & HD' as defined below:

PCs	From COPERT Tables 3-89 to 3-92 expanded for NL	)
LCVs	From COPERT Tables 3-93 to 3-96 expanded for NL	) See Appendix II
Other LD & HD	From COPERT Table 3-97	)