# Test report

## Emission measurement on one (1) passenger cars of M1 type diesel, Euro 5 – with two (2) type of diesel fuel (MK1 and MK3)

DRAFT

A report for the Swedish Transport Administration

2012-04-15
Report no. 127058

Ecotraffic

# Content

# ABSTRACT

In this study tests on chassis dynamometer with two types of fuels have been carried out on a Euro 5 diesel passenger car. The objective of the work was to investigate if there is any difference in emission levels by using Swedish MK1 diesel or MK3 (EN 590 – 2009) diesel. All tests were carried out during March 2012 at TUV NORD's emission laboratory in Essen, Germany. Beside regulated emissions also several unregulated components were measured in this study.

The main conclusions of these tests are:

- For regulated emissions there are no significant differences in emissions between MK1 and MK3
- At cold ambient temperatures the emission of CO and HC show higher values for MK3 compared with MK1 (but the differences are small)
- The emission of $CO_2$ (is about 1.3 % higher for MK3 compared with MK1. This is however fully explained by comparing the carbon content per MJ. MK3 has about 1.5 % higher carbon content per MJ than MK1.
- The fuel consumption is about 1.0 % lower per km for MK3 compared with MK1. This is explained by comparing the energy content per liter (the difference is about 2 %)
- The conclusion based on these tests are that it is not any significant differences in PAH emissions from MK1 and MK3. It is not possible to compare these results with older tests based on older test vehicles (without DPF etc).
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In parallel to this study (within this program) a literature study has also been carried out (Ecotraffic report 127059). The main objective was to find studies including both MK1 and MK3. Off road, heavy duty and light duty vehicles were included in this study.

# Project information (in Swedish)

| | | | |
|---|---|---|---|
| **Beställare** | Trafikverket | **Beställningsnummer** | TRV2011/48682 A |
| **Beställningsdatum** | 2011-11-16 | **Slutdatum enligt beställning** | 2012-04-15 (reglerad)<br>2012-05-15 (oreglerat) |
| **Ansvarig hos beställare** | Magnus Lindgren | **Projektnummer** | 7058 |
| **Ansvarig hos Ecotraffic** | Lars Eriksson | **Rapportering** | Testrapport (engelska) |
| **Avvikelser** | | **Provningsplats** | TUV NORD - Essen |
| **Rapport språkgranskad** | | **Rapport godkänd av** | Börje Gevert |
| **Rapportnummer** | 127058 | **Rapporteringsdatum** | 2012-04-15 |
| **Författare** | Lars Eriksson, Peter Ahlvik, Felix Köhler (TUV NORD) | | |

# Abbreviations, acronyms and glossary

| | |
|---|---|
| CVS | Constant Volume Sampler/Sampling, a dilution device used for dilution of engine/vehicle exhaust for emission measurements. |
| CH4 | Methane |
| CO | Carbon monoxide |
| CO2 | Carbon dioxide |
| DOC | Diesel Oxidation Catalyst |
| EGR | Exhaust Gas Recirculation |
| FAME | Fatty Acid Methyl Esters |
| FC | Fuel Consumption |
| NEDC | New European Driving Cycle |
| NOX | Nitrogen oxides (NO + NO2) |
| NO | Nitrogen oxide |
| NO2 | Nitrogen dioxide |
| PM | Particulate Matter |
| PMP | Particulate Measurement Programme (the EU programme for developing new measurement methods for particle mass and number) |
| PN | Particle number |
| RME | Rasped Methyl Ester |
| MK1 | Swedish Environmental Class 1 Diesel |
| MK3 | European diesel (EN590) |
| PAH | Poly Aromatic Hydrocarbons |
| DPF | Diesel Particle Filter |

# 1. The assigment

## *Scope of work*

Ecotraffic shall on behalf of Trafikverket carry out emission tests on one diesel fuelled passenger car of M1 type, Euro 5 by using two types of fuels, MK1 and MK3 (EN590 2009). Both regulated and unregulated components shall be measured.

Result shall be reported as modal results for exhaust components NMHC, $CH_4$, CO, $CO_2$, BF, $NO_X$, $NO_2$ and PN.

Used driving cycles shall be:

- 2*UDC at + 22°C
- Artemis (hot)
- 2*UDC at – 7°C

The study shall be reported as a technical test report and the modal results shall be reported is such formatting so they can be used for calculation of emission factors.

## *Test sites*

All tests have been carried out at TUV NORD in Essen. All tests were performed during March 2012.

| | **Test Cell** |
|---|---|
| **Climatisation** | -20°C - +35°C<br>WEISS |
| **Chassis Dynamometer** | MAHA ECDM 48L 4x4 |
| **Control Unit** | MAHA |
| **CVS-Unit** | MAHA-CVS |
| **Analytical System for gaseous emissions (CO, $CO_2$, THC, NMHC, NO, $NO_X$)** | MAHA-AMA D1 |
| **Particle Collector** | MAHA-PTS |
| **Particle Balance for particle mass** | SARTORIUS SE2-F |
| **Particle Counter** | MAHA |

## *Dynomometer settings*

Identical values as in the type approval tests have been used

| | | Roller | Street |
|---|---|---|---|
| **F0** | N | 61 | 115 |
| **F1** | [N/(km/h)] | 0,0517 | 0,370 |
| **F2** | $[N/(km/h)^2]$ | 0,0312 | 0,031 |
| **Inertia** | kg | 1 590 | 1590 |

## *Fuel used*

In this study, two fuels have been used, MK1 and EN 590. The fuel specifications are described in chapter 4.

## *Type approval values*

Deterioration factors are included in the values below.

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO** mg/km | **THC** mg/km | **NMHC** mg/km | **NOX** mg/km | **THC+NOX** mg/km | **PM** mg/km | **PN** **#/km** |
| 386,3 | -- | -- | 158,3 | 207,9 | 0,41 | $0{,}01 \cdot 10^{11}$ |
| **CO2** Urban g/km | **CO2** Extra Urban g/km | **CO2** Combined g/km | **FC** Urban liter/ 100 km | **FC** Extra Urban liter/100 km | **FC** Combined liter/100 km | |
| 160 | 113 | 129 | 6,1 | 4,3 | 4,9 | |

### *Vehicle*

One diesel cars of euro 5 class have been used in this study. The car was a Germany car (German registration plate).

| | |
|---|---|
| **Manufacture** | Volkswagen, VW |
| **Model** | GOLF VI, (1K) |
| **Chassi no** | WVWZZZ1KZBP169860 |
| **Gear Box** | MT5 |
| **Wheel/Tires** | 205/55 R16 |
| **Engine displacement** | 1,6l (CAYD) |
| **Power** | 77 kW |
| **Odometer** | 27 169 km |
| **Emission class** | EURO 5 |
| **Year model** | 2011 |
| **Type of exhaust gas**<br>**Technology** | DPF, (no additive used for regeneration)<br>EGR<br>DOC |

### *Un-regulated emissions*

PAH analysis was performed by the research group of Roger Westerholm at the department of Analytical Chemistry at Stockholm University. Extraction of the collected PUF and filter samples was conducted using pressurized fluid extraction on an ASE 200 accelerated solvent extraction system (Dionex Corporation, Sunnyvale, CA, USA). The filters were extracted using a method recently validated for PAH analysis with diesel particulate matter standard reference materials from the US National Institute of Standards and Technology (NIST) [Masala et al., 2011; Sadiktsis et al., 2012]. Extractions of five consecutive 30 min static extraction cycles were performed with a mixture of toluene and methanol (9:1; v/v) at elevated temperature and pressure (200 °C and 3000 psi). The PUF samples were extracted with acetone at 110 °C and 500 psi using two extraction cycles of 5 min. The extracts were evaporated to 0.5 ml and subjected to clean-up using silica solid phase extraction as described in detail elsewhere [Bergvall and Westerholm, 2006]. The analysis of PAHs was performed using a hyphenated High Performance Liquid Chromatography- Gas Chromatography/Mass Spectrometry (HPLC-GC/MS) system, previously described in detail [Christensen et al., 2005]. Detailed description on the method parameters used is available elsewhere [Sadiktsis et al., 2012]. [Ref 1 – 4]

Aldeydes, ketones and alkenes were analyzed by IVL in Göteborg. Samples were collected in adsorption pipes and in canisters. During analyzing of samples, air is pumped through an electrically cooled, sorbent packed, focusing trap. After sampling the trap is heated and the analyses are transported into a gas chromatograph (GC) with two separate column lines and two separate flame-ionisation detectors (FID). The analyze method is fully described in reference, Potter, A.(2005). Analysis Method for Ozone Precursor Volatile Organic Compounds, IVL Rapport U1121.

### *Driving Cycles*

See also chapter 3 for more details.

#### 2*UDC

In this study, the first part of European driving cycle (NEDC) is used. This part also known as UDC (Urban Driving Cycle) is a cycle that is commensurate with a typical run in a typical European town. The cycle consists of four identical parts with a total length of 13 minutes. Maximum speed is 50 km / h. The UDC was repeated 2 times, i.e. 8 repetitions, totaling 26 minutes. Before starting the vehicle should take the ambient temperature and the start will be preceded by 40 seconds idle

## Artemis

Artemis is a driving cycle that is supposed to be more reality-like than the NEDC. In these tests Artemis was started with a “warm engine”. In practice this means that the catalyst has reached operating temperature already at the start. Compared to the UDC driving cycle - Artemis has higher load, faster acceleration and higher top speeds. The cycle consists of three parts, urban (about 15 minutes, 4.5 km), rural (about 18 min, 17 km) and highway (about 18 min, 29 km).

### Test sequence

The tests were carried out in the order described in the table below. Marked with underline = also unregulated components. Rest is only regulated components.

