Realistic real-world driving emissions tests: the last chance for diesel cars?

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A briefing by TRANSPORT & ENVIRONMENT

Summary

Harmful levels of air pollution are endemic in European cities, especially close to roads, causing 400,000 premature deaths annually and costing the EU a whopping €1 trillion a year[1]. Despite the fact that air emissions limits for cars, vans and trucks (Euro Standards) have been progressively tightened on paper, the obsolete tests and optimisation strategies deployed by car manufacturers have meant that they have failed to deliver real-world improvements. Notably Euro 6 diesel cars on average emit seven times their official limit for nitrogen oxides (NOx).

To rectify this, the Commission has proposed a new real-world driving (RDE) test to be implemented for new Euro 6 vehicles. After long deliberations, the first package of the testing procedure itself was agreed on 19 May 2015. Member States are discussing the second RDE package, with key decisions on the introduction dates and stringency of the limits still pending.

Promised since 2012, the new RDE test must come into force in 2017. The stringency of the emission limits, i.e. conformity factors, must be as close to the originally agreed NOx limit of 80mg/km as possible. Achieving real emission reductions on the road is diesel's last chance to restore its credibility and continue to be driven on polluted EU roads.

1. Europe's air pollution crisis

Almost all EU citizens are exposed to levels of air pollution the World Health Organisation considers harmful to health[2]. Up to a third of citizens live in locations breaching the EU's own, weaker ambient air pollution standards – levels that should have been met already in 2010. As a consequence, the European Commission has commenced infringement proceedings against 18 member states for breaching the EU limits on particulate matter (PM10) and/or nitrogen dioxide (NO_2). As a result of high levels of air pollution, there are 400,000 premature deaths annually, 10 times the number killed in road accidents. Air pollution also causes 569 million days of restricted activity annually and over 100 million lost working days[3].

THE ANNUAL COST OF AIR POLLUTION IS ESTIMATED TO BE BETWEEN €1,000-2,000 PER PERSON PER YEAR FOR EVERY EU CITIZEN, KILLING AN EQUIVALENT OF THE POPULATION OF FLORENCE EACH YEAR!

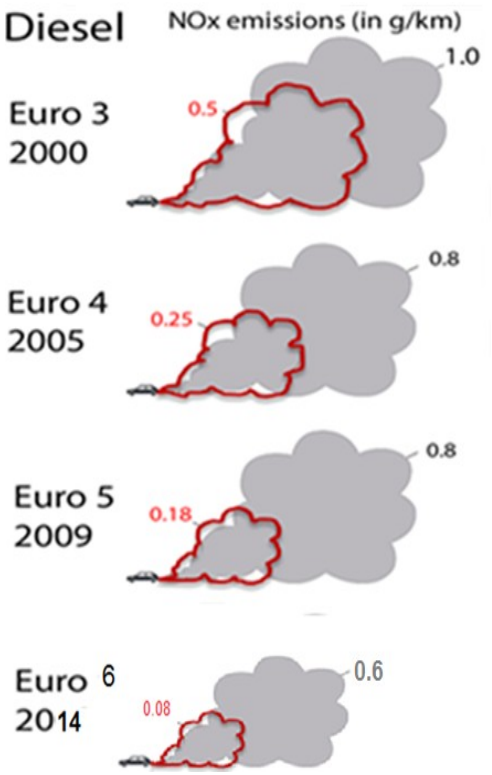
Emerging evidence suggests the shocking health impacts of air pollution are underestimated as they only include the effect of fine particles and ozone and exclude that of NO_2. In addition to the known effect of increasing asthma symptoms; a recent King's College London study has quantified the additional

1 The Clean Air Policy Package Impact Assessment, 2013, http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf
2 EEA, 2013, Air quality in Europe — 2013 report, http://www.eea.europa.eu/publications/air-quality-in-europe-2013/at_download/file
3 The Clean Air Policy Package Impact Assessment, 2013, http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf

