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Local Air Quality Management

Practice Guidance 4

Practice Guidance to Local Authorities on Measures to Encourage the Uptake of Retro-Fitted Abatement Equipment on Vehicles

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Executive summary

i. This guidance is principally for local authorities in England to have regard to, if relevant, in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995. This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by providing relevant policy and technical guidance on a specific transport measure – **encouraging uptake of retrofit abatement equipment.** The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

ii. Retrofit schemes are defined area(s) or locations where the most polluting of vehicles are encouraged to retrospectively install technologies to reduce its emissions. The aim is to reduce the emissions of more polluting vehicles being used in a particular area by setting particular emission standards or criteria encouraging them to retrofit abatement equipment, with the aim of improving local air quality. A range of systems exist for vehicles that could abate particulate matter (PM_{10}) and nitrogen oxides (NO_x) emissions. Where emission criteria are expressed in technology-neutral terms (i.e. a given Euro-standard must be achieved) then retrofit as opposed to vehicle replacement can become a viable route to compliance.

iii. Schemes are operating in several UK and overseas cities. The most significant existing scheme in the UK is the London Low Emission Zone scheme which from July 2008 requires that all heavy duty vehicles achieve at least a Euro III emission standard for PM_{10}. Many operators are expected to comply with the scheme restrictions via retrofitting particulate filters.

iv. The legal approach for implementing a traffic control measure in the UK is usually by Traffic Regulation Orders under the Road Traffic Regulations Act 1984 (commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme). Local authorities can also consider voluntary approaches such as Quality Bus Partnership Schemes, contract/licence conditions to manage emissions from contracted bus services and taxi fleets or more formal regulation of local bus services via Quality Partnership Schemes or Quality Contract Schemes.

v. Schemes should be developed via appraisal and this guidance provides information on assessing emissions, air quality and costs assessments. It also provides information on using these data in cost-effectiveness and cost-benefit analyses that are consistent with a generic guidance note on appraising the cost-effectiveness of local air quality action plan measures. Local authorities are strongly encouraged to refer to this guidance note too.

vi. Schemes tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of

more polluting vehicles owing to the high potential health benefits. Previous studies have demonstrated that the most cost-effective vehicles to target in a scheme with enforceable restrictions are diesel powered Heavy Duty Vehicles.

vii. Between now and 2010-2012 an equivalent Euro III standard should be considered as the minimum standard for retrofit schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local source apportionment and analysis should be used to determine which vehicles and which pollutants are the most relevant to target. This should be considered as part of the scheme design, to determine the cost-effectiveness of various options.

viii. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Examples of Low Emission Zones from mainland Europe include manual and low-tech enforcement methods as well as camera-based systems. A particular feature of retrofit schemes is the need for a robust system of certifying and identifying those vehicles that have had abatement equipment retrofitted so that they can enjoy the incentives of the given scheme. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

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1 Introduction

1.1 Purpose of this Guidance Document

1.1. This guidance is principally for local authorities in England to have regard to in carrying out their local air quality management (often shortened to LAQM) duties under Part IV of the Environment Act 1995.[1] This guidance is intended to enable local authorities to improve on the service they already provide in tackling poor air quality by specifically providing relevant policy and technical guidance on a specific transport measure – **encouraging the uptake of retrofit abatement equipment.**

1.2. The guidance provides information on selecting methods for implementing this measure, practical issues that have arisen in implementing previous examples of this measure and advice on appraising potential costs and air quality benefits of the measure in cost-effectiveness and cost-benefit analyses.

1.2 Background to the Guidance

1.3. The guidance has been developed to be consistent with key government guidance on appraising new policy and road transport policies in particular.

1.4. The Government Green Book requires that there should be an economic assessment of the social costs and benefits of all new policies projects and programmes. Within the Green Book and related HM Treasury guidance on assessment of the Business Case (5 Case Model), policies are considered under five components and this guidance is consistent with the Green Book as follows.

- Applicability: Retrofitting of vehicles potentially contributes towards strategic objectives in the areas of environment (air quality and climate change).
- Appropriateness: Guidance is given in this document to help develop policies for which costs and benefits are either balanced or overall beneficial in economic terms.
- Attractive: Guidance is given in this document to help authorities to prepare their commercial case for retrofitting schemes by considering scheme costs including those falling on vehicle operators.
- Affordable: Guidance is given in this document to help authorities to prepare budgets for retrofitting scheme costs.
- Achievable: Guidance is given in this document on existing examples of retrofitting schemes and key implementation issues including enforcement powers and other practical considerations.

1.5. As far as possible this guidance is also consistent with the government's New Approach to Transport Appraisal (NATA). In practical terms NATA guidance is delivered via the web-based Transport Analysis Guidance (webTAG). In

[1] Separate policy guidance will be issued by the devolved administrations in Scotland and Northern Ireland. The technical guidance that accompanies this guidance covers the whole of the UK.

particular this includes guidance on how to conduct a transport policy or scheme appraisal that meets the Department for Transport (DfT) guidelines. Although every care has been taken to ensure consistency if contradictions do occur, for example as guidance changes, then primacy should be given to this guidance in the consideration of air quality impacts (air quality and climate change effects) and webTAG guidance for wider transport impacts.

1.6. These sources of guidance have been consulted during the development of this guidance document so that a high degree of consistency with overarching governmental guidance on economic appraisal and road transport appraisal in particular have been achieved.

1.3 How should the guidance be used?

1.7. The guidance is advisory not mandatory. Local authorities that have declared Air Quality Management Areas (AQMAs) must have regard to the guidance when developing their Air Quality Action Plans. However, the guidance is also suitable and recommended for those other local authorities that are considering implementing measures to improve local air quality.

1.8. Local authorities should have regard to this guidance in conjunction with other relevant guidance with regard to LAQM duties. These guidance documents are:

- Local Air Quality Management Technical Guidance 2009.
- Local Air Quality Management Policy Guidance 2009 including
  - Practice Guidance on the Economic Principles for the assessment of local measures to improve air quality,
  - Practice Guidance relating to Low Emission Zones (LEZ),
  - Practice Guidance relating to measures to encourage the uptake of Low Emission Vehicles (LEV).

1.9. It is advised that local authorities give regard to all guidance documents on local air quality measures rather than just this one. Each one contains important information, some of the guidance overlaps between documents and local authorities are also strongly recommended to follow the general guidance on the economic principles of local air quality assessments regardless of the measure being considered.

1.10. It is highlighted that the specific schemes in the guidance are not the only measures that local authorities should examine when considering how to improve local air quality. The relevant policy guidance is clear that local authorities should be prepared to consider all possible measures if relevant. However, there is now an increasing amount of experience in implementing these particular measures in the UK and in other countries. Where possible this guidance document therefore presents relevant details of this experience in order to highlight current practice in implementing Incentives for the uptake of Incentives for the uptake of retrofit abatement equipment schemes.

1.11. Further help on the guidance can be obtained from Defra (air.quality@defra.gsi.gov.uk), or by contacting the Local Authority Air Quality

Action Plan Helpdesk (Telephone:0870 190 6050 Email: lasupport@aeat.co.uk).

1.4 Definitions of Retrofit Schemes

Local Incentive Schemes for the Retrofitment of Abatement Equipment

1.12. These are schemes that promote the retrofitment of emissions abatement equipment via **local** incentives. There have been a number of national schemes of this type such as the TransportEnergy CleanUp scheme (2000-2004. This guidance focuses on actions local authorities could take to incentivise the uptake of LEVs.

1.13. A scheme may be implemented in a geographically defined area where the most polluting of vehicles are encouraged to install technologies to reduce emissions of air pollutants. The aim is to improving the air quality by reducing emissions from the highest polluting vehicles.

Retrofit Emissions Abatement Equipment

1.14. Retrofit emissions abatement equipment are systems that can be applied to existing vehicles typically to reduce their particulate matter (PM) and nitrogen oxides (NO_x) emissions.

1.15. A range of systems exist and these are briefly summarised below:

Cleaner Vehicle Retrofit Options
Diesel particulate filters (DPFs) (particulate traps). These are usually fine ceramic filters that collect carbon particles. These devices are generally only acceptable with some means of self-regeneration. This may be a fuel borne catalyst or embedded catalyst within the filter. There were earlier issues with DPFs for urban driving as a certain exhaust gas temperature is required for regeneration (to burn off collected particulate material), though these have been largely resolved through lagging pipes, good oil control and catalyst size. Full flow filter traps (rather than partial traps) reduce particulate levels by around 90 to 95% based on conventional PM measurement methods. A large number of heavy vehicles were fitted with DPFs under EST's CleanUp programme. The estimated cost of such systems was considered in the Air Quality Strategy Review. It is known that particulate control technologies using oxidation catalysts lead to an increase in the proportion of NO_x emitted as nitrogen dioxide (NO_2). In order to regenerate the particulate trap (i.e. burn off the particulate matter collected), these filters convert a proportion of the nitric oxide (NO) emissions in the exhaust stream to NO_2, which is then used for trap regeneration. For diesel vehicles equipped with these filters, the proportion of NO_x emitted directly as NO_2 can be as high as 50% (compared to approximately 10% for diesel vehicles not equipped with this technology). The implication is that PM_{10} concentrations could be reduced but at the cost of increased NO_2 concentrations. **Selective catalytic reduction (SCR)**. This involves reduction of NO_x to nitrogen (N_2) using ammonia (NH_3). Reductions of 50-90% in NO_x can be achieved; some studies quote central values of 65%. Carbon monoxide (CO) and hydrocarbon emissions are also reduced. It is best suited to larger vehicles, as it is a bulky system. A number of Euro IV and V Heavy Goods Vehicles (HGVs) now have SCR fitted to meet NO_x emission limits and there is a

Cleaner Vehicle Retrofit Options

network of urea re-filling locations to support the technology. There is less experience with retrofit SCR is on a commercial basis, although trials have taken place and some London taxis have been retrofitted. A DPF could be fitted alongside SCR, but there may be space limitations in some vehicles, which could make this difficult, if not impossible. However, there is at least one commercially available system which combines DPF and SCR into a single unit. While the size of this unit may still be an issue for some vehicles, it may be worthwhile to undertake an assessment of the proportion of relevant fleets that could retrofit both a DPF and SCR unit if a strategy to reduce both PM_{10} and NO_x/NO_2 emissions is desired. .

Exhaust Gas Recirculation (EGR). This uses a valve to recirculate the exhaust gas back into the engine. This inhibits formation of NO_x as the exhaust gas is depleted in oxygen. Exhaust Gas Recirculation is often used in conjunction with an oxidation catalyst or a particulate trap because on its own it generally leads to an increase in particulate emissions. Exhaust Gas recirculation has been fitted to all new light duty diesel (LDV) vehicles for several years but has not been fitted to HGVs (and may now be superseded by SCR for Euro 5 vehicles). Retrofitting EGR may involve upgrading the cooling system of the vehicle, and attention has so far focused on inner city buses. The addition of EGR technology can lead to up to an estimated 45% reduction in NO_x emissions. As with DPFs with embedded catalysts any EGR system using an oxidation catalyst may increase the proportion of NO_x emitted as NO_2.

Re-engining. One strategy is to re-engine older vehicles, i.e. to replace the engine with a newer unit with lower emissions. However, the substitution of an older engine with a later engine may be complicated by necessary changes to exhaust, cooling system, transmission interface and electronic engine management. In theory the emissions reduction from re-engining is equivalent to the difference between the emissions limits of the Euro standard being replaced and the standard of its replacement. Re-engining costs vary widely with vehicle type.

1.16. There are important limitations associated with some of these systems. Firstly, abatement systems featuring oxidation catalysts have been observed to increase the proportion of NO_x that is emitted as NO_2. This means that the system may reduce PM_{10} emissions but may worsen the local air quality with respect to NO_2. Secondly, the size and costs of some of these systems are such that they may only be a cost-effective and feasible option for specific vehicles.

1.17. Local authorities and operators considering these systems should examine the impact of the limitations described and consult both manufacturers and vehicle operators before making final decisions on schemes.

1.18. The extent by which emissions may be reduced by these systems can vary significantly to achieve any given standard. To simplify the setting of targets, schemes that typically promote the uptake of retrofit equipment define either:

- the type of equipment that must be fitted and certified; or
- the Euro standard emissions limits that should be met by vehicles once they have fitted the equipment.

1.19. Local authorities may prefer the second of these definitions since operators are free to choose whichever abatement system is most suitable and cost-

effective for their vehicles. A key feature of such schemes is that local authorities define both the standard and the year in which it must be achieved in order for vehicles to benefit from an incentive.

Incentives and enforcement

1.20. In the context of these schemes, 'incentives' could mean there being one of the following:

- penalties for the use of vehicles not complying with emissions standards (via abatement equipment);
- discounts for the use of vehicles complying with emissions standards (via abatement equipment); or
- a mixed situation where high emitters are penalised and low emitters are given discounts. Such a scheme could potentially be fiscally neutral.

1.21. This guidance will focus on enforceable restrictions of traffic and parking on the public highway and planning obligations to control vehicle use and parking at private development sites via penalties or discounts, as a basis for setting up a scheme.

Overlap with other guidance

1.22. There is some overlap between this document and the practice guidance documents on LEZs and LEVs; . This guidance includes information from those guidance documents where appropriate. However, it is recommended that the other guidance documents be considered for a more complete set of recommendations concerning incentivising LEZs or LEVs .

1.5 Economic rationale for retrofit incentive schemes

1.23. The economic rationale for schemes such as these is linked to the external costs of operating polluting vehicles. Those undertaking polluting activity are placing costs on society as a whole through adverse health impacts and damage to ecosystems and the wider environment. The separation of private transport benefits and public impacts means that individuals are likely to consume transport in a way that is not socially optimal, unless there is an intervention. To place a limit on this, in relation to air quality for example, there are specific concentration limit values that have been defined and implemented to prevent unacceptable societal damages. Schemes described in this guidance document seek to provide additional incentive in order to make progress towards the limit values by reducing the external costs of transport.

1.24. Retrofit incentive schemes are focussed on the addition of abatement equipment to existing vehicles thereby lowering their local pollutant emissions. The main impacts of such replacement are likely to be:

- reduced emissions and improved air quality, hence contributing to UK environmental, health and economic objectives; and
- an additional capital cost (for the abatement equipment).

1.25. Three retrofit policy scenarios were studied during the development of the UK Air Quality Strategy[2]. The scenarios assumed different uptake rates of DPFs in the UK bus, coach and HGV fleets with emissions standard Euro IV or worse from 2006 onwards. Considering scenario H3 it was assumed that the uptake would increase from 3% in 2006 up to 35% by 2012.

1.26. The emissions benefits of this uptake rate were estimated at 1005 tonnes PM_{10} nationally in 2010 and diminishing in subsequent years due to underlying vehicle turnover rates. Retrofit equipment has been considered to reduce fuel efficiency but more recent consultation with industry concluded that the effect on fuel efficiency and hence carbon emissions is neutral.

1.27. Health benefits of the order of 13-14,000 life years saved were estimated to accrue from the retrofit uptake scenario. In monetised terms this is equivalent to an annual present value of £18-26million. This result clearly demonstrates the potential for emissions reductions in the Heavy Duty Vehicle (HDV) fleet from retrofits and the benefits that may accrue.

1.28. The additional cost of the retrofit technology for HDVs was estimated at between £1350-1750 per vehicle with an additional £160-240 annual cleaning costs. Nationally these are estimated to give rise to costs of around £25million in present value terms. The best assessment comparison of the costs and health benefits found overall benefits and costs to be balanced.

1.29. The conclusion of the national level analysis is that retrofit incentive schemes could deliver substantial benefits nationally. The emissions reductions due to abatement equipment are likely to also have a beneficial effect on air quality in concentration hot-spots (AQMAs). On this basis, local authorities are therefore encouraged to consider local retrofit schemes.

