

Gasoline particulate emissions: The next auto scandal?

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Summary

Harmful levels of air pollution are endemic in European cities, especially close to roads, causing around 500,000 premature deaths annually and costing the EU a staggering €1 trillion a year.¹ Despite the fact that air emission limits for cars, vans and trucks (Euro Standards) have been progressively tightened on paper, obsolete tests and optimisation strategies deployed by car manufacturers have meant that regulations have failed to deliver significant real-world improvements. The Dieselpgate scandal has focused on the high emissions of diesel nitrogen oxides (NO_x). But advanced gasoline direct injection engines are now the main concern regarding high emissions of particle numbers (PN).

To tackle high exhaust PNs the European Commission has proposed a third real-world driving emission (RDE) package to be implemented from 2018 for all new cars. But leaks of European Commission draft regulations and minutes of meetings with member states, plus documents prepared by carmakers, show there is concerted attempt to further weaken an already inadequate proposal. This is intended to circumvent the new test and avoid the need for carmakers to fit a simple Gasoline Particulate Filter (GPF) that costs just €25 and would clean up the emissions.

The Commission proposal is now being finalised and is expected to be agreed by the Commission and Council by the end of 2016. The weaknesses in the proposal are explained in this paper along with who is lobbying to weaken the proposals and what is needed in order to avoid a future Petrolgate scandal of increasing particulate emissions.

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 30% 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 (NO₂). As a result of high levels of air pollution, there are nearly 500,000 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 days³.

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

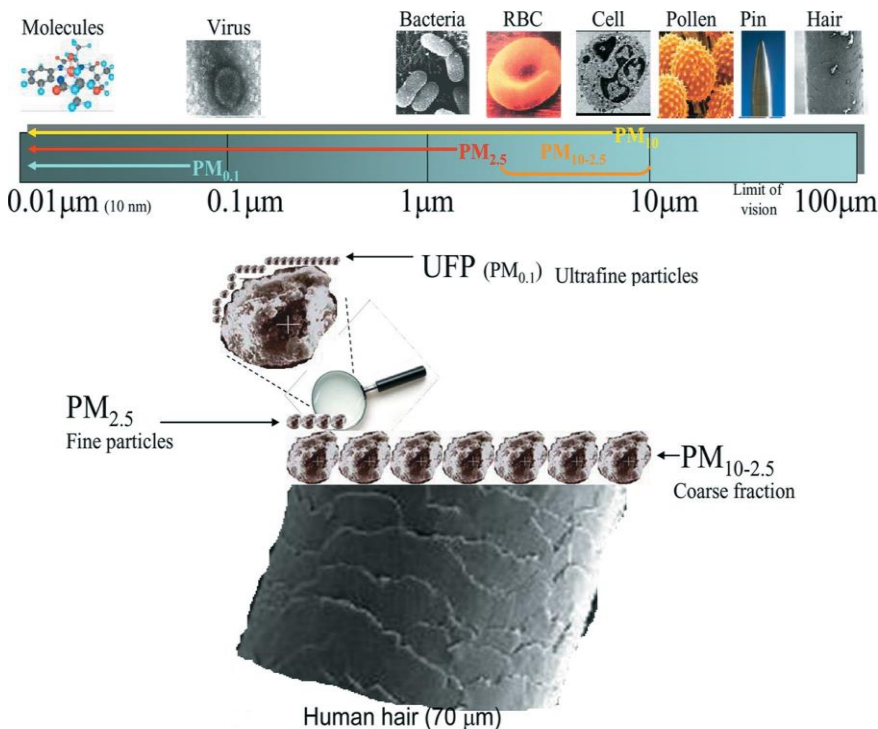
1 European Commission, 2013, [The Clean Air Policy Package Impact Assessment](#)

2 European Environment Agency (EEA), 2015, [Air quality in Europe](#) – 2015 report

3 European Commission, 2013, [The Clean Air Policy Package Impact Assessment](#)

2. Gasoline particulate emissions

Petrol cars with uncontrolled gasoline direct injection (GDI) engines produce even higher numbers of particles than modern diesels that are now fitted with a filter. The share of GDI engines has grown rapidly as a result of their improved fuel economy and lower CO₂ emissions and now represents 40% of the gasoline engine market.⁴ GDI technology is expected to largely replace current port fuel injection (PFI) engines⁵ and also erode the market share of diesel. It has been estimated that by 2030 particle numbers from GDI vehicles will be more than those of diesels.⁶ Uncontrolled GDI engines typically emit around 10 times more particles (by mass) than PFI engines and more than one-hundred times the number of particles.⁷



It is hard to comprehend quite how small the ultra-fine particles produced by GDI and diesel engines are (as illustrated⁸). Some are smaller than a virus, similar in size to molecules. A measured PM_{2.5} mass concentration of 10 μg/m³ can contain as many as 2.4 million 20-nm particles/cm³, but could also be represented by a single 2.5 μm particle.⁹ There is particular concern about the huge numbers of particles and large surface area to diameter ratio of the particles increasing their capacity to transport toxic metals and hydrocarbons directly into the body and specifically transport these to the alveoli in the lungs and on into

the blood.

