TRANSPORT & ENVIRONMENT

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Briefing

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

Summary

Harmful levels of air pollution are endemic in European cities and adjacent to heavily trafficked roads. Air pollution from cars is a major cause of 400,000 premature deaths annually and is responsible for more than 100 million lost working days a year. The astronomical cost of air pollution in the EU is estimated to approach €1 trillion a year.[1]

Air pollution emissions limits for cars, vans and trucks (Euro Standards) have been progressively tightened, on paper, over 25 years but have failed to deliver real-world improvements for several key pollutants, notably nitrogen dioxide. This is because obsolete tests and "cycle beating" techniques[2] have been used by carmakers leading to levels of emissions from some cars many times higher on the road than in laboratory tests.[3] High emissions and increasing numbers of diesel cars are contributing to air pollution levels remaining well above EU limits and WHO guidelines, and the European Commission has taken action against 17 member states for breaches of particulate (PM_{10}) and nitrogen dioxide limits.

To address the high real-world emissions, Euro 6 standards were adopted in 2007and these came into force on the 1 September 2014. These included the introduction of new real-world driving emissions (RDE) tests. Early results for new Euro 6 diesel cars indicate emissions measured on the road can be over 20 times the new 80mg/km nitrogen oxide limit. Lobbying by carmakers has delayed finalisation and introduction of the new test that should already have commenced monitoring and reviewing actual emissions before becoming legally binding in 2017. Carmakers have unsuccessfully argued the Commission has overreached its powers in introducing new real-world tests,[4] and are now seeking to weaken the effectiveness of the new test. They are doing this by: introducing loopholes in the test and data assessment procedures; making the test unrepresentative of real-world driving; reducing the range of pollutants being tested; and seeking to restrict access to test results.

In October, the Commission will be discussing progress and next steps with EU member states at the Technical Committee on Motor Vehicles (TCMV). This paper outlines key issues for member states to ensure that the new real-world (PEMS) tests are robust and representative of real-world driving in order for emissions to decline on the road.

Member states exceeding nitrogen dioxide limits are relying on effective RDE tests to reduce emissions in the future and avoid infraction proceedings for failing to meeting ambient air pollution limits. A weak and ineffective testing regime will not improve air pollution or tackle the widespread health consequences. As a result, the only solution left to cities will be to ban all diesel vehicles. If this is necessary it is likely to result in a significant decline in sales and strongly impact on European carmakers that specialise in diesel cars.

[1] The Clean Air Policy Package Impact Assessment, 2013, http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf
[2] Cycle beating are techniques used by carmakers to achieve test results in the knowledge that emissions will be much higher on the road
[3] ICCT, 2013, European Vehicle Market Statistics, http://www.theicct.org/sites/default/files/publications/EU_vehiclemarket_pocketbook_2013_Web.pdf
[4] ACEA, 2014, email 9th June 2014 from Paul Greening to Members of the Technical Committee Motor Vehicles

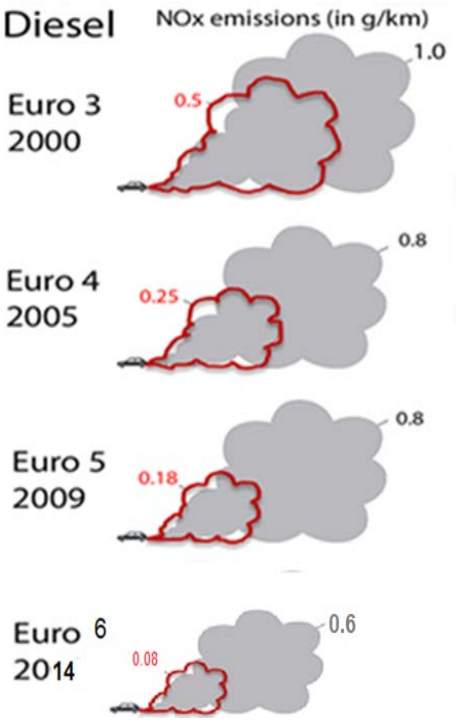
The failed system of Euro Standards

Virtually all EU-citizens are exposed to levels of air pollution the World Health Organisation considers harmful to health.[5] 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 in 2010. As a result the Commission has commenced enforcement proceedings against 17 member states for breaching EU limits for particular matter (PM10) and nitrogen dioxide. As a result of high levels of air pollution, there are 400,000 premature deaths annually,[6] 10 times the number killed in road accidents. Every year across the EU there are also 569 million days of restricted activity and over 100 million lost working days caused by the effects of air pollution.