1.30. Other analyses have considered retrofit strategies for complying with LEZ restrictions. They have concluded that schemes focussed on HDV emissions in urban centres offer the best outcomes in terms of cost-effectiveness. Such schemes should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Therefore, between now and 2010-2012 a Euro III standard should be considered as the minimum standard for retrofit schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing with time.

[2] Defra (2007). An Economic Analysis to inform the Air Quality Strategy volume 3, Updated Third Report of the Interdepartmental Group on Costs and Benefits.

2 Options for retrofit schemes

2.1. The purpose of this chapter is to provide practical guidance on available options for retrofit schemes. Options include the different legal bases under which local authorities are empowered to introduce schemes and the various aspects of scheme design such as boundaries, emissions criteria, management and enforcement. The chapter structures these options and the headings are introduced in the left hand column of the table below. The table also summarises key aspects associated with the headings and options whereas the relevant text following the table expands on this to provide more detail in each case.

Table 1: Structured options and key aspects for introducing retrofit uptake schemes

Scheme options	**Vehicle restrictions**	**Parking restrictions**	**Using the planning system**	**Bus fleet conditions**
Legal basis	Traffic Regulation Order (TRO) under Road Traffic Regulations Act 1984 (RTRA 1984). Enables access by permitted vehicles, which can be based on environmental criteria.	Traffic Regulation Order under RTRA 1984. Enables differential charging, which can be based on environmental criteria.	S106 agreement. Enables obligations based on environmental objectives.	Contract conditions for contracted services. Quality bus partnership agreements (QBPA), quality partnership schemes (QPS) or bus quality contracts (QC) for local commercial services. Enables conditions based on environmental objectives.
Scheme design				
Location of boundaries	May determine scheme capital and operating costs. Should take account of any source apportionment results and extent of activity in AQMAs by vehicle type.			
Vehicle emission standards	Recommended to be based on: • Equivalent euro standards • Emission abatement retrofit technology • Specific certification that vehicles comply with the standard Objective Euro-standards allow operators flexibility in how they comply since they are technology neutral. Basing standards on in-service emissions is not practicable. Phased approach to tightening standards in future years ensures benefits continue over time.			
Management of permitted vehicles	Scheme rules must be accessible to all vehicle owners. Large schemes may require	Schemes could be introduced via residents parking or season ticket holders, which provides a	See Government policy on planning obligations – www.communities.gov.uk/publications/planningandbuilding/c	Management of permitted vehicles is responsibility of contracting authority, local traffic authority or

Scheme options	Vehicle restrictions	Parking restrictions	Using the planning system	Bus fleet conditions
	database of permitted vehicles	management system to build upon.	ircularplanningobligations	traffic commissioner depending on the approach taken.
Enforcement powers and penalties	Outside London the relevant moving vehicle offences are currently enforceable by Police. Powers under Traffic Management Act 2004 (TMA 2004) may provide civil enforcement powers to local authorities. These are necessary to effectively enforce a scheme.	Traffic Management Act 2004 now provides for the civil enforcement of most types of parking contraventions. Local authority appointed Civil Enforcement Officers can issue Penalty Charge Notices (PCN) for parking contraventions.	Guidance on enforcement of planning conditions is available at www.communities.gov.uk/documents/planningandbuilding/pdf/324923.pdf. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides guidance on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).	Responsibility for enforcement will also vary as above depending on the approach taken. Levels of penalties would range from no penalty for partnership agreements through to termination of contract or removal of licence to operate on routes covered by quality partnership or contract schemes
Vehicle detection	Various methods, which can be combined in one scheme: • manual observation; • Automatic Number Plate Recognition (ANPR) cameras (fixed sites or mobile units); • Tag and beacon or swipe-card technology[3].	Generally done by manual observation, although camera (CCTV) systems have been used.	In principal the same methods as for Traffic Restrictions would be available	In principal the same methods as for Traffic Restrictions would be available although simple manual methods will have significant advantages.

[3] It must be noted that any new on board equipment will need to be consistent with the European Electronic Tolling Service (EETS)

2.1 Legal basis for implementation

2.3. Based on this guidance note's scope of coverage the following section covers two main routes to setting up an area with traffic or parking controls based on vehicle emission criteria:

- Traffic Regulation Orders for enforceable restrictions on the public highway; and
- Section 106 agreements as planning obligations for development sites and private land.

2.4. Apart from these authorities can also consider setting up schemes for buses or coaches using:

- quality bus partnership agreements;
- contract conditions of tendered services;
- quality partnership scheme;
- bus quality contract schemes.

Traffic Regulation Order - Traffic and parking orders

2.5. There are several types of enforceable restrictions that can be employed by highway authorities under current legislation. The general basis for these is the TRO. Traffic Regulation Orders are commonly introduced for example to manage traffic flow at specific locations, to define on-street parking conditions, or as part of a broader traffic management scheme. For example, TROs can be used to restrict access to a given area or to certain types or weight of vehicle or during specific time periods. Traffic management schemes are typically focused on historic or busy commercial centres, where the effects of traffic on safety, noise and pollution levels can be quite dramatic, and also in sensitive residential neighbourhoods.

2.6. Highway authorities are empowered under the RTRA 1984 to make TROs to regulate the speed, movement and parking of vehicles and to regulate pedestrian movement. Traffic Regulation Orders are required for any enforceable restriction on the highway. They may be made under the terms of the RTRA 1984 or, for "special events", the Town Police Clauses Act 1847. The RTRA 1984 specifies what restrictions a TRO may impose. The Local Authorities Traffic Orders (Procedure) (England) Regulations 1996 lay down the legal requirements for making and implementing a TRO.

2.7. The main points relating to the making of Orders that may be used for enforceable restrictions are summarised as follows:

i) The Highway Authority may restrict any/all classes of vehicle from using any road or from carrying out certain activities in any road either permanently or on certain days/dates /times, provided that it specifies a valid reason (as defined in the RTRA 1984) in the statement of reasons. They may do this by making restrictions, which prohibit, restrict or regulate the use of any road by vehicular traffic or specified classes of vehicle. Restrictions may require traffic to proceed in a certain direction, restrict waiting or loading or prohibit through traffic.

ii) valid reasons for making an Order include:

a) for avoiding danger to persons or other traffic using the road or any other road or for preventing the likelihood of any such danger arising, or
b) for preventing damage to the road or to any building on or near to the road, or
c) for facilitating the passage on the road or any other road of any class of traffic (including pedestrians), or
d) for preventing the use of the road by vehicular traffic of a kind which, or its use by vehicular traffic in a manner which, is unsuitable having regard to the existing character of the road or adjoining property, or
e) (without prejudice to the generality of paragraph (d) above) for preserving the character of a road in a case where it is specially suitable for use by persons on horseback or on foot, or
f) for preserving or improving the amenities of the area through which the road runs, or
g) for any of the purposes specified in paragraphs (a) to (c) of subsection (1) of section 87 of the Environment Act 1995 (EA 1995).

2.8. As noted, under point g), the EA 1995 broadened the purposes for which a TRO might be made to include the pursuit of environmental objectives. The relevant parts from the EA 1995 are Section 36 of Schedule 22, which states that TRO can be used “with respect to the assessment or management of the quality of air”. This is relevant to a traffic or parking control scheme designed to maximise environmental benefits.

2.9. Orders can be made that apply to certain classes of vehicle, or to set up a permitting system to exempt certain vehicles from the controls. The criteria for a permission (or permit) is defined by the Authority making the TRO. Therefore, it can be based on an environmental/emission standard linked to local objectives and circumstances. This approach has been used in a priority access scheme in the city of Bath.

2.10. All local authorities need to develop a parking strategy covering on- and off-street parking. Many different types of on-street parking schemes can be created under the powers provided in Part IV of the RTRA 1984. Local authorities use TROs to put parking schemes in place and appropriate traffic signs and road markings so that the public know what the restrictions mean.

2.11. A highway authority has the power to set charges for parking permits pursuant to the RTRA 1984 (as amended) and in doing so may set differential charges for different types of vehicle. In exercising its duties under the 1984 Act, a highway authority is under a duty to secure the expeditious, convenient and safe movement of traffic (including pedestrians) and suitable and adequate parking on and off the road. In meeting these duties, the highway must have regard to:

- the effect on amenities of any locality;
- the strategy prepared under s.80 EA 1995.
- any other matters appearing to the local authority to be relevant.

2.12. These matters provide a legal basis for the differential charging based on CO_2 and other emissions.

2.13. The signing of a vehicle access control scheme should be one of the first elements to consider when designing a scheme, to ensure it can be legally signed. It is important that the design of all sign faces is considered when drawing up the TRO. All signs used for a scheme should be in accordance with the Traffic Signs Regulations and General Directions and used as described in the Traffic Signs Manual. Sometimes the objectives for vehicle access control schemes have led to designs for which no suitable sign is prescribed in Traffic Signs Regulations and General Directions. In such cases it is necessary to seek authorisation for a specific sign from the Department for Transport, before any variation to the prescribed signing takes place. Considering all the available prescribed signing must be a first step.

Planning conditions

2.14. Local planning authorities can impose conditions on planning permissions only where there is a clear land-use planning justification for doing so. Conditions should be used in a way which is clearly seen to be fair, reasonable and practicable. One key test of whether a particular condition is necessary is if planning permission would have to be refused if the condition were not imposed. Otherwise, such a condition would need special and precise justification. Unless otherwise specified, a planning permission runs with the land. Exceptionally, however, the personal circumstances of an occupier, personal hardship, or the difficulties of businesses which are of value to the welfare of the local community, may be material to the consideration of a planning application. In such circumstances, a permission may be made subject to a condition that it is personal to the applicant. Such arguments will seldom outweigh the more general planning considerations, however. See The Planning System: General Principles - www.communities.gov.uk/publications/planningandbuilding/planningsystem - for more information, including on enforcement.

It should be noted that planning conditions cannot be used to require financial contributions. See Circular 11/95: Use of conditions in planning permission (www.communities.gov.uk/publications/planningandbuilding/circularuse).

2.15. Where it is not possible to include matters that are necessary for a development to proceed in a planning condition, developers may seek to negotiate a planning obligation under section 106 of the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). Planning obligations should meet the Secretary of State's policy tests set out in Circular 05/05 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations); i.e. they should be:

- necessary;
- relevant to planning;
- directly related to the proposed development;

- fairly and reasonably related in scale and kind to the proposed development; and
- reasonable in all other respects.

The use of planning obligations must be governed by the fundamental principle that planning permission may not be bought or sold. It is therefore not legitimate for unacceptable development to be permitted because of benefits or inducements offered by a developer which are not necessary to make the development acceptable in planning terms. Planning obligations are only a material consideration to be taken into account when deciding whether to grant planning permission, and it is for local planning authorities to decide what weight should be attached to a particular material consideration.

2.16. In terms of air quality, the impact of a development on air quality should be considered with regard to Planning Policy Statement 23 (often referred to as PPS23), particularly Annex 1 www.communities.gov.uk/publications/planningandbuilding/pps23annex1.

2.17. Both environmental impacts of a development and location of a development (whether it is close to a source of pollution or contributing further to an existing problem) can be taken into account as material planning considerations.

2.18. A useful document on the subject of low emission strategies - using the planning system to reduce transport emissions - has been produced by the Beacons Low Emission Strategies Group[4]. Broader guidance, aimed at ensuring that air quality is properly accounted for in local development control processes, has been produced by the NSCA (now Environmental Protection UK) as 'Development Control: Planning for Air Quality' (updated in 2006)[5].

Approaches for Buses

2.19. The approaches discussed here will ultimately be affected by the progress and outcome of the Local Transport Bill, which is still being debated. Once this Bill is enacted work will begin to produce final regulations and guidance before the provisions of the Bill can commence. Local Traffic Authorities are therefore advised to monitor the progress of the Bill, regulations and guidance when considering using these approaches to regulate bus emissions.

2.20. It is also noted that local passenger transport is a function of the Passenger Transport Authorities and Executives in metropolitan areas, and county councils elsewhere whereas LAQM is a function of district authorities. This is therefore a clear case where, in two-tier authorities there will need to be close liaison between the two tiers to implement such schemes.

[4] Beacons Low Emission Strategies Group (2008). Low emission strategies - using the planning system to reduce transport emissions.
[5] NSCA (2006). Development Control: Planning for Air Quality

Quality Bus Partnership Agreement

2.21. To set up a QBPA the local authority provides and maintains facilities to improve local bus services, which helps make bus travel more reliable and attractive. In return the main bus operators using the infrastructure agree to make improvements to their fleet or service levels.

2.22. A voluntary or partnership approach to the scheme could in theory be low cost to the authority. However, QBPA generally work by both parties investing in the improvement to services, voluntary agreement on an ambitious emissions reduction programme could be easier to achieve if complementary measures are also introduced that significantly improve the commercial environment for bus operations.

2.23. It is a voluntary agreement, entered into freely on both sides, with generally a non-binding document setting out the terms. Note that agreements are constrained by general legislation such as the Competition Act 1998 but that The Local Transport Bill would, however, introduce a new competition test that could make it easier for local authorities to enter into agreements with several bus operators, rather than separate agreements with each. Examples of schemes given listed earlier in this section illustrate the actions that several authorities are undertaking to include emissions based criteria within their Agreements.

2.24. An authority could decide at any time whether they wish to try to use a QBPA approach to setting up a scheme. Taking forward a bus emission reduction strategy based on a QBPA can be divided into the following two stages:

Preparation

- Authority prepares evidence base, scenario(s) and preferred outcome for future bus fleet profiles for all local commercial service providers, tourist coach, express coach and city tour services, including:
  - Target emission reduction;
  - A possible target for carbon reduction.
- Authority prepares negotiation framework with outline of process, actions and timescales based both on a voluntary approach and using mandatory options (if they prove necessary) taking into account:
  - Target implementation dates;
  - Target emission standards (plus phasing, proportions etc);
  - Preferred timescale for achieving emission reductions (via process);
  - Key milestones en route (such as those below);
  - Any decision points related to the accompanying political processes.

Negotiation

- Authority enters negotiations with bus operators for raising emissions standards through voluntary means, within a timetable for achieving the preferred (or next-best) outcome and commitment to move to more enforceable approaches such as QC Schemes described later;
- Evaluate the proposals of the bus operators if they fall short of the Authorities preferred scenario, quantify shortfall, and make a decision if the bus operator proposals are acceptable. Assessment should include

evaluation of emissions and any requests for additional expenditure on highways or roadside infrastructure.

2.25. If the negotiation route with one or more operators does not produce the result the Authority wishes for, then there are more enforceable options described later.

2.26. Quality Bus Partnership Agreement is an approach that authorities could use with smaller bus operators and authorities may wish to avoid scenarios where smaller operators are forced to be uncompetitive relative to bigger operators offering increasingly high-quality services that capture a greater market share. However, choosing the QBPA approach may mean the Council accepting that they cannot include smaller operators in any meaningful way in the scheme. The impact of smaller operators on overall emissions should be assessed in preparation for this outcome, and taken into account when decisions about which approach will be used to set up the scheme. A key issue may be whether the main bus operators will still participate in a voluntary scheme of higher emission standards even if smaller operators refuse to join.

2.27. Within the QBPA approach there could be some scope for reaching agreement with coach and city tour service providers. They are users of roadside infrastructure in the city and a business that operates from the city, and therefore may wish to benefit from infrastructure improvements.

Contract conditions of tendered services

2.28. Tendered services are time-limited contracts to provide a service for:

- subsidised public services;
- education department (i.e. school buses); and
- other contracts (for example, Park and Ride buses).

2.29. Local authorities have the power to regulate the emissions performance of tendered services including subsidised services, educational contracts and other specialised contracts. Many councils do not currently specify emissions criteria in their contracts. However pricing preference schemes (whereby commitments to operate new vehicles on the contracted routes get a preferred weighting during procurement assessments) have the effect of encouraging the use of brand new vehicles on subsidised bus routes when their contracts are renewed. Subsidised public services are regulated by Bus Service management function within local authorities.

