

Economic Regulation and Incremental Costs

- Consultation Paper -

February 2001

***Civil Aviation Authority
CAA House, 45-59 Kingsway, London WC2B 6TE***

TABLE OF CONTENTS

Executive Summary	v
Responses	vi
1. Economic regulation and incremental costs	1
<i>What are incremental costs?</i>	1
Incremental costs falling on the supplier.....	1
Externalities	2
<i>Common costs and incremental costs</i>	2
<i>Short run marginal costs (SRMC) and long run incremental costs (LRIC)</i>	3
Regulatory credibility.....	5
The difficulty of making longer term projections	6
<i>Links with other work streams</i>	7
Benchmarking.....	7
Single till	8
Service quality	8
Competition within airports	8
Contracting outside of the price cap	8
Pricing structures.....	8
Treatment of capital expenditure.....	9
<i>Conclusions</i>	9
2. Estimating incremental costs	11
<i>Forward looking incremental costs</i>	11
Definition of outputs to be costed.....	12
What increments should be considered?	14

Time period for estimation.....	14
Constraints to be assumed in the estimation	15
How should the least cost plan be identified and challenged?.....	16
<i>Incremental costs of different dimensions of output.....</i>	<i>17</i>
3. Conclusions and next steps.....	19
Annex 1: Examples of estimating incremental costs at airports	21
Annex 2: Estimating incremental costs in other regulated industries	29

Executive Summary

This paper considers the estimation of incremental costs, and the role this could play in the regulatory oversight of the designated airports. A basic principle of economics is that welfare is maximised where prices reflect marginal costs. There are practical difficulties in applying this in the area of monopoly regulation, but this provides an important guiding principle.

Two forms of incremental costs are considered. Forward looking incremental costs are concerned with the costs of producing additional outputs over time. These costs may be higher or lower than the average costs of the outputs currently produced. Reflecting these costs in the approach taken to the price caps should provide improved signals for users and the airports to increase outputs over time, and to invest appropriately in new capacity.

The second form are the incremental costs of the different dimensions of the airports' outputs. For example, the incremental costs of providing particular levels of service quality. Estimates of these could provide useful information to the regulator, particularly when considering the issue of pricing structures, and could also be the basis of more useful information for users.

Estimating incremental costs of either form is not straightforward. Ultimately, the use which is made of the estimates will depend on how robust they prove to be. The CAA intends in the first instance to use the airports' business plans as the basis for preliminary estimations.

The paper is presented for consultation on the general analysis of incremental cost estimation and the potential use of those estimates. Comment is invited on any areas of the discussion. However, given that the process of estimation itself will be complex, the text does not raise specific questions on the estimation. As the process for estimating incremental costs evolves, the CAA may subsequently raise specific questions.

Responses

Comments on the issues raised in this paper and any other issues which respondents believe should be considered by the CAA in reviewing the airports should be sent in writing by **23 April 2001** to:

**Susie Talbot
Economic Regulation Group
Civil Aviation Authority
CAA House
45-59 Kingsway
London
WC2B 6TE**

**Email: talbots@caaerg.co.uk
Fax: 020 7453 6244**

All responses will be treated as public information unless otherwise specified. If a response is made in confidence it should indicate that.

If you have any queries regarding this document they should be addressed to:

**David Matthew
Head of Economic Regulation and Competition Policy
Civil Aviation Authority
K405
CAA House
45-59 Kingsway
London
WC2B 6TE**

**Email: matthewd@caaerg.co.uk
Telephone: 020 7453 6228**

1. Economic regulation and incremental costs

- 1.1 The most fundamental principle of economics is that the best level of output arises where the prices of outputs reflect marginal costs¹. Where prices are above marginal costs, then additional outputs could be provided which would generate greater benefits to society than the costs of providing them. If prices are below marginal costs, then outputs are being provided to the point where the additional costs exceed the additional benefit they create.² This principle should provide an important cornerstone for economic regulation.
- 1.2 But the practicalities of identifying the outputs being provided, and estimating their incremental costs are not straightforward. There are also considerable theoretical and practical challenges in integrating such estimates into the framework for the economic regulation of monopoly providers.

What are incremental costs?

- 1.3 Properly specified, the incremental costs of an output should encompass the additional resource costs of providing the additional units of the product to the supplier and any costs (or benefits) which do not fall directly on the supplier, but which may fall on other parties.

Incremental costs falling on the supplier

- 1.4 The first category of incremental costs are the direct costs to suppliers of producing the outputs, or dimensions of an output, concerned. Airports provide a wide range of services and facilities to airlines, to freight-forwarders, to passengers, to ground handling agents, and to other parties. The airport “product” therefore consists of many outputs, each of which has many dimensions and their own incremental costs. The separation between different outputs and different dimensions of each of these outputs is sometimes difficult. For example, the provision of remote aircraft stands and pier stands can be interpreted as two different airport outputs, or alternatively as two varieties of a single output which differ in the dimension “quality”. A useful criterion for defining an airport output is to what extent two products are complements or substitutes. Remote stands are usually reasonable substitutes for pier stands. It would therefore be adequate to define them as two varieties of the output

¹ The difference between “marginal costs” and “incremental costs” is partly one of definition. One distinction is that “marginal cost” envisages a continuous cost function, whereas “incremental cost” allows for the existence in increments that are larger than a single additional unit of output. Incremental costs are therefore a pragmatic proxy for strict marginal costs which is easier to estimate.

² This principle applies to reductions in outputs as well as to additional outputs. The additional cost or saving to the buyer should equal the additional cost or saving to the supplier.

“provision of aircraft stands”. Contrary to this, the provision of check-in desks and aircraft stands are complementary, as both are required for airline operations.

Externalities

- 1.5 Providing an additional unit of output to a user may result in costs (or benefits) which do not fall directly on the direct supplier. In the case of airports, there are two important categories of costs of this type: opportunity costs and congestion costs. Opportunity costs may arise where the use of the service or facility by one user prevents another party from using that service or facility. The most extreme example is the fact that runway capacity at Heathrow and Gatwick is fully utilised and, at current levels of airport charge, there is excess demand for it. Thus the use of this capacity by current users is denying its use to potential users. An efficient outcome requires that users are exposed to the full opportunity costs of that scarcity and make use or sell decisions accordingly. Congestion costs arise where increasing use of available airport facilities to accommodate additional demand results in a lower quality of service for all users (for example through increased delays). A further externality which arises from aviation more generally are the environmental costs generated.
- 1.6 The important point to note is that while these are important costs that in principle should be internalised by users of airport services, they are not costs which are borne directly by the service provider. Airport regulation is concerned with setting limits on the prices that can be charged by the airports. This affects economic efficiency in two ways. First, it affects the demand for access to the airport. If this were the only concern then the price cap might be as good a vehicle as any for ensuring that the externalities were taken into account. But the price cap also affects the incentives for the airport to provide outputs at the appropriate level. If the airport is allowed to set prices to cover the opportunity costs of access, and thereby to gain from the scarcity rents which exist, its incentives to increase output may be diluted. For this reason, where there are other, more efficient, mechanisms for internalising this element of costs they are likely to have superior efficiency properties. Efficient market allocation of slots is the most obvious candidate.
- 1.7 If airport prices are set to reflect only the direct incremental costs to the airport, and not the opportunity costs of scarce capacity, then in periods where capacity constraints exist, airport prices would not be the key driver of demand at the airport at that point in time. This is the case currently for elements of the facilities at some of the airports, such as runway charges at Heathrow and Gatwick.

