APPENDIX 7.9

FUTURE YEAR EMISSIONS CALCULATIONS

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Introduction

Atmospheric dispersion modelling is used to determine the effect of future development traffic on local air quality. The modelling utilises predictions of the composition and emissions profile of the vehicle fleet which are produced by Defra in the emissions factor toolkit (EFT). The composition and emissions profiles are provided on a year by year basis from 2013 to 2030, with the database being periodically updated.

The main issue with regard to the modelling of future traffic impacts is the choice of emission factors to use given that there is a degree of uncertainty as to the accuracy of the emission factors, as well as uncertainty introduced by the modelling process and the traffic data on which the predictions are based. This has become more important in recent years as it has been realised that previous versions of the EFT were likely to have significantly underestimated the real world emissions of the vehicle fleet, as well as the more recent revelations concerning the use of 'defeat devices' on VW group vehicles.

This note therefore sets out PBAs approach to the choice of vehicle emission factors for future year assessments. The note has been revised following updating of the Defra Emissions Factor Toolkit in July 2016.

Modelling Methodology

As a prelude to the discussion of emission factors, it is useful to recap on the general methodology that is used for dispersion modelling of road traffic emissions:

- Traffic data is entered into the dispersion model to represent the baseline situation and the model is used to predict how NO_x emissions are dispersed in the environment.
- The dispersion modelling predictions are compared to monitoring data to obtain a verification factor; the factor by which the predicted road traffic concentration must be multiplied by to agree with the monitored concentration.
- The modelling is repeated for the future year situation; with traffic data representing the situation without the development in place (the 'without' scheme scenario) and with the development in place ('with' scheme). In both cases, the verification factor obtained from the baseline modelling is used to multiply the model results by, in essence assuming that the model is equally as accurate in the future as it was for the baseline scenario.

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The verification factor is one of the key elements in the discussion regarding vehicle emission factors. One element of uncertainty in the modelling is the degree to which the emission factors in the EFT are different to actual emissions of the vehicle fleet on the local road network. The use of the verification factor for the future year predictions essentially assumes that the difference between the EFT emission factors and real world emissions is the same in the future as it was in the baseline year. In other words, unless there is some reason to believe that the future year emission factors are less accurate than the baseline year emission factors, the degree to which the EFT emission factors and real world emission factors differ is taken into account in the modelling by the use of the verification factor. This is discussed further in the following sections.

Emission Factor Toolkit

The EFT contains estimates of the future composition of the vehicle fleet in terms of the age and type of vehicles. The composition of the vehicle fleet is primarily related to the age of the vehicles (in terms of their emissions class) and the fuel that they use (i.e. petrol or diesel). In general terms, the majority of new vehicles replace much older vehicles, and as the emissions performance of vehicles is generally taken to improve over time, both current and historical versions of the EFT predict very large reductions in NO_x emissions in the future. It is also obvious that the further one looks into the future, the more uncertain the predictions become as they depend on the rate of vehicle renewal and the size and fuel mix of the vehicles bought; which are all estimates.

The emissions performance of the vehicles is classified in terms of Euro type approval testing; Euro 1 to 6 concerning light duty vehicles and Euro I to VI heavy duty vehicles. Whilst the introduction of each Euro class has generally seen a tightening of emission standards, the standards up until now have been based on laboratory testing of vehicles. The emissions performance of the vehicles in real world driving conditions has been higher than the laboratory testing results, especially for diesel vehicles. This factor was not recognised in earlier versions of the EFT, and combined with the fact that diesel vehicles have much higher NO_x emissions than petrol vehicles and there has been a very large increase in the number of diesel vehicles on the road, has meant that the NO_x emissions and NO_2 concentrations have not reduced as previously predicted.

The trends in NO_x emissions in the vehicle fleet, especially diesel vehicles and the accuracy of the current version of the EFT, is therefore critical in terms of the choice of emission factors in modelling.

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Trends in NO_x emissions

For light duty vehicles, the latest Euro standard is Euro 6, which was introduced from September 2015 (with a derogation in the UK for the registration of new vehicles until September 2016).

The emissions standards currently relate to a laboratory test whereby the average emission rate is calculated over an idealised drive cycle. The cycle used is the New European Drive Cycle (NEDC) and there has been extensive criticism that the drive cycle does not represent real world driving conditions. It has therefore been agreed that a new drive cycle will be introduced, the World Light-duty Test Cycle (WLDTC), as well as an on-road test termed Real Driving Emissions (RDE).

