EUROPEAN COMMISSION
JOINT RESEARCH CENTRE (JRC)
C4-DIRECTORATE FOR ENERGY, TRANSPORT & CLIMATE
SUSTAINABLE TRANSPORT UNIT

WPK 4845 REDEEM

Progress report Real Driving Emissions of new diesel vehicles (REDEEM) 2017 Progress report on the Procedure for selecting vehicles and subsequent start of actual testing.

The purpose of this document is to provide DG ENV with an independent assessment of the real-driving pollutant emissions (specifically NOx and/or PN) of new light-duty vehicles.

Introduction:

Air pollution remains the most important environmental cause of premature death in the EU as well as globally. Despite notable improvements during the last decades, poor air quality continues to cause over 400.000 premature deaths in the EU each year. These figures represent only a fraction of the health and environmental impacts which extend to acute and chronic respiratory, cardiovascular and other diseases and associated socio-economic costs. The European Clean Air Programme considers the high concentrations of particulate matter, nitrogen dioxide and ground-level ozone of most concern. Hence the strategic objectives are set accordingly based on an extensive evaluation and impact assessment. It is furthermore noted that EU air quality standards are less strict than the specific guideline values provided by World Health Organization (WHO). To achieve compliance with the EU air quality standards and, in the long term, move towards those stated in the WHO guidelines, air pollutant emissions need to be reduced at local, national and transboundary levels.

The successive revisions of the EU type approval legislation aimed at reducing emissions from cars through the introduction of the respective EURO standards (1-

6). The latest focus was on PM and NOx. The latter was the main focus of the Euro 6 norm for passenger cars which came into force in September 2014 (albeit still relying on standardized laboratory tests). However, in 2011, also the JRC identified that cars actually emit more than the legal standards under real driving conditions, thereby confirming earlier speculations about a growing problem in this field. The difference in emissions can be anywhere between 2 to 20 times the legal emission limits.

These high real-driving emissions create a direct challenge to Member States in terms of meeting their air quality objectives set for the purpose of protecting citizens against the harmful effects of air pollution. Despite the growing consequences on the problem, it remained difficult to gather the political will to act. The Volkswagen case has brought this matter to the forefront of the political agenda both in the EU and in the Member States, and has undermined consumer confidence in the car industry and the regulator.

The overall objective of this Administrative Agreement is to gain targeted independent evidence and assessments about the sector's progress in reducing real-driving exhaust emission levels of air pollutants, especially NOx and PN, from new vehicles added to the EU market.

Undersigning the Administrative Agreement № 070201/2016/743134/SER/ENV.C3 DG Environment (DG ENV), requested the DG Joint Research Centre (JRC), an independent assessment of the real driving pollutant emissions (specifically NOx from diesel vehicles, later PN from petrol vehicles was also requested) of new light-duty vehicles. Efforts will focus on the most popular new diesel and petrol passenger car models available in the EU with the aim to: (i) provide the Commission and the public with information about the level of real driving emissions, (ii) provide technical input for the further development of vehicle emissions policy by the Commission, and (iii) support informed decision making towards a voluntary system for the identification of low-emission vehicles.

Procedure for selecting vehicles

The JRC has been performed real world testing of light duty vehicles for many years now, as documented in several publications. JRC has also been fully involved in the preparation of the RDE acts, supporting discussions with scientific evidence throughout the whole process and has been actively involved in setting new emission factors for use in air quality modelling through the ERMES group.
DG-ENV requested that efforts will focus on testing and assessing 10 of the most popular new diesel and petrol models on the market, as these are assumed to contribute most to total emissions, especially in urban areas. This will provide further technical input to vehicle emissions policy considerations by the Commission, particularly in relation to considerations towards setting up a voluntary system for identification of low emission vehicles. Another objective is to provide a better indication of the current state of real driving emissions to the Commission and the public at large.