Common costs and incremental costs

- 1.8 It is often the case that different products, or different dimensions of a product, have a common cost element. In the case of airports this may be a large proportion of the costs of some services. A terminal building, for example, is

used to provide a wide range of services to users, many of which could not be provided without the terminal building. The incremental costs of providing check-in desks in the terminal might be quite small given that the terminal exists; if the terminal had to be built in order to provide the check-in desks, however, the “stand alone” cost would be very large.

- 1.9 This raises a problem that is common to many regulated utilities. If there are significant common costs, setting prices for the various outputs at their incremental costs would not generate sufficient revenue to cover the common costs. A firm subject to regulation on this basis would therefore make a loss. The problem is therefore how to set prices in order to minimise the inevitable deviation of prices from incremental costs. It is widely recognised that the most efficient solution involves setting mark ups over incremental costs which reflect the elasticities of demand for the various products; the largest mark-ups are applied to those products where higher prices will have the smallest effect on the amount actually demanded.³
- 1.10 Because of information difficulties it would be almost impossible for a regulator to impose such a solution. The objective is to incentivise the firm to move to the best solution itself (recognising that, while the firm itself will not have perfect information either, it will be better informed than the regulator, particularly given the existence of informed users). In the case of airports there is very little information available on the incremental costs of different dimensions of the airport product, and there is only limited price differentiation in airport charges to users.
- 1.11 The first step is to improve the availability of information on what the incremental costs of the various services are, and to consider how the form of the price cap might affect incentives to set an efficient structure of prices.

Short run marginal costs (SRMC) and long run incremental costs (LRIC)

- 1.12 Short run marginal costs may be defined as the costs of providing additional units of output where only some elements of inputs are variable, capital usually being fixed. New investments are not directly taken into account. For example, once a terminal is constructed, the incremental costs of meeting additional volumes of passengers may be initially relatively low (while there is unused capacity in the terminal). As the terminal becomes fully used, the SRMC of meeting additional demand may increase, as additions to the terminal become necessary to accommodate it. Ultimately, without further terminal capacity being developed, it will become impossible to accommodate additional passengers, meaning the incremental cost becomes very high, particularly when congestion

³ “Ramsey pricing”, in economic terms.

costs are allowed for. If a new terminal were built there would be a new SRMC curve associated with that terminal. Where large indivisible investments such as new terminals are significant, a projection of SRMC over time will show a “saw tooth” pattern, with costs rising sharply as capacity become fully utilised, and then dropping as new capacity is added.

- 1.13 SRMC pricing is likely to be effective in providing for the efficient allocation of capacity (ideally where the estimates include congestion costs or the opportunity costs of scarce capacity). However they are less effective in providing optimal investment signals to the airport providers. This is because for SRMC pricing to provide good investment incentives, the regulator would have to commit to a price path over time that involved large price spikes to reflect high SRMCs (when capacity was fully utilised). Subsequently there would be sharp drops in price once that capacity was completed, with future price spikes in the future as the new capacity became fully utilised and further capacity was required. The problem is that the airport would only invest in the new capacity if it were convinced that the future price spikes would be forthcoming. It would therefore place heavy pressure on regulatory commitment to the volatile price path. Otherwise the airport would be more likely simply to accept the high charges associated with existing capacity. Moreover, highly volatile charges may be viewed as undesirable more generally. This volatility may also be difficult to accommodate in a regulatory system based around five year fixed price caps. Properly estimating SRMC to include congestion and opportunity costs would also require an estimate of these less tangible variables, with less robust estimates as a consequence.
- 1.14 Long run Incremental Costs reflect the costs of investments in infrastructure (subject to external constraints, which may arise if planning permission is not given for such developments), and includes these as part of the estimation. Both the capital and operating costs of meeting demand are projected. Typically these are then averaged out across the outputs that they deliver on a present value basis. LRIC pricing likely to be less effective than SRMC pricing in ensuring that resources are best used in the short run. However, it is likely to provide better investment incentives and is likely to be easier to implement in practice. In the first instance therefore, the CAA will focus on estimating LRIC, recognising that checks for consistency, over time, with SRMC will be appropriate.

Informing a price path and regulatory credibility

- 1.15 It was noted above that there are two problems that that price cap seeks to address. One is the effect on ensuring that the cost of using resources is faced by those who use them. The second is the incentives it provides for the regulated monopoly to supply the optimal level of outputs and to invest appropriately. This section focuses on the latter issue.
- 1.16 Purely from the perspective of investment incentives, the standard regulatory asset base framework does seek to ensure that prices reflect the additional costs

of supplying outputs. However, it spreads these additional costs across all outputs, not just the additional outputs. It therefore sets prices against forward looking average accounting costs. In theory, the airport still has incentives to invest. The problems with the framework revolve more around the distorted incentives arising from basing returns primarily upon asset base additions, rather than the level of the price *per se*.⁴ If the issue were purely the level of prices, that could be addressed under the regulatory asset base approach simply by raising the returns allowed on the asset base.

1.17 Moving to pricing on the basis of incremental costs could provide superior incentive properties if it is part of a more general move to a framework in which prices (or combinations of prices in the form of revenues) are the key driver of investment decisions. Incremental cost projections would provide the best basis for such a framework to have appropriate investment incentive properties. To be effective, incremental cost estimates would need to support a price path some distance into the future, not just for a five year period.

1.18 Extending the effective length of a price cap raises two important questions:

- Regulatory credibility;
- The difficulty of making long term projections.

Regulatory credibility

1.19 Economic regulation of designated airports is governed by the Airports Act. This requires that the price controls be reset every five years.⁵ Neither the CAA nor the Competition Commission is in a position to enter into legally binding commitments as to how the cap will be reset at future reviews. This is a problem for an attempt to set a price cap aimed at influencing long term investment strategy since there is nothing to prevent the regulatory bodies from changing their views at subsequent reviews.

1.20 But it is also a problem for the asset-based system of regulation. At past reviews agreements have been established as to how the regulatory asset base should be rolled forward to form the basis for price setting at future reviews. It is widely accepted that this provides a reasonable basis for regulated utilities to embark on large-scale investments, albeit subject to a degree of regulatory risk. But there is no statutory basis for it. Instead, the regulatory bodies have committed in non-statutory ways by public statements of how they intend to treat the various elements of the regulatory regime, and because the decisions that they have made

⁴ For more discussion on this, see CAA January 200, *Economic Regulation and Capital Expenditure*.