Current Euro 6 vehicles are only tested in the laboratory against the NEDC, and these vehicles are termed Euro 6ab. However, from September 2017, new models will be tested against the WLDTC and will also have a RDE test. The initial introduction of the RDE test will allow vehicles to have average RDE test emissions of 2.1 times the WLDTC test; in other words, real life emissions will be allowed to be 2.1 times the laboratory emissions. The 2.1 factor is termed the conformity factor and will apply to new models from September 2017 and new vehicles from September 2019. From January 2020, the conformity factor will reduce to 1.5 for new models (January 2021 for new vehicles).

Air Quality Consultants have undertaken some research into the performance of diesel vehicles to support a methodology that they have adopted for undertaking air quality assessments[1]. As part of the analysis, they compared the real word test results of current Euro 6ab diesel vehicles and calculated an average conformity factor of 3.9 from the tests that were assessed.

Subsequently, Department for Transport have undertaken testing of Euro 5 and 6ab diesel vehicles and found that the average NO_x emissions were 1135 mg/km for Euro 5 vehicles and 500 mg/km for Euro 6ab vehicles[2]. These work out to be a conformity factor of 6.30 and 6.25 for Euro 5 and Euro 6ab respectively. Adding in the DfTr results to the AQC results gives an overall average conformity factor for Euro 6ab vehicles tested of 4.1.

A paper presented by Dr Marc Stettler at the recent Westminster Energy, Environment & Transport Forum[3] included results of RDE testing of existing Euro 6ab vehicles. Whilst there was wide range in the results, a number of the vehicles tested did already comply with the Euro 6c standard.

[1] Emissions of Nitrogen Oxides from Modern Diesel Vehicles. AQC January 2016
[2] Vehicle Emissions Testing Programme DfTr Cm 9259 April 2016
[3] Priorities for reducing air quality impacts of road vehicles. Dr Marc Stettler 17th May 2016

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Similar results have been reported in a study led by Rosalind O'Drscoll of Imperial College[4]. This showed that the average NO_x emissions were 4.5 times higher than the Euro 6 limit, with an average NO_2 percentage of 44%.

From the emissions testing work undertaken to date on Euro 6ab vehicles it is clear that the NO_x emissions performance of Euro 6ab vehicles is significantly better than Euro 5 vehicles, although not in line with the laboratory standards. The introduction of Euro 6 should therefore see a significant reduction in NO_x emissions in the future, as outlined in the following table.

Emission Standard	Real Driving Emissions NO_x mg/km
Euro 5, DfTr testing	1135
Euro 6ab, DfTr testing	500
Euro 6c, September 2017 models	168
Euro 6c, January 2020 models	120

In terms of modelling, the issue therefore becomes how well does the EFT represent the real world emissions performance of the vehicles.

Emissions in the EFT

As noted in Section 3, the EFT contains estimates of vehicle emissions by Euro Class. The database was updated in July 2016 from v6.02 to v7.0. It now uses NO_x emissions factors for the vehicles taken from the European Environment Agency's COPERT 4 v11 database compared to the previous version V10. In the November 2015 submissions to the European Union for compliance against EU Limit Values, Defra used COPERT 4 v11 factors without taking account of the real world performance of the vehicle fleet to data.

The AQC paper provides a representation of the emissions from Euro 6 vehicles at different speeds in terms of the conformity factor. The results are shown in the following graph.

[4] A Portable Emissions Measurement System (PEMS) study of NO_x and primary NO_2 emissions from Euro 6 diesel passenger cars and comparison with COPERT emission factors. Rosalind O'Driscoll. September 2016

