Driver & Vehicle Standards Agency

Vehicle Market Surveillance Unit

Results of the 2017 programme

Moving Britain Ahead

March 2018

The Department for Transport has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the Department's website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact the Department.

Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone 0300 330 3000
Website www.gov.uk/dft
General enquiries: https://forms.dft.gov.uk

Contents

1. Introduction

1.1 In April 2016 the Department for Transport published the results of a testing programme on emissions from diesel cars. This programme was established quickly in response to the announcement that Volkswagen Group had cheated on emissions tests, to urgently check whether this practice was widespread across the industry. The testing did not find evidence that other manufacturers were using equivalent 'cycle recognition strategies' but found higher levels of nitrogen oxide (NOx) emissions in test track and real world driving conditions than in the laboratory for all manufacturers' vehicles.

1.2 In the summer of 2016, the Department for Transport established the Vehicle Market Surveillance Unit (the Unit) to oversee and manage the continued testing of vehicles and components. This new Unit is based within the Driver and Vehicle Standards Agency (DVSA) and works closely with the Vehicle Certification Agency (VCA). Its role is to check that new products placed on the UK market comply with the relevant legal obligations - this is often referred to as 'in-service' testing.

1.3 For 2017 we chose to continue to focus on vehicle emissions testing and selected a programme that included petrol cars, light vans, trucks and buses, to complement the recent work on diesel cars. In future years we expect to continue expanding the testing to a wider selection of vehicles and components.

1.4 Where necessary, the Unit is also able to react quickly to new information about products in the market. Early examples of this include the testing that we conducted on (i) two Fiat Chrysler vehicles, following allegations against the US version of this vehicle from the USA authorities and (ii) two Mitsubishi vehicles following allegations that they had falsified fuel economy tests for 625,000 vehicles, mainly in Japan. These vehicles were not part of our original testing programme but we were able to source UK vehicles and insert them into the programme, in order to undertake our own testing. The results of this can be found in section 5.

1.5 It is very important that the testing results of the Unit are transparent and published in full. This report contains the results and conclusions from this first testing programme and the underlying data will be made available shortly.

2. Establishing the testing programmes

2.1 The testing programme was designed to check the pollutant emissions produced by a selection of the most popular vehicle types used on UK roads. We focused on testing petrol cars, light duty vans, trucks and buses. From each of these categories we selected a representative sample of vehicles to test. We had previously tested pollutant emissions for a range of diesel cars and so did not expect to select any further vehicles from this category. This programme also provided us with the opportunity to extend our investigations to measure the carbon dioxide emissions produced by the selected vehicles.

2.2 The primary aim was to assess if the vehicles complied with the standards to which they were approved. For the cars and vans the testing was also designed to assess how the real world performance of these vehicles compares against the newly introduced Real Driving Emissions (RDE) standards. The RDE legislation sets a legal limit that vehicles must comply with in real world testing, in addition to passing a laboratory test. This requirement has been applicable to new types of car from September 2017 and will apply to new types of van from September 2018. The cars and vans that we tested in this programme were not required to comply with these limits, as they were all approved before these introduction dates, and so this part of our testing was to improve our own understanding, rather than assess compliance. The RDE requirements for NOx will apply to all new cars that are sold from September 2019 and for all new vans from September 2020.

2.3 While this report does not provide a comprehensive study of the entire vehicle fleet, between this and our previous publication on diesel cars, we have significantly enhanced our knowledge of the emissions of the vehicles on UK roads.

Choosing our sample of vehicles

Cars and vans

2.4 The cars and vans were chosen predominantly on the basis of their UK sales and then refined to ensure a suitable range of manufacturers were covered. To make this assessment we considered the total new registrations for each vehicle for the period 2010-2016.

Trucks and buses

2.5 New truck and bus registrations accounted for less than 2% of the total number of registrations in Great Britain in 2016. In 2016 there were 2,665,300 new cars and 378,800 light vans registered, compared to 51,300 heavy good vehicles and 10,000 buses and coaches. There is also considerable variability within that small sample of truck and bus vehicles in terms of the weight category and number of axles. For this initial testing programme we concentrated on the most popular category, namely 2 and 3 axle rigid bodied vehicles, and selected test vehicles from the range of manufacturers.

Sourcing suitable vehicles

2.6 We were clear that the vehicles needed to be sourced independently of the manufacturers to make sure that they were representative of those in use on our roads and that they had not been subject to any special preparation or modification which could make the test results unrepresentative. For this reason we sourced vehicles from hire fleets. For the buses, this was not possible and so we hired them from operators.

2.7 The cars and vans assessed in the programme were checked for any defects that may impact upon the emission control system before being tested. The fuel was drained and replaced with standard laboratory reference fuel, which was kept consistent across all tests. These vehicles were tested on the New European Drive Cycle (NEDC (cold)) test, in accordance with their original type approval requirements. The further testing was not legislative and was conducted for information purposes.

2.8 The trucks and buses were tested in accordance with the in-service emissions testing requirements as set out in EU regulations. This means that these vehicles were tested using market fuel.

Number of tests

2.9 Our testing was designed to check the compliance of an individual vehicle. Sampling only one vehicle means that our results show a snapshot of the emissions performance from the vehicles, rather than providing a definitive result for each model. Where unexpected results were found, we reviewed the data and, if necessary, conducted additional tests. In some of these cases, it was appropriate to source a second vehicle, to identify whether there may be an issue with a particular model across the wider fleet.

Testing locations

2.10 The testing was undertaken at a selection of commercial emission test laboratories across the UK. For the cars and vans the track testing was undertaken from VCA's site in Nuneaton. RDE tests were carried out either by VCA or at a commercial laboratory, using Portable Emissions Measuring System (PEMS) equipment owned by VCA or the laboratories. We did not conduct testing in laboratories that are owned by vehicle manufacturers.

3. Undertaking the testing

Cars and vans

3.1 The testing programme was designed first to check that the cars and vans we had selected complied with the official laboratory test - the NEDC (cold) test. Further testing was constructed around variations of this cycle with testing being undertaken both in emissions laboratories and on test tracks to assess how the emissions results under these circumstances varied compared to the official laboratory test.

3.2 Further tests were conducted on public roads to assess the emissions performance of the vehicles in typical real world conditions.

Preparing vehicles for the dynamometer

3.3 Modern vehicles are equipped with a range of electronic systems, often fitted to improve safety, and which rely on a number of sensors on the vehicle to perform correctly. Some of these sensors may detect implausible situations when a vehicle is driven on a chassis dynamometer in a laboratory. For example, the vehicle speed sensor indicates that the vehicle is moving but the wheel speed sensors detect that only the driving wheels are rotating. These contradictory signals may cause the vehicle to default to a safe operating mode and this may prevent it from undertaking the laboratory test.

In order to allow laboratory testing, some vehicles are equipped with a 'dyno mode' which suppresses this function and enables the vehicle to be driven on the chassis dynamometer. When the vehicles are initially type approved, these 'dyno modes' may be in operation, however legislation does not allow engaging dyno mode to improve the effectiveness of a vehicle's emissions control system in order to pass the test. During our testing programme, in the following cases the vehicles needed additional input to test them in the laboratory:

- Nissan do not have a sequence which allows 'dyno mode' to be engaged. Instead they connected a special wiring harness to the vehicle to allow a computer to enable the vehicle to drive on the dynamometer.
- To enable the Honda to enter 'dyno mode' a 'Handyman' tool was connected to the vehicle OBD port and 'dyno mode' was selected from the on screen menu.

To understand these functions it has been necessary, in some cases, to allow the manufacturer to access the vehicle being tested. We are considering how we might test further vehicles in our next testing programme without allowing such access.

Laboratory testing

3.4 We first carried out the official legislative NEDC (cold) test for each vehicle as part of our initial check that its emissions system was functioning as it had been when that model was presented for type-approval. This test is known officially as the "Type I" test but we have referred to it as the NEDC (cold) as the engine is not warmed up prior to the test. The vehicle is given a standard pre-conditioning test, then left in a temperature controlled room so that the whole vehicle including engine oil and coolant is 'soaked' to a temperature between 20 and 30°C, as specified in the EU type approval regulations. Following that the official test is run with emissions measured from engine start.

3.5 We then ran a series of variations of the NEDC test. These tests aimed to assess how well a vehicle controlled its emissions in comparison to its performance on the official NEDC (cold) test. These variations consisted of:

- A hot NEDC test - the same test cycle, but starting with a fully warmed up engine.
- A hot double NEDC test - running two consecutive NEDC tests, recording emissions for both, to assess the consistency of the results.
- A hot 'reversed' NEDC test - in which the higher speed section of the test, which usually takes place at the end, was conducted at the beginning of the test.
- A hot NEDC + 10% test - in which the speeds of the test cycle were increased by 10% compared to the standard test.

As the speeds and acceleration rates in the NEDC + 10% test are higher, the engine loads are higher. The results in comparison to the standard NEDC test therefore indicate how well the vehicle's emissions control systems cope with this increase in load.

3.6 In the laboratory we attached PEMS equipment to each vehicle and used this alongside the laboratory emissions measurement system to validate that the result from the PEMS equipment was comparable to the laboratory result. This gave us confidence in the accuracy of the later track and road testing.

Track testing

3.7 The track test element of the programme was designed to replicate, as far as practicable, testing in the laboratory. We conducted tests on a track measuring emissions using the PEMS equipment fitted to each of the vehicles. We recreated the NEDC test by providing the driver with a screen showing a trace of the speed versus time that they needed to maintain for each section (as is done in the laboratory test). The track tests were designed to check that the vehicle's emissions did not significantly increase when essentially running exactly the same drive cycle as in the laboratory.

On road testing

3.8 The final part of our testing was an on-road RDE test. This is the test that new types of cars have been required to comply with from September 2017, to ensure that they properly control exhaust emissions in real world use. This element involved driving the vehicle for approximately 1.5 hours over a test route on public roads. The route included urban, rural and motorway driving and tests were carried out during the day in normal traffic conditions. The results presented in this report are the overall emissions for the whole RDE trip (in grams per kilometre for NOx and number per kilometre for particle number emissions). These figures have not been processed using the data normalisation tools, EMROAD or CLEAR, and are therefore labelled as 'basic' RDE results.

3.9 Under RDE legislation, if temperatures drop below 3°C, this is considered ‘extended’ conditions and the emissions results for the test are divided by a factor of 1.6. For transparency reasons in this report we are presenting ‘raw’ RDE results which have not been post-processed and have not had additional factors such as the extended conditions factor applied.

Heavy goods vehicles and buses

3.10 The legislative requirements for heavy duty vehicles are different from the light duty requirements. New types of heavy duty engines and vehicles have been tested in the real world to obtain their type approval since 31 December 2012. Real world testing could be introduced earlier for larger vehicles, because there is more space to fit the necessary PEMS equipment (which has since been developed further to reduce its size allowing it to be fitted to cars and vans).

3.11 Heavy duty vehicles are not tested on a chassis dynamometer at type approval in the same way as light duty vehicles. Instead, as well as on road PEMS testing, more controlled and repeatable emissions testing is conducted on the engine alone, using an engine bench dynamometer, i.e. the engine is tested out of the vehicle and without a transmission system.

On road testing

3.12 The vehicles were set up with the PEMS equipment and we undertook a real world test that complied with the legislative requirements. This lasts for approximately 2.5 hours and includes urban, rural and motorway driving. There are set parameters that the test must stay within to ensure that each vehicle is representatively tested.

3.13 The emissions measured in the real world test using the PEMS are normalised to the laboratory engine test using carbon dioxide as an assessment of the amount of 'work done'. This enables mass emissions per unit of energy (measured in kilowatt-hours, kWh) to be calculated. The result is then compared to the laboratory limit to determine whether it is within the conformity factor specified in legislation.

3.14 The conformity factor is the maximum permitted ratio of the normalised RDE emissions test result in g/kWh compared to the emissions limit specified for type approval engine testing. For heavy duty vehicles, the NOx conformity factor is 1.5, recognising that the on-road PEMs test covers a much wider range of operating conditions than the dynamometer engine test, and that real world on-road emissions measurements will be subject to greater margins of uncertainty. A similar approach is used in the light duty RDE legislation.

4. Results

4.1 Following the testing of the cars and vans, we arranged for independent analysis of the data to quality assure our testing. In the light of the Volkswagen Group emissions scandal in September 2015, we also reviewed the data for any unexpected results that may have suggested the presence of prohibited defeat devices. This involved reviewing the emissions profile from each of the laboratory and track tests.

4.2 The cars and vans were only required to comply with the legislative laboratory test, but we conducted variants of this and reviewed the data from these tests for unexpected results. We also compared the track and real world results against the European Commission's guidance for market surveillance testing which recommends a maximum acceptable conformity factor compared to the laboratory limit.

4.3 For the heavy duty vehicles the test data was analysed using the method in the heavy duty legislation for in-service emissions testing and conformity factors.

4.4 Following the initial tests, we determined which of the vehicles required further investigation and invited the relevant manufacturers to meetings to discuss our results. In some cases we conducted additional testing to verify our original data.

4.5 The summary results for all of the vehicles tested are shown below. Where vehicles required further investigation this is set out with the detail of what we originally found, any further testing that we conducted, and the outcomes of our discussions with the manufacturers. From this we have drawn our conclusions about the compliance of each vehicle.

Petrol cars

4.6 We tested 15 petrol passenger cars in this programme. When tested on the legislative laboratory test, they all complied with the regulatory limits. The petrol vehicles selected included both direct and indirect injection engines. The results of the NEDC (cold) test for each vehicle are shown in figure 4-1.