2.30. To fully understand the timeline and decision points for influencing the tendered service bus fleet, it will be necessary to catalogue each of the tendered service contracts, noting the number of vehicles, anticipated vehicle mileage, duration of contract and contract end date. This will show the scope and future opportunities for influencing the retrofitment of abatement equipment. It is suggested that this work could be done in parallel with any preparation work for negotiation on commercially operated services, though the QBPA.

Quality Partnership Schemes

2.31. Statutory QPS apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). From this it follows that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, is within the definition of local service and so could be regulate by this route.

2.32. It is suggested that the use of a QPS be considered in parallel to the BQPA route, as it would provide a contractual framework for the scheme should the authority decide they will provide additional infrastructure and investment for bus services in the city in exchange for faster than currently planned fleet turnover.

2.33. Under a statutory QPS, the local authority - for these purposes, county councils, unitary authorities and Passenger Transport Authorities - draws up a scheme, aimed at implementing the policies in its local bus strategy. The bus strategy forms part of the local transport policies required under section 108 of the Transport Act 2000. A QPS in effect represents a commitment on the part of the authority to provide certain facilities to improve local bus services, and to maintain them throughout the life of the scheme; and an obligation on the part of participating bus operators to meet the quality standards prescribed in the scheme when using the facilities in question.

2.34. The cost of the scheme to the authority will largely be comprised of any investment in roadside infrastructure, bus priority etc. This is probably what bus operators would prefer to see in any QBPA so the cost to the authority may not be any greater than that of the voluntary approach.

2.35. Such schemes have statutory force and would be registered with the Traffic Commissioner, who can prevent non-compliant operations from using corridor facilities. In this respect, a QPS varies from a QBPA, the latter being entirely voluntary.

2.36. The essence of a QPS is that:

- the Authority and where appropriate District Councils provide facilities to improve bus operation – including bus lanes and other priority measures and facilities like stops and shelters;
- the Authority also specifies a quality level for buses that must be met by bus operators as a condition of using the facilities provided.

2.37. Department for Transport guidance notes that the specified standard of services should be one which can be reasonably met by any operator, unless the standard is higher but the benefits derived from its application outweigh the costs of compliance. For instance, a requirement to operate buses with facilities to give a high standard of accessibility for disabled people will probably be considered reasonable, as the benefit to the travelling public would justify any operator investment. However a requirement to operate

vehicles built by a particular manufacturer or to a particular design is likely to be unreasonable.

2.38. A key question is therefore what is the standard of service the main bus operators and smaller bus operators would find reasonable to offer in return for incentives by the Authority? The QPS is still a partnership between the Authority and one or more operators, so the key question is finding out what grounds there are for reaching an agreement. As per the QBPA process, the Council(s) should determine what their minimum or target emission standard is, based on air quality impacts, in order to assess the position of any given bus operator.

2.39. The participating bus operators are then obliged to meet the quality standards prescribed in the scheme when using these facilities, and must give a written undertaking to the traffic commissioners to provide the service to the specified standard. Quality standards can relate to the vehicles to be used, and this can include the percentage of vehicles that meet a given Euro standard either due to vehicle replacement or due to retrofitting abatement equipment.

2.40. Quality Partnership Schemes address the potential problem found in voluntary approaches that operators who do not agree to raise their standards cannot be excluded from using the new facilities. Bus operators might be reluctant to enter partnerships and spend money if they can be undercut by low cost, low quality rivals. Therefore the number of vehicles provided by smaller operators and their ability to increase investment in vehicles will need to be considered by authorities. If sufficient services can be provided by those operators willing and able to meet the QPS standards, provision of bus services would not suffer as a result of some operators being excluded from using the routes/areas covered by a QPS.

2.41. Operators that choose to continue to operate along a route subject to a QPS but which are not participating in the Scheme, will need to give thought to what, if any, stopping points they observe. They will need to satisfy the Traffic Commissioner that they are neither using the facilities included in the Scheme, nor are they planning to stop in places that will create adverse traffic congestion or safety impacts.

2.42. The Act in its current form specifically excludes the Authority from specifying timetables and fares as part of the scheme. In this respect, a QPS scheme differs from the provisions of a QC (discussed later in this guidance), and QPS represent something of a half-way house between a voluntary QBPA and a QC Scheme.

2.43. The Local Transport Bill currently before Parliament would make significant changes to QPS while retaining its essential nature. In particular, it would allow Authorities to specify frequencies, timings and maximum fares in a scheme, subject to safeguards to give existing operators in the area the opportunity to object to such a proposal, and to ensure that all relevant operators are involved in subsequent fare reviews. (However, operators would not have a similar right to object to provisions about vehicle standards). The Bill also contains provisions to restrict the registration of new

services, or the variation or cancellation of existing ones, in the area of the scheme if these would be detrimental to the operation of the scheme. These would not necessarily apply in every scheme, this being for the Authority to determine. The Local Transport Bill provisions would not prevent an Authority from making a scheme of the kind permitted under the existing legislation, they simply add further options. The Bill would be supplemented by regulations and guidance, drafts of which are available at www.dft.gov.uk/pgr/regional/localtransportbill/ltbdraftguidance.pdf and may be subject to consultation and further amendment.

2.44. From DfT Guidance on QPS in England, the following milestones and decision points can be picked out.

- Preliminary discussions with bus operators can be anticipated to take a number of months. Local transport authorities are advised to make informal contact with bus operators at an early stage of planning a QPS, and with the Highways Agency where there is potential for impact on the trunk road network. This will ensure that the published proposals come as no surprise and that operators have a chance to comment on the feasibility and acceptability of the proposals
- Having drafted a QPS, the local transport authority making it is obliged to publish it and undertake a formal consultation exercise in accordance with section 115 of the Transport Act 2000. The local transport authority (or authorities) would publish a notice of the proposed QPS in one or more newspapers circulating in the area it would cover. Either the notice itself must give full details of the facilities covered by the Scheme and the standard of service required, or it must state where such details may be inspected. Formal consultation does not have to last a specified length of time, so around three months could be considered sufficient.
- After giving notice, the local transport authority must formally consult the stakeholders. It is obligatory to consult:
  - all operators of local bus services that they think would be affected by the QPS;
  - organisations representing the users of local bus services (in the absence of a known local group, the local transport authority should consult the national organisation, Bus Users UK, which can be found at www.bususers.org);
  - other relevant local authorities that they think would be affected by the QPS - these include other local transport authorities, metropolitan district councils, and also, where appropriate, adjoining local transport authorities in London, Wales or Scotland;
  - the Traffic Commissioner for each traffic area affected by the QPS;
  - the chief officer of police for each police area affected by the QPS.
- The local transport authority should also consult any other persons they think fit. This could well include non-metropolitan district councils whose policies (for example on planning or on [off-street] parking) could be affected by the Scheme, and those affected by the proposed works (i.e. development of the facilities) required prior to the Scheme's commencement.
- There is no fixed time limit for consultation but sufficient time should be allowed to ensure that those who are likely to have views have a

reasonable opportunity to make a considered response. Central Government's practice is to allow a minimum of 12 weeks for consultation except in cases of urgency.

- Following consultation, the local transport authority may make the QPS, either as originally proposed or with modifications. The date of coming into operation must not, in any event, be less than three months after the date on which the QPS is made. But if one or more traffic regulation orders are needed to give effect to the Scheme then the date must also be at least three months after the date on which the order (or the latest of those orders) is made. However, these are only minimum times, and the important issue is that sufficient time is allowed for the local transport authority to provide all the necessary facilities and for operators to provide services to the specified standard.
- Once the QPS has been made, within 14 days, a further notice must be published in one or more newspapers circulating in the area to which the Scheme relates.
- Although the QPS must specify a date of coming into operation, there may be instances where, due to unforeseen circumstances, it becomes impossible to make all the necessary arrangements by that date. There is therefore a provision for postponing the date for up to (but no more than) 12 months from the original proposed implementation date.
- The Transport Act 2000 provides that a QPS must remain in operation for at least five years. There is no upper limit, but local transport authorities should bear in mind that policies and service requirements are likely to change over time and that Schemes should therefore be reviewed at reasonable intervals.

2.45. The Local Transport Bill, if enacted, will make certain changes to the provisions for QPS, and regulations and statutory guidance made under these provisions will also be relevant. However, the changes will not fundamentally affect issues concerning vehicle emissions standards

2.48. Current progress of the Local Transport Bill can be found here, showing the latest round of reading in the Commons/Lords: http://services.parliament.uk/bills/2007-08/localtransporthl.html

Bus Quality Contract Schemes

2.46. As with QPS, statutory QC Schemes apply only to “local services” (bus services where passengers may travel at “separate fares” for distances less than 15 miles). Therefore it is reiterated that contracted schools services (i.e. not charging “separate fares”) and many inter-urban long distance (“coach”) services, chartered coach, etc would be excluded. However, typical “city sightseeing tours” that can be joined at a bus stop without being a pre-formed party, are within the definition of local service and so could be regulate by this route.

2.47. Smaller operators are not particularly excluded from such a scheme, but they may find it difficult to offer the level of service or investment required in competition with larger operating groups for a QC, in cases where they run an older than average fleet.

2.48. The powers of the Transport Act 2000 enable local authorities to bring forward schemes in which they can determine what local bus services should be provided in their area, and to what standards, and can let contracts with bus operators giving them exclusive rights to provide services to the authority's specification. The Authority may determine the routes, timetables, fares and ticketing arrangements for the bus services, and any other matters relating to their standards including the emissions standards of the vehicles used. The local authority, not the traffic commissioner, carries out enforcement and operation of QC contracts.

2.49. Under the existing legislation a QC scheme must relate to the implementation of a bus strategy, and the making of a scheme must be 'the only practicable way' of implementing the bus strategy. Schemes require Ministerial approval.

2.50. No schemes are currently in operation. However, the Local Transport Bill includes a number of changes to the legislation aimed at making this a more realistic option for Authorities with a good case for using it. In particular, the Bill would replace the “only practicable way” criterion with new, more objective criteria based on increasing bus use and improving service quality. In England, an Approvals Board, chaired by a traffic commissioner, would approve schemes, rather than the Secretary of State, with a right of appeal to the Transport Tribunal.

2.51. Given the lack of experience of introducing these schemes it is difficult to make sound estimates over timescales. However, DfT has estimated that a “small uncontroversial scheme” could go through the statutory processes from statutory notice prior to consultation in 15 months. “For complicated schemes we may need to add up to ten months for the tendering process and for appeal (by any operator) to the Transport Tribunal perhaps a further three months.” In addition, an approvals board that requires any scheme modifications will mean further consultation.

2.52. There are details about guidance and obligations for consultation for QC schemes set out in DfT guidance on the subject in ‘Quality Contract schemes for bus services: Guidance to English local authorities’ found via this link: www.dft.gov.uk/pgr/regional/buses/quality/. This will be revised by the Local Transport Bill in due course.

2.2 Scheme design

2.53. The starting point for the design of any retrofit scheme should be the scheme objectives, i.e. the targeted improvement of the emissions performance of older vehicles by retrofitting abatement equipment. Having established the objectives for the zone in which the vehicles are to be regulated, there are further design considerations local authorities need to take into account. Key issues in the design of a zone where retrofitting is incentivised for the most polluting vehicles are organised in this section under the following headings:

- location of boundaries;
- vehicle emission standards;
- management of permitted vehicles;
- enforcement powers and penalties; and

- vehicle detection.

2.3 Location of boundaries

2.54. The location of boundaries is an important component of scheme design either in cordon or area-wide schemes. An early indication of the options for boundaries may be important since significant infrastructural and operating costs (if relevant) will largely be determined by the location. The geographical extent of schemes would necessarily take into account of the conclusions of LAQM Review and Assessments that have identified which vehicle types are contributing to the level of exceedence observed in the AQMA and how much of their activity is focussed in these areas.

2.4 Vehicle emission standards

2.55. The approach for defining retrofit standards on which to base enforceable restrictions (on the public highway or at development sites) could be determined in one or a combination of ways. The following criteria are relevant to schemes which target local pollutants:

- a list of approved proprietary retrofit or fuel conversion technologies (which can be used on older vehicles to clean up exhaust emissions, generally PM or NO_x);
- an emission attainment standard usually expressed in terms of an equivalent to emissions limits in a particular Euro standard for one or more pollutants.
    - Euro standards (the term for European type approval standards for new vehicles, which includes the emission performance against a defined test cycle).

2.56. Several existing LEV schemes such as the London LEZ (see chapter 5 for examples of retrofit schemes) use equivalent Euro standards as the basis for setting emission criteria. Such an approach allows compliance either via vehicle replacement or retrofit approaches. In a number of cases there exist supplementary criteria to allow some exemption (or time-extensions) for retrofitting emission abatement technology to vehicles that previously complied with the zone emission criteria.

2.57. The benefit of the retrofit approach being allowed for within these schemes is that they can provide a ‘safety net’ for those vehicle owners who do not want, or cannot afford, to buy a new vehicle to comply with a given Euro standard. Emission abatement technology can be retrofitted to a vehicle to make it meet more stringent emissions limits than those to which it was originally type approved. For vehicles with long lifetimes and high usage, such as buses, this can be more cost-effective than replacing the vehicle.

2.58. A feature of schemes that promote the uptake of retrofit equipment is that their local environmental benefits will reduce over time unless the defined emissions standards and incentives are reviewed and revised periodically. For example, a scheme that provides incentives for compliance with Euro III emissions limits for HDVs will no longer provide local benefits once all HDVs in the fleet are compliant with that standard. Therefore, local authorities

should consider a phased approach whereby tighter emission standards are required in future years to qualify for the incentive. The London LEZ is an example of this approach.

2.59. Whatever the criteria used, it is essential is that they are open to and operable by any normal user. This would rule out region or country specific standards that might not be available to vehicle owners across Europe.

Local Pollutant Criteria

2.60. Euro standards describe the emissions criteria that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU. Euro I vehicles began to be produced for a EC-specific type approval standard that came into force in 1993, with pre-Euro vehicles generally being those registered before this date. Note that Euro standards actually include more criteria than simply emissions and form the standards that vehicle manufacturers must type approve their vehicles to in order to supply for general sale in the EU.

2.61. The benefits of using Euro standards for a scheme design are that they describe the emission performance in a well-defined way, based on an approved testing procedure that defines the manufacturing process. They are criteria against which any vehicle in Europe can be judged; therefore it is interoperable across countries.

2.62. However, the complicating factor within schemes that allow retrofit approaches is how to set and certify equivalent Euro standard criteria for vehicles that retrofit abatement equipment. To adequately certify or permit a vehicle for a retrofit scheme more relevant information in the UK context than can be found from one or a combination of the vehicle registration documents and the DVLA record are required i.e. an additional identifier that a vehicle has retrofitted abatement equipment is required. The most developed system of this kind in the UK is found for the London LEZ. The following box provides the relevant details.

2.63. One current drawback, from scheme objective and administration viewpoints, is that while retrofit PM abatement technology can be approved in the UK (via the VOSA Reduced Pollution Certificate (RPC) process) there is not an equivalent national incentive for retrofitting NO_x abatement equipment. While the RPC scheme has been extended until 1 October 2009 to include Euro V and Envrionmentally Enhanced Vehicles (EEVs), in practice only new vehicles rather than those with retrofits can realistically achieve the RPC criteria. While NO_x abatement equipment is available for retrofitting to HDVs the lack of an approval and certification route makes it impossible to design schemes with NO_x abatement objectives via a nationally recognised certificate. However, this does not preclude the possibility of creating a local certification scheme along similar lines to the London Low Emissions Certificate (LEC).