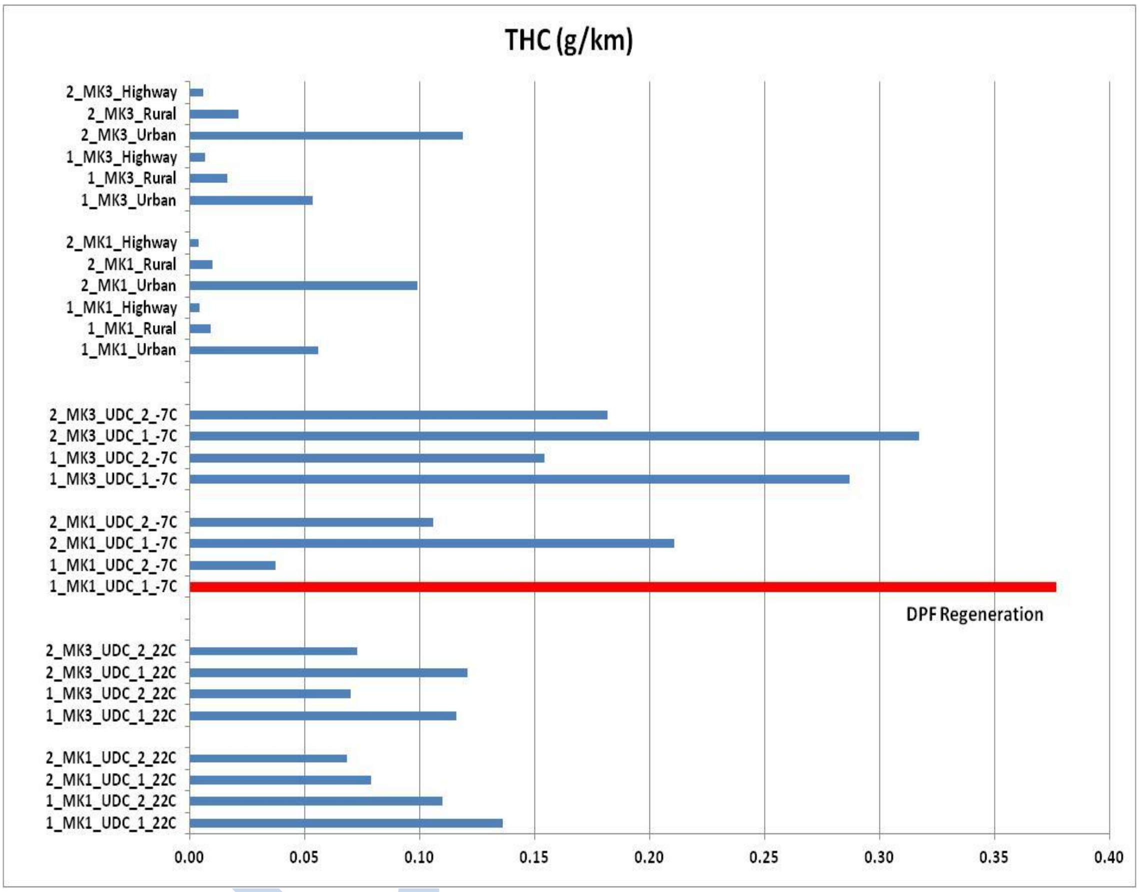
| Test no. | Driving Cycle | |
|---|---|---|
| | ***Fuel = MK1*** | |
| 1 | UDC + UDC | + 22 C |
| 2 | Artemis (hot start)* | |
| 3 | UDC + UDC | -7 C |
| 4 | UDC + UDC | + 22 C |
| 5 | Artemis (hot start)* | |
| 6 | UDC + UDC | -7 C |
| | ***Fuel = MK3*** *(also change oil and filter)* | |
| 7 | UDC + UDC | + 22 C |
| 8 | Artemis (hot start)* | |
| 9 | UDC + UDC | -7 C |
| 10 | UDC + UDC | + 22 C |
| 11 | Artemis (hot start)* | |
| 12 | UDC + UDC | -7 C |
| | No car – only air from dilution tunnel | |
| 13 | Zero / Blank test | Performed after MK1-tests (between no 6 and 7) |

*Artemis: Un-regulated emissions were sampled from the urban part of the Artemis cycle. Regulated components were divided in all three parts, urban, rural and highway.

## 2. Results

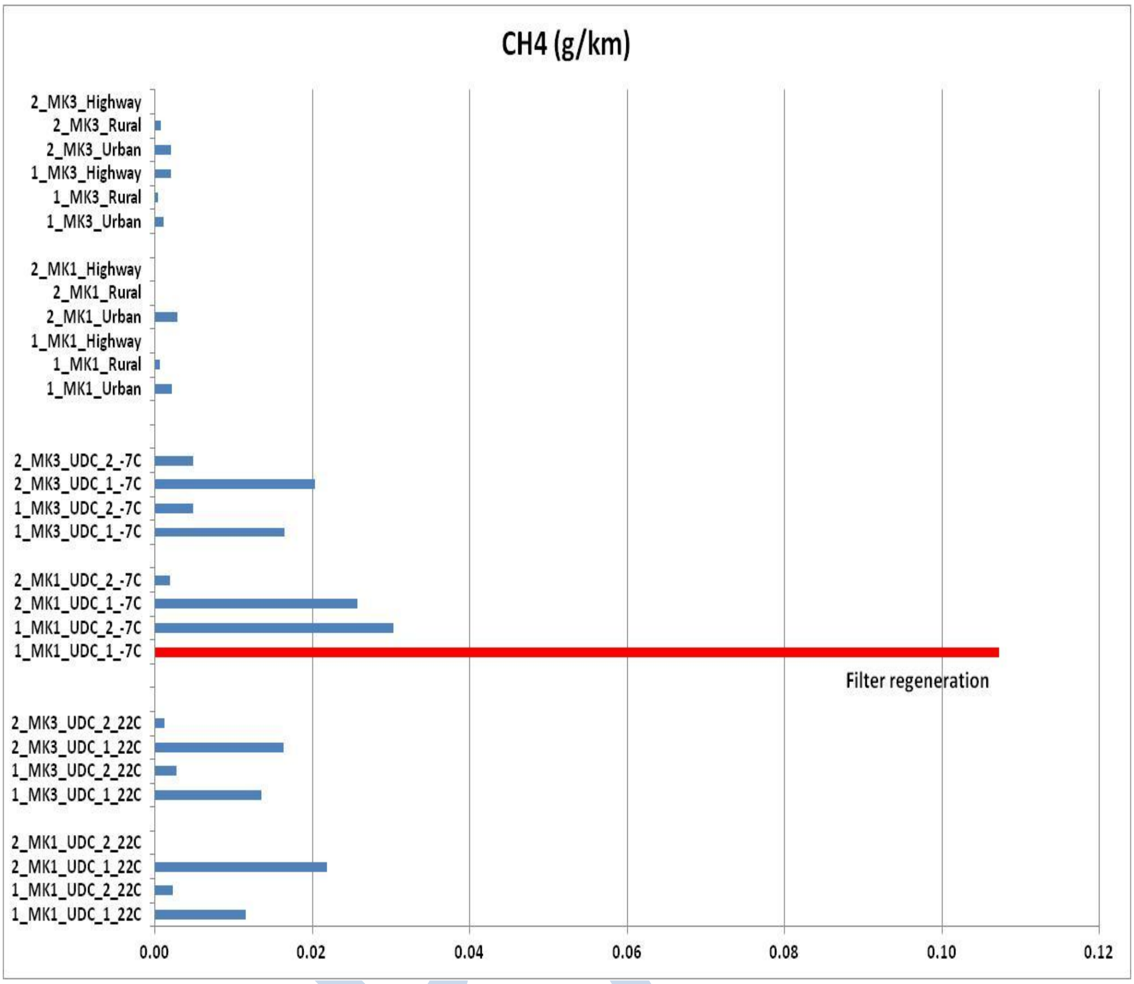
Below results from the measurements are showed and short comments are given. On the first test for MK1 at -7 C it was a regeneration of the diesel particle filter (DPF) during that cycle. *Marked with 1_MK1_UDC_1_-7*

This explains increase in exhaust emission in that driving cycle.



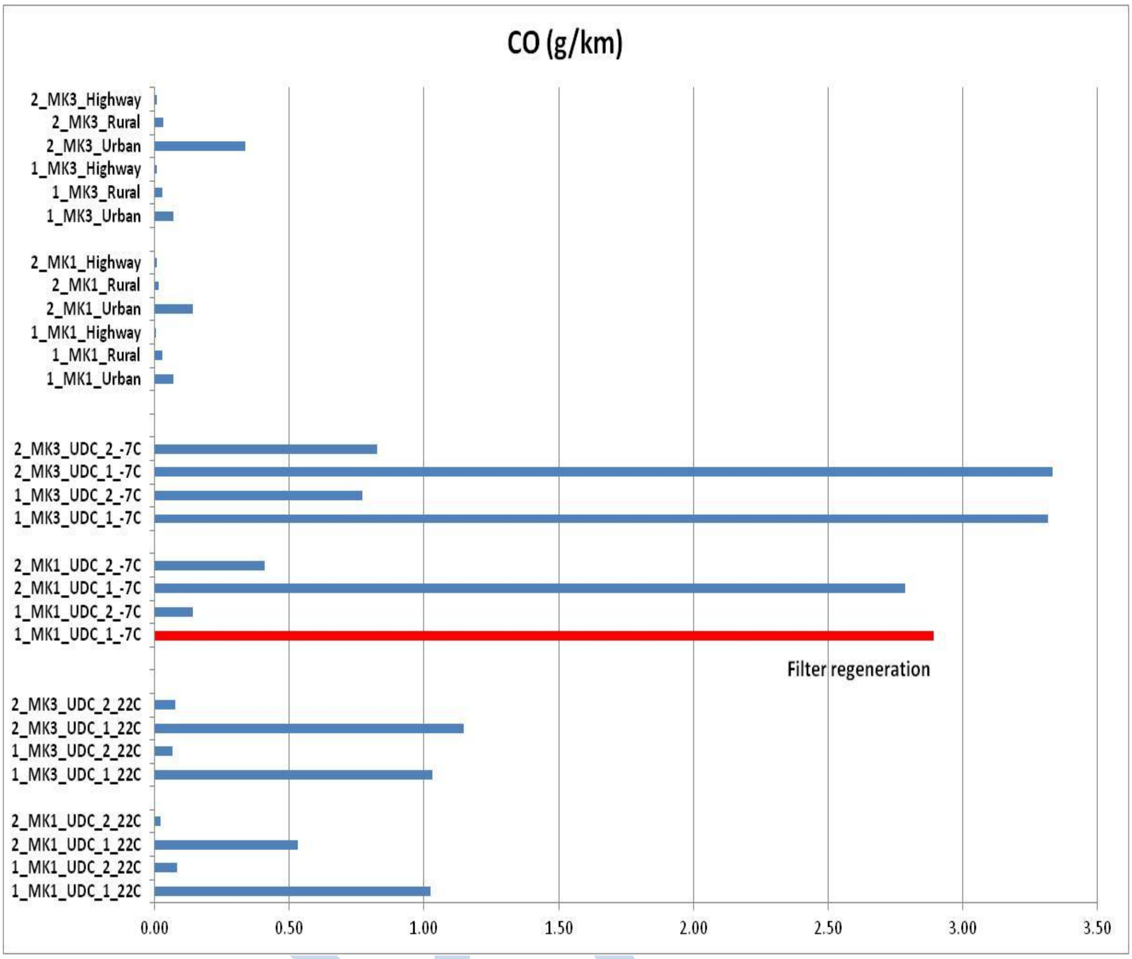

There are no significant differences in HC emissions by using MK1 or MK3 as fuel. At – 7 it seems that the emissions are higher for MK3. However the difference showed is small and the absolute levels are low.