As required in the Regulation 443/2009, Members States have to record information on each new passenger cars registered in its territory. This information is recorded by the European environment Agency and made available through a publically available dataset. These data were filtered and summarized in tidy data, based on the type approval number and make of the vehicle before to be cross-checked with consolidated data from European Automobile Manufacturers Association (ACEA) registered for the enlarged Europe. Figure 1 presents the 2016 registration number of passenger cars in EU broken down by main group of manufacturer as defined in the ACEA data.
It has to be noted that ACEA data includes registration made in EU28 (excluding Malta and Cyprus) and from Iceland, Norway and Switzerland. Data from EEA includes registration made in EU28. This difference can explain the higher registration number displayed by the ACEA. In addition, the tidy data process on the EEA original dataset may also result in discarded data (misspelling or wrongly annotated entry) which resulted in lower registration number in the final dataset. The total number of new registration of passenger car in 2016 obtained after data

processing (excluding small-volume[1] and niche manufacturers[2]) from the EEA and ACEA sources were 13.87M and 15.11M respectively.

Figure 1: New passenger car registrations in EU28 (source EEA) and in enlarged Europe (source ACEA) broken down by main vehicle manufacturer groups.

As the project was focussed on high sales vehicles and technologies, small-volume[3] and niche manufacturers[4] were excluded from the testing program for 2017. The remaining car manufacturers were included and considered for the entire selection process. The choice of the regions and the grouping for the selected

[1] Manufacturers responsible for less than 10 000 new vehicle registrations per year.
[2] Manufacturers responsible for 10 000 to 300 000 new vehicle registrations per year.
[3] Manufacturers responsible for less than 10 000 new vehicle registrations per year.
[4] Manufacturers responsible for 10 000 to 300 000 new vehicle registrations per year.

manufacturers was purely arbitrary and only meant to ensure that vehicles are picked throughout the different regions and possibly for most manufacturers.

JRC selected top best-selling models on the EU market following the criteria described below. This section summarizes a list of selection criteria, to ensure a wide and fair coverage of the European market.

Vehicle Selection criteria

1. Vehicle Types and Segments:

- A&B: Mini and Small cars
- C: Medium cars
- D&E: Large and executive cars
- Light Commercial Vehicles

2. Vehicle Emissions Control and Powertrain Technologies (Euro 6+):

- Diesel (EGR+SCR+DPF, EGR+LNT+DPF,...)
- Gasoline (PFI, GDI, GDI + GPF,...)

3. Mainstream" manufacturers (EU and non-EU) to choose from:

- DE: VW (VW/Skoda/Seat), BMW, Daimler, Audi
- US/DE: Ford, Opel
- FR: Renault (Renault, Dacia), PSA (Peugeot, Citroen, DS)
- IT/UK/SE: FCA (Fiat, Jeep), JLR (Jaguar Land Rover), Mini, Volvo
- Japan: Toyota, Honda, Suzuki, Nissan, Mitsubishi, Mazda
- Korea: Hyundai, Kia

Table 2: Vehicles selected to be tested in the laboratory and under RDE and their characteristics.

	Segment	Engine type	After-treatment	Engine displacement (cm^3)	Engine power (kW)	Euro
Fiat Panda	A	PFI	TWC	1242	51	Euro 6b - 2016
Audi A1	A	GDI	TWC	999	70	Euro 6b - 2016
Renault Twingo	A	PFI	TWC			Euro 6b - 2017
Opel Astra	B	GDI	TWC	999	77	Euro 6b - 2017
VW Golf	B	TDI	DOC+ DPF+LNT	1968	110	Euro 6b - 2015
Kia Sportage	B	TDI	DOC+ LNT+ DPF	1685	85	Euro 6b - 2017
Peugeot 308	B	TDI	DOC+ DPF+SCR			Euro 6d-TEMP - 2017
VW Tiguan	D	GDI	TWC+ GPF			Euro 6d-TEMP - 2017
BMW 530	E	TDI	DOC+ LNT+ SCR+ DPF	2993	193	Euro 6b - 2016
Peugeot Partner	F	HDI	DOC+ DPF+SCR	1560	73	Euro 6b - 2015

Vehicles test procedure

The selected vehicles are tested in the laboratory under the NEDC and the WLTP. The test performed using the NEDC is needed to ensure that vehicle is in good operating conditions. The experience gain over these years shows that a vehicles that is type-approved under the NEDC will present emission factors close to its corresponding Euro standard. Hence, using the NEDC will give a first indication of the vehicle fitness. On the other hand, the WLTP test is need to obtained the CO_2 emission factors that will be used for the data processing of the on-road data during RDE.

