Dealing with Uncertainty in Vehicle NO_x Emissions within Air Quality Assessments

July 2018 | Version 1.1

The IAQM issues Position Statements on matters that could affect the way in which Members carry out their professional tasks and on air quality topics and issues where the IAQM can provide a unique perspective from which to give a professional opinion.

Please note that this position statement has been withdrawn.

The position statement (PS): Dealing with Uncertainty in Vehicle NOx Emissions within Air Quality Assessments was published in July 2018 (Version 1.1).

The PS identifies that previous versions of Defra's Emissions Factors Toolkit (EFT) (v8.0 at the time of the PS) predicted large reductions in nitrogen oxides (NOx) emissions that were not borne out in measured roadside concentrations due to vehicle standards used in the fleet forecasting not being realised.

There is a growing body of evidence to suggest that the latest COPERT vehicle emission factors, which feed into the EFT (v9 and onwards), reflect the real-world NOx emissions more accurately.

It is judged that an exclusively vehicle emissions-based sensitivity test is no longer necessary.

On this basis, the EFT may be used for future year modelling with greater confidence when considering the per vehicle emission, provided that the assessment is verified against measurements made in the year 2016 or later.

This judgment does not negate the importance that air quality practitioners acknowledge the uncertainty inherent in vehicle emissions modelling, including the future vehicle fleet composition/age and vehicle flows which contribute to the emissions provided by the EFT.

IAQM Members should routinely identify any factors which introduce uncertainty in their assessments and exercise professional judgement on the implications for the findings of any assessment carried out, this may include the use of sensitivity tests.

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The issue

It has been known since around 2011 that nitrogen oxides (NO_x) emissions from diesel vehicles have not declined as expected despite the introduction of increasingly more stringent European Union (EU) emission limits since the early 1990s[1]. This, together with an increase in numbers of diesel cars and the use of emission control devices that increase the proportion of the nitrogen dioxide (NO_2) in the exhaust NO_x, has resulted in annual mean concentrations of NO_2 remaining high, particularly at roadside locations. Both the annual mean national air quality objective and the EU limit value are widely exceeded.

Defra's emission factor toolkit (EFT v8.0) for road transport provides forecasts of NO_x emissions up to 2030. This is widely used as input to dispersion models such as ADMS-Roads to estimate future NO_2 concentrations close to new developments. Previous versions of the toolkit have consistently over-estimated the impact of the European diesel vehicle emission standards on NO_x emissions and, therefore, the modelling has under-estimated future concentrations. Although the latest version of Defra's EFT (v8.0) provides a far more reasonable match for real world emissions in the current UK fleet than previous versions, there remains uncertainty regarding future NOx emissions from the vehicle fleet.

Background

The current version of Defra's EFT (v8.0) uses emission factors from COPERT (v5.0)[2]. COPERT is the most commonly used European model for the calculation of emissions from road transport. COPERT is updated every few years and version 5 incorporates different emissions functions from Euro 6 vehicles to broadly coincide with the phased introduction of Real Driving Emissions (RDE) tests for vehicle type-approval.

COPERT emission factors (and therefore EFT emissions factors) are based on average vehicle speeds. Real world driving emissions data show that emissions increase during acceleration, which is not well represented by the COPERT speed-emission curves. There can be a large variation in emissions for the same average speed. These effects are observed across all ages of vehicle and, since there is no indication that this will change in the future, this issue is not specific to future-year predictions.

There is uncertainty in the impact on emissions of the introduction of the World-harmonised Light-duty Test Procedure (WLTP), which replaced the current driving cycle and the RDE test procedure in September 2017 for new model types, and which will become the standard test for all new cars from 2019. Many diesel vehicles satisfying the requirements of the early stages of the Euro-6 emissions standards (Euro-6a and 6b) are on the road and have been shown in emissions tests to have substantially lower NO_x emissions than Euro-5 vehicles[3]; however, these vehicles were not required to meet the WLTP. In addition, the new and complex emission control technology used in some current Euro-6 vehicles and, in future Euro-6 RDE compliant vehicles, have unknown deterioration and failure rates, which may lead to increases in emissions over time.

The evidence from real-world testing (including both PEMS and remote sensing) is that NO_x emissions from current Euro-6 diesel vehicles are substantially lower than from Euro-5 vehicles. Although there are uncertainties over the WLTP's effects on emissions, NO_x emissions from Euro-6 RDE compliant vehicles are likely to be lower than from current Euro-6 vehicles. In addition, there is a general consensus that Euro-VI for Heavy Duty Vehicles is delivering substantial benefits over Euro-V.