The annual costs of air pollution are estimated to be around €1,000 to €2,000 per person per year for every EU citizen.

The principal reason why air pollution levels in cities and areas adjacent to heavily trafficked roads are not improving is because diesel cars emit much more pollution than permitted under EU Euro Standards legislation.[7] Euro standards were designed to limit the amount of air pollution from vehicles and have been progressively extended and tightened since they were introduced in 1990. However, a combination of an obsolete laboratory test[8] and "cycle beating" techniques deployed by carmakers to circumvent the test limits has artificially lowered test results.[9] A range of real-world tests on diesel cars shows there has been no material improvement in actual nitrogen oxide emissions since Euro 3 standards were introduced in 2000. This is illustrated in the image[10] that compares the typical NOx emissions of diesel cars on the road with the limit value standard (in red).

A range of research has shown Euro 3 to 5 vehicles on the road produce NOx and particulate numbers (PN) emission five to 10 times the limit. As a result, Euro 6 standards introduced in 2007[11] required that, "The Commission shall keep under review the procedures, tests and requirements [...] as well as the test cycles used to measure emissions. If the review finds that these are no longer adequate or no longer reflect real-world emissions, they shall be adapted so as to adequately reflect the emissions generated by real driving on the road."



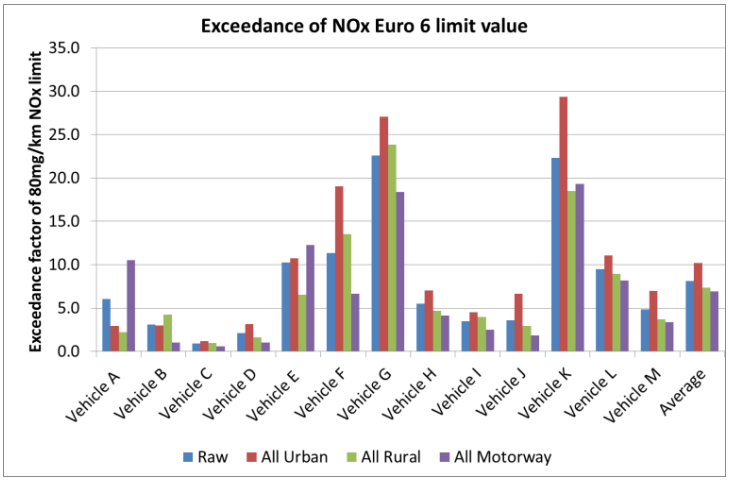
Lobbying by carmakers has successfully delayed the introduction of the new real-world driving emission (RDE) test that was originally scheduled to commence in 2012, and then in 2014, before limits apply in 2017.

There must be no further delays to the testing programme and the full range of pollutants measured from the start of the monitoring period.

[5] EEA, 2013, Air quality in Europe — 2013 report, http://www.eea.europa.eu/publications/air-quality-in-europe-2013/at_download/file
[6] The Clean Air Policy Package Impact Assessment, 2013, http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf
[7] 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
[8] 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
[9] Sunday Times,2014, Diesel cars built to foil test for toxic fumes, http://www.thesundaytimes.co.uk/sto/news/uk_news/Health/article1461995.ece
[10] Adapted from ICCT, 2013, European Vehicle Market Statistics
[11] 715/2007/EC Article 14(3)

Euro 6 failures

Euro 6 limits came into force on the 1 September 2014, but tests on Euro 6 vehicles shows the issue of high diesel NOx emissions remains unresolved. Recent research by the ICCT[12] tested 13 Euro 6 or equivalent vehicles and found breaches of the 80mg/km NOx limit ranging from two to 22 times in different vehicles. The average breach was by a factor of 8, broadly consistent with previous research that found breaches of 6-9 times,[13,14] One vehicle (C) achieved the target in the ICCT tests.