Once the laboratory testing are performed the selected vehicles are tested on-road. Vehicles are tested using state of the art PEMS equipment for measuring of all RDE regulated pollutants in accordance with applicable RDE provisions. It should be

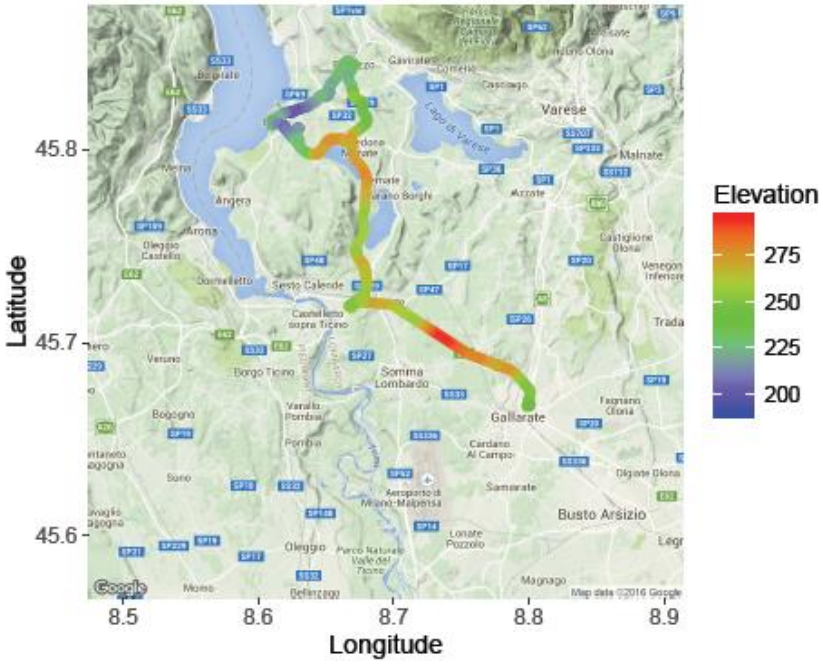
ensured that the main part of testing is performed in line with RDE trip requirements (i.e., urban/rural/motorway shares) and boundary conditions. Additional data coming from testing outside the scope of RDE parameters and boundary conditions will also be produced. On-road tests were performed following four different routes, namely Esperia, Labiena, Sacromonte e Milano (see below).

