Department for Transport

Concessionary travel for older and disabled people: guidance on reimbursing bus operators (England)

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1. Introduction

1.1 A mandatory bus concession for older and disabled people has been in place since 2001. The concession has gradually been extended since its introduction and since April 2008 has provided free off-peak local bus travel to eligible older and disabled people anywhere in England.

1.2 The mandatory bus concession is administered locally by Travel Concession Authorities (TCAs). The following authorities are TCAs: County Councils, Unitary Authorities, Passenger Transport Executives, and London Boroughs.

1.3 In addition to the mandatory bus concession TCAs are also able to offer discretionary concessionary travel schemes.

1.4 Provision for travel concessions in England is at present contained in five separate pieces of primary legislation: the Transport Act 1985, the Greater London Authority Act 1999, the Transport Act 2000, the Travel Concession (Eligibility) Act 2002 and the Concessionary Bus Travel Act 2007. The reimbursement of bus operators by TCAs for carrying concessionary passengers is governed by European regulation No 1370/2007 as well as domestic legislation.

1.5 This guidance is solely concerned with how TCAs in England reimburse bus operators for concessionary travel in accordance with the legal requirements. The Department intends that this guidance will assist TCAs in their compliance with legal requirements, in particular European regulation No 1370/2007. This guidance supersedes previous guidance published on reimbursement.

1.6 This guidance applies to schemes commencing on or after 1 April 2021.

1.7 This guidance has been informed by an extensive programme of research by the Institute of Transport Studies (ITS). Representatives of local government and bus operators have been consulted and their views have been taken into account by the Department during the development of this guidance. The contents of the guidance, however, represent the considered views of the Department alone. Guidance on reimbursement will continue to be improved in the future as new evidence becomes available.

1.8 TCAs and Bus Operators should also note the provisions of the Travel Concession Schemes Regulations 1986 (under the Transport Act 1985) and the Mandatory Travel Concession (England) Regulations 2011 (under the Transport Act 2000). Both sets of regulations set out the framework for reimbursement arrangements and the appeal process.

1.9 This guidance is designed to provide pragmatic advice on calculating appropriate reimbursement for bus operators. It does not seek to be a definitive interpretation of the law, which is ultimately a matter for the Courts. It applies only to England (including London for the purposes of reimbursement of non-London Bus Network Services[1]).

1.10 The methodology set out in this guidance represents the Department for Transport's preferred approach for calculating reimbursement. TCAs are free to use the methodology of their choice in estimating reimbursement subject to ensuring compliance with European regulation No 1370/2007 as well as relevant domestic legislation that governs concessionary travel reimbursement. While the Department for Transport has drafted this guidance to be wholly consistent with legal requirements pertaining to the compensation payable to bus operators, in specific certain circumstances it may be appropriate to deviate from it in order to give effect to the 'No better, no worse off' principle. We strongly encourage TCAs to discuss reimbursement arrangements with their local bus operators at the earliest opportunity.

1.11 In determining appeals by bus operators, the Secretary of State (or decision makers appointed on his behalf) will apply the law relating to the compensation of operators. The Secretary of State will be guided by the DfT reimbursement guidance but will also consider any additional evidence brought forward by parties when determining appeals.

1.12 The guidance sets out:

- The legislative background;
- The appeal process;
- Background to reimbursement principles;
- Advice on how to estimate the revenue forgone and additional costs;
- Background to the theoretical framework for reimbursement, including a summary of the available research evidence;
- Information on the calculations in the Department for Transport's Reimbursement Calculator through worked examples.

1.13 If you want to discuss reimbursement guidance with other local authorities please register with the Knowledge Hub at: htttp://www.khub.net and then join the concessionary travel group at: https://www.khub.net/group/concessionarytravelengland.

[1] Arrangements for compensating Transport for London (TfL) for the cost of the statutory concession on the London Bus Network are negotiated between London Councils and TfL.

1.14 Alternatively, if you have any comments, suggestions or questions about reimbursement you can contact the Department directly at: concessionaryfares@dft.gsi.gov.uk.

2. Legislative Background

The Legislative Framework

2.1 Travel Concession Authorities (TCAs) are required to implement the mandatory travel concession as set out in the Transport Act 2000 and the Greater London Authority Act 1999, both of which were amended by the Concessionary Bus Travel Act 2007. The mandatory travel concession guarantees free off-peak local bus travel to eligible older and disabled people anywhere in England[2].

2.2 In addition to the mandatory bus concession, TCAs are also able to offer discretionary concessionary travel schemes, using the powers provided in the Transport Act 1985.

2.3 TCAs are required by law to reimburse bus operators for carrying concessionary passengers. In respect of the mandatory concession, TCAs must reimburse bus operators for all concessionary journeys starting within their boundaries, regardless of whether the concessionary passholder making the journey is resident in the TCA area.

2.4 In addition to the UK legislation governing concessionary travel schemes, TCAs are obliged to comply with European regulation No 1370/2007, which sets out the overarching rules for reimbursement of public service obligations and places a duty on TCAs to ensure that bus operators are neither over- nor under-compensated. Concessionary travel schemes are considered to be public service obligations. A copy of the Annex to the Regulation (EC) 1370/2007, which sets out the compensation rules, is included at Annex A to the guidance.

2.5 In both the Transport Act 1985 and the Transport Act 2000 there is provision for bus operators to apply to the Secretary of State for modification and in the case of schemes established under the Transport Act 1985, cancellation of the arrangements of the TCA, if they consider that there are special reasons why the arrangements would be inappropriate.

The Mandatory Concession

2.6 The provisions of sections 149 and 150 of the Transport Act 2000 apply in determining how operators are to be reimbursed in respect of the

[2] Free local bus travel anywhere in England between 9.30am and 11pm on weekdays and at anytime at weekends and bank holidays.

mandatory concession. The Mandatory Travel Concession (England) Regulations 2011 make provision for the reimbursement arrangements between Travel Concession Authorities and bus operators. A summary of the timetable for agreeing reimbursement arrangements as set out in the Transport Act 2000 is provided in the table below.

Table 2.1 Mandatory concession timetable			
Final dates for action (where X = date of scheme commencement/ variation)	X minus 4 months	X minus 28 days	X plus 56 days
Required process for the mandatory concession	TCA to publish reimbursement proposals in as much detail as possible to allow for meaningful negotiation. (Transport Act 2000, section 150(1))	TCA to determine final reimbursement arrangements (Transport Act 2000, section 149(2))	Last date for bus operators to appeal to the Secretary of State. Prior notice must be given to the TCA. (Transport Act 2000, section 150(4) and 150(5)

Discretionary Enhancements

2.7 In addition to the mandatory bus concession, TCAs are also able to offer discretionary concessionary travel schemes, i.e. schemes which go beyond the statutory minimum in one or more respects under the provisions of the Transport Act 1985. This does not necessarily require a separate scheme to be created; a scheme which offers benefits which include but are more generous than the statutory minimum will at the same time fulfil any obligation to ensure that the statutory minimum is provided.

2.8 The proposed arrangements for discretionary concessionary travel schemes should be published by the TCA at least 28 days before the scheme commences. It should be clear to operators from the published details what concessions they will be required to offer and the timing and amount of reimbursement that they can expect to receive to cover their revenue forgone and any additional costs incurred.

2.9 The Transport Act 1985 permits the service of a Participation Notice upon an operator who does not wish to participate voluntarily in a travel concession scheme made under that Act (a "section 93 scheme").

2.10 The operator may lodge an application to the Secretary of State regarding the Participation Notice if he feels that there are special reasons why his participation would be inappropriate, or if he considers that any details of the scheme or the reimbursement arrangements are inappropriate. Any such applications must be made no later than 56 days from the date the obligation to participate commences (or in the case of a new service from the date that the service is due to begin). TCAs can request a specific period of notice (of at least seven days) if an operator intends to appeal.

2.11 If, under section 97(2) of the Transport Act 1985, a TCA wishes to be in a position to serve a Participation Notice in the event of the operator indicating that he was not prepared to accept a Variation to the Scheme, then the Authority should allow a period of at least 56 days plus any time required for the delivery of notices between the issue of a Variation Notice and the date on which the Variation is due to take effect. This would allow 28 days for operators to respond to the Variation notice, and a further 28 days for the TCA to serve a Participation Notice.

2.12 When establishing what, if any, local enhancements to offer, TCAs need to consider how the reimbursement arrangements will work in practice and the potential impact on additional cost claims by operators. This is particularly important when the add-on involves a right to travel free, or at a concessionary rate, outside of the TCA's boundary (for example, cross-boundary travel before 9.30am on weekdays). It is important that in such situations there are clear and transparent arrangements in place with the neighbouring TCAs for reimbursing the local bus operators.

2.13 Ideally, bus operators should be able to claim reimbursement from the same TCA for all journeys starting in a particular area, with inter-authority settlements (or "knock-for-knock" agreements) to cover out-of-area take-up of enhanced concession. Unclear and confusing arrangements are likely to result in the bus operator applying to the Secretary of State for a modification of those arrangements.

The Appeal Process

2.14 The right of an operator to make an application to the Secretary of State for Transport for cancellation or variation of a Participation Notice under section 97(2) of the Transport Act 1985 and for modification of reimbursement arrangements under section 150(1) of the Transport Act 2000 is an important safeguard. This application process is often referred to as the 'appeal process'. The procedure is set out by Regulations made under the relevant Act, i.e. The Travel Concession Schemes Regulations 1986 regarding the 1985 Act, and The Mandatory Travel Concession (England) Regulations 2011 regarding the 2000 Act.

2.15 Applications by operators should only be submitted after proper consideration and after attempts to reach a resolution at the local level have been exhausted. The time limit for making an appeal is 56 days from the commencement or variation of a scheme.

2.16 Any application submitted by an operator should be properly evidenced. Data pro forma for evidence gathering are provided by the Department for both the applicant operator and the TCA. It should be made clear in the application and pro forma exactly which elements of the reimbursement arrangements are being disputed. In its pro forma, the TCA should set out the elements of reimbursement which it considers are in dispute. Operators and TCAs have the opportunity, and are encouraged to comment on the other party's pro forma.

2.17 Even after the submission of an application, TCAs and bus operators are encouraged to continue local negotiation with the aim of reaching a settlement. An operator may withdraw his/her application at any time before the Secretary of State has reached a determination.

2.18 The Department for Transport has published further guidance for TCAs and bus operators with regards to the appeal process which can be found on the Department's website.

2.19 In determining appeals by bus operators, the Secretary of State (or decision makers appointed on his behalf) will apply the law relating to the compensation of operators. The Secretary of State will be guided by the DfT reimbursement guidance but will also consider any additional evidence brought forward by parties when determining appeals.

3. Principles of Reimbursement

The Objective –"No Better, No Worse Off"

3.1 Requiring operators to use their assets to provide a free service for a proportion of the population is a major market intervention, and the requirement to provide adequate reimbursement is a fundamental one. Equally, however, European regulations prevent concessionary travel schemes being used to provide hidden subsidy (or state aid) to operators. The underlying principle which underpins reimbursement is set out in domestic Regulations which state that operators should be left ***'no better and no worse off'***[3] as a result of the existence of concessionary travel schemes.

3.2 This means that Travel Concession Authorities should

- compensate operators for the ***revenue forgone*** – i.e. the revenue they would have received from those concessionary passengers who would otherwise have travelled and paid for a (full fare or discounted) ticket in the absence of a scheme; and

- pay operators any ***net additional costs*** they have incurred as a result of the scheme – this could for instance include the cost of carrying additional generated passengers (i.e. concessionary passholders that would not have travelled in the absence of the scheme) or other costs that would not have been incurred in the absence of the concession such as scheme administration costs. Those costs are net of additional revenue.

TOTAL REIMBURSEMENT DUE = Revenue Forgone [R] + Net Additional costs [A]

[3] 'No Better and no worse off' is in relation to what the situation would have been in the absence of the scheme, not in relation to last year or to the year prior to the introduction of the scheme.

The Elements of Reimbursement

3.3 Calculating concessionary travel reimbursement is therefore predicated on determining what would have happened in the absence of the scheme, otherwise known as the **counterfactual**. It is important to note that the counterfactual refers to a hypothetical situation (the absence of a scheme now), it does not describe a particular point in the past such as for instance the situation as it was in 2005/06 before the introduction of the national free-fare scheme.

3.4 TCAs need to estimate the various components of reimbursement as outlined below.

3.5 The revenue forgone is an estimate of the revenue that would have been received in the absence of a scheme – it is therefore dependent on

- The number of <u>journeys</u> that would have been made by concessionary travellers in the absence of a scheme. These journeys are also known as non-generated journeys: they would have happened anyway. This is covered in Section 6.
- The <u>fares</u> that operators would have offered and concessionary travellers paid in the absence of a scheme. This is covered in Section 5.

Revenue forgone [R] = Non-generated journeys [N]
X
Average fares that would have been paid [F]

3.6 The recommended approach to estimate the number of journeys that would have taken place in the absence of the concession is to apply an adjustment factor – the ***reimbursement factor*** – to the number of observed concessionary journeys made using the free fare concession. The reimbursement factor depends on the sensitivity to fare changes of passengers' desire to travel by bus. Annex C provides some theoretical background on the relationship between fares and the demand for travel.

Non-generated journeys [N] = Total concessionary journeys at free fare [J]
X
Reimbursement factor [RF]

3.7 The additional costs are made of up to four components (see Section 7):

- ***Scheme administration costs*** – these are administration costs associated with running the scheme.

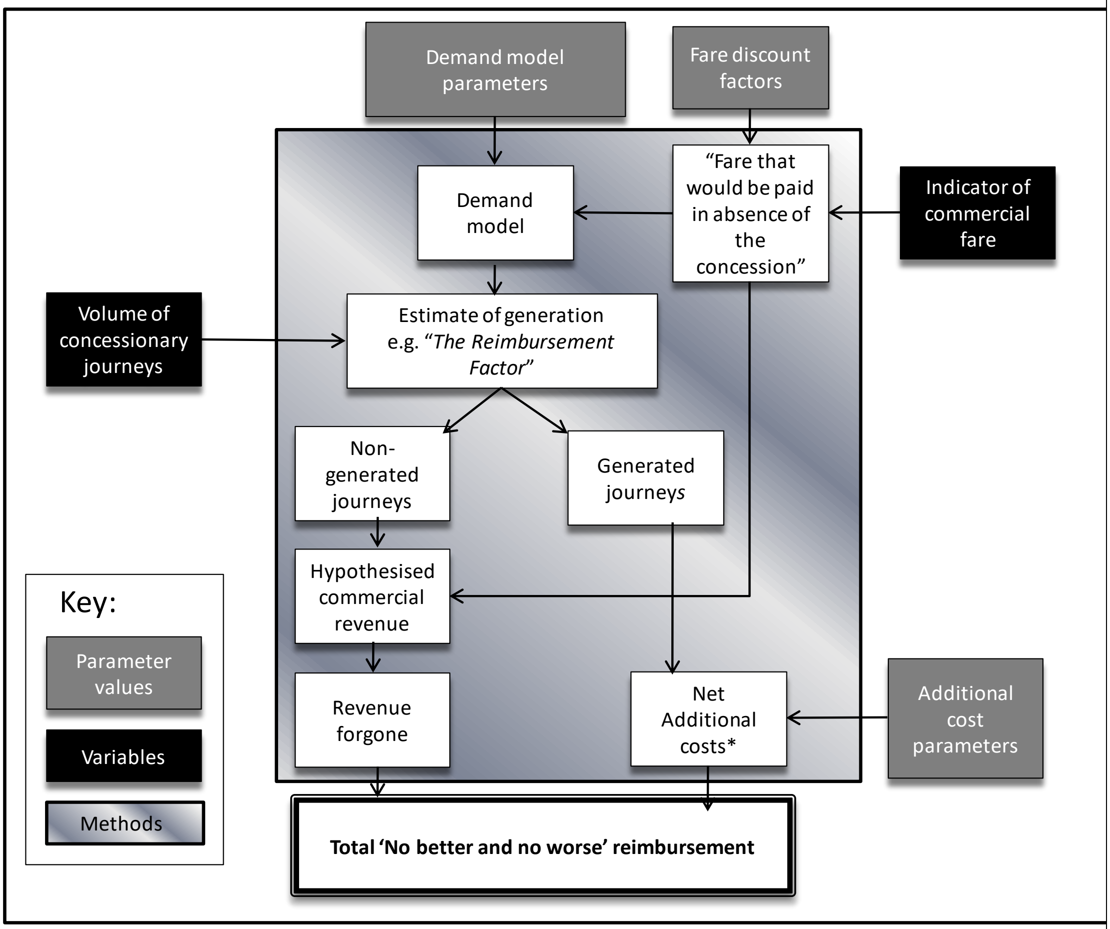
- ***Marginal operating costs*** – the costs of carrying additional passengers assuming service levels are held constant.
- ***Marginal capacity costs*** – the net costs incurred from additional capacity on a route to accommodate generated journeys, after allowing for revenue gain.
- ***Peak Vehicle Requirement (PVR) costs*** – the costs associated with the requirement to run additional vehicles in the peak period due to generated concessionary travel.

Net Additional costs [A] = Generated journeys [G] X Net Additional costs per generated journey [C] + PVR costs [P] + Scheme administration costs (S)
Net Additional costs per generated journey [C] = Marginal operating costs [MOC] + Net marginal capacity costs [MCC] per generated journey
Generated journeys [G] = Total concessionary journeys at free fare [J] X (1 - Reimbursement factor [RF])

3.8 EU Regulation Number 1370/2007 states that an allowance for 'reasonable profit' must be made in the reimbursement of bus operators. There is an implicit allowance for operator **profit** within the revenue forgone element of reimbursement through the average fare forgone. In addition, the guidance recommends that a profit allowance be made, in the form of rate on return on capital employed for additional peak vehicle requirements.

3.9 The flowchart below illustrates how the various components of reimbursement fit together. The rest of the guidance provides more detailed explanations as to what data inputs are required and how the different elements are calculated and combined. In addition, Annex B contains a Glossary of Terms, Annex D provides a simple illustration of how the different components of reimbursement are calculated and Annex H provides details of how the Calculator works, together with further worked examples.

Figure 3.1 Components of reimbursement



Approach of the Guidance and Tools

3.10 This guidance sets out DfT's preferred approach for calculating reimbursement based on the latest research and evidence available. TCAs are free to use the methodology of their choice in estimating reimbursement subject to ensuring compliance with the law. We strongly encourage TCAs to engage with their local bus operators as early as possible to help define the key variables in their schemes.

3.11 In determining appeal applications by bus operators, the Secretary of State (or decision makers appointed on his behalf) will apply the law relating to the compensation of operators and will be guided by the DfT reimbursement guidance. The Secretary of State will also consider any additional evidence brought forward by parties when determining appeals.

3.12 This guidance is concerned with providing practical advice on how to calculate reimbursement. A Reimbursement Calculator based on the recommended methods is available (on the DfT website) to aid TCAs in their estimation of the total reimbursement required by operators and can be used to assist discussions and negotiations with bus operators. The Calculator is accompanied by instructions on how to perform the calculations and Annex H provides worked examples of some of the detailed calculations in the tool.

3.13 The new methodology outlined in this guidance requires much fewer data inputs than were previously needed. Nevertheless data quality is an important factor in achieving an accurate estimate of reimbursement and TCAs are encouraged to check and validate the data that feed into the calculations.

Research Evidence

3.14 The advice provided in the guidance draws from extensive research commissioned by DfT from the Institute for Transport Studies (ITS) at Leeds University. The purpose of the research was to develop a robust, evidence-based framework for estimating concessionary travel reimbursement.

3.15 A Reimbursement Working Group comprised of relevant parties from the bus industry and local government was also consulted during the research phase and during the development of this guidance. Its contents, however, represent the considered views of the Department alone. Guidance on reimbursement will continue to be improved in the future as new evidence becomes available.

3.16 Annex E provides a summary of ITS main research findings and other relevant evidence which underpin the reimbursement calculation methods described in the guidance.

Level of Calculation

Spatial Aggregation

3.17 The principles set out in this guidance can be used at different levels of spatial aggregation (e.g. area, operator, route, service type, etc) and ultimately TCAs need to consider what level of calculation is most appropriate in the view of local circumstances. It is suggested that generally, it would be sensible to undertake revenue reimbursement, marginal operating costs and marginal capacity costs calculations at operator level but this is subject to local circumstances.

3.18 Whatever the level of aggregation at which the calculations are made, it is important, however, to use the same type and coverage of average fare in estimating the revenue forgone as the average fare used to determine the reimbursement factor. In both cases they should ideally be the level of average fare (or the change in average fare) that concessionary passengers would have paid in the absence of the scheme for a specific operator. A disconnect between the average fare forgone and the reimbursement factor (for instance by applying a TCA-wide reimbursement factor to an individual operator's average fare) may create an incentive for fares to be set with reimbursement in mind. Consistency in type and coverage of average fares particularly applies to estimating average fares and the change in average fares in future years.

Treatment of infrequent services, community bus services, small operators and small route legs

3.19 TCAs may wish to consider making special arrangements for the reimbursement of **infrequent bus services**. The reason for making this provision is that concessionary passengers using infrequent bus services may not have the same incentive or opportunity to increase the number of journeys with free fares compared with a situation of no concessionary scheme as would be the case with users of more frequent bus services. The users of infrequent bus services are relatively small in number so do not show up in national surveys or datasets. However such services are an important link for rural communities and can be an important part of the business of small bus operators.

3.20 This guidance recommends that the definition of infrequent services is a service of once a day or less.

3.21 The same principle applies to **community bus services** which are eligible for the national travel concession.

3.22 This guidance does not recommend a particular elasticity or reimbursement rate for both of these types of services. It is recommended that operators and TCAs should consider appropriate local data or results of surveys to determine appropriate reimbursement.

3.23 TCAs may also wish to have regard to the regulations governing concessionary travel reimbursement. These recognise that the application of a standard method may prove unduly onerous to both the authority and the operator in the case of **small operators** and that in such cases the operator and the authority may reach an ad hoc agreement as to the reimbursement to be paid through negotiation.

3.24 Similarly, calculating reimbursement using a standard method such as provided in this guidance may be burdensome in the case of a small number of services going through a local authority for just a **few stops**, irrespective of the size of the operator operating these routes. In this case the TCA and operator may agree to calculate reimbursement off-model.