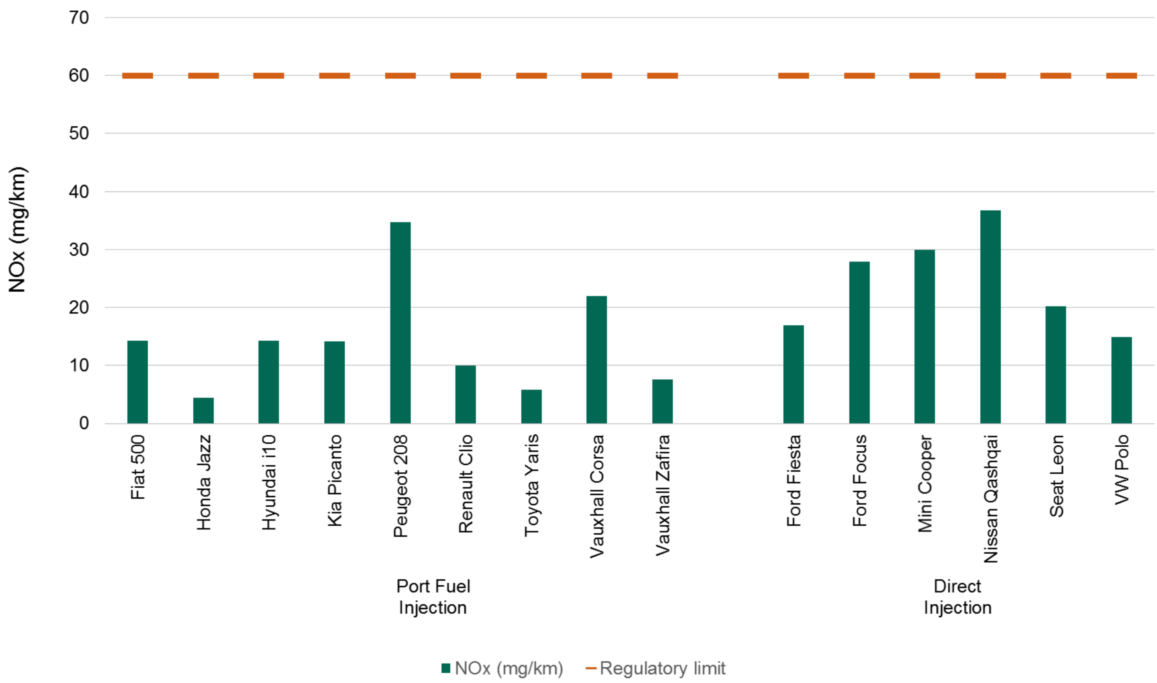

Figure 4-1 Laboratory results for petrol cars against the regulatory limit for NEDC (cold).

4.7 The results from the PEMS track testing showed that NOx emissions were generally higher on the test track than allowed in the laboratory testing. For the majority of cases these remained within the guideline limits of two to five times the laboratory test limit that the European Commission proposed in the guidance that they published on 26 January 2017. However these guideline limits were developed primarily with diesel vehicles in mind, as real world diesel NOx emissions had often been found to be higher. Figure 4-2 shows the results of the vehicles when tested on one of the track tests we conducted (NEDC A hot).

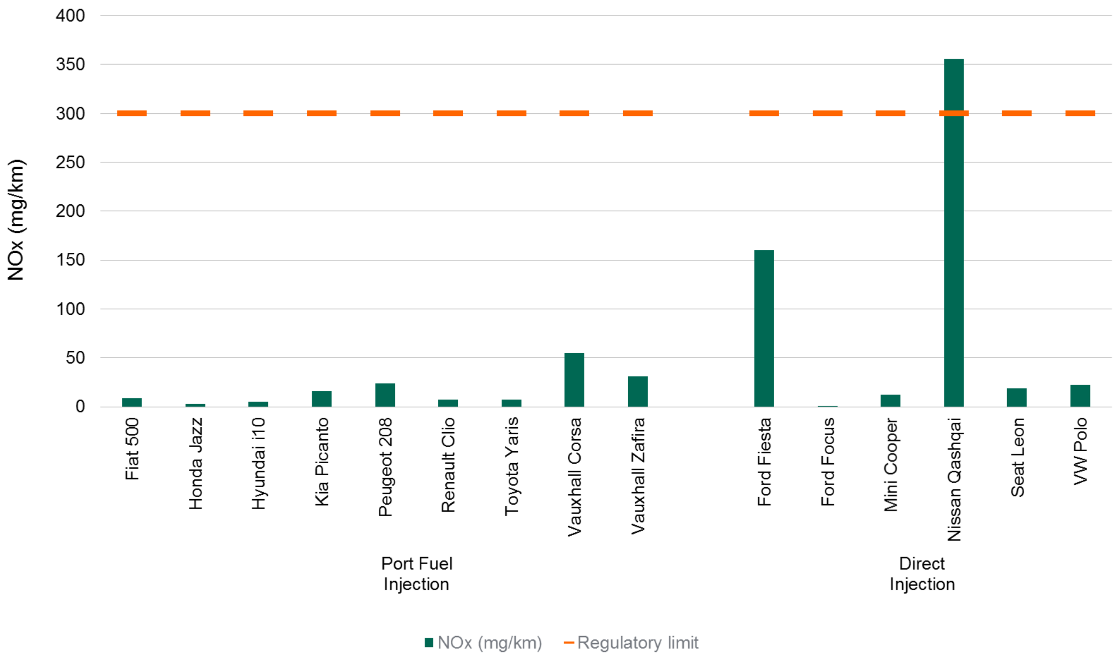

Figure 4-2 NEDC A (hot) track test results for the petrol cars against EU recommended guidance limits.

4.8 We observed similar results when the vehicles were tested in real world conditions. See figure 4-3.

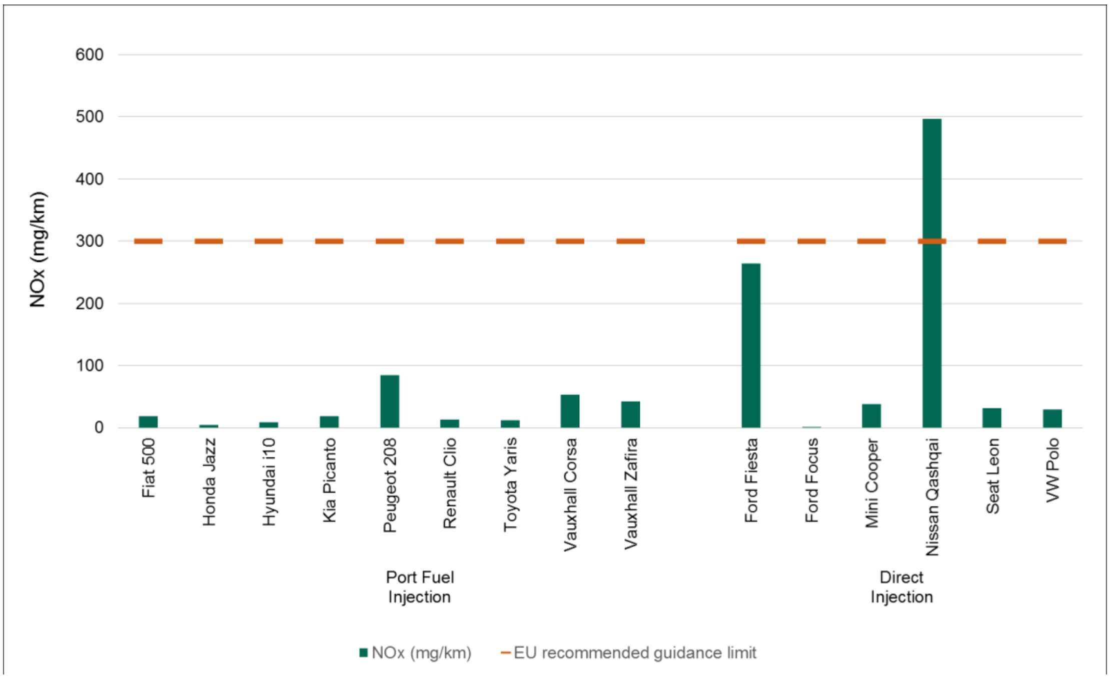

Figure 4-3 Real world results for the petrol cars against EU recommended guidance limits.

4.9 For petrol vehicles to demonstrate poor real world NOx control is surprising given that three-way catalysts that convert NOx are a long established technology and catalyst selection to achieve good real world NOx control is comparatively easier than the selecting the technology for diesel vehicles.

4.10 As of September 2017, all new petrol and diesel cars have been required to control NOx emissions to within 2.1 times the NEDC (cold) test limit when tested in accordance with the RDE test procedure.

4.11 In the case of the Nissan Qashqai, track and real world tests gave results which were more than eight times higher than the NEDC (cold) test limit. We were also disappointed by the results of the Ford Fiesta which emitted over four times the regulated results. We conducted further investigations into both of these cases, which are discussed below.

Nissan Qashqai

4.12 This vehicle passed the NEDC (cold) which is the official laboratory test required to obtain type approval. Results for hot NEDC tests, and in particular the reverse and +10% NEDC tests were higher. We did not expect this given that for these tests the catalytic converter would have been close to or at its minimum temperature for good conversion efficiency at the start of the test. It is notable that when tested on the new WLTC test cycle, which is more representative of real world driving, NOx emissions were more than three times higher than those on the cold NEDC test. However, at the time of approval this vehicle was not required to meet the regulatory limits for this new test cycle and so the vehicle would not have been calibrated for this test.

4.13 We found that when conducting NEDC tests on a test track and for the RDE test, NOx emissions results were significantly higher than the Euro 6 laboratory test limit for this vehicle. The RDE result was almost ten times higher than the average for the petrol cars we tested, and was also higher than some diesel cars we tested last year. While the RDE test was not a legislative approval requirement when this vehicle was approved, we wanted to understand why these results were so high and had a meeting to discuss our findings with Nissan.

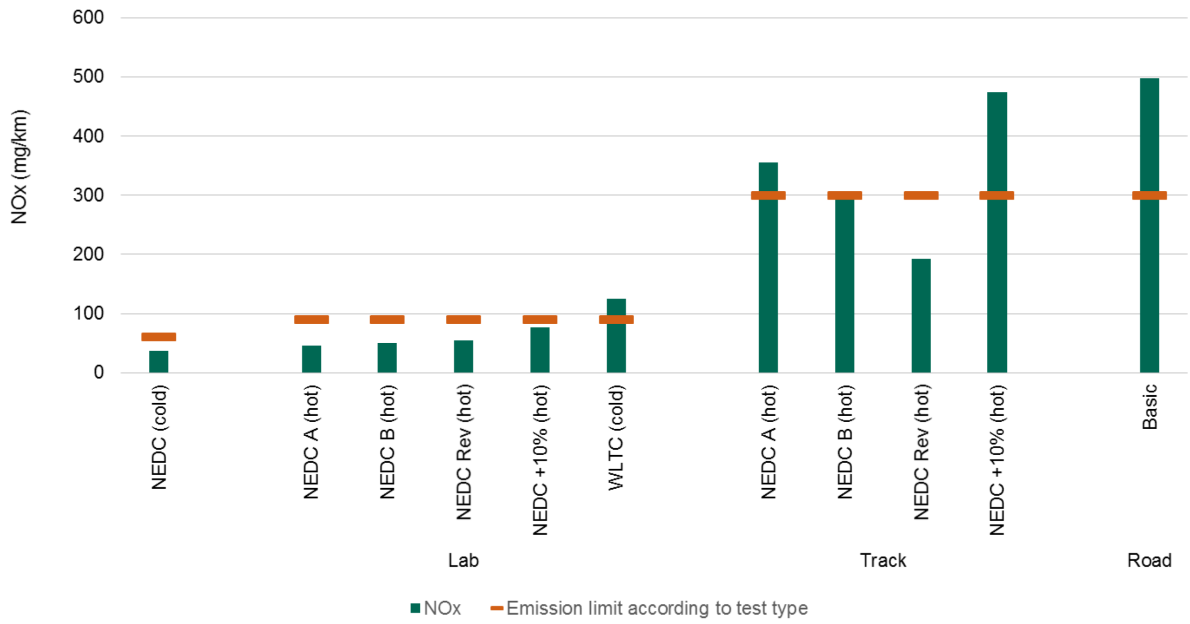

Figure 4-4 Results of testing on Nissan Qashqai for NOx (mg/km). Emissions limit for NEDC (cold) is legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

4.14 When this vehicle was tested on the track and road its test mass was 88% of the stated gross vehicle weight. Whilst this is significantly higher than the mass used to generate dynamometer settings for the NEDC it is not considered excessive for on road testing and is within the RDE legislation payload requirements.

4.15 Following receipt of our data, Nissan advised that they had conducted comparable testing and obtained similar results and therefore that our findings matched their understanding. Nissan advised that the size of the engine in this particular variant is comparatively smaller than some of their other models, meaning that it is working harder, and therefore producing more NOx. Nissan advised that they downsized the engine in an effort to reduce carbon dioxide emissions.

4.16 We requested that Nissan develop a recalibration for these vehicles that would improve the real world NOx performance. Nissan has stated that they are still considering whether this is possible and are awaiting further analysis which they will consider internally. In the meantime Nissan has confirmed that a new engine will be introduced for this particular variant of the Qashqai, in the summer. They state that this will significantly improve real world emissions and meet the standards of the new Real Driving Emissions (RDE) regulations, although they stated that the vehicle approval is to Euro 6d-TEMP (known as RDE Step 1) rather than RDE Step 2/Euro 6d.