⁵ Unless the CAA opts to extend the period of an existing cap, as it has done in the case of the current cap for BAA. However, this does not provide a legal option to stick with the same cap without a review indefinitely.

in practice act as important signals for the future. It should also be noted that commitments in relation to the regulatory asset base do not provide a strong commitment in relation to other important elements of price cap setting (efficiency assumptions, for example).

- 1.21 Non-statutory commitments could also be made in relation to other bases for setting the price cap at future reviews, not just the regulatory asset base model. A clear and transparent statement on a longer term price path, combined with early decisions which signal an intention to retain consistency with it, should equally act as a reasonable incentive to bring forward investment projects. This is especially true if the outcome of a regulatory asset base model would result in prices that are below long run incremental costs. In the CAA's view, the issue is more one of how well specified a longer run commitment to a price path can be, in terms of pre-commitment to how it will be recalculated, than the principle of pre-commitment *per se*.

The difficulty of making longer term projections

- 1.22 A problem with a longer term projection is that it extends the scope for forecasting error. To the extent that long term projections are used to determine prices for the next five years (for example under LRIC based pricing) this problem is mitigated by the fact that discounting of future projections means that they carry less weight in the calculations than the more immediate projections. Nevertheless it is clearly a problem to be addressed.
- 1.23 The potential solutions to this problem will depend in part on the *ex ante* confidence on how robust or not the estimates are likely to be given the risk of technology and demand changes. As a general statement, however, there are likely to be some variables, which will be important drivers in the estimations, which can be isolated and for which pre-commitment can be given for how deviations in actual outcomes from the forecasts will be treated. Traffic forecasts are an example where it would be relatively easy to pre-specify adjustments. If certain cost drivers could be clearly specified, these too might be taken into account (this is akin to the current cost pass-throughs for security costs). Others might be event variables. Suppose, for example, that a LRIC calculation had been undertaken on the basis that no further runway capacity were permitted in the south-east. It would be possible to have a statement anticipating the approach that the regulator would take if circumstances changed and a runway were permitted. While such commitments might not be perfectly calibrated in advance, this is no more of a problem than attempting to pre-specify treatment of elements of capital expenditure in a regulatory asset model, which is also rarely quantified in a fully specified way.
- 1.24 Another approach would be to pre-specify the methodology and modelling of the incremental cost estimation, but to focus the five yearly reviews on re-estimating the key inputs into them. This would give the regulated firm less certainty, but again, not obviously less certainty that the capital expenditure and

operating efficiency reviews which often underpin the re-estimation of average costs under the regulatory asset based system.

- 1.25 Where it seems clear that forward looking incremental costs are above average costs, and are likely to be so into the foreseeable future, moving to incremental costs is unlikely to result in greater regulatory risk than average cost pricing. A price cap based on mis-specification essentially runs two risks with regulatory credibility: that the firm will face financial pressures and that the firm will make excessive profits. Where forward looking incremental costs are higher than average costs, the problem of potential financial difficulties is less likely to arise. Where, however, forward looking incremental costs are similar to average accounting costs, or are below them, then the question of regulatory risk is more critical.
- 1.26 Finally, if there remained serious concerns about regulatory commitment, the regulator could continue to calculate what the price would have been under the regulatory asset base model, as comfort that the new approach to price setting was not having the effect of renegeing on any pre-existing regulatory “contract” in relation to sunk assets. In this review the CAA has signalled its intention to estimate and publish the projected outcome under the pre-existing model.⁶
- 1.27 While much will depend on the methodology eventually used for the incremental cost estimations, and upon the robustness of the rules required for pre-commitment under that methodology, the CAA does not consider that the difficulties in making longer term projections prevents a pre-commitment to a longer term price path for acting as an effective incentive drivers for investment decisions.

Links with other work streams

- 1.28 The purpose of investigating incremental costs is to provide good incentives for well directed and efficient investment, to act as a signal of when demand for additional outputs should be met, and in considering incentives for moving to more efficient pricing structures in the face of a multi-dimensional product. The CAA is considering a number of other potential solutions to these issues. A summary of them, and their links to the incremental cost work, is outlined below.

Benchmarking

- 1.29 Benchmarking could provide one source of information for estimating incremental costs. The CAA has commissioned an initial study for the scope for cross sectional benchmarking and time-series econometric investigations to be used to estimate a cost function, which could inform the incremental cost

⁶ *The CAA Approach to Economic Regulation and the Work Programme for the Airport Reviews*, paragraphs 3.86-3.96. October 2000.

estimation. It may also be appropriate to benchmark particular elements of the airport-specific forward looking cost plans, such as the costs of particular terminals and ancillary facilities.

Single till

- 1.30 The single till issue is essentially a debate surrounding different asset based approaches to determining prices. Identifying the incremental costs of the aeronautical business or of the commercial business, is one approach to determining the costs of an aeronautical till. The question of estimating incremental revenues as well as incremental costs has some parallels with the single till debate (see paragraph 2.20)

Service quality

- 1.31 The CAA's review of service quality could potentially inform the consideration of outputs under an incremental cost regime. The incremental cost estimates themselves are also likely to be relevant to the consideration of service quality (what are the costs of the different dimensions of service quality?)

Competition within airports

- 1.32 The introduction of competition within airports for the provision of certain services and facilities could reduce the scope of the regulatory price cap. This may result in the incremental cost estimates being set against a smaller set of facilities, services and outputs.

Contracting outside of the price cap

- 1.33 Similar issues would apply in the case of a price cap based on incremental costs as would apply to one based on average costs. The objective would be for the cap to provide a defined basis for direct contracting outside of the cap. Incremental cost estimates for different dimensions of the services and facilities that an airport provides would potentially aid the contracting process itself.

Pricing structures

- 1.34 The form of an incremental cost based price cap would have implications for the airports' incentives to price different dimensions of its outputs efficiently in the same way as an average cost price cap. The question of whether it should be a revenue yield cap, or a tariff basket would still arise. Peak-load pricing is also closely related to incremental cost pricing. This is because the demand and willingness to pay for new capacity differs across user groups. In principle, the incremental costs of additional capacity should be born by users demanding the additional outputs.

Treatment of capital expenditure

- 1.35 A key objective of incremental cost based pricing is to provide good incentives to implement appropriate investments, through providing a signal for the airports as to when such investments should be undertaken. As such it provides one means by which capital expenditure incentives could be improved.