## $CH_4$



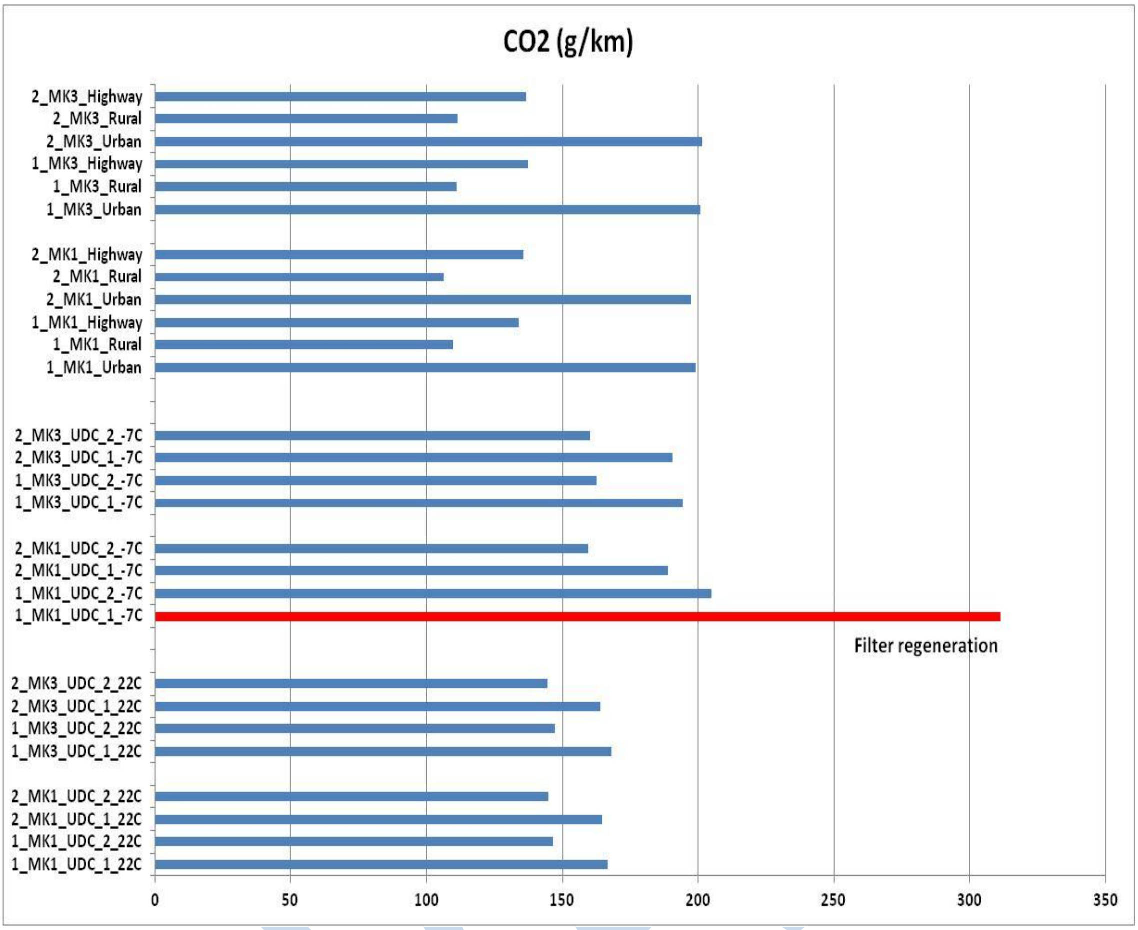

The emissions of methane are low for both type of fuels and the levels are low (except for MK1 at – 7 due to the filter regeneration). Methane is considered a relatively potent greenhouse gas, about 25 CO2 equivalents, but otherwise as a harmless component.

## *CO*




There are no significant differences in CO emissions by using MK1 or MK3 as fuel. At – 7 it seems that the emissions are higher for EN 590. However the difference showed is small and the absolute levels are low. See also THC.

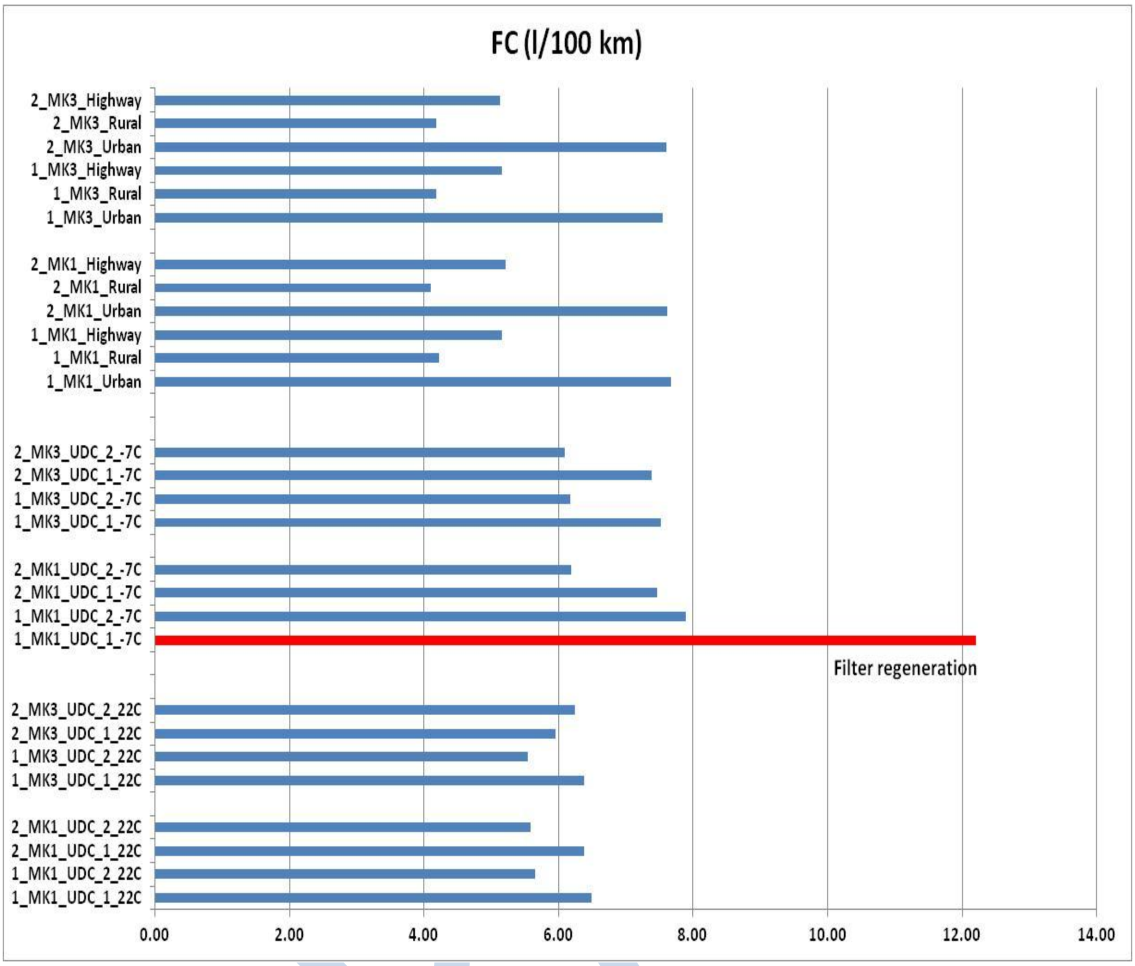
### *$CO_2$*




There are no differences in $CO_2$-emissions between the two fuels that not may be explained by the differences in carbon content in the fuels. By study the values in detail the the emission of $CO_2$ is about 1.3 % higher for MK3 compared with MK1. This is however fully explained by comparing the carbon content per MJ. MK3 has about 1.5 % higher carbon content per MJ than MK1.

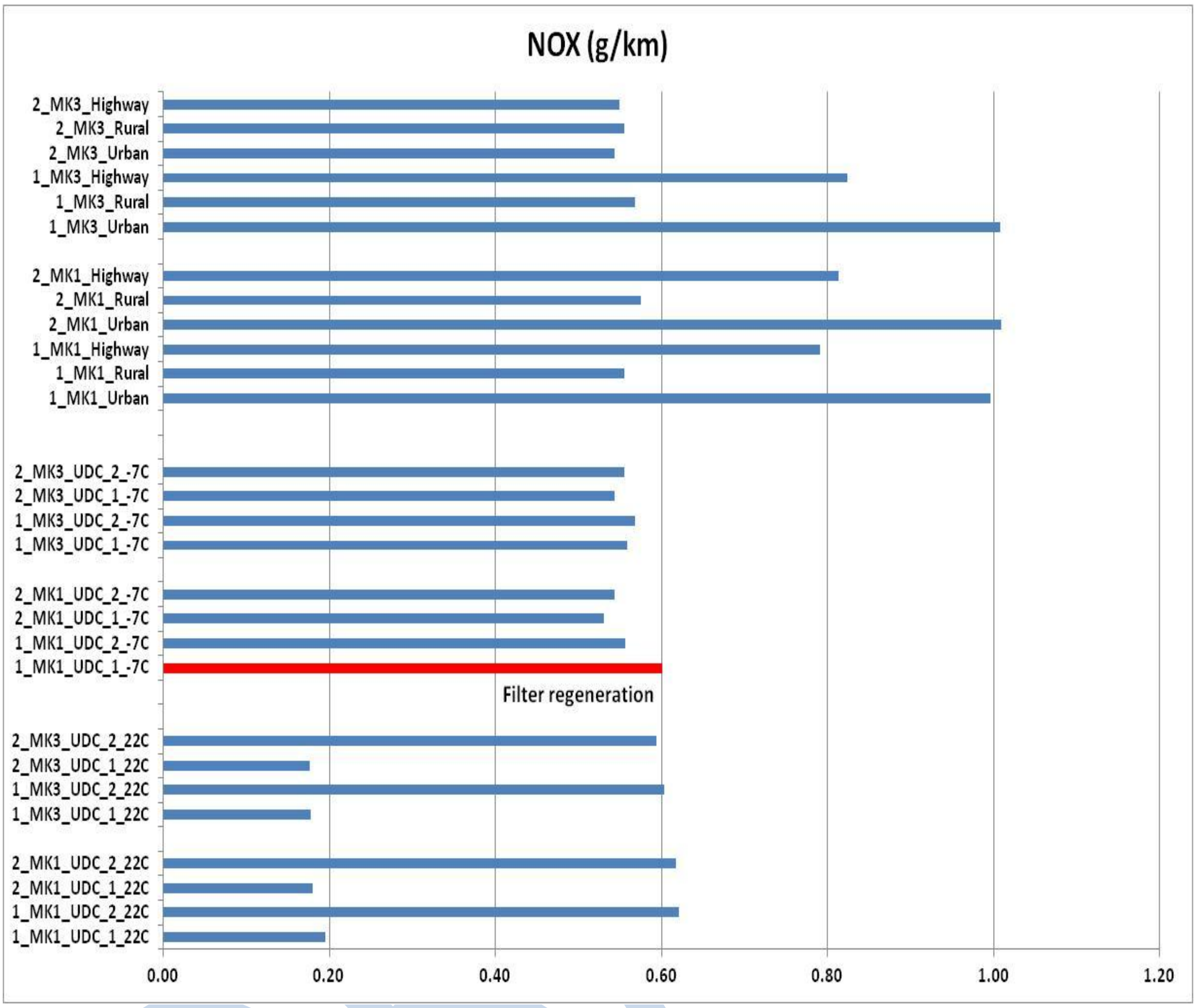
The relatively high emission for MK1 at – 7 is due to filter regeneration.