4.17 Although these vehicles were not required to pass real world tests, due to the legislation not being in effect when they were approved, Nissan will need to meet the conformity factor of 2.1 for any cars registered after September 2019. Our findings suggest they will need to make substantial improvements to do this.

Ford Fiesta

4.18 As shown in figure 4-5, the Ford Fiesta's air pollutant emissions were comfortably below limits on the legislative cold NEDC test. The results were also acceptable on the variants of the laboratory test. NOx emissions in the laboratory were on average 18 mg/km compared to the legislative test limit of 60 mg/km. There was one exception where we obtained a higher result than we expected for particle number on the non-regulatory NEDC 'reverse' test, but in considering all of the laboratory results together we were satisfied with the vehicle's performance.

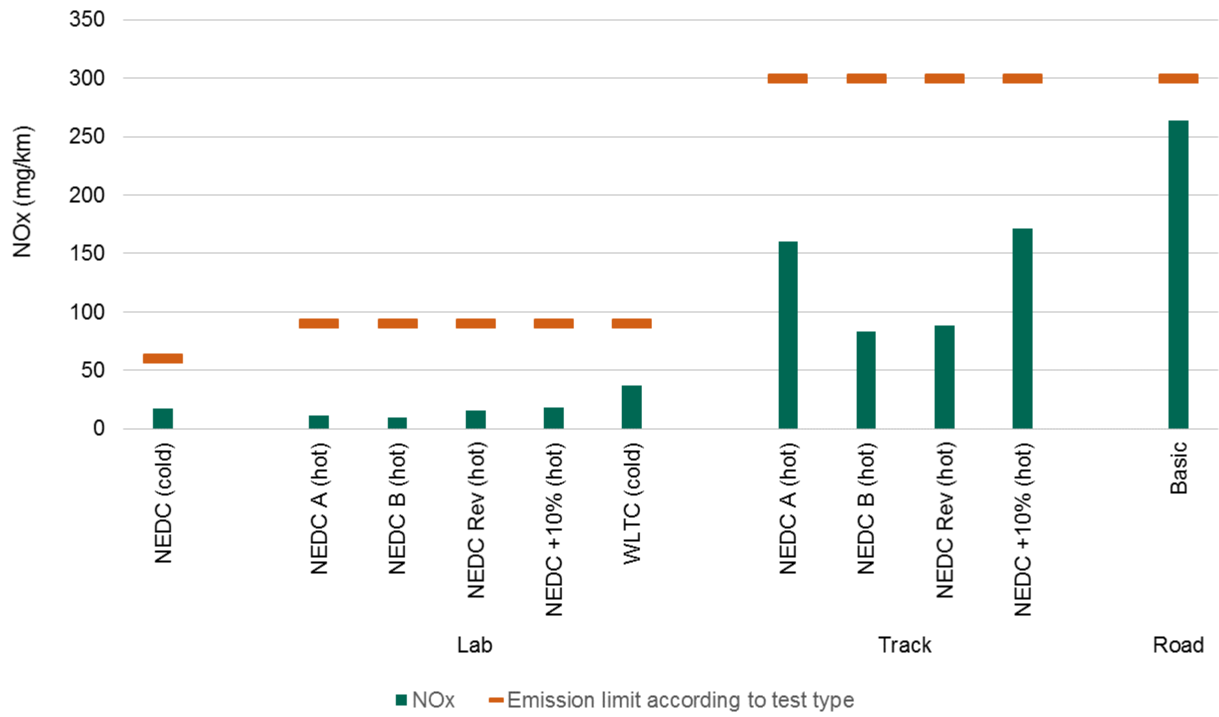

Figure 4-5 Results of testing on Ford Fiesta for NOx (mg/km). Emissions limit for NEDC (cold) is legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

4.19 However outside the laboratory, NOx emissions were found to be much higher – averaging 126 mg/km during test track testing, and 264 mg/km during real world driving. This is a surprising increase in NOx emission and is not in alignment with that seen from other petrol cars in the programme. Three-way catalytic converters are a long established and highly effective method for converting NOx emissions from petrol engines and other vehicles in our tests are using this technology to deliver results much closer to their laboratory test values.

4.20 When we met with Ford to discuss these results, they highlighted that the track and road tests were performed in January with ambient air temperatures at 0-1°C (the coldest of any of the cars that we tested) and that this would increase both aerodynamic drag and rolling resistance. Ford confirmed that the effectiveness of the emissions control system of the vehicle is not dependent on ambient air temperature, however they highlighted that if the extended conditions factor is applied, the emissions would be divided by 1.6 giving a result of 165mg/km..

4.21 They also advised that the test mass during track and road tests was higher than that during laboratory testing, and that this, in combination with the road surface, increased variability in driving speeds (transience) and additional auxiliary electrical loads would have increased engine loads compared to the laboratory testing. Ford concluded that the vehicle complies with all the applicable emissions requirements and that "this combination of conditions are outside the normal Fiesta customer usage profile".

4.22 When we met with Ford, we requested that they consider developing a recalibration for this vehicle. However, they stated that they had already looked into this and did not feel it would be possible to conduct any service actions to improve real world NOx control. They also highlighted that the vehicle tested by the Unit is now out of production and has been replaced by a new Fiesta model with significant changes to the emissions after-treatment system.

4.23 We are disappointed by this response. We believe that our road and track tests are representative of conditions that might reasonably be expected to be encountered in the UK and the technology to control NOx emissions under these conditions is available and well understood. While these results do not appear to imply any non-compliance with legislative requirements, in our view they do indicate an emissions control system which has not been designed to manage NOx in what might be reasonably expected real world driving conditions.

Light vans

4.24 The six light diesel vans that we tested were mainly Euro 5 with one Euro 6. We selected these as they are currently the most common on UK roads. Our testing indicated that all of these vehicles complied with the NEDC (cold) approval test. However we needed to undertake further testing on three of the vehicles in order to establish this, as explained below.

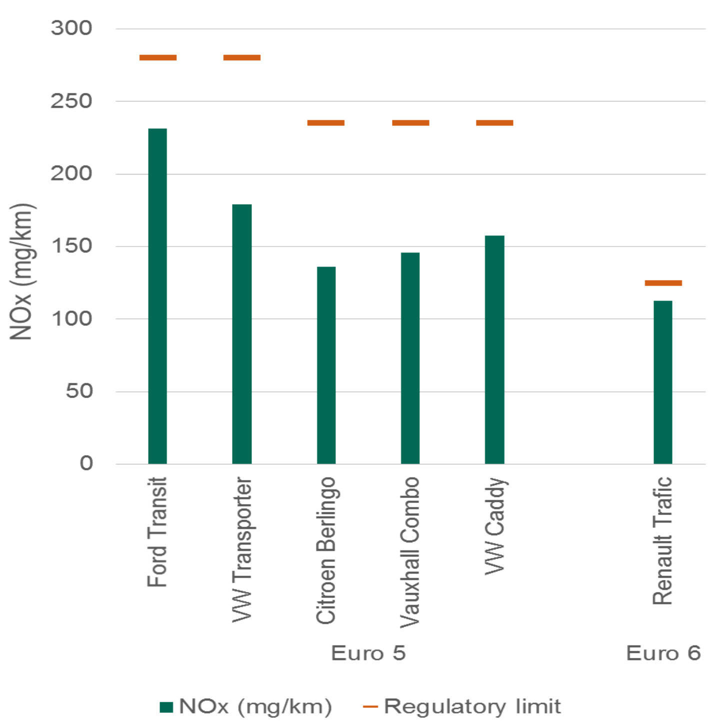

Figure 4-6 Laboratory results for the light vans on the NEDC (cold) test against the legislative limit[1].

[1] The different limit levels within the Euro 5 vehicles is due to the different sizes of vehicle. Category N1 - I vehicles have a reference mass of less than or equal to 1305kg and are subject to a limit of 180mg/km of NOx. Category N1 - II vehicles have a reference mass of 1305kg - 1760kg and are subject to a limit of 235mg/km of NOx. Category N1 - III vehicles have a reference mass of more than 1760kg to a maximum of 3500kg and are subject to a limit of 280mg/km of NOx.

Ford Transit

4.25 Our initial tests of the Ford Transit on the NEDC (cold) test resulted in NOx emissions over twice the legislative limit. As a result we sourced a second vehicle, but this gave very similar results.

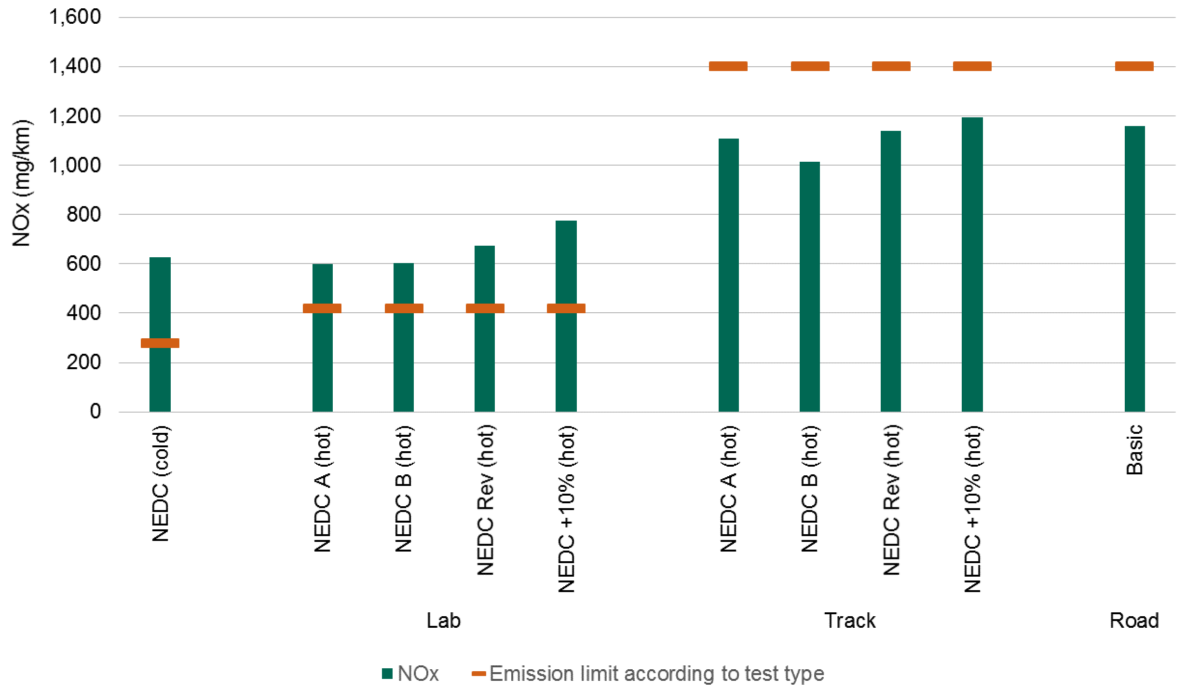

Figure 4-7 Results of first set of tests on the first Ford Transit. Emissions limit for NEDC (cold) is the legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

4.26 We shared these findings with Ford. They highlighted that during the higher speed portion of the test we had used sixth gear but that sixth gear had not been used when this vehicle had been type approved, as its use was optional.[2] We explained that we used sixth gear as that was what the vehicle's gear shift indicator display recommended for fuel efficient driving. Ford requested that we retest the vehicle but conduct the testing without using sixth gear during the high speed portion of the test as this is how the vehicle was type approved. This additional testing was undertaken at Ford's expense but remained independent of the company.

4.27 We re-tested the first Transit without using sixth gear. The NOx results were slightly above the legislative limit for the first two NEDC (cold) tests but below the limit on the third test. The average of these results produced a pass and so we concluded that the vehicle complied with the legislative limits, as would be the case for in-service compliance testing.

[2] Use of a sixth gear (if available) was optional at the manufacturer's discretion at the time this vehicle was type approved. The new WLTP test procedure introduced on 1 September 2017 removes this flexibility, specifying gear selection and shift points.

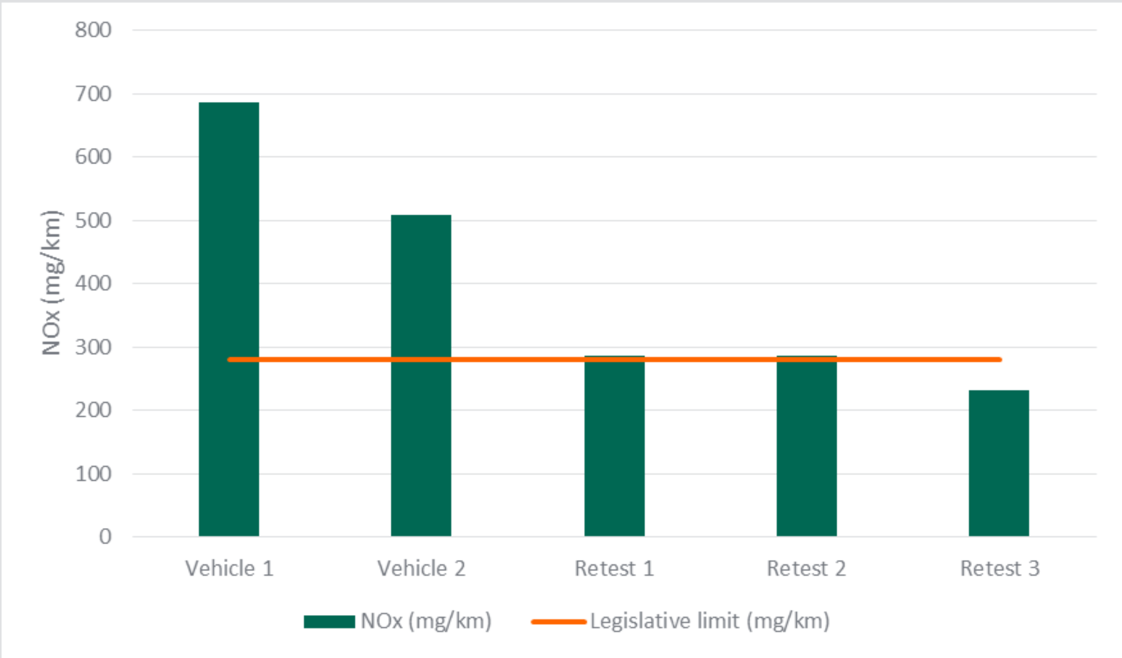

Figure 4-8 NOx Results of all NEDC (cold) tests conducted on both Ford Transit vehicles.