New exhaust technologies have been introduced to meet stricter Euro emissions standards, and these might affect the NO_2/NO_x ratios in real-world emissions. Recent evidence[4] indicates that the proportion of NO_x emitted from the tailpipe directly as primary NO_2 is up to a factor of two smaller than the estimates used in emission inventories. This could result in lower future projected concentrations of ambient NO_2.

In addition to uncertainty relating to emissions factors, there is also uncertainty relating to the future UK fleet mix, in particular the uptake and purchasing trends of diesel vehicles and ultra-low emission vehicles. Defra's EFT v8.0 includes fleet mix projections up to 2030 which are based on assumptions regarding the turnover of the fleet, but there is potential for the future vehicle fleet mix to differ from these predictions.

IAQM's Position on this issue

It is important that air quality practitioners acknowledge the uncertainty in the EFT emissions factors and future vehicle composition and that they adequately account for this uncertainty when predicting future NO_2 concentrations. There are a number of approaches that could be taken, including applying a sensitivity test that assumes NO_x emissions will not reduce as rapidly as shown by the EFT. The choice of approach will depend on the specific circumstances of the project being assessed.

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If a sensitivity analysis is undertaken and shows a large difference in the predicted future NO_2 concentrations there needs to be careful consideration of the implications, particularly how this will affect the impact descriptors in Table 6.3 of EPUK/IAQM guidance on *Land-Use Planning & Development Control: Planning For Air Quality* (EPUK/IAQM, 2017)[4]. If the sensitivity analysis shows that the objective is likely to be exceeded by only a small margin, and the assessment year is many years in the future, it may be concluded that it is likely that the objective will be achieved. On the other hand, if it is exceeded by a large margin, and the assessment year is only a few years away, it would be prudent to assume that that there may be an exceedance. IAQM Members should take a precautionary approach. Where it is likely that there will be an exceedance of the objective, taking into account the results of any sensitivity analysis, appropriate mitigation measures should be recommended.

References

[1] Carslaw, D.C., Beevers, S.D., Westmoreland, E., Williams, M.L., Tate, J.E., Murrells, T., Stedman, J., Li, Y., Grice, S., Kent, A. and I. Tsagatakis (2011). Trends in NO_x and NO_2 emissions and ambient measurements in the UK. Version: July 2011.

[2] Defra, 2017, Emissions Factors Toolkit v8 User Guide. Available: https://laqm.defra.gov.uk/documents/EFTv8-user-guide-v2.pdf.

[3] Department for Transport, 2016. Vehicle Emissions Testing Programme.

[4] Grange, S.K., Lewis, A., Moller, S.J. and Carslaw, D.C. (2017) Lower vehicular primary emissions of NO2 in Europe than assumed in policy projections. Nature Geoscience, 10, 914-918

[5] EPUK/IAQM, 2017. *Land-Use Planning & Development Control: Planning For Air Quality.*

About the Institute of Air Quality Management (IAQM)

The IAQM aims to be the authoritative voice for air quality by maintaining, enhancing and promoting the highest standards of working practices in the field and for the professional development of those who undertake this work. Membership of the IAQM is mainly drawn from practising air quality professionals working within the fields of air quality science, air quality assessment and air quality management.

Original Publication Date

October 2016

Change Log

V1.1 - July 2018

Paragraph 2 - Change from EFT v7.0 to v8.0 'benefits' changed to 'impact'. Additional sentence added to the end of paragraph commenting on v8.0.

Paragraph 3 - commentary updated to latest versions of EFT and COPERT and explanation of COPERT shortened.

Paragraph 5-8 - changes and additions made to reflect WLTP's introduction, new evidence from PEMs and remote testing and new exhaust technologies.

Paragraph 9 - "and future vehicle fleet composition" added to first sentence. "Based" changed to "including" to indicate sensitivity test are only one of several approaches. "such as the future assessment year and professional judgement of an experienced practitioner should be used to justify the approach" added to the final sentence.

Paragraph 10 - "Whether it is likely to be 3% or 10% above the objective (the cut-offs in Table 6.3 of the guidance) will need to be determined on a specific project basis and requires expert judgement" removed.

Minor typographical changes throughout for clarity.