Timing of Calculations

3.25 Data used in reimbursement calculations may change in the course of the year – for example up-to-date outturn data on journeys or fares may become available or forecasts of inflation may be revised – and TCAs should consider whether they will want to reconcile calculations when more up-to-date data becomes available. Where TCAs take the view that their calculations will need to be reconciled and / or reviewed, it is advised that published schemes should set out clearly under what circumstances, at what frequency and how such reconciliation exercises are to take place. This is important to provide clarity from the outset to both TCAs and operators.

3.26 Failure to set out clearly the circumstances and method for reconciling /revising reimbursement calculations in published arrangements means that any significant changes to the level of reimbursement may constitute a variation to reimbursement arrangements under the Transport Act 1985 or the Transport Act 2000.

3.27 In terms of best practice, it would seem unreasonable to set scheme terms that:

- Limit the number of fare changes that an operator can apply in a year;
- Include clauses reserving the right for unilateral changes to terms, rates of factors at any time without consultation;

3.28 Where revisions/reconciliations take place, it is important to use the same type and coverage of average fare in estimating the revenue forgone and average fare used to determine the reimbursement factor. This is to avoid a disconnect between the average fare forgone and the reimbursement factor which may create an incentive to increase fares during the year in order to increase revenue reimbursement (for instance if the change in real fares is revised upwards, the reimbursement factor should accordingly be adjusted downwards and vice-versa).

Comparisons over time

3.29 When combining data across a number of years (e.g. in deriving the percentage increase in fares between 2005/06 and 2021/22), it is important that the figures used are on a like-with-like basis.

3.30 For instance, the data should cover the same range of services. Data based on a sample of months should cover similar periods and the periods should be chosen to be representative of concessionary travel. In comparing financial years, consideration should be given to normalising the data to take account of the fact that the timing of the Easter holiday period relative to the end of the financial year varies from year to year (a financial year may include one or two Easter holiday periods).

Data Provision

3.31 Regulation 8 of the Mandatory Travel Concession Regulations 2011 stipulates that

When formulating reimbursement arrangements, a travel concession authority may request information from operators which it reasonably considers relevant to assisting it in the formulation and operation of those arrangements.

3.32 Bus operators are therefore legally obliged to provide data (as long as it is available) relevant to the calculation of reimbursement except for the data items specified in Regulation 13. However, TCAs may only use the data in connection to reimbursement calculations and may not disclose the information without the prior written consent of the operator (Regulation 12).

3.33 We strongly encourage TCAs and bus operators to discuss data requirements at the earliest opportunity. For ease of reference, Annex F includes a list of the data items likely to be required if the DfT guidance and Calculator are being used to estimate reimbursement. Other data may be required if the TCA uses a different method for calculating reimbursement.

4. Measuring Concessionary Journeys

4.1 Of all the data items required to provide a sound estimate of reimbursement, the total number of concessionary journeys (boardings) undertaken by older and disabled people in the reimbursement period is most easily observed and should be the easiest to obtain.

4.2 Concessionary journeys can be estimated using operator data or statistically robust surveys. Almost all operators now have electronic ticket machines and should be able to provide empirical data on concessionary boardings by fare stage. However, it is recognised that it is difficult to audit data that have no fare transaction (i.e. estimates of passengers enjoying free travel). The increasing roll-out of smart ticketing may help in this regard but pending the full introduction of smart ticketing, TCAs may want to use statistically robust surveys to provide supporting information on the number of concessionary journeys or undertake spot checks to validate operator-supplied figures.

5. Estimating the Average Fare

Introduction

5.1 Operators should be reimbursed for the ***average fare forgone***, i.e. the fare that concessionary travellers would have paid in the absence of a scheme. The average fare forgone features in reimbursement calculations in two ways:

- as a determinant of generation and the reimbursement factor (larger increases in fares imply higher levels of generation and a lower reimbursement factor) – see Section 6;
- as a direct input in the calculation of revenue forgone (revenue forgone = average fare forgone x observed concessionary journeys x reimbursement factor).

5.2 The calculation of the average fare forgone is not as straightforward as looking at the average equivalent single fare or, in the absence of such data, the average commercial adult 'cash fare'[4]. In the absence of the concession, it is likely that some of those passengers who now use buses for free would have bought various discounted products such as travel cards, day tickets and weekly tickets which allow an unlimited number of journeys to be made in a given period. These products offer a lower average fare per journey and take-up of those types of tickets would therefore have had the effect of reducing the average revenue per journey earned by operators. There is evidence from smartcard journey frequency data that some concessionary passholders use buses sufficiently often to make ticket type choice a real question in the absence of a scheme.

5.3 It is also plausible to suggest that in the absence of a scheme operators would want to consider their marketing strategies to older people very carefully and either introduce discounted products for some of those now benefiting from the concession or rebalance the tariff structure (e.g. lower off-peak fare, higher peak fare) or combinations of both. However, there is not sufficient evidence to be able to quantify this potential effect.

5.4 In general we would therefore expect the average commercial adult cash fare to be higher than the average fare forgone that concessionary travellers would have paid in the absence of a scheme. It is therefore not

[4] The average equivalent single fare is the fare that would have been paid by the passenger if a cash single ticket had been purchased. A cash fare is a type of ticket that allows the purchaser to make a finite number of journeys such as singles or returns.

appropriate to use the average commercial adult cash fare in reimbursement calculations. However, there may be some circumstances where an operator does not offer discounted tickets or where tickets are priced such that they attract only a very small minority of passengers. In those cases it may be appropriate to use the average commercial adult cash fare as a proxy for the fare that would have been paid in the absence of a scheme.

Recommended approach

5.5 The recommended approach to estimate the average fare forgone is to use the **Discounted Fare method**. This method is the preferred default approach for all operators because fewer data inputs are required, they are easily auditable and it is not necessary to make assumptions about the journey rates associated with discounted tickets.

5.6 The method consists in applying a discount factor based on the prevailing ticket price structure for a TCA/operator to the average commercial adult cash fare. This is essentially a method similar to the Basket of Fares method except that the underlying journey frequencies used to derive the discount factor are based on observed data for the concessionary market and therefore reflect the actual travel behaviour of concessionary passholders.

5.7 However, this approach may not be appropriate in certain circumstances as outlined below.

5.8 The Discount Fare method is not appropriate for operators with predominantly **low frequency services**. These are defined as operators who have 60 per cent or more of concessionary passenger boardings (on services serving a TCA's area) carried on buses where the average weekday daytime frequency (09.30 to 18.00) is one bus per hour or less.

5.9 In these cases, TCAs can use the **Basket of Fares method** as a fall-back approach. This consists in estimating the average fare based on the average fare per journey of a range of commercial cash and non-cash fares weighted by the journeys that would have been made by concessionary passengers in the absence of the scheme using each ticket type. To guard against unintended consequences such as routes being split or reorganised to artificially meet the criteria, TCAs may wish to consider the combined frequency along a corridor as well as for individual registered services.

5.10 There are also some cases which cannot currently be catered by the Discount Fare method (e.g. particular ticket combinations or price ratios) and where the Basket of Fare method should therefore be used:

- In the case of operators who a) only have **cash fares and weekly tickets** but no daily tickets *or* b) only **daily and weekly tickets** but no cash fares.

- In the case of certain ticket price combinations which result in the **daily ticket to average cash fare price ratio to be greater than 5** (before or after degeneration). Users will be alerted to this problem when using the Calculator. This is not expected to be a common occurrence.
- There may also be some rare cases where the Discount Factor method may yield **implausible** results: if in using the methodology it is found, after de-generation, that the proportion of daily or period ticket to cash fare ticket sales is higher for concessionary passengers than for current fare paying passengers, then the alternative fare basket method of estimating the average fare is a more appropriate method to use.

5.11 Finally, in large urban areas, such as **PTEs**, the discount on the cash fare may be significantly different than that suggested by the Discount Factor method for several reasons. For instance, the proportion of high frequency bus users may be greater than for the areas from which the 'default' journey frequency distributions were derived; the use of discounted tickets may also be greater in large urban areas because of the relatively large proportion of multi-modal journeys; and there may be a higher proportion of interchange journeys relying on more than one bus operator. There may also be significant differences between the length of journeys made on cash fares and discounted tickets and the associated price structures, which can lead to particularly high discount factors where these are measured against the average equivalent cash fare of concessionary passengers.

5.12 TCAs in those areas may also have access to comprehensive journey data (e.g. from continuous sample surveys) and are able to develop average fare calculation methods in line with the principles of the DfT Discount Fare methodology. In those cases it would be justified for those TCAs, in consultation with operators, to use their own data and methods to estimate the average fare forgone.

5.13 The table below summarises when the different methods should be applied:

Table 5.1 Recommended method to calculate the Average Fare Forgone

Circumstances	**Method**
All cases except those below	Discount Fare method
Operators with cash fares only	Average cash fare as per Table 5.2
Operators with no cash fares	Basket of Fare method
Operators with atypical ticket price combinations	Basket of Fare method

The daily ticket to average cash fare price ratio to be greater than 5 (before or after degeneration)	
Operators with ticket price ratios that lead to implausible results in the Discount Fare method *The proportion of daily or period ticket to cash fare ticket sales is higher for concessionary passengers than current fare paying passengers*	Basket of Fare method
Operators with predominantly low frequency services *60 per cent or more of concessionary passenger boardings (on services serving a TCA's area) are carried on buses where the average weekday daytime frequency (09.30 to 18.00) is one bus per hour or less*	Basket of Fare method
PTEs	Local method
TCAs with appropriate smartcard data	Discount Fare Method with locally derived smartcard lookup table

Discounted Fare Method

Introduction

5.14 This is the recommended approach for estimating the average fare for predominantly urban operators. The basic principle of this method is to calculate a discount factor to adjust the full commercial adult cash fare downward so as to reflect the fact that in the absence of free-fare schemes, individuals would take up discounted tickets.

5.15 The discount factor is derived from a sample of smartcard data on observed concessionary passholders journey frequencies at free fares from four districts in the NoWcard scheme in Lancashire. The journey data have been used to model how eligible people would allocate themselves to different ticket types (cash, daily and weekly tickets) depending on the relative price structure.

5.16 Ideally we would want to base the discount factor on the journey distribution which would occur in the absence of the scheme but this is not observable so this has to be inferred from the distribution in the presence of the scheme (at free fares). However, in the absence of a scheme and faced with having to pay full fares, it is expected that individuals would make fewer journeys and would buy a different mix of ticket types. The journeys in the observed NoWcard frequency distribution are therefore adjusted to account for this (journeys are reassigned from discounted products to single tickets and the total number of journeys is reduced).

5.17 Smartcard data based on zero-fare concessionary journeys has the advantage that it records actual travel behaviour by concessionary passengers and will not be coloured by the prevailing commercial strategies of bus operators.

5.18 Because the smartcard data used in the derivation of the discount factor is based on a sample for a particular time period and particular area, there is no guarantee that the dataset is representative of concessionary passengers everywhere although the journey frequency distributions from the NoWcard data were found to be similar to those derived from Nottingham's smartcard data and from data from a large conurbation.

5.19 At present NoWcard data provide the best available opportunity to observe concessionary journey frequency distributions in urban areas and provide a default set of assumptions in the absence of good alternative data on the likely distribution of ticket type purchase by concessionary passengers. Annex E provides further information on the characteristics of the underlying NoWcard data used in the Discount Fare method.

5.20 Local smartcard data on concessionary passholder journey making is beginning to become more widely available in a sufficiently comprehensive form to be directly drawn upon by individual TCAs. Where such data is available TCAs may wish to replace the NoWcard data in the model with their local smartcard data or smartcard data from another area which they can demonstrate to be representative of their own area.

5.21 The Smartcard data should be drawn from a sufficiently large sample (i.e. cover enough representative weeks), be appropriately cleaned and imputed for missing data before it can be used in the Discount Fare Method. Annex G provides further information on how to clean and process smartcard data to derive a lookup table for use in the Discount Fare Method.

Generic Ticket Types

5.22 The only information required as an input for calculating the average fare is data on the prevailing ticket price structure expressed as the price ratio of three generic ticket types.

5.23 In practice, fare structures can be extremely complex with a wide variety of ticket types being available across different operators (singles, returns, carnets, five-day tickets, weekly tickets, monthly tickets, etc) and with various geographical (Zone, A, Zone B, Zone A+B) and temporal (peak/off-peak, weekends) combinations. Ticket products which are directly comparable are also likely to be branded with different names. It would be therefore difficult for TCAs to assemble a framework dealing with each distinct ticket product and monitor their prices.

5.24 The proposed method assumes that ticket products and their geographical and temporal dimensions can be summarised into three generic ticket types:

- 'cash' fares which entitle the purchaser to make a finite number of journeys, i.e. include cash singles, cash returns and carnets (e.g. ten journey tickets, etc);
- daily tickets; and
- weekly tickets.

5.25 Although concessionary travellers would have made use of all sorts of ticket types, including monthly tickets, the three generic products outlined above are deemed to be a sufficiently representative way of summarising the range of non-cash fares relevant to concessionary travel reimbursement without creating too complicated an overall structure.

5.26 In practical terms TCAs will need to discuss with each operator how to map individual ticket products onto the generic ticket types. Decisions will need to be made as to which tickets are in scope and which are deemed to be not relevant to the concessionary market (e.g. annual season tickets, peak period tickets, child tickets, etc). Some pragmatic judgements may also need to be made about atypical products and how they fit into the three generic ticket types.

5.27 The types of products selected should as far as possible correspond to the period of the concession, include those tickets which apply within the TCA area and should **exclude child tickets**. In making choices about what tickets are in scope, TCAs and operators should attempt to come to a shared understanding of the likely ticket mix that concessionary passengers would purchase in the absence of the scheme. Note that weekly tickets are assumed to be in scope. Although it may be appropriate to exclude weekly tickets in particular circumstances, the general presumption is that some (typically small) proportion of the journeys made by concessionary passengers in the absence of the scheme would be made on weekly tickets. A table in the Calculator next to the final calculated fare shows the final ticket allocation and journey distribution.

5.28 Preferably the mapping should be defined in terms of the internal ticket product codes that operators use in their ETM systems, thus ensuring precision and auditability, and also facilitating production of data by the operator. A complete mapping exercise should only be needed when systems are initially set up, but should then be kept under review as operators change the product mix (but not as they change prices as this will be captured in the sales revenue data).

5.29 In some areas, multi-operator tickets may be widely available and may constitute a significant proportion of ticket sales. In those cases, TCAs may wish to consider these types of tickets for inclusion in the calculations. The total number of multi-bus tickets sold could be, for instance, apportioned to an individual operator on the basis of their share of total journeys or using other methods as appropriate.

Price Ratios

5.30 Once the various products have been mapped onto the generic ticket types, data on **total ticket sales** and **ticket revenue** for each of the three ticket types can be obtained from operators so as to derive the average price per journey. These data should be easily available and auditable and do not require operators to make assumptions about the number of journeys made with each ticket type.

5.31 The average price of each generic ticket type can be derived as follows:

Average ticket price = Total revenue / Total number of tickets sold

5.32 Care will need to be taken in the cash fare category as this may comprise tickets with a different number of journeys per ticket. For instance the total revenue for return tickets will need to be divided by two and the total revenue for carnets of ten journeys will need to be divided by ten before the average revenue per journey for cash fares tickets is calculated.

5.33 The example in the tables below illustrates how ticket revenue and sales data on the products which have been assigned to generic ticket types can be used to derive the average price of each ticket type. The examples are purely illustrative using made-up data. The Calculator includes a facility to calculate price ratios in this way. Only ticket sales and revenue data are required.

Cash fares

Table 5.2 Derivation of average cash fare (Illustrative example)

Product	Ticket price (£) [A]	Single journey multiplier [B]	Number of tickets sold [C]	Total revenue (£) [D]	Equivalent number of journeys [E=BxC]
Single Zone 1	£1.50	1	50,000	75,000	50,000
Single Zone 1+2	£1.80	1	180,000	324,000	180,000
Return Zone 1	£2.80	2	15,000	42,000	30,000
Return Zone 1+2	£3.40	2	90,000	306,000	180,000
Carnet (10) Zone 1+2	£16.0	10	5,000	80,000	50,000

All cash fares				827,000	490,000
Average cash fare (per journey) = £827,000 / 490,000 = **£1.69**					

Day tickets

Table 5.3 Derivation of average day ticket price (Illustrative example)			
Product	**Ticket price (£) [A]**	**Number of tickets sold [B]**	**Total revenue (£) [C=AxB]**
Day saver (Advance)	£3.20	3,000	9,600
Day saver (Standard)	£3.80	20,000	76,000
All day tickets		**23,000**	**85,600**
Average day ticket price = £85,600 / 23,000 = **£3.72**			

Weekly tickets

Table 5.4 Derivation of average weekly ticket price (Illustrative example)			
Product	**Ticket price (£) [A]**	**Number of tickets sold [B]**	**Total revenue (£) [C=AxB]**
5 Day saver	£13.00	3,000	39,000
7 Day saver	£15.00	1,000	15,000
All weekly tickets		**4,000**	**54,000**
Average weekly ticket price = £54,000 / 4,000 = **£13.50**			

Deriving the Discount Factor Using the Calculator

5.34 The three average ticket prices can be input in the Average Fare Calculator and the discount factor associated to that price structure is then easily derived. It can then be applied to the average cash fare reported for the period to derive the fare that would have been paid in the absence of a scheme:

Average fare forgone = Average cash fare x (1 – Discount Factor%)

5.35 Annex H explains in detail how the discount factor in the Reimbursement Calculator is derived by way of a worked example.

Different combination of ticket types

5.36 As discussed above, the Discount Fare method does not work if the only ticket types available are daily tickets and weekly tickets - in those cases the recommended approach is to use the Basket of Fare method. Other ticket combinations, cash fares / daily / weekly tickets or cash fares / daily tickets or cash fares / weekly tickets work with the Discount Fare method and the Calculator has a facility to enter the appropriate ticket combination.

5.37 Operators who only offer cash fares can calculate the average cash fare according to Table 5.2 (a template is included in the Calculator).

Basket of Fares Method

Introduction

5.38 This method was the recommended approach in the previous DfT Reimbursement Guidance and Reimbursement Analysis Tool and is appropriate for TCAs to use where the discount factor method is not suitable, i.e. for operators with a high proportion of passengers carried on infrequent buses.

5.39 It allows TCAs to estimate an effective discount rate by calculating a weighted average fare per journey from assumed usage of different commercial ticket types. It is not dissimilar to the first method but requires more data inputs and requires TCAs to make assumptions about the number of journeys that would have been taken with each ticket purchased in the absence of the scheme and the proportion of total journeys that would have been taken by concessionaires holding each type of ticket in the absence of the scheme.

Data Requirements and Method

5.40 Table 5.5 below illustrates how the average fare should be calculated using a basket of fares. It should be noted that this is an example with illustrative ticket types and illustrative assumptions about journeys per ticket. In particular the suggestion of applying the method at a very disaggregated level or for different lengths of journey is entirely optional and depends on the types of products available.

Table 5.5 Basket of fares (Illustrative example)

Type of ticket [A]	Price £ [B]	Assumed journeys per ticket purchased [C]	Implied revenue per journey £ [D=B/C]	% of total journeys with this ticket type [E]	Weighted revenue per ticket [F=DxE]
Single (<1 mile)	1	1	1	6.7%	0.067

Return (<1 mile)	1.8	2	0.9	44.4%	0.3996
Single (>1 mile)	1.3	1	1.3	4.4%	0.0572
Return (>1 mile)	2.1	2	1.05	26.7%	0.28035
Daily pass	2.5	3	0.83	6.7%	0.05561
Weekly pass	10	16	0.63	11.1%	0.06993
Totals				100%	
Weighted average fare					**£0.9294**

5.41 The first step is to consider all the ticket types [Col. A] that would have been purchased by concessionary passholders in the absence of the scheme and the associated commercial price [B]. Operator or survey evidence will be helpful in identifying the most relevant basket of tickets. In deciding what tickets are in scope, TCAs and operators should attempt to come to a shared understanding of the likely ticket mix that concessionary passengers would purchase in the absence of the scheme. As a general principle, weekly tickets should be presumed to be in scope unless there is evidence to indicate that concessionary passengers would not purchase them in the absence of the scheme.

5.42 TCAs will have to make explicit assumptions about how many journeys [C] would have typically been made by holders of each ticket type. Although it is reasonably obvious for single and return tickets, it requires some judgements to be made on the use of multi-journey tickets. Again, good evidence from operators or surveys will be helpful in deciding what assumptions to make.

5.43 The default position is to assume that new passholders behave exactly the same as old pass-holders in terms of average journey lengths. Data from the National Travel Survey in Table 5.6 below shows that in 2009 the average local bus boarding length (outside London) ranged from 3.4 miles to 5.4 miles in different types of area.

Table 5.6 Average bus boarding length by over 60 passholders (miles), 2009	
London	2.3
Met built up areas	3.4
Other urban	4.0
Rural	5.4

Source: National Travel Survey

5.44 Another assumption needs to be made about the proportion of total journeys [E] that would have been made by eligible concessionaires in the absence of a scheme using each type of ticket. The percentage split does not correspond to the commercial share of journeys but need to be weighted in line with the likely purchase of such tickets by concessionary passholders.

5.45 From the data inputs above the following information can be derived:

- The implied revenue generated by each journey using a particular ticket type [D] – this is the price per ticket divided by the assumed number of journeys per ticket;
- The weighted revenue per ticket [F] – this is the implied revenue per journey multiplied by the percentage share of journeys made with this ticket type.

5.46 The average weighted fare per journey is the sum of the weighted revenues per ticket. In this example it is around 93 pence. Clearly it is lower than the average price of a single ticket.

5.47 In practice the best estimate of average fare in the basket of fares may be based on a combination of: (i) historical data (where available) about the types of ticket that those eligible for concessions previously bought; (ii) surveys of current concessionary travellers; and (iii) operator Electronic Ticket Machine (ETM) data about the type of tickets being purchased now by non-concessionary travellers. Some quality assurance of these last two data sources would significantly enhance the robustness of this calculation. Asking concessionaires what ticket they would have bought in the absence of the scheme may not always give accurate data, and the travel patterns of non-concessionaires as indicated by ETM data may not reflect the likely patterns of concessionaires in the absence of the scheme. However, such data may help inform judgements made in applying this methodology.