4.28 We challenged Ford for an explanation of why the NOx was so much higher when sixth gear was used. Their response was that the gear shift indicator light is used to encourage drivers to drive in a fuel efficient manner under real world driving conditions, but not NEDC driving conditions.

4.29 For the NEDC drive cycle, due to the differences in operating loads the gear shift indicator light may indicate an upshift at a certain vehicle speed due to the low load conditions of the NEDC. Driving to the gear shift indicator light on certain accelerations on the NEDC would result in a higher gear being requested which if selected would cause the engine to run in a high load, low engine speed condition close to the engine operating limit.

4.30 Although the vehicles passed the legislative tests, it is still concerning that the NOx levels were much higher when sixth gear was used, which is what the vehicle's gear shift indicator display recommends since it is more fuel efficient. This could result in a substantial increase in real world NOx emissions under certain conditions.

4.31 However the introduction of Real Driving Emissions, for new types of car from September of this year and for new types of van from September 2018, means that vehicles will have to demonstrate that they control emissions in real world conditions. There will not be any restriction on using sixth gear in these tests. The test will require vehicles to control emissions across a range of normal driving with or without use of the gear shift indicator. Additionally the introduction of the new, more rigorous, laboratory test from September of this year does not allow the manufacturer to choose if sixth gear is used and so will resolve this issue.

Confirmatory retests

4.32 Following our initial results we undertook additional testing on two further vehicles, the Renault Trafic and Citroen Berlingo. We shared our results, worked with the manufacturer and explored the findings with them to discuss the possible causes of the initial failures.

Renault Trafic

4.33 The Renault Trafic exceeded the legislative limits for NOx and Particle Number on the first legislative test. There were some issues with this test as the laboratory humidity was slightly outside of the usual limits and there were two mistakes from the driver in following the prescribed speed/distance trace. We were unable to retest the same vehicle at this stage so we sourced a second vehicle and tested this on the legislative cycle three consecutive times. The second vehicle was compliant with all of the relevant limits.

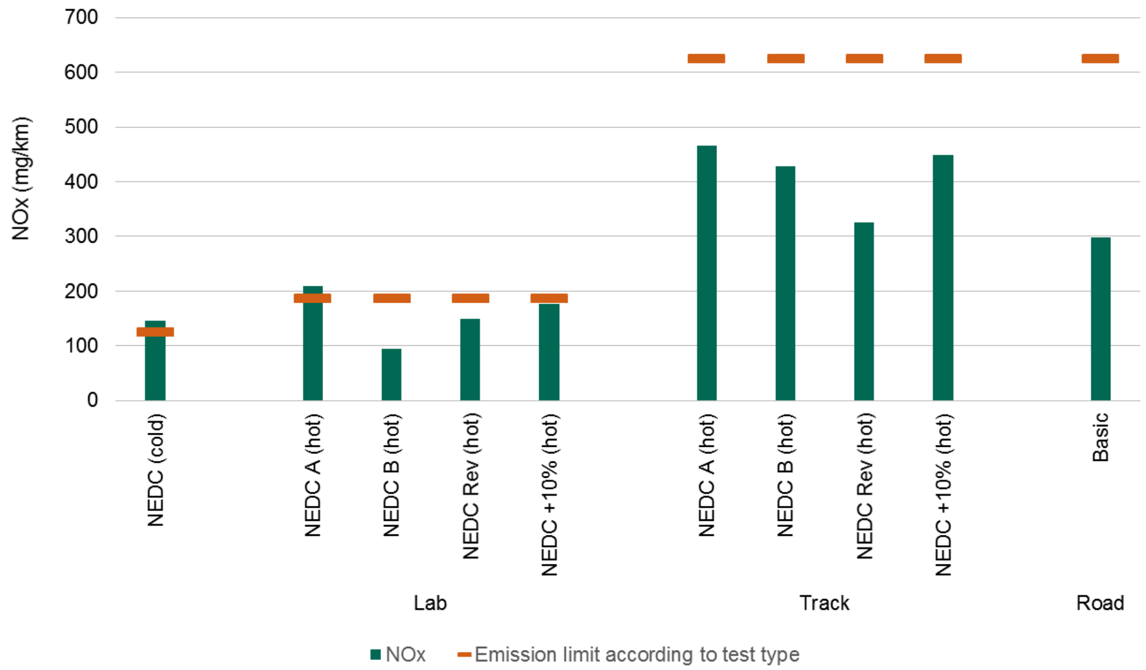

Figure 4-9 Results of initial tests on the Renault Traffic (mg/km). Emissions limit for NEDC (cold) is the legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

4.34 We requested a meeting with Renault for them to consider the first test results and discuss our findings. The NOx failure may have been influenced by the humidity. However Renault were surprised by the PN failure and so we agreed to retest the first vehicle, at Renault's expense. The NEDC (cold) test was undertaken a further four times on this vehicle, and it passed every time. From this we were satisfied that the vehicle had demonstrated it was compliant, as shown in figures 4-10 and 4-11 below.

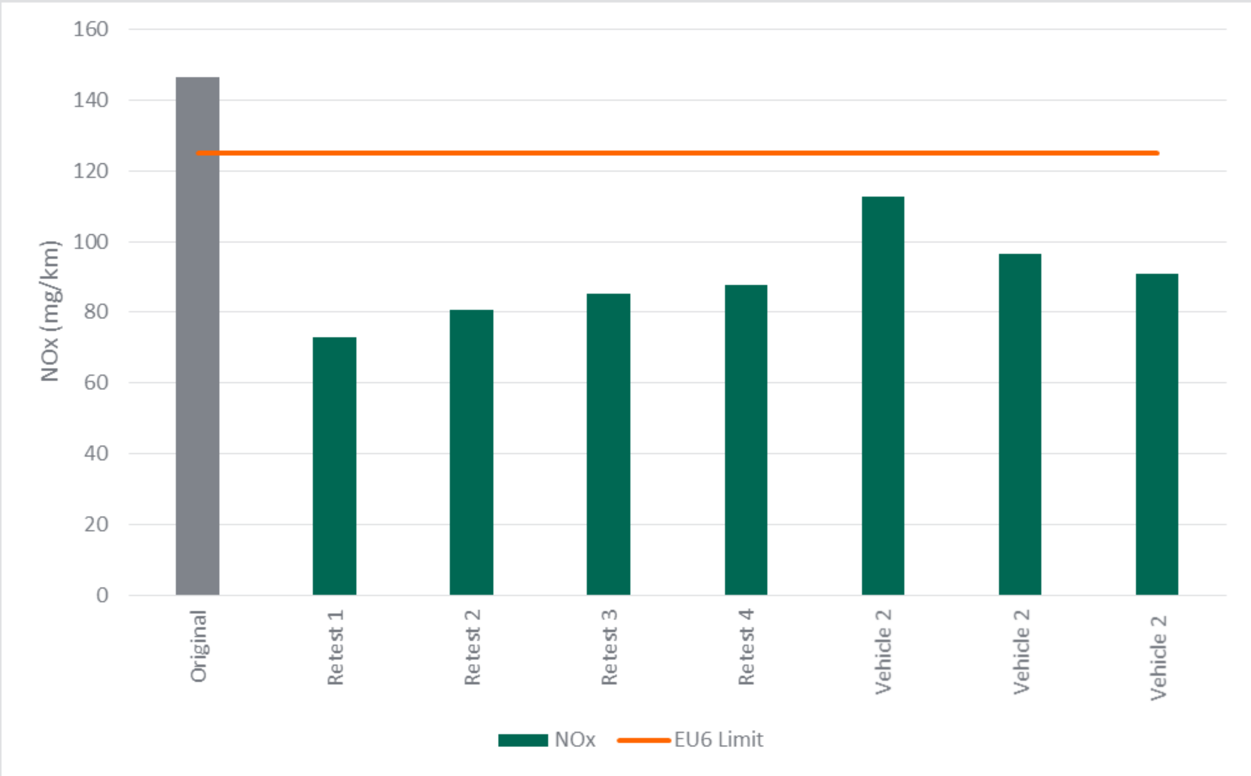

Figure 4-10 NOx Results of all NEDC (cold) tests conducted on both Renault Trafic vehicles

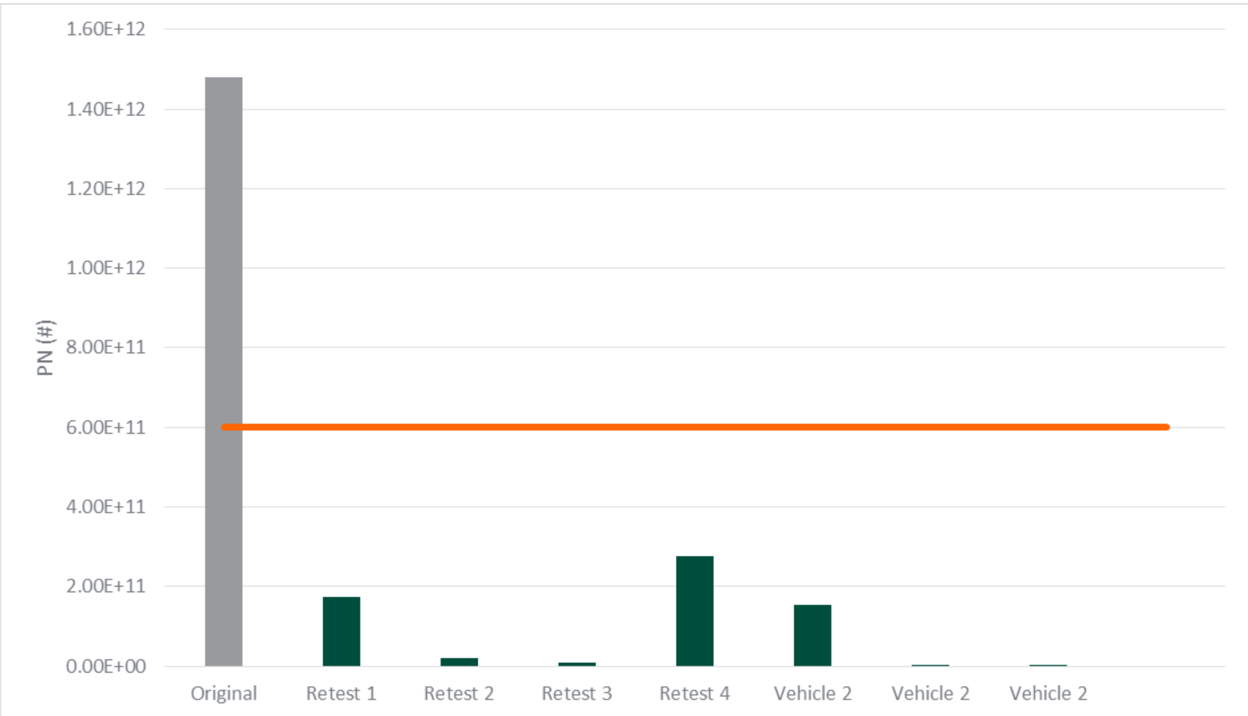

Figure 4-11 PN results of all NEDC (cold) tests conducted on both Renault Trafic vehicles

Citroën Berlingo

4.35 The Citroën Berlingo originally failed the NEDC (cold) test for Particle Number (PN). We discussed our results with Citroën who advised that the PN failure was due to a "regeneration" of the diesel particulate filter (DPF)[3] happening just prior to the test.

4.36 Citroën agreed to pay for further retesting to show this was the case. When we retested a second vehicle it passed three consecutive tests, as shown in the graph below. From this we were satisfied that the vehicle was compliant.

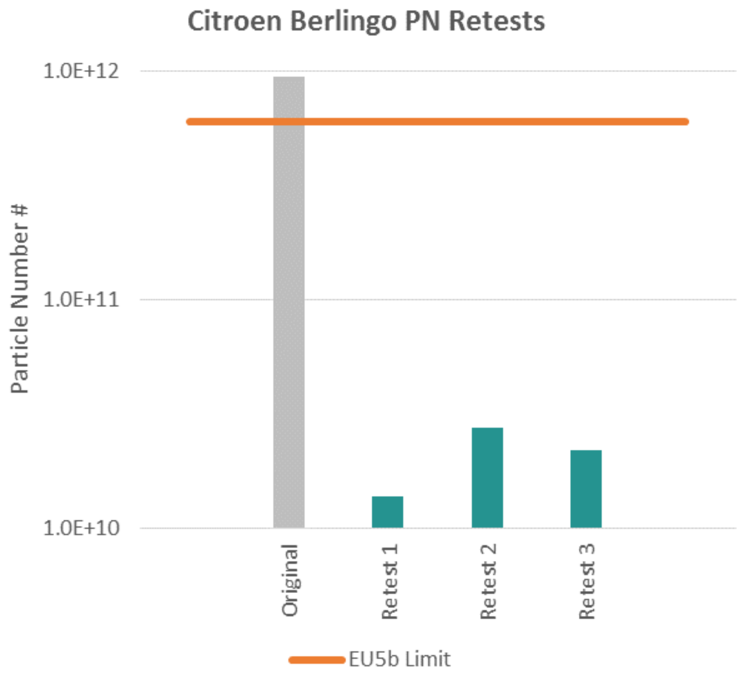

Figure 4-12 Results for Particle Number on Citroën Berlingo.