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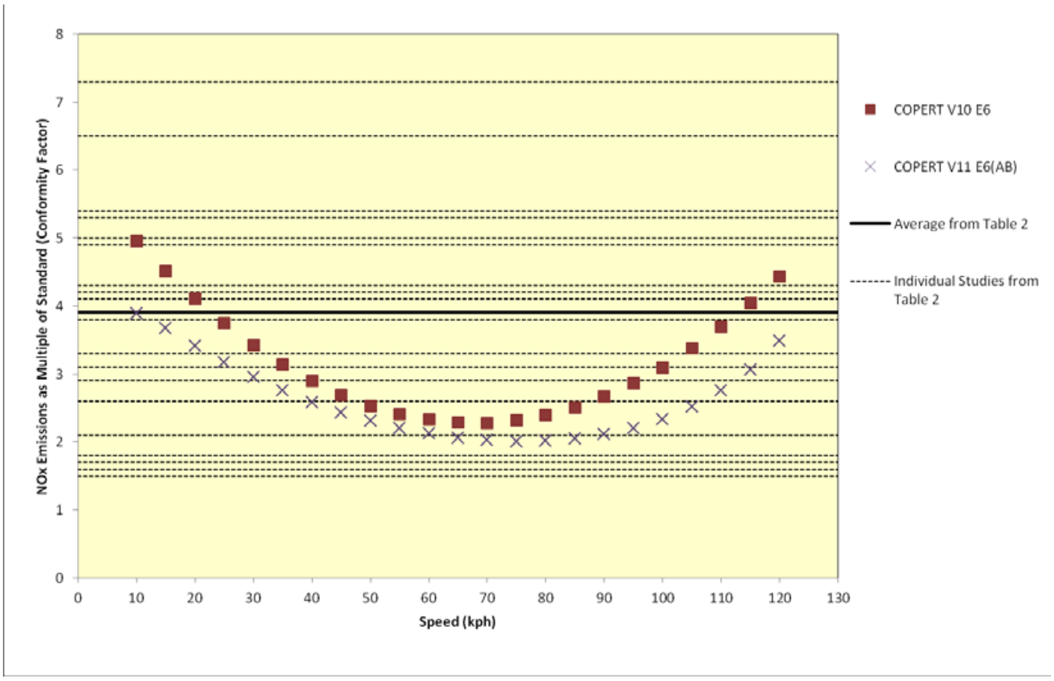

The graph shows that the COPERT4 v10 based EFT emissions have a conformity factor ranging from 2.3 to 5. The conformity factor is higher at low and high speeds. Overall, the average conformity factor is less than the factor determined from the testing of Euro 6ab vehicles to date, but higher than the conformity factor that will be required by the introduction of Euro 6c. The COPERT v11 factors for Euro 6ab vehicles would appear to be, on average, approximately 80% of the V10 factors.

In terms of light duty vehicles, the AQC report concluded that for future year assessments, the base case modelling should use the EFT v6.02 factors for the future year of the traffic data, i.e. unaltered. However, a sensitivity test was also recommended, whereby the average conformity factor for Euro 6 diesel vehicles is raised to 5, with the following result in terms of the EFT.

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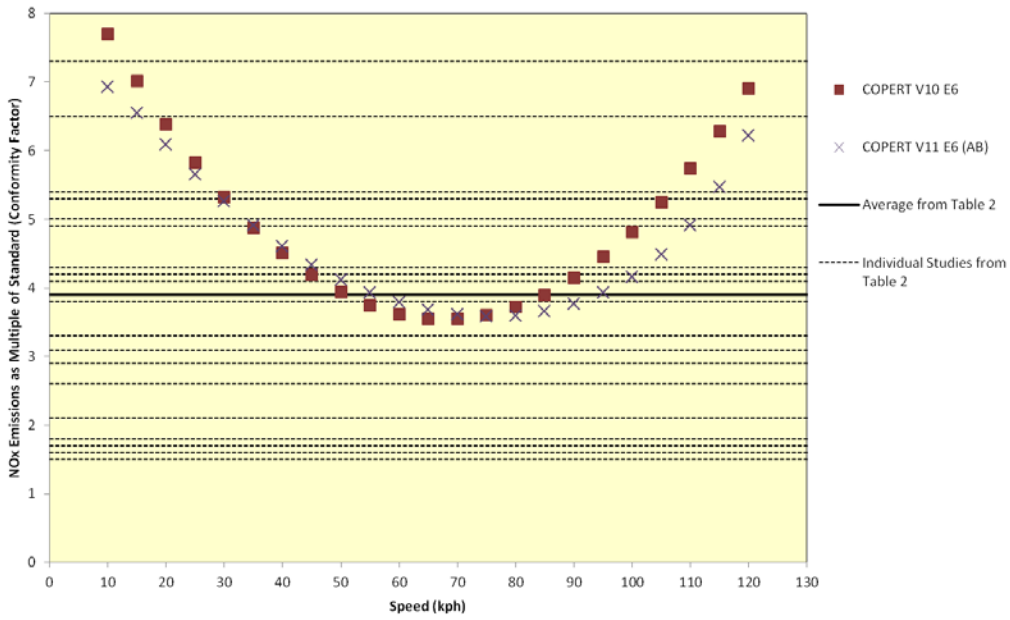

Clearly, using the sensitivity test, the average emission rate in the EFT is higher than the average from the Euro 6ab testing to date, for either COPERT v10 or v11 factors. The AQC report concluded that if the two assessments were undertaken, then the likely pollutant concentration would lie between the two estimates.