Conclusions

- 1.36 There are several levels at which estimates of the incremental costs of the services and facilities that airports provide could inform the review. The most basic is that indications of the incremental costs of providing additional outputs, and of the additional dimensions of outputs, is important for both the regulator and the industry in understanding the activities that are subject to regulation. The next level up is that such estimates, depending on how robust they are, could act as an indicator of whether the price paths indicated by other approaches to setting the price cap appeared to be consistent with incremental costs. It is also relevant to the issues surrounding service quality, capital expenditure, and the form of the price cap. In its most ambitious form, incremental costs could be used as the direct basis for price cap setting, both in terms of the level of prices on a forward looking basis, and in terms of the structure of prices. The degree to which the cap can inform these matters depends on how robust the estimates of incremental costs are. The next section considers the estimation of incremental costs in more detail.

2. Estimating incremental costs

2.1 There are two categories of incremental costs that are relevant: forward looking incremental costs of increasing outputs, and the incremental costs of different dimensions of outputs. Although the two are in many cases related, it is convenient to discuss them separately.⁷

Forward looking incremental costs

2.2 The previous section highlighted the potential differences between SRMC and LRIC. The essential difference lies in the scale of the increment being considered, and, reflecting this, the time period over which it should be considered. These are differences of degree, with the main difference emanating from the treatment of indivisibilities⁸. This section sets out some of the main issues that need to be considered. They are:

- How should the outputs being costed be specified?
- What increments should be taken for these outputs?
- Over what time period should the incremental costs be estimated?
- What constraints should be taken as given in estimation?
- Methodology and challenge in estimating the least cost plan.

2.3 Before reviewing these, it is useful to summarise the main forms of forward looking incremental costs that have been considered by other regulators or proposed by other commentators. More detail on this is provided in the Annexes to this paper, but the key approaches which have been taken are:

- Average Incremental Cost (AIC): the “project” approach. Under this approach, the forward looking costs of providing additional outputs are identified. An example of such an approach would be a new terminal. Typically these costs are averaged over time (“average incremental cost”). If the new terminal were expected to serve X million passengers over its lifetime, and cost Y billion pounds, then the average incremental cost would be (discounted) Y divided by X.

⁷ For example, the cost of new facilities may be a function of their impact on the volume of output and the level of quality associated with that output. The costs of both together may be less than the costs of each independently.

⁸ “indivisibilities” arise where the least cost plan for meeting demand over time includes some large (and sunk) capital projects which will provide the basis for a large increase in output.

- Long Run Average Incremental Costs (LRAIC): the “smoothed project” approach. Under this approach, the forward looking average incremental costs at different points in time are identified and averaged. This approach is one means of smoothing the fluctuations that result from taking different starting points in time as the basis for the estimation.
- The “perturbation” approach. Under this approach, the least cost plan for delivering a set of outputs is defined (using a similar starting point to that underpinning the average incremental cost and LRAIC approaches). The effect of changing elements of either the outputs or the composition of the least cost plan are then considered. In this way the incremental costs of the dimensions of outputs, or the timing of major capital projects, can be estimated in a rigorous way. This approach also provides a good test of whether the “least cost plan” is robust to relatively minor changes in the specifications

2.4 Each of these approaches requires similar core data, including the determination of the outputs, and the increments of the outputs, to be costed, and the estimation of the costs of delivering them. The estimation of these over a long enough period provides the starting point for each of the approaches identified. The difference between the LRIC and the LRAIC approaches is one means of addressing the question of smoothing and profiling. The perturbation approach would essentially take the LRIC approach as its starting point, although the perturbations themselves would require further estimates.

Definition of outputs to be costed

Dimensions of outputs

2.5 There are two important categories to address. There are the volumes of throughput for different outputs, such as passenger numbers and runway movements, and there are the quality levels associated with these volumes. The most pragmatic approach is to attempt to cost projected outputs against a standardised quality level. The difficulty, of course, is that the optimal expenditure plans undertaken by an airport include, often important, elements of quality enhancement. There are two possible avenues for dealing with this.

2.6 The first is to estimate the incremental costs of additional volumes, assuming that there is no change from quality levels at existing facilities.⁹ This would specify, for example, that the planning guidelines used for the construction of previous output enhancements would be applied to future expansions also (fixing the

⁹ If it were the case that quality levels at existing facilities should also be changed, then that could provide the basis for the estimation of the incremental costs rather than existing quality levels. However, it should be noted that the incremental costs would still be estimated against the costs of increasing volumes where the new level of quality applied to the additional volumes; the average costs of changing quality standards more generally would not be properly included as an incremental cost.

space per passenger in the terminal, the availability of stands with air bridges, and so on). One version of this approach would be to ask for an expert assessment of the costs of expanding output under these conditions, and not use the airports' business plans as the main vehicle for the estimations. Alternatively, or in combination, the fact that the airports' own plans may envisage an element of quality enhancement could be addressed through a more qualitative review of the additional costs these were creating

- 2.7 The second approach would be to identify those dimensions of quality enhancement expected to be delivered by the plans, and estimate these on a 'with-or-without' basis. For example, if the plan will deliver greater stand with air bridge availability than that provided by existing capacity, the plans would be re-estimated on the basis that only a lower or higher level of air bridge service was provided.
- 2.8 Because traffic movements and passenger numbers do not come in fixed proportions, there is the question of whether the incremental costs of each output should be considered separately. The CAA intends to work primarily with passenger numbers as a proxy for the overall bundle of outputs. This assumption is supported by the current uncertainty regarding future runway development. The CAA will consider the possibility of different projections of traffic forecasts as one of its sensitivities.

Peak and off peak outputs

- 2.9 It is characteristic of airports that the infrastructure required to meet peak demand levels is likely to be less intensively used in off-peak periods. Current operations at Heathrow and Gatwick are perhaps an exception to this, since there the peak now extends for the bulk of the day. However, even at those airports, once capacity has been added, peaks may re-emerge.¹⁰ Satisfying demand at peak times is different from satisfying it at off-peak times. While an airport may grow volumes at off-peak periods, this may be meeting demands from quite different users than those who would have used the airport at the peak if capacity had been available. For example, charter users may be happy with off-peak slots, while scheduled airlines may need peak slots. A volume measure which simply estimates the forward looking costs of all additional passenger numbers or movements may therefore be somewhat imperfect.

Estimates at individual airports and estimates across airport systems

- 2.10 In the case of BAA, there is an argument that incremental costs should be identified against the three airports as a system, rather than at each airport individually. The CAA considers that the focus should be on individual airports,

¹⁰Since incremental cost pricing is intended to act as a signal for the need for new capacity, there is an argument in favour of peak pricing even where capacity in the short term is fully utilised.

since the service being provided across all airports is not a commodity. Capacity at Stansted, for example, is not likely to be perceived by many users as a good substitute for capacity at Heathrow. It is also worth noting that the incremental costs of additional capacity are very different across the three London airports. BAA's capital expenditure programme for example shows that it is much less expensive to add facilities for another 10 million pax at Stansted than at Heathrow. Incremental costs as a pricing guideline need to reflect this difference to give the right incentives for relative airport use. However, such an analysis may still shed useful light on the interconnections between the BAA airports, and the CAA recognises that it may be useful to consider this dimension of the question.