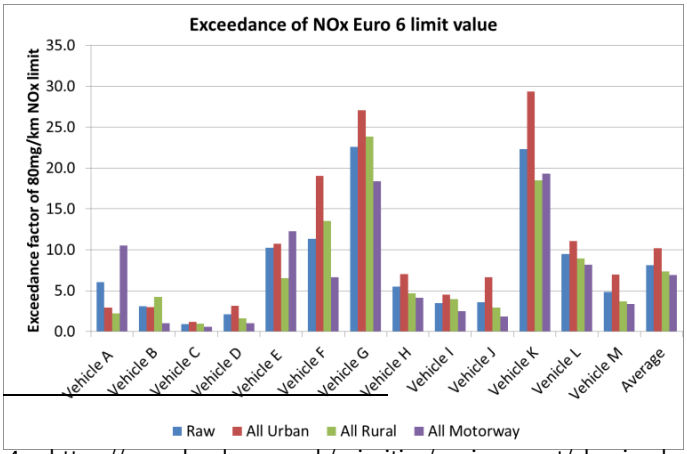
premature deaths in London. The impact was to increase the estimates of premature deaths in 2010 to 9,400[4] – from the previous estimate of 4,300 – thus more than doubling the amount of people killed by air pollution in London. It is very likely similar results would be found in other major cities where air pollution is traffic-dominated.

2. The principal cause – diesel cars

The principal reason why NOx air pollution levels in cities and areas adjacent to heavily trafficked roads are not improving is that diesel cars emit much more pollution in real life than permitted by regulations (EU Euro Standards legislation[5]). Euro standards were designed to limit the amount of air pollution from vehicles and have been progressively extended and tightened since they were first introduced in 1990. However, a combination of an obsolete laboratory test[6] and "cycle beating" techniques deployed by carmakers to circumvent the test limits has artificially lowered test results[7] but failed to deliver progress on the road. A range of real-world tests on diesel cars shows there has been limited improvement in actual nitrogen oxide emissions since Euro 3 standards were introduced in 2000. The right hand image[8] compares the typical NOx emissions of diesel cars on the road (grey cloud) with the limit value standards (in red).



A range of research has shown Euro 3 to 5 vehicles on the road produce NOx emission 5 to 10 times the limit. This is why the Euro 6 legislation introduced in 2007[9] required the Commission to review the current NECD test procedure "so as to adequately reflect the emissions generated by real driving on the road." But lobbying by carmakers has successfully delayed the introduction of this new real world driving emissions (RDE) test.



3. Euro 6 cars perform little better

Euro 6 limits came into force on 1 September 2014, but tests on Euro 6 vehicles show the issue of high diesel NOx emissions remains unresolved. Recent research by the ICCT[10] tested 15 Euro 6 or equivalent vehicles and found breaches of the 80mg/km NOx limit ranging

4 https://www.london.gov.uk/priorities/environment/clearing-londons-air/understanding-the-health-impacts-of-air-pollution-in-london

5 JRC, 2013, A complimentary emission test for light duty vehicles : Assessing the technical feasibility of candidate procedures, http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/27598/1/ld-na-25572-en-n_online.pdf

6 T&E, 2014, Mind the Gap! Why official car fuel economy figures don't match up to reality, http://www.transportenvironment.org/sites/te/files/publications/Real%20World%20Fuel%20Consumption%20v15_final.pdf