Trucks

4.37 For heavy duty vehicles, testing was conducted in line with the Euro VI in-service on-road emissions test as described in section 3.13. We tested five trucks in this programme. We found four of these to be compliant with the legislative requirements but found an issue with the remaining vehicle. See figure 4-13.

[3] A DPF is a filtration device which captures solid matter emitted by the engine. When the stored particulate matter reaches a predetermined level, the emissions control system will initiate a regeneration event during which the captured solid matter is burnt off.

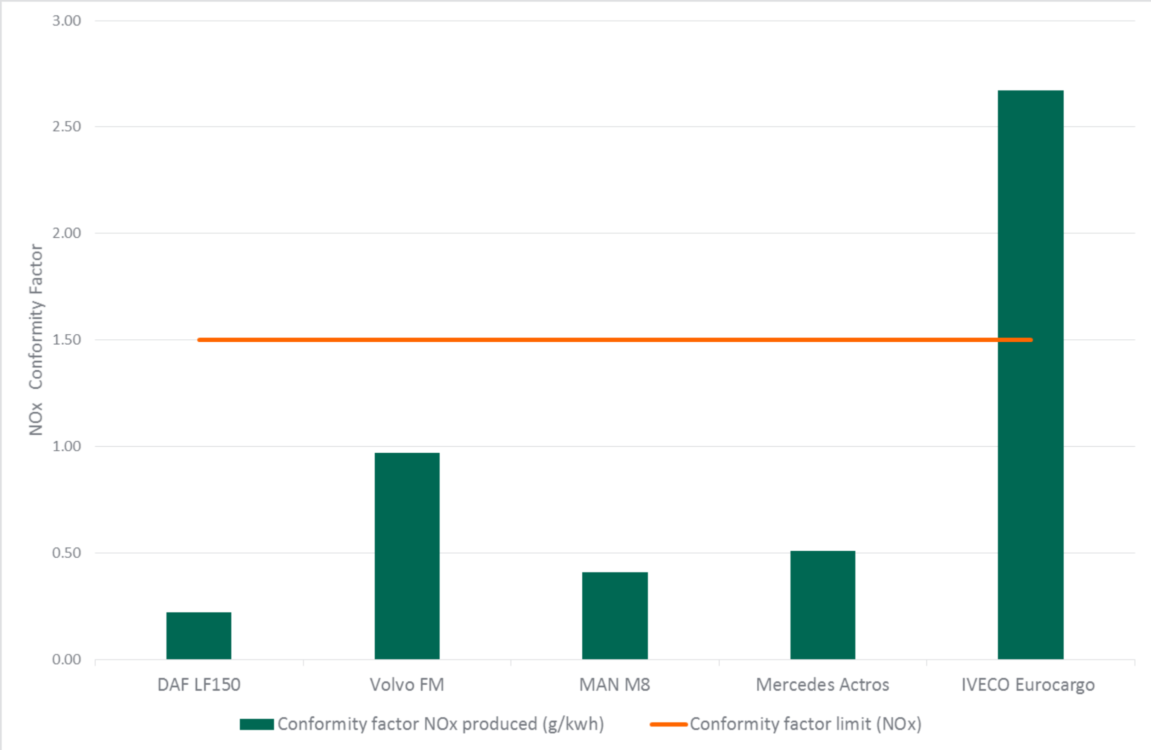

Figure 4-13 Results of in-service on-road emissions tests conducted on 5 HGVs. NOx results have been calculated in line with the relevant conformity factors, described in section 3.10.

IVECO Eurocargo

4.38 When this vehicle was tested on the legislative test for heavy duty vehicles, we found that the NOx emissions were nearly twice as high as permitted. We therefore requested a meeting with IVECO to discuss this. Following their consideration of the detailed data set that we provided, they confirmed that we had identified an issue with the emissions control system of these vehicles under certain circumstances, of which they were previously unaware. We conducted further testing, at IVECO's expense, which confirmed our original results.

4.39 The results show that the higher NOx levels are seen in a particular combination of circumstances that had not been fully considered during the vehicle development process. While it is disappointing that this is the case, IVECO has been fully cooperative in exploring the issue and has worked quickly to develop a solution.

4.40 The solution they propose is a software recalibration for these vehicles which ensures that the vehicle's emissions control system operates correctly under all circumstances. They have also conducted an assessment of all the other vehicles types that may be affected and identified which need updating and which do not.

4.41 We are unable to quantify the benefit of IVECO's recalibration across all UK driving conditions, however, tests conducted by the VCA showed that NOx emissions of the original vehicle had a conformity factor of 2.73 when compared to the legislative limit. The conformity factor limit for this vehicle is 1.5. Following application of the recalibration, NOx emissions were reduced to a conformity factor of 0.76 of the legislative limit. We were therefore satisfied that the recalibrated vehicle had been brought into compliance. See figure 4-14.

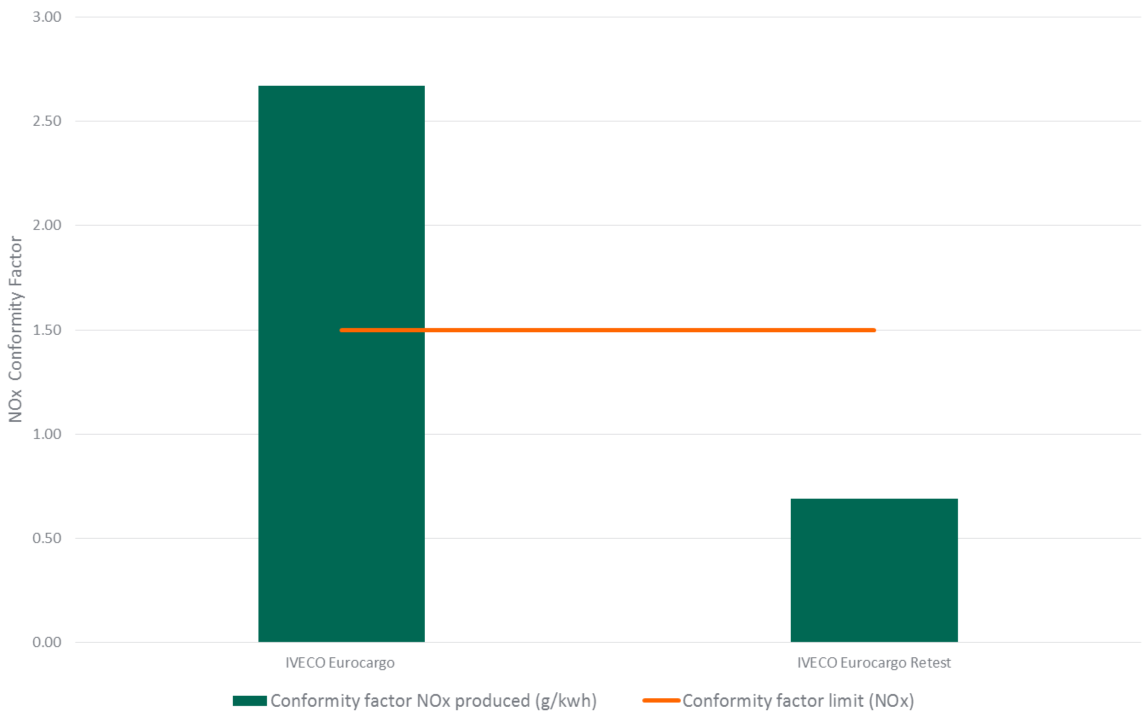

Figure 4-14 Comparison of NOx produced from initial IVECO Eurocargo test and retest of the same vehicle once IVECO's recalibration had been applied. NOx results have been calculated in line with the relevant conformity factors, described in section 3.13.

4.42 We alerted the Italian approval authority to our findings, as they issued the original approval for these vehicles. It is their responsibility to conduct their own independent assessment and IVECO has worked through this process with them to validate the new solution.

4.43 IVECO released its upgrade in the UK market in December 2017 and has contacted the owners of affected vehicles to inform them that their vehicles need to undergo this recalibration. They will soon engage with consumers across the rest of Europe. There are 5,803 affected vehicles registered for use on UK roads, which accounts for approximately 20% of the total number in Europe. As of 24th February 2018, IVECO reported that they had updated 745 UK vehicles.

Buses

4.44 We tested 3 buses in this programme, and have a set of results which shows that all of these are compliant with the legal obligation.

4.45 The ADL Enviro 200 and Enviro 400 both contain a Cummins engine whereas the Wrightbus contains a Daimler engine.

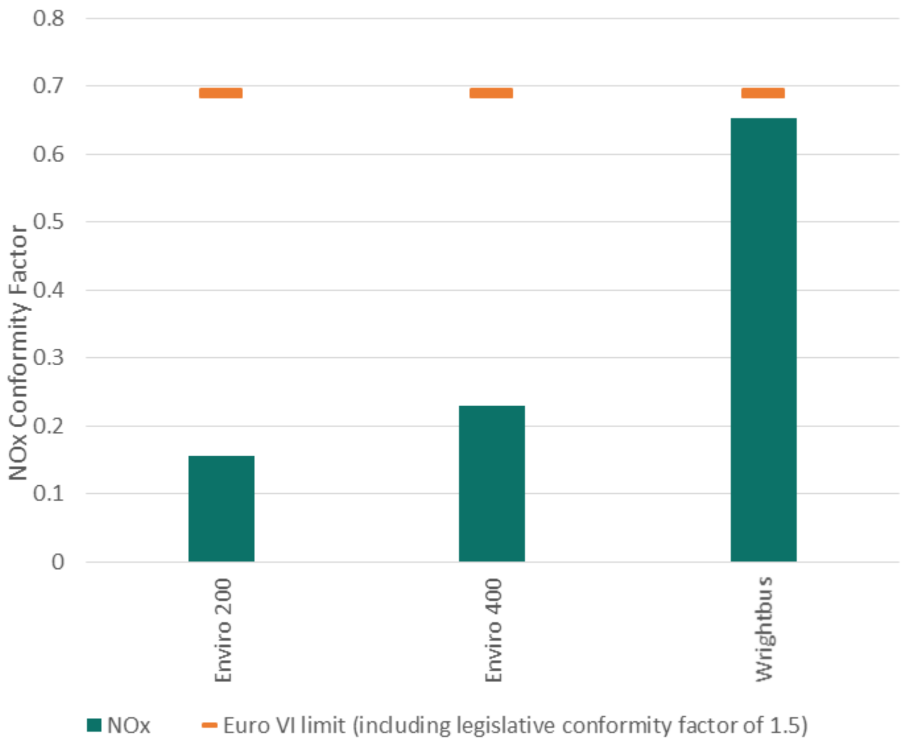

Figure 4-15 Results of in-service on-road emissions tests conducted on 3 buses. NOx results have been calculated in line with the relevant conformity factors, described in section 3.13.

5. Results of testing conducted following allegations against manufacturers

5.1 As diesel cars had been the focus of the 2016 investigation, we did not expect to include them for this programme. However, the Unit has been established so that we are able to respond to allegations and claims about certain vehicles and test them at short notice. Both cases below fall into this category.

Mitsubishi

5.2 In 2016, Mitsubishi admitted that it had manipulated the fuel economy figures for some of their vehicles sold in Japan, including a number that they had manufactured for Nissan. Despite reassurance from Mitsubishi that vehicles in the European market were not affected, we sourced two diesel Mitsubishi vehicles in order to conduct independent checks.

5.3 There is no legal limit for carbon dioxide, unlike for NOx and particle number, but there are European Regulations that mean a manufacturer must meet a sales weighted fleet average for vehicles that are registered in the EU. At type approval the manufacturer is asked to declare the amount of carbon dioxide produced by the vehicle. This is then validated by the relevant authority during type approval tests.

5.4 We tested the Mitsubishi ASX and Outlander diesel vehicles on the same suite of tests as the other cars in this programme, as described in section 3. Our previous testing has used data from the original type approval to establish the settings for the chassis dynamometer however, given that the concern raised in 2016 was that the manufacturer had manipulated the test, we recognised that this direct comparison approach may not be valid. Previous testing had provided data about the difference between the declared CO2 emission and that measured in programme for a range of vehicles. We used this information to assess whether the Mitsubishi vehicles displayed any unusual behaviour.

5.5 The results indicated that the difference between the declared carbon dioxide value and the results of our testing were similar in proportion to those seen for the wider population of vehicles that had previously been tested. See figures 5-1 and 5-2.