6. Estimating Demand

Introduction

6.1 The amount of revenue forgone that needs to be paid to operators is dependent on non-generated travel or the number of journeys that would have been made by current concessionary passengers in the absence of the concessionary travel scheme – it is not possible to observe this directly it and needs to be estimated.

6.2 The purpose of this section is to provide guidance on how the relative proportions of generated and non-generated journeys should be estimated.

6.3 Throughout this section, and for the sake of simplicity, reference to ‘free fares’ or ‘free scheme’ should be taken as meaning free or concessionary fares, as the same principles apply. This is only relevant where the TCA chooses to use its powers under the 1985 Act to enhance the local scheme by adding travel at reduced (rather than free) fares at times, on services, or for groups outside the national concession.

The Demand for Bus Travel

The Reimbursement Factor

6.4 The level of non-generated journeys is best expressed by the ***Reimbursement Factor (RF),*** the percentage of journeys that would have been made in the absence of a scheme (i.e. if commercial fares had been charged). The higher the reimbursement factor, the higher the number of journeys that are generated by the scheme and the lower the number of journeys that are generated by the scheme.

Reimbursement Factor =

$$\frac{\textbf{Estimated} \text{ journeys made in the absence of the free scheme}}{\textbf{Observed} \text{ journeys made at free fare}}$$

6.5 As explained in Section 4, the Reimbursement Factor is applied to the observed number of journeys made at free fare to derive the estimated number of journeys made in the absence of a scheme. This, multiplied by the fare that would have been paid, gives the total revenue forgone for which operators need to be reimbursed:

Revenue forgone = Reimbursement Factor x Observed journeys at free fares x Average fare

The Concept of Demand and Fare Elasticity

6.6 The number of journeys that people make depends on the prevailing fares and how they respond to changes in prices. The relationship between prices (fares) and the demand for a commodity (bus travel) is described by a ***demand curve*** and the responsiveness in demand for a good to a change in its price is the ***price elasticity of demand***. There is an inverse relationship between the fare elasticity of demand and the reimbursement factor – a higher fare elasticity (in absolute terms), with all other things being equal, gives a lower reimbursement factor and vice versa. Annex C provides some background on these concepts and the impact of fares on the demand for concessionary travel.

The Single Demand Curve Approach

6.7 The level of generated journeys is determined by the shape of the demand curve, the fare elasticity and other observed data on journeys made by concessionary travellers before and after the introduction of the free fare scheme. This is explained further in Annex C.

6.8 The purpose of the research commissioned by the Department has been to establish a robust relationship between the demand for bus travel by concessionary passholders and the fares that they would have paid based on best available evidence to date. A framework based on a Single Demand Curve (SDC), that represents the entire concessionary travel market covering all those who hold free bus passes has been produced. This enables the Reimbursement Factor corresponding to a change in average fare in a local area for an operator to be calculated accordingly.

6.9 The responsiveness of concessionary bus passholders depend on a number of factors; the analysis of available evidence showed some differences in the responsiveness of concessionary bus passholders by PTE and non-PTE areas. Largely it did not support the view that individual responsiveness to changes in fares varied significantly by more detailed disaggregation of regions, income, age or other similar characteristics. Therefore, two Single Demand Curves – one for residents in PTE areas and one for residents in non-PTE areas – have been estimated.

6.10 Annex E provides detailed explanations of this conceptual framework and the research evidence which underpins it.

Choice of PTE/non-PTE Single Demand Curve

6.11 As a general principle, TCAs in PTEs should use the PTE demand curve and non-PTE areas should use the non-PTE demand curve. It is important to note that the PTE and non-PTE demand curves relate to the inherent characteristics of residents within an area (i.e. they reflect the responsiveness to fares of concessionary passholders).

6.12 The guidance recognises that the responsiveness of people in some non-PTE areas is more similar to the responsiveness of people in PTE areas (than in other non-PTE areas) and it is therefore **suggested that some TCAs in non-PTE areas may wish to use the PTE Single Demand Curve**.

6.13 An important determinant of bus use is the level of car availability, which also has some influence on responsiveness to changes in bus fares. Therefore one approach to matching areas to the appropriate Single Demand Curve is based on a measure of car availability.

6.14 The method of defining areas to include in the PTE Single Demand Curve on the basis of this approach uses data on car availability amongst the eligible population by local authority area from the 2011 Census. The current eligibility age is approximately 62, so the eligible population has been assumed to be those people aged 62 or above. Car ownership, when weighted by population density in individual local authorities within PTE areas, showed that car availability amongst the eligible population ranged from 58% per cent in Tyne and Wear to 68% per cent in West Yorkshire. Taking the top end of the range, which is considered to be indicative of similarity with PTE areas, there were 17 local authority areas in England outside PTEs and London that had car availability lower than 68 per cent (this excludes the Isles of Scilly). The local authority areas whose characteristics are more similar to PTEs in terms of car availability are listed below:

Table 6.1 List of areas with car availability lower than 60 per cent
County Durham
Hartlepool
Middlesbrough
Blackpool
Burnley

Kingston upon Hull
Leicester
Nottingham
Lincoln
Harlow
Norwich
Brighton & Hove
Portsmouth
Southampton
Oxford
Cambridge
Blackburn with Darwen

6.15 This method of defining areas to be included in the PTE Single Demand Curve is simple and is based on one variable. It is acknowledged that it does not take into account other potential factors that may be indicative of the responsiveness of people more similar in nature to that found in PTE areas. Therefore TCAs may wish to use the list in Table 6.1 to identify areas to where the PTE Single Demand Curve should be applied; however, TCAs should also use their own judgement and assess the strength of local evidence as to which demand curve is most appropriate.

6.16 This table has been updated to reflect 2011 Census data on car ownership amongst the population of older people who are eligible for the statutory concession. The previous list was based on 2001 census data and assumed an eligibility age for the statutory concession at 60.

6.17 Where a TCA area is made up of an area which is thought to be a "PTE like" area, but the rest of the TCA area is not, the TCA needs to decide how to determine which Single Demand Curve applies. A possible method would be to define routes that fall wholly or mainly in one or other of the area types, and then apply the appropriate Single Demand Curve for reimbursement on those routes so defined.

6.18 A TCA which is classified as a PTE-like area but attracts considerable cross boundary journeys from non PTE areas characterised by high car ownership may wish to consider using the non PTE reimbursement rate for the return journeys made by those non-residents. Likewise, residents who make journeys taking them out of the TCA should be reimbursed at the PTE reimbursement rate. However, this depends on the extent to which data is available to be able to distinguish between journeys made by the TCA's own residents and those visiting from outside.

Application of the fare in the Single Demand Curve (SDC)

6.19 Section 5 of the guidance describes how the average fare that concessionary passengers would have paid in the absence of the concessionary fare scheme should be calculated for the reimbursement period. This section deals with how the average fare is applied to the SDC in order to calculate reimbursement.

Principle

6.20 The SDC measures the effect of changes in fare on the demand for journeys by concessionary passengers. The appropriate reimbursement factor must be calculated based on the change in local fares between 2005/06 and the current reimbursement period. This approach recognises that bus services are not now, and were not in 2005/06, homogenous in journey length or quality.

6.21 In order to calculate the reimbursement factor in the SDC, it is therefore necessary to estimate the growth in real fares between 2005/06 and the current reimbursement period. The higher the growth in real fares between 2005/06 and the current reimbursement period, the lower the rate of reimbursement will be and vice versa.

Growth in fares since 2005/06 and impact on reimbursement

6.22 The nominal change in fares is as follows:

Percentage growth in nominal fares =

$$[(\text{Nominal fare}_{\text{current}} / \text{Nominal fare}_{2005/06}) - 1] \times 100$$

6.23 The percentage change in nominal fares needs then to be adjusted for inflation using the CPI index and then applied to the Single Demand Curve.

6.24 Assuming no change in real fares, the reimbursement factor would be as follows:

Table 6.2 2021/22 Reimbursement Factor with no change in real fares since 2005/06		
	PTE	NPTE
2021/22 Reimbursement Factor with no change in real fares since 2005/06	51.2%	43.4%

6.25 However, if there has been an increase in real fares since 2005/06 the reimbursement factor for 2021/22 will be lower, and if real fares have decreased since 2005/06 the reimbursement factor will be higher.

Estimating the growth in nominal fares between 2005/06 and the year of calculation

6.26 The best way to estimate a reimbursement factor for an individual operator is to use an estimate of the change in fares across the whole period which is specific to that operator. It is desirable for the calculation to be based on as large a sample of routes as possible and for these routes to be based on a representative sample period[5]. It is recognised that comparable fare data going back to 2005/06 may not be readily available, for instance because the data may not have been collected, there may have been significant changes to the operator's network or more simply because an operator is new to the market.

6.27 In these cases, the guidance and Calculator suggest two alternative options to calculate the change in nominal fares. Both these options recommend calculating fare changes in two steps: between 2005/06 and 2010/11 and from 2010/11 onwards. The reason for this two-step approach is that from 2010/11 onwards, there is a presumption that the appropriate operator-specific or TCA-wide data will have been collected for the purpose of estimating the reimbursement factor using this guidance.

6.28 The suggested options to calculate the growth in fares required are as follows (in order of preference):

Option 1 – Comparing operator-specific fares between 2005/06 and the year of calculation

6.29 If the appropriate data are available, TCAs can produce a best estimate of the fare that concessionary passengers would have paid in the absence of a concessionary fare scheme in 2005/06 for a specific operator.

6.30 TCAs and operators may have a record of this fare because it is likely to have been used in the previous reimbursement methodology, including the Reimbursement Analysis Tool (RAT), and it is also used in the Appeal pro forma.

6.31 It is acknowledged that the precise methodology for estimating the average fare forgone in 2005/06 will not necessarily be the same as the methodology used to estimate the average fare in the current reimbursement period. This guidance does not require TCAs or operators to undertake a full re-calculation of the 2005/06 fare using the discount fare method, where a discount fare method was used as the

[5] It is preferable for the sample period to be one full (financial) year, making appropriate adjustments for seasonal oddities such as the Easter period falling twice in one (financial) year. Where it is not feasible, or disproportionately costly to use a sample period of one full year, it is important that the sample period chosen is demonstrated to be sufficiently reliable to have confidence that the sample period being used is representative of the full year. The first few months of the (financial) year are unlikely to be sufficient.

basis for calculating reimbursement in the year of calculation (e.g. 2021/22).

6.32 The comparison of the 2005/06 fare and the year of calculation should, however, cover the same range of services. If operators have either taken over other operators or run new routes, or have closed routes, then these changes should be factored out as far as possible so that the comparison of fares is on a like-for-like basis.

6.33 Where a 2005/06 fare comparable with a fare in the year of calculation is not available, local authorities can consider the following next best options outlined below.

Option 2 – Using TCA-wide average fares up to 2010/11 and operator-specific fares then onwards

6.34 If like-for-like comparisons of fares cannot be made at the operator level, for example if the operator did not run services in 2005/06, or there has been a radical change in the services run by the operator or records of fares do not exist in 2005/06, then the next best approach is to estimate the fare change in two steps:

a. Compare the TCA-wide average fare in 2005/06 and 2010/11 (in nominal prices). This should be a reasonable proxy for local changes in fares over that period.
b. Use operator-specific changes in fares between 2010/11 and the year of calculation provided it is on a like-with-like basis (i.e. cover a similar range of services; see above). If a fare change is not available (e.g. in the case of new operators or those with significantly different networks), a TCA-wide change in fares can be used between 2010/11 and subsequent years.

Option 3 – Using the National Bus Index

6.35 If operator or TCA data are not available going back to 2005/06 then the guidance suggests that the national bus index up to 2010/11 should be used to estimate the change in average fares. The national bus index provides an estimate of the average change in fares in PTE and non PTE areas over the period.

6.36 From 2010/11 onwards, operator-specific fares, or failing that TCA-wide fares, should be used such as in Option 2.

Other combinations of years

6.37 The methods described above and implemented in the Calculator are based on a small number of possible combinations of data and years (e.g. use TCA-wide average change in fare up to 2010/11 and operator-specific change in fare between 2010/11 and 2021/22). There are many other combinations possible and data availability and the feasibility of comparing data on a like-with-like basis across years will be determinant factors in what combination is optimal.

6.38 Although the options above are the recommended approach, TCAs and operators may end up having to use combinations of years which are not operationalised in the Calculator. The paragraphs below illustrate how to calculate a percentage change and how to combine percentage changes over different years to calculate a compound percentage change across the whole period.

6.39 A percentage change between two years is calculated by simply dividing the final year price by the first year price and subtracting one. For instance, let's assume that the nominal fare is £1.00 in the first year and £1.23 in the final year. Then the percentage increase in nominal fares between these two years is £1.23 ÷ £1.00 = 1.23, 1.23 - 1 = 0.23, which equates to 23 per cent.

6.40 In circumstances where it is necessary to calculate nominal fare increases between at least two sets of years, a simple formula can be used to estimate the overall percentage change in fares across the whole period. This formula is illustrated below using an example where three price rises are calculated between three time periods using three different methods (e.g. TCA-wide or operator-specific data or based on a different subset of services).

6.41 Between 2005/06 and 2008/09 nominal fares increased by 18 per cent, between 2008/09 and 2011/12 fares increased by 7 per cent and between 2011/12 and 2012/13 fares increased by 3 per cent. The overall nominal fare increase between 2005/06 and 2012/13 can be calculated as follows:

- Add one to the percentage figures (i.e. 18 per cent becomes 1.18)
- Multiply these figures together (i.e. 1.18x1.07x1.03 = 1.30)
- Subtract one from this figure (i.e. 1.30 - 1 = 0.30)
- Therefore the overall percentage nominal fare increase is 30 per cent.

6.42 Going forward, TCAs and bus operators should make every effort to collect the relevant fare data for future calculations of the change in fares.

Non-zero fare concessionary schemes

6.43 The reimbursement factors produced by the Single Demand Curve can be used for a non-zero fare concessionary scheme.

6.44 For example, for a half fare scheme in PTE areas the PTE Single Demand Curve suggests that 76.8 per cent of the number of concessionary journeys observed would be made at full adult fare, and in non PTE areas the non-PTE Single Demand Curve suggests 74.2 per cent of the number of concessionary journeys observed would be made at full adult fare. These percentages would be the reimbursement factor to apply to the number of concessionary journeys observed at half fare. This example assumes that there has been no change in real fares since 2005/06. If real fares have increased, the reimbursement factor would be lower and if real fares have decreased, the reimbursement factor would be higher.

6.45 The average fare in the revenue forgone calculation would be the average fare that would have been paid in the absence of the concession minus the concessionary fare actually paid (half fare). The operator also receives the revenues from the half fare. This approach assumes that journeys made under the non-zero fare concession are separately counted from the journeys made under the zero fare concession.

7. Estimating Additional Costs

Introduction

7.1 In order to meet the principle of “no better, no worse off” bus operators should be reimbursed for the additional costs incurred as a result of the concessionary travel scheme. This section provides guidance on the procedure for calculating the amount of additional costs. It outlines a recommended approach, describes the unit values to be applied and when and where to apply those values. Annex E goes into more detail about the research and thinking behind the recommended approach.

7.2 This guidance is based in part on findings of detailed research about how different cost elements relate to demand for bus services and an approach that can be practically implemented by TCAs and operators with varying amounts of relevant data about the bus operations in their area. The default approach in this guidance does not require the building of complex models, but rather applies unit costs and relationships established from available empirical evidence to produce a rate of additional cost per passenger that is likely to be broadly right for the particular circumstances of a TCA and operator.

7.3 This guidance does not rule out the use of alternative approaches such as detailed network modelling or data analysis to estimate the effect on costs of passenger demand with and without journeys generated by the concessionary travel scheme. The application of an alternative approach depends on circumstances and in particular the availability of robust and verifiable data to populate models. It is desirable that such models should have a mechanism that includes the implications for the operator’s net revenues of changes in demand and frequency. If it is the opinion of the TCA or the operator that more reliable results could be obtained from an alternative approach then it may use that approach. Operators may also wish to suggest alternative approaches that the TCA could adopt, though the final choice of a locally appropriate methodology rests with the TCA.

7.4 The research has investigated differences in cost relationships between areas and, apart from a difference between PTE and non PTE areas, finds differences to be relatively small. However we recognise that this will not always be the case so local data and local relationships can be used where these are demonstrably more appropriate. We also recognise that a different approach may be needed in a small number of places where the frequency of services and route density is significantly untypical, or the size of operators is small. Particular criteria are described below.

Types of Additional Costs

7.5 For the purpose of this guidance additional costs fall into four categories plus a set of other generic issues:

- Scheme administration costs;
- Marginal operating costs;
- Marginal capacity costs;
- Peak vehicle requirements;
- Other issues.

Scheme Administration Costs

7.6 Costs associated with the production of concessionary passes will be borne by the TCA. There are, however, likely to be other administration costs such as publicity, ticketing, software changes and management time which will be incurred by the operator, for which reimbursement should be made. Management time and other costs to do with special requests for information are also included in this heading. It is reasonable to set against such costs the savings associated with bulk purchase of travel, such as a reduced need for fares information and promotion.

7.7 Regular information supplied by the operator to the TCA as part of the scheme, for example number of journeys, and costs to do with information about services, are covered as part of the marginal operating costs.

7.8 The relevant amounts are a matter for negotiation between the TCA and the operator.

Marginal Operating Costs

Definition

7.9 Marginal operating costs are the costs to a bus operator of carrying an additional passenger assuming a fixed level of service. The components of these costs comprise fuel, tyres and oil, maintenance and cleaning, insurance, information and additional time costs. These costs exclude operators' administration/management time.

7.10 Marginal operating costs are applicable to all eligible services and all eligible operators without the need for further information.

Recommended Value

7.11 The recommended value is **6.1p per generated journey** (at 2009/10 prices). Annex E provides further information on how this value was derived.

Variation by Journey Length

7.12 The marginal operating cost per additional concessionary passenger of 6.1p is based on an average journey length of 3.9 miles. If TCAs and operators have good evidence that the average concessionary journey length in their area is different from the default value, then they may use a local average concessionary journey length value instead and apply the following formula to calculate a marginal operating cost:

Marginal operating cost = 5.5 + 0.6 x [AverageConcessionaryJourneyLength (in miles) / 3.9]

All in pence 2009/10 prices

7.13 Evidence may come from surveys of passengers, observation of boardings and alightings or interpretation of ticket sales data. For the purposes of this guidance, evidence on the stage length of all concessionary journeys is sufficient (the distinction between the average stage length of generated and non-generated concessionary journeys is not essential).

Elements of Marginal Operating Costs

7.14 If there are local circumstances where one or more elements of the marginal operating costs is significantly higher or lower than the standard approach then the TCA and the operator may negotiate a different rate. The research findings on the bottom up approach to estimating marginal operating costs have the following components:

Table 7.1 Elements of marginal operating costs

Item	Marginal cost per generated concessionary passenger (pence, 2009/10 prices)	Percentage of total
Fuel, tyres & oil *Of which fuel*	0.4 *0.3*	8% *6%*
Maintenance & cleaning	0.1	2%
Insurance	2.7	54%
Information	0.5	10%

Additional time costs	1.3	26%
Total	**5.0***	**100**

* Note: ITS have identified a bottom up component approach to marginal costs. The total of these identified components comes to 5.0 pence. This is different from the recommended composite marginal operating costs of 6.1 pence. However in making any adjustment local variations to marginal operating costs they should be justified by reference to the components. If a change to any of the components is agreed then this change is scaled by the difference between 6.1 and 5.0. Thus if the agreed change is an increase of 0.5p in one of the components the recommended value is increased by 6.1*0.5/5.0 = 0.61 or to 6.71 pence (in 2009/10 prices).

7.15 The component values cited in the above table are deemed to be robust and should be applicable in most cases. However, if TCAs or operators have good evidence that the level of one or more of these components is significantly different in their area from that described above, then a revised level of marginal operating cost can be applied. However, components values should not be considered independently so as to avoid either party being selective with particular elements to the detriment of others. The guidance therefore suggests that a change should only be agreed when **all** components have been reviewed and evidenced.

7.16 The evidence to support a change should as far as possible be auditable and verifiable and clarify the way in which the calculation is different from the default value. For example in the case of fuel costs a variation on the default values should state assumptions about passengers per tonne of additional weight, fuel economy and effect of additional weight on fuel economy. The insurance cost rate quoted above includes an allowance for the higher level of claims by concessionary passengers. Auditable evidence on claims paid or insurance costs per concessionary passenger might support a different value, and operators may be required to provide appropriate information to inform the TCA’s judgement as to the appropriate rate to apply.

7.17 In cases where a different value is agreed by the TCA and operator then the overall marginal operating unit cost (6.1p) should be adjusted by a proportion using the relationship below:

Adjustment to Marginal Operating Cost = 6.1 x [**Agreed** item unit cost minus **Default** item unit cost] / 5.0

Marginal Capacity Costs

Definition

7.18 These are the costs to a bus operator of carrying additional passengers and allowing the capacity of bus services to increase, by using the existing bus fleet more intensively to provide that additional capacity through increased frequency.

7.19 Marginal capacity costs should be net of the additional revenue generated from commercial journeys that arise from increased frequency. These costs are additional to the marginal operating costs.

7.20 Additional marginal capacity costs arise from increased frequency. Issues relating to increased seating capacity (larger buses) are covered later on in the guidance in the ‘Other issues’ section.

When to Apply Marginal Capacity Costs

7.21 There is a presumption that marginal capacity costs could potentially apply to all routes within a network.

7.22 Additional marginal capacity costs arise from increased frequency. Issues relating to increased seating capacity (larger buses) are covered later on in the guidance in the ‘Other issues’ section.

Method to calculate marginal capacity costs

7.23 Marginal capacity costs can be calculated using the DfT MCC Calculator (which gives an estimate in pence per generated journey) or other methods such as counterfactual or hypothetical network models where available.

7.24 When using counterfactual or hypothetical network models, it is important that the counterfactual represents the service that would be provided by the operator in the absence of the concessionary scheme. It should not be assumed that the capacity provided before the introduction of the concessionary scheme represents the capacity that would have been provided in the current year in the absence of the concessionary scheme. The operator will need to be able to demonstrate that the capacity being provided is additional capacity compared to what would have been provided in the absence of the scheme, and that this additional capacity is a result of an increase in passenger numbers because of the concessionary scheme. This could for example include the need to evidence different timetables to carry the extra concessionary passengers, analysis of the pattern of commercial patronage to show that it has fallen and that the current pattern of services is maintained because of concessionary services. It should also take into account the limits to the level of service reduction which the operator could make if he were to ensure an attractive level of service to the commercial market.