Some particles emitted from GDI engines are smaller than a virus 10nm

Testing performed on behalf of T&E¹⁰ (illustrated overpage) shows that by fitting a Gasoline Particulate Filter (GPF) to the exhaust, GDI cars produce over 100 times less particles using the current European test (NEDC), the new European test (WLTP) and the more-aggressive US test (US06). The AECC¹¹ gets similar results on the upcoming Real-Driving Emissions (RDE) test in several ambient conditions. GPFs are cheaper, simpler, more compact and more durable than those used in diesels. Since the higher temperature of the GDI exhaust prevents an accumulation of soot and enables continuous regeneration of the filter. GPFs are available on the market but in the absence of regulations are only fitted to a tiny fraction of gasoline

⁴ The ICCT, European vehicle market statistics, [Pocketbook 2015/2016](#)

⁵ AVL Powertrain Engineering, Paul Whitaker, Powertrain strategies for the 21st century, July 22th 2015

⁶ JRC, 2011, Feasibility of Introducing Particulate Filters on Gasoline Direct Injection Vehicles

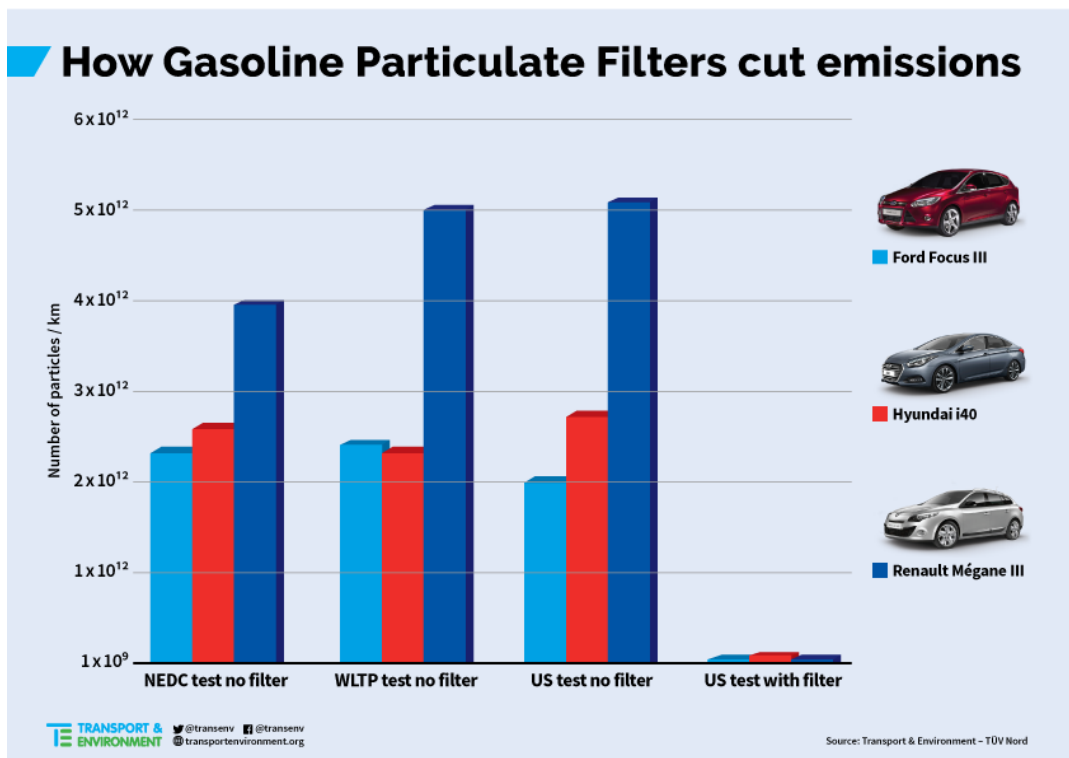
⁷ JRC, 2012, Assessment of particle number limits for petrol vehicles

⁸ Adapted from [Clinical Science](#)

⁹ Oberdörster et al. 1995

¹⁰ T&E, [Particle emissions from petrol cars](#), Briefing paper, November 2013

¹¹ AECC, [Project on real-world GDI PN emissions](#), AECC technical seminar on RDE PN, July 4th 2016



vehicles despite being estimated to cost just €25.¹² Daimler,¹³ Volkswagen¹⁴ and PSA Group¹⁵ have announced plans to use GPFs on most future models (not all). However, many carmakers intend to avoid fitting a GPF by adjusting the combustion of gasoline in the cylinder to decrease PN emissions¹⁶.