The ICCT found 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 as a result of driving uphill, sustained accelerations from a standstill, or regeneration of the diesel particulate filter.[15] But for some vehicles, the NOx performance was poor even in the 'undemanding' situations. There were also wide differences in the performance of different tested models, as illustrated. Urban emissions were typically around 30% higher than those produced on motorways or in rural driving. If the car was driven in an undemanding way, emissions were about 20% lower in urban areas and 30% lower on motorways and in rural areas.

The ICCT research shows Euro 6 emission limits *can* be met in real-world driving but whether they are depends upon the choice of emissions abatement technology and how it is configured within the vehicle.

The research demonstrates tests representative of real world emissions must use a realistic driving style and must not distort the raw emissions data to exclude or down-weights emissions peaks.

Real-world driving emission tests

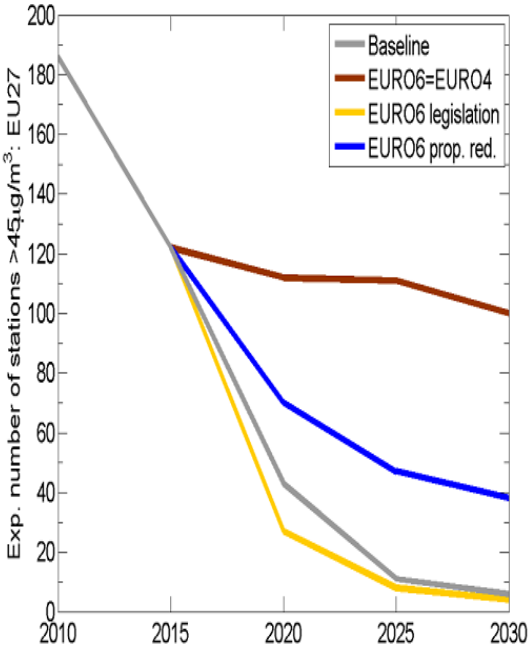
The Commission, working with stakeholders and member states, is presently finalising the RDE testing procedure. It has agreed to use Portable Emissions Monitoring System (PEMS) to measure gaseous emissions and T&E supports the use of this approach for measuring particulate mass and number also.

The issue will be discussed with EU member states at the TCMV in October. A wide range of issues remain outstanding that will have a significant impact upon the effectiveness of future RDE tests and whether these lead to a reduction in emissions from diesel vehicles

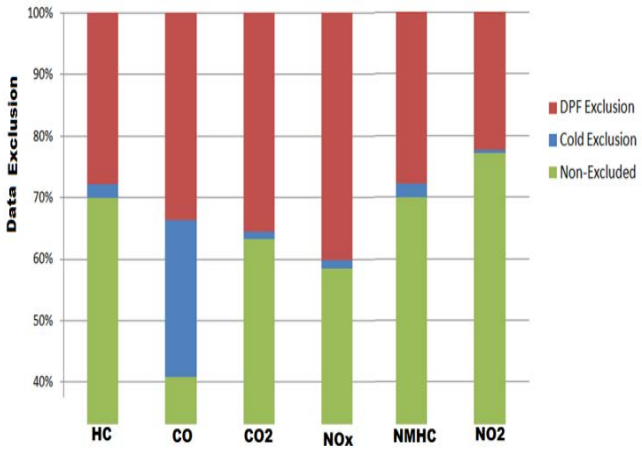
[12] ICCT, 2014. Assessment of PEMS Datasets from Modern Diesel Passenger Cars. 20th International Transport and Air Pollution Conference (TAP) 2014.
[13] TNO, 2013, Investigations and real world emission performance of Euro 6 light-duty vehicles, https://www.tno.nl/downloads/investigations_emission_factors_euro_6_ld_vehicles_tno_2013_r11891.pdf
[14] 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
[15] 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

and less air pollution. In reaching conclusions about the design of PEMS tests, member states should be aware of the following issues:

1. PEMS tests should reproduce a representative range of driving conditions and styles to ensure the emissions generated correspond to those typically achieved by drivers.
2. Not-to-exceed limits that apply from 2017 should match Euro 6 limits where the test is conducted under "normal driving conditions". Euro 6 limits can be met and any higher limit will result in a large number of ongoing breaches of ambient air pollution standards. This is illustrated in the graph[16] that shows if Euro 6 vehicles only produce emissions matching Euro 4 vehicles (as many currently do) the nitrogen dioxide limit will continue to be widely breached. Even a proportionate reduction in emissions leads to around 50 breaches of limits in 2025. In contrast, full compliance with the 80mg/km target enables almost all cities and highly trafficked locations to meet targets thereby avoiding infraction proceedings and potential fines on member states.



3. There should be an element of randomisation in test routes to avoid carmakers being able to utilise cycle-beating techniques. Drivers should also not be overfamiliar with routes to prevent unrepresentatively smooth driving.
4. RDE should use PEMS testing for all pollutants since the alternative approach, using a random test cycle on the chassis vehicle dyno, is subject to "cycle beating" in a similar way to current tests.
5. Data from the engine control unit (ECU) should not be the primary source of any data collected during a test. This is to avoid any potential manipulation of test data and to prevent any "defeat devices"[17] being activated.
6. Data should not be normalised without more extensive testing of the selected tool and appreciation of how it affects PEMS test results. If normalisation is to be used to account for driving style there must be one tool, EMROAD, which is representative of real-world driving. More than one tool or a choice of tools will discredit the RDE test and weaken its effectiveness.
7. Given the high frequency of short urban trips with cold engines these emissions must be included in the test.
8. Emissions occurring during regeneration of Diesel Particulate filters (DPFs) must be included in test results. These events are part of normal driving and observed in around 15% of tests on diesel cars.[18] Omitting this data would result in a sizable reduction[19] in the



[16] The Clean Air Policy Package Impact Assessment, 2013, http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf
[17] A device designed to allow a test limit to be met but which does not operate on the road
[18] Emissions Analytics, 2014, Personal Communication
[19] AECC 2014, proceedings from the AECC Workshop on Clean Air and Real Driving Emissions, 3rd of September 2014, Bonn

data collected for most pollutants and lower emissions being measured.

9. Humidity and other climate corrections should be avoided as a wide range of climatic conditions exist in Europe.
10. The data should not be corrected to zero when the engine is off as residual emissions exist in the exhaust pipe.

PEMS tests are significantly cheaper than chassis-dyno tests once the capital and operational costs of the laboratory are accounted for. Tests can therefore be performed on a large number of vehicles at modest costs and large "families" of vehicles being covered by a single test should be avoided.

A last chance for diesel cars

An effective system of RDE tests would ensure that, by 2017, NOx emissions from new diesel cars achieve Euro limits that were established in 2007. It is a lost decade in which air pollution in urban areas and adjacent to heavily-trafficked roads has failed to improve – but could represent the tipping point for future improvements.

But the effectiveness of RDE tests depends on details in the way it is designed. Carmakers want a test that is unrepresentative of real-world driving to make compliance easier. But this will result in Euro 6 failing to improve air pollution emissions just as previous Euro standards have failed.

If Euro 6 fails and RDE tests do not reduce emissions, cities will be left with no choice but to ban diesel cars with levels exceeding nitrogen dioxide limits. If not, the health of citizens will continue to be heavily effected and member states run the risk of fines for breaching EU rules. It has been estimated such fines could amount to £1.25 billion by 2025.[20]

Strong measures by cities to reduce or refuse access to polluting diesel cars will inevitably impact on sales, particularly disadvantaging carmakers that focus on this technology. Diesel cars amount to two-thirds or more of German and French carmakers' sales.

An effective RDE test will reduce the health effects and costs of air pollution and ensure clean diesel cars can continue to play a role in delivering urban mobility. But an ineffective system of RDE that fails to reduce emissions sufficiently on the road will present governments and city authorities with few options other than to reduce or prevent the use of diesel cars in polluted areas. The Commission and member states have a chance to ensure RDE tests can be effective and that diesel cars can finally be clean.

For more information

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[20] Client Earth, 2014, The Commission's air infringement cases