DfT MCC Model[6]

Network approach to the calculations

7.25 The DfT MCC Calculator is a network model and as such **the preferred approach is to calculate marginal capacity costs at network level rather than route by route**, even though the data inputs to the model may only be available at route level.

7.26 However, TCAs and operators may wish to consider grouping routes/services with similar characteristics into subsets of networks rather than calculating an MCC for one single network.

7.27 The route data will need to be aggregated into network averages for use in the Calculator. Route data should be weighted using the number of journeys on each route. Annex J provides further advice on calculating network averages from route-level data.

Data inputs into the Calculator

7.28 It is recommended that local values should be used in the MCC Calculator where available. However default values have been provided should no local data be available. **It is advised that the Calculator is to be used with either all default values or all local values.** This is because mixing local and default values may distort the relationships between variables and lead to spurious results.

7.29 Some elements of the Calculator are fixed, such as the relationship between the change in demand and change in costs (Mohring factor), and the relationship between the change in service frequency and demand (frequency elasticity). These are fixed because they represent network averages.

7.30 Variables that can be varied locally include average bus occupancy, average speed, average one way bus route length (miles), average journey length, the proportion of journeys that are commercial fare paying in the period that the concession is valid and the average commercial fares. Where local data on these factors is not available, then default values are suggested in the Calculator (with the exception of the average commercial fare).

7.31 It is recommended that the default values for vehicle hour costs and vehicle mile costs (these are the cost elements which vary with time and with mileage) are used because of the difficulty in determining accurate local estimates. However, local values may be used where TCAs are confident that these estimates constitute an accurate, verifiable and auditable representation of marginal vehicle hour and vehicle mile costs (see further explanation below).

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[6] Annex H includes a worked example and Annex I includes a more detailed explanation of how the Marginal Capacity Cost Calculator works

7.32 The table below summarises the various inputs to the model and which variables can be varied locally. When local values are used, it is preferable where possible, to base these values on one full (financial) year of data making appropriate adjustments for seasonal oddities such as the Easter period falling twice in one (financial) year, to avoid the perception of favourable selection of data. Where it is not feasible, or disproportionately costly to provide one full year of data, it is important the sample of data chosen is demonstrated to be sufficiently reliable for users of the data to have confidence that the data being used is representative of the actual operator specific value.

Table 7.2 Summary of inputs to the cost model

Variable	Use default values	Use local values
Mohring factor	0.6	0.6
Speed	PTE – 8.8 mph Non-PTE – 10 mph	Local evidence
Average route length	PTE – 6.2 miles Non-PTE – 7.1 miles	Local evidence
Average journey length	PTE – 3.1 miles Non-PTE – 3.6 miles	Local evidence (or 50 per cent of route length)
Average occupancy	10 (passengers per bus mile)	Local evidence
Unit Costs (2009/10 prices) Vehicle hours Vehicle miles	 £13.30 £0.70	 £13.30* £0.70*
Demand response to service change	0.66	0.66
Commercial journeys as % of total in statutory concession period	60 per cent	Local evidence
Average commercial fare	Local evidence	Local evidence

* These may be varied locally subject to the caveats outlined below (Paragraph 7.43).

Vehicle miles & demand (Mohring factor)

7.33 This relationship is required to estimate the extent to which operators will change the frequency or network density of their services in response to changes in demand. It is a standard assumption that vehicle miles increase less than proportionately to demand.

7.34 For the purposes of this guidance we suggest using a **Mohring factor** of **0.6**, i.e. vehicle miles change by 0.6 per cent for every 1 per cent change in total demand. This is a network average and is therefore fixed whichever the approach chosen (default or local values).

Speed

7.35 The model provides a default **average speed** estimate of **8.8** mph and **10** mph for PTEs and non-PTEs respectively. The speed estimates should include turn times and recovery time but exclude scheduled breaks.

7.36 This variable can be varied locally. A detailed breakdown of speeds by broad area type and local area is available from CUBS (Comparison of Bus Systems)[7]. This data tends to cover urban areas.

Occupancy, journey length and route length

7.37 The default **average bus route length** is **6.2** miles in PTE areas and **7.1** miles in non-PTE areas. If operators or TCAs have good evidence that these averages in their local area are different then local averages may be used.

7.38 The default **average bus journey (boarding) length** is **3.1** miles in PTE areas and **3.6** miles in non-PTE areas. If operators or TCAs have good evidence that these averages in their local area are different then local averages may be used.

7.39 In many areas, average journey length data may not be readily available. It may be possible to derive an estimate using fare stage data. Alternatively, an estimate could be derived by making assumptions about the relationship between average journey length and route length. TCAs and operators could use a rule of thumb that the average journey length is about half the average route length. However, the 50 per cent rule of thumb may not apply for some types of services such as inter-urban services. TCAs and operators may wish to take into account how this relationship could vary depending on the nature of the routes under consideration.

7.40 The default value for **mean occupancy** is **10** passengers per bus mile. An estimate of average occupancy can be calculated from local data on total passenger journeys multiplied by the appropriate journey length and divided by local data on bus vehicle miles.

Unit costs

7.41 Marginal capacity costs are the costs of increasing the supply of bus services using resources from within the existing bus fleet. The costs

[7] http://cubs.reseaulutions.com/

include elements that vary with mileage and those that vary with time on the road.

7.42 The recommended cost rates are **£0.70 per vehicle mile** and **£13.30 per vehicle hour (in 2009/10 prices)**. These rates are applied to the calculated increase in vehicle miles and vehicle hours required to carry one additional passenger.

7.43 The derivation of these default values is explained in Annex E. It is recommended that the default values are used in the Calculator. Although data on vehicle costs may be readily available from operators' accounts, it is not straightforward to estimate a true marginal cost. As explained in Annex E, accounting models typically attribute elements of costs that may not necessarily be 'marginal' such as staff overheads and materials, vehicle maintenance and administrative staff. These costs are unlikely to vary with increases in the number of vehicle hours operated. For instance, for the purposes of calculating additional vehicle hour costs from an additional generated passenger, it is the costs that increase with additional vehicle hours that are relevant. However, if TCAs can satisfy themselves that locally derived values are an accurate measure of the true marginal unit costs and can be audited, then a local value could be used.

7.44 It should be noted that DfT default value for vehicle hour costs includes London (see Annex E for further details).

Commercial journeys as percentage of total journeys

7.45 The percentage of commercial journeys is used to derive average one way commercial boardings (by reference to the relevant average occupancy, average route length, and frequency). The number of commercial boardings is required to estimate the additional commercial revenue generated from the increased frequency (see MCC worked example in Annex H).

7.46 The figure should relate to the period during which the frequency effects take place. This is the same period over which the marginal capacity costs apply. Commercial journeys undertaken by children paying the full commercial child fare[8] should be included in the number of commercial journeys and in the number of total journeys, as these passengers occupy seats and generate a commercial revenue. It is most important that the definition of commercial journeys in this input is consistent with the definition used for the commercial fare (see below). The percentage of commercial journeys should be calculated as follows:

[8] Children paying the full commercial child fare excludes children paying a fare that is part of an arrangement with the local authority, such as a child concession

Commercial journeys as a percentage of total journeys =

[commercial adult journeys + commercial child journeys]

/

[[commercial adult journeys + commercial child journeys + concessionary older/disabled journeys]

Where 'child' journeys refer to children paying the full commercial child fares

7.47 In England outside London, total commercial bus journeys as a proportion of total journeys is around 66 per cent with little variation by broad area type (Source: DfT PSV survey).

7.48 A plausible estimate after 9.30 am is around **60 per cent**. If operators and TCAs have good evidence that commercial journeys as a percentage of total journeys in the period when the concession is available is significantly different in their local area then that data can be used.

Average commercial fare

7.49 The average fare to be used in the calculation of the offsetting revenue gain due to increased frequency of services should be the local average commercial fare per journey (including commercial adults and full-fare paying children), taking account of the different ticket types available to commercial passengers (e.g. cash fares, daily, weekly, monthly tickets and other season tickets such as three-monthly and annual tickets), their prices and the number of journeys made using the ticket. The fare data should be relevant to the operator or area to which the costs are being applied and should be consistent with the journey data used to estimate the percentage of commercial journeys. This fare is not the same as the average fare forgone (the fare that would have been paid by concessionary passengers in the absence of the scheme).

7.50 An example is shown below with illustrative figures:

Table 7.3 Calculation of the average commercial fare - Illustrative example

Type of ticket	Price (£)	Average Journeys per sale	Sales	Total Journeys (Sales * journeys per sale)	Revenue (Sales * price)
Single	1.50	1	500	500	750

Return	3	2	100	200	300
Daily	4	3	50	150	200
Weekly	20	18	30	540	600
Monthly	60	80	10	800	600
Totals				**2,190**	**2,450**
Average commercial revenue per journey = Total revenue / total journeys = **£1.12**					

7.51 The first three columns are local data inputs (where available). The last two columns are calculated. The average weighted fare is total revenue divided by total journeys.

Demand response to service change

7.52 Evidence suggests that demands responds to increased frequency of bus services. For the purposes of this guidance we recommend that a long run service elasticity of **0.66** should be used in all cases i.e. that for a 1 per cent increase in frequency a 0.66 per cent increase in demand will occur in the long term. Annex E discusses this in more detail.

Net revenue effect

7.53 The net additional revenue per journey should be deducted from the gross marginal capacity costs to give net marginal capacity costs. In some cases the net additional revenue per journey from commercial passengers may outweigh the gross marginal capacity cost from the generated concessionary passengers. In such cases the net costs are set to zero.

7.54 The calculation of the net revenue effect with the interaction of the demand response to service change, average fare and other factors is illustrated at Annex H.

7.55 The net marginal capacity costs are additional to the marginal operating costs.

Generated journeys

7.56 Marginal capacity costs are calculated per additional generated concessionary journey. This rate per journey is applied in the Calculator to the generated journeys. The generation factor used to estimate generated journeys should be derived from the reimbursement factor used in the calculation of revenue forgone (generation factor = 1-reimbursement factor).

Costs on subsidised journeys

7.57 Where the service is secured through Minimum Gross Cost tender, the level of service is specified in the contract. Given that the TCA takes on all revenue risk, the need for separate reimbursement for additional costs (additional capacity and marginal operating costs) does not arise.

7.58 Where the service is secured through Minimum Subsidy or Net Cost tender, the authority is determining the capacity it wishes to see provided so that additional capacity costs are covered through the tender process. However, in this case the operator should be reimbursed for the marginal operating cost of carrying additional passengers on that secured capacity.

Peak Vehicle Requirements (PVR)

Definition

7.59 These are the costs associated with the requirement to run additional vehicles in the peak period due to generated concessionary travel. Generated concessionary travel may add demand in the peak period of travel, change the peak period or not affect the peak period of travel. The latter is likely to apply in the majority of cases and in such circumstances no additional peak vehicle is required, and no peak vehicle costs are calculated.

When PVR Costs Apply

7.60 If the operator wishes to claim additional peak vehicle requirements then the operator must supply data and analysis to support such a claim. The expectation is that additional peak vehicle requirements will be exceptional so that operators will have to demonstrate that exceptional or unusual circumstances are relevant.

Evidence to Be Provided

7.61 Operators wishing to make a claim for additional peak vehicle costs will have to supply detailed data on passenger boardings by route by annual (or neutral period) average weekday half hour (or if not possible hourly) intervals for all services (individually) covered by the claim. As a minimum the time periods covered should be 0700 to1900 weekdays. If the existing peak of boardings (including concessionary travel) per hour or half hour, or the peak hour or half hour without generated concessionary travel is at the weekend, data should be supplied for the weekend hours as well.

7.62 Data on passenger boardings should be broken down into concessionary journeys under the statutory concession, other concessionary journeys and other journeys. In addition the concessionary journeys under the statutory concession should be split between journeys made because of the statutory concessionary travel scheme and those that would have been made at the relevant average adult fare in the absence of the concession. This split should use the generation factor derived in the revenue reimbursement part of the calculation and assume that the rate of generation is the same in all time periods.

7.63 This methodology does not imply that every peak demand is met in full by putting on extra buses. Operators should demonstrate the criteria they use to decide whether to put on extra services to meet peaks in commercial journeys or allow load factors to be above 100 per cent for short periods.

Calculation

7.64 The formula to use for working out the peak vehicle requirement (PVR) is derived from the peak vehicle requirement parameter of **£16,745** – this is the cost per vehicle per annum that has to be added to the fleet to cater for additional concessionary journeys (Annex E provides further information on how this value was derived).

7.65 This is a per year figure so equates to £64.40 per PVR per weekday or £1.61 per PVR seat per weekday assuming 260 weekdays per year and a mean of 40 seats per vehicle.

7.66 If the new peak lasts one hour and that each additional peak passenger blocks one seat for one route length, the PVR cost per **additional peak period passenger** can be estimated using the overall route time and speed. The calculation would be £1.61 multiplied by one way route time (expressed in hours, and based on local circumstances or defaults) = £[…] per additional journey in the peak hour (or period).

7.67 In cases where the peak period with and without additional concessionary journeys is the same time period, then the calculated unit cost per additional journey can be applied directly to the additional concessionary journeys in that peak period only to calculate a total peak vehicle requirement cost.

7.68 In cases where the peak period with generated concessionary journeys is different from the peak period without generated concessionary journeys, for example, where the pm peak is higher than the am peak, the calculation is slightly different. The unit cost may be different between the two periods if the one way route times are different, but otherwise would be the same. The additional concessionary journeys over which the unit cost is applied are the difference between journeys in the "with generated journeys" peak period minus journeys in the "without generated journeys" peak period.

7.69 In these calculations the period referred to may be an hour or half hour, but should be the same length of time, i.e. hour or half hour when comparing journeys in the peak period.

7.70 The following illustrative example demonstrates how the PVR calculations should be done:

PVR cost per additional peak period passenger (including profit allowance) = £1.50
Number of generated journeys on the service that has the additional PVR, and in the time period over which the PVR has been justified:
100 concessionary journeys * (1-reimbursement factor 0.5) = 50
Grossing up from weekday to annual = 260
Annual PVR cost for that service (in 2009/10 prices) = 260 x £1.50 x 50 = £19,500.

7.71 The peak vehicle requirement costs should be added to other elements of the additional cost calculation.

Profit

7.72 This guidance is informed by the relevant European regulations and case law. Regulation (EC) No 1370/2007 defines ‘reasonable profit’ as ‘a rate of return on capital that is normal for the sector in a given Member State and that takes account of the risk, or absence of risk, incurred by the public service operator by virtue of public authority intervention’.

7.73 Reasonable profit is defined therefore as **expected rate of return on capital invested** and not a constant profit margin on all costs. In cases where an increase in the peak vehicle requirement is identified this guidance recommends that the reimbursement should include an allowance for profit.

7.74 In the light of evidence from a recent research report (Review of Bus Profitability, DfT – see Annex E) this guidance recommends that where peak vehicle requirement is increased as a result of the additional concessionary journeys then a return on capital of 10 per cent is used and added to the PVR costs. This is done by obtaining the value of a vehicle and multiplying by **10 per cent**. This cost is then to be added to the £16,745 (See 7.52) above to calculate the total peak vehicle cost per additional passenger. Operators should derive the average value of a vehicle from their accounts, and this should be the average written down value and not the new value. Therefore the total peak vehicle requirement parameter cost should be

Total PVR cost = £16,745 + [Average written down value x 10%]

Other Issues

Seating Capacity

7.75 The unit costs and inputs in this guidance refer to an average seating capacity. It is recognised that a possible response to the increase in demand from generated concessionary travel would be to increase seating capacity rather than increase frequency of service. Where this is likely to be the case operators can submit, or may be required to provide, information on the extra costs arising from the use of larger buses, but these costs should not exceed the net costs of increasing frequency (including revenue effects) of using existing buses.

Different Types of Areas and Operators

7.76 The ITS research produced indicative cost rates for services in PTE and urban non-PTE areas. ITS also considered services in rural areas, and the relevant inputs that could be used. ITS noted that the calculations were problematic because they were based on frequency and route density effects normally found in urban areas. Also load factors on some services in rural areas may not warrant the application of marginal capacity costs. On the other hand some, perhaps many, services in rural areas serve urban areas and to some extent may have the same characteristics as services in urban non-PTE areas. There is no hard and fast rule as to what constitutes a rural service, but we suggest that where more than half of boardings are in rural areas then that service might come within the definition of rural. In the case of rural services so defined, this guidance suggests that the additional costs should be calculated as set out above, but that TCAs and operators should bear in mind that in order to meet the no better no worse off principle in domestic Regulations there is scope for variation in approach according to local circumstances, such as frequency of existing service and load factors.

7.77 The approach adopted in this guidance is appropriate for larger operators. In some cases smaller operators may find that the approach does not match their circumstances, for example ability to manage frequency changes within existing bus fleets. Operators with large fleets may find this easier as the variation in daily and hourly demand profiles for different services can be supplied from a common vehicle pool. Operators with small fleets (20 or less) may be less able to match supply with variations in demand from a common vehicle pool. In these cases this guidance suggests that small operators, in conjunction with the relevant TCA, should agree which aspects of the approach described in this guidance can be used and where different approaches are required. Different approaches should be evidence based and demonstrate that they are consistent with the 'no better, no worse off' principle. The evidence required to support a claim for a peak vehicle requirement would remain the same as described above.

Uprating Figures

7.78 The marginal operating, marginal capacity and peak vehicle requirement unit cost figures quoted in the guidance are in **2009/10 prices**. To update to the prices of future years for the purpose of calculating reimbursement in those years this guidance recommends that the actual or forecast GDP Deflator index should be used to uprate costs. This is done automatically in the Calculator. The GDP deflator is regularly published and updated on the HM Treasury website.

7.79 The GDP deflator is the price index of domestic production. The guidance suggests using this index for future uprating of costs because it reflects general trends in costs and productivity and provides incentives to undertake productivity improvements when costs increase.

7.80 Other inputs to the calculation such as journey lengths should be left unchanged unless there is good evidence to change them.

ANNEX A: Regulation (EC) No 1370/2007

Rules applicable to compensation in the cases referred to in Article 6(1)

The compensation connected with public service contracts awarded directly in accordance with Article 5(2), (4), (5) or (6) or with a general rule must be calculated in accordance with the rules laid down in this Annex.

The compensation may not exceed an amount corresponding to the net financial effect equivalent to the total of the effects, positive or negative, of compliance with the public service obligation on the costs and revenue of the public service operator. The effects shall be assessed by comparing the situation where the public service obligation is met with the situation which would have existed if the obligation had not been met. In order to calculate the net financial effect, the competent authority shall be guided by the following scheme:

- costs incurred in relation to a public service obligation or a bundle of public service obligations imposed by the competent authority/authorities, contained in a public service contract and/or in a general rule,
- minus any positive financial effects generated within the network operated under the public service obligation(s) in question,
- minus receipts from tariff or any other revenue generated while fulfilling the public service obligation(s) in question,
- plus a reasonable profit,
- equals net financial effect.

Compliance with the public service obligation may have an impact on possible transport activities of an operator beyond the public service obligation(s) in question. In order to avoid overcompensation or lack of compensation, quantifiable financial effects on the operators networks concerned shall therefore be taken into account when calculating the net financial effect.

Costs and revenue must be calculated in accordance with the accounting and tax rules in force.

In order to increase transparency and avoid cross-subsidies, where a public service operator not only operates compensated services subject to public transport service obligations, but also engages in other activities, the accounts of the said public services must be separated so as to meet at least the following conditions:

- the operating accounts corresponding to each of these activities must be separate and the proportion of the corresponding assets and the fixed costs must be allocated in accordance with the accounting and tax rules in force,
- all variable costs, an appropriate contribution to the fixed costs and a reasonable profit connected with any other activity of the public service operator may under no circumstances be charged to the public service in question,
- the costs of the public service must be balanced by operating revenue and payments from public authorities, without any possibility of transfer of revenue to another sector of the public service operator's activity.

'Reasonable profit' must be taken to mean a rate of return on capital that is normal for the sector in a given Member State and that takes account of the risk, or absence of risk, incurred by the public service operator by virtue of public authority intervention.

The method of compensation must promote the maintenance or development of:

- effective management by the public service operator, which can be the subject of an objective assessment, and
- the provision of passenger transport services of a sufficiently high standard.

ANNEX B: Glossary of Terms

Bus Journey

A bus journey is defined as a single bus boarding. The journey starts when the concessionary passenger boards the bus at a bus stop and ends when the passenger alights the bus. A journey is different from a trip in that a trip can include several separate bus boardings/journeys. However, the word 'trip' can sometimes be used to mean ‘journey’ in such expressions as 'trip frequency', 'trip rate', 'trip making'.

Revenue Forgone

The revenue operators would have received from those concessionary passengers who would otherwise have travelled and paid for a (full fare or discounted) ticket in the absence of a concession. It is the product of the number of journeys made in the absence of a concession and the average fare forgone.

Additional Costs

The costs imposed on an operator by the existence of the concession that would not otherwise have been incurred. Additional costs can take the form of scheme administration costs, marginal operating costs, marginal capacity costs and peak vehicle requirement costs.

Reimbursement Factor

The number of journeys estimated to be made at ‘average fare forgone’ as a proportion of total journeys that are observed to be made at zero fare. The reimbursement factor is applied to the number of observed concessionary journeys at zero fare to estimate the number of journeys that would have been made in the absence of the scheme (non-generated journeys) and to determine the amount of revenue forgone. The reimbursement factor is closely related to the generation factor (mathematically RF = 1 / (1+GF)) and hence the fare elasticity. The higher the fare, the lower the reimbursement factor. The larger the increase in fare, the lower the reimbursement factor.

Non-Generated Journeys

Non-generated journeys are those journeys that are estimated to be made by concessionary bus passholders in the absence of the free fare scheme, if they had to pay ‘the average fare forgone’.

Generated Journeys

Generated journeys are those journeys that are made by concessionary bus passholders as a result of a reduction in fares – these are in addition to the non-generated journeys that would have happened anyway.

Generation Factor

The generation factor (GF) is a measure of the increase in journeys, relative to the previous level of journeys, as a result of a reduction in fares. For example, a generation factor of 50 per cent at half fare means that journeys have increased by 50 per cent (as a proportion of the original number of journeys) as a result of moving from full fare to half fare. Thus the definition of generation depends on the starting point. In this guidance, other than where stated, generation is based on patronage that would have occurred with ‘average fare forgone’ being charged.