Setting and Certifying Equivalent Euro Standard Criteria – The London Experience

Equipment and Testing: Vehicle operators must ensure that they purchase an abatement system that is on the approved list. For HDVs this list is found at www.tfl.gov.uk/roadusers/lez/comply/5074.aspx).

Heavy duty vehicle operators must submit their vehicles for acceleration and smoke testing by an approved examiner being either VOSA or a VOSA-authorised Approved Examiner (who may also have fitted the abatement device).

The authorised examiner will complete a Declaration of Conformity and Declaration application form which will be sent to VOSA and if the test is successful, VOSA will issue a LEC or RPC and send this directly to the applicant within ten days of the test.

Reduced Pollution Certificate
Some Euro I and II vehicles will already have a RPC certificate. If they have had an RPC issued before 1st January 2001 and it has lapsed, they can be eligible for a RPC test. However, vehicles which have not previously had an RPC cannot be issued with an RPC even if they have an eligible engine, since the DfT's Reduced Pollution Certificate Regulations changed in January 2001**.**

Specific types of vehicles registered in the UK prior to October 2006 are able to obtain a RPC. Vehicles with a valid RPC can be registered for a reduced level of VED. Vehicles that are eligible to obtain a RPC are:

- vehicles over 3500kg revenue weight in tax class HGV, used in connection with a trade or business, including vehicles used for exceptional loads and haulage vehicles (not showman's);
- coaches i.e. Public Service Vehicles in tax class Bus that have been demonstrated:
  - to comply to an enhanced environmental standard as approved by VCA, or
  - to a higher environmental standard, or
  - to run on petrol or gas.

In practice this requires that all compliant pre-Euro IV diesel HDVs must have been constructed or adapted (via addition of particulate trap equipment for example) to achieve a considerably higher standard of particulate emission than that required by the EU emissions directive in force at the time of manufacture. The higher standards required are set out in Schedule 2 to the Road Vehicles (Registration and Licensing) Regulations 2002 (SI 2002 no 2742) as amended.

Additionally vehicles in the tax classes above fitted with Euro 5 or EEV engines and NO_x control can now be accepted for RPC provided they are registered in the UK prior to 1 October 2009.

More information on certification via RPC can be found at www.transportoffice.gov.uk/crt/lorryandvanoperators/londonlowemissionzone/reducedpollutioncertificatesandlowemissionscertificates.htm#P1_61.

Low Emissions Certificate
This is a certificate offered by Transport for London (TfL) to allow vehicles to provide proof they comply with the emissions requirements of the scheme. It is issued to vehicles or engines which are not eligible for the RPC, but which comply with the LEZ emissions standards. After a LEC or RPC test has been conducted, the test results are transferred from VOSA to TfL automatically and the data is updated on TfL's database within ten days.

Vehicles that are eligible to obtain a LEC are:

- vehicles and passenger vehicles over eight seats plus driver used in connection with a trade or business, including vehicles used for exceptional loads and haulage vehicles;
- where no RPC compliant solutions are available, for example some vehicles between 3500kg and 5000kg revenue weight;
- in tax classes not eligible for RPC (for example, private HGVs, private light goods (PLG)LG including private minibuses and motorhomes);
- which were not UK registered prior to 1 October 2006 or first RPC tested prior to 5 January 2001.

Which are:

- identified on the TfL Eligible Engines List;
- known to comply with an enhanced environmental standard as approved by VCA that would have (except for date of test or registration) been eligible for an RPC and will meet the London LEZ emissions standards.
- modified to an enhanced PM standard as approved by VCA or Energy Savings Trust EST, including filter or other abatement technology that doesn't meet the RPC eligibility criteria. The LEC approved device list can also be found on the TfL website;
- re-engined to a higher environmental standard, or
- fitted/converted to run solely on petrol or gas.

2.64. The key elements of the approach adopted in London and which are relevant for new schemes are:

- a clear definition of vehicle types affected and their required emissions performance;
- a clear definition of the requirements that abatement devices and suppliers have to meet to prove the equipment is able to meet this standard;
- a defined list of approved suppliers/fitters and abatement devices which are certified as meeting the emission standard on specific engines;
- a defined list of approved testers and test conditions to certify compliance;
- a central database able to identify those vehicles that have been certified as compliant.

2.65. It should be noted that there is no reliable approach for basing a scheme on emissions performance 'in service'. However, this has not proved a barrier to the introduction of a LEZ in the UK (London) or other European countries, as they use age and/or equivalent Euro standards as a basis.

2.5 Management of permitted vehicles

2.66. The scheme operator maintains the definition of what is a permitted vehicle. Processes are required to verify the emission standard of a particular vehicle. Certification processes may be necessary, or useful to include in a scheme if they already exist, if there is likely to be a lack of information about potential users of the scheme such as the case where scheme design means retrofit emission abatement equipment is allowed.

2.67. Management of the permission to enter the zone requires information and identification of individual vehicles with administration systems to cross-check permissions.

- In a large scheme covering a number of types of vehicle this would probably require the creation of a database with links to the DVLA records as well as reduced pollution certification records, as for the London LEZ (see later chapter on example schemes).
- If a scheme is small-scale, affecting relatively few vehicles or one focussed on local fleets, then a basic permit management and verification system might be sufficient using vehicle registration documents and local reduced pollution certification records. This might be the case for schemes focussing on bus and coach fleets or on development sites.

2.68. Management of permitted vehicles in a scheme focussed on a development site should be more straightforward compared to the public highway. Through-traffic is not normal and all vehicles are destined for privately controlled parking. The costs of administering any scheme would be expected to be borne by the developer, or ongoing management company set up by the developer or development occupiers.

2.69. In the case of bus fleets the management and cost of maintaining information on permitted vehicles would be borne by the authority concerned with the approach adopted as follows.

- Quality Bus Partnership Agreement – the Local Traffic Authority.
- Contract conditions – the contracting Authority.
- Quality Partnership Schemes – the Traffic Commissioner.
- Quality Contract Schemes - the county council, unitary or Passenger Transport Authority.

2.70. Once a vehicle owner has checked with the scheme rules whether their vehicle complies or not they must be able to prove the status of their vehicle against the scheme rules. The vehicle registration mark (VRM) shown on the number plate can be used if this information is linked with the data used to verify the emissions criteria. As a supplement, a specific sticker or plate may be issued by the scheme operator following verification of a qualifying emission standard, for example certifying that an approved abatement system has been retrofitted.

2.6 Enforcement powers and penalties

Traffic and parking orders

Parking enforcement

2.71. Local authorities have long been responsible for managing all on-street and some off-street parking, whether directly or indirectly. The powers to control waiting and loading and to provide and charge for on-street parking are provided by the RTRA 1984, with various amendments since such as by the Road Traffic Regulation (Parking) Act 1986, and most recently the TMA 2004.

2.72. The Road Traffic Act 1991 significantly changed the way that on-street parking restrictions are enforced. Before 1991, the police and traffic wardens were responsible for enforcement and income from fixed penalty notices (FPNs) went to the Exchequer. However, the police service found itself increasingly unable to resource parking enforcement. The 1991 Act made it optional for local authorities (not London boroughs) to take on the civil enforcement of non-endorsable parking contraventions. When a local authority takes over this power from the police, staff employed directly or indirectly by them issue PCNs and the local authority keeps the income for operation of the scheme.

2.73. Part 6 of the TMA 2004 now provides for the civil enforcement of most types of parking contraventions. It replaces Part II and Schedule 3 of the Road Traffic Act 1991 and some local legislation covering London only. The TMA 2004 and the associated regulations have given to English authorities outside London many powers already available to authorities in London, giving greater consistency across the country while allowing for parking policies to suit local circumstances.

2.74. It is assumed that most Authorities interested in using variable parking charges to incentivise lower emission vehicles will also be those interested in taking up the powers available to them under the TMA 2004. Therefore, this guidance note is written with these latest regulations in mind and the environment of Civil Parking Enforcement that they provide.

Traffic enforcement

2.75. The TMA 2004 provides a single framework to make regulations for civil enforcement by local authorities or parking and waiting restrictions, bus lanes and some moving traffic offences. It is therefore a very important piece of legislation for Local Traffic authorities that wish to better manage their road networks and take on aspects of enforcement that may not be a priority for the Police.

2.76. Regulations under Schedule 7 to the Traffic Management Act 2004 would allow Local Traffic Authority appointed Civil Enforcement Officers the powers to monitor and penalise a range of moving traffic offences such as stopping in boxed junctions and making banned turns. This would complement civil enforcement powers already available for parking management. Powers for moving vehicle enforcement may be extended in the future for authorities in England with regulations provided by DfT. Updates are available via www.dft.gov.uk/pgr/roads/tpm/tmaportal/.

2.77. Extending civil enforcements powers would enable Highway Authorities outside London to use camera evidence of traffic contraventions. This would provide such authorities parity with those in London where legislation has enabled the adoption of civil enforcement of moving vehicle contraventions.

2.78. If powers are extended by the Schedule 7 regulations then road traffic signs described by the TMA 2004 for civil enforcement might be used to sign a zone where LEVs are incentivised. For example ‘motor vehicles prohibited’

(sign 619) can include the supplementary text 'except for permitted vehicles'. This appears sufficient to legally sign an access control scheme.

2.79. Civil penalties for moving vehicle contraventions (under TMA 2004) may be the same as currently applied to bus lane, parking and other similar moving traffic offences. Parking penalty charges are set at different bands and levels, up to £70 outside London, with discount or further charge depending when paid. It would be appropriate for a Highway Authority to consider the level of penalty charge required for effective enforcement. A supplementary local authority circular or relevant guidance is a mechanism that would enable a variation of the PCN charge in certain circumstances.

Planning obligations

2.80. Section 106 of the Town and Country Planning Act 1990 introduced the concept of planning obligations, which comprises both planning agreements and unilateral undertakings. It enables a planning obligation to be entered into by means of a unilateral undertaking by a developer as well as by agreement between a developer and a local planning authority.

2.81. Section 106(1) provides that anyone with an interest in land may enter into a planning obligation enforceable by the local planning authority. Such obligations may restrict development or use of land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically.

2.82. Section 106(5) provides for restrictions or requirements imposed under a planning obligation to be enforced by injunction,

2.83. ODPM Circular 05/2005 (issued by what was then the Office of the Deputy Prime Minister) provides existing policy on planning obligations under the Town and Country Planning Act 1990 (www.communities.gov.uk/publications/planningandbuilding/circularplanningobligations).

2.84. In the case of the Greenwich Peninsula development, the obligation to develop the LEZ aspects of the development in more detail falls on the developer, and the obligation to comply is borne by the developer and the future occupiers.

Bus-based schemes

2.85. The previously discussed legal bases for bus focussed schemes included detail on which authority would have responsibility for enforcing the scheme. In summary the responsibility for enforcement will vary.

- Quality Bus Partnership Agreements are generally non-binding documents so that the ability to force non-compliant operators to comply is weak.
- Criteria for tendered services can clearly be enforced via the contracting authority via the conditions of contract.

- The Traffic Commissioner who can prevent non-compliant operations from using the facilities provided by the authority can enforce Quality Partnership Schemes.
- Bus Quality Contract Schemes would be enforced and operated by the local traffic authority and not the Traffic Commissioner.

2.86. Note that apart from QPS the local traffic authority would be responsible for enforcement; unless the district authority also lets tendered services so that they too may have responsibility. These authorities would therefore need there to be adequate systems and resources to check the compliance of vehicles. The potential penalties involved are the withdrawal of contract and any incentives associated with this.

2.7 Vehicle detection

2.87. This section identifies the likely approaches for detecting vehicles and determining which do not comply with the criteria. For traffic or parking it is assumed that powers under the TMA 2004 for civil enforcement of both parking and moving vehicle contraventions on the public highway are available and have been taken up.

2.88. Identification of a vehicle that complies with scheme criteria could be via a paper permit, windscreen sticker, or by the VRM on the number plate. A scheme design could require the vehicle to self-identify itself, by use of a transponder or a proximity smart card.

2.89. Detection of a vehicle for subsequent identification of emission status could be carried out by a variety of methods, sometimes in combination:

- Manual methods, whereby enforcement personnel visually check vehicles travelling within or parked within the scheme area for identification marks (VRM and/or a permit/sticker). In the mainland Europe examples of LEZ the checks would tend to focus on older looking vehicles and might use a mixture of manual recording and possibly photography (see later chapter on example schemes). Some post-checking against a database of compliant vehicles would then be necessary. External identifiers of these kinds would be particularly useful to aid detection and enforcement in retrofit based schemes.
- Digital cameras and ANPR – all passing number plates are recorded and recognised using Optical Character Recognition (OCR) for matching against a database of vehicles (and their certification of an approved retrofit is necessary). A network of cameras could be installed on the key routes into/out of the boundary of the scheme and possibly at key junctions within the zone if it is very large. As a supplementary, or alternative approach, mobile ANPR cameras could be used to monitor key junctions and/or ‘hot-spots’ of possible non-compliance.
- Dedicated Short Range Communication (DSRC) – tags and beacons, more suitable for schemes with relatively few and pre-determined users, which comply with the scheme criteria. Tags or proximity smartcards are commonly issued to vehicle owners for accessing private car parks, or

can be scanned through a windscreen, and have also been used to trigger bollards which control access on the public highway.

Manual Detection

2.90. The benefits of manual detection methods are lower capital costs, and some flexibility over future operating costs if enforcement levels can be reduced. Manual enforcement is suitable for parking schemes, whether on-street parking on development sites. A drawback of manual enforcement is the limit on the number and speed of vehicles that can be checked by a person. However, existing schemes show this approach should not be ruled out.

2.91. The London Lorry Control Scheme (commonly referred to as 'The London Lorry Ban') is an example of a successful manually enforced scheme. A small team of five officers manage to cover the prescribed route network across London and actively investigate some 500-600 vehicles a month. Officers position themselves at junctions known to be attractive, but controlled, routes for HGV. In addition, they will respond to complaints from residents of vehicles 'off-route'. The main objective is deterrence and to assist HGV drivers with better route planning in order to raise compliance rates. This scheme, and those LEZ enforced manually in other European countries, indicate that manual detection could be a basis for enforcement. Detection of HDVs is likely to be more successful than LDV, as HDV are larger and less numerous.

2.92. In most urban areas of the UK it might also be anticipated that compliance by bus fleets could be detected manually due to the smaller number of operators, vehicles and layover locations.

Automated Detection

2.93. Traffic Management Act 2004 regulations currently give the power to authorities throughout England to issue PCNs for parking contraventions detected with a camera and associated recording equipment (approved device). Regulations from the Act may also be prepared for moving vehicle contraventions. Cameras can only be used by Highway Authorities in a civil enforcement environment. There is current experience of using camera enforcement within London for moving traffic enforcement, and outside London for bus lane enforcement. The Secretary of State must certify any type of device used solely to detect contraventions and once certified they may be called an 'approved device'.

2.94. The benefits of such automated enforcement systems are that high speed and volume flows of vehicles can be detected and recorded, and that every vehicle can be checked. Drawbacks can include the relative inflexibility of fixed camera systems once they are installed, and the up-front capital costs.

2.95. Automatic number plate recognition cameras can provide one part of such an automated system. They are able to capture 90%+ of passing number plates. Automatic number plate recognition cameras are used in the London Congestion Charge Scheme (CCS) and for the London LEZ. In the London CCS, images are kept for checking of vehicles whose details are not in a

database of vehicles for which a charge has been paid (or registered as exempt). In order to cover ‘hotspots’ of non-permitted vehicles within the LEZ, mobile (van-based) enforcement units could be suitable.

2.96. There will be additional options for identification and detection of vehicles entering development sites, depending on the layout and approach for managing traffic and parking. Development sites generally have a limited number of entry and exit points, and are able to use manual or automatic barriers at these and at entrances to car parks. The road network tends to discourage through-movement, and access by non-residents or visitors. These factors enable greater opportunity for checks on vehicles. Parking permit and management systems provide opportunities for further identification and detection, to verify against a permitted vehicle database.