### *Fuel consumption*



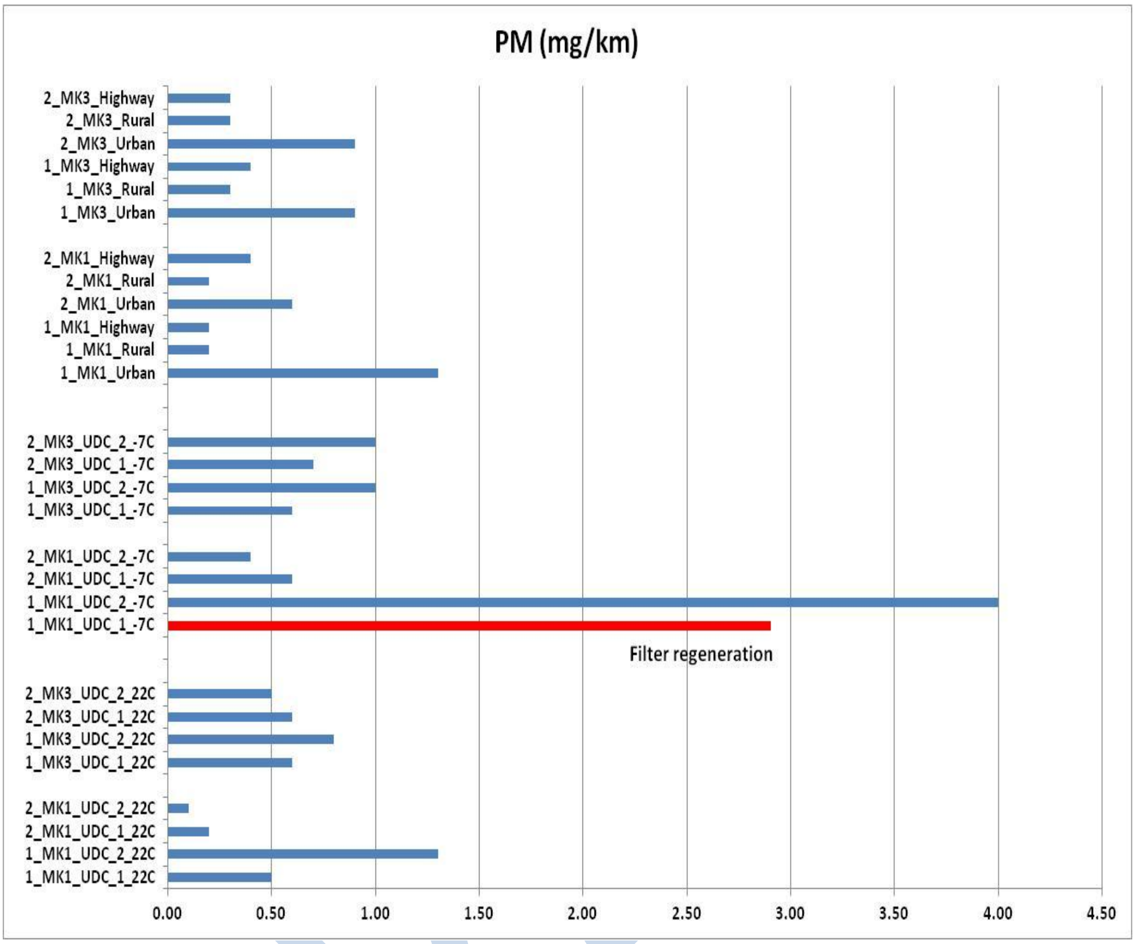

Fuel consumption can use the same reasoning as for $CO_2$. The contribution of $CO_2$ in the calculation of fuel consumption is quite dominant. The fuel consumption is about 1.0 % lower per km for MK3 compared with MK1. This is explained by comparing the energy content per liter (the difference is about 2 %)

## *$NO_X$*




There are no differences in $NO_X$-emission between the two fuels. The levels are relatively high except for the first UDC cycles. After the first UDC – $NO_X$ values increases from about 0.18 g/km to 0.6 g/km. This is not fully understood but this is however an issue outside this study.

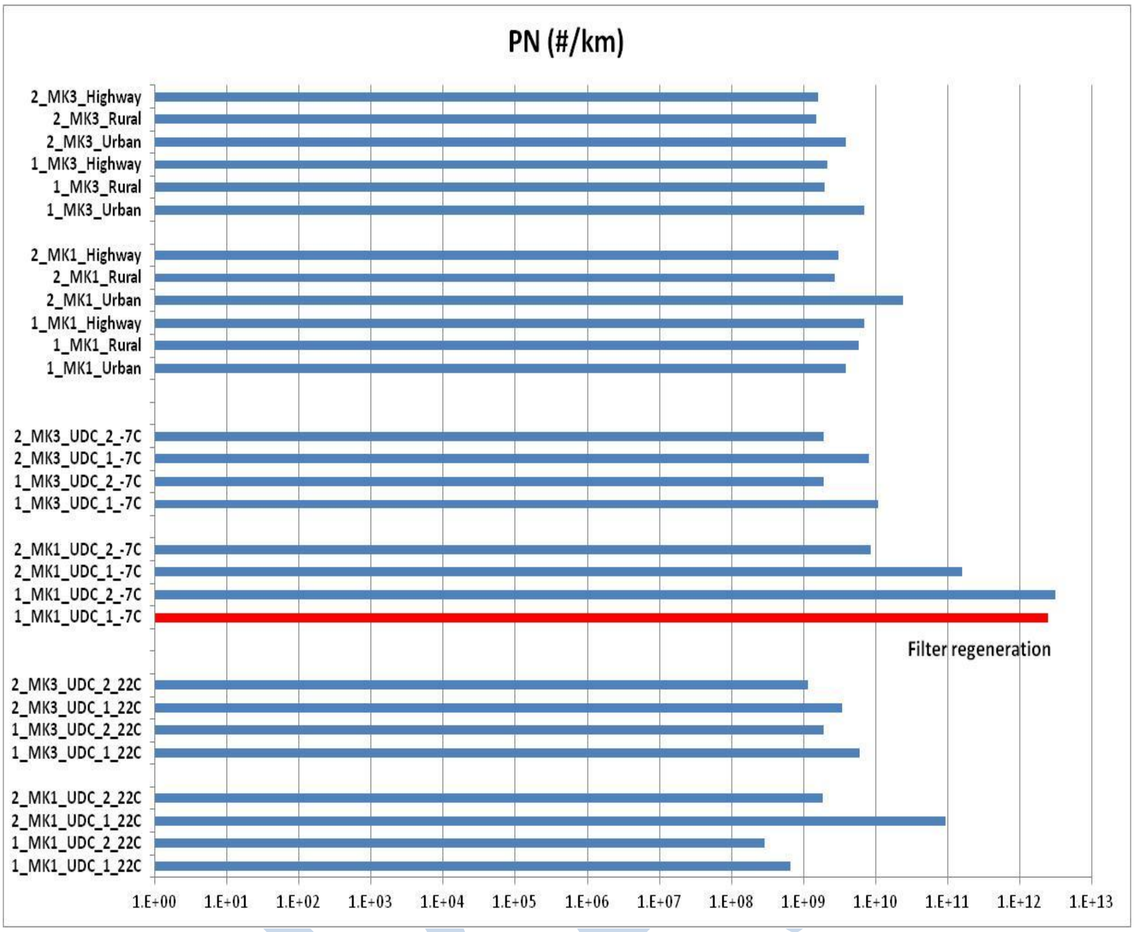
### *Particle mass (PM)*




PM was measured by collecting particles on filter paper. These are very low weights (in absolute terms). This allows the measurement uncertainty is relatively large, so large that it is difficult to draw relevant conclusions from filter weight. A general conclusion is that there are very low PM emissions and that it is not any differences due to the use of fuel MK1 or MK3.

The relatively high emission for MK1 at – 7 is due to filter regeneration. After the regeneration (1_MK1_UDC_2_-7) the particle mass emission increases. This phenomena due to that a clean filter has lower filtration capacity (a soot layer is necessary for full function) than a not regenerated filter.

### *Particle number (PN)*



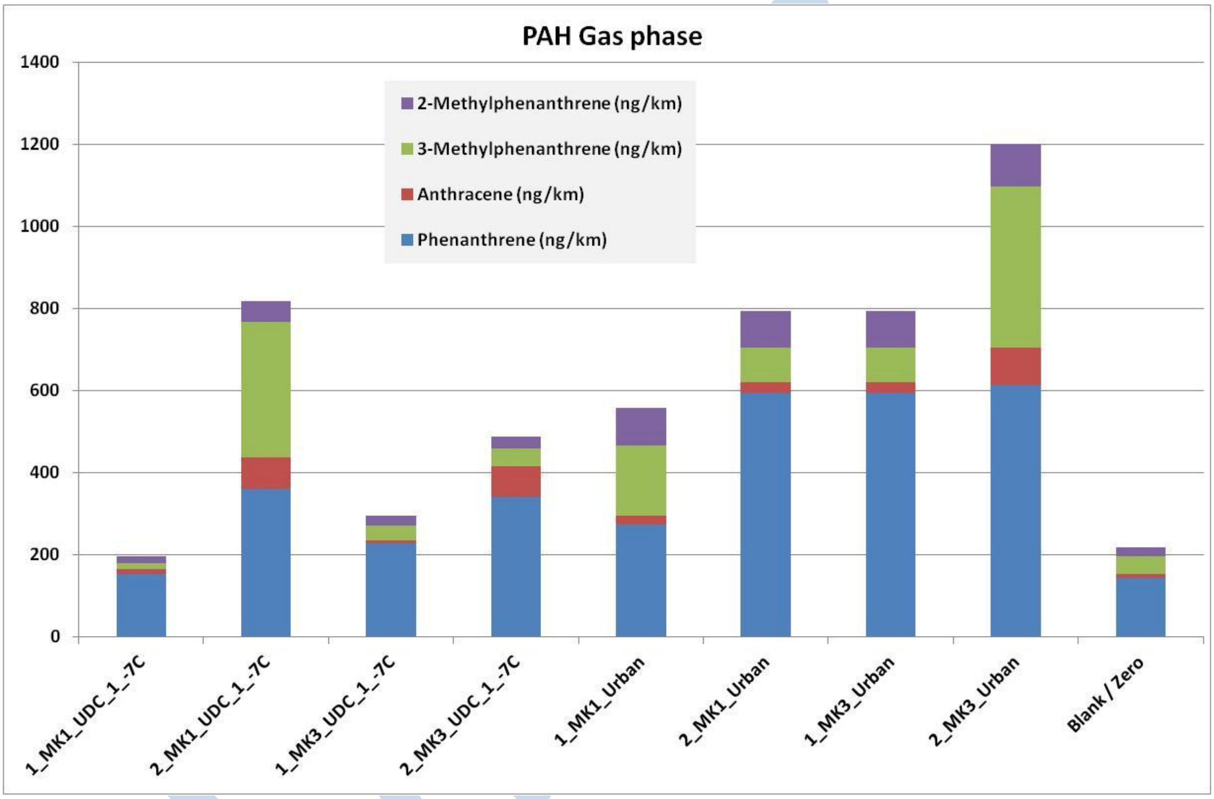

Measurement of particles number according to the PMP is associated with many uncertainties. The vehicle is equipped with particulate filter (DPF). When this type of filter is running and has a layer of soot in it so is the filtration rate is very high. It is however possible to draw the conclusion that the emissions of particle number is very low and that the filter work well. To draw conclusions other than it is associated with considerable uncertainty.

The relatively high emission for MK1 at – 7 is due to filter regeneration. See alos similar discussion as for the PM-emissions above.

### *Un-regulated results – PAH*

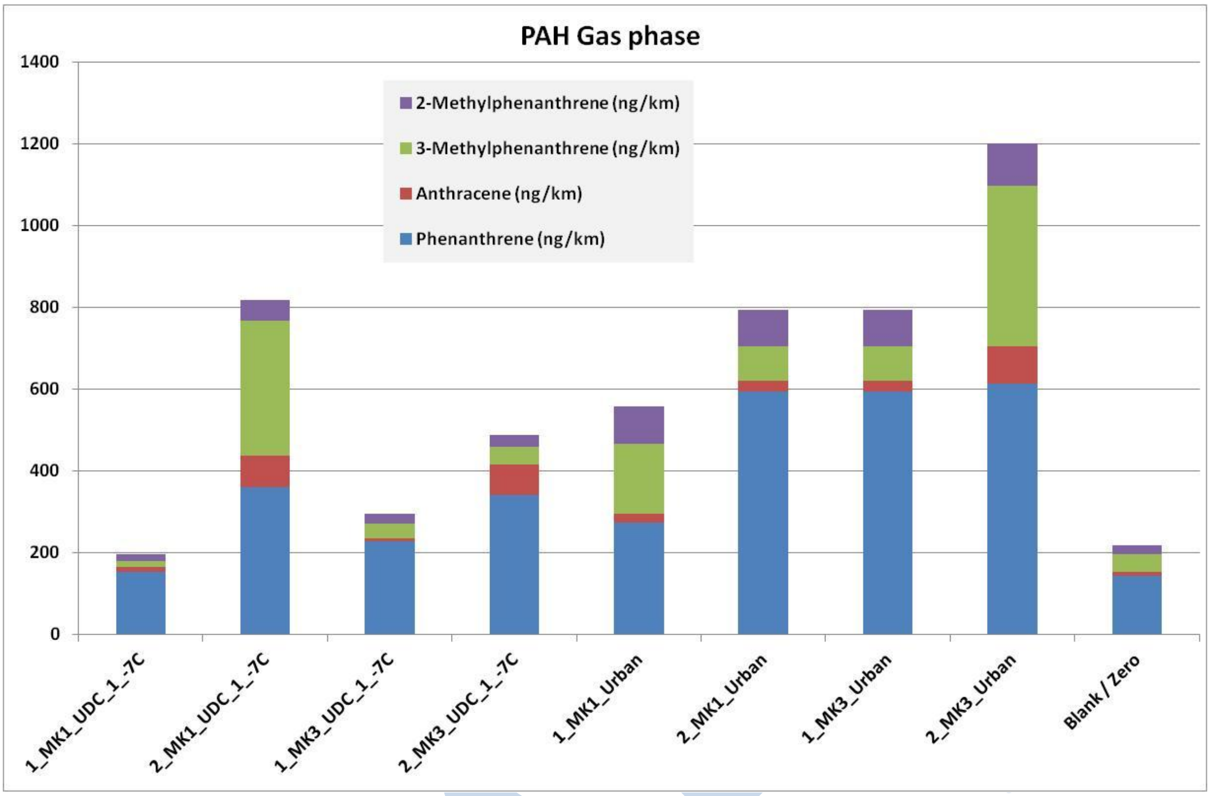
PAH emissions were measured as gas phase and particle phase emissions (condensate on particles). In appendix, all results are presented as result tables.