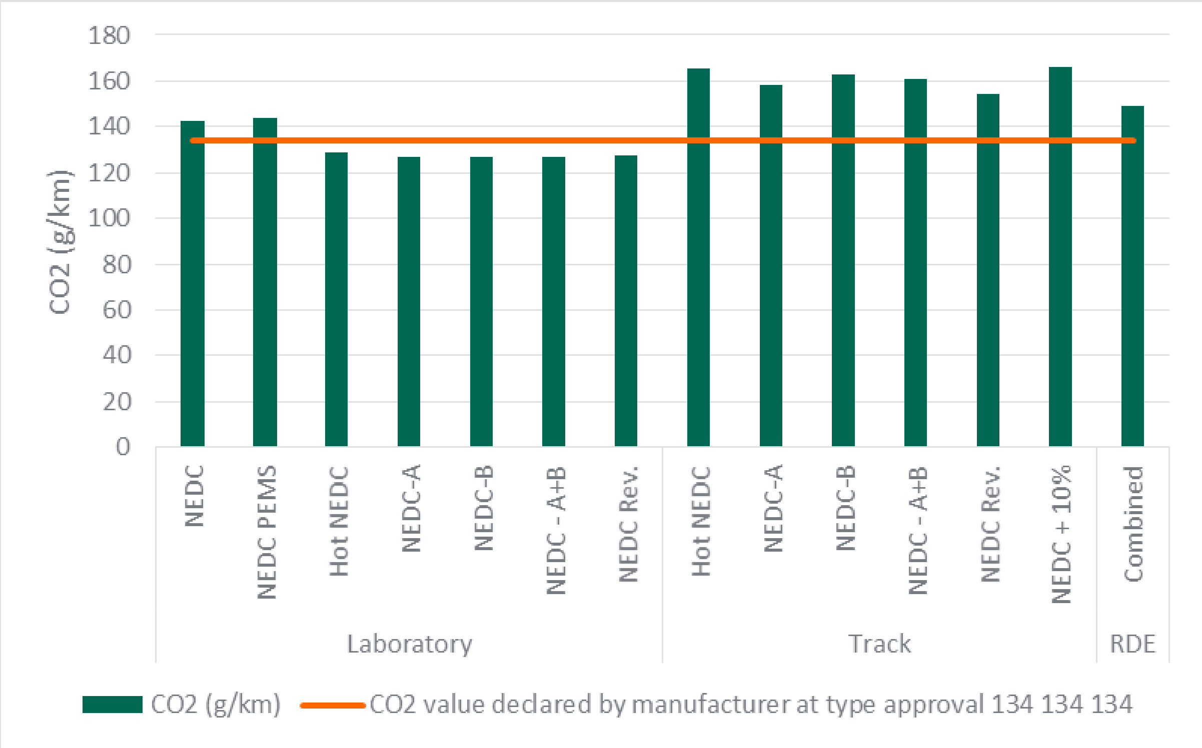

Figure 5-1 Results of fuel economy tests conducted on a Mitsubishi ASX vehicle. The limit shown is the value declared by Mitsubishi for this variant of the ASX at type approval.

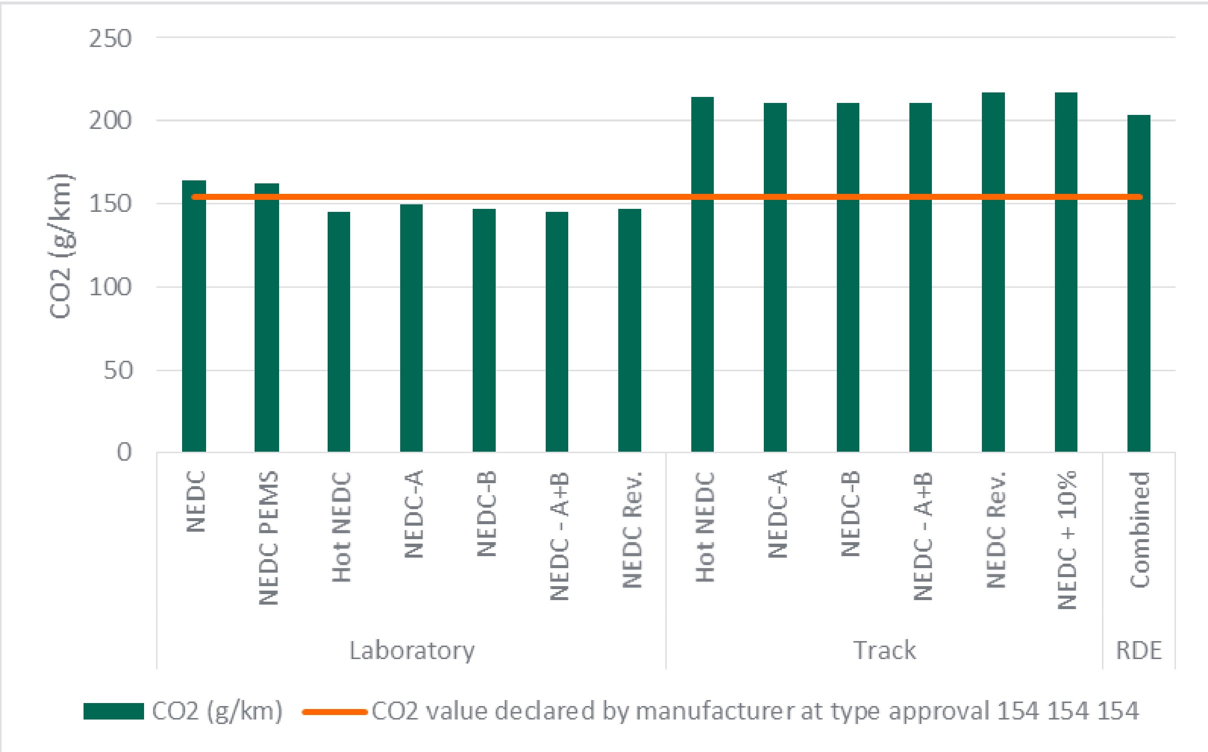

Figure 5-2 Results of fuel economy tests conducted on a Mitsubishi Outlander vehicle. The limit shown is the value declared by Mitsubishi for this variant of the Outlander at type approval.

Fiat Chrysler Automobiles

5.6 In January 2017, the US Environmental Protection Agency (EPA) issued a Notice of Violation against Fiat Chrysler Automobiles (FCA) for failing to disclose Auxiliary Emission Control Devices (AECDs) in the Jeep Grand Cherokee 3.0l and Dodge Ram 1500 in the US market. They state that one or more of the AECDs, either alone or in combination with each other, results in excess emissions of NOx.

5.7 The Secretary of State for Transport immediately wrote to the Managing Director of Fiat Chrysler UK seeking assurances that the vehicles in the UK market do not contain prohibited defeat devices and that this matter would be resolved appropriately and quickly.

5.8 We estimated from the DVLA database that there are around 3,700 of the Jeep Grand Cherokee 3.0l and only a very few Dodge Ram 1500s in the UK. The response from Fiat Chrysler UK confirmed that Jeep Grand Cherokees with the same hardware as the version under investigation in the USA were sold in the UK from the second half of 2015, and that 1,530 of these vehicles had been sold by the end of 2016. The response also stated that the European and US versions of the vehicle contained different software features and accompanying calibrations to regulate emissions.

5.9 We decided it was important to test these vehicles ourselves, and given its more significant presence in the UK market chose to test the Jeep Grand Cherokee. As the specific details of the vehicles tested in the US were unclear, we tested both a Euro 5 and Euro 6 vehicle to provide the fullest possible picture.

Euro 5b

5.10 The Euro 5b Jeep Grand Cherokee was assessed using our standard set of tests. In the laboratory it complied with the legislative NOx emissions limit. When tested on variations of the 'hot' NEDC test, NOx emissions increased to up to 2.7 times the legislative test limit. Results from track testing and an RDE test showed NOx emissions nine to fifteen times higher. This is one of the worst we have seen during this and our 2016 programme.

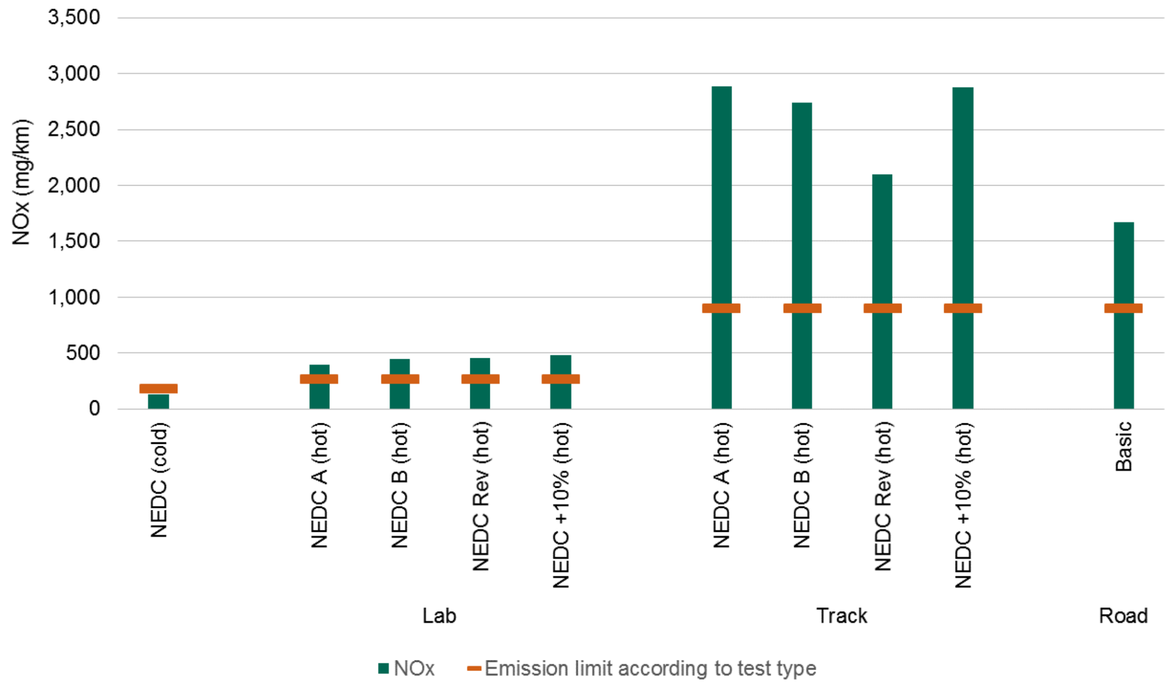

Figure 5-3 Results of testing on Jeep Grand Cherokee (EU5b) for NOx (mg/km). Emissions limit for NEDC (cold) is legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

5.11 We held a meeting with FCA to discuss the results for the Jeep. The company's representatives noted that the track and RDE results were much higher than expected and explained that this could be due to the low ambient temperature at which the RDE tests had been performed (between 1 and 8°C). FCA explained that, in these conditions, the EGR is modulated to avoid deposits of carbon and lacquers on internal engine components. We were disappointed by this as these temperatures are not uncommon in the UK.

5.12 We were, and remain, concerned that the results were in such high excess of the European Commission's recommended maximum acceptable conformity factors for market surveillance testing. The purpose of the introduction of these conformity factors is to allow market surveillance authorities to identify vehicles which may contain a defeat device. Throughout our discussions with FCA they have not yet provided evidence which fully satisfies our technical experts that the system used in the Jeep Grand Cherokee is compliant with the relevant legislation. In our view, the very high level of real world NOx emissions are, at the very least, cause for serious concern and not within the spirit of the relevant legislation.

5.13 We have therefore agreed with Jeep that they will develop an in-service upgrade for these vehicles, which will be offered to their customers on a voluntary basis. This upgrade will consist of an improvement of the EGR modulation for low air inlet temperature to better contain the NOx in these test conditions. We are in discussions with the company over the timing and expected impact of these changes. It is expected to be available to vehicle owners by April 2018. Jeep have informed us that there are 2806 of these vehicles in the UK.

5.14 They also produced an earlier EU5 version of the Jeep Grand Cherokee and we are aware that they are in discussions with another approval authority about a recalibration for this variant. There are 1751 of these earlier variants in the UK and we will require that any recalibration that is developed is also available for these UK vehicles.

5.15 In our laboratory test, the vehicle also exceeded the limit for particle number (PN). FCA was concerned that the laboratory test had been affected by a repair that had been made to the vehicle, after an issue had been discovered with the exhaust prior to testing which they believe might have influenced the release of particles from the exhaust. FCA therefore believed that these test results are not representative of the behaviour of the vehicle in terms of PN. We did not agree with FCA that this would have had a negative effect on the PN result and so will reassess this when we test a vehicle that has undergone the recalibration.

Euro 6

5.16 The Euro 6 Jeep Grand Cherokee failed the legislative test for NOx. The track and real world results also showed high NOx. Our testing of other diesel vehicles in our programme last year, found that the average RDE NOx emissions from Euro 6 vehicles was 500 mg/km. The Euro 6 Jeep Grand Cherokee produced NOx emissions of 670 mg/km and so was substantially higher than this average.