2.97. It should be noted that it is not strictly necessary to achieve a 100% detection level for a scheme to be effective. The level of compliance, and impact non-compliance has on emission impacts, will impact on the value for money of any scheme. However, the aim should be to achieve a balance with sufficient enforcement to provide an effective deterrent, in order to achieve the scheme objectives.

3 Developing and appraising retrofit schemes

3.1. Schemes may be designed using the options introduced in the previous chapter. Local authorities will need to appraise these options to make decisions on the most appropriate and cost-effective for a scheme in their area. This chapter provides guidance on the most important aspects of appraisal in particular regarding appraising the cost-effectiveness and benefits of schemes in terms of air quality objectives.

3.2. The chapter is structured as follows.

- The overall or generic effects of schemes are defined.
- A staged approach to appraising emissions and air quality effects of scheme designs introduced. Staging the appraisal may allow a number of designs to be scoped out of the appraisal at an early stage on grounds of negligible benefits.
- The important types of capital and operating costs are introduced to allow a realistic appraisal of scheme design costs and costs to operators to be drawn up during appraisal.
- Guidance on using emissions and costs data to complete cost-effectiveness and cost-benefit appraisals is then provided.

3.1 Generic Effects of the Scheme

3.3. It is likely that retrofit schemes will have significant impacts on environmental objectives. Indeed improving the environment is a key objective of such schemes. The nature of the impacts will be scheme specific and depend on the scheme location and the scheme's impact on vehicle emissions by location and the composition of traffic. The environmental impacts of a scheme will also depend on the extent to which the scheme is combined with other measures. Table 2 describes qualitatively the potential impacts of these schemes.

Table 2: Qualitative assessment of the potential impacts of a retrofit incentive scheme

Impact	Qualitative assessment	Notes/assumptions
Inside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	True for Euro-standard based schemes. Schemes may address NO_x and PM_{10} either individually or not.
CO_2 emissions	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	-	
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	X	Costs of certification of equipment and vehicles to be considered.
Costs to operators	X	Additional operating costs or abatement equipment costs. Could be partially offset by increased passenger fares for some vehicle types
Outside scheme zone		
Pollutant emissions (NO_x, PM_{10})	✓	Compliant vehicles that use the zone are also active outside of the zone
CO_2 emissions	-	Most likely neutral or marginally negative impacts for Euro-standard based schemes
Noise	-	
Travel time	-	Assuming the same number of vehicles circulate either complying with the scheme or not
Costs to regulators	-	Potentially no regulatory costs outside of zone
Costs to operators	-	Potentially neutral operator costs if travel time impacts are neutral

Notes:
1. Qualitative assessment: ✓ symbolises a beneficial impact, x symbolises a negative impact, - symbolises a neutral impact.
2. Abatement equipment incentive schemes are potentially unlikely to have significant non-air quality impacts other than economic impacts. However, local authorities are advised to have regard to the generic guidance on the economic principles that apply when assessing these schemes. This guidance provides more detail on actions to take to assess significant non-air quality impacts.

3.2 Emissions/Air Quality Impact Assessment

3.4. Local authorities are advised to proceed through a staged process to assess the potential emissions and air quality impacts. These stages are:

- a screening stage (to identify the potential of such schemes);
- intermediate stage (consistent with LAQM methods and duties such as action planning and progress reporting);
- detailed stage (using the webTAG from DfT on appraising road transport schemes).

3.2.1 Screening assessment

3.5. The purpose of a screening assessment is to quickly assess the potential benefits of a scheme. It is intended to be simple and to use a minimum of information that is available.

3.6. At a basic level retrofit schemes are intended to upgrade older vehicles to ones with more stringent emissions standards, for example, fitting a particulate filter to a Euro II or older would convert it to being a vehicle with an equivalent Euro III emission standard or better. In these basic terms the potential benefit from a retrofit scheme is therefore associated with the reduction in unit emissions (or emission factors).

3.7. A broad assessment could proceed as follows:

1. Define a zone inside which a retrofit scheme might operate and identify those vehicle types that the scheme would seek to regulate.
2. Assemble from transport models or otherwise estimate the annual activity (veh km) of those vehicle types within the zone. One way of estimating activity is to multiply traffic volumes by link length and then to sum over all links in the zone.
3. Define a year in which the scheme may start.
4. Use the emissions factor toolkit for vehicle emissions (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) to obtain the year and vehicle type specific emission factors for NO_x and PM_{10} (g/veh km).
5. Multiply activity by emission factor to estimate the base-case emissions.

3.8. The effect of scheme depends on the emission standard set. For example, fitting particulate filters may reduce unit PM_{10} emission factors by up to 95% and SCR may reduce unit NO_x emissions by up to 65%.

1. The effect is to change the weighted emission factors for HDV types (see worked example in later section).
2. Recalculate the product of the activity and the emission factors to estimate the annual emissions with the scheme in operation.
3. The difference from the base-case is the potential emissions benefit of the scheme.
4. In combination with screening assessments of other schemes the relative attractiveness of each scheme in emissions terms can be compared.

3.9. Note that this simple approach to assessing retrofit schemes does not address potentially important effects such as the re-distribution of traffic and the contribution to emissions from congested conditions. Intermediate or detailed assessments are advised to address these issues more fully.

3.2.2 Intermediate assessment guidance

3.10. For an intermediate assessment Local authorities are advised to have regard to the related guidance documents on generic economic principles for assessment local air quality schemes. This guidance document provides background information on emissions and air quality impact assessments. In particular it sets out recommendations on:

- developing a detailed baseline emission inventory;
- potential sources of data for the inventory;
- available tools for estimating the emission impacts of transport measures;
- having regard to the technical guidance on further assessment of local air quality for assessing compliance against the air quality objectives.

3.11. The underlying principle for emissions or air quality impact assessment is to firstly define the baseline or business as usual emissions or air quality. This is the case that currently applies and would apply in future years if no additional action were taken. Once the baseline case has been defined the effects on baseline emissions and or air quality from new policies can be assessed. Emissions and air quality assessments are technical tasks. Therefore local authorities are referred to the guidance document Local Air Quality Management Technical Guidance 2008 for additional information.

3.12. Inventory should be sufficiently detailed to allow the impacts of a range of potential policies to be assessed. A detailed emission inventory allows baseline and with-policy emissions to be calculated that account for:

- the impacts of national policies such as Euro standards for vehicle emissions;
- the impacts of local transport policy on traffic growth and other actions to which the local authority is already committed including transport policies and new developments;
- road transport activity potentially disaggregated by zone and vehicle type. This allows the effects of policies that reduce activity, move its location or switch from one transport mode to another to be assessed;
- the contribution from stationary traffic. This allows policies that reduce congestion to be assessed;
- fleet numbers and ages for key vehicle types. This allows the effects of policies to promote the uptake of newer vehicles to be assessed.

3.13. By assessing the impacts of measures on the baseline emissions the local authority can then more accurately assess the potential cost-effectiveness and air quality health benefits associated with the measures.

3.14. Potential sources of data from which to develop emission inventories are summarised below:

- **Source activity**: Road transport models can provide average speed and annual average daily flow data disaggregated by road link and usually split between light and heavy duty vehicles. More detailed surveys have been used to disaggregate HDV types between buses and heavy goods vehicles. Furthermore, some traffic models also provide link specific data on the daily average time that traffic is stationary at junctions and the average length of these queues. These data are necessary to estimate the potential contribution from congestion.
- **Vehicle emission factors**:
  - The Air Quality Archive local authority emissions toolkit (www.airquality.co.uk/archive/laqm/tools.php?tool=emission) has tools that allow calculation of road traffic exhaust emissions for different vehicle categories and splits, at various speeds, and on different road types. This tool also calculates emission factors in future years.
  - Local authorities may also consider using the tool Defra has developed to be used by local authorities in calculating emissions of NO_x and PM_{10} under the new performance indicator framework (i.e. NI 194: Air quality – % reduction in NO_x and primary PM_{10} emissions through local authority's estate and operations). www.defra.gov.uk/environment/airquality/local/indicator.htm. This tool can be used to indicate the potential difference in emissions due to replacement by one vehicle type with another or due to a reduction in annual mileage.

Specific fleet inventories:

3.15. In the case of specific and relatively small fleets (such as the local authorities own fleet or commercially operating bus fleets) it is recommended that a specific fleet inventory is developed. A key reason for this is that the distribution of vehicle ages within these fleets can typically vary quite significantly from the national average age distribution. For example, the local bus fleet may be significantly older or younger than the national average. For better accuracy it is therefore recommended to list the age and abatement equipment of each vehicle. In these cases local authorities should attempt to work in partnership with commercial and other fleet operators to obtain the relevant data.

3.16. Other key factors in the inventory: To be useful as a policy assessment tool, local authorities are advised to consider including the following additional capabilities in their local inventories.

- Compliance rates. Depending on the range of regulatory approaches being considered to enforce a local measure (strong or weak) then a greater or lesser rate of compliance may be expected. If this is a significant factor then local authorities should include the capability within their inventory for assessing the emissions impact of compliance rates less than 100%.

- Compliance year (or year that the measure under consideration would come into force): Natural vehicle replacement rates mean that on average the national fleet unit emission factors decrease over time. If the compliance year is in the future then local authorities are advised to include this effects in their inventory. Otherwise the inventory is likely to overestimate the potential emissions impact of a local measure.

Air Quality Assessment

3.17. Air quality assessments use monitoring, dispersion model and Geographical Information Systems (GIS) data to assess a) where the air quality objectives are exceeded and b) whether there is relevant exposure at these locations. The methods to be used in these assessments are provided in detail in Local Air Quality Management Technical Guidance 2008 and local authorities are recommended to have regard to this guidance.

3.18. For assessing the effects of local measures it is most appropriate to consider the exercise as a formal Further Assessment i.e. this is the most detailed of review and assessment technical activities and is designed to estimate the contribution of different sources to the local air quality (source apportionment).

3.19. An appropriate further assessment allows air quality arising from baseline and with-policy cases to be calculated that account for the same criteria as those described for detailed emission inventories. By assessing the impacts of measures on the baseline air quality the local authority can then more accurately assess the potential effect on compliance with the air quality objectives associated with the measures.

Specific guidance on assessing retrofit abatement schemes

3.20. These schemes aim to change the emission factors of vehicles that circulate in an authority by promoting the uptake of retrofit abatement equipment. Therefore the emissions and air quality assessments should be designed to include the following parameters or indicators.

- Annual average daily road transport activity (veh.km) disaggregated by vehicle type and road links.
- Implementation year (so that future underlying changes in emission factors are accounted for).
- Fleet inventories (number of vehicles, their breakdown by euro standard and existing retrofit abatement equipment if relevant) for vehicle types affected by the measure.

3.21. During the design phase of a retrofit scheme local authorities should assess the effect (or range of effects) of the scheme on these indicators. In particular the effects of requiring compliance with minimum equivalent Euro standard limits (attained through retrofit) by an implementation date for specific vehicle types will be a key impact. Local authorities should include an assessment of the likely rate of compliance with the scheme, which may vary according to the ‘strength’ of the approach used to regulate the scheme. Applying these

changes to the baseline emission inventory and air quality dispersion model will estimate the potential emissions and air quality benefits of the measure.

3.2.3 Detailed assessment guidance

3.22. If assessment of the scheme proceeds to the need for a formal road scheme appraisal consistent with the NATA then local authorities should have full regard for the detailed guidance on completing these appraisals.

3.23. The full Transport Analysis Guidance can be found online at www.webtag.org.uk/. Unit 3.3.3 contains the specific guidance on local air quality assessment.

3.3 Costs Assessment

3.24. The main factors that will affect a consideration of cost and timescale for setting up and operating a retrofit scheme are the types or sub-categories of vehicles that are to be included (and any differences in standards), the size of the scheme and the level of technology used for detection and enforcement. Together these factors contribute much to the level of complexity of a scheme's design.

3.25. Typically, the greater the number of vehicle types within the scheme, the greater the number of vehicles, so set-up and running costs associated with a scheme will tend to rise. In broad terms, the size of the UK fleet rises proportionately from bus/coach to HGV to Light Goods Vehicle (LGV) (vans) to passenger cars. Therefore, a scheme which includes only HDV will tend to cost the scheme operator less than one which only includes passenger cars, all other things being equal. This does not yet take into account operator costs. This relationship fits well with the known contribution to emissions (per vehicle) that tends to show that, due to engine size and power output, each HDV produces more pollutant emission than each passenger car.

3.26. A larger scheme will tend to cost more to set up and operate, if all other factors remain equal. Hence, a small number of strategic access points that effectively controls most of the relevant cross-city traffic or parking in a historic urban area is considerably cheaper than a large city centre scheme with urban dual carriageway through-routes.

3.27. The third major factor is the level of technology used. High technology schemes, based on automatic number plate recognition cameras, will tend to have greater set-up and running costs than paper or sticker-based schemes. However, the relationships is not as simple as that because issues around detection/compliance rate mean that a scheme's more costly operating basis (i.e. technology) may be more *effective* to the extent it is actually more cost-effective. So, for example, there may be concerns about a windscreen sticker-based system working in the UK context. However, if a windscreen sticker-based system works effectively in the UK context, it will tend to be more cost-effective than one closely monitored by camera systems.

3.28. These three factors (vehicle type, scheme size and technology basis) will tend to interact with one another to produce variations in complexity, and hence cost.

3.29. Considering the various cost elements that might be relevant to any scheme, we can divide these into capital costs (i.e. set-up or investment costs) and operating costs. A list of generic cost categories is set out in Table 3 below.

Table 3: Potential cost items for retrofit scheme set-up and operation

Capital costs	Operating costs
• Scheme design and planning • Legal/ set-up costs • Consultation process • Marketing and information campaign • Traffic management / safety • Roadside equipment (signing, detection, enforcement) • Central administration and IT systems (vehicle record, certification, enquiry handling)	• Accommodation • Staff costs • Any new vehicle identification method (for example windscreen stickers) and the issuing process for this • Equipment / software replacement and maintenance costs • Supplies, services and transport • Certification of retrofit devices, suppliers and vehicles fitted with retrofit devices

3.4 Cost-effectiveness and cost-benefit Assessment

3.30. Cost-effectiveness analysis and cost-benefit analysis are both methods for economic appraisal. The Practice Guidance on Economic Principles provides more detailed information on these techniques and how to use them. This section summarises the key points.

3.31. Cost-effectiveness compares different ways of achieving the same objective. It is relevant for air quality when looking to achieve (or to make progress towards) the reduction of air quality exceedences, i.e. legally binding concentrations that must not be exceeded. However, such a cost-effectiveness analysis focuses only on one objective, and does not consider other Government environmental goals. The benefit of cost-effectiveness analysis is that it allows the relative attractiveness of different options or combinations of measures to be assessed, in order to achieve the overall objective (the removal of the exceedence) in the most cost-effective way, i.e. economically efficiently.

3.32. Cost-benefit analysis assesses whether the total benefits of a project or policy exceed the costs. It is therefore an absolute measure and can assess value for money. It quantifies costs and benefits in monetary terms, including values not captured by markets (i.e. the full costs and benefits to society). The UK Government, in its guidance for economic appraisal, favours the use of cost-benefit analysis. This is also the main part of the approach used in local transport appraisal – and has been the case for many years. Cost-benefit analysis is relevant for all air quality proposals, but especially those which are not specifically addressing an existing exceedence. The results of

a cost-benefit analysis can then be used to update the cost-effectiveness analysis to consider all environmental goals, by working with 'net' cost-effectiveness, where the capital and scheme costs are expressed net of all environmental costs or benefits, before the cost-effectiveness ranking.

3.33. Note that these two techniques can be complementary. Cost-effectiveness is part of both techniques, but in cost-benefit analysis, the analysis is extended to compare directly to the benefits of the proposals.

