TRANSCO PRICING CONSULTATION PAPER PC38

REVIEW OF LDZ TRANSPORTATION CHARGE FUNCTIONS

SUMMARY

A revision to the methodology for calculating LDZ transportation charges is proposed. In total the methodology change implies a large redistribution of LDZ transportation charges, with increases for larger consumers and reductions for domestic consumers. Transco proposes to phase the move to charges based fully on the new methodology over a number of years. If approved, the LDZ transportation charge algorithm will be based on the new methodology outlined, but with a phased implementation for October 1999. From that date, LDZ transportation charges will be reduced by 4.8% for domestic loads with increases of up to 13% for some larger firm loads when compared with charge rates applicable at 1st May 1999. The algorithm continues to be based on postalised charges and average costs.

The revised methodology is believed to offer an improved reflection of costs incurred on each pressure tier within the LDZ. This conclusion has been reached through analysis of Transco's ABC costs to provide information regarding the appropriate distribution of charges between tiers.

An updated model of low pressure system use has been developed based on an analysis of system inputs and exit points for a sample of low pressure systems. The outcome of this analysis is a reduced differential between charges for domestic and larger users connected to the low pressure system.

A probability matrix of system usage by various consumption groups has been updated. Included in this analysis is a revised reflection of demand distribution across the consumption groups. The revised matrix provides a closer reflection of demand distribution, as reported in Transco's annual Base Plan Assumptions document.

REVIEW OF LDZ TRANSPORTATION CHARGE FUNCTIONS

1.0 Introduction

In 1998 Transco suggested to industry participants that it would be appropriate to undertake a review of the LDZ charging algorithms. This attracted wide support. LDZ transportation charges recover approximately 52% of Transco's income. The present capacity and commodity charging algorithms are continuous functions that avoid step changes in charges for marginal changes in load. The charge calculations disassociate loads from their physical connection to pipeline pressure tiers in order to present a function based upon size of load. The charging algorithm therefore avoids having dissimilar charges for transportation to customers in close proximity to each other, with similar load characteristics but that may be connected to different tiers of the pipeline system. Postalised charges are used to maintain a national charging structure.

The review of LDZ transportation charges has concentrated on two areas, Average or Marginal costs and a review of system use by various consumption groups. In the latter section changes to the Low pressure system model and minimum unit charges for the LTS are proposed.

2.0 Average or Marginal cost

2.1 Average Cost

The present methodology is based on average cost calculations for use of each pressure tier. Transco's use of activity based cost (ABC) accounting has overtaken the methodology for allocating costs between the various sectors of the distribution system. The costs reported through Transco's ABC accounts are grouped into asset groups. The groups include LTS, IP/MP and LP pipeline systems. A summary of Transco's ABC costs is published annually. The document (Activity Based Costing Review of 1997) summarises costs for LTS, IP/MP and LP systems. Use of ABC costs as the basis for determining the appropriate split of charges due from each pressure tier should foster greater cost reflectivity than would be the case for charges that are based upon a proportion of assets attributable to each pressure tier. Continuing use of the present methodology may hinder changes to charges that would otherwise be signalled as appropriate by changes to ABC costs.

Replacement of the present asset based split of charges between pressure tiers with a distribution determined by ABC costs will produce a change in the balance of costs attributable to each tier.

Distribution of Average Costs

	LTS	IP/MP	LP
1991 Costs	18%	21%	61%
1998 Costs	23%	18%	59%

If the 1998 costs are taken as the basis for distribution of costs between pressure tiers then a redistribution of costs away from the LP, IP and MP systems is indicated. The rise in proportion of costs for LTS systems is not a rise in absolute terms but a redistribution of the total LDZ cost pool. The ABC results show that Transco has reduced costs by a greater proportion within the lower pressure systems. It is noteworthy that customers located on the low pressure systems attract charges for use of the LTS.