Below, results from gas phase are presented. In total, 18 PAH components were measured. 12 of these were close to or under detection limits for both MK1 and MK3. The values are low (nano grams) and it is not possible to find any significant differences between the two fuel used.



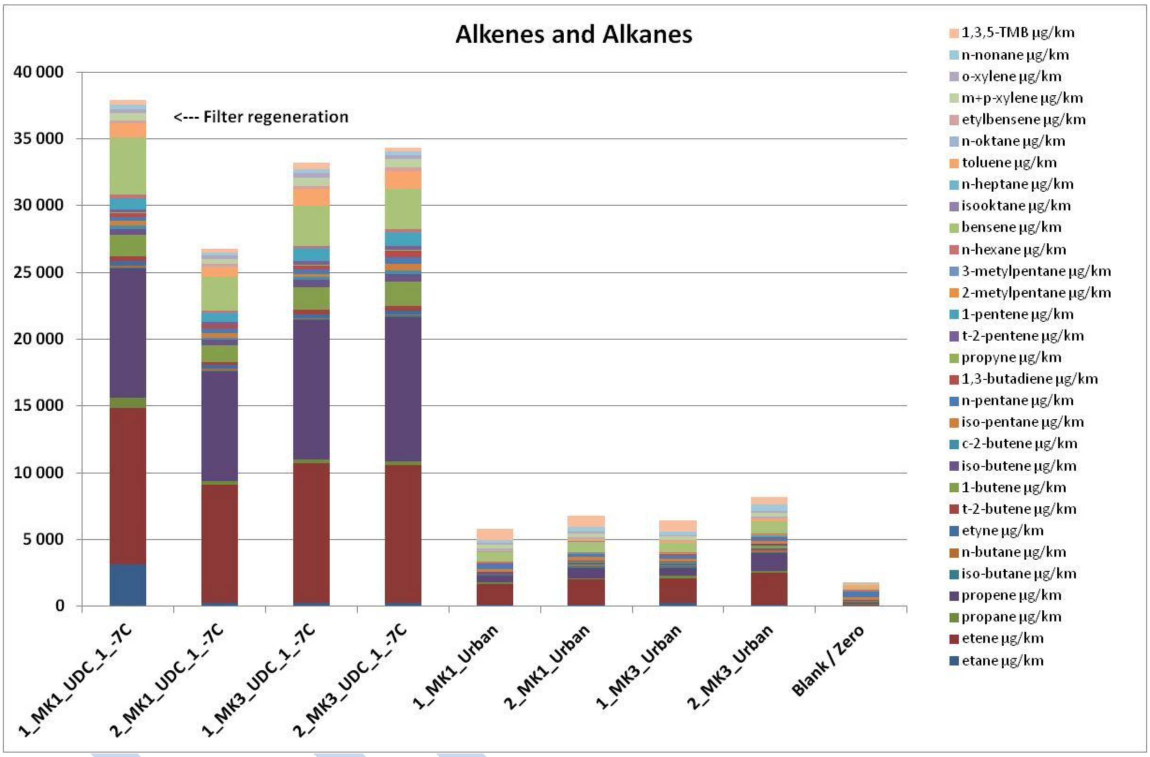

For PM phase, see figure on next page, the emission values are lower compared with the gas phase. This results due to the effective diesel particle filter used on the test vehicle.

The conclusion based on these tests are that it is not any significant differences in PAH emissions from MK1 or MK3. It is not possible to compare these results with older tests based on older test vehicles (without DPF etc).


PAH Gas phase
2-Methylphenanthrene (ng/km)
3-Methylphenanthrene (ng/km)
Anthracene (ng/km)
Phenanthrene (ng/km)
1400
1200
1000
800
600
400
200
0
1_MK1_UDC_1_-7C
2_MK1_UDC_1_-7C
1_MK3_UDC_1_-7C
2_MK3_UDC_1_-7C
1_MK1_Urban
2_MK1_Urban
1_MK3_Urban
2_MK3_Urban
Blank / Zero

## *Un-regulated results – Alkenes and alkanes*

After the catalytic converter has reach the light off temperature there are no differences between the two fuels, see results for Artemis driving cycle below. For start at low temperature it seems to be a small benefit for MK1. This difference may be explained by higher cold start emissions of propene, 1.3 butadiene, benzene and toluene for MK3 compared with MK1. However, it is low absolute values and the differences are not large.




In appendix, all results are presented as result tables.

*Un-regulated results – Aldehydes*

DRAFT

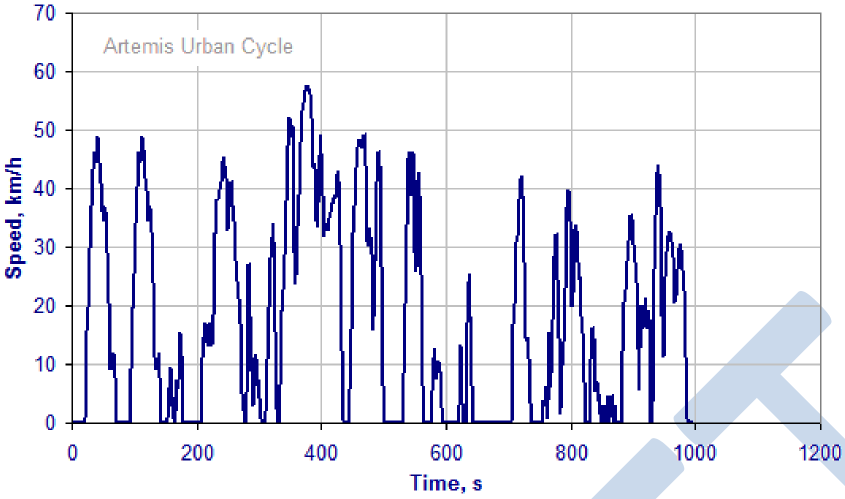
## *Conclusions*

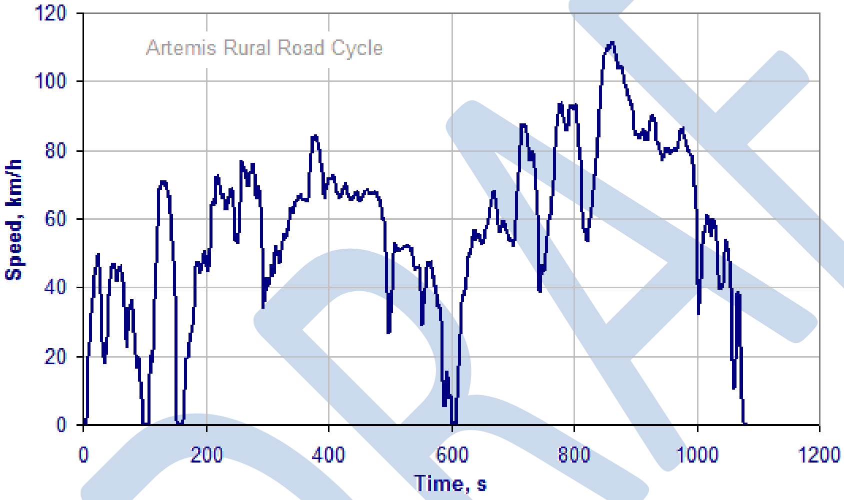
By comparing emission from the two types of fuel we can draw these conclusions:

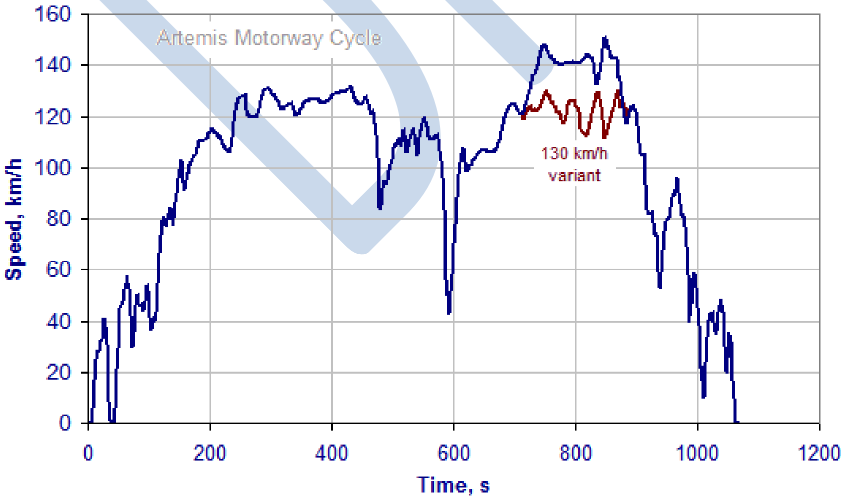
- For regulated emissions there are no significant differences in emissions between MK1 and MK3.
- At cold ambient temperatures the emission of CO and HC show higher values for MK3 compared with MK1 (but the differences are small)
- The emission of $CO_2$ (is about 1.3 % higher for MK3 compared with MK1. This is however fully explained by comparing the carbon content per MJ. MK3 has about 1.5 % higher carbon content per MJ than MK1.
- The fuel consumption is about 1.0 % lower per km for MK3 compared with MK1. This is explained by comparing the energy content per liter (the difference is about 2 %)
- The conclusion based on these tests are that it is not any significant differences in PAH emissions from MK1 and MK3. It is not possible to compare these results with older tests based on older test vehicles (without DPF etc).
-