3.34. In order to undertake either cost-effectiveness analysis or cost-benefit analysis, it is necessary to collate and assess information on costs for use in an economic framework. It is highlighted that practitioners often confuse financial and economic appraisal. An economic appraisal considers the costs in terms of society as a whole and the overall value for money. A financial appraisal looks at the affordability of a proposal, and is more likely to be more familiar as it will be similar to local budgetary framework, financial costs and accounts (an accountancy based perspective). For any scheme, both the economic and financial case for a proposal will be important, as it will be necessary to show the wider value for money of a proposal, but also ensure that from the local authority perspective, it is affordable. However, for cost-effectiveness analysis and cost-benefit analysis, the economic assessment should be used. The Practice Guidance on Economic Principles provides more details.

3.35. In economic appraisal, all historic and future cost estimates need to be expressed in equivalent terms, so they can be directly compared. The Practice Guidance on Economic Principles provides details of how to analyse cost information so it can be used in cost-effectiveness and cost-benefit analysis. This is likely to require some analysis of cost data (including future costs). It is also necessary to work within an economic framework in the assessment of costs, which requires analysis of all costs (not just those that occur to the local authority in the local authority area), and has to exclude all transfers, such as VAT, taxes or charges. The Practice Guidance on Economic Principles provides more details.

3.36. To undertake a scoping cost-effectiveness analysis, the annual emissions benefits of a measure, as estimated using the approach set out in the previous section, are combined with the cost data, where costs are expressed as an equivalent annual costs. The annual emission benefits are divided by the equivalent annual cost to give the cost (£) to reduce one tonne of emissions (cost per tonne). This gives the cost-effectiveness of a measure – and this allows different options can be compared – those with the lowest cost per tonne abated (the lower cost per tonne) are the most cost-effective. Note that in the case of an AQMA, the relevant metric is likely to be the emissions abated in the area of the exceedence, though more accurately, it is the cost per level of air quality improvement (µg m^{-3}). However, such an analysis only considers one environmental goal, and it is also necessary to consider other environmental objectives in a 'net' cost-effectiveness analysis to correctly prioritise measures (see below).

3.37. It is also possible to use the cost-effectiveness ranking to build up an action plan towards the reduction of an exceedence. Those measures that are most

cost-effective, i.e. that achieve greatest air quality improvements for least cost should be included first in the plan. Progressively less cost-effective options are then added until the target air quality improvement is achieved, or until proportional progress towards the target can be demonstrated. Undertaking analysis in this way will also provide a total cost of compliance. Note, however, that cost-effectiveness works only with a single pollutant. To address this, it is possible to work with the 'net cost-effectiveness' to consider other environmental objectives. Moreover, the cost-effectiveness of a measure is only one element of the options, and other factors will be important in determining the overall ranking of measures, including the wider assessment, legal and technical issues, practicality and acceptability.

3.38. To undertake a cost-benefit analysis, the same information on emissions and costs is used, though there are important differences. First, the emissions benefits are expressed in monetary terms. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants, such as NO_x and PM_{10}) are estimated, along with the monetary values for other environmental effects such as greenhouse gas emissions, using the Government damage cost (the shadow price for carbon). This is used to generate the total present value of benefits, which can be compared against the total present value of costs of the options (note cost-benefit analysis works with the total stream of costs, i.e. the present value, not the annualised costs used in cost-effectiveness analysis above).

3.39. The cost-benefit analysis simply compares the present value of the stream of benefits divided by the present value of the stream of costs, to generate a net present value (NPV). The NPV is the primary criterion for deciding whether government action can be justified, i.e. whether a scheme has a positive net present value. A higher NPV indicates an option is preferable. However, other factors will be important in determining the overall ranking of measures, including any other benefits or costs, legal and technical issues, practicality and acceptability.

3.40. The cost-benefit analysis results can be used to provide a 'net' cost-effectiveness analysis. The 'net' cost effectiveness is equal to the present value of costs less present value of benefits / by reduction in tonnes pollutant, or in the above case where the cost-effectiveness analysis is concerned with air quality targets in a given year, is equal to annualised costs less annualised benefits / by reduction in tonnes pollutant (or $\mu g\ m^{-3}$). The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other environmental objectives, i.e. reductions of other air quality pollutants or changes in greenhouse gas emissions, and so provides a more holistic overall ranking method for planning.

3.41. Previous studies have looked at the cost-effectiveness and cost-benefit analysis of retofit schemes. These include for example, the Interdepartmental Group on Costs and Benefits (IGCB) Economic Analysis to Inform the

Review of the Air Quality Strategy (www.defra.gov.uk/environment/airquality/publications/stratreview-analysis/index.htm) and the London LEZ (www.tfl.gov.uk/roadusers/lez/default.aspx).

3.42. A worked example is included in the following section. A number of studies have examined the balance of costs, benefits and the effectiveness of these schemes. A consistent set of conclusions has emerged from these studies that local authorities should consider when examining these schemes for their region.

- Cost-effective schemes and enforcement are possible for small specific parts of the fleet (such as buses and taxis) but that are typically significant emitters in AQMAs. However, they are still significant in terms of operator cost.
- Regulating emissions from larger, less regulated parts of the fleet is increasingly costly, much less cost-effective and potentially provide very few local air quality benefits.
- Overall it is judged that there may be significant air quality benefits (in terms of compliance with the air quality objectives at least) in introducing schemes to retrofit abatement equipment to older diesel-fuelled HDVs (pre-Euro, Euro I, Euro II and Euro III vehicles) particularly where they undertake a significant share of the road transport activity within an AQMA or urban centre.
- However, it is much less cost-effective to apply a retrofit strategy to private cars.
- This means that authorities may currently prioritise their efforts to regulate emissions via retrofit incentive schemes in the following order of decreasing priority: buses and coaches>HGV>diesel-fuelled taxis (if significant).

4 Worked example

4.1 Introduction

4.1. To illustrate how the guidance in chapter 3 may work in practice the following worked example provides guidance on assessing emissions effects, costs and cost-effectiveness and cost benefit assessment.

4.2. This worked example assumes a policy is implemented to retrofit existing buses with abatement equipment. The example illustrates the effect of:

- varying the emission standard with which the buses must comply either targeting PM emissions or targeting PM and NO_x emissions;
- varying the year by which buses must comply (i.e. the implementation year).

4.2 Emissions assessment

4.2.1 Do minimum or baseline case

4.3. This policy would affect buses only. The first step would be to collate information on:

- number of vehicles potentially affected;
- their age (i.e. when first registered) and whether they already have abatement equipment fitted;
- planned replacement rates (i.e. how long each is expected to remain in service).

4.4. This information is best obtained from the vehicle operators and this provides an opportunity to engage with these key stakeholders at an early stage of policy development.

4.5. It is also necessary to collate estimates of the total annual vehicle kilometres travelled by these vehicles. The total can again be calculated from data supplied by operators. Note that if the policy to retrofit abatement equipment will only be enforced in a specific zone that the total annual vehicle kilometres travelled by these vehicles in that zone should be estimated. This can be estimated by multiplying the total link length on bus routes by their annual service frequency.

4.6. Note that this example will deal with a single fleet representative of all buses operating in an area but it is possible to disaggregate this fleet according to type of bus operation (commercial, contracted, etc) and/or operator. This level of disaggregation may be important depending on the enforcement approach being considered and also if there are significant differences between the fleets of different operators. An example of the collated data is shown in Table 4.

Table 4: Baseline bus data

Number of buses	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8
Euro III	72	78	53	53	53	53	49	46	46
Euro III + CRT	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90
Total number of buses	151	150	149	149	149	149	149	149	149
Total veh.km (millions) in central zone	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Total veh.km (millions)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

4.7. Note that these data illustrate:

- the ongoing effects of existing vehicle replacement policies;
- that some Euro II and Euro III vehicles already have continuous regenerating particulate traps (CRT) fitted to abate their PM emissions. Manufacturers should be consulted for information on the abatement efficiency of their equipment. In this example the abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions. Later in the example a joint PM_{10} and NO_x abatement system (using SCR to reduce NO_x emissions) is discussed. The NO_x abatement efficiency for this system is assumed to be 60%.

4.8. The next step is to calculate the trend in emission rates for the baseline case. Emission rate/speed data disaggregated by vehicle type and Euro standard are available from the National Atmospheric Emissions Inventory (NAEI) web pages. Using these rates and the data illustrated above the baseline trend in emission rates (average weighted by vehicle age and abatement equipment if relevant) can be calculated. These are presented in Table 5.

Table 5: Age and abatement-weighted emission rates at 30 kph

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83
PM (mg/km)	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63

4.9. Note that this example takes a simple view that an average speed of 30 kph is representative of bus activity. Detailed analysis should include consideration of emissions associated with bus stops, layovers and journey delays due to congestion if these are relevant to the case.

4.10. Emission rates and activity data from Table 5 are multiplied to estimate the baseline bus emissions shown in Table 6.

Table 6: Estimated baseline bus emissions

	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x emissions (tonnes) in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78
Total NO_x emissions (tonnes)	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74
PM_{10} emissions (tonnes) in central zone	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10} emissions (tonnes)	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23

4.11. Note that the estimates illustrate a decline in emissions over time due to vehicle replacement plans and more stringent Euro standards in new vehicles. In particular there is a large relative decrease in PM_{10} emissions between 2007 and 2008 due to the introduction of CRT equipment to the majority of the Euro II vehicles.

4.2.2 Estimated effect of varying the emission standard to be achieved

4.12. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting future emission standards.

4.13. From 2009 onwards there would normally be only Euro II vehicles remaining that have PM abatement fitted. If CRT abates normal PM emissions by 90% then a Euro II vehicle is in effect equivalent to a Euro IV vehicle in terms of PM emissions. Therefore only the Euro III vehicles in the fleet have a worse PM emissions performance than Euro IV whereas ALL of the Euro III and Euro II vehicles (including those with CRT) have worse NO_x emissions performance than Euro IV. A NO_x abatement system with 60% efficiency would also convert a Euro II vehicle to an equivalent Euro IV vehicle.

4.14. This discussion illustrates the point that aiming the emission standard to be achieved on one pollutant or other can have an important implication in terms of the number of vehicles affected and hence the potential emissions benefits and costs.

4.15. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur if the fleet had by 2009 to achieve:

a) an equivalent Euro IV standard for PM emissions (requires the retrofit of CRT to all the Euro III vehicles in the fleet)
b) a Euro IV equivalent standard for all emissions (requires the retrofit of CRT and SCR to all the Euro III vehicles in the fleet and SCR to all remaining Euro II vehicles in the fleet)
c) a Euro III equivalent standard for all emissions (requires retrofit of SCR to all remaining Euro II vehicles in the fleet).

4.16. The tables include a calculation of the difference in annual emissions relative to the base case.

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Criteria	Euro IV equivalent for PM									Euro IV equivalent									Euro III equivalent								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	36	36	36	36	12	8	9	45	0	0	0	0	0	0	0	9	45	0	0	0	0	0	0	0
Euro II+CRT+SCR	0	0	0	0	0	0	0	0	0	0	0	38	36	36	36	36	12	8	0	0	38	36	36	36	36	12	8
Euro III	72	78	0	0	0	0	0	0	0	72	78	0	0	0	0	0	0	0	72	78	53	53	53	53	49	46	46
Euro III+CRT	0	0	53	53	53	53	49	46	46	0	0	53	53	53	53	49	46	46	0	0	0	0	0	0	0	0	0
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90	0	11	46	48	48	48	52	84	90	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																											
NO_x (g/km)	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.83	5.19	4.67	2.96	2.95	2.95	2.95	2.88	2.67	2.63	5.19	4.67	2.96	2.95	2.95	2.95	2.88	2.67	2.63
PM (mg/km)	123.53	72.52	17.49	17.60	17.60	17.60	17.93	19.47	19.68	123.53	72.52	17.49	17.60	17.60	17.60	17.93	19.47	19.68	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	51.63
Emissions (tonnes)																											
NO_x in central zone	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.78	16.08	14.46	9.19	9.16	9.16	9.16	8.94	8.27	8.15	16.08	14.46	9.19	9.16	9.16	9.16	8.94	8.27	8.15
Total NO_x	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	12.74	23.34	20.99	13.34	13.29	13.29	13.29	12.98	12.00	11.83	23.34	20.99	13.34	13.29	13.29	13.29	12.98	12.00	11.83
PM_{10} in central zone	0.38	0.22	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.38	0.22	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.16
Total PM_{10}	0.56	0.33	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.56	0.33	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.23
Difference from Baseline (tonnes)																											
NO_x in central zone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.97	2.81	2.81	2.81	2.81	0.94	0.63	0.00	0.00	2.97	2.81	2.81	2.81	2.81	0.94	0.63
Total NO_x	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.31	4.08	4.08	4.08	4.08	1.36	0.91	0.00	0.00	4.31	4.08	4.08	4.08	4.08	1.36	0.91
PM_{10} in central zone	0.00	0.00	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.00	0.00	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PM_{10}	0.00	0.00	0.17	0.17	0.17	0.17	0.15	0.14	0.14	0.00	0.00	0.17	0.17	0.17	0.17	0.15	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.2.3 Estimated effect of varying the implementation year

4.17. The baseline bus fleet age and abatement equipment data can be analysed for realistic options for setting the year by which standards should be achieved.

4.18. In this example it is assumed that the emission standard to be achieved is a Euro IV equivalent (i.e. PM and NO_x abatement must be fitted to all Euro II and Euro III vehicles). The effects of requiring this change by 2010 and 2015 are examined.

4.19. Examining the baseline bus data table it can be seen that the 2010 compliance date will affect 89 vehicles whereas the 2015 date will affect 54 due to the natural replacement rate of vehicles over this period. Therefore the 2015 compliance date is likely to require lower costs but would also have a lesser effect.

4.20. This discussion illustrates the important point that setting an early compliance date will achieve more local air quality and emission benefits but at higher costs.

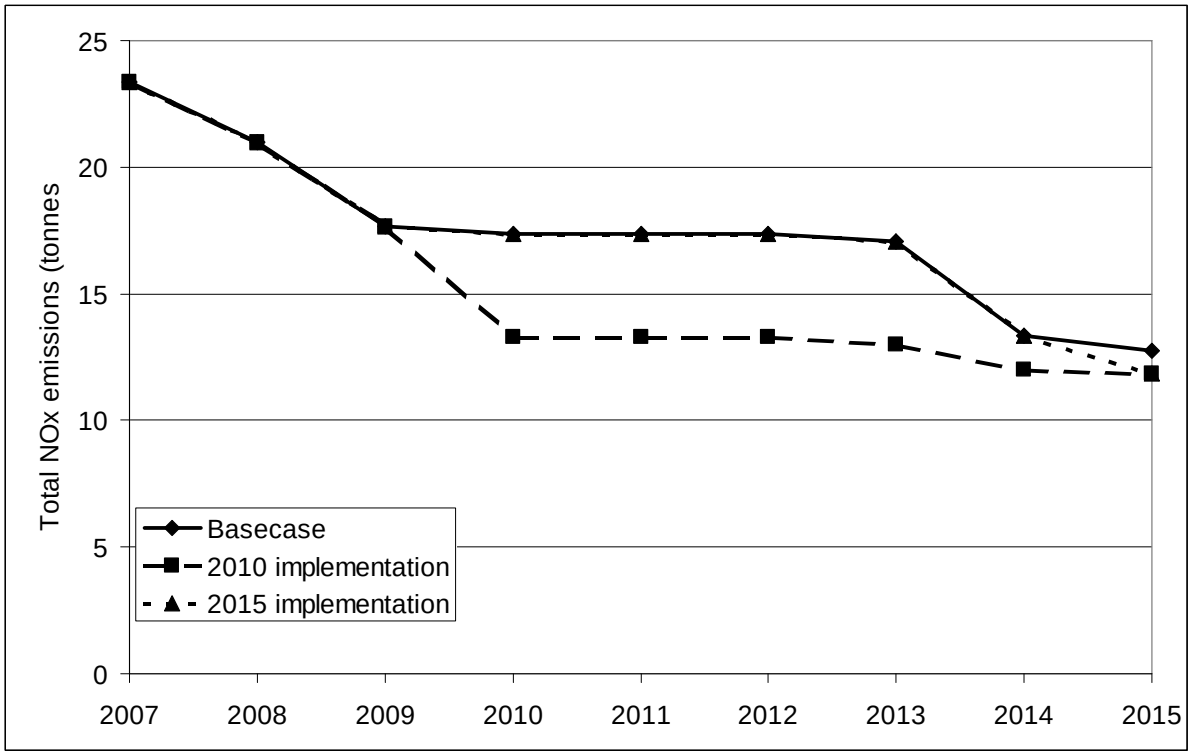
4.21. The tables below illustrate the changes to the baseline bus fleet and emissions that would occur for the examples that if the fleet complies with an equivalent Euro IV standard by:

- 2010 (requires the retrofit of CRT and SCR to all the Euro III vehicles in the fleet and addition of SCR to all Euro II vehicles in the fleet);
- 2015 (requires same interventions as above but dealing with fewer vehicles.