What increments should be considered?

- 2.11 The objective of the investigation is to provide good pricing signals for providing additional outputs, both to users and to the airports. Forward looking costs could be identified against small increments (the cost of each additional million passengers) or rather larger increments (the cost of each additional 30 million passengers), or for convenient increments in between. Taking smaller increments would provide estimates that are closer to the SRMC of increasing outputs, but carry the problem that the estimates are likely to be highly volatile. Taking larger increments is a more pragmatic means of costing indivisible projects, since the costs of large additions to capacity are spread across a larger number of outputs than simply the first set of passengers or users who take advantage of them.
- 2.12 The difference between taking small and large increments as the basis for the estimation is largely a question of smoothing the cost function over time. Taking a new terminal as an example, the key element of the estimate is the incremental capital and operating costs of the terminal, the number of additional passengers that it permits the airport to serve, and the projected demand for use of the terminal (over and above the capacity provided by existing facilities). How that cost is attributed to different elements of the outputs it produces can be taken into account in a number of ways. Taking small increments as the basis for estimation would result in a sudden peak in incremental costs at the point where the new terminal was constructed, with a drop thereafter. Taking a large increment would smooth the costs of the new terminal over a larger number of the passengers it was expected to serve.
- 2.13 As discussed below, the CAA's view is that the practicable basis for incremental cost estimation are the airports' business plan projections, but on an incremental basis and having been subject to challenge. Following this approach, the size of the increments are most easily defined according to the major increments identified in those plans. This will vary with the airports concerned.

Time period for estimation

- 2.14 Estimating the incremental costs of a particular increment of outputs may involve long term projections of the demands and costs associated with that

increment. Consider the case of a new terminal. Once the terminal is completed it will allow the airport to handle X million additional passengers. There will be a period in which the additional capacity is not fully utilised, and a subsequent period when it is fully utilised. The outputs that it produces would not be X million passengers that make up the annual operating capacity of the terminal, but the aggregated (in present value terms) number of additional passengers that the airport can serve over time. Thus the estimate of this slice of incremental cost would need to be based on long term projections.

- 2.15 The second question is how far into the future should the costs of additional outputs be estimated. This is closely related to the question of what the appropriate basis is for estimations at future reviews. Incremental cost pricing is a forward-looking concept that does not take into account existing assets (except as providing the starting point for the estimation). Estimating forward looking incremental costs over the next five years, for example, will create problems where there are large investment projects. The estimates prior to the project being completed will be in line with LRIC, but the estimates at future reviews, once the project has been completed may be well below this level (since the costs of the project would no longer be taken into account).
- 2.16 One way of approaching this point is to estimate incremental costs over a longer period into the future, to encompass capacity increments beyond the immediate development. As the immediate development is completed, while that investment would not be included in future estimations, the costs of the increment beyond would be included. A second approach would be to use the longer run estimates to project a price path over time, and commit to that path. At future reviews the focus would be on how the key elements of that price path should be re-estimated, not the core projection itself. There are various other ways of accommodating the problem.
- 2.17 Whichever approach is taken, in the first instance it is useful to project the incremental costs of outputs as far into the future as is possible (while noting that the effect of discounting is to reduce the importance of future costs in the calculation). Long run projections are also likely to provide a better basis for considering perturbations against the base case.

Constraints to be assumed in the estimation

- 2.18 Airport planning is subjected to a number of constraints. While these may change over time in the light of future policy developments, it makes sense in the first instance to estimate incremental costs taking some of these constraints as fixed. These estimates could then be subject to sensitivity testing in alternative scenarios, where these constraints are not treated as fixed.
- 2.19 The first and most obvious constraint is that the airports already exist, and the facilities there are, for the most part, sunk. The CAA will take this as given and not focus on green field estimates of incremental costs. For the base estimations

the CAA will assume that there are constraints in relation to runways. To put these estimates in context, the CAA may also consider sensitivities to the incremental cost projections in an environment where some of these constraints are lifted.

How should the least cost plan be identified and challenged?

- 2.20 Incremental cost estimation needs to identify the additional costs that delivering the specified additional outputs would generate. It covers only those costs which are truly incremental; i.e. costs which would not have arisen if the additional outputs had not been supplied. Identifying these costs is not straightforward, and a number of methodological approaches are outlined below. There is also the question of incremental revenues. Some airport facilities which are required to deliver the additional outputs specified for the incremental cost estimation, will also generate some additional revenues. There are parallels here with the single till debate. The investigation into estimating incremental costs based upon one or more of the methodologies outlined below will also consider the question of incremental revenues.
- 2.21 The first is to estimate a broader cost function for airport activities, using econometric estimation techniques. In essence this would take cross sectional data over time to identify how costs appear to vary with outputs. The CAA has incorporated this form of estimation into its work on benchmarking.
- 2.22 The second is to take airport specific (or possibly airport system) business planning projections, identify the incremental cost elements of these, and subject them to challenge. The working assumption for this approach is that the airports' plans approximate to the least cost means of meeting demand for additional outputs. Clearly this assumption would require testing. The first element of any test would be whether the cost specifications for the elements of the plan appear to be reasonable. The second element would be whether the projects planned themselves appear to be properly specified. The third element is how the incremental cost elements of the plan can be identified if the plan itself has not been formulated on the basis of a proper estimation and evaluation of incremental costs.
- 2.23 The third option is to take an engineering approach, and, starting from the current infrastructure, consider the costs of producing additions to that infrastructure. This could also be part of testing the airports' plans.
- 2.24 The fourth is to estimate incremental costs using perturbations to the outputs specified, or some of the key project inputs. What this approach does is pose the question "how would the discounted least cost path change given a small but significant change in the outputs it is to provide?" Under a plan which is well specified the answers should not be very dissimilar to the estimates of the basic estimation. If they do turn out to vary considerably, this calls into question the basis for the basic estimations. Deciding what perturbations should be adopted

will depend in part on the estimation of the base case. However, the type of questions which could be asked would be:

- What will the change in costs be if the growth in passenger demand is greater or less than forecast by a small amount?
- If a particular project were delayed for five years against the plan, what would be the costs of continuing to provide the outputs that the plan had been expected to deliver?