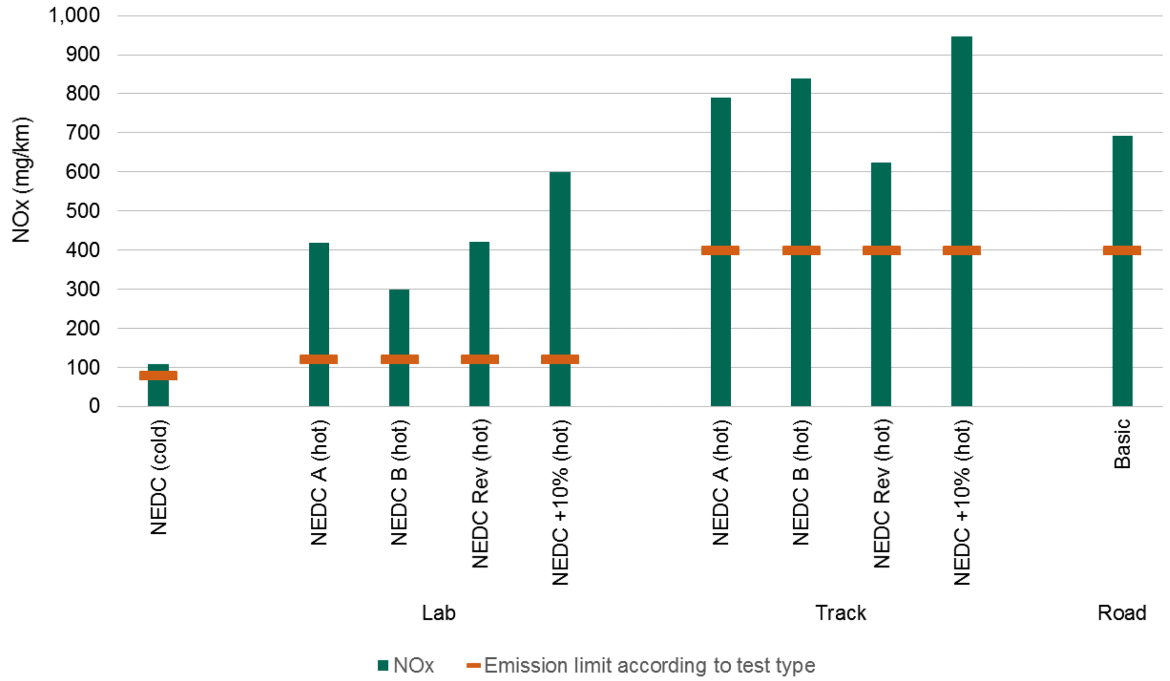

Figure 5-4 Results of testing on a Jeep Grand Cherokee (EU6) for NOx (mg/km). Emissions limit for NEDC (cold) is legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

When tested on variants of the legislative test, the vehicle showed between 3.75 and 7.5 times higher NOx emissions than the legislative NEDC 'cold' test. These results were surprisingly high considering that in 'hot' test conditions the emissions control systems might be expected to be operating at a higher efficiency. This is depicted in more detail in Figure 5-5, which shows the NOx trend during the whole test, both for the legislative NEDC 'cold' and the 'hot' variant. There is a substantial difference in

NOx emissions throughout - even at the end of the test-cycle, when the engine temperature would be expected to be almost the same as it would be for the 'hot' variant.

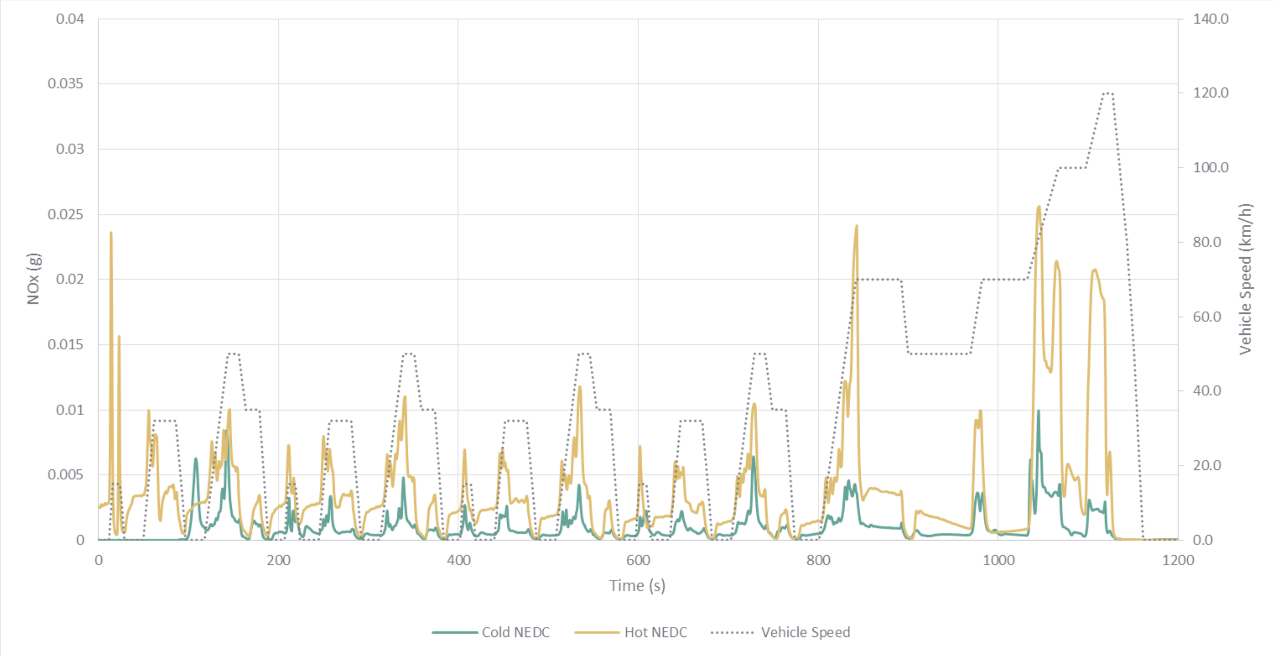

Figure 5-5 Comparison of Jeep Grand Cherokee (EU6) NOx results for the NEDC (cold) against the NEDC (hot).

5.17 These laboratory results for the Euro 6 vehicle concerned us and so we requested that Fiat Chrysler explain the emissions control strategy of their vehicle and justify why we had seen these results. The company had serious concerns about the condition of the first test vehicle as when they inspected it they found certain errors stored in the Engine Control Unit. They shared data with us from tests they had conducted internally, which they claimed to be more representative of the vehicle behaviour. We were sceptical about the validity of this argument as the vehicle had been checked for fault codes or issues prior to testing and none were detected. However, we agreed to test a further independently sourced EU6 vehicle to provide certainty.

5.18 The second vehicle that was tested passed the legislative test. The track and RDE results were also significantly better and all below the guidance limit recommended by the European Commission. However in the laboratory the NOx results for variants of the legislative test were still much higher than the legislative test.

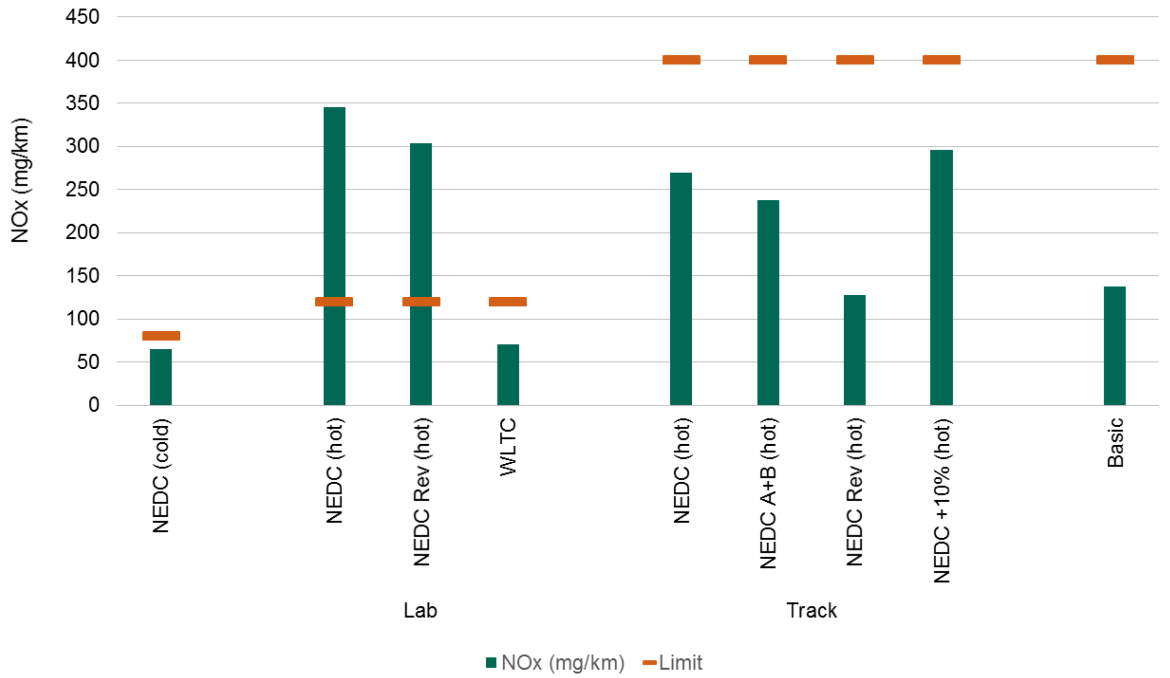

Figure 5-6 Results of testing on a second Jeep Grand Cherokee (EU6) for NOx (mg/km). Emissions limit for NEDC (cold) is legislative limit. The indicated emissions limits for the other tests are the EU recommended guidance limits.

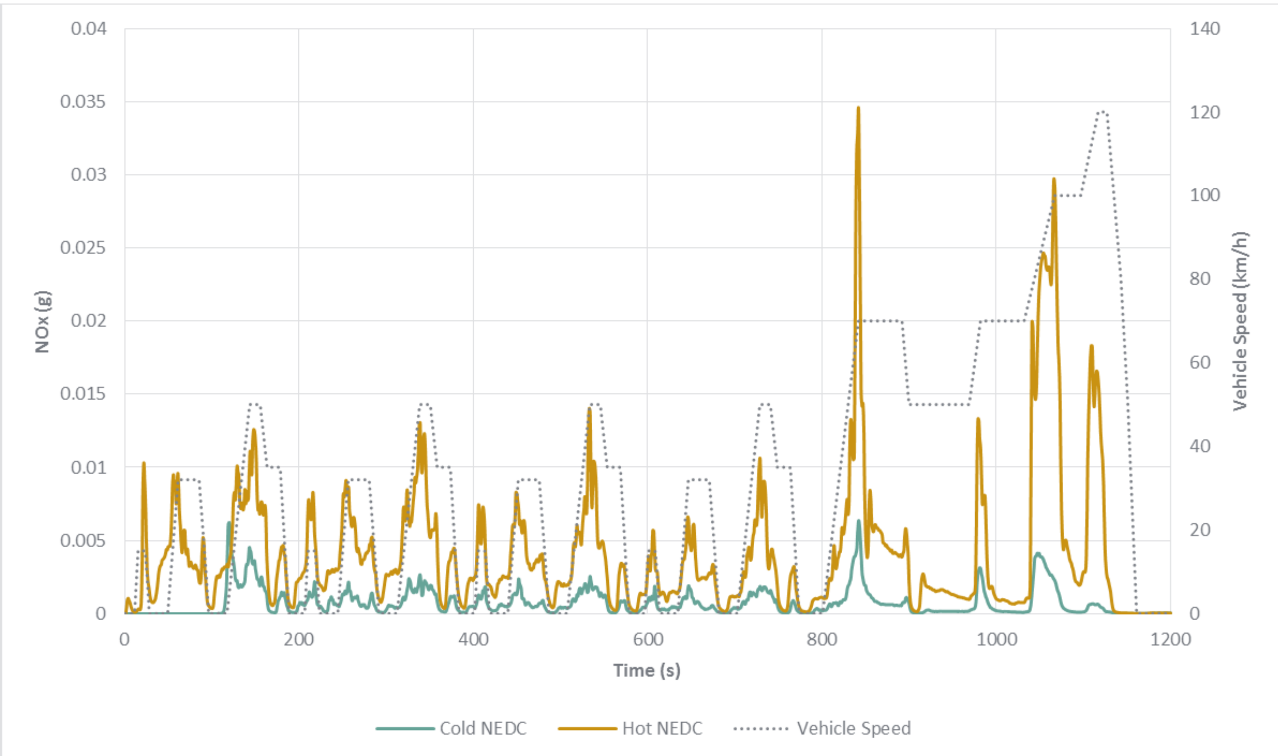

Figure 5-7 Comparison of NOx results for the NEDC (cold) against the NEDC (hot) on a second Jeep Grand Cherokee (EU6).

5.19 Fiat Chrysler explained the difference in results between the legislative test and variants of the legislative test for the second vehicle as due to the temperature of the SCR system dropping below the minimum required for NOx conversion during the extended soaking time between the two tests, which causes a low NOx conversion efficiency during the subsequent urban portion of the cycle. Fiat Chrysler documented that repeated NEDC cycles without extended soaking time between cycles results in lower NOx. This is confirmed by the NOx results of the WLTC and RDE tests, which are lower than on the NEDC “hot” tests and by the fact that in the variants of the legislative test the vehicle performed better on track than in laboratory. On a cold-engine start, a 'rapid heat up' strategy is used to bring the SCR up to operating temperature and this strategy would be activated on a cold NEDC. However Fiat Chrysler stated that a more accurate management of the after-treatment temperature during extended soaking periods must be based on an improved thermal model of the component, and that vehicles approved to the later Euro 6c and 6d standards will have more complex thermal management control features which prevent these issues.

5.20 We continue to have concerns about the performance of this vehicle and are aware that other testing has found similar results. We will continue to engage with Fiat Chrysler to further understand their claims about the first vehicle and have pressed them to consider whether they can improve the performance of the Euro 6b vehicles through service updates. We intend to include the final outcome of this investigation in our next annual report.

6. Carbon dioxide for cars and light vans

6.1 The results below compare the carbon dioxide result with the value stated on the Certificate of Conformity (CoC) for cars and vans. There is no legal limit value for carbon dioxide for an individual vehicle but the manufacturer must comply with a sales weighted fleet average for vehicles that are registered in the EU, and the type approval is used for the vehicle's official fuel consumption figure.