# 3. Driving cycles (graphs)

## *Artemis*

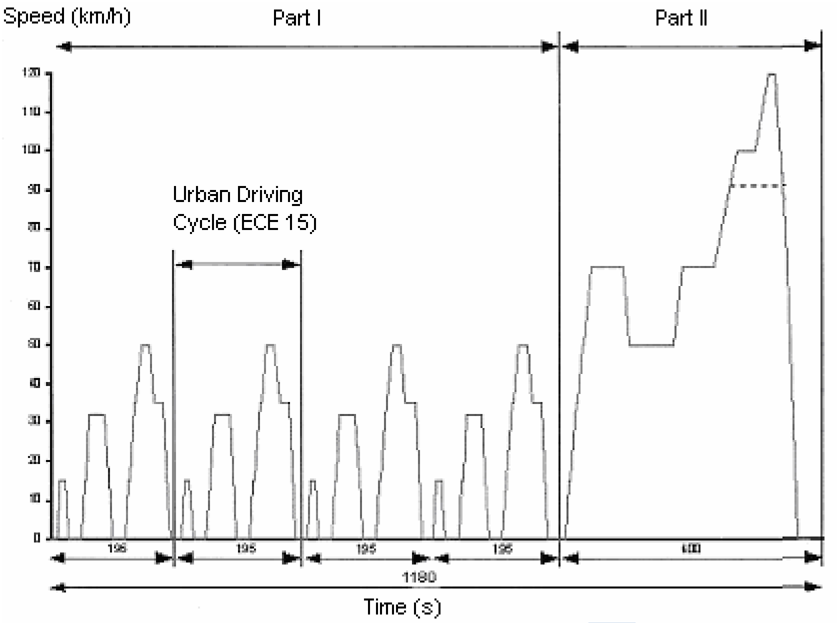



Source – Dieselnet

## *UDC*




Source – GlobalNEST

# 4. Fuel specifications

PREEM AB
Certificate of Quality

| | | | |
|---|---|---|---|
| Product Code: | **Diesel B7** | Vessel: | |
| Nomination number: | **FAT.111114.B7** | Destination: | |
| Lineblend: | | Account: | |
| Tank: | **DBB7 från OKQ8** | Delivery Date: | |
| Revised Issue: | | Sample Number: | **2011029238** |

**SWEDISH AUTOMOTIVE GASOIL MK1**

| Properties | Results | Units | Ref. Test Methods |
|---|---|---|---|
| Appearance at 20°C | 1 | rating | ASTM D 4176-04 |
| Appearance at 20°C | BRIGHT AND CLEAR | | Visual inspection |
| Aromatic content | 4,0 | % V/V | SS 15 51 16:1993 |
| Ash content | < 0,010 * | % m/m | SS-EN ISO 6245:2003 |
| Carbon residue (on 10% dist res) | < 0,20 * | % m/m | SS-EN ISO 10370:1996 |
| Cetane index | 52,5 | - | SS-EN ISO 4264:2007 |
| Cetane number | 56,0 | | SS-EN ISO 5165:1998 |
| Cloud point | -30 | °C | SS-EN 23015:1994 |
| Cold Filter Plugging Point | -40 | °C | SS-EN 116:1999 |
| Colour (ASTM scale) | < 1,0 | | SS-ISO 2049:1997 |
| Conductivity | 230 | pS/m | SS-ISO 6297:1998 |
| Cu strip corrosion (3h at 50°C) | 1A * | | SS-EN ISO 2160:1998 |
| Density at 15°C | 819,5 | kg/m3 | SS-EN ISO 12185 T1:99 |
| Dist: IBP | 179,9 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 65% V/V evap. | 253,1 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 95% V/V rec. | 314,4 | °C | SS-EN ISO 3405:2000 |
| FAME content | 6,9 | % V/V | - |
| Flash point | 67,5 | °C | SS-EN ISO 2719:2003 |
| Lubricity (WSD 1.4) at 60°C | 188 | µm | SS-EN ISO 12156-1:06 |
| PAH content | < 0,02 | % V/V | SS 15 55 16:1993 |
| Polycyclic aromatic content | 0,26 | % m/m | EN 12916:2006 |
| Sulphur content | < 3 | mg/kg | SS-EN ISO 20884:2004 |
| Total contamination | < 24 * | mg/kg | SS-EN 12662:2008 |
| Water content | < 30 | mg/kg | SS-EN ISO 12937:2001 |
| Viscosity at 40°C | 2.140 | mm2/s | SS-EN ISO 3104/AC:99 |

* Värderna kommer från Prod Spec. Diesel D15RSE OKQ8 027/07 (MK1)

Results according to ISO 4259
This product meets the quality requirements according to customer's nomination.

Work by: Dolores Martinez
Chemist in Charge:

Telephone: +46 (0)10 450 41 85
Fax: +46 (0)10 450 41 86

For Preemraff Göteborg: ……………………………………

PREEM AB
Certificate of Quality

| | | | |
|---|---|---|---|
| Product Code: | **SD-DIESEL EUR VI B7** | Vessel: | |
| Nomination number: | **FAT.111114.B7** | Destination: | |
| Lineblend: | | Account: | |
| Tank: | **DBB7 från OKQ8** | Delivery Date: | |
| Revised Issue: | **Andrad från prov nr. 2011029238** | Sample Number: | **2012007318** |

## Diesel Euro VI B7

| Properties | Results | Units | Ref. Test Methods |
|---|---|---|---|
| Appearance at 20°C | BRIGHT AND CLEAR | | Visual inspection |
| Aromatic content | 4,0 | % V/V | EN 12916:2006 |
| Ash content | < 0,010 * | % m/m | SS-EN ISO 6245:2003 |
| Carbon content | 85,0 | % m/m | ASTM D 5291-10 |
| Carbon Hydrogen Ratio | 5,97 | | ASTM D 5291-10 |
| Carbon Oxygen Ratio | 115,10 | | ASTM D 5291-10 |
| Carbon residue (on 10% dist res) | < 0,20 * | % m/m | SS-EN ISO 10370:1996 |
| Cetane index | 52,5 | - | SS-EN ISO 4264:2007 |
| Cetane number | 56,0 | | SS-EN ISO 5165:1998 |
| Cloud point | -30 | °C | SS-EN 23015:1994 |
| Cold Filter Plugging Point | -40 | °C | SS-EN 116:1999 |
| Colour | Undyed | | Visual inspection |
| Copper content | < 1 | mg/kg | ASTM D 6443:2010 |
| Cu strip corrosion (3h at 50°C) | 1A * | | SS-EN ISO 2160:1998 |
| Density at 15°C | 819,5 | kg/m3 | SS-EN ISO 12185 T1:99 |
| Dist: IBP | 179,9 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 10% V/V rec. | 208,6 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 50% V/V rec. | 239,3 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 90% V/V rec. | 295,2 | °C | SS-EN ISO 3405:2000 |
| Dist: Temp. at 95% V/V rec. | 314,4 | °C | SS-EN ISO 3405:2000 |
| Dist:FBP | 326,0 | °C | SS-EN ISO 3405:2000 |
| Dist:Residue | 1,0 | % V/V | SS-EN ISO 3405:2000 |
| FAME content | 6,9 | % V/V | SS-EN 14078:2009 |
| Flash point | 67,5 | °C | SS-EN ISO 2719:2003 |
| Hydrogen content | 14,3 | % m/m | ASTM D 5291-10 |
| Lubricity (WSD 1.4) at 60°C | 188 | µm | SS-EN ISO 12156-1:06 |
| Net heat of combustion | 42,75 | MJ/kg | SS 15 51 38:1992 |
| Oxidation stability | < 25 | g/m3 | SS-EN ISO 12205:1996 |
| Oxidation stability at 110°C | > 20,0 | hours | EN 15751:2009 |
| Oxygen content | 0,7 | % m/m | ASTM D 5291-10 |
| Polycyclic aromatic content | 0,3 | % m/m | EN 12916:2006 |
| Strong acid number SAN | < 0,10 | mg KOH/g | ASTM D 974-04 |
| Sulphur content | < 3 | mg/kg | SS-EN ISO 20846:2004 |
| Total contamination | < 24 * | mg/kg | SS-EN 12662:2008 |
| Water content | < 30 | mg/kg | SS-EN ISO 12937:2001 |
| Viscosity at 40°C | 2,140 | mm2/s | SS-EN ISO 3104/AC:99 |
| Zinc content | < 1 | mg/kg | ASTM D 6443:2010 |

* Värderna kommer från Prod Spec. Diesel D15RSE OKQ8 027/07 (MK1)

Results according to ISO 4259

This product meets the quality requirements according to customer's nomination.

Work by: Dolores Martinez
Chemist in Charge:

Telephone: +46 (0)10 450 41 85
Fax: +46 (0)10 450 41 86

For Preemraff Göteborg: Dolores Martinez

# 5. References

1. Bergvall C, Westerholm R (2006) Determination of dibenzopyrenes in standard reference materials (SRM) 1649a, 1650, and 2975 using ultrasonically assisted extraction and LC-GC-MS. Anal Bioanal Chem 384 (2):438-447.

2. Christensen A, Östman C, Westerholm R (2005) Ultrasound-assisted extraction and on-line LC–GC–MS for determination of polycyclic aromatic hydrocarbons (PAH) in urban dust and diesel particulate matter. Anal Bioanal Chem 381 (6):1206-1216.

3. Masala S, Ahmed T, Bergvall C, Westerholm R (2011) Improved efficiency of extraction of polycyclic aromatic hydrocarbons (PAHs) from the National Institute of Standards and Technology (NIST) Standard Reference Material Diesel Particulate Matter (SRM 2975) using accelerated solvent extraction. Anal Bioanal Chem 401:3305–3315.

4. Sadiktsis I, Bergvall C, Westerholm R (2012) Determination of 178-302 Da PAHs in the diesel particulate standard reference materials 1650b and 2975 using pressurized fluid extraction and online HPLC-GC-MS. In preparation. To be submitted to Anal Bioanal Chem.

# 6. Appendix 1 – result table regulated emission

| Test | THC (g/km) | CO (g/km) | CO2 (g/km) | NOX (g/km) | FC (l/100 km) | PM (mg/km) | PN (#/km) |
|---|---|---|---|---|---|---|---|
| 1_MK1_UDC_1_22C | 0.1362 | 1.024 | 166.7 | 0.1947 | 6.497 | 0.5 | 6.54E+08 |
| 1_MK1_UDC_2_22C | 0.1101 | 0.0832 | 146.45 | 0.6214 | 5.657 | 1.3 | 2.86E+08 |
| 2_MK1_UDC_1_22C | 0.0788 | 0.5321 | 164.75 | 0.1805 | 6.381 | 0.2 | 9.31E+10 |
| 2_MK1_UDC_2_22C | 0.0684 | 0.0224 | 144.91 | 0.6169 | 5.585 | 0.1 | 1.84E+09 |
| | | | | | | | |
| 1_MK3_UDC_1_22C | 0.1161 | 1.0301 | 168.17 | 0.1775 | 6.385 | 0.6 | 5.93E+09 |
| 1_MK3_UDC_2_22C | 0.0698 | 0.066 | 147.28 | 0.6031 | 5.539 | 0.8 | 1.89E+09 |
| 2_MK3_UDC_1_22C | 0.1207 | 1.1468 | 164.02 | 0.176 | 5.962 | 0.6 | 3.37E+09 |
| 2_MK3_UDC_2_22C | 0.073 | 0.0766 | 144.6 | 0.5943 | 6.237 | 0.5 | 1.16E+09 |
| | | | | | | | |
| | | | | | | | |
| 1_MK1_UDC_1_-7C | 0.3765 | 2.8889 | 310.97 | 0.5993 | 12.186 | 2.9 | 2.38E+12 |
| 1_MK1_UDC_2_-7C | 0.0374 | 0.1409 | 204.92 | 0.556 | 7.898 | 4 | 3.14E+12 |
| 2_MK1_UDC_1_-7C | 0.2109 | 2.7859 | 189.04 | 0.5302 | 7.468 | 0.6 | 1.59E+11 |
| 2_MK1_UDC_2_-7C | 0.1058 | 0.4084 | 159.71 | 0.5437 | 6.183 | 0.4 | 8.53E+09 |
| | | | | | | | |
| 1_MK3_UDC_1_-7C | 0.287 | 3.3166 | 194.31 | 0.5591 | 7.521 | 0.6 | 1.08E+10 |
| 1_MK3_UDC_2_-7C | 0.1543 | 0.7712 | 162.73 | 0.5677 | 6.17 | 1 | 1.87E+09 |
| 2_MK3_UDC_1_-7C | 0.3171 | 3.331 | 190.68 | 0.544 | 7.39 | 0.7 | 8.08E+09 |
| 2_MK3_UDC_2_-7C | 0.1819 | 0.8245 | 160.32 | 0.5553 | 6.086 | 1 | 1.89E+09 |
| | | | | | | | |
| | | | | | | | |
| 1_MK1_Urban | 0.0558 | 0.0699 | 199.09 | 0.9965 | 7.676 | 1.3 | 3.89E+09 |
| 1_MK1_Rural | 0.0089 | 0.0308 | 109.77 | 0.555 | 4.226 | 0.2 | 5.82E+09 |
| 1_MK1_Highway | 0.0044 | 0.0067 | 133.86 | 0.7915 | 5.152 | 0.2 | 6.98E+09 |
| 2_MK1_Urban | 0.0991 | 0.1407 | 197.51 | 1.0085 | 7.62 | 0.6 | 2.42E+10 |
| 2_MK1_Rural | 0.0099 | 0.0169 | 106.42 | 0.575 | 4.097 | 0.2 | 2.70E+09 |
| 2_MK1_Highway | 0.0038 | 0.0071 | 135.51 | 0.8138 | 5.215 | 0.4 | 3.05E+09 |
| | | | | | | | |
| 1_MK3_Urban | 0.0534 | 0.0719 | 201 | 1.0075 | 7.553 | 0.9 | 6.91E+09 |
| 1_MK3_Rural | 0.0164 | 0.0293 | 111.25 | 0.5685 | 4.178 | 0.3 | 1.97E+09 |
| 1_MK3_Highway | 0.0066 | 0.0091 | 137.53 | 0.8233 | 5.162 | 0.4 | 2.16E+09 |
| 2_MK3_Urban | 0.1189 | 0.3366 | 201.58 | 0.544 | 7.598 | 0.9 | 3.87E+09 |
| 2_MK3_Rural | 0.0213 | 0.0337 | 111.44 | 0.5553 | 4.189 | 0.3 | 1.51E+09 |
| 2_MK3_Highway | 0.006 | 0.0094 | 136.73 | 0.5497 | 5.132 | 0.3 | 1.59E+09 |