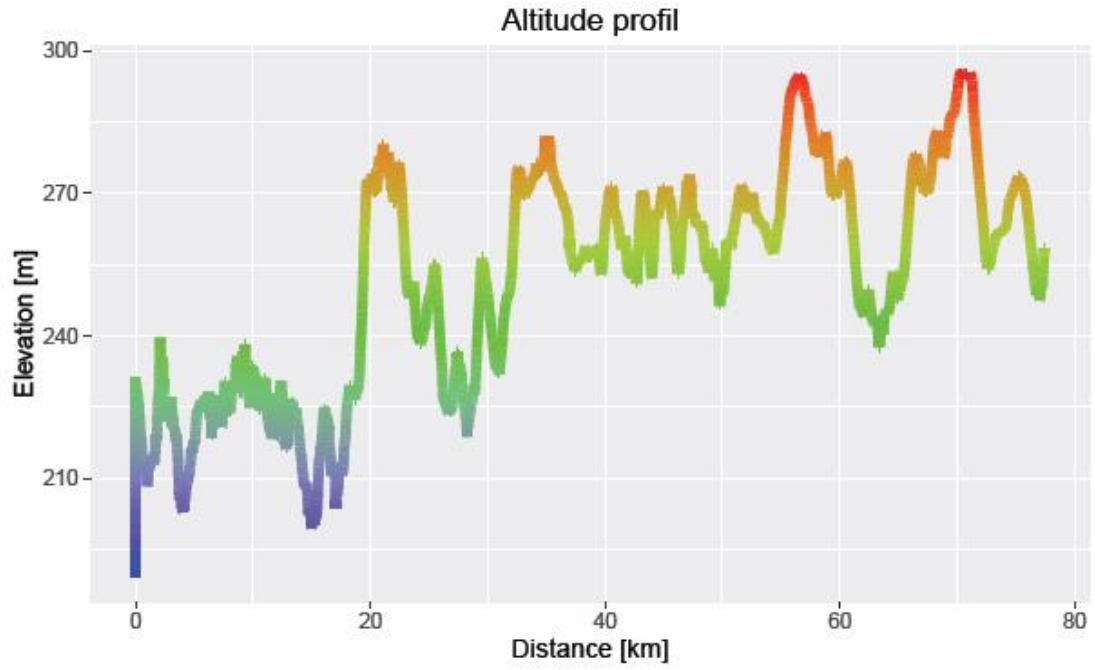
The routes Esperia and Labiena were performed as RDE compliant tests and also tests that were driving dynamically, i.e., aiming at exceeding b*A boundary. The route Sacromonte give address the positive gain boundary as during this test we reaches 1100 m above sea level and 1800m cumulative gain. Finally, the route Milano foresees a motorway share longer than what is required, and allowed, in RDE legislation allowing evaluating the effect of long motorway driving. This route also include city driving, which is of paramount importance to study the performance of the vehicle and its emission control systems in actual cities.

The different routes and their main features are described below:

Route# 1 - Esperia

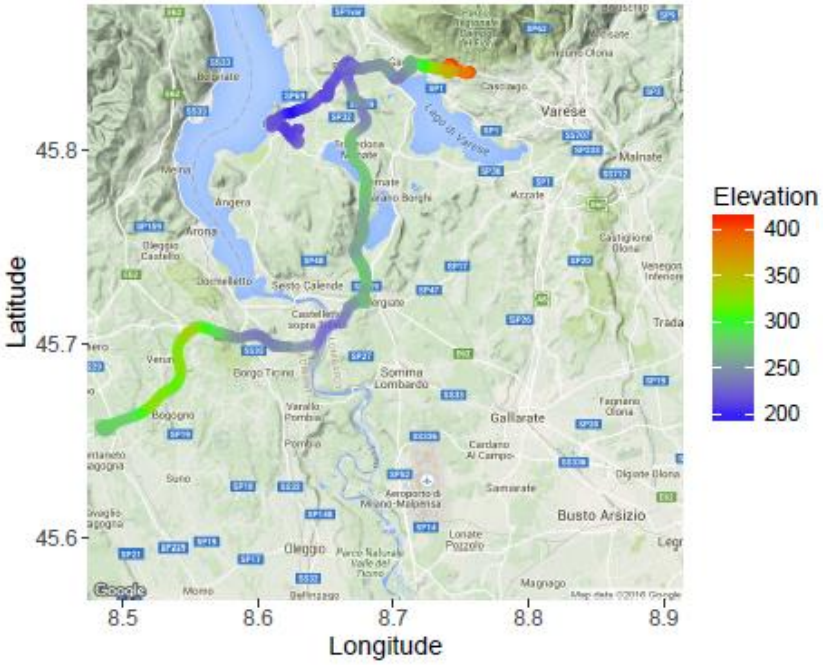
Total Distance [km]	▪ Ca. 79
Urban Rural Motorway Distance Shares [%]	▪ 38.5 – 27.5 – 34.0
Average speed [km/h]	▪ 48.8
Average urban speed [km/h]	▪ 27.5
Cumulative altitude gain [m/100km]	▪ 631