Average Fare Forgone

This is the average fare that bus operators would have received from concessionary passengers in the absence of the free fare concession.

Discount Factor

The average fare forgone will be a weighted average of the single, daily, weekly and other period tickets that concessionary passengers would have bought in the absence of the scheme. This is generally expected to be lower than a single cash fare. So a discount factor is applied to the cash fare to obtain an estimate of the average fare forgone.

Demand Curve

The demand curve is the relationship between the price of a particular good and the quantity that is demanded by consumers at that price. As a general rule, the demand curve slopes downward from left to right. So the higher the price, the lower will be the quantity demanded, holding all other factors constant. This general rule is expected to hold for the concessionary market where the higher the fare, the lower will be the number of journeys made, holding all other factors constant.

Fare Elasticity

The fare elasticity in economics refers to the slope of the demand curve or alternatively the proportionate change in quantity demanded of a particular good with a proportionate change in its price. In the context of the demand curve for the concessionary market, an increase in fares is expected to produce a less than proportionate reduction in demand. Depending on the functional form of the demand curve, the elasticity at different points on the demand curve can vary proportionately with fares, or less than proportionately with fares.

Damping Factor

For the concessionary market, it is expected that the fare elasticity will increase less than proportionally with higher fares. The damping factor λ can be between 0 and 1. As λ approaches zero (the higher the damping), the point elasticity is both closer to zero and is less sensitive to the fare.

Marginal Cost

In economics, the marginal cost is the change in total cost when the quantity produced changes by one incremental unit. In the context of reimbursement, the marginal cost is the increment in total cost that arises from one extra generated concessionary passenger journey.

Marginal Operating Cost

The marginal operating costs associated with an incremental passenger are the costs to an operator of additional (generated) concessionary journeys without any change in service capacity. These costs include wear and tear, insurance and fuel costs associated with the extra journeys.

Marginal Capacity Cost

If journey generation from concessionary passengers at free fare results in operators having to increase their service frequencies by using their existing fleet of vehicles, they will incur some additional costs beyond the marginal operating costs. These costs will include the additional fuel costs, bus driver costs etc of running the extra services.

Peak Vehicle Requirement Costs (PVR)

If journey generation from concessionary passengers at free fare during peak hours results in operators having to extend their bus fleet, the additional costs that are incurred, i.e. the costs of purchasing the new vehicle, additional bus driver costs etc, are referred to as the PVR costs.

Mohring Factor

The Mohring factor is an estimate of the responsiveness of service frequency or network density of their services in response to changes in demand. It is expected that vehicle miles change in less than proportion to demand.

ANNEX C: Economic Principles

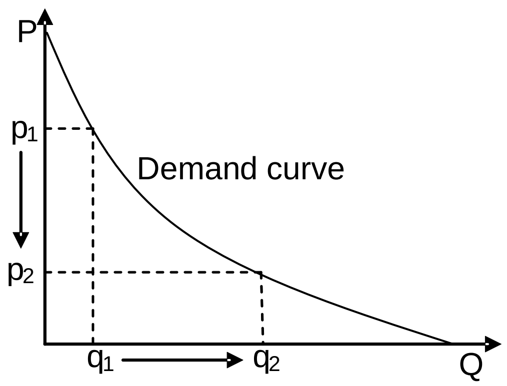
Introduction

C.1 This Annex provides some theoretical background on some of the economic principles which underpin concessionary travel reimbursement. Further information can be found in ITS Research Paper Economic Principles Underlying Reimbursement.

The Relationship between Price and Demand

C.2 The amount of any good or service that people buy depends, among other things, on its price. The relationship between the price of a particular good and the quantity that is demanded at any such price level is described by the demand curve. An illustrative example is shown below:

Figure C.1 Demand curve



C.3 In the figure above, the x-axis is the quantity of the particular good demanded and the y-axis is the price of that particular good. Generally the demand curve is expected to slope downwards from left to right indicating that the higher the price the lower the quantity demanded will be. As illustrated, a reduction in price from p1 to p2 leads to an increase in the quantity demanded from q1 to q2.

C.4 Another important aspect of the demand curve is its slope. The steeper the demand curve, the less responsive people's demand will be to a change in price. The slope of the demand curve at any particular point is referred to as the point elasticity of demand. This elasticity is usually negative as the demand curve slopes downward from left to right – people buy more as the price falls. However, for convenience, in discussions of the price elasticity the sign is often omitted, and 'higher' elasticity values are generally meant to refer to larger elasticity values in absolute terms (so an elasticity of 0.5 might be referred to as being larger than an elasticity of -0.4).

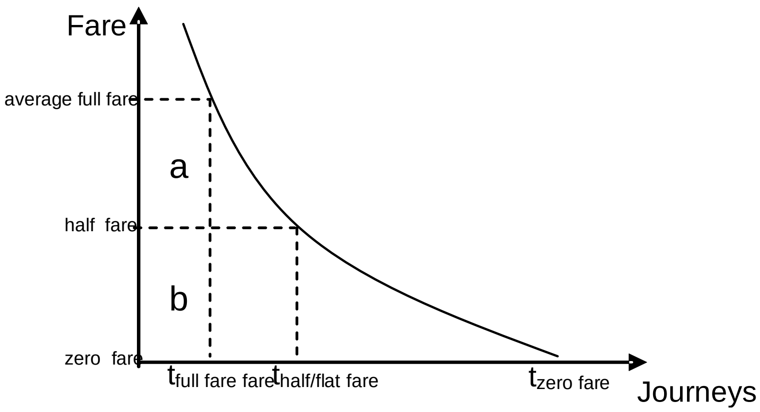
Demand for Bus Travel

C.5 The demand for bus travel is no different from that for other goods and services. As ticket prices change so do the number of journeys made by bus. The existence of concessionary fares schemes means that eligible travellers face much lower prices (in fact, zero outside the am-peak in most areas) and thus we would expect there to be more journeys made by these people than in the absence of a scheme. Indeed there is very strong evidence to support a relationship between falling fares and more bus passengers. This aggregate evidence, however, disguises the fact that there are two distinct groups responding to this fall: those that already use buses and those that start to use them only as a result of the improved price, or 'offer'. It is likely that these two groups behave differently.

C.6 The demand for essential goods and services tends to be more inelastic than demand for "luxuries" i.e. the quantity demanded is less responsive to changes in price. In the context of bus users, demand for journeys to the nearest place where they can buy reasonably-priced food is likely to be less elastic than demand for journeys to distant places. People who are in employment (and many older and disabled people work) will have relatively inelastic demand for their journey to work. If they have no alternative means of travel (car, train, bicycle) their demand will be still more inelastic.

The Impact of Free Fares on Concessionary Travel

Figure C.2 Impact of free fares on demand for concessionary travel



C.7 The figure above illustrates the impact of the move from full fare to a half-fare scheme (as in most TCAs) and then to free local and national travel in 2005/06. The y-axis gives the average fare and the x-axis the number of journeys made purchased (in a year) for local bus travel. If the average fare falls from **full fare** to **half/flat fare**, then $\mathbf{t}_{\text{half/flat fare}}$ will be demanded. If the fare falls to zero then $\mathbf{t}_{\text{zero fare}}$ will be demanded. This represents the amount of concessionary travel in the first year of free local bus travel.

C.8 In the absence of any concession the operator earns an amount equal to the number of journeys multiplied by the (average) full fare, here represented by the areas **a** and **b** (setting aside additional costs at this stage). Under a free fare scheme the operator earns no revenue from concessionary passengers. The operator needs to be reimbursed for the lost revenue from those who would have travelled at full price i.e. the areas **a** and **b**.

C.9 The difference between $\mathbf{t}_{\text{full fare}}$ and $\mathbf{t}_{\text{zero fare}}$ represents the number of additional journeys that are made by concessionary travel passholders because of the introduction of the free fare. To estimate the revenue forgone by the operator, the recommended approach is to apply an adjustment factor to $\mathbf{t}_{\text{zero fare}}$ to give revenue of **a + b**. This is obtained by applying a factor called the **Reimbursement Factor (RF)** to the average full fare. It is the reimbursement factor that determines the number of generated journeys and it is estimated to ensure that the operator receives the revenue he would have originally received in the absence of a scheme.

The Reimbursement Factor

C.10 The reimbursement factor is the proportion of journeys that are made at zero fare that would have been made in the absence of the concession.

Reimbursement Factor =

$$\frac{\textbf{Estimated}\text{ journeys made in the absence of the free scheme}}{\textbf{Observed}\text{ journeys made at free fare}}$$

The Generation Factor

C.11 The generation factor is the proportion of journeys that are made at zero fare in addition to those to those that would have been made in the absence of the concession.

Generation Factor =

$$\frac{\text{Observed journeys made at zero fare minus Estimated journeys made at full fare}}{\text{Observed journeys made at free fare}}$$

C.12 Therefore, the higher the reimbursement factor, the lower the generation factor and vice versa.

Fare Elasticity of Demand and the Reimbursement Factor

C.13 There is a direct relationship between the fare elasticity of demand and the reimbursement factor. At higher fare elasticities, people are more sensitive to changes in fare, and the reduction in journeys in moving from free fares to the full fare will thus be greater than if lower elasticities apply. Therefore, holding all other factors constant, the higher the elasticity, the lower the reimbursement factor will be and vice versa.

Demand and the Reimbursement Factor

C.14 The calculation of the reimbursement factor requires the estimation of a demand curve for the whole concessionary travel market and thereby an estimate of the number of journeys made at full fare.

The Shape of the Demand Curve

C.15 The demand curve can take one of several shapes depending on the specific characteristics of the market. Empirical evidence on the shape of the demand curve for the concessionary travel market is not clear-cut and a number of different sources of data, logical argument and assumptions are needed for its estimation. There is evidence on the behaviour of the adult commercial market in the region of adult full fares and the evidence about the concessionary market in the range of half to zero fare, or flat fare to zero fare. However, there is no recent information on the actual observed behaviour of eligible concessionary passholders between half fare and full fares so some extrapolation is required.

C.16 Based on the recommendations of ITS research, the preferred demand function is a damped negative exponential curve taking the following form:

$$T = ke^{\beta F^{\lambda}}$$

where:

e = Mathematical constant (2.7183 to four decimal places)
T = Number of bus journeys at fare F
k = Constant
β = Elasticity Constant
λ = Damping factor (0> λ >1)

C.17 This functional form is referred to as the ***damped negative exponential curve***. It has the following desirable properties:

- It crosses the x-axis implying a finite number of concessionary journeys at zero fare.

- The elasticity is damped by λ so that a proportionate change in fares will result in a less than proportionate change in demand elasticity.

The Damping Factor and Old and New Passholder Elasticities

C.18 The aggregate demand curve for concessionary bus journeys encompasses submarkets with different characteristics. There are those who took up the concessionary bus pass when they became eligible at the half fare, these passholders are referred to as old passholders. In addition, there are those who signed up for the bus pass just because of the introduction of the free fare scheme. People in this segment are referred to as new passholders. There is good reason to expect that the demand patterns and the responsiveness to changes in fares for these two market segments are different with new passholders being more sensitive to changes in prices and thus having higher elasticities of demand. In aggregating these two submarkets into a Single Demand Curve, the demand elasticity will be a weighted average of the submarket elasticities. These weights change as fares increase as at higher fares, we would expect a higher proportion of the highly elastic submarket or the new passholders, will stop making many of their journeys with their concessionary bus pass. The elasticity must be damped to take these factors into account.

C.19 The formula for a fare elasticity based on the negative exponential demand curve is:

Fare Elasticity = $\lambda \beta F^{\lambda}$

C.20 The exact relationship between fares and fare elasticity depends on the exact magnitude of λ:

- A λ= 1 implies that the fare elasticity varies in exact proportion to fares, i.e. the fare elasticity is equal to βF. So a 5 per cent increase in fares will lead to a 5 per cent increase in the fare elasticity.
- With 0<λ<1, the fare elasticity varies less than proportionately with fares.

C.21 For instance with λ = 0.9 (low damping), the fare elasticity is 0.9β and a with λ = 0.3 (high damping), the fare elasticity is 0.3β. It follows from this simplified example that with low damping (0.9), the fare elasticity will be more sensitive to fare changes than with high damping (0.3).

C.22 The formula for a Reimbursement Factor based on the negative exponential demand curve is:

Reimbursement Factor = $e^{\beta F^{\lambda}}$

C.23 With low values of λ (implying high damping), the reimbursement factor will be much higher in comparison to fare elasticity with λ=1. On the other hand, at high values of λ (implying lower damping), the reimbursement factor will only be slightly lower than the fare elasticity at λ=1.

ANNEX D: Reimbursement Worked Example

200 **concessionary journeys** are observed to be made by concessionary passholders today.

Of those, 90 journeys would have been made even if passengers had to pay a full fare in the absence of the scheme. There are therefore 90 **non-generated journeys** for which the operator needs to be reimbursed fully (i.e. at full fare)

The **reimbursement factor (RF)** is 90/200 = 45%.

These 90 journeys would have been made at an average fare of £1.50 (the **average fare forgone**).

The **revenue forgone** by the operator (that she/he would have received in the absence of the scheme) is thus 45%*200*£1.50 = £135.

The remainder (110) of the observed journeys are **generated journeys**, journeys being made because travel is free.

The **generation factor** is 110/200 = 55% (i.e. 100%-RF).

For these journeys, operators are reimbursed the additional costs they have incurred as a result of passengers travelling because it is free. There are two main components to these additional costs (in addition to scheme administration costs and potential PVR costs): marginal operating costs and marginal capacity costs.

In this case, marginal operating costs are paid at 6.1p per generated journey. These are the additional costs from having to carry additional passengers with the same level of service.

Total marginal operating costs due to operators are 200*55%*£0.061 = £6.71.

In this case, marginal capacity costs apply and are reimbursed at 10p per generated journey. These are the costs incurred from having to increase the frequency of the service to cater for the increased demand.

Total marginal capacity costs due to operators are 200*55%*£0.10 = £11.

PVR costs do not apply in this case.

Total reimbursement due is the sum of the revenue forgone and additional costs: £135+£6.71+£11 = £152.71.

This represents an **average reimbursement** of £152.71/200 = £0.76 per observed concessionary journey.

ANNEX E: Research and Summary of Evidence

Introduction

E.1 The advice provided in the guidance draws from extensive research commissioned by DfT from a research consortium led by the Institute for Transport Studies (ITS) at Leeds University.

E.2 The purpose of the research was to investigate the factors influencing the reimbursement of bus operators for concessionary travel using the latest data available with a view to develop a robust, evidence-based framework for estimating concessionary travel reimbursement.

E.3 The research team produced ten research reports which are available on the DfT website:

Table E.1 ITS research reports

Research Report Number (RP)	Title
1	*Economic Principles*
2	*Issues Relating to Average Fares*
3	*Analysis of Concessionary Passholder Data from Lancashire and Nottingham*
4	*Shape of the Demand Curve*
5	*Elasticity Estimates from PTE and MCL Datasets*
6	*Analysis of the National Travel Survey Data*
7	*Survey Report*
8	*Whole Market Demand Elasticity Variation*
9	*Costs*
10	*Concessionary Fares Main Report* (final summary report)

E.4 This Annex provides a summary of ITS main research findings and other relevant evidence which underpins the reimbursement calculation methods described in the guidance.

Average Fare

Characteristics of the NoWcard Data

E.5 Journey data was extracted for all concessionary journeys made by passholders from four TCAs in the NoWcard consortium for a five week period from 22nd February to 28th March 2009, two weeks before Easter. All four Districts are relatively urban in character, but they are not parts of contiguous large urban areas, and they each include some non- urban and rural areas to varying degrees.

E.6 Data has been provided for approximately 90,000 passholders, and nearly 600,000 concessionary journeys. These are defined as those starting in the NoWcard area on smartcard-enabled buses.

E.7 The data therefore exclude journeys made by card holders outside the NoWcard area and journeys in the NoWcard area made by card holders living outside the four districts.

E.8 The journey totals include peak concessionary journeys made before 9:30 am on weekdays by disabled passholders, the majority of whom will have paid a £0.50 flat fare. These represent about 1.25 per cent of the total.

Demand

Evidence on Elasticities

E.9 While there has been considerable academic interest in the magnitude of fare elasticities in existing research, not much of past research has been focused specifically on the concessionary travel market. Therefore only some basic inferences can be made into the nature of the market from such past studies. For the purposes of reimbursement, obtaining elasticity estimates that pertain to the concessionary market is absolutely vital and the ITS research explored the following data sources among others, to obtain elasticities specific to the concessionary market for bus journeys in England:

- The National Travel Survey (NTS);
- The Department for Transport STATS100A database of bus traffic and revenue;
- Scheme specific data on concessionary journeys following the introduction of free travel in four PTE areas and seven Shire Counties;
- A specifically commissioned telephone survey of those eligible for the concession on the basis of their age.

E.10 A brief description of the key features of these data sources and the inferences that were made from them is provided in the following table:

Table E.2 Concessionary travel elasticities: sources of evidence

Source	**Description**	**Inferences**
PTE/Shire Data	Data on concessionary journeys and pass holding before and after the introduction of the local free fare scheme in 2006	- Actual number of journeys made at free fare in 2008/9 and number of journeys made at half/flat fare in 2005/6 - New passholders made up 10percent of all passholders in PTE areas and 40percent in the Counties - PTE point elasticity of –0.54 at £1 in 2005/6 prices and -0.55 in Counties - Estimates of average fare forgone of £1.12(PTE) and £1.20(Non PTE) in 2005/6 prices
STATS100A	Econometric estimation of whole market elasticities split between concessionary and commercial travellers in PTE areas	- Whole market long run point elasticity in the range of -0.3 to -0.4 at prevailing average revenue per journey including one day and period tickets is supported - No systematic variation in elasticities with average revenue per journey - No systematic regional variation in elasticity according to county type - Commercial market long run elasticities of ranging from -0.4 and -0.52 for PTEs
NTS Analysis	Panel data giving trip rates over a long period of time capturing changes that occurred to the concessionary scheme overtime	- The trip frequency distribution of passholders - In the absence of the zero fare scheme, concessionary travel would have declined by -3.0percent p.a. in PTE areas and -1.7percent p.a. in non PTE areas - Trends in car ownership and licence holding of bus users. - Analysis of NTS enabled trip rate models show that the introduction of the free fare scheme increased journeys rates by 26.5percent in PTEs and 45.4percent in Shires. The implied elasticities at full fare are -0.65 in the Mets and -0.75 in the Shires in 2008.
Telephone Survey	ITS Commissioned research on eligible concessionary travellers based on a Stated Intentions Approach	- Full fare elasticity of -0.58 using a proportional elasticity model. - By area type: -0.47 for Mets, -0.53 for the Unitaries and -0.60 for Shire districts. - Half fare/flat fare elasticity of -0.17 for Metropolitan areas, -0.27 for Unitaries and -0.3 for Shire districts at the prevailing concessionary fare

E.11 The ITS research recommends that long run elasticities are the most appropriate to be used for the purposes of concessionary travel reimbursement. Short run elasticities or the concessionaire reactions immediately after the introduction of the zero fare concession in terms of journeys demanded will not take full account of adjustments made by concessionary travellers to travel patterns and will likely underestimate their fare elasticity.

E.12 Based on the inferences from the various data sources and academic judgement, the ITS research gives the following as their estimates of long run elasticities at "average full fare" as follows:

Table E.3 Long-run elasticities at average full fare

	Central Estimate	**Reasonable Range**
PTE	-0.5	-0.45 to -0.55
Non-PTE	-0.65	-0.60 to -0.70

E.13 Further information on the derivation of the elasticities can be found in ITS *Concessionary Fares Main Report* (Research Report 10).

E.14 Beyond this disaggregation in elasticities by PTE and Non-PTE areas, the ITS research did not find any other significant variation in elasticities by any other detailed disaggregation by area type, income or age.

The Treatment of New Passholders

E.15 As mentioned previously, one of the key outcomes of the free fare concession has been to expand the concessionary bus journey market to include new passholders. Given the inherent differences in the characteristics between new and old passholders, for the derivation of the relevant Single Demand Curve for the entire market, an estimate of the proportion of total journeys that are made by new passholders is required.

E.16 The NTS data shows that while increases in pass holding in PTE areas have been fairly modest, the increase in pass holding in non-PTE areas is significantly higher. Data on observed journeys made after the introduction of the free fare concession does not distinguish between new and old passholders.

E.17 New passholders can be categorised into:

- Type I: Those who become eligible for the concession because they have reached the pensionable age
- Type II: Individuals eligible for the statutory concession but those who previously opted for alternatives to bus travel made available by TCAs such as tokens.

- Type III: Individuals who had chosen not to obtain the free bus pass prior to free bus travel being introduced.

Evidence on the Relationship between New and Old Passholder Trip Rates

E.18 The most quoted source of data on the relationship between trip rates by old and new passholders is the MVA study on the impact of the Welsh Assembly Government's free concessionary fare scheme. Survey data was collected on passholders that allowed the comparison of trip rates of old and new passholders. New passholders were simply defined as those who obtained a pass after free travel was introduced, so this includes both Type I and Type II passholders. The data published by this study suggest an all Wales average weekly trip rate ratio between new and old passholders of 46 per cent.

E.19 The ITS research team also had access to Smartcard data on concessionary travel patterns of residents in parts of Lancashire and Nottingham following the introduction of the English National Concession in 2008. On average, this data showed that Type III new passholders made half the number of journeys per week of those of old passholders of the same age. i.e. new passholder trip rates are approximately 50percent of old passholders' trip rates.

Estimating the Relevant Demand Curve

E.20 In the transition period from the half/flat fare scheme and zero fare scheme, there have been many changes in the concessionary market with Old Passholders making more journeys and new passholders taking up the bus pass and making bus journeys. The impact of all these changes has been to widen the concessionary bus travel market including a higher proportion of car owners. Car owners are expected to have higher fare elasticities as they have the choice of making any journey either by car or by bus and are more likely to drop out of the concessionary travel market at higher fares than non-car owners.