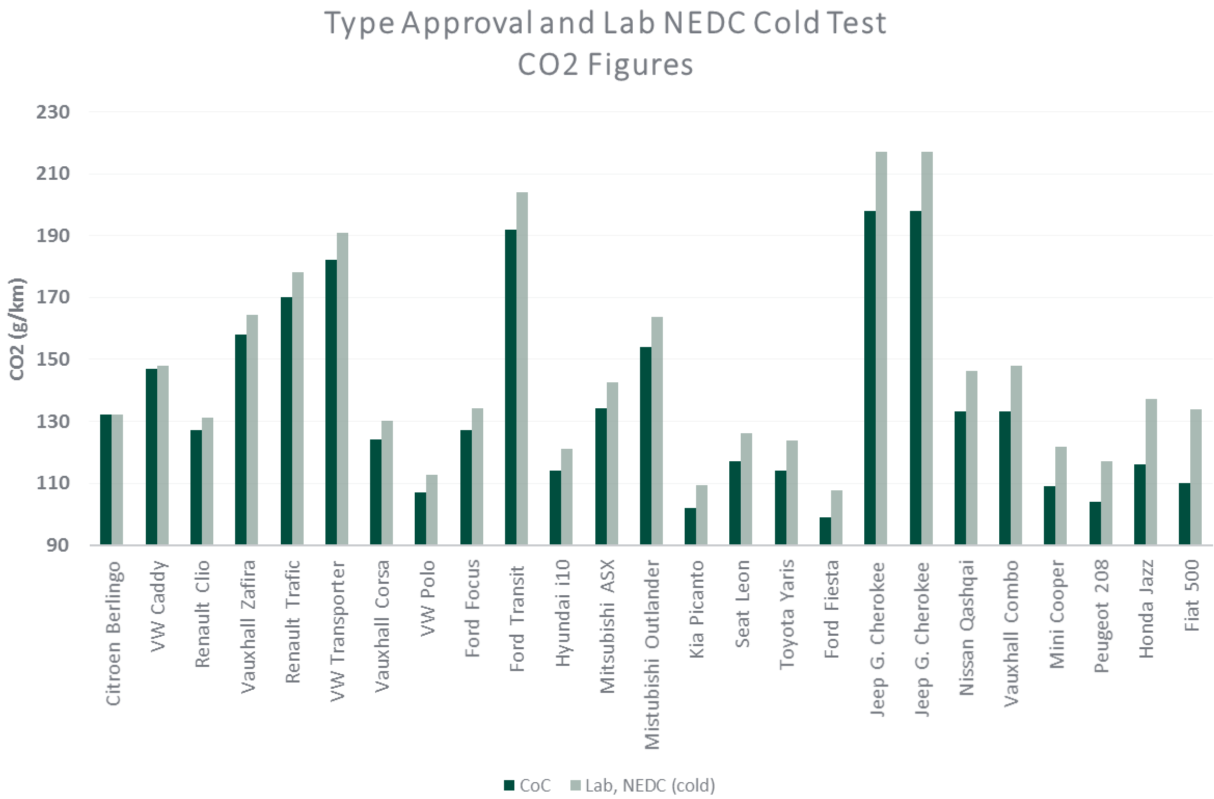

Figure 6-1 Results of laboratory carbon dioxide tests against type approval values for each car and van.

6.2 The vehicles in Figure 6-1 are listed in order of the difference in value of their test result from their type approval value. Of the 22 cars and vans tested, the only one to match its type approval value was the Citroen Berlingo van. While test to test variability will account for some of this difference, all the others gave a higher carbon dioxide value than the type approval value despite being tested in accordance with the full legislative test procedure. The Honda Jazz and Fiat 500 had the biggest percentage differences to their type approval values. Figure 6-2 shows the difference in percentage of each vehicle's test result from its type approval value.

6.3 The divergence between NEDC (cold) carbon dioxide and fuel consumption values, and those obtained in real world use has been a point of discussion for some time.

From September 2017, the new World harmonised Light-duty vehicle Test Procedure (WLTP) has replaced the NEDC. This introduces a much more representative test cycle and more stringent procedures for the test. As a result it is expected to provide much more representative 'official' carbon dioxide and fuel consumption figures. However none of the cars or vans tested in this report were type approved to the new WLTP requirements.

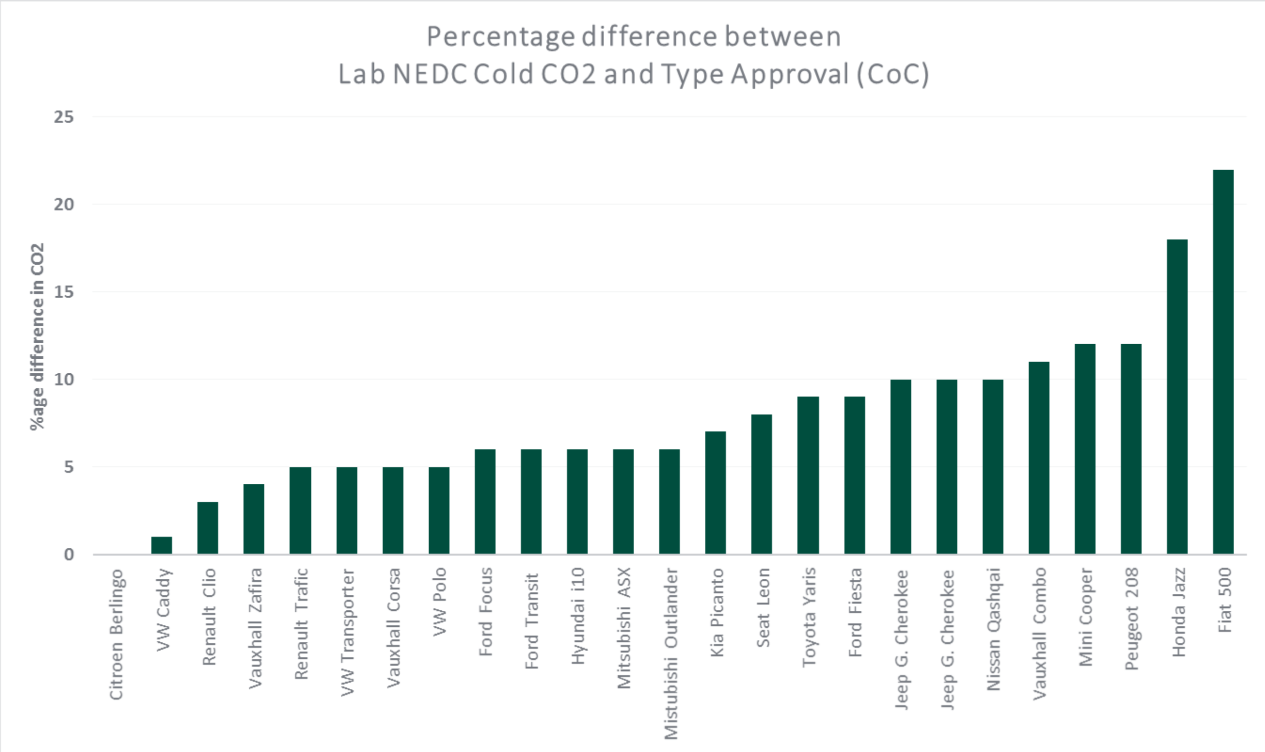

Figure 6-2 Results of laboratory carbon dioxide tests as a percentage difference from their type approval value.

7. Conclusions and future testing

7.1 This testing of petrol cars, diesel vans, HGVs and buses, and our previous testing of diesel cars, has shown us that vehicles in use on UK roads are, in general, compliant with the type approval requirements. However this year's work has identified a clear non-compliance in the heavy duty sector, which we are pleased to see will lead to vehicles across Europe being recalled and having software updated to improve their real world emissions. As a result of our real world testing we were also able to persuade a further manufacturer to develop an upgrade for one of their diesel car models to reduce its emissions.

7.2 We remain concerned by the poor real world emissions control of a number of the other vehicles we tested this year. While these appear to comply with type approval requirements, as with the Euro 5 and Euro 6 diesel cars that we tested last year, their real world NOx emissions are much higher and are directly contributing to the air quality problems we face and the resulting health impacts. We therefore intend to conduct a further programme of emissions testing across all categories over the next year.

7.3 Our fuel economy results show not only are real world fuel economy figures far worse than the official figures, but for many of the cars and vans tested we were unable to match the published figures when tested on the official test cycle.

7.4 These emissions and fuel economy results demonstrate the importance of the new 'Real Driving Emissions' legislation and much stricter WLTP laboratory test procedure introduced in September 2017. We look forward to seeing industry bring forward cleaner vehicles with more representative fuel economy figures as soon as possible.

7.5 We have so far selected our vehicles based on their existing market share, and so have tested most of the best-selling models on UK roads. We now intend to focus our attention on new vehicle launches which are likely to be large volume sellers, in all of these categories.

7.6 As Real Driving Emissions standards started to apply to new types of cars from September, we will also be checking that these vehicles comply with the new requirements. Our existing real world testing has been to enhance our understanding of the difference between laboratory and real world performance, and this has shown that we should expect to see substantial air quality benefits from vehicles which comply with these new requirements.

7.7 We will also be conducting testing programmes to check that vehicles and components comply with the other standards that they are required to meet, including on safety performance for road vehicles, and the emissions from Non Road Mobile Machinery (NRMM) where the Department has the lead. We do not intend to share the details of these programmes in advance of publishing the results, as it is better that manufacturers and importers do not know where we are focusing our surveillance in any given period.

7.8 In addition to planned testing the Market Surveillance Unit will investigate areas of potential non-compliance that are brought to our attention. We welcome any information or concerns from within the relevant industries or from members of the public. If you would like to contact the Market Surveillance Unit then please email marketsurveillance@dvsa.gov.uk. The information that you supply will be considered carefully and we will decide whether further investigation is needed. Whether we are able to share the outcome of that consideration and any further action taken will depend on the specific circumstances. We will take a judgement on whether it is in the public interest to do so. The Market Surveillance Unit is responsible for checking whether vehicles and components on the market meet the standards they were approved to. If your concern applies to an individual vehicle it would be best to contact the manufacturer or dealer. If you need to escalate your concern then this is likely to be to Trading Standards or the Motor Ombudsmen.

7.9 We are confident that the Market Surveillance Unit will play an important role in ensuring that vehicles on the UK market comply with the standards that they are required to meet. We hope that the information contained in this and future reports will provide reassurance that the Government takes compliance extremely seriously and is committed to restoring trust in the vehicle approval system.

8. Annex – Summary of vehicles tested

Petrol Cars

Manufacturer	Model	Engine	Euro Level	Type Approval Authority	EGR	TWC	GDI
Fiat	500	1242	6b	e3	N	Y	N
Honda	Jazz	1318	6b	e6	Y	Y	N
Hyundai	i10	1499	6b	e1	N	Y	N
Kia	Picanto	998	6b	e4	N	Y	N
Mini	Cooper	1499	6b	e1	N	Y	Y
Peugeot	208	1200	6b	e2	N	Y	N
Renault	Clio	1149	6b	e2	N	Y	N
Seat	Leon	1395	6b	e9	N	Y	Y
Toyota	Yaris	1329	6b	e11	Y	Y	N
Vauxhall	Corsa	1229	6b	e1	N	Y	N
Vauxhall	Zafira	1364	6b	e4	N	Y	N
Volkswagen	Polo	1197	6b	e1	N	Y	Y
Ford	Focus	1498	6b	e13	N	Y	Y
Ford	Fiesta	998	6b	e9	N	Y	Y
Nissan	Qashqai	1197	6b	e11	N	Y	Y

Diesel Cars

Manufacturer	Model	Engine	Euro Level	Type Approval Authority	EGR	DOC	SCR	DPF	LNT
Jeep	Grand Cherokee	2987	5	e4	Y	Y	N	Y	N
Jeep	Grand Cherokee	2987	6b	e4	Y	Y	Y	Y	N
Mitsubishi	ASX	1798	5b	e1	Y	Y	N	Y	N
Mitsubishi	Outlander	2200	6b	e1	Y	Y	N	Y	Y

Light Vans

Manufacturer	Model	Engine	Euro Level	Type Approval Authority	EGR	DOC	SCR	DPF
Ford	Transit	2198	5	e11	Y	Y	N	Y
Volkswagen	Transporter	1968	5	e1	Y	Y	N	Y
Citroen	Berlingo	1560	5	e2	Y	Y	N	Y
Vauxhall	Combo	1248	5	e3	Y	Y	N	Y
Volkswagen	Caddy	1598	5	e1	Y	Y	N	Y
Renault	Trafic	1598	6b	e2	Y	Y	Y	Y

Trucks

Manufacturer	Model	Engine	Euro Level	Type Approval Authority	EGR	DOC	SCR	DPF
IVECO	Eurocargo	4500	VI	e3	N	Y	Y	Y
DAF	LF150	4500	VI	e11	Y	Y	Y	Y
Volvo	FM	10837	VI	e2	Y	Y	Y	Y
MAN	M8	4580	VI	e4	Y	Y	Y	Y
Mercedes	Actros	7698	VI	e1	Y	Y	Y	Y

Buses

Manufacturer	Model	Engine	Euro Level	Type Approval Authority	EGR	DOC	SCR	DPF
Alexander-Dennis	Enviro 200	4500	VI	e11	Y	Y	Y	Y
Alexander-Dennis	Enviro 400	6700	VI	e11	Y	Y	Y	Y
Wrightbus	StreetDeck	5132	VI	e1	Y	Y	Y	Y

Key for Type Approval Authorities:

e1 = Germany
e2 = France
e3 = Italy
e4 = Netherlands
e6 = Belgium
e9 = Spain

e11 = UK
e13 = Luxembourg

Key for emissions control systems

EGR = Exhaust Gas Recirculation
DOC= Diesel Oxidation Catalyst
DPF = Diesel Particulate Filter
SCR= Selective Catalytic Reaction
LNT = Lean NOx Trap