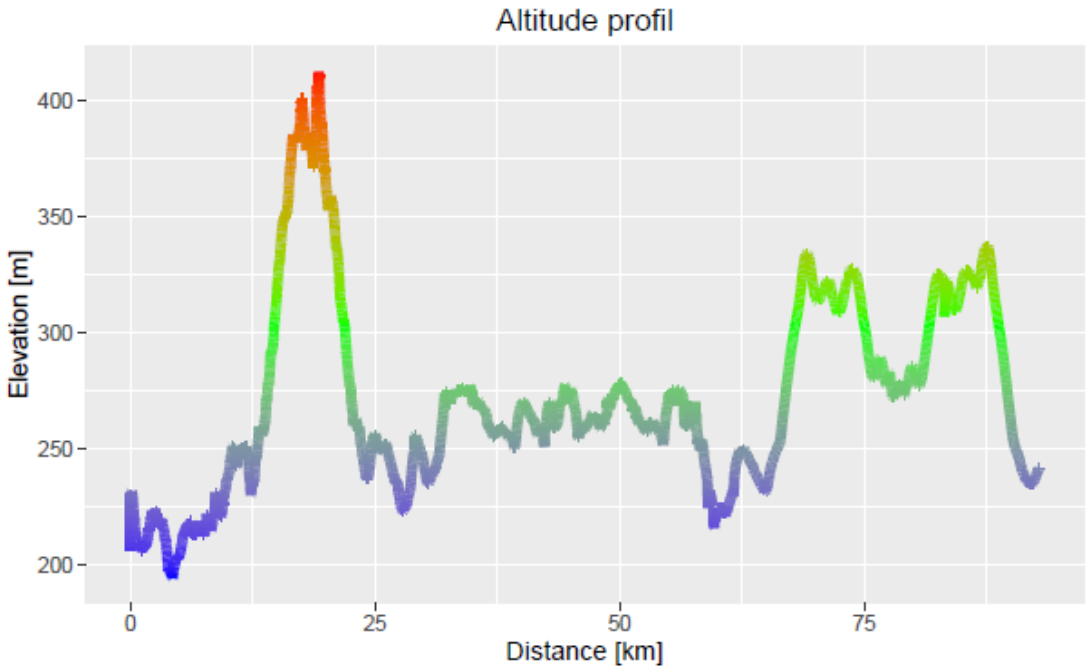




Route# 2 - Labiena

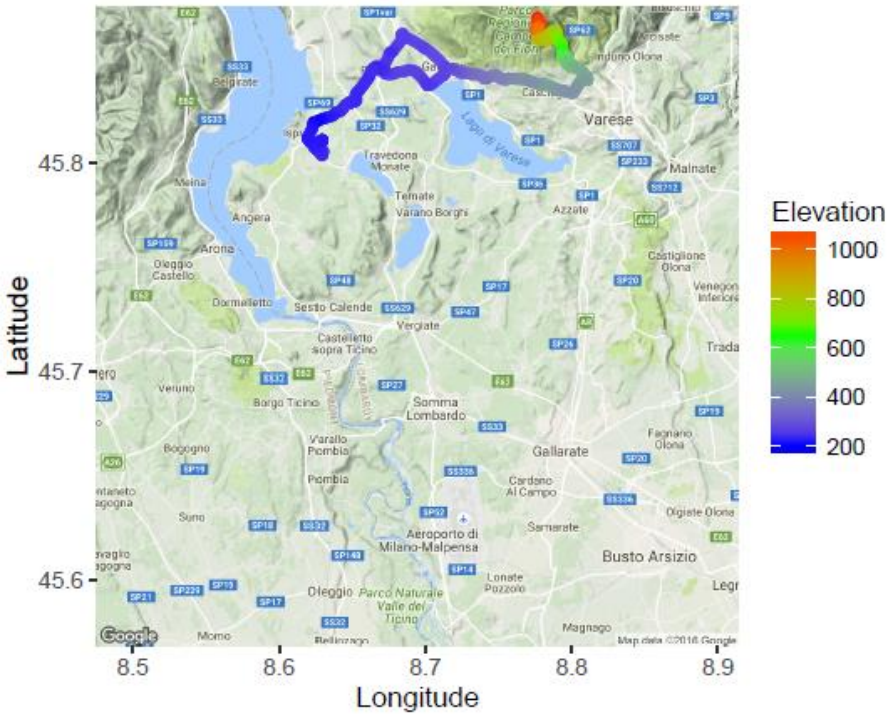
Total Distance [km]	▪ Ca. 94
Urban Rural Motorway Distance Shares [%]	▪ 36.7 – 25.7 – 37.6
Average speed [km/h]	▪ 51.0
Average urban speed [km/h]	▪ 27.5
Cumulative altitude gain [m/100km]	▪ 739