E.21 So as discussed above, the aggregated Single Demand Curve for old passholders who have a lower level of car ownership and new passholders who have a higher level of car ownership will be shallower in the region from half fare to free fare. If the zero fare concessionary policy is reversed, then it is expected that with a sufficient time lag, the new sub market will drop out again. Based on this assumption it is expected that between half/flat and full fare, the market will only consist of **old passholders**, so the upper segment of the curve must largely represent the characteristics of **old passholders**. The damping factor λ for the old passholders' demand curve is predicted to be in the range of 0.8 for PTEs and 0.9 for Non-PTEs. This reflects the view that the proportionate reduction in journeys made by old passholders declines with higher fares.

E.22 So with an upper section with relatively low fare elasticity (because it largely represents old passholders) and a lower section with higher fare elasticity (representing old and new passholders), a damping factor within the range of 0.7 is plausible for the aggregate Single Demand Curve for both PTE and Non-PTE areas.

Abstraction

E.23 New passholders and some of the old passholders (prior to the introduction of the national concessionary scheme) would have paid commercial fares to make bus journeys in the absence of the scheme. It is therefore reasonable to expect that these passholders would instead of dropping out completely from the market from half fare and above, will instead actually make some additional journeys at the higher fare.

E.24 Given evidence from the telephone survey suggesting that only a small proportion of the growth in journeys made by concessionaires in 2008/9 was due to cross boundary and out of area journeys, the issue of abstraction is more relevant to New Passholders.

$$\text{The abstraction ratio} = \frac{\text{Journeys made at commercial fare before the take up of concessionary bus pass}}{\text{Journeys made after take up of concessionary bus pass}}$$

E.25 From the NTS analysis we have:

Table E.4 Trip frequencies from the National Travel Survey		
	2003-2006 (half/flat fare)	**2006-2008 (free local travel)**
Passholders	55 percent making 2.3 journeys/week	65 percent
Non passholders	45 percent making 0.3 journeys/week	35 percent

E.26 From the before and after data of the NTS sample it can be inferred that roughly 10 percent of the sample in 2006-2008 are those who switched into pass holding from not holding a pass pre-2006. Old passholders make more journeys because of the free fare concession, so it is plausible to assume that their trip rate has risen to about 2.6 journeys per week after the introduction of the free fare scheme from about 2.3 journeys/week before. From the discussion above, it is also known that the rate of new passholder journeys is roughly half that of old passholder journeys. Therefore the new passholders in the sample of those with passes in 2006-2008 make approximately 1.3 journeys per week. Those who switch from not holding a free pass at half fare are likely to be more active in terms of trip making to those who do not switch to holding a free bus pass to make it worthwhile for them to take up the pass. It is therefore assumed that the new passholders who switch made 0.4 journeys per week compared to the average of all non-passholders prior to the free fare scheme introduction in 2005/06.

E.27 Thus the journeys per week made at commercial fare by new passholders before free bus pass take up are 0.4 and journeys per week at free fare are 1.3.

The abstraction ratio = 0.4/1.3 ≈ 30 percent

E.28 With a New Passholder trip rates of 5.8 per cent and 23.2 per cent in PTEs and Non-PTEs respectively, applying a 30percent abstraction ratio gives an increase in journeys at every fare level above half fare of 1.74 per cent and 6.96 per cent respectively.

Derivation of the Single Demand Curve

E.29 With all of the above assumptions and evidence, we can map two separate Single Demand Curves for PTE and Non-PTE areas that estimate the level of demand for bus journeys at every fare level for the whole concessionary market. The appropriate reimbursement factor that corresponds to the estimation of the local average forgone can then be read off the relevant Single Demand Curve.

E.30 Most of the data on which the Single Demand Curve analysis relies was initially collected for operational purposes, in order to calculate periodic reimbursement payments to bus operators. It was never intended to be used for time series analysis. Much detailed work has been necessary to ensure that comparisons between years for individual scheme data are not coloured by changes that are not related to the introduction of statutory free travel, or year-on-year changes in the nature of the concessions offered.

Additional costs

Marginal Operating Costs

E.31 The paragraphs below outlines the original ITS findings and recommendations on marginal operating costs. A few arithmetic miscalculations and inconsistencies in the original input values used in calculating the operator capacity cost were subsequently uncovered. This has led to a revision of the initial MOC estimate from ITS. A one-off adjustment has also been made to the figure to take account of the 20 per cent reduction in the Bus Subsidy Operator Grant (BSOG) on 1 April

2012. The original calculations and subsequent changes are explained below.

ITS Research Report results

E.32 The research considered evidence from three different types of sources: (i) a new econometric model of bus operator costs, based on data for the period 1999–2007; (ii) past claims and settlements; and (iii) evidence from official statistics, the industry and academic research on the individual sub-components of marginal cost such as fuel and insurance.

E.33 The econometric model combines data from STATS 100 and TAS using operator level data. Total cost is the dependent variable and explanatory variables comprise final outputs (journeys), and intermediate outputs (vehicle miles, peak vehicle requirement). The preferred model is a translog function. The marginal cost per additional journey is calculated as the derivative of dTC/dQ where TC is total costs and Q is the number of trips holding vehicle miles and vehicle fleet constant. The model has a good fit to the data. The coefficient on the journey variable is not quite significant at the 95 per cent confidence interval. The estimated marginal cost per journey from this model is estimated to be 8p.

E.34 The sub-components approach presented in the ITS research report estimated that operating costs add up to 6.7p per generated concessionary journey. The estimates of the different sub-components are derived from a variety of sources including official publications, industry data and academic research.

E.35 Recent claims and settlements were considered. There are problems with interpreting this data due to concern about whether quoted costs are average rather than marginal and whether costs include an element of additional capacity costs. A wide range of 1p to 15.3p per additional journey is found in this data.

E.36 The research gives most weight to the econometric and bottom-up estimates, with most weight given to the latter given the wide confidence interval on the econometric results. The research report recommends a mean value per generated passenger journey outside London of 7.2 pence (at 2009/10 prices).

E.37 The research also considered varying the marginal cost estimate for journey length. This variation is justified given the variation in fuel, tyres and oil, and maintenance and cleaning costs with distance. The recommended approach is composed of a fixed element, 4.2 pence, and an element that is variable with distance[9]. The average bus stage length

[9] The formula to adjust marginal operating costs per generated concessionary passenger by journey length is 5.5+0.6*(average journey length, (miles)/3.9) (all in pence 2009/10 prices).

of concessionary passengers is 4.1 miles from the National Travel Survey 2008.

Revisions to the recommended MOC estimate

E.38 Arithmetic miscalculations have been found to affect some of the components of the bottom-up estimate of marginal operating costs. The estimates of these components have been revised as a result. Some of the revisions have been made to ensure consistency of approach with other elements of the guidance. The changes are outlined below.

Fuel cost

E.39 The fuel cost component was originally estimated at 1.5p per generated passenger (2009/10 prices). The following issues were identified:

a. The fuel price used in the original calculation excluded all tax and duty. However, the BSOG rate only partly compensates bus operators for fuel duty and therefore the fuel price should include the non-recoverable duty. Diesel duty in 2009/10 was estimated to be on average 56.19p and the BSOG rate was 43.21p.

b. An average journey length per concessionary passenger of 4.8 miles was used. However, this figure is based on NTS trips - these include all stages of a journey from the point of origin to destination (and thus are likely to include other modes of transport and not just individual bus boardings). Therefore the appropriate figure to use from the NTS is the average bus boarding length by concessionary bus passholders aged over 60 in England (excluding London), which for 2009/10 was estimated at 3.9 miles.

E.40 As a result of these revisions, the estimate for the fuel cost component of the marginal operating cost per passenger is 0.24p and the revised bottom-up estimate for fuel, tyres and oil is 0.3p (2009/10 prices).

Additional time cost

E.41 The costs due to additional vehicle time were estimated at 0.7p per generated concessionary passenger (2009/10 prices) in the research. However, this was based on an estimate of vehicle hour costs of £14.90. This figure was subsequently changed in the guidance to £13.30 (see section on Marginal Capacity Costs below). The more up-to-date value of £13.30 was therefore applied to the revised calculation of additional time costs to ensure consistency with marginal capacity costs.

E.42 In the original research paper, a reimbursement factor of 60 per cent was also assumed to estimate the net boarding and alighting time effect per generated passenger. However, in their final research report, ITS subsequently revised the parameters of the Single Demand Curve which resulted in a lower reimbursement rate. In order to ensure consistency with the current demand curve used in the guidance, the reimbursement factor used in the calculation of additional time costs has been revised to 45 per cent (based on a weighted average of the reimbursement factors in PTEs and NPTEs derived from the Single Demand Curve assuming a nominal fare increase between 2005/06 and 2009/10 in line with the National Bus Index).

E.43 These methodological revisions result in an increase in additional time costs from the original 0.7p to 1.3p.

Maintenance and cleaning cost

E.44 The maintenance and cleaning cost of 1.2p reported in ITS research is estimated using an average journey length of 4.8 miles - this should be 3.9 miles for the reason explained above.

E.45 The calculation of the estimated figure also implies that this figure represents an average cost and not a marginal cost. The ITS research report suggests that there are likely to be strong economies of scale in repairing and cleaning the bus and therefore the cost elasticity with respect to passengers is likely to be greater then zero, but not much greater. They present a cost elasticity with respect to passengers of 0.0635 which needs to be applied to the average cost estimate to calculate a marginal cost estimate

E.46 These corrections result in a revised maintenance and cleaning cost estimate of 0.1p in 2009/10 prices.

BSOG adjustment

E.47 In addition, an upward adjustment has been made to the fuel component of the marginal operating cost to account for the 20 per cent reduction in BSOG from 1 April 2012. The fuel component was adjusted by the percentage change in fuel cost resulting from the reduction in BSOG. As a result the marginal fuel cost (in 2009/10 prices) is 0.3p and the overall marginal cost for fuel, tyres and oil is 0.4p.

Revised MOC estimate

E.48 The table below summarises the revisions to the components of the bottom-up estimate (including adjusting for BSOG):

Table E.5 Revisions to components of MOC bottom-up estimate, pence (2009/10 prices)

Component	Original value	Revised value
Fuel, tyres and oil *Of which fuel*	1.6 *1.5*	0.4 *0.3*
Maintenance and cleaning	1.2	0.1
Insurance	2.7	2.7

Information	0.5	0.5
Additional time costs	0.7	1.3
Bottom-up estimate of MOC	**6.7**	**5.0**

E.49 The resulting total bottom-up estimate is therefore 5.0p (revised down from 6.7p). The implied weights used by ITS in their published study in combining the bottom-up estimate and the estimate from the econometric model (8.0p) yields an overall MOC estimate of **6.1p**.

Marginal Capacity Costs

E.50 The research estimated marginal capacity cost using evidence from: (i) the econometric model of bus costs; (ii) accounting cost models of the CIPFA type; (iii) and a range of other evidence which is required to complete the analysis. Unit costs have been updated to 2009/10 prices.

E.51 The econometric evidence is based on evidence about vehicle miles and peak vehicle numbers. Vehicle hours were not included due to lack of data. The estimates derived from the econometric model are marginal capacity costs in the economic sense because the calculation is concerned with the way in which costs vary with vehicle mile and vehicle numbers. The econometric results provide an estimate of the additional capacity costs per vehicle mile of £0.853 (£0.530 per vehicle km) with a 95 per cent statistical confidence interval of £0.507 to £1.201 (£0.315 to £0.746 per vehicle km).This implies a cost elasticity, or marginal capacity costs as percentage of average capacity cost, at 46 per cent. Peak vehicle costs are £17,941 per vehicle with a 95 per cent statistical confidence interval of £12,335 to £23,547.

E.52 Accounting cost models provide estimates of the cost of vehicle hours, vehicle miles and peak vehicle requirements – see the table below:

Table E.6 Additional capacity costs from accounting models, 2009/10 prices

Accounting models	Per vehicle hr	Per vehicle mile	Per peak vehicle
NERA (2006) – PTE	£29.86	£0.811	£27,515
NERA (2006) - non-PTE	£22.34	£0.607	£20,203
Whelan, Toner, Mackie and Preston (2001)	£26.01	£0.232	£24,030

E.53 The econometric and accounting evidence cannot be directly compared because accounting models typically attribute elements of costs that may not necessarily be 'marginal' such as staff overheads and materials, vehicle maintenance and administrative staff. These costs are unlikely to vary with increases in the number of vehicle hours operated. For the purposes of calculating additional vehicle hour costs from an additional generated passenger, it is the costs that increase with additional vehicle hours that are relevant. The econometrics model attempts to estimate this true 'marginal' cost. However, the econometric model excludes vehicle hours and that exclusion would tend to increase the estimates of the parameter value on vehicle miles in the econometric equation.

E.54 An independent review of the evidence carried out by Professor Ian Preston concluded that there was a risk of double counting by adding in a separate estimate of the vehicle hours costs to the econometric results. The research and review noted that in theory an adjustment to the parameter on vehicle miles could be made to strip out the vehicle hours effect. But the size of that adjustment is unclear.

E.55 In order to make an informed judgement about the appropriate level of unit costs, and bearing in mind the comments about double counting, DfT also considered confidential evidence from operators and the timing and size of the change in demand likely to take place in the absence of a concessionary travel scheme. The unit costs proposed are well below average accounting costs. The largest component of the vehicle hours unit cost is likely to be drivers' hours. ITS also noted that drivers wages were paid on average as £10.20 per hour plus on-costs. Evidence of tenders suggests that marginal costs per hour can be lower than driver wages if drivers are being paid for hours that they do not drive. On the other hand, operators suggest that there is little slack in driver schedules so that a requirement to drive extra hours in the middle of the day requires additional remuneration for the additional hours employed.

E.56 Given the uncertainties about the use of the econometrics, the use of the accounting data, the use of the cost elasticities and other evidence, a pragmatic view that the appropriate hourly costs are around the hourly costs of drivers including an allowance for on-costs, i.e. a vehicle hours unit cost of **£13.30** is recommended.

E.57 This unit cost estimate is primarily based on 2009/10 ASHE (Annual Survey of Hours and Earnings) data on the gross hourly pay for bus and coach drivers. It is the mean hourly wage for bus and coach drivers in England, including London, plus an additional allowance of 30 per cent to include non-wage costs (e.g. National Insurance contributions and pensions).

E.58 While wage rates in the East and South East tend to be higher than in other regions, the wage rate in London is significantly higher than anywhere else. Exclusion of the London hourly wage from the calculation would result in a sharp downward impact on the estimated wage cost. This is illustrated in the table below.

Table E.7 ASHE results on hourly earnings of bus and coach drivers in 2009		
Region	**Number of jobs**	**Hourly pay**
North East	6,000	£8.73
North West	12,000	£8.88
Yorkshire and the Humber	9,000	£8.74
East Midlands	7,000	£8.52
West Midlands	9,000	£9.04
East	10,000	£9.59
South East	12,000	£9.42
South West	10,000	£8.69
London	34,000	£12.99
England excl. London w/o overheads		**£9.00**
England excl. London with 30 per cent overheads		**£11.69**
England incl. London w/o overheads		**£10.24**
England incl. London with 30 per cent overheads		**£13.31**

E.59 It is also worth noting that the addition of the 30 per cent overheads is likely to be overestimating the true marginal vehicle hour cost. While there will be certain costs that vary with vehicle hours other than drivers' wages, the addition of 30 per cent is likely to be an overestimate.

E.60 The recommended value for the rate per mile is based on a consideration of a range of evidence and in particular costs that are likely to vary directly with bus mileage, such as fuel, and excluding fixed costs. This suggests a figure of £0.61 per vehicle mile.

E.61 In addition an adjustment has been made to the vehicle mile unit cost to account for the 20 per cent reduction in BSOG from 1 April 2012. The fuel component was isolated using assumptions in the ITS research about the fuel component (92 per cent) and adjusted by the percentage change in fuel cost resulting from the reduction in BSOG. As a result the recommended value for the vehicle mile unit cost is **£0.70** per vehicle mile.

E.62 The peak vehicle requirement cost is set at £16,745 per peak vehicle using considerations similar to those made in the derivation of the unit costs.

E.63 In coming to a view of the figures, we have considered that the change in overall journeys due to the concessionary travel scheme is significant, at least 15 to 20 per cent on average, in the period when concessionary travel is valid. The scale of this change is large compared with overall changes in demand that have occurred in the recent past. We have also considered whether the unit costs should vary.

Mohring factor

E.64 Evidence on the Mohring factor is limited. The value of 0.6 suggested in this guidance is within the range of values found in mainly theoretical studies that consider the response of operators to changes in demand that maximises the overall net benefit of passengers and bus operators. The theoretical relationship also depends on an element of spare capacity. In a practical situation where the criteria for changing vehicle miles is the effect on operator profit and load factors are also driven by commercial considerations it is possible that the Mohring factor would be different, but we do not know by how much. For the purpose of this guidance we recommend using a value of **0.6**.

Demand Response to Frequency Change

E.65 The extent to which the demand for bus service responds to increased levels of service has been covered in the literature, including TRL Report 593. The basic premise is that increases in the frequency of bus services reduces waiting time and increases in network density reduces walk time. Waiting and walk time have a higher value (higher disbenefit) than in-vehicle time so that passengers respond to changes in frequency and network coverage. The degree of response is thought to be significant but less than proportionate, i.e. demand increases but by less than the proportionate increase in bus vehicle miles. For the purpose of this guidance we subsume the service frequency and route density effects into a single vehicle miles effect.

E.66 Evidence considered in TRL 593 suggests that a 1 per cent change in vehicle miles leads, in the long term, to a 0.66 per cent change in passenger journeys. There is some evidence that responsiveness to a given frequency change is greater where frequency is lower to start with. This guidance recommends that an elasticity of **0.66** is used as a default unless there is very good evidence to the contrary.

Profit

E.67 A recent report for the Department for Transport by LEK, Review of Bus Profitability in England, considered the appropriate weighted cost of capital for bus operators. This proposed a range of the nominal weighted cost of capital of 8.2 per cent to 10.9 per cent in 2009. The report noted that feedback from major operators suggested that they believe that their respective weighted average cost of capital to be at the top end of this range. In the light of this evidence this guidance recommends that where peak vehicle requirement is increased as a result of the additional concessionary journeys then a return on capital of 10% is used and added to the PVR costs.

ANNEX F: Data Provision

F.1 The Mandatory Travel Concession Regulations 2011 provide that a TCA may request information from operators which it reasonably considers relevant to assisting it in the formulation of reimbursement arrangements. The following lists the data items that may be required in using the DfT guidance and Calculator.

F.2 All data items relate to the year of reimbursement calculation unless specified otherwise.

Table F.1 Data items required to use DfT Reimbursement Guidance

Component of reimbursement	**Data items**
Journeys	Total concessionary journeys (older/disabled people)
Average fare – Discount Fare Method	For each product within the cash fare, daily ticket and weekly ticket categories: - Total revenue - Total number of tickets sold The data should cover the period of the concession and exclude child tickets
Average fare – Basket of Fare Method	For each product in the basket: - Price of ticket - Assumed number of journeys per ticket - Percentage of journeys made with ticket type
Reimbursement Factor	Percentage increase in nominal fares between 2005/06 and the year of calculation
Marginal Operating costs	Average concessionary journey length [optional]
Marginal Operating costs	All components of marginal operating costs (per concessionary passenger) [optional]: - Fuel, tyres and oil - Maintenance and cleaning - Insurance - Information - Additional time costs

Marginal Capacity Costs	- Average commercial fare - Average speed [optional] - Average route length [optional] - Average journey length [optional] - Average occupancy [optional] - Commercial journeys as a % of total [optional]

ANNEX G: Processing of Smartcard Data

Raw data

G.1 The subset of data to be extracted should be selected such that the geographical coverage is deemed comprehensive (i.e. to maximise the capture of data by smartcard-enabled operators) and representative of the local area.

G.2 The data should include all concessionary journeys starting in the local area on smartcard-enabled buses for the period of the concession. Data from non-residents could be included but consideration should be given to whether the coverage of their journeys is not complete and could therefore undermine the main strength of the data source.

G.3 The data should include a record for each journey made by concessionary passholders within the time period. Data on the passholder (unique ID, postcode, gender, date of birth, older/disabled concession and disability type, TCA of issue and date card issue) is useful for analytical and data validation purposes.

Data cleaning and processing

G.4 The data should be analysed and cleaned to exclude outliers, extreme values and records of suspicious quality. For instance the data should be sense-checked to identify the following potential issues:

- Records with missing passholder ID information;
- Passholders who are too old or too young (e.g. under 5s);
- Passholders who were issued a pass after the data extraction start date (the week of issue should be excluded to provide a clean period for analysis).
- Duplicate card holders;
- Possible outliers (implausible number of journeys) based on the distribution of the data.

G.5 It is likely that a number of journeys will have been excluded from the dataset due to transaction failures. It should be possible to derive operator and service-specific expansion factors to correct for this based on information from the operator on failure rates and on other data sources such as continuous surveys. It is advisable to use the weighted journey data to derive the lookup table.

Derivation of lookup table for use in the Discount Fare Method

G.6 The individual bus transaction records should be summarised into the total number of concessionary journeys made by each passholder on each day of the sample period (passholder days) as follows:

Table G.1 Aggregation of raw data into passholder days

PassholderID	Day 1	Day 2	…
ID1	Number of journeys made	Number of journeys made	Number of journeys made
ID2	Number of journeys made	Number of journeys made	Number of journeys made
ID3	Number of journeys made	Number of journeys made	Number of journeys made

G.7 The number of journeys made on each day by individual passholders can be summarised further into the total number of journeys made in each week of the sample period (passholder weeks).

G.8 The data can then be allocated into the lookup table which can be seen in Cells A25:R62 of the Calculator. The lookup table is dimensioned as follows:

Table G.2 Smartcard look-up table

Weekly Ticket Price as Multiple of Cash	Weekly Tickets		No Day Ticket			Daily Ticket Price as Multiple of Cash Fare per Trip								
						1			2			... up to 10		
	Weekly Tickets	Weekly Trips	Daily Tickets	Daily trips	Cash Fare trips	Daily Tickets	Daily trips	Cash Fare trips	Daily Tickets	Daily trips	Cash Fare trips	Daily Tickets	Daily trips	Cash Far trips
No weekly ticket	0	0	0	0	591,063	280,070	591,063	0	179,204	475,999	115,064	...	...	...
1	123,557	591,063	0	0	0	0	0	0	0	0	0	...	...	...
2	100,948	565,088	0	0	25,976	22,609	25,976	0	0	0	25,976	...	...	...
3	68,175	491,632	0	0	99,431	61,001	99,431	0	27,154	60,560	38,871	...	...	...
4	56,508	453,453	0	0	137,610	83,644	137,610	0	37,185	84,935	52,675	...	...	...
5	42,106	391,625	0	0	199,439	115,094	199,439	0	58,177	134,716	64,722	...	...	...
6	33,311	344,074	0	0	246,989	139,550	246,989	0	72,036	170,145	76,843	...	...	...
7	26,815	302,851	0	0	288,213	159,692	288,213	0	86,387	205,011	83,202	...	...	...
... up to 40	...	...	...	...	...	...	...	...	...	...	...	...	...	...