WITH A WEAK TEST PROTOCOL IT WILL BECOME EASIER FOR CARMAKERS TO AVOID MEETING THE PN LIMIT WITH A FILTER DURING RDE - BUT EMISSIONS ON THE ROAD WILL STILL BE 100 TIMES HIGHER THAN IF THEY FITTED ONE.

Gasoline particulate filters capture almost all the particles from gasoline direct injection engines

3. The Commission Proposal

The European Commission is currently finalizing the 3rd Package of real-world driving emissions (RDE) regulations. These define how particle numbers should be measured during on-road tests. The Package also defines how to take account of higher emissions of NO_x emissions from diesel cars when the engine is cold and during regeneration (cleaning) of the diesel particulate filter (DPF). T&E has acquired a copy of the current draft of the Commission proposals. This was presented to member states at a recent meeting of the Technical Committee on Motor Vehicles (the group that controversially in 2015 doubled and delayed NO_x emissions limits for diesel cars).¹⁷ T&E has also acquired minutes of the TCMV meeting that show which member states are lobbying on behalf of their car industries notably: Spain and Sweden initially, other countries' positions are not clear yet. By comparing these against copies of industry presentations it is clear these countries are simply following the line of their national carmakers contrary to the interests of citizens.

Weakly drafted regulations and the abuse of loopholes in vehicle testing and approval requirements are one of the primary causes of the diesel NO_x scandal. The current proposals on the third RDE package will undermine the effectiveness of real-world emissions tests resulting in significantly higher emissions - this is a Petrolgate scandal in the making. The following sections detail the current issues.

¹² Engine Technology International, Chris Pickering, [Polarizing filters](#), January 2016

¹³ Automotive News Europe, [Daimler invests \\$3.35 billion in clean diesel technology](#), May 27th 2016

¹⁴ Automotive News Europe, [VW to fit filters to clean up gasoline engines](#), June 24th 2016

¹⁵ Engine Technology International, Chris Pickering, [Polarizing filters](#), January 2016

¹⁶ Ibid.

¹⁷ T&E, [Governments double and delay air pollution limits for diesel cars](#), Press release, October 28th 2015

3.1. Timing

The Euro 6 regulation established a PN limit for GDI vehicles of 6×10^{11} in real-world driving and RDE Package 1 defines most of the conditions under which the tests should be performed. The Commission and member states have already agreed the PN limits will apply from September 2017 for new types of vehicles and a year later for all new cars sold. But some member states are trying to delay the introduction of the tests notably Spain (home of Seat) and Sweden (Volvo). TCMV has a history of requiring last minute delays to regulations that have been agreed years before.

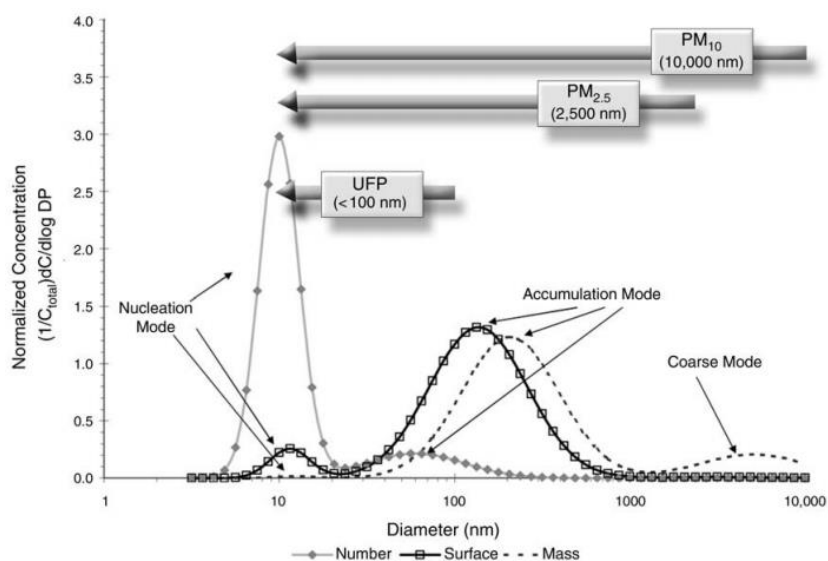
THE EURO 6 PN LIMITS MUST NOT BE THE NEXT REGULATION THAT THE TCMV COMMITTEE DELAYS.

3.2. Limits

Although the Euro 6 regulation establishes a limit of 6×10^{11} the draft proposal from the Commission allows for 50% higher emissions to take account of uncertainties in the test procedure. The car industry wants even higher emissions - 300% more than the limit to make it easier to pass the test and to enable them to avoid fitting a GPF. However, if the car was fitted with a GPF the emissions would be around x100 lower than the limit.