7 Sunday Times,2014, Diesel cars built to foil test for toxic fumes,

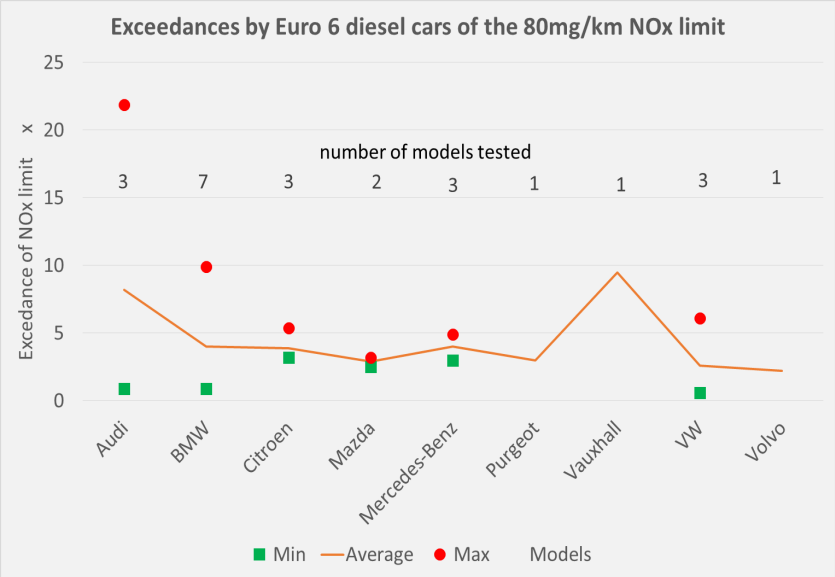
8 Adapted from ICCT, 2013, European Vehicle Market Statistics

9 715/2007/EC Article 14(3)

10 ICCT, 2014. Assessment of PEMS Datasets from Modern Diesel Passenger Cars. 20th International Transport and Air Pollution Conference
(TAP) 2014.

from 2 to 22 times in different vehicles. The average breach was by a factor of 7, broadly consistent with previous research that found breaches of 6-9 times [11] [12] . Only one vehicle achieved the target in the ICCT tests. Emissions Analytics report[13] that there has been an improvement in NOx emissions in recently tested vehicles in 2014 and 2015, with the average exceedance of the Euro 6 limit of 5 times.

The ICCT found that a high proportion of the NOx emissions were concentrated in emission spikes of a few seconds and in most cases could not be attributed to 'extreme' or 'untypical' driving but resulted from transient increases in engine load such as a result of driving uphill, sustained accelerations from a standstill, or regeneration of the diesel particulate filter[14]. But for some vehicles the NOx performance was poor even in the 'undemanding' situations. There were also wide variations in the performance of different tested models, as illustrated.[15]



The ICCT research shows Euro 6 emission limits can be met in real-world driving (technology exists and one vehicle complied) but whether they are or not depends on the choice of emission abatement technology and how it is configured within the vehicle. For example the Selective Catalytic Reduction (SCR) technology has been proven to effectively reduce NOx to Euro 6 limits.

The diverse performance of Euro 6 cars depends on the technology fitted to the car and the way it is configured. Notably, in the absence of a robust testing framework, many manufacturers have chosen to game the test to save costs but fail to resolve the NO_x problem. Only about a third of Euro 6 cars are fitted with SCR technology, the remainder using cheaper and overall less effective exhaust treatment systems. The additional manufacturing costs for an SCR system for medium and large vehicles are usually quite low, around €100 since these vehicles are typically already equipped with a NOx reduction catalyst. For vehicles fitted with only Exhaust Gas Recirculation (EGR) both an SCR and NOx reduction catalyst must be added and the costs are in the range of €264 – 491 for a small to large car.[16]

The effectiveness of the SCR system depends upon how it is used. SCR injects a small amount of a chemical (urea) into the exhaust to trap the NOx. But the urea is used up in the process and needs to be replaced. To avoid inconveniencing drivers, most carmakers design the systems to use a minimal amount of urea to avoid needing to fit a large reservoir or refilling between service intervals. As a result the vehicles perform variably on the road depending on the way and the amount of the urea used.

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11 TNO, 2013, Investigations and real world emission performance of Euro 6 light-duty vehicles, https://www.tno.nl/downloads/investigations_emission_factors_euro_6_ld_vehicles_tno_2013_r11891.pdf

12 JRC, 2013, A complimentary emission test for light duty vehicles : Assessing the technical feasibility of candidate procedures, http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/27598/1/ld-na-25572-en-n_online.pdf

13 http://www.aecc.eu/content/RDE_seminar/05%20%20AECC%20RDE%20seminar%20EMISSIONS%20ANALYTICS%20Euro%206%20cars.pdf