Incremental costs of different dimensions of output

- 2.25 The focus of analysis of this type is identifying the incremental costs of the different dimensions of output that airports provide. This is important information for considering issues of service quality and pricing structures (as opposed to price levels), and is also relevant to the question of what information the airports should be making available to users. These costs also have an important forward looking element.
- 2.26 This form of incremental costs can be considered on a fairly detailed level. Consider the costs of providing air bridges. An incremental cost estimate would pose the question, what would be the difference in output if stands with air bridges were supplied more or less comprehensively, and what would the difference in cost be. This will involve estimating the direct costs of the stands with air bridges, the opportunity costs of using scarce airport space for the stands, and the changes to the capital expenditure plan which would result. It may throw up answers that are very different from the straight forward accounting estimates of the costs of air bridges. The forward looking element of this can be addressed using the perturbation approach. For example, the projected costs of increasing airport throughput with or without a specified level of air bridge service could be identified.
- 2.27 Another option would be to estimate the costs of a change in the airports' planning objectives. This would provide information about the incremental costs of increasing the level of service quality at an airport. It could be possible to estimate the costs of changing BAA's planning objectives. The following questions might be of interest:
- What are the incremental costs of a lower average waiting time and increasing space at check-in desks?
 - What are the additional costs of increasing space and seating facilities at departure lounges?
 - What are the incremental costs of lowering the average amount of time passing between the first and the last bag at the baggage reclaim?

2.28 The CAA will further consider those dimensions of output and service quality for which it would be useful to have incremental cost estimates in the light of responses to its consultation paper on service quality.

3. Conclusions and next steps

- 3.1 This paper has set out some of the issues raised by incremental cost estimation, and outlined some of the ways in which the estimates might inform the eventual price cap or other elements of this review. How far this proves to be productive will depend largely on the quality of the estimates.
- 3.2 The estimation of forward looking costs requires, in the first instance, a projection of the additional costs of delivering future outputs according to the “least cost” plan. Since the appropriate starting point is the current infrastructure at the airports, these estimates will initially be based on the airports’ business plan projections, suitably adjusted. Once a reasonable estimation is achieved of this, the CAA will consider such perturbations of that projection as seems appropriate.
- 3.3 In relation to the costs of different dimensions of outputs, the CAA will rely in part on the perturbations approach and, where it seems particularly important following responses to the service quality consultation paper, the CAA may also consider a direct cost estimate of some quality dimensions, both currently and on a forward looking basis.

Annex 1: Examples of estimating incremental costs at airports

This annex summarises different empirical approaches to estimate long run incremental costs of airports to date¹¹. It reviews

- BAA's history in LRIC estimations
- a study of LRIC of Wellington Airport
- an econometric study of BAA's LRIC by Loughborough University

BAA's work on LRIC estimations

BAA has a long history in applying a charging approach based on LRIC¹². A UK Government White Paper stated in the late 1960s that pricing policies should be related to long-run marginal costs. The general agenda of relating charges to long-run marginal cost was found to be hard to interpret in the case of airports, because it can be covered in a multiplicity of ways and because a specific financial target may preclude LRIC pricing because it would fail to guarantee commercial airport operation¹³.

It was also recognised that in the case of lumpy investment projects, to price according to LRIC would not guarantee that the pricing system would result in optimal investment, since it does not directly take into account the full valuation of users for additional capacity.¹⁴ Estimation of consumer surplus is however demanding, and LRIC are usually seen as a pragmatic approach to providing good signals for the timing of new infrastructure.

In the 1980s, BAA undertook several studies that reviewed the level and structure of BAA charges. In 1982, before the opening of Heathrow T4 and Gatwick T2, a BAA study¹⁵ concluded that the prevailing level of charges was broadly in line with LRIC at Heathrow (after offsetting net commercial income). Gatwick was found to have a

¹¹ Throughout this Annex the term "LRIC" is used to cover a variety of other terms which were actually used ("LRMC" for example.)

¹² An overview of BAA's charging policy in the 70's and 80's can be found in Little/McLeod, 1972, *The New Pricing Policy of the British Airports Authority*, in: Journal of Transport Economics and Policy, May: 101-15 and Toms, M., 1994, *Charging for airports – The new BAA approach*, in: Journal of Air Transport Management Vol. 1(2): 77-82.

¹³ Little/McLeod, 1972, *op. cit.*, 102-3.

¹⁴ Little/McLeod, 1972, *op. cit.* 103, c.f. Williamson, O., 1966, *Peak-Load Pricing and Optimal Capacity under Indivisibility Constraints*, in: American Economic Review 56: 810-827 and Starkie, D., 1982, *Road Indivisibilities – Some Observations*, Journal of Transport Economics and Policy, September: 259-66.

¹⁵ BAA (1982), *Cost and Charging Study*, BAA 76/82, October 1982.

charging level of less than 50% of LRIC, reflecting the considerable degree of spare capacity at the Sussex airport. Peak periods and surcharges at both airports appeared to be justified as well as a rebalancing of the structure of charges from weight-related landing charges to peak passenger charges.

BAA argued that a short run marginal cost (SRMC) based approach was appropriate for industries which have “lumpy” assets. The study however comments that “the capacity as a whole in the South-East airports system has been, and is likely to be, increased in a gradual way and so cannot be regarded as typically ‘lumpy’”¹⁶

BAA also argued that

- it would not be efficient to premise the need for new capacity on demand only temporarily attracted by low (SRMC) prices;
- a long run price signal may be more important to airlines than a short run price signal;
- congestion costs as part of SRMC would be difficult to measure and are partially borne by airlines;
- SRMC pricing would not ensure that BAA achieved financial break-even.

These issues are discussed below in more detail.

Measuring Incremental Costs

The measurement of incremental costs has to solve the problem that the output of an airport is multi-dimensional. A measure with only a single dimension is therefore unlikely to represent demand imposed on different parts of the airport system as a whole.

The following table characterises the demand measure and characteristics of major airport functions:

Major Airport Function	Demand Measure	Demand Characteristics
Provision and maintenance of runways and taxiways	Flight or A.T.M	Size/loading of the aircraft
Provision and maintenance of stands/aprons Provision of access to stands and waiting facilities (piers and gate-rooms) Loading Bridges	Stand occupancy or turn-round time	Size of aircraft and service level required (pier service, airbridge service etc.)

¹⁶ BAA (1982), *op. cit.*, p.4.