4.22. Figure 1 illustrates the trends in emissions due to the different implementation dates.

4.23. Key points to note in the graph are that the 2010 implementation date would deliver several years of benefits relative to the base case. However, as time passes the gap between the base case and the equivalent Euro IV standard decreases due to replacement of older vehicles. By 2014 the benefits due to the Euro IV standard is very small. The policy of requiring the Euro IV standard by 2015 would only deliver a small benefit – this policy delivers too little too late.

Figure 1: Graph of annual nitrogen oxides emissions for the base case, 2010 and 2015 implementation dates for an equivalent Euro IV standard.



Criteria	2010 Compliance date									2015 Compliance date								
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euro II	63	4	0	0	0	0	0	0	0	63	4	0	0	0	0	0	0	0
Euro II + CRT	9	45	38	0	0	0	0	0	0	9	45	38	36	36	36	36	12	0
Euro II+CRT+SCR	0	0	0	36	36	36	36	12	8	0	0	0	0	0	0	0	0	8
Euro III	72	78	53	0	0	0	0	0	0	72	78	53	53	53	53	49	46	0
Euro III+CRT	0	0	0	53	53	53	49	46	46	0	0	0	0	0	0	0	0	46
Euro IV	7	12	12	12	12	12	12	7	5	7	12	12	12	12	12	12	7	5
Euro V	0	11	46	48	48	48	52	84	90	0	11	46	48	48	48	52	84	90
Total	151	150	149	149	149	149	149	149	149	151	150	149	149	149	149	149	149	149
Emission rate																		
NO_x (g/km)	5.19	4.67	3.92	2.95	2.95	2.95	2.88	2.67	2.63	5.19	4.67	3.92	3.86	3.86	3.86	3.79	2.97	2.63
PM (mg/km)	123.53	72.52	54.30	17.60	17.60	17.60	17.93	19.47	19.68	123.53	72.52	54.30	54.41	54.41	54.41	51.97	51.42	19.68
Emissions (tonnes)																		
NO_x in central zone	16.08	14.46	12.16	9.16	9.16	9.16	8.94	8.27	8.15	16.08	14.46	12.16	11.97	11.97	11.97	11.75	9.21	8.15
Total NO_x	23.34	20.99	17.65	13.29	13.29	13.29	12.98	12.00	11.83	23.34	20.99	17.65	17.37	17.37	17.37	17.06	13.37	11.83
PM_{10} in central zone	0.38	0.22	0.17	0.05	0.05	0.05	0.06	0.06	0.06	0.38	0.22	0.17	0.17	0.17	0.17	0.16	0.16	0.06
Total PM_{10}	0.56	0.33	0.24	0.08	0.08	0.08	0.08	0.09	0.09	0.56	0.33	0.24	0.24	0.24	0.24	0.23	0.23	0.09
Difference from Baseline (tonnes)																		
NO_x in central zone	0.00	0.00	0.00	2.81	2.81	2.81	2.81	0.94	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63
Total NO_x	0.00	0.00	0.00	4.08	4.08	4.08	4.08	1.36	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91
PM_{10} in central zone	0.00	0.00	0.00	0.11	0.11	0.11	0.11	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Total PM_{10}	0.00	0.00	0.00	0.17	0.17	0.17	0.15	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14

4.2.4 Conclusions

4.24. In terms of emissions and air quality benefits the main points to be considered for any vehicle retrofit policy are as follows.

1. To set an appropriate emission standard for one or more pollutants to achieve an outcome where there are local emissions reductions relative to the base case. The higher the Euro standard the bigger the potential reductions.
2. To set an appropriate implementation year to achieve an outcome where there are local emissions reductions relative to the base case. Earlier is better.
3. To consider setting further Euro standards and implementation years (i.e. subsequent phases of emission reduction) otherwise the benefits of the policies will be eroded over time by natural vehicle replacement rates.
4. That the emission standards and implementation years have to be balanced up against issues of costs but also the level of action required to achieve the air quality objectives in the AQMA.

4.3 Cost-effectiveness and cost-benefit assessment

4.25. A simple example is given below on cost-effectiveness analysis and cost-benefit assessment for retrofit. Note that this example does not follow-on from the detailed emissions example above, it is a separate example to illustrate the concepts.

4.3.1 Cost-effectiveness analysis

4.26. The first example is to generate a simple cost-effectiveness value for retrofit options for buses. The estimated capital and running costs of abatement equipment is summarised in Table 7 below, along with the lifetime. Note that for the economic analysis, it is the resource costs (technology costs) that are used, rather than the market prices. For the financial analysis, the market prices are relevant.

Table 7: Cost input data

Equipment – heavy vehicle	Resource Costs	Annual cleaning / maintenance cost	Annual additive cost	Change in fuel efficiency	Lifetime
Diesel Particulate Filter (DPF)*	1750	240	0	0%	5 years

* source: IGCB Economic Analysis to Inform the Review of the Air Quality Strategy, based on value for articulated HGVs. Note for the analysis here, the lifetime is assumed to be five years. For the IGCB analysis, the actual lifetime of equipment was estimated at ten years. We have assumed the shorter lifetime here to reflect retirements in the fleet for older vehicles.

4.27. The costs of these individual options over their lifetime then has to be calculated, and expressed in equivalent terms, as a present value of costs. For the analysis here, we assume that the scheme starts the following year

(year 1). In each case, the costs in each year are multiplied by the discount factors, to allow the discounted costs to be estimated. The sum of these discounted costs gives the present value of costs. These are then converted to an equivalent annual cost for the cost-effectiveness analysis (using either the Equivalent Annualised Cost equation[6] , or the excel formula, see worksheet example). As an example, the values for the DPF estimation are shown in Table 8 below.

Table 8: Estimation of Present Value of Costs, and Equivalent Annual Cost

Equipment – bus (£)	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 5**
DPF capital (resource)	1,750				
DPF maintenance	240	240	240	240	240
DPF fuel efficiency change	0	0	0	0	0
Total	**1,990**	**240**	**240**	**240**	**240**
Discount factor	1.0000	0.9662	0.9335	0.9019	0.8714
Discounted cost	1,990	232	224	216	209
Present value (sum)	2,872				
Equivalent annualised cost	636				

4.28. This provides an estimate of the annualised costs of the equipment, which can be compared with the annual tonnes abated. For the DPF, an abatement efficiency is assumed to be 90% effective in terms of PM emissions and to have no impact on NO_x emissions.

4.29. The annual emissions benefits are based on buses driving in urban conditions, 30 kph, are shown below from the NAEI webpages. We assume each bus drives 20,000 km a year in the central zone. If it is assumed that there is a flat 90% removal efficiency across all vehicle types and Euro standards, then the cost-effectiveness is determined by the equivalent annual cost above, divided by the annual emissions reduction. The values are first shown for the DPF. As expected, the cost per tonne increases as progressively more modern vehicles are targeted. Note implicit in this assumption is that the equipment will be functional for the potential lifetime (for DPF, five years). For older vehicles, the vehicle lifetime might be shorter, so the capital cost above are spread over less years of operation, and the equivalent annual cost will rise and the cost-effectiveness will fall.

4.30. This shows the general finding that it is more cost-effective to target older vehicles (subject to the caveat about vehicle operating lifetimes). Indeed, it shows that the cost-effectiveness drops very dramatically when targeting

[6] Equivalent annualised cost = NPV multiplied by

$$\left[\frac{r(1+r)^n}{(1+r)^n-1}\right]$$

where r is the discount rate (3.5% in the UK, i.e. 0.035) and n is the scheme length in years.

Euro IV vehicles (the costs per tonne rise by a factor of five), showing it is not cost-effective to target this part of the fleet.

Table 9: Cost-effectiveness Analysis Diesel Particulate Filter

	Emissions gPM_{10}/km	PM_{10} t / yr in central zone	PM_{10} abated /yr at 90% effic.	Annualised costs	cost per tonne
Euro II	0.194	0.00387	0.0035	614	£176,242
Euro III	0.139	0.00279	0.0025	614	£244,781
Euro IV	0.029	0.00058	0.0005	614	£1,174,947
Euro IV+	0.029	0.00058	0.0005	614	£1,174,947

4.31. It would be possible to compare to other technologies, such as EGR or SCR (plus DPF) and compare the cost-effectiveness of options using the same approach. However, for some options, for example SCR + DPF, some equipment abates both PM and NO_x emissions. A cost-effectiveness analysis can only take one pollutant into account at a time (this is one of the problems with cost-effectiveness). It is possible to address this by estimating **'net' cost-effectiveness** of options to correctly prioritise measures taking other objectives into account (see below).

4.32. The overall benefits of an option (for example, across pollutants) can also be assessed using cost-benefit analysis, and this highlights the complementary role for using the two approaches together.

4.3.2 Cost-benefit analysis

4.33. The first stage in a cost-benefit analysis is to estimate the monetary value of the benefits.

4.34. The valuation of emission benefits can be undertaken using the Defra damage costs, which give the benefits in (£) per tonne of pollutant reduced, using the Defra damage cost spreadsheet, available at www.defra.gov.uk/environment/airquality/panels/igcb/guidance/index.htm. The benefits in each year over the scheme lifetime are used (rather than the benefits in one year), and the total monetary benefits of all pollution benefits (for multiple pollutants) are estimated.

4.35. As an example, the values for annual PM emissions from a DPF on a Euro II bus was shown above. However, in this case, it is necessary to look at the full benefits of the scheme (the full value to society) rather than the benefits that only occur in the central zone. For this, it is assumed that the bus also has an annual mileage of 30,000 km in the outer zone of the city. Note that for PM_{10}, it is important to consider the location of the emissions benefits, as these affect the values (for NO_x, all emission benefits are valued the same, irrespective of location). The total benefits are therefore shown in Table 10.

Table 10: Benefits Diesel Particulate Filter

Euro II	Emissions gPM_{10}/km	PM_{10} Tonnes / year	PM_{10} Tonnes abated /yr at 90% effic.
Central zone	0.194	0.00387	0.0035
Outer zone	0.194	0.00581	0.0052

Assumes 20,000 km/year central zone and 30,000 km/year outer zone.

4.36. The values are then entered in the damage cost calculator. In this case, we assume:

- a 2008 start date;
- a five year lifetime;
- The central zone corresponds with area location 12 – inner conurbation;
- The outer zone corresponds with area location 13 – outer conurbation.

4.37. The spreadsheet outputs are shown below. Note in this case, even though we have PM_{10} emissions, because we need to assign different monetary values, we have to separate the central and outer emissions and treat them as two separate pollutants. The two PM calculation sheets are shown below.

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*12*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00349	0.00349	0.00349	0.00349	0.00349		

CALCULATED RESULTS		
Central Estimate Present Value	£ 0.00	Million
	£ *1,966*	

Estimated Range	£ 0.00	-	0.00	Million
	£ *1,537*	-	*2,231*	

1. What length (in years) is your policy appraisal?	5
2. What is the base year for the appraisal?	2008
3. What pollutant are you assessing? (click box to select from drop-down menu)	*13*
4. Input the annual changes in emissions below (in tonnes)	

Year	*2008*	*2009*	*2010*	*2011*	*2012*		
Change in emissions (tonnes)	0.00523	0.00523	0.00523	0.00523	0.00523		

CALCULATED RESULTS		
Central Estimate Present Value	£ 0.00	Million
	£ 1,832	

Estimated Range	£ 0.00	-	0.00	Million
	£ 1,433	-	*2,080*	

4.38. These are added together (£1,966 + £1,832) to give a total central estimate of £3,798 present value of benefits.

4.39. This can be compared against the present value of costs in the earlier table, which were £2,872. This shows the option has a positive NPV. A similar analysis could be undertaken with other equipment, importantly comparing equipment that reduces PM and NO_x and estimating the total benefits across pollutants. The option with the highest NPV is preferable.

Table 11: Cost-Benefit Analysis Results

Equipment - bus	Present Value Benefits	Present Value Costs	Net Present Value
DPF	3,798	2,872	+ 926

4.40. The same approach can be used to build up the analysis of cost-effectiveness analysis and cost-benefit analysis for entire schemes, as with the emissions benefit example above.

4.41. The information from a cost-benefit analysis can also be used to consider other environmental objectives as part of a 'net' cost-effectiveness analysis. For the case of air pollution, where we are concerned with achieving air pollution targets in a given year, this is estimated from the estimation of annualised costs less annualised benefits / by reduction in tonnes pollutant. The advantage of this 'net' cost-effectiveness assessment is it allows consideration of other air quality pollutants, and greenhouse gas emissions, in the cost-effectiveness ranking and so provides a more holistic overall ranking method. For the example above, the Present Value of benefits has to be first expressed as an equivalent annual term. It can then be compared to the equivalent annual costs, and to emissions improvements, to estimate the net cost-effectiveness. The advantage of this approach is it allows multiple pollutants (for example NO_x and PM_{10}) benefits to be taken into account when undertaking the cost-effectiveness ranking between options.

Table 12: 'Net' Cost-Effectiveness Results

Equipment - bus	Annualised Costs	Annualised Benefits	'Net' Cost-effectiveness
DPF	£636	£841	-£58,853

5 Examples of retrofit schemes

5.1. The purpose of this chapter is to provide key information on existing or planned retrofit schemes. This includes a brief description of how key implementation and enforcement issues are addressed in these schemes and also a wider discussion of these issues.

5.2. Traffic control schemes are common in UK towns and cities. Linking a variety of access control schemes on sections of the public highway builds up the overall traffic management approach in many city and town centres. A small number of such traffic control schemes in the UK have either been designed to include emission criteria or have been examined for such a modification, and are therefore can be considered examples of retrofit incentive schemes.

5.3. A selection of relevant schemes includes:

- buses and coaches: Quality Bus Partnerships and voluntary action in Oxfordshire among others, London Bus scheme;
- heavy Goods Vehicles: the London LEZ among others;
- taxis (Hackney Carriages): London scheme;
- cars: large scale retrofit of the car fleet is not considered cost-effective currently and is not considered in this guidance note.

5.4. These schemes achieve their emission objectives either by applying regulatory or access controls or charges to more polluting vehicles and discounts to less polluting vehicles. Key summary information on the schemes is provided in Table 13 whereas more detailed information is found in the following text sections.