14 Regeneration is the process through which the filter is cleaned, this can occur after prolonged high-speed driving on motorways when the exhaust becomes very hot or can be artificially induced by a heater

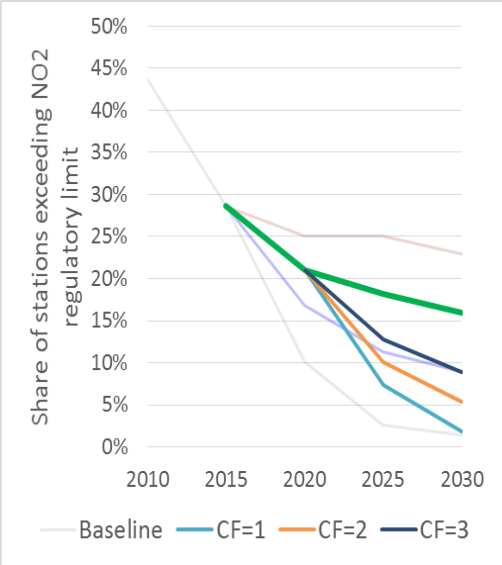
15 T&E 2015 compilation of real-world testing results

16 TNO 2013 Implementation of Euro 6 light-duty vehicle pollutant standards and benchmark against other international standards

4. Real World Tests

To ensure that Euro 6 diesels deliver low emissions on the road, a new real-world driving emissions (RDE) testing procedure is being introduced. The new test will use Portable Emissions Monitoring System (PEMS), as illustrated, to measure diesel NOx emissions. It will for the first time see cars and vans being taken out of the laboratories to be tested on roads, and is the best technology available today to measure real emissions.

An important RDE milestone was reached in May 2015, when the technical specifications of the testing procedure itself were agreed by Council. But some key aspects still need to be finalised, notably the dates of implementation and the stringency of the limits. The stringency of the limits was set in 2007 by the Euro 6 legislation (80mg/km for diesel NOx). But the Commission and Member States have proposed to introduce so-called conformity factors (CF) to raise the permitted limits through the backdoor. This will initially allow for a phase-in of the regulation and subsequently account for uncertainties in the test procedure. A CF is a multiplier by which the originally agreed Euro 6 limits are allowed to be exceeded (e.g. a CF of 2 would give a 80*2 = 160 mg/km NOx limit), known as a not-to-exceed limit.



The use of conformity factors weakens the Euro regulation and leads to more exceedances of NO_2 ambient air pollution standards that are widely breached across Europe. T&E reanalysis of IIASA data prepared for the Commission on the current exceedances of EU air quality legislation in the Member States shows that with a conformity factor of 3, 10% of monitoring stations will continue to exceed the legal air quality limits in 2030. In contrast, a conformity factor of 1 (i.e. full compliance with the 80mg/km target) will enable almost all cities and highly trafficked locations to meet targets (only 2% exceedance) thereby avoiding infraction proceedings and potential fines on Member States. Research by the catalyst industry association[17] has shown that existing SCR systems can be easily configured to achieve a conformity factor of 1.5 without requiring significant hardware changes to the vehicle such as bigger urea tanks.

5. Way forward and recommendations

It is highly likely that the serious health effects of nitrogen dioxide in London are replicated across European cities and that the true health effects of air pollution in the EU are between half and three-quarters of a million premature deaths annually (instead of 400,000 estimated today). The primary cause is diesel vehicle pollution and the failed system of Euro standards which has not delivered the anticipated improvement in real world emissions as a result of carmakers circumventing the obsolete system of testing to enable them to fit ineffective, cheaper exhaust treatment systems to cars. An effective system of RDE tests and low conformity factors (stringent not-to-exceed limits) will address the problems and improve air pollution levels (our recommendation in the table below).