However, the EFT does not fully take account of the emissions Euro 6c vehicles which should have significantly lower NO_x emissions than current Euro 6ab vehicles, and therefore both sets of results could be conservative.

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However, the AQC report also acknowledges that the EFT does not include Euro 6c vehicles which should have significantly lower NO_x emissions than current Euro 6ab vehicles, and therefore both sets of results could be conservative.

Future Year Assessment Methodology

The selection of emission factors for a future year assessment depends partly on the situation regarding the assessment to be undertaken. Where pollutant concentrations are low and are unlikely to exceed threshold levels, then one may take a conservative approach and keep emission factors at current levels. This will produce a conservative result, but as the result

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will be ‘acceptable’ in terms of leading to no exceedances of National Air Quality Strategy Objectives, then it is a reasonable approach to adopt as it avoids uncertainty as to whether there will be exceedances in the future.

In contrast, where pollutant concentrations are high, then a different approach to uncertainty is required. In addition, for a formal Environmental Impact Assessment the legal requirement is to assess ‘likely significant effects’. This is not ‘worst case’ significant effects, but ‘likely’ significant effects and therefore must allow for a degree of uncertainty in the predictions.

The approach taken to date by PBA for the assessment of future year effects when the development is completed a number of years into the future is to choose an intermediate year between the baseline model verification year and the completed development year. This approach requires revisiting in light of the latest information regarding vehicle emission factors.

As noted in Section 6, the AQC approach is to undertake two assessments; one using the EFT for the assessment year and one using higher emission factors for a sensitivity test. In addition to consideration of diesel car emissions, the AQC approach also considers taxis, light goods vehicles and heavy duty vehicles (HDVs). For taxis and light goods vehicles, a similar approach to diesel cars is proposed.

The evidence on the performance of Euro VI HDVs is more difficult to interpret; but it indicates significantly reduced NO_x emissions between Euro V and VI, although the AQC report concludes that the EFT may underestimate emissions of Euro VI HDVs. The approach proposed by AQC for HDVs for COPERT v10 emissions is to keep Euro IV and Euro V emissions the same as Euro III and make Euro VI emissions 20% of Euro V. This approach was considered to result in Minorly high HDV emissions. The average COPERT v11 HDV emission factors are higher than v10 at speeds above 40 kph and lower at speeds less than 40 kph (AQC, Figure 23). Overall therefore, it would appear to be appropriate to continue the proposed AQC approach for HDV emissions for COPERT v11 emission factors.

The following graph has been prepared using the AQC approach (CURED v2A) and the EFT v7 for urban vehicles outside of London at 30kph with a 5% heavy duty vehicles mix. Given that both emissions estimates would need to verified against the same monitoring data, then the predictions would be the same for the same initial model verification year (i.e. 2015 in this case). The relative difference in the predicted emissions in the future is therefore the important factor.