G.9 The smartcard data is to be aggregated for each combination of weekly to cash fares and daily to cash fares price ratios to derive a 40x10 lookup table (see also worked example in Annex H):

- For each value of the weekly ticket price to cash fare ratio (1:1, 2:1, 3:1, …, 40:1) the total number of passholders who had weekly journey totals at or above that value are counted and the number of journeys made are summed. For instance for a weekly ticket priced at three times the cash fare, it is assumed that all passholders who make three or more journeys a week would purchase a weekly ticket. Summing across all such passholders would then yield the number of weekly tickets, and summing their journeys would yield the total number of weekly journeys at that price ratio.
- The process is repeated for the remaining journeys (the journeys not assigned to weekly tickets) for each value of the daily ticket price ratio (1:1, 2:1, …, 10:1).
- The journeys not categorised as weekly or daily tickets are assigned to the cash fare category.

G.10 The final lookup table can be pasted directly in the hidden AF Workings sheet of the Calculator (to view go to Format/Sheet/Unhide). No further changes to the spreadsheet are required. However, TCAs using local smartcard data should assure themselves that using the Discount Fare Method using a locally derived lookup table yields plausible results.

ANNEX H: Reimbursement Calculator

Introduction

H.1 A Reimbursement Calculator in Excel format based on the recommended approach set out in this guidance is available on the DfT website to aid TCAs in their reimbursement calculations and assist in discussions with bus operators.

H.2 This Annex briefly describes the Reimbursement Calculator and goes into the detail of some of the underlying calculations by way of worked examples.

Reimbursement Calculator

H.3 The Reimbursement Calculator is subdivided into six sheets which take users through the various steps required to calculate reimbursement:

Table H.1 Reimbursement Calculator sheets	
Instructions	Instructions on how to use the Calculator. Note numbers are provided as hyperlinks throughout the Calculator which bring back users to this instructions sheet and the relevant detailed notes.
Start Page (Step 1)	On this page, users chose the relevant area type, the year of calculation and enter the number of observed concessionary journeys.
Average Fare (Step 2)	On this page users calculate the Average Fare Forgone.
Reimbursement Factor (Step 3)	The Reimbursement Factor is calculated on this page based on the change in fares between 2005/06 and the year of calculation.
Additional Costs (Step 4)	On this page users can calculate or enter the various components of additional costs.
Marginal Capacity Costs (Step 5)	Marginal Capacity Costs are calculated on this sheet.
Result Page (Step 6)	This page brings together the various components of reimbursement calculated in steps 1 to 5 and provides a figure for total reimbursement due.

H.4 Some of the detailed workings are contained in the Reimbursement Calculator sheets (e.g. marginal capacity costs, basket of fares, etc) while other underlying calculations are done in separate working sheets. These are hidden but they can be 'unhidden' (Format/Sheet/Unhide). They are as follows:

Table H.2 Reimbursement Calculator working sheets (hidden)	
AF workings	Estimation of the discount factor using the Discount Factor method.
RF workings	Calculation of Reimbursement Factor using estimated change in fares.
PTEs	Construction of the Single Demand Curve for PTEs.
Non-PTEs	Construction of the Single Demand Curve for Non-PTEs.

Start page (Step 1)

H.5 On this page users enter

- The appropriate area type (PTEs/Non PTEs) - this will dictate which Single Demand Curve parameters are used in the degeneration process in the estimation of the average fare forgone, which Single Demand Curve is used in the estimation of the Reimbursement Factor and which default values are used in the Marginal Capacity Cost Model – ['Start page' Cell G3];
- The year for which reimbursement needs to be calculated – [Cell G4];
- The total number of concessionary journeys observed in reimbursement period (See Section 4 of the guidance) – [Cell G6].

Average Fare (Step 2)

Average Fare Calculator

H.6 Users can choose which method to apply to calculate the average fare forgone using the buttons in ['AF model' Row 3] The options are as follows:

Table H.3 Average Fare Calculation - Options		
Method	**Criteria**	**Action**

Discount Fare method	Most circumstances (see § 5.7–5.12 for exceptions)	Enter the average ticket prices of cash fares, day and weekly tickets either directly in [Cells C21–C23] or using the templates in [Cells B53–D96] (see § 5.27–5.30 for how these should be calculated). The average fare is calculated in [Cell C29] and then copied to [Cell C10]
Basket of Fare method	For operators with a high proportion of total boardings on low frequency services or with particular ticket combinations (see § 5.7–5.10)	Enter data in [Cells B33:G48] and the average fare is calculated in [Cell G48] and copied to Cell [C10]
Local method	For operators in large urban areas such as PTEs where trip patterns are significantly different (see § 5.11-5.12)	Enter locally derived fare in [Cell C10]
Use of local smartcard data	Where robust smartcard data is available in a local area	Derive alternative lookup table and copy/paste in [Cells A32–AJ76] of *AF Workings*

H.7 The final Average Fare Forgone appears in [Cell C10] and will be fed through the Reimbursement Factor calculations in Step 3.

Calculation of the Discount Factor (AF workings)

H.8 The section below explains how the discount factor (in the Discount Factor method) is calculated in the hidden sheet *AF workings*. To view the sheet go to Format/Sheet/Unhide.

NoWcard data

Smartcard Data Ticket Choice Assignment

H.9 Smartcard data on journey frequencies from the NoWcard scheme have been used to model how concessionary passholders would allocate themselves to different ticket types (cash, daily and weekly tickets) and fares at free fares. The data provides information on the concessionary journeys of about 90,000 passholders made over a five-week period in four Lancashire districts.

H.10 The data have been summarised to give the number of concessionary journeys made in each day of the five-week period, as well as the number of journeys made in each of the five weeks. The summarised data have then been used to simulate how the observed travel patterns would map onto different ticket types, assuming different combinations of price ratios.

H.11 For instance, in a fare structure where weekly tickets are priced at ten times the average cash fare and daily tickets are twice as expensive as the average cash fare, one would expect weekly tickets to become financially attractive to those making 10 or more journeys per week and we would expect those making two or more journeys in a day to buy a one-day ticket:

Table H.4 Example of smartcard data ticket choice assignment based on a specific price structure

Ticket type	Price ratio	Tickets	Journeys	Journeys per ticket
Cash fare	1 (e.g. £1.6)	100,551	100,551	1
Daily	2 (e.g. £3.2)	121,673	297,313	2.4
Weekly	10 (e.g. £16.0)	13,431	193,200	14.4
Total		235,655	591,063*	
Discount factor	19.1%			

* Components may not add up to total due to rounding.

- There were 591,063 zero-fare concessionary journeys observed in the dataset over the five-week period.
- Some 193,200 journeys were made in weeks where 10 or more journeys were made. These would have been associated with 13,431 weekly tickets (passholder weeks), leading to an average of about 14 journeys per ticket.
- Some 397,863 journeys would not be allocated to weekly tickets on this basis. Of these, 297,313 were made on days in which two or more journeys were made. These journeys would have been associated with 121,673 daily tickets purchased (passholder days)– this correspond to an average journey rate per ticket of 2.4.
- About 100,551 journeys would not have been made either in weeks where ten or more journeys were made or in days in which two or more journeys were made. It is assumed that these journeys would be allocated to cash fares.

H.12 The analysis is repeated for a range of ticket price ratios and a look-up table dimensioned by the price ratio of weekly to daily to cash tickets is constructed. Owing to the limited period for which the data is available, in practice the analysis was limited to weekly ticket priced at 30 times the cash fare or less and daily ticket priced at 5 times the cash fare or less.

H.13 The look-up table is contained in the hidden sheet AF Workings. To view the sheet go to Format/Sheet/Unhide. [Cells A29:AJ76].

Discount Factor

H.14 For each price ratio and associated journey frequencies, a discount factor can be derived. If a passenger make two or more journeys using a daily ticket, the average cost per journey will be less than the average cash fare per journey, so that effectively the passenger buys his/her bus travel at a discount relative to the cash fare.

H.15 The implied discount factor on the cash fare based on this particular price ratio of 10:2:1 is derived from the total revenue denominated in terms of the cash fare:

Discount factor = 1 – [10 x 13,431 + 121,673 x 2 + 100,551] / 591,063 = 19.1%

H.16 However, this is the discount factor at free fares, before de-generation (see below).

Interpolation

H.17 In practice TCAs will need to input price ratios in the Calculator derived from real data and those are likely to be decimal numbers rather than integers (e.g. 9.9:1.8:1 based on a pricing structure of weekly tickets priced on average at £15.84, daily tickets priced at £2.88 and an average cash fares of £1.60). This is a purely illustrative example. In those cases it is necessary to make an estimate of the number of journeys associated with that particular price structure by interpolating between the lower and upper band of the price ratio. This is done in [Cells A1:H19] of *AF workings*.

Figure H.5 Discount factor calculations - interpolation

(2) Interpolation

	Input values	Interpolation		
		Lower band	Upper band	Factor
Weekly ticket price	9.9	9.00	10.00	0.90
Daily Ticket Price	1.8	1.00	2.00	0.80
Weekly Tickets		16,612	13,431	0.90
Weekly journeys		223,132	193,200	0.90
Daily Tickets		208,794	120,688	0.80
Daily journeys		394,870	294,713	0.80
Cash Fare journeys		0	100,157	0.80
Check journey total		618,002	588,070	

H.18 In this example the weekly ticket price lies between 9 and 10 and the daily ticket price ratio lies between 1 and 2 (the lower band price ratio is 9:1:1 and the upper band is 10:2:1). The number of journeys and tickets sold corresponding to each price ratio are looked up from the smartcard data table [Cols E and F] in the case of weekly tickets and weekly journeys or derived in the case of daily tickets, daily journeys and cash fare journeys.

H.19 To illustrate how values are derived from the smartcard data table, take the example of daily tickets. Given the weekly ticket price ratio of 9.9, for a daily ticket price ratio of 1, we must be 0.9 of the way between 196,746 and 210,133, i.e. the number of daily tickets will be 196,746 + 0.9*(210,133 – 196,746) = 208,794. Similarly, for a daily ticket price ratio of 2, the number of daily tickets will be 111,818 + 0.9*(121,673 – 111,818) = 120,688.

H.20 A weighted average of the journeys made and tickets sold in the upper band and lower band price structure is taken [Col. H] with the weights based on the difference between the input values and lower band values [Col. G].

H.21 The last column in the table shows the interpolated journeys and tickets which correspond to a price structure of 9.9:1.8:1 and the associated discount factor ([Cell H18]).

Degeneration

H.22 The discount factor estimated above is based on concessionary passholders journey frequencies at free fare. However, in the absence of a free concession, the number of journeys that would be made would be significantly smaller if fares were paid than if travel was free. It is therefore necessary to 'de-generate' journeys to allow from the move from free to full fare. The amount of generation that was created depends on the assumed price per journey of the discounted tickets, which in turn depends on the assumed use. Hence, the degeneration factor is estimated using the parameters of Single Demand Curve parameters (lambda and beta) and the fares of the individual ticket types.

H.23 For instance in our example the price or fare per journey is the average price per ticket divided by the number of journeys per ticket – this is calculated in [Cells K1:N12].

Figure H.6 Discount factor calculations - average price per journey

	Cash Far	Daily	Weekly
Price ratio	1	1.80	9.90
Price per ticket	£1.60	£2.88	£15.84
Tickets sold (from Look Up Table)	80,126	138,309	13,749
journeys made (from Look Up Table)	80,126	314,744	196,193
journeys per ticket	1.000	2.276	14.270
Price per journey	£1.60	£1.27	£1.110

H.24 The resulting fares are used to estimate the associated reimbursement factor from the Single Demand Curve using the following formula

$$RF = e^{\beta \times FarePerTrip^{\lambda}}$$

where the Single Demand Curve parameters are

β (PTE) = -0.669
λ (PTE) = 0.723
β (NPTE) = -0.836
λ (NPTE) = 0.640

H.25 The resulting Reimbursement Factors are then used to adjust the weekly and daily price ratios upwards in [Cells Q1:R9] (this examples relates to a non PTE in 2012/13).

Figure H.7 Discount factor calculations - degeneration of price ratio

	RF	Price ratio
Cash Fare	0.415179	1
Daily	0.46933	2.6447936
Weekly	0.498817	14.838285

H.26 This effectively amounts to reassigning the number of journeys allocated to the weekly, daily and cash tickets as shown in [Cells T1:AA18].

Figure H.8 Discount factor calculations - journey reassignment

	Input values	Interpolation			
		Lower band	Upper band	Factor	Int'lated value
Weekly ticket price	14.8	14.00	15.00	0.84	
Daily Ticket Price	2.6	2.00	3.00	0.64	
Weekly Tickets		5,316	4,222	0.84	4,399
Weekly journeys		98,805	82,968	0.84	85,529
Daily Tickets		156,281	30,064	0.64	74,897
Daily journeys		394,058	114,514	0.64	213,810
Cash Fare journeys		111,476	391,020	0.64	291,724
Check journey total		604,339	588,502		591,063

H.27 However, this leads to too many single journeys in the basket and these are also abated using the reimbursement factor at cash fare in [Cells AD1:AG8]. However, the abatement is only applied to the initial number of journeys in the basket (80,126) as the rest of the single journeys have been reassigned from weekly and daily tickets from the first de-generation step.

Figure H.9 Discount factor calculations - degeneration of single journeys

	Cash Fare	Daily	Weekly
Price ratio	1	2.64	14.84
Tickets sold (from Look Up Table)	258,458	74,897	4,399
Journeys made (from Look Up Table)	258,458	213,810	85,529

Average Fare Forgone

H.28 The resulting discount factor is 6.5 per cent in [Cell AG18]. This is fed back to the Average Fare calculator sheet in [Cell C27]. The discount factor is applied to the average cash fare to derive the average fare forgone in [Cell C29]. In this example:

Average fare = Cash fare x (1 – Discount Factor)

£1.50 = £1.60 x (1 – 0.065)

Reimbursement Factor (Step 3)

Reimbursement Factor Calculator

H.29 The area type and year of calculation selected in the Start page and the average fare forgone calculated in the *AF model* worksheet are displayed in [Cell C4:C6] for ease of reference. There are several options available to the user to estimate the reimbursement factor.

a. To estimate the reimbursement factor based on the change in operator-specific nominal fares between 2005/06 and the current reimbursement period:
   - In the RF Model sheet click on "Enter % change in nominal fares between 2005/06 and current period". This will take users to [Cell C30] where the appropriate percentage change can be entered. This percentage is fed into the hidden RF Workings sheet which calculates the reimbursement factor (to view go to Format/Sheet/Unhide).
   - Clicking on the "done" button next to [Cell C30] will take users to [Cell C14] where the appropriate reimbursement factor is displayed.

b. To estimate the reimbursement factor based on TCA-wide change in nominal fares:
   - Clicking on "Enter % change in TCA-wide nominal average fares" will take users to [Cell C35] where the change in TCA wide average fare between 2005/06 and 2010/11 can be entered. From 2010/11 to current reimbursement period, users should enter the operator specific change in nominal fares in [Cell C36]. The total of these percentage changes is fed into the hidden RF Workings sheet (see above) which calculates the reimbursement factor.
   - Click on the "done" button next to [Cell C36] to go to [Cell C14] where the appropriate reimbursement factor is displayed.

c. To estimate the reimbursement factor based on National bus fare index;
   - Click on "Use national bus fare index" to go to [Cell C39] where the change in operator specific fares from 2010/11 to the current reimbursement period can be entered. The percentage change in national bus fares between 2005/06 and 2010/11 is automatically entered into the RF workings by chosen area type. The total of

these percentage changes is fed into the *RF Workings* sheet which calculates the reimbursement factor.

- Click on the "done" button next to [Cell C39] to go to [Cell C14] where the appropriate reimbursement factor is displayed.

d. To estimate the reimbursement factor for a new operator who did not exist before the current reimbursement period.

- Click on "New Bus Operator" to go to [Cell C48] where enter the change in TCA wide average fares from 2005/06 and current reimbursement period can be entered. This percentage change is fed into the RF Workings sheet which calculates the reimbursement factor.
- Click on the "done" button next to [Cell C48] to go to [Cell C14] where the appropriate reimbursement factor is displayed.

Estimation of the Reimbursement Factor (RF workings)

H.30 The underlying calculations are performed in the *RF workings* worksheet.

H.31 **Calculating the reimbursement factor based on the change in operator specific fares between 2005/06 and the current year:**

- The current average nominal fare forgone is retrieved from the *RF model* worksheet [Cell G42]
- The current nominal fare is deflated to 2005/06 prices [Cell G43] by referring to the CPI index/GDP deflator table [Cells E2:G13]
- The percentage change in nominal operator specific fares entered by the user is retrieved from the *RF model* worksheet [Cell G44]
- This percentage change is applied to the nominal operator specific fare in the current period [Cell G42] to give the nominal operator specific fare in 2005/06 in [Cell G45]
- This 2005/06 fare in nominal terms is base fare to which the real fare in the current year [G43] is benchmarked against. The real fare in the current year [G43] divided by the operator fare in 2005/06 [Cell G45] gives the index value[Cell G46] appropriate to be used in the Single Demand Curve
- The appropriate Single Demand Curve parameters are referred to [Cells E25:G23]. These are then applied to the index value [Cell G46] to calculate the appropriate reimbursement factor.

H.32 **Calculating the reimbursement factor based on TCA wide average fares between 2005/06 and 2010/11 and operator specific fare from 2011/12 onwards**

- The current average nominal fare forgone is retrieved from the *RF model* worksheet [Cell G53]
- The current nominal fare is deflated to 2005/06 prices [Cell G54] by referring to the CPI index/GDP deflator table [Cells E2:G13]
- The change in TCA wide average fares between 2005/06 and 2010/11 entered in *RF Model* is retrieved in [Cell G55]
- The change in operator specific fares between 2010/11 and the current year is entered in *RF Model* is retrieved in [Cell G56]
- These changes are aggregated in [Cell G57]
- This aggregate change in fares is applied to the current nominal fare to derive an estimate of average fare in 2005/06 (in 2005/06 prices)[Cell G58]. This is the benchmark fare against which the real average fare is compared.
- Dividing the real average fare in the current year [Cell G54] by the fare in 2005/06 gives you the appropriate index to be applied to the Single Demand Curve [G59]
- The appropriate Single Demand Curve parameters are referred to [Cells E25:G23]. These are then applied to the index value [Cell G59] to calculate the appropriate reimbursement factor [Cell G60].

H.33 Calculating the reimbursement factor based on the National Bus Index between 2005/06 and 2010/11 and operator specific fare from 2011/12 onwards

- The current average nominal fare forgone is retrieved from the *RF model* worksheet [Cell G66]
- The current nominal fare is deflated to 2005/6 prices [Cell G67] by referring to the CPI index/GDP deflator table [Cells E2:G13]
- The change in appropriate national bus index (PTE/Non-PTE) between 2005/06 and 2010/11 is retrieved from [Cells E35:G36] to [Cell G68]
- The change in operator specific fares between 2010/11 and the current year entered in *RF Model* is retrieved in [Cell G69]
- These changes are combined to give the change in fares between 2005/06 and the current year [Cell G70]
- This change is applied to the current nominal fare to obtain an estimate of the fare in 2005/06(in 2005/06 prices)[G71]. This is the benchmark against which the current real fare [G67] is compared against.

- Dividing the real average fare in the current year [Cell G67] by the fare in 2005/06 gives you the appropriate index to be applied to the Single Demand Curve [G72]
- The appropriate Single Demand Curve parameters are referred to [Cells E25:G23]. These are then applied to the index value [Cell G72] to calculate the appropriate reimbursement factor [Cell G73].

H.34 Calculating the reimbursement factor for a new operator

- The current average nominal fare forgone is retrieved from the *RF model* worksheet [Cell G79]
- The current nominal fare is deflated to 2005/06 prices [Cell G80] by referring to the CPI index/GDP deflator table [Cells E2:G13]
- The change in TCA wide average fares between 2005/06 and the current year entered in *RF model* is retrieved in [Cell G81]
- This change is applied to the current nominal fare to obtain an estimate of the fare in 2005/06(in 2005/06 prices)[G79]. This is the benchmark against which the current real fare [G80] is compared against.
- Dividing the real average fare in the current year [Cell G80] by the fare in 2005/06 gives you the appropriate index to be applied to the Single Demand Curve [G83]
- The appropriate Single Demand Curve parameters are referred to [Cells E25:G23]. These are then applied to the index value [Cell G83] to calculate the appropriate reimbursement factor [Cell G84].

Derivation of the Single Demand Curve (PTE sheet)

H.35 The following is a worked example of the estimation of the Single Demand Curve for PTE areas. The same principles apply to the Non PTE sheet.