[17] http://www.aecc.eu/content/RDE_seminar/06%20%20AECC%20RDE%20seminar%20AECC%20Clean%20Diesel%20RDE%20Program.pdf

Going forward and looking at EU vehicle testing architecture more widely, there remain some important issues to address in relation to all pollutants that the Commission needs to resolve according to the following timetable:

Date	Action	Note
2015	The RDE test commences for diesel NOx for monitoring and reporting	1
2016	Test method for particle number (PN) finalised and testing commences for monitoring and reporting Procedure to account for cold starts and regeneration events incorporated into the RDE test procedures	2 3
2017	Stage 1 conformity factor of 1.5 applies to all *newly type-approved* cars and vans for diesel NOx; and particle number for all vehicles RDE test procedure finalised for all other air pollutants and CO_2	4 5
2018	Stage 1 conformity factor applies to all *registered* diesel cars and vans; and the PN limit applies to all registered vehicles	3
2019	Stage 2 conformity factor of 1 applies to all *newly type-approved* cars and vans for diesel NOx and particle number for all vehicles RDE testing for all pollutants for new type-approvals	4
2020	Stage 2 conformity factor of 1 applies to all *registered* diesel cars and vans; and the PN limit applies to all registered vehicles RDE testing for all pollutants from new registrations Commission proposal for Euro 7/VII limits for cars, vans and trucks to align limits for diesel and gasoline vehicles and ensure ambient air pollution limits are met	5
2025	Euro VII/7 limits apply to all new type approvals	6
2026	Euro VII/7 limits apply to all new registrations	6

Notes:

1. From 2015 all test results should be published for all models;
2. This was the date accepted in the Commission's Cars 2020 Communication.[18] The car industry has had 10 years to achieve implementation since Euro 6 was agreed in 2007 and further delay is unacceptable;
3. The exclusion of these factors leads to an underestimation of emissions by RDE tests
4. The AECC has shown this limit can be met by SCR systems without hardware changes. All diesel cars should now be fitted with SCR – the only system capable to complying with RDE tests/Euro 6 limits. The choice of carmakers to continue to use inadequate, cheap exhaust treatment systems nearly 10 years after Euro 6 standards were adopted (2007) is not a reason for delaying the introduction of the RDE test or raising the conformity factor further;
5. RDE test procedures must be extended to cover all air pollutants and CO_2 emissions to ensure all emissions are below Euro 6 levels;
6. The Euro 7/VII limits should make a material contribution to ensuring WHO limits can be met EU-wide

Carmakers are calling for much more relaxed RDE limits, informing the European Parliament[19] they would like a conformity factor of 2.75 to progressively apply to more models from 2018 but not apply to all registrations until 2021. They propose a second stage conformity factor of 1.5 to apply from 2020/21 only for all new type-approvals / registrations – this timetable fails to recognize the health crisis being caused by diesel vehicles. This also de facto changes the Euro 6 limit agreed between the EU co-legislators from 80 to 120mg/km through the back door of comitology.

[18] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52012DC0636&from=EN
[19] ACEA 2014; ENVI Committee – Public Hearing on Air Quality Policy (December 2014)

If the Euro 6 fails and RDE tests do not reduce emissions, cities will be left with no choice but to ban diesel cars that exceed NOx limits. If not, the health of citizens will continue to be heavily affected and Member States run the risk of fines for breaching EU rules. It has been estimated such fines could amount to €1.5 billion by 2025.[20] Carmakers claim constraints on diesel car use would undermine progress to achieving the 2021 car CO_2 regulation. In reality, average CO_2 emissions from standard gasoline hybrid cars (92g/km in 2013)[21] are substantially lower than those from diesel cars (128g/km) and gasoline (130g/km). A decrease in diesel and increase in gasoline hybrid vehicle sales would therefore support achieving the CO_2 limit. The gap between the efficiency of conventional gasoline vehicles and diesel cars has also narrowed appreciably as a result of better downsized gasoline direct injection vehicles with turbochargers coming to market and because diesels tend to be much higher performance vehicles.

Implementing robust and effective RDE testing architecture in line with the timetable above is diesel vehicles' last chance to regain credibility and have a place on EU roads in the future.

Further information

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[20] Client Earth, 2014, The Commission's air infringement cases
[21] ICCT 2014, European Vehicle Market Statistics Pocketbook 2014