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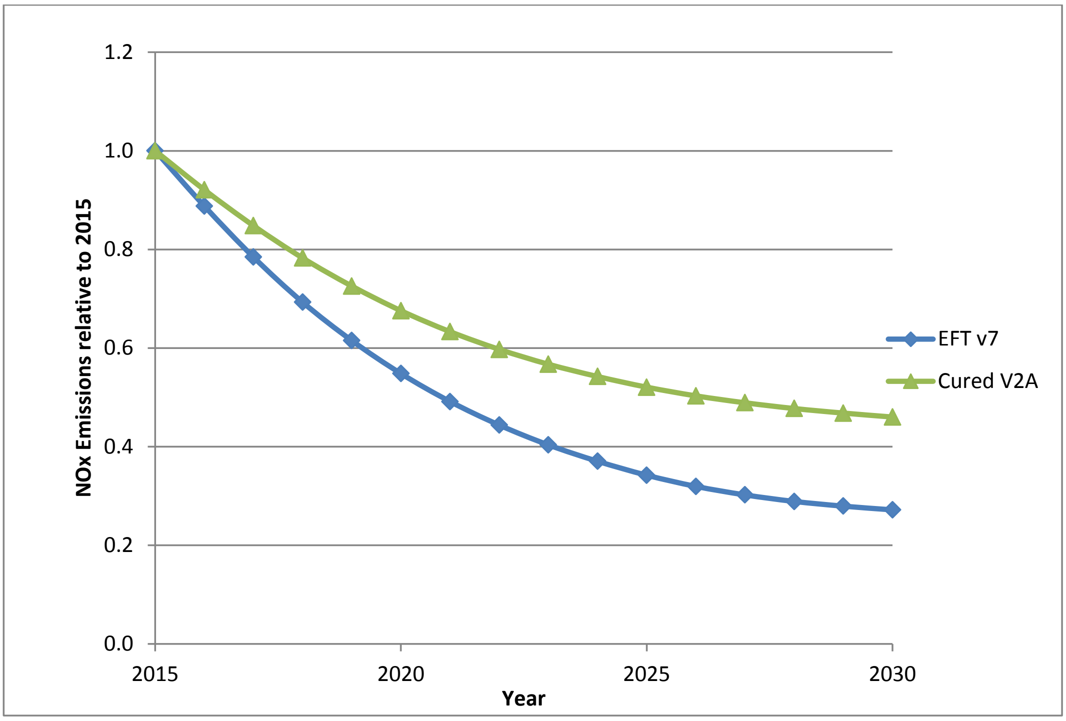

Prior to 2020, the difference between the emission factors amounts to less than 2 years; it rises to approximately 9 years by 2030 as a greater proportion of Euro 6 vehicles is contained in the vehicle fleet and the AQC Cured emissions remain essentially at Euro 6ab levels.

As noted in Section 5, the EFT does not fully take account of the introduction of Euro 6c vehicles, which will begin to be introduced from 2017 with a conformity factor of 2.1, and from 2020 with a conformity factor of 1.5, significantly lower than the average for v7 of the EFT. Beyond 2020 therefore, as Euro 6c vehicles become more prominent in the vehicle fleet, the EFT is likely to become more representative of real world emissions than it currently is.

As discussed in Section 2, the use of the verification factor in the modelling takes account, amongst other things, of the difference in the real world emissions performance of vehicles in the fleet. Data contained within the AQC report indicates that the EFT may have underestimated emissions of earlier classes of vehicles to a similar extent as for Euro 6ab vehicles. As such, one could be justified in using the emission factors from the year of the assessment as the uncertainty in the emission factors is taken account of by using the verification factor.

The verification factor is not the only consideration however:

- The emission factors are in terms of NO_x which is a combination of NO and NO_2. Historically, most of the NO_x emission was NO, with a small proportion of NO_2. There

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is some evidence that the proportion of NO_2 in the NO_x is rising, which would counteract reductions in overall NO_x emissions when one considers compliance with NO_2 National Air Quality Strategy Objectives.

- There is uncertainty in the production of the traffic data on which the air quality modelling is based, as well as uncertainty within the EFT as it is based on assumptions regarding the replacement of vehicles into the vehicle fleet (over and above assumptions on the actual emissions performance of those vehicles).
- The predicted pollutant concentration from the road traffic modelling is added to an estimate of the background concentration, which itself, is subject to uncertainty.

The above factors justify a more conservative approach to future year emissions than simply using the EFT emission factors for the year of the assessment.

Taking into account the various factors discussed above, it is proposed that for the determination of likely significant effects we will use an emissions year two years earlier for future year assessments up until 2025, and three years earlier from 2026. This is likely to be conservative given the introduction of Euro 6c vehicles into the fleet (from 2017), but recognising increasing uncertainty regarding predicting the composition of the vehicle fleet and vehicle emissions in the future.

The following table shows the effect of the proposals.

Assessment Year	Emission Factor Year
2015	2015
2016	2015
2017	2015
2018	2016
2019	2017
2020	2018
2021	2019
2022	2020
2023	2021
2024	**2022**
2025	2023
2026	2023
2027	2024
2028	2025
2029	2026
2030	2027
2031	2028
2032	2029
2033 and beyond	2030

The choice of emission factors and background concentrations needs to take into account the specific circumstances of the assessment being undertaken, but the above approach is considered to provide a conservative basis on which to assess likely future pollutant concentrations.

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