Services to aircraft on stand		
Immigration & Customs facilities Arrivals concourse & meeters/greeters facilities Access to rail/road Check-in facilities Departure lounge Facilities (toilets. Lifts, etc.)	Passengers (& escorts)	Type (Domestic, long-haul, short-haul) & pax load per aircraft
Baggage handling & Reclaim facilities Porterage facilities	Passengers	Bags per pax for different pax types (domestic, long-haul, short-haul)
Roads – forecourts etc.	Vehicles	

Source: British Airports Authority (1982): Cost and Charging Study, October 1982, p. 7

3.4 For its own 1982 charging study, BAA applied a methodology for estimating LRIC in three steps:

- Identification of airport function costs, encompassing capital and operating costs of each airport function under the headings of passengers, baggage, ATMs, stand occupancy and commercial activities. For example, the detailed area analysis of Heathrow T4 construction costs split the annual capital costs in the following way: Passenger (Public Areas): 24.9%, Baggage (Handling & Reclaim): 13.3%, Aircraft Stand (Piers, Gaterooms etc.): 19.8%, Commercial (Shops, Catering, Offices) 20.5%, Staff (BAA Offices): 2.4%, Equipment (Plant Room etc.): 19.1%, and the proportions were then applied to the terminal costs. Operating costs were disaggregated into five categories (staff, staff-related, area-related, equipment-related and others). They also were broken down into the three categories “capacity”, “traffic” and “other”. “Capacity costs” were subsequently allocated to peak traffic, ‘traffic costs’ to all traffic, and other costs recovered as overhead mark-ups;
- Variation of costs with demand characteristics, encompassing examination of the extent to which costs vary with the different characteristics of each of the demand measures (e.g. short-haul/long-haul passenger costs). A base case was defined and the impact of different mixes of passenger traffic, for example on queue lengths and occupancies, was then simulated. Varying requirements of different passengers as well as the associated annual capital and operating costs could be derived. Aircraft stand costs were derived for three different categories.
- Relationship between costs and demand, encompassing the allocation of the costs to the appropriate levels of demand which each new development is expected to handle. The identified annual passenger- and baggage-related costs were attributed to the appropriate passenger number, and aircraft stand

costs formed the basis for hourly parking costs. Within this exercise, capacity-related costs were allocated only to peak traffic.

The study concluded that actual landing, passenger and parking charges at Heathrow and Gatwick were considerably lower than the benchmark charges derived by the exercise described above.

In 1983, BAA undertook a follow-up study of cost-related charges at Heathrow and Gatwick¹⁷. The study argued that prices related to SRMC would oscillate over time, and that this would be unlikely to lead to an efficient allocation of resources since many airlines cannot adjust schedules easily and demand would be relatively unlikely to respond to short term variations in price. LRIC would therefore provide the basis for a more stable pricing policy.

BAA also concluded that the increase in airport capacity by the opening of T4 should be regarded as the marginal unit of supply because it would not be cost effective to provide new terminals with less passenger capacity. Furthermore, total costs of the terminal should be recovered over its economic life, including the excess capacity in early years. The study argued that SRMC including some form of congestion costs are the appropriate indicator for economic costs of runways since their capacity cannot be expanded. Capital expenditure of T4 was translated into a present value and converted into an annualised cost for the working life of the asset. Operating costs were assessed for a period when the terminal is operating at capacity. As in the 1982 study, costs of different demand characteristics were assessed to derive a causal relationship. BAA derived significant peak patterns and related differences in passenger and parking related costs.

Assessment of LRIC at Wellington Airport

In 1993, long run incremental costs were estimated as part of a court case between Air New Zealand and Wellington Airport¹⁸ to assess a charging proposal of Wellington International Airport (WIAL). It was argued that the incremental costs of the existing airport runway should be considered because it is not possible to construct a second runway at Wellington. Terminal arrivals capacity was however inadequate, and as site constraints did not apply to the development of terminal capacity, the approach of calculating the incremental costs of expanding capacity at the margin was applied. As there was no evident need for expansion of aircraft stands and gate facilities in the short or medium term, the costs of using the existing assets were seen as the appropriate charging concept for these facilities.

¹⁷ BAA, 1983, *Heathrow Traffic – Cost Related Charges*, BAA Position Paper.

¹⁸ Starkie, D, 1993, *Affidavit in the High Court of New Zealand*, CP 829/92.

As in the BAA study of T4, peak patterns emerged at the New Zealand airport. It was argued that the next tranche of capacity should strike a balance between the size of the capacity increment added and the anticipated growth in traffic. As it would not have been economic to add capacity would not be fully utilised until well into the future, a modular approach to expansion was seen as the least cost option, and it consequently formed the basis for the the calculation of charges for the use of terminal facilities¹⁹.

A number of terminal development options were examined, and the option which promised to achieve the best possible balance between existing capacities and requirements across all terminals was identified. Terminal costs recouped from separate charges were subtracted and, as it was necessary to calculate charges separately for domestic and trans-Tasman traffic, costs estimates were provided for incremental costs that resulted only from a need to accomodate extra domestic traffic and for the incremental costs resulting from trans-Tasman traffic.

Annual operating costs (excluding taxation and depreciation) were divided between capacity related, time related and volume related costs. Capital expenditure was annualised over the terminal's working life and then added to the annual operating costs. Because it was possible that traffic growth in off-peak periods could continue to be handled within the existing terminal capacity, incremental capacity costs as well as the fixed operating costs of the new terminal were applied only to peak demand.

Within a sensitivity analysis, the important factors conditioning the results were varied. For example, capital expenditure was assumed to increase by up to 150%, and operating costs up to 120% of the base case, and discount rates of 5%, 7% and 9% were applied for discounting future capital expenditure. This produced a range of charges around the base case.

Finally, the revenue implications of the estimation of charges were compared with the existing charges, and implications of the incremental cost-based charges for operating the airport commercially were assessed.

Econometric Estimation of long run cost airport functions

Parametric benchmarking of airports²⁰ and further econometric modelling is an alternative option for estimating airport cost functions as the long run relationship between costs and appropriately specified outputs.

In 1990, a comprehensive estimation of airport cost functions was conducted by TOLOFARI/ASHFORD/CAVES²¹. In investigating the economics of the UK airport

¹⁹ Starkie, 1993, *op. cit.*, p. 25.

²⁰ See CAA, December 2000, *Benchmarking of Airports, Discussion Paper* (available at www.caaerg.co.uk)

industry, the study estimated the short and long run costs of Heathrow, Gatwick, Stansted, Glasgow, Edinburgh, Prestwick and Aberdeen airports up to 1986/87. A question of special importance was whether there are economies of scale and density in the operation of these airports.

The estimation of long run cost functions based on cross-section data of different airports is faced with several problems which reflect the problem of coping with indivisibilities in investment. It implicitly assumes “that each airport will have adjusted its capital stock (runways, terminal buildings, airport access/service roads, land, etc.) to an optimal level appropriate to cope with its normal or expected scale of operation. In the real world, capital investment in airports is not easily varied to cope with changes in throughput levels”.²² The planning process as well as the inherent indivisibility of much of the airport capital stock hinder or delay such an immediate accommodation of the capital stock. Airports might therefore temporarily operate in disequilibria below or above their optimal capex/opex ratio for a specific throughput. A properly specified estimation of an airport’s cost function should therefore include a variable for capacity utilisation levels.

A related problem exists with the usual time lag between the time of the capital expenditure and the phase when the corresponding airport facility become operational. This lagged relationship between total cost and output might bias the cost function estimate.