2.2 Marginal Costs

Marginal cost analysis is based upon the anticipated cost of capital expansion as well as changes in operating expenditure associated with an increase in demand within an LDZ. It should be noted that a natural monopoly such as gas transportation may display economies of scale with marginal costs for handling additional load below average costs. This would result in a permanent financial deficit for the monopoly service provider if only marginal cost pricing were to be applied. A reduction of average costs has been reported over time by Transco, whilst capacity has been steadily expanded. A methodology for setting LDZ. charges based on marginal costs would thus require a method of allocating residual costs up to the total allowed by Transco's price control formula.

Investment planning within each LDZ is managed on a similar basis to the structure previously described for reporting ABC costs. That is investment costs are collated for LTS and distribution, with no distinction within the distribution category for IP, MP and LP systems. Using the investment forecasts and ABC costs, an average incremental cost can be calculated for a given amount of growth in demand. From that a proxy for marginal cost can be calculated by dividing the average incremental cost by the increased quantity of demand.

	LTS	Distribution
Marginal cost	7.28p/pdkWh	3.65p/pdkWh

The marginal costs above are based on Transco's recent LDZ capacity/commodity analysis, as reported in Pricing discussion document PD4.

The scarcity of marginal cost data points does not help when seeking to construct a capacity charge algorithm. The data does however, provide useful information regarding the appropriate transportation charge differential between an average load on the LTS and an average load on the distribution system The differential between average use of each pipeline group (LTS and distribution) on a marginal cost basis is 3.65p/pdkWh. Marginal cost for transportation through both pipeline groups is 10.93p/pdkWh, whilst transportation charges at present reflect a maximum peak day differential of 18.07p/pdkWh. Reflection of marginal use through the transportation charges would reduce the differential between typical loads using each pipeline group.

2.3 Route Specific Charges

Transco has explored the potential for adapting its Transcost model to provide a measure of long run marginal costs (LRMC) within each LDZ. Transcost is designed to calculate route specific reinforcement costs between a number of entry and exit points. A number of difficulties have been encountered that lead to the conclusion that at present Transcost cannot indicate reliable LRMC based transportation charges to replace the LDZ algorithms. Considerable simplifications would be required to attain a workable version of Transcost for the LDZ’s which may bring in to question the value of any results it produces.

One such problem concerns the nature of distribution systems. These are designed to deliver gas up to a peak hour threshold for above 2 bar systems, and a peak 6 minute period for below 2 bar systems. This is in contrast to bulk supplies on the NTS, which are delivered up to a peak daily demand, with each day having a flat profile. Against a backdrop of constant within day supply levels from the NTS, demand levels will be constantly changing within the LDZ to match many different customer profiles. During most days demand will routinely exceed supplies into the distribution system for a number of hours. Diurnal storage is used to provide the balance whenever demand exceeds supply. At the peak hour demand level, diurnal storage is drawn upon and pressures may drop towards their minimum safe levels. It is at this period when marginal cost analysis should be used to calculate the cost of expanding the system. However Transcost requires supplies and demands to be in balance because it does not allow for a balancing volume of gas. Allocation of the quantities of diurnal storage to various parts of the pipeline system would fundamentally effect the results of the analysis because the amount of storage required will always tend to exceed the size of LRMC increment that is used.

It should also be noted that there are many possible pipeline routes through the LTS, with 120 entry points into the LTS and approximately 2,500 exit points on a national basis. This makes use of Transcost to estimate route specific costs extremely complex even for the LTS. To bring arrangements on the LTS more generally into line with the NTS, the number of entry and exit points may need to be reduced to a lower level to maintain a workable commercial regime with a limited amount of trading possible between adjoining pipeline routes. However any such simplification would probably be at the cost of the cost reflectivity which is the reason for pursuing a route specific schedule of charges.

3.0 Use of Pressure tiers

3.1 Determination of system usage by consumption band

The LDZ transportation charge methodology determines charges based upon a customers Annual Quantity (AQ). Determination of charge rates based only upon identification of pressure tier to which a customer is connected would present considerable difficulties. Anomalies may be possible with customers of similar AQ and location, being charged at different rates by virtue of being connected to different sections of the transmission system. Such a methodology would also require considerable resources to manage. The present methodology overcomes these problems by basing charges upon AQ and using a probability matrix to determine the likelihood of customers of given size being connected to each pressure tier.