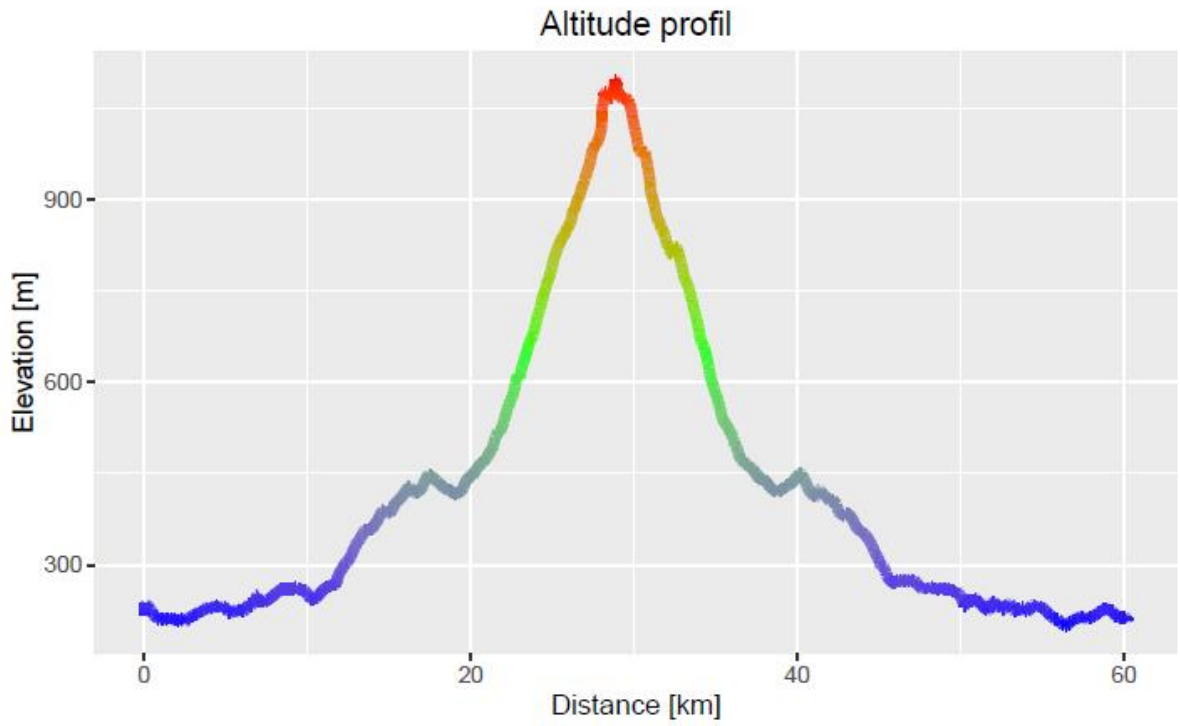




Route# 3 - Sacromonte

Total Distance	▪ Ca. 62
Urban Rural Motorway Distance Shares [%]	▪ 95.5 – 4.5 – 0%
Average speed [km/h]	▪ 34.5
Average urban speed [km/h]	▪ 33.8
Cumulative altitude gain [m/100km]	▪ 1800





Route# 4 - Milano

Total Distance	▪ Ca. 141
Urban Rural Motorway Distance Shares [%]	▪ 30.1 – 13.7 – 56.2
Average speed [km/h]	▪ 60.3
Average urban speed [km/h]	▪ 30.9
Cumulative altitude gain [m/100km]	▪ 374