THE EURO 6 REGULATION MAKES NO MENTION OF ACCOUNTING FOR THE UNCERTAINTY IN THE TEST AND THE PN LIMITS SHOULD BE MET ON THE ROAD NOT ARTIFICIALLY RAISED BY 50%.

The measurement equipment used during the tests also fails to count all of the smallest particles produced by GDI engines. This also biases the test procedure in favour of carmakers trying to pass the test without fitting a GPF. The instruments only count half the particles with a diameter below 23nm. As illustrated¹⁸ there is a large proportion of ultrafine particles (UFPs) significantly smaller than those emitted in exhausts. The failure to measure these particles is a serious limitation of the current methods.



The test method fails to count all the ultrafine particles

T&E SUPPORTS THE CURRENT METHOD AS THE BASIS FOR COMMENCING REGULATION BUT THE COMMISSION NEEDS TO ASSESS TO WHAT EXTENT THE PARTICLE NUMBERS ARE BEING UNDERESTIMATED AND INTRODUCE IMPROVED METHODS WITH THE SECOND STEP OF THE RDE NO_x LEGISLATION IN 2020.

¹⁸ Health Effects Institute, 2013

3.3. Fuel quality

The quality of fuel sold in the EU is strictly controlled and for petrol cars must comply with the international standard CEN 228. However, within the standard the exact composition of the fuel varies and this affects the number of particles emitted by a GDI engine. At low temperatures some petrol blends may emit 5 times more particles than the legal limit without fitting a GPF.

Vehicle manufacturers want to prevent tests being conducted with some entirely legal fuels on sale in petrol stations around the EU even if they meet international standards! Incredibly, the European Commission appears to be acceding to their demands by including in the regulation a clause (recital 16) that states: (16) “Market fuel plays an important role in real-world emission performance of motor vehicles. Therefore, a new methodology will be developed in the 4th regulatory act to take into account the effect of market fuel blending variability on particle emissions from direct injection gasoline engines.”

This clause opens the door to ensuring cars are only tested on the road with fuels that produce low emissions, not the full range of fuels on sale in the EU. This loophole would assist carmakers to meet the limits without fitting a GPF.

A REAL WORLD TEST SHOULD BE ABLE TO USE ANY LEGAL FUEL ON SALE IN THE EU.

3.4. Cold starts

The aim of RDE tests is to assess as accurately as possible the pollutant emissions of a vehicle in real-world driving conditions. Cars emit much more pollution when the engine is cold and the exhaust treatment system is not fully operational. The RDE test is substantially longer (90-120 mins) than a typical journey in Europe (15-20 minutes) and accordingly the cold start emissions, particularly for nitrogen oxides (NO_x), are seriously underestimated during an RDE test compared to the operation of the car in the real world.

The inclusion of a method to correctly calculate the effect of cold starts was originally planned within the first RDE package but has been repeatedly delayed. It has now been included in the proposals for the third package but in a way that grossly underestimates the effect of these emissions. Several countries including the Netherlands, the UK, France, Sweden, and Germany support this weak compromise despite better alternatives to calculate their share. T&E believes there should be proper accounting of cold start emissions from 2021 that would ensure the test is representative of real-world emissions.

COLD START EMISSIONS SHOULD BE CORRECTLY BUILT INTO THE REGULATION FROM 2020 ONWARDS.

3.5. Diesel Particle Filter regeneration

Periodically, diesel particulate filters must be cleaned to avoid creating too much of a disruption to the exhaust flow. These regeneration events produce high levels of NO_x emissions and must be taken into account for the calculation of emissions during RDE tests. The 3rd Package proposals do this but in a way that assumes regeneration events are twice as infrequent as in real life. In addition, the proposal allows carmakers to connect the test equipment to the engine control unit. This potentially provides an opportunity for the car to identify it is being tested and to deploy a defeat device.

REGENERATION EVENTS SHOULD BE CORRECTLY BUILT INTO THE REGULATION FROM 2020 ONWARDS.

4. Final remarks

The reputation of both the car industry and diesel vehicles has been irreparably damaged by the Dieselgate scandal. It arose primarily from manufacturers using cheap but ineffective exhaust treatment systems that weak testing systems and compromised testing and type approval authorities failed to detect. Now, a new issue is emerging, particle emissions from GDI vehicles. Again there is a cheap solution, the GPF, but instead carmakers want to ease the test conditions so they can save the €25 it would cost to fix the problem for good. A new Petrolgate scandal is in the making. It is avoidable by establishing robust test procedures that make it difficult to meet the limits without a GPF. The European Commission and member states need to establish these good test procedures to protect the industry from its own short-sightedness. If not, the likelihood is that in a few years' time we will see continuing high levels of particles killing hundreds of thousands of citizens prematurely and the industry claiming they are only complying with the rules.

Further information

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