# 7. Appendix 2 – test protocols regulated emission

## 1. MK1 - 2*UDC (22 C)

| MPAS Kurzprotokoll TÜV - Essen | ECE | 2012-03-14 09:17 | TÜV NORD | Testzelle: TC#1 |
|---|---|---|---|---|

**Testbegleitdaten** **TC#1-20120314-1**

| | | | |
|---|---|---|---|
| Testdatum: | 2012-03-14 09:17 | Fahrkurve: | 2_UDC\|Default\|Hand\|0\| |
| Bediener: | Jab | Schaltpunkttabelle: | |
| Fahrer: | Jab | Gesetzgebung : | ECE |
| Device Konfiguration : | | Berechnungsmethode : | DIESEL |
| | | Kilometerstand: | 26713 |

**Fahrzeugdaten** ***VW Golf VI 1.6TDI***

| | | | |
|---|---|---|---|
| Auftraggeber: | Ecotraffic | Auftragsnummer: | |
| Hersteller: | | Motorcode: | |
| Fahrzeugmodell: | Golf VI | Hubraum [cm³]: | |
| Kennzeichen: | ohne | Getriebe: | M5 |
| Fahrgestellnummer: | | Reifengröße: | |

| **Rollendaten** | | **alte Rollenlast** | | **Straßenlast** | |
|---|---|---|---|---|---|
| Schwungmasse [kg]: | 1590 | F0 [N]: | 60,99 | F0 [N]: | 115 |
| Radstand [mm]: | 0 | F1 [N/(km/h)]: | 0,0517 | F1 [N/(km/h)]: | 0,37 |
| Coastdown [s]: | | F2 [N/(km/h)2]: | 0,03124 | F2 [N/(km/h)2]: | 0,031 |

**Kraftstoffdaten** **STA D-Referenz MK1**

| | | | | |
|---|---|---|---|---|
| Kraftstoffart: | Heizwert [BTU/lb]: | 18460.00 | C-Gehalt: 0.859 | Dichte[kg/l]: 0.819 |

| **Umgebungsdaten** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| Umgebungstemperatur: | [°C] | 22.4 | 22.6 | | | 22.527 |
| Luftdruck: | [mbar] | 1021 | 1021 | | | 1021 |
| Relative Luftfeuchtigkeit: | [%] | 33.8 | 33.8 | | | 33.8 |
| Absolute Luftfeuchtigkeit: | [g/kg] | 5.6 | 5.7 | | | 5.7 |
| NOX Korrekturfaktor: | [-] | 0.858 | 0.859 | | | 0.858 |
| Verdünnungsfaktor (Beutel): | [-] | 32.15 | 36.22 | | | 34.19 |
| CVS Volumen bei 20°C: | [m³] | 98.768 | 98.780 | | | 197.548 |
| CVS Volumen bei 0°C: | [m³] | 92.030 | 92.041 | | | 184.070 |
| CVS Temperatur | [°C] | 34.942 | 35.088 | | | 35.015 |
| PTS-Volumen bei 20°C | [l] | 195.4 | 195.5 | | | 391.0 |
| PTS-Volumen bei 0°C | [l] | 182.1 | 182.2 | | | 364.3 |
| Wegstrecke | [km] | 4.042 | 4.065 | | | 8.107 |
| Wegstrecke | [mi] | 2.512 | 2.526 | | | 5.037 |
| Phasendauer | [s] | 780 | 780 | | | 1560 |
| Fahrer Verletzung | [s] | | | | | |
| Anzahl Fahrfehler | [-] | | | | | |
| Primärfilter Diff | [mg] | 0.004 | 0.011 | | | |
| Sekundärfilter Diff | [mg] | 0.000 | 0.000 | | | |
| Partikelanzahl | [1/cm³] | 2.68E+01 | 1.18E+01 | | | 1.93E+01 |
| Partikelanzahl | [1] | 2.64E+09 | 1.16E+09 | | | 3.81E+09 |
| Partikelanzahl vor Verd. | [1/cm³] | 0.268 | 0.117 | | | 0.192 |
| Verd. Faktor (Partikelanzahl) | [1] | 99.579 | 99.579 | | | 99.579 |

| **Konzentrationen** | | **A 1** | **L 1** | **A 2** | **L 2** | **A 3** | **L 3** | **A 4** | **L 4** |
|---|---|---|---|---|---|---|---|---|---|
| THC Tunnel | [ppm C1] : | 12.66 | 3.09 | 10.79 | 3.02 | | | | |
| CH4 | [ppm C1] : | 2.66 | 2.01 | 2.27 | 2.19 | | | | |
| NMHC | [ppm C1] : | | | | | | | | |
| CO | [ppm] : | 36.77 | 0.80 | 3.69 | 0.77 | | | | |
| NOX | [ppm] : | 4.89 | 0.03 | 15.65 | 0.07 | | | | |
| CO2 | [%] : | 0.412 | 0.040 | 0.368 | 0.040 | | | | |

| **Beutelmassen/km** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| HC | [g/km] | 0.1362 | 0.1101 | | | 0.1231 |
| CH4 | [g/km] | 0.0116 | 0.0023 | | | 0.0069 |
| NMHC | [g/km] | | | | | |
| NOX | [g/km] | 0.1947 | 0.6214 | | | 0.4086 |
| HC+NOx | [g/km] | 0.3309 | 0.7315 | | | 0.5318 |
| CO | [g/km] | 1.0244 | 0.0832 | | | 0.5525 |
| CO2 | [g/km] | 166.70 | 146.45 | | | 156.55 |
| Partikel | [g/km] | 0.0005 | 0.0013 | | | 0.0009 |
| Partikelanzahl | [1/km] | 6.54E+08 | 2.86E+08 | | | 4.69E+08 |

| **Verbrauch-Beutel** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| Kraftstoffverbrauch | [l/100km] | 6.497 | 5.657 | | | 6.076 |

## 2. MK1 - Artemis Urban

| MPAS Kurzprotokoll TÜV - Essen | ECE | 2012-03-14 10:10 | TÜV NORD | Testzelle: TC#1 |
|---|---|---|---|---|

**Testbegleitdaten** **TC#1-20120314-2**

| | | | |
|---|---|---|---|
| Testdatum: | 2012-03-14 10:10 | Fahrkurve: | CADC_urban_neu\|Default\|S_2\|0\| |
| Bediener: | Jab | Schaltpunkttabelle: | |
| Fahrer: | Jab | Gesetzgebung : | ECE |
| Device Konfiguration : | | Berechnungsmethode : | DIESEL |
| | | Kilometerstand: | 26724 |

**Fahrzeugdaten** ***VW Golf VI 1.6TDI***

| | | | |
|---|---|---|---|
| Auftraggeber: | Ecotraffic | Auftragsnummer: | |
| Hersteller: | | Motorcode: | CAYC |
| Fahrzeugmodell: | Golf VI | Hubraum [cm³]: | |
| Kennzeichen: | ohne | Getriebe: | M5 |
| Fahrgestellnummer: | | Reifengröße: | |

| **Rollendaten** | | **alte Rollenlast** | | **Straßenlast** | |
|---|---|---|---|---|---|
| Schwungmasse [kg]: | 1590 | F0 [N]: | 60,99 | F0 [N]: | 115 |
| Radstand [mm]: | 0 | F1 [N/(km/h)]: | 0,0517 | F1 [N/(km/h)]: | 0,37 |
| Coastdown [s]: | | F2 [N/(km/h)2]: | 0,03124 | F2 [N/(km/h)2]: | 0,031 |

**Kraftstoffdaten** **STA D-Referenz MK1**

| | | | | | |
|---|---|---|---|---|---|
| Kraftstoffart: | Heizwert [BTU/lb]: | 18460.00 | C-Gehalt: | 0.859 | Dichte[kg/l]: 0.819 |

| **Umgebungsdaten** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| Umgebungstemperatur: | [°C] | 22.5 | | | | 22.534 |
| Luftdruck: | [mbar] | 1021 | | | | 1021 |
| Relative Luftfeuchtigkeit: | [%] | 34.0 | | | | 34.0 |
| Absolute Luftfeuchtigkeit: | [g/kg] | 5.7 | | | | 5.7 |
| NOX Korrekturfaktor: | [-] | 0.859 | | | | 0.859 |
| Verdünnungsfaktor (Beutel): | [-] | 29.13 | | | | 29.13 |
| CVS Volumen bei 20°C: | [m³] | 125.739 | | | | 125.739 |
| CVS Volumen bei 0°C: | [m³] | 117.160 | | | | 117.160 |
| CVS Temperatur | [°C] | 35.080 | | | | 35.080 |
| PTS-Volumen bei 20°C | [l] | 580.7 | | | | 580.7 |
| PTS-Volumen bei 0°C | [l] | 541.1 | | | | 541.1 |
| Wegstrecke | [km] | 4.844 | | | | 4.844 |
| Wegstrecke | [mi] | 3.010 | | | | 3.010 |
| Phasendauer | [s] | 993 | | | | 993 |
| Fahrer Verletzung | [s] | | | | | |
| Anzahl Fahrfehler | [-] | | | | | |
| Primärfilter Diff | [mg] | 0.028 | | | | |
| Sekundärfilter Diff | [mg] | 0.000 | | | | |
| Partikelanzahl | [1/cm³] | 1.50E+02 | | | | 1.50E+02 |
| Partikelanzahl | [1] | 1.89E+10 | | | | 1.89E+10 |
| Partikelanzahl vor Verd. | [1/cm³] | 1.506 | | | | 1.506 |
| Verd. Faktor (Partikelanzahl) | [1] | 99.579 | | | | 99.579 |