Table 13: Summary of key information on example schemes in this guidance

Scheme	**Basis**	**Area**	**Vehicles**	**Standards (retrofit/incentives)**	**Enforcement**	**Management of permitted vehicles**	**Comments** (Strengths/weaknesses)
London bus emission strategy	Transport for London specifications	Greater London	London Bus fleets	Minimum of Euro II plus particulate filter and moving to diesel-electric hybrid vehicles in the future	Transport for London		QPS or quality contract schemes are needed outside London to exert a similar level of control over commercial services
Oxfordshire	QBPA	Oxford City	Bus fleets	Under review	Under review		A range of approaches may be necessary to regulate emissions from all relevant bus fleets
London - LEZ	Charge	Greater London	HDV (HGV, Coach etc), with heavy vans to be added later.	From 4th February 2008, a standard of Euro 3 for PM for lorries over 12 tonnes Gross Vehicle Weight (GVW), and buses and coaches over 5 tonnes GVW. From July 2008, a standard of Euro 3 for PM for lorries between 3.5 and 12 tonnes, buses and coaches From October 2010, a standard of Euro 3 for PM for larger vans and minibuses From January 2012, a standard of Euro 4 for PM for lorries over 3.5 tonnes GVW, buses and coaches over 5 tonnes GVW.	Large network of ANPR cameras. Penalty for non-compliance and non-payment is £500/£1000 depending vehicle size.	Compliant vehicles self-registered via number plate and DVLA records. Non-standard cases and retrofit vehicles required to register vehicle, and retrofit vehicles inspected annually by VOSA. Daily charge (£200 or £100, depending on the size/type of vehicle) for vehicles who do not comply. Retrofit for PM possible.	Phased approach to ensure tightening emission standards.
London Taxi emission policy	Public Carriage Office (PCO) licence conditions	Greater London	Hackney carriages	Euro 3 emission standard by July 2008	Licensing conditions		Scheme allows operators to charge extra fares to cover cost of upgrades. Significant administration to certify upgrades.

Buses and coaches

Oxfordshire

5.5. Oxfordshire is reviewing the costs and effects of introducing an emissions protocol into a QBPA (and other approaches to regulating emissions from commercial bus fleets). Any regulatory approach is likely to remain technology neutral meaning that emission reductions may be achieved via retrofits or vehicle replacement. Also within Oxfordshire, the Oxford Bus Company has placed air quality and emission control centrally within its commercial strategy. It has undertaken a benchmarking exercise to ensure that its fleet is among the best in the UK in controlling PM, NO_x and other emissions. All vehicles have CRTs retrofitted as a minimum requirement and the fleet average age is currently six years old and vehicles are now replaced by ones that are Euro V standard or better.

London

5.6. The London Bus Emission Strategy is a long term programme of bus upgrading in part to improve the fleet's emissions performance. As at March 2007 there were 8181 vehicles in the fleet. In advance of the London LEZ going operational the fleet was improved mainly via emissions abatement retrofits (further information on the London LEZ can be found in Chapter 5 of the Practice Guidance for LEZs). As a result the fleet contained 36% Euro II vehicles plus particulate filters, 61% Euro III vehicles plus particulate filters and 3% Euro IV vehicles with in-built SCR or EGR NO_x abatement.

5.7. Compared to the fleet as it was in 2000 TfL has estimated that emissions of PM_{10}, CO and hydrocarbons has been reduced by 90% as a result of the particulate filter policy. Nitrogen oxides emissions are assessed to have been largely unchanged but one negative effect of the filters is an increase in the proportion of NO_x that is emitted as NO_2 as has been noted previously in this guidance.

5.8. In addition to local pollutant emission reductions the London bus fleet priority is also to reduce carbon emissions. As a result there are now strategies to replace conventional diesel powered vehicles with diesel-electric hybrid vehicles in the short to medium term. These technologies are already under trial in London and are predicted to result in further reductions of local pollutant emissions and NO_x emissions in particular. Further information on LEVs can be found in the Practice Guidance on uptake of LEVs.

Heavy Goods Vehicles

London – Low Emission Zone

5.9. The London LEZ started operation in 2008. The aim of the scheme is to improve air quality in the city by deterring the most polluting vehicles from driving in the area. The vehicles affected by the LEZ are older diesel-engine HDVs including lorries, buses, coaches, large vans, minibuses and other heavy vehicles that are derived from lorries and vans, such as motor caravans and motorised horse boxes. Cars and motorcycles are not affected by the scheme. As a result, the scheme tends to target heavy diesel-powered

vehicles, thereby prioritising PM reduction. The largest number of vehicles that will potentially be affected in the first phase of the scheme are HGVs .

5.10. The LEZ commenced on 4 February 2008 for lorries over 12 tonnes, with different vehicles affected over time and tougher emissions standards due to be introduced in January 2012.

5.11. The London LEZ emission standards describe the minimum Euro standard which vehicles must meet to be exempt from a charge. Meeting these emission standards can be done by using a vehicle whose engine was type approved to this standard (or better) or by retrofitting exhaust after-treatment technology to raise the emission standard. The standards by vehicle/weight and timescale are as follows.

- From 4 February 2008, a standard of Euro III for PM for lorries over 12 tonnes.
- From 7 July 2008, a standard of Euro III for PM for lorries between 3.5 and 12 tonnes and buses and coaches over 5 tonnes.
- From 4 October 2010, a standard of Euro III for PM for larger vans and minibuses.
- From 3 January 2012, a standard of Euro IV for PM for lorries over 3.5 tonnes and buses and coaches over 5 tonnes.

5.12. The important point to note is that defining compliant vehicles in these Euro standard terms is in effect technology neutral. Operators are free to choose between vehicle replacement and retrofit using one of the approved technologies on the market. Depending on the age and use of the vehicle it may be much more cost-effective to choose a retrofit strategy over a vehicle replacement strategy.

5.13. The London LEZ actually operates as a road charging scheme. The important differentiator is that polluting vehicles are not banned from entering the London LEZ, they simply incur a discouragingly high charge to enter or their drivers risk a penalty if they do not pay. It was set up using a Scheme Order, which is the same legal basis as the London CCS. However, it is not a congestion charge as the objective is not to reduce traffic levels.

5.14. The London LEZ began operation in 2008 and there has not yet been an ex-post analysis made of the scheme impacts. Transport for London has planned a work programme that will undertake this analysis and it is expected that results will be made public in due course. The scheme has been scrutinised closely during its development and a recent TfL analysis of the potential impacts of the scheme[7] found the following. The LEZ is anticipated to produce significant air quality benefits both within and beyond the LEZ boundary. In 2008 the scheme is expected to reduce the area of Greater London that exceeds the daily PM_{10} limit by 7% and by 15% by 2012. By 2010 the scheme is expected to reduce the area of Greater London that exceeds the annual mean NO_2 limit by 4% and by 16% by 2012. Health benefits associated with these changes are estimated to be £170-250 million

[7] TfL (2007). Report to the Mayor following consultation with stakeholders, businesses, other organisations and the public on the Scheme Order 2006.

due to predicted reduction in illness and extended life expectancy (years of life gained).

5.15. Information on a wide number of other current and planned low emission zones across Europe can be found via the EU-wide LEZ Network (www.lowemissionzones.eu). The web site provides information about network members' schemes and is a mechanism for members to publicise access restrictions on a pan-Europe basis.

Taxis and Private Hire Vehicles

London

5.16. The Public Carriage Office (PCO) of TfL administers the Emission Strategy for London Taxis. Under the scheme all taxis must meet Euro 3 emission standards for NO_x and PM_{10} by July 2008. Pre-Euro, Euro 1 or Euro 2 vehicles presented for annual licensing inspection from July 2007 onwards were required to have fitted either approved emission reduction equipment or an approved conversion to run on an alternative fuel. Approved emission reduction equipment and fitters have been published by TfL. Impacts of costs of abatement equipment have been partially subsidised by the temporary addition of a £0.2 environmental fee per journey. Prior to the strategy the London taxi fleet was estimated to be responsible for 12% of NO_x and 24% of the PM_{10} from road transport emissions in central London. More information on the scheme can be obtained at www.tfl.gov.uk/businessandpartners/taxisandprivatehire/1414.aspx.

6 Conclusions

6.1. A range of schemes have been and could be developed by local authorities to directly influence the emission standards of vehicles downward in sensitive areas on the public highway or private land. Retrofits have been almost exclusively applied to HDVs and there remain significant benefits in many cases to reducing the emissions of pre-Euro III HDVs in the short to medium term but in the medium to long term focus should shift to reducing the emissions of pre-Euro IV or V HDVs. For these vehicles there are a range of proprietary PM and NO_x abatement systems.

6.2. Existing schemes have been implemented by a wide variety of approaches illustrating the large number of options available to local traffic authorities to introduce an element of emissions control into their policies regardless of vehicle type.

6.3. At the voluntary level authorities can encourage the uptake of retrofits via QBPS. The authority can do much to facilitate uptake providing adequate facilities for bus services. The success of such approaches will necessarily rest on the efforts to engage with the vehicle operators in a detailed and constant manner.

6.4. If voluntary approaches are not realistic then there is a range of methods to encourage or compel the uptake of retrofits.

6.5. Traffic and parking restrictions can be developed into schemes by the Highway Authority, and development control schemes by Planning Authorities. So far the LEZ Scheme is the most developed UK instance of controlling emissions via traffic access restrictions but smaller schemes of these types are being considered in other areas of the UK.

6.6. Traffic access restrictions may be the only practical approach to manage emissions from HGVs (and could be used to manage all vehicle types) unless significant traffic could be regulated via development control schemes. The Greenwich Peninsula scheme is a good example of attempting to manage emissions from these vehicles as far as possible. These schemes tend to be focussed on city and town centres, where land-use is dense, traffic is heavy and population exposure is high. There is the highest value in such areas from restricting, discouraging or deterring the use of more polluting vehicles. Small areas, road networks with limited access points, and areas with existing traffic restrictions (for example pedestrian zones) provide the scope for adding emission criteria components at lower cost than areas without, and if air quality assessments justify it can be the most cost-effective areas to tackle first.

6.7. For buses a number of approaches are necessary since bus and coach services are supplied under a variety of commercial, contracted and ad hoc models. The options for regulating emissions of commercial services are changing with the advent of the Local Transport Bill. Once regulations under this are produced there should be an improved route to including emissions based criteria within Quality Partnership and Quality Contract Schemes.

Emissions based contract conditions could and are being included now for contracted services in some local authorities.

6.8. Since many buses undertake a large proportion of their activity in urban centres (and by extension within many AQMAs) and since there are still many Euro III or older vehicles in fleets, local authorities are strongly encouraged to fully explore all of the available voluntary and regulatory options to manage emissions from these vehicles.

6.9. Within scheme design and appraisal the environmental objectives of the scheme are a key consideration. Source apportionment should be used to determine which vehicles and which pollutants are the most relevant to target and to determine the cost-effectiveness of various options.

6.10. From existing examples, the most common vehicles to target in a scheme with enforceable restrictions are HDVs (and bus fleets in particular) due to their cost-effectiveness relative to schemes that would restrict other vehicle types. The worked example in this guidance illustrated the key points that the scheme should aim to regulate emissions to a sufficiently high standard and early enough to produce benefits over and above the business as usual case. Between now and 2010-2012 a Euro III standard should be considered as the minimum standard for LEZ schemes. From 2010-2012 then higher standards should be considered. Following this recommendation is predicted to produce three to four years of benefits, albeit diminishing. However, local authorities will need to consider their own case, costs and benefits when setting emission standards and compliance dates.

6.11. Similar standards within a country are useful, but not essential to setting up and operating schemes. Emissions standards described in technology neutral terms will be important if it is intended that operators will be able to comply via a retrofit strategy rather than a vehicle replacement strategy. A common framework, with cities free to choose the level of standard within it forms a possible model (seen in Germany). A common set of standards across all vehicles, with authorities choosing which vehicles from the framework to include in their scheme and how to enforce it, might provide another model. When choosing standards, co-operation between neighbouring authorities can be useful, to harmonise standards and reduce competition between those with schemes and those without.

6.12. The most common toxic pollutant to target is PM, shown by schemes that include LDV setting standards that are more difficult for diesel vehicles to meet. It is likely this is due to a number of factors:

- Heavy Duty Vehicles produce higher levels of emissions than lighter, smaller engined vehicles;
- the options for retro-fitting HDV are better developed and more cost-effective given the cost of PM abatement equipment compared to NO_x abatement, cost of retrofitting as a proportion of HDV value, and the potential reduction in overall level of emissions (compared to a LDV);
- a scheme that encompasses more vehicles will generally be more costly to set-up and administer, therefore in value for money terms it is more cost effective to target those vehicles with the highest overall emission

contribution first (for example bus fleets with large urban centre activity), which is also where any grants or subsidies for retrofitting should be aimed;
- diesel vehicles tend to produce higher levels of PM emissions than the equivalent petrol vehicle, and reduction in PM emission generates significant levels of health benefits.

6.13. The most effective methods of managing permitted vehicles (for traffic, parking or development control schemes) will be to use existing systems and sources of information as far as possible. Unfortunately, existing systems will probably not provide a complete solution and the example LEZs showed that new systems and processes were required (see Practice Guidance on LEZs). Taking a practicable approach to completing gaps in information, and making the scheme as straightforward as possible for the user is recommended. There may need to be some trade-off between the optimum operation of a scheme (for emission reduction and cost) against ease of use and acceptance. The examples of QBPA illustrate that management solutions need not be complex.

6.14. Given constraints on revenue budgets a scheme which has low operating costs will tend to be more attractive from a whole-life cost viewpoint. However, this needs to be carefully balanced against the resulting level of compliance by users with the scheme emission standards, or the purpose and value of the scheme is undermined.

6.15. Planning condition and obligation schemes can have significant potential for specific locations. The cost of designing and operating a planning condition and obligation scheme can be borne by the developer. A scheme can apply to both construction and operational phases of a development, with obligations passed onto future occupiers. Such an approach provides a useful method of incorporating vehicle specific environmental criteria into planning decisions.

6.16. The assessment of emissions, air quality, cost-effectiveness and cost-benefits of such schemes may be a necessary task in order to develop the evidence to allow decisions on such schemes to be determined. This is particularly true of schemes with either significant costs or ones that affect many vehicle operators. The guidance makes it clear that existing capacity and tools to assess emissions and air quality may have to be supplemented with specific local data to improve the accuracy of assessments. Local authorities that wish to consider schemes are therefore encouraged to plan their data and assessment needs in advance of any stage where the costs and benefits of different scheme options are to be assessed.

Appendix 1: Glossary

ANPR	Automatic number plate recognition
AQMA	Air Quality Management Area
CCS	Congestion Charge Scheme
CO	Carbon monoxide
CO_2	Carbon dioxide
CRT	Continuous regenerating particulate traps
Defra	Department for Environment Food and Rural Affairs
DSRC	Dedicated Short Range Communication
DfT	Department for Transport
EA 1995	Environment Act 1995
EGR	Exhaust Gas Recirculation
FPN	Fixed Penalty Notice
GIS	Geographical Information Systems
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IGCB	Interdepartmental group on costs and benefits
LAQM	Local air quality management
LDV	Light Duty Vehicle
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
LGV	Light Goods Vehicles
NAEI	National Atmospheric Emissions Inventory
NATA	New Approach to Transport Appraisal
N_2	Nitrogen
NH_3	Ammonia
NO	nitric acid or nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen or nitrogen oxides
NPV	Net Present Value
OCR	Optical Character Recognition
PCN	Penalty Charge Notice
PM_{10}	Particulate matter smaller than 10 microns
QBPA	Quality Bus Partnership Agreement

QPS	Quality Partnership Schemes
QC	Quality contracts
RPC	Reduced Pollution Certificate
RTRA 1984	Road Traffice Regulation Act 1984
SAFED	Safe and Fuel Efficient Driving
SCR	Selective Catalytic Reduction
TfL	Transport for London
TMA 2004	Traffic Management Act 2004
TRO	Traffic Regulation Order
VED	Vehicle Excise Duty
VRM	Vehicle Registration Mark
WebTAG	Web-based Transport Analysis Guidance