Analysis based on time series might face different problems. A change in the relative prices of different input factors, or new available technologies might cause a change in the relationship between output and costs, resulting in a shift of the cost function of individual airports. Nevertheless it appears to be reasonable to assume that most parts of the airport business are not faced with major technology changes so that large structural shifts are unlikely.

Restrictive functional specifications of the underlying econometric model (e.g. with respect to returns to scale) may also restrict the quality of the econometric results on which any further derivation of forward-looking costs are based. The study of BAA airports’ cost relationships did not make any *a priori* assumption about the underlying airport technology by using a translog function, expressing cost as a function of outputs, input prices and other output and input related attributes (e.g. per cent of international traffic and scheduled services, Pax/ATM, capacity utilisation etc.).²³

Another approach is to derive a long run cost function from the observable short run cost function. “The essence of this approach is that the difference between the two

²¹ Tolofari, S./Ashford, N./Caves, R., 1990, *The Cost of Air Service Fragmentation*, Loughborough University of Technology, Department of Transport Technology.

²² See Tolofari et al., *op. cit.*, p. 23.

²³ See Tolofari et al., *op. cit.*, p. 27.

functions will serve as an estimate of the cost of excess or insufficient capacity for the individual airports in the sample".²⁴ Within this approach, the short-run period is limited to periods without any substantial changes in fixed assets (e.g. new terminal developments).

Capital expenditure can be used for investment in facilities which offer new capacity, but also to increase the quality of existing facilities. In the optimal case, cross-sectional and time-series analysis include the quality dimension of the airport assets. This can be done by specifying airport outputs in different dimensions which include quality as well as capacity.

The study was based on data up to 1986/87. Some of its conclusions are nevertheless interesting. Heathrow was found to experience increasing returns to density. High levels of passengers per air transport movement/international traffic combined with high levels of terminal capacity utilisation were found to result in reductions in operating costs. Increases in terminal capacity utilisation levels were found to bring a less than proportionate rise in variable costs. Long-run economies of scale were found for the average BAA airport as well as for Heathrow in terms of the airport's 1986/87 observations. It was concluded that it was reasonable to expect that given an airport's capacity level, higher average loads can still be used as an operating strategy to achieve cost economies without further capacity expansions.

²⁴ See Tolofari et al., *op. cit.*, p. 29.

Annex 2 - Estimating incremental costs in other regulated industries

This section provides a brief summary of how other regulators approached incremental cost estimation²⁵. OFTEL and OFWAT in particular have given the issue a considerable amount of attention. OFTEL adopted a LRAIC approach to determine interconnection fees, while OFWAT asked the regulated firms to submit their estimates on long-run marginal costs during the 1999 review process.

OFTEL's approach to calculating LRIC

In 1994, OFTEL published a consultative document²⁶ which paved the way for applying an LRIC approach to interconnection charges. It defined incremental costs as a general concept which refers to the increase in the firm's total cost when output is expanded by a specific amount. OFTEL argued that

“ the specific amount could be a single unit (in which case it is generally called 'marginal' cost rather than incremental cost); it could be the total level of output of the relevant product (in which case average incremental cost is measured); or it could be some intermediate amount. In principle, it would be possible to measure incremental cost on a short or long run basis (Short run incremental costs are those that vary with changes in output when certain inputs are fixed whereas long run costs are based on the assumption that all costs or inputs are variable.)²⁷

In many subsequent consultative documents and studies, OFTEL refined the methodology for interconnection charges to be based on the basis of long run incremental costs²⁸. Under its license, BT is currently required to prepare statements of LRIC. However, it appears to be the case that OFTEL has used the LRIC methodology not only for any incremental output, but also for the replacement of existing outputs.

These incremental costs are calculated backwards as “the cost avoided through no longer providing the output of the defined increment given that costs can be varied ..”²⁹ which

²⁵ Throughout this Annex the term “LRIC” is used to cover a variety of other terms which were actually used (“LRMC” for example).

²⁶ OfTel, 1994, *A Framework for Effective Competition – A Consultative Document on the future of interconnection and related issues*.

²⁷ OFTEL, 1994, *op.cit*, p. 12.

²⁸ See, for example, OFTEL, 1997, *Long Run Incremental Costs: The Bottom-Up Network Model*, and Bromwich/Chong, 2000.

²⁹ BT, 1999, *Accounting Documents*, 16 September 1999, p.55.

would be saved in the long run if an incremental output would not be offered. This allows all costs that do vary, even in the very long term, to adjust to changes in output.

OFTEL discussed two principal methods of estimating forward-looking costs: an engineering economic model reflecting best practice and a top-down approach using management accounts where assets are revalued according to current cost principles. It recognised that the latter method has the disadvantage that it may incorporate inefficiencies but argued that it would provide a more realistic basis for setting charges.

To establish a robust methodology of calculation, two different modelling approaches were developed. Firstly, BT developed a top-down model³⁰ which started from BT's financial accounts and removes costs that are not incremental. An industry working group secondly constructed a bottom-up model of an efficient telephone network using economic engineering models that identify the engineering elements required to build a network. The model was subsequently populated with the costs of an efficient operator.

Each of the two approaches was evaluated and a hybrid figure was derived. As the accounting costs were used within the top-down approach, the resulting figures show incremental costs which depend on accounting costs and depreciation (e.g. HCA – CCA). As LRIC is a forward-looking approach, an asset valuation with current costs appears to be more appropriate. If correctly specified, the top-down model will provide an accurate and disaggregated picture of the relationship between individual costs drivers and output levels. It can however be a very demanding and involves complex modelling which is vulnerable to inaccuracies, while a bottom-up model can be relatively straightforward to understand³¹. The latter might also help to understand the key drivers and interdependencies of the airport business.

OFWAT's approach to LRIC

During the last water review OFWAT promoted LRIC as a pricing concept. OFWAT explicitly assumed that supply costs increase with increased output as the lowest cost facilities are developed first³² and asked the regulated water companies to submit least-cost plans as well as LRIC estimations. This reflected the difficulties for the individual water companies to find a consistent way to calculate LRIC. The final decision on the price caps for the 26 UK water companies did not place extensive reliance on the results.

Transco's 'Transcost' Model

Transco uses LRIC estimates derived by its 'Transcost' model to apportion gas entry and exit capacity charges for the transmission network. Starting from a base network and its

³⁰ See BT, 1997, *Long Run Incremental Cost Methodology*.

³¹ For the strengths and weaknesses of the different approaches compare OFTEL (1996): *The Methodology to Calculate Long Run Incremental Costs*, report prepared by NERA.

³² See, for example, OFWAT, 1997, *Water Pricing – The Importance of Long Run Marginal Costs*, MD letter No. 123.

extensions to support demand growth over time, the model assumes hypothetical additional increments to demand over ten years and subsequently reconfigures the network. The present value of the cost difference between the two network configurations is interpreted as the LRIC of the hypothetical increment. This is an example of the “perturbation” approach to estimation.