Step 1 – Estimating the Old Passholder Demand Curve

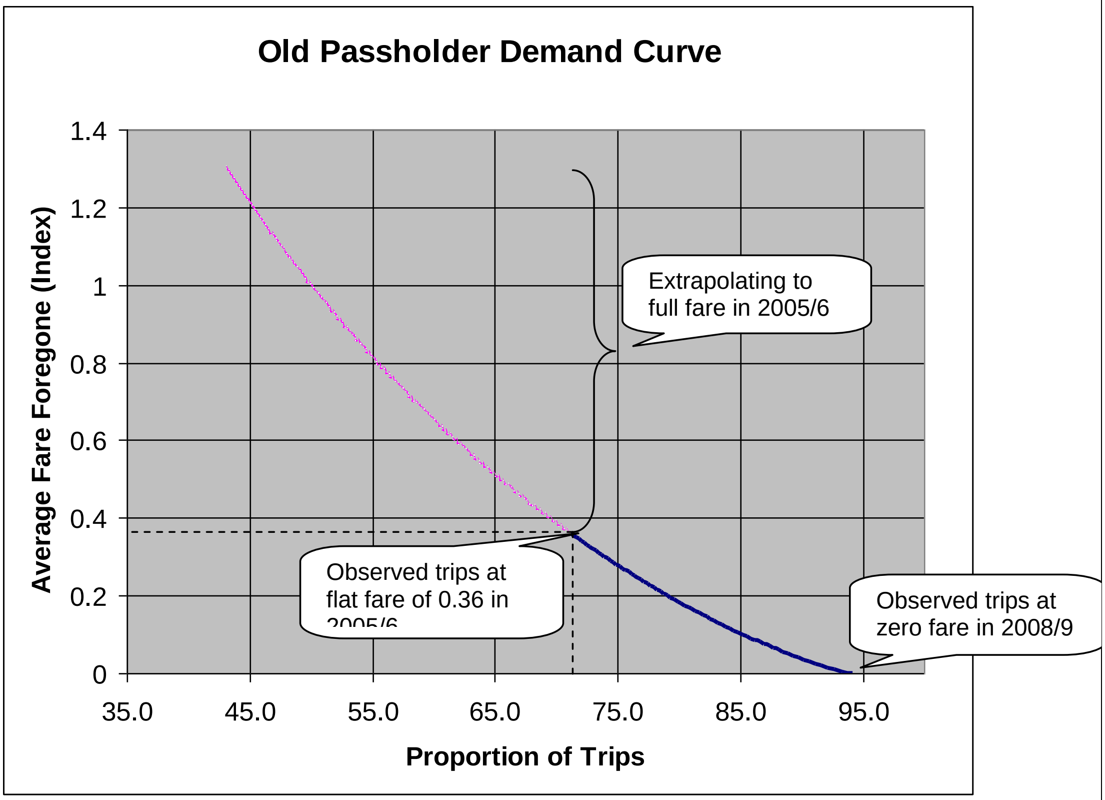
H.36 Let's assume the observed number of journeys at free fare is 100 [Cell B6]. There is also an estimate of the proportion of all journeys that are made by New Passholders. So taking the example of PTEs, 5.8 per cent of all journeys are estimated to be made by New Passholders, so at zero fare Old Passholders make 94.2 (index value) of journeys [Cell B35].

H.37 The number of journeys made by old passholders at half or flat fare is observed. For PTE areas the number of concessionary journeys by Old Passholders at flat fare (indexed at 0.36) as a proportion of journeys that are made at zero fare is 119.618/158.28 = 0.752959 [Cell C1].

H.38 Multiplying Old Passholder journeys at full fare of 94.2 journeys by this proportion gives us 70.9 journeys at the flat fare of 0.36 [Cell B26].

H.39 Using the two points 94.2 and 70.9 a demand curve is estimated using an assumed damping factor of 0.8 for old passholders and extrapolated to full fare. This gives an estimated demand at full fare (2008/9) of 48.0 (index value) [Cell C604].

Figure H.10 Old Passholder Demand Curve



Step 2 – Estimating the Single Demand Curve for all Passholders

H.40 The New Passholder journeys at zero fare are added back so that the index value of journeys is now 100. The impact of adding these journeys on to the lower section of the demand curve is that we now have a kinked demand curve. A single smoothed demand curve is estimated through the number of journeys observed at zero fare (100) [Cell E816], the degenerated journeys at half fare (71.2) [Cell E743] and the number of journeys estimated to be made at full fare by old passholders (48.4)[E604]. In this process, the elasticity constant β and the damping factor λ are re-estimated.

H.41 For the purpose of estimating the Single Demand Curves for PTEs and Non-PTEs respectively, the ITS research team derived an average fare forgone of £1.12 and £1.20 for PTEs and Non-PTEs respectively in 2005/06 prices. These fares are indexed at 1 as they are the relevant averages for the aggregate data on which the Single Demand Curve is based on. To calculate a local reimbursement factor, the change in real terms in the local average fare between 2005/06 prices and the calculation year should be applied.

H.42 So for example, for an average fare of £1.50 in a PTE area in 2009/10, deflating back to 2005/06 with CPI gives £1.50 x 0.89 = 1.34. The comparable actual local average fare in 2005/06 is £1.25. Therefore the factor to be applied to the Single Demand Curve is 1.34/1.25 = 1.072. This gives a reimbursement factor of 49.5 per cent.

Step 3 – Abstraction

H.43 The next step is to allow for the abstraction of new passholders from the commercial market to the concessionary market. For PTEs this implies an increase in the number of journeys made from half fare onwards of 1.74 per cent. i.e. : 30% x 5.8% = 1.74 [Cell J604].

Step 4 – Final Demand Curve for All Those Eligible for the Travel Concession

H.44 The final step is to smooth the demand curve by connecting journeys at zero fare (100) [Cell K816], journeys at half fare (72.9) [Cell K743] and journeys estimated to be made by all passholders at full fare (50.2) [Cell K604]. This final step will give us the final estimate of the elasticity constant β(-0.66) [Cell K7] and damping factor λ (0.723) [Cell K8].

Additional Costs (Step 4)

H.45 On this page users can estimate the various components of additional costs as they apply.

Marginal operating costs (MOC)

H.46 In the MOC Calculator in [Cells B12:B18], there is flexibility to vary the default value of 6.1p by the average boarding length (see § 7.12) if there is good evidence that the journey length in user's area is different from the average default value of 3.9 miles - in these case users should select the option 'Vary by Local journey Length' in [Cell C15] and enter a local value in [Cell D16].

H.47 The marginal operating cost is calculated using the formula in § 7.12.

Marginal capacity costs (MCC)

H.48 The MCC calculator is in a separate spreadsheet *MCC Model* and, given the aggregate nature of the model, should be used at network level to estimate additional marginal capacity costs (see § 7.23). Some of the parameter values in the model are average network values and are therefore fixed (Mohring power, service elasticity) while for other parameters, users can either enter local values or use the default values provided (it is recommended not to mix local and default values). The guidance recommends that the default values for unit costs (vehicle hour costs and vehicle mile costs) should be used unless TCAs are confident that accurate locally-derived values can be derived.

H.49 The marginal capacity cost per generated journey is then given in Column U and applied to generated journeys.

H.50 All the underlying calculations are performed in the columns to the right of the Calculator and there is also a worked example in 'MCC worked example' as described below. Annex I includes a more detailed explanation of the methodology behind the Calculator.

Data inputs

H.51 The Table below shows some illustrative data inputs that enter the MCC calculations for this worked example (it is the same worked example as in the Calculator and is for a non-PTE in 2009/10 prices):

Table H.11 Illustrative data inputs for the MCC Calculator

Variable	Status [Cell reference where option is chosen as applicable]	Value	Cell reference of value
Mohring power	Given	0.6	[D4]
Vehicle/mile cost	Given	£0.70	[D5]
Vehicle/hr cost	Given	£13.30	[D6]
Speed (mph)	Local	10.9	[D7]
Mean vehicle occupancy	Local	17.8	[D8]
Mean route length (miles)	Local	10	[D9]
Mean journey length (miles)	Local	4.9	[D10]
Service elasticity	Given	0.66	D13
Average commercial fare	Local	£1.50	[D11]
Commercial journeys as a % of total	Local	45%	[D12]

Step 1: The link between patronage and frequency supplied (the supply response to demand changes)

H.52 This step predicts the increase in service frequency as a result of increased bus demand from generated concessionary patronage. It is not expected that commercial bus operators will increase bus frequencies in direct proportion to demand.

H.53 The aggregate relationship between demand and frequency supplied is estimated as follows:

The Mohring rule

$$\left(\frac{\chi_1}{\chi_0}\right) = \left(\frac{B_1}{B_0}\right)^{0.6}$$

Where:

χ is frequency supplied (0 without an additional passenger, 1 with an additional passenger)

B is patronage (0 without an additional passenger, 1 with an additional passenger)

Therefore the proportionate change in frequency supplied is modelled to be the proportionate change in patronage to the power of two-thirds.

H.54 This formula implies that operators' response to an increase in demand will be a combination of a less than proportional increase in frequency and load factor.

H.55 The Mohring relationship is based on proportionate changes in patronage and proportionate changes in frequency supplied so it is necessary to make assumptions about a base case scenario.

Base case assumptions

10 minute service frequency = χ_0 = 6 buses/hour

Mean journey length = M = 4.9 miles

Mean vehicle occupancy = MVO = 17.8

Mean route length = 10 miles

With mean occupancy = $\frac{MB}{\chi}$

Where

M = mean passenger journey length

B = passenger boardings per mile of route per hour

Applying assumptions on journey length, mean vehicle occupancy and service frequency to this relationship gives:

$$B_0 = \frac{MVO \times \chi}{M} = \frac{17.8 \times 6}{4.9} = 21.7959 \; passenger\ boardings / mile\ of\ route / hour$$

H.56 One additional generated passenger on a route translates into 1/10 (additional passenger/route length) passengers per mile of route/hour.

H.57 Applying this to the Mohring rule, the frequency supplied with one additional passenger is calculated as follows:

$$\chi_1 = \chi_0 \times \left(\frac{q_1}{q_0}\right)^{0.6} = 6 \times \left(\frac{21.8959}{21.7959}\right)^{0.6} = 6.0165$$

Step 2: Additional vehicle hour costs from one additional generated passenger

$$Vhr = \frac{\chi}{s / L}$$

Where:

Vhr is the rate at which vehicle hours are supplied to a route
s is speed
L is route length

Without the marginal passenger,

$$Vhr_0 = \frac{\chi_0}{s / L} = \frac{6}{10.9/10} = 5.5046$$

With one additional marginal passenger,

$$Vhr_1 = \frac{\chi_1}{s / L} = \frac{6.0165}{10.9/10} = 5.5197$$

Change in vehicle hours supplied = 5.5197-5.5046 = 0.0151

Vehicle hour cost = £13.30

Additional vehicle hour cost per additional passenger = £13.30x0.0151 = **£0.20**

Step 3: Additional Vehicle mile costs from one generated passenger

$Vm = Vhr \times s$

Where

Vm = Vehicle miles
Vhr = Vehicle hours
s = speed

Vehicle miles without the additional passenger

$Vm_0 = Vhr_0 \times s = 5.5046\,x\,10.9 = 60$

Vehicle miles with additional passenger

$Vm_1 = Vhr_1 \times s = 5.5191 \times 10.9 = 60.165$

Change in vehicle miles = 60.1647 - 60 = 0.165

Additional Vehicle mile cost per additional passenger = 0.16473 x £0.70 = **£0.12**

Step 4: Commercial revenue generated from increased frequency

H.58 Evidence on the demand response to service frequency changes is used to estimate demand increase and increase in revenue gain brought about my commercial passengers.

Fare paying passengers have a long run service elasticity = 0.66

$$Service\,Elasticity = \frac{\%\ change\ in\ \ patronage}{\%\,change\ in\ service\ \ frequency}$$

% change in frequency = ((6.0165 /6) -1)x100 = 0.275%

% change in demand = 0.275% x 0.66 = 0.18%

Total number of boardings per hour = B x L = 21.7959 x 10 = 217.959

Assuming that 45% of total patronage on the bus is commercial

Total number of commercial boardings per hour = 217.959 x 45% = 98.08

The increase in commercial patronage with increased frequency = 98.08 x 0.18% = 0.1765 If average commercial fare = £1.50 This implies a revenue gain = 0.1765 x £1.50 = £0.27 There will however be marginal operating costs from the additional commercial patronage generated Applying the default marginal operating cost to the increase in commercial patronage: 0.1765 x 0.061 = £0.01

Summary: Net additional capacity cost

Table H.12 Net additional capacity cost: worked example

Cost component/generated passenger	£
Time related additional capacity costs from generated concessionary journeys	0.20
Distance related additional capacity costs from generated concessionary journeys	0.12
Revenue gain from additional commercial journeys	0.27
Additional cost from generated commercial journeys	0.01
Net additional capacity cost per generated concessionary journey	0.06

H.59 Net additional capacity cost per generated passenger journey = Time related capacity cost + distance related capacity cost - additional revenue from generated commercial journeys + additional operating cost from generated commercial journeys.

Impact of Changes to Inflation Index on Reimbursement Calculator

H.60 The reimbursement calculator uses a data series of past and forecast inflation, to work out the reimbursement factor, as well as other elements of reimbursement. The inflation data series is based on the Consumer Price Index (CPI) and GDP deflator.

H.61 In past editions of the calculator, the CPI used a base index of the year 2005 (i.e. 2005 is equal to the index 100). The Office of National Statistics (ONS) have revised this time series, and it is now issued with

2015 as the base year (i.e. 2015 is equal to the index 100). The ONS have also made minor revisions to the change in CPI between some years.

H.62 Editions of the reimbursement calculator since those issued for 2017/18 schemes, use the new index. The rebasing, ONS revisions to past years' CPI figures and Treasury updates to GDP deflators, all have a minor effect on the reimbursement factor and additional costs in new versions of the calculator. For instance, comparing the 2017/18 and 2016/17 reimbursement calculators' results for *the same* financial year (e.g. 2016/17), will display a minor difference in reimbursement factor (by usually around 0.1 to 0.2 percentage points), marginal operating costs and marginal capacity costs. It will therefore lead to a minor difference in total reimbursement payable.

ANNEX I: Marginal Capacity Cost Model

I.1 This Annex describes the methodology behind the Marginal Capacity Cost Calculator and the way it works. The variables that go into the Calculator are highlighted below together with a description of how they fit in the Calculator.

I.2 The Marginal Capacity Cost Calculator can be used to estimate the additional capacity costs that would be incurred if there was an increase in demand of one journey given the existing demand and supply of bus services. In other words it can be used to calculate the marginal capacity cost of one additional (generated) journey, a journey that would not have been made in the absence of a concessionary scheme.

I.3 It is recommended that the Calculator is used to calculate marginal capacity costs at the network level. The model is aggregate in nature and its parameters are most suitable for a network-based approach.

I.4 It is important to bear in mind that the Calculator estimates the cost of the marginal boarding per mile and assumes that changes in capacity can be continuous (or very small). In reality capacity changes tend to be discrete or large. For example, it would not make sense to change frequency by a fraction of a minute; similarly it would not make sense to change capacity in response to an increase in demand of one passenger. In order to identify the marginal capacity cost per generated journey it is necessary to estimate the impact of a small change in demand on capacity provision which, when grossed up, presents a more realistic picture.

Accommodating extra demand

I.5 Theoretically, there is an expectation that marginal capacity costs will be zero when generated passengers join the bus with free seats. However, if potential passengers are being systematically left behind at bus stops then service capacity will be increased to accommodate them. This is because bus operators are assumed to care about demand and associated revenue.

I.6 Extra demand can be catered for in two ways; either by increasing load factors or by increasing capacity. The Calculator estimates additional capacity cost where the increased capacity is provided through an increase in frequency.

I.7 Clearly there is a trade-off between these. Allowing load factors to rise will lead to an increase in boarding and alighting times, an increase in the number of stops made and impact on the ability of a bus operator to maintain timetables or expected journey times. Increases in journey times and unreliability would reduce demand. Apart from the potential loss of revenue this would not involve any additional costs. On the other hand, increases in frequency would increase demand as waiting time is reduced (generally valued as twice as much as in-vehicle time). This, however, would involve additional costs.

I.8 Economic theory and some empirical research have shown that if the network is fixed, i.e. if there is no change in access times (walking to the bus stop), then the mix would be 50:50[10]. This means that 50 per cent of an increase in demand would be accommodated by an increase in load factors and 50 per cent of demand would be accommodated by an increase in frequency. If the network is not fixed and access times can be reduced then this mix would change to 66:33 in favour of a change in frequency.

I.9 A central position recommended by ITS in its Research Report 9 (Costs) was that 60 per cent of a change in demand would be accommodated by a change in frequency. This is referred to as the **Mohring Factor** in the Calculator – the response in service frequency to a change in demand.

I.10 Based on this relationship between an increase in demand and the increase in frequency needed to accommodate this demand, the additional capacity costs that would be incurred with an increase in demand of one additional passenger can be calculated using the vehicle costs per mile and hour.

I.11 The methodology from this point is fairly straightforward. Given a level of service and a level of demand the Calculator simply converts the "required" increase in frequency into costs.

I.12 The level of demand is given by the **average load** or the average utilisation of seats. To be used in the Calculator it needs to be converted into the number of passenger boardings per route kilometre per hour. This is done to ensure that the marginal increase is not distorted by journey length.

---

[10] This is the "square-root rule" which was a theory put forward by Vickrey (1955) and developed by Herbert Mohring (1972). It has been developed further by Jannson, Jara-Diaz and Small with similar conclusions. A useful summary is given in Jara-Diaz and Gschweinder, Transport Reviews, 2003, Vol 23 No.4, "Towards a general micro-economic model for the operation of public transport".

Passenger boardings per route mile per hour =

$$frequency\,.\frac{route\ length}{trip\ length}.\frac{average\ load}{route\ length} = frequency.\frac{average\ load}{trip\ length} \qquad [1]$$

I.13 The marginal increase would be the marginal boarding per route mile:

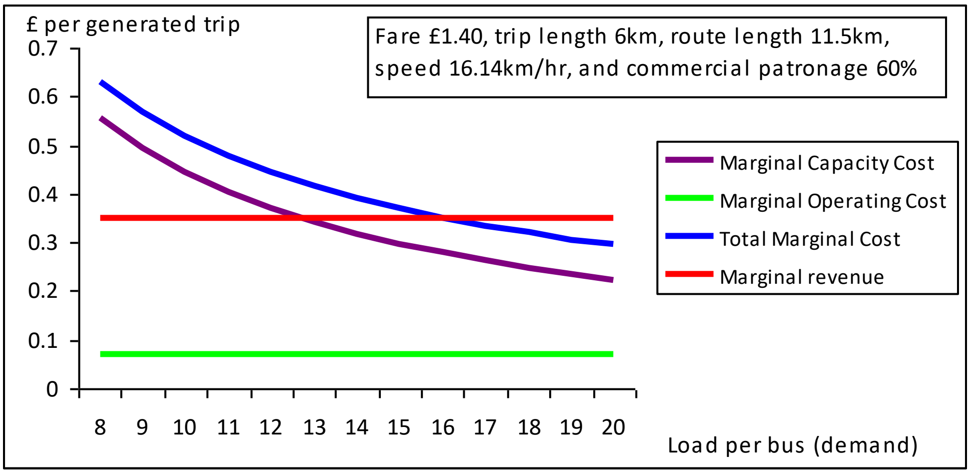
Marginal boarding per route mile =

$$\frac{1}{trip\ length}.\frac{trip\ length}{route\ length} = \frac{1}{route\ length} \qquad [2]$$

I.14 The change in demand at the margin is [2] ÷ [1].

I.15 Given this marginal increase is fixed, the higher the existing demand is, and the higher the existing supply is, the smaller this increment will be in percentage terms. As a result, the frequency response (60 per cent of the change in demand) reduces as demand rises and the percentage increase in vehicle hours and vehicle kilometres falls. In other words a smaller increase of a larger base is needed to accommodate one additional passenger mile. The marginal capacity cost is then seen to fall as demand increases as shown in Figure I.1 below:

Table I.1 Marginal capacity costs, revenues and loadings



I.16 The resulting increase in frequency will result in an increase in vehicle miles and vehicle hours which can be monetised using the additional cost data.

I.17 The cost per vehicle hour is a large component of costs so it is necessary to account for **average bus speeds** to estimate the impact on vehicle hours of an increase in frequency.

Frequency generated revenue effect

I.18 As noted above, an increase in frequency will affect demand because waiting times will be reduced. Therefore, there will be an effect on commercial revenue that will need to be taken into account when looking at the overall impact of an increase in frequency.

I.19 The revenue effect of a marginal change in frequency will depend on the **average commercial fare**, the **percentage of commercial passengers** and their response to changes in service, i.e. **their service elasticity**.

I.20 The overall effect is that marginal capacity costs will tend to vary inversely with demand and, at some point, be less than the revenue effect of changes in frequency. This is shown in Figure E.1.

I.21 Some of the variables in the MCC Calculator can be input to reflect local conditions. The averages used for purpose of illustration are national averages, or reasonable assumptions based on available evidence.

ANNEX J: Aggregation of MCC Model Data Inputs

J.1 The MCC Calculator is a network model and as such it is recommended that variables at route level are aggregated into a network average for use in the Calculator.

J.2 Estimating a network average is not as straightforward as calculating an arithmetic average of the route values – these need to be weighted to reflect the fact that some routes are more heavily used and therefore should contribute more to the total estimate of marginal capacity costs.

J.3 The example below illustrates how a weighted average should be calculated:

> Let's assume a network consists of two routes.
>
> Route 1 carries 200 concessionary journeys which are on average 4-miles long.
>
> Route 2 carries 100 concessionary journeys which are on average 10-miles long.
>
> The simple arithmetic average journey length across the network is (4+10)/2 = 7 miles. However, this does not recognise the fact that the route with longer average boardings carries fewer passengers (i.e. the formula overstates the weight of the Route 2).
>
> The network average journey length should be the weighted average of the journey length on each route, i.e. the sum of the total journey length on each route divided by the total number of journeys made on each route:
>
> Network average journey length = (200x4 + 100x10)/(200+100) = 6 miles.

J.4 The table below provides guidance on how each route variable used as an input to the MCC Calculator should be aggregated into a network average:

Table J.1 Aggregation of route variables into a network average	
Route variable	**Aggregation into a network estimate**
Mohring power	0.6 (fixed network value)
Average journey length	Weighted average by concessionary journeys
Average route length	Weighted average by concessionary journeys
Speed	Aggregate underlying components first - average route length as below - convert each route speed into a journey time in minutes (journey time = 60 x route length / speed) - calculate a weighted average of the journey times by concessionary journeys Average network speed = 60 x average network length / average network journey time
Average occupancy	Aggregate underlying components first - sum vehicle miles - sum passenger miles (passenger miles on a routes = journeys x journey length) Average occupancy = total passenger miles / total vehicle miles
Unit costs – vehicle hours	It is highly unlikely that this should vary by route (see also caveats about using local value). If this is the case use weighted average by concessionary journeys.
Unit costs – Vehicle miles	It is highly unlikely that this should vary by route (see also caveats about using local value). If this is the case use weighted average by concessionary journeys.
Demand response to service change (service elasticity)	0.66 (fixed network value)
Passenger journeys (concessionary, commercial, all)	Sum across routes
Commercial journeys as percentage of total	Total commercial journeys (summed across routes) / total ‘all’ journeys (summed across routes)
Average commercial fare	Weighted average by commercial journeys