| **Konzentrationen** | | **A 1** | **L 1** | **A 2** | **L 2** | **A 3** | **L 3** | **A 4** | **L 4** |
|---|---|---|---|---|---|---|---|---|---|
| THC Tunnel | [ppm C1] : | 6.64 | **3.02** | | | | | | |
| CH4 | [ppm C1] : | 2.00 | 1.94 | | | | | | |
| NMHC | [ppm C1] : | 4.64 | 1.08 | | | | | | |
| CO | [ppm] : | 3.23 | 0.95 | | | | | | |
| NOX | [ppm] : | 23.44 | 0.05 | | | | | | |
| CO2 | [%] : | 0.459 | 0.041 | | | | | | |

| **Beutelmassen/km** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| HC | [g/km] | 0.0558 | | | | 0.0558 |
| CH4 | [g/km] | 0.0022 | | | | 0.0022 |
| NMHC | [g/km] | 0.0538 | | | | 0.0538 |
| NOX | [g/km] | 0.9965 | | | | 0.9965 |
| HC+NOx | [g/km] | 1.0522 | | | | 1.0522 |
| CO | [g/km] | 0.0699 | | | | 0.0699 |
| CO2 | [g/km] | 199.09 | | | | 199.09 |
| Partikel | [g/km] | 0.0013 | | | | 0.0013 |
| Partikelanzahl | [1/km] | 3.89E+09 | | | | 3.89E+09 |

| **Verbrauch-Beutel** | **Einheit** | **Phase 1** | **Phase 2** | **Phase 3** | **Phase 4** | **Gesamt** |
|---|---|---|---|---|---|---|
| Kraftstoffverbrauch | [l/100km] | 7.676 | | | | 7.676 |

# 8. Appendix 3 – unregulated emissions

| Gas phase PAH | 1_MK1_UDC_1_-7C | 2_MK1_UDC_1_-7C | 1_MK3_UDC_1_-7C | 2_MK3_UDC_1_-7C | 1_MK1_Urban | 2_MK1_Urban | 1_MK3_Urban | 2_MK3_Urban | Blank / Zero |
|---|---|---|---|---|---|---|---|---|---|
| | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km |
| Phenanthrene (ng/km) | 153 | 362 | 227 | 342 | 274 | 593 | 594 | 614 | 143 |
| Anthracene (ng/km) | 12 | 75 | 8.3 | 74 | 22 | 27 | 27 | 91 | 9.4 |
| 3-Methylphenanthrene (ng/km) | 15 | 332 | 37 | 44 | 170 | 85 | 85 | 394 | 44 |
| 2-Methylphenanthrene (ng/km) | 16 | 49 | 24 | 27 | 92 | 89 | 89 | 102 | 22 |
| 2-Methylanthracene | 0.86 | Nd | Nd | 3.0 | Nd | 4.4 | 4.4 | Nd | Nd |
| 9-Methylphenanthrene | 14 | 44 | 46 | 76 | 79 | 103 | 103 | 117 | 25 |
| 1-Methylphenanthrene | 12 | 28 | 19 | 30 | 64 | 68 | 68 | 81 | 17 |
| 9-Methylanthracene | Nd | 418 | 97 | 93 | 126 | Nd | Nd | 497 | 31 |
| Fluoranthene | 30 | 33 | 10 | 25 | 25 | 92 | 92 | 44 | 27 |
| Pyrene | 24 | 44 | 26 | 34 | 35 | 94 | 95 | 63 | 36 |
| 1-Methylfluoranthene | Nd | Nd | Nd | Nd | 1.4 | 1.7 | 1.7 | 3.8 | 1.6 |
| Benzo(b)fluoranthene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Benzo(k)fluoranthene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Benzo(a)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,l)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,e)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,i)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,h)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd | Nd |

| PM phase PAH | 1_MK1_UDC_1_-7C | 2_MK1_UDC_1_-7C | 1_MK3_UDC_1_-7C | 2_MK3_UDC_1_-7C | 1_MK1_Urban | 2_MK1_Urban | 1_MK3_Urban |
|---|---|---|---|---|---|---|---|
| | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km | ng/km |
| Phenanthrene (ng/km) | 35 | 34 | 65 | 59 | 34 | 43 | 15 |
| Anthracene | 6 | 3 | 4 | 4 | 3 | 8 | 2 |
| 3-Methylphenanthrene (ng/km) | 9 | 8 | 19 | 23 | 27 | 20 | 5 |
| 2-Methylphenanthrene (ng)km | 13 | 10 | 11 | 11 | 36 | 28 | 8 |
| 2-Methylanthracene | 1 | 1 | 1 | 1 | 2 | 1 | 0 |
| 9-Methylphenanthrene (ng/km) | 9 | 9 | 44 | 50 | 24 | 22 | 6 |
| 1-Methylphenanthrene (ng/km) | 8 | 7 | 15 | 19 | 24 | 18 | 5 |
| 9-Methylanthracene | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Fluoranthene (ng/km) | 29 | 25 | 24 | 15 | 27 | 71 | 21 |
| Pyrene (ng/km) | 34 | 33 | 30 | 23 | 46 | 84 | 29 |
| 1-Methylfluoranthene | 2 | 1 | 1 | 1 | 7 | 4 | 1 |
| Benzo(b)fluoranthene | 2 | 1 | 1 | 1 | 2 | 2 | 1 |
| Benzo(k)fluoranthene | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| Benzo(a)pyrene | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dibenzo(a,l)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,e)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,i)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd |
| Dibenzo(a,h)pyrene | Nd | Nd | Nd | Nd | Nd | Nd | Nd |

| | etane | etene | propane | propene | iso-butane | n-butane | etyne | t-2-butene | 1-butene | iso-butene |
|---|---|---|---|---|---|---|---|---|---|---|
| | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km |
| **1_MK1_UDC_1_-7C** | 3147 | 11689 | 770 | 9666 | 102 | 141 | 345 | 356 | 1603 | 426 |
| **2_MK1_UDC_1_-7C** | 245 | 8868 | 229 | 8214 | 116 | 118 | 242 | 255 | 1277 | 368 |
| **1_MK3_UDC_1_-7C** | 276 | 10452 | 252 | 10452 | 59 | 82 | 310 | 294 | 1689 | 549 |
| **2_MK3_UDC_1_-7C** | 253 | 10334 | 271 | 10795 | 118 | 116 | 267 | 323 | 1811 | 609 |
| **1_MK1_Urban** | 115 | 1567 | 107 | 497 | 43 | 65 | 70 | 13 | 49 | 57 |
| **2_MK1_Urban** | 122 | 1883 | 98 | 745 | 176 | 90 | 125 | 20 | 88 | 74 |
| **1_MK3_Urban** | 222 | 1847 | 226 | 521 | 141 | 126 | 111 | 14 | 50 | 57 |
| **2_MK3_Urban** | 87 | 2407 | 115 | 1357 | 103 | 85 | 113 | 37 | 198 | 154 |
| **Blank / Zero** | 64 | 77 | 62 | 70 | 81 | 51 | 15 | 0 | 5 | 30 |
| | | | | | | | | | | |
| | c-2-butene | iso-pentane | n-pentane | 1,3-butadiene | propyne | t-2-pentene | 1-pentene | 2-metylpentane | 3-metylpentane | n-hexane |
| | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km |
| **1_MK1_UDC_1_-7C** | 275 | 312 | 303 | 286 | 58 | 255 | 801 | 21 | 23 | 230 |
| **2_MK1_UDC_1_-7C** | 200 | 296 | 386 | 238 | 36 | 214 | 617 | 19 | 24 | 160 |
| **1_MK3_UDC_1_-7C** | 236 | 194 | 341 | 337 | 59 | 255 | 910 | 25 | 35 | 197 |
| **2_MK3_UDC_1_-7C** | 227 | 491 | 506 | 522 | 62 | 271 | 973 | 32 | 46 | 242 |
| **1_MK1_Urban** | 8 | 187 | 366 | 11 | 0 | 13 | 28 | 14 | 16 | 97 |
| **2_MK1_Urban** | 14 | 227 | 211 | 13 | 0 | 21 | 54 | 13 | 16 | 75 |
| **1_MK3_Urban** | 9 | 219 | 316 | 9 | 0 | 13 | 26 | 31 | 37 | 66 |
| **2_MK3_Urban** | 25 | 210 | 234 | 25 | 0 | 35 | 131 | 28 | 34 | 99 |
| **Blank / Zero** | 0 | 193 | 424 | 10 | 0 | 0 | 5 | 19 | 23 | 129 |
| | | | | | | | | | | |
| | bensene | isooctane | n-heptane | toluene | n-octane | etylbensene | m+p-xylene | o-xylene | n-nonane | 1,3,5-TMB |
| | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km | µg/km |
| **1_MK1_UDC_1_-7C** | 4271 | 10 | 49 | 992 | 59 | 211 | 494 | 331 | 359 | 357 |
| **2_MK1_UDC_1_-7C** | 2505 | 13 | 46 | 748 | 44 | 153 | 388 | 255 | 187 | 316 |
| **1_MK3_UDC_1_-7C** | 2954 | 10 | 20 | 1238 | 36 | 225 | 626 | 300 | 325 | 451 |
| **2_MK3_UDC_1_-7C** | 2985 | 7 | 22 | 1294 | 32 | 243 | 626 | 304 | 303 | 268 |
| **1_MK1_Urban** | 715 | 32 | 21 | 106 | 47 | 65 | 264 | 152 | 248 | 848 |
| **2_MK1_Urban** | 779 | 11 | 42 | 128 | 59 | 59 | 307 | 145 | 331 | 883 |
| **1_MK3_Urban** | 668 | 10 | 19 | 130 | 42 | 50 | 258 | 87 | 282 | 851 |
| **2_MK3_Urban** | 858 | 9 | 30 | 205 | 55 | 78 | 307 | 132 | 494 | 537 |
| **Blank / Zero** | 55 | 8 | 3 | 258 | 5 | 18 | 67 | 15 | 8 | 58 |

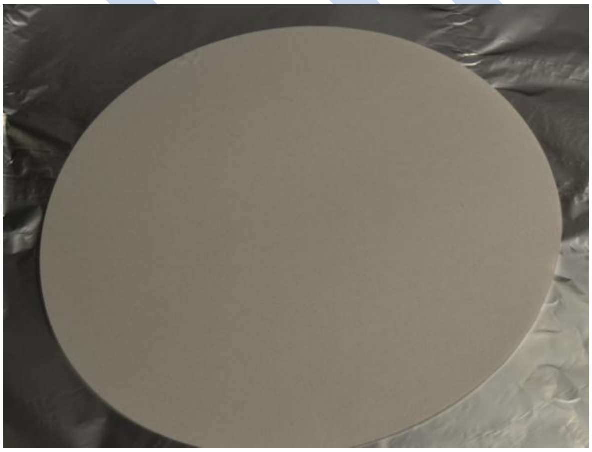
# 9. Appendix 4 – photos from the tests in Essen

Above, CVS Dilution tunnel is showed

Felix Köhler (TUV NORD) and Peter Ahlvik (Ecotraffic) discussing un-regulated emissions.

Above, pump and flow meter for sampling PAH-sampling.

Above, Filter holder for solid phase PAH and for gas phase PAH (blue). Up to left is the tube for aldheyde samping probes showed.



Above, Filter after two UDC. The filter is almost clean.