The results of a sampling exercise conducted in 1998 to validate the matrices for capacity and commodity (Appendix 2) are broadly similar to the results obtained during the 1992 exercise. Such an outcome is unsurprising because the majority of customers, once connected to a transportation pipeline, may be expected to retain that initial connection configuration throughout the life of the gas supply contract. However, a greater proportion of large customers (>293,071 MWh) has been shown to have direct connection to the MP system than was previously indicated to be the case. However, the larger 1998 sample of that customer group instils greater confidence in the updated results.

The profiles can be applied to the total peak day and annual volumes to produce an estimated offtake matrix. The original offtake matrix is based on peak and annual demand forecasts provided for 1991. In that years demand forecasts the domestic (less than 73.2 MWh) share of LDZ demand was estimated to be 72% of peak and 60% of annual LDZ. demand. Transco's 1999 Base Plan Assumptions document identifies both peak and annual LDZ demand forecasts for above and below 73.2 MWh. Scrutiny of the forecasts suggests that the domestic "share" of total LDZ demand has fallen to 64% of peak and 50% of annual forecasts. Both new matrices have been updated to reflect the revised shares of domestic and industrial demands.

Extract from 1999 Base Plan Assumptions document - 1999 forecast

	Capacity (GWh)	Commodity (MWh)
0 - 73.2 MWh	2,854	367
LDZ. > 73.2 MWh	1,620	362
Total	4,474	729
Domestic "share"	64%	50%

The impact of the changing ratio of domestic to industrial demand has an effect on the assumed distribution of costs within the Low Pressure system. Average costs for the use of each pressure tier, particularly the relationship between IP, MP and LP systems will change because the new matrices suggest a more even distribution of customers across tiers for non-domestic customers. Domestic customers are, however, still most likely to be connected to the LP system.

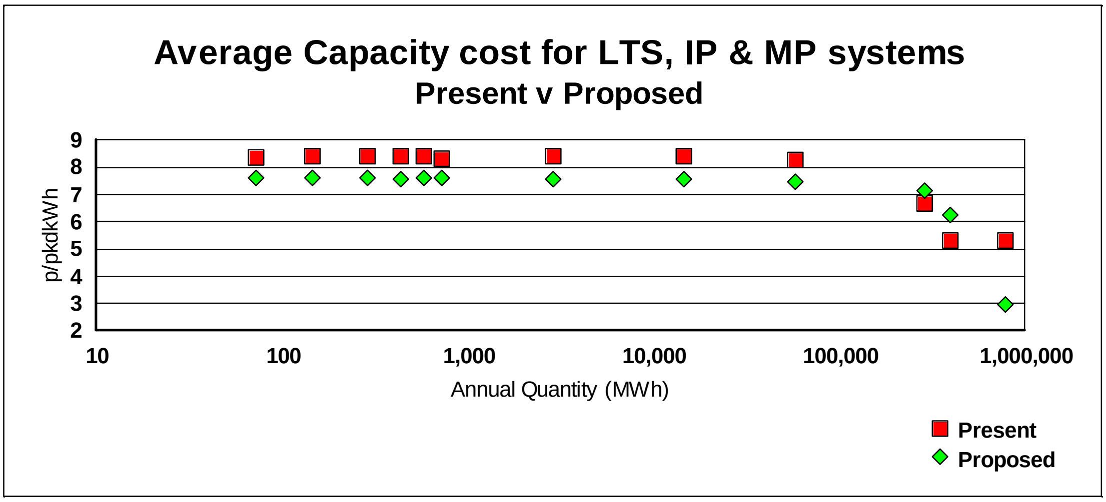
3.2 Use of LTS

The present LDZ charging algorithm includes a minimum charge that is equivalent to the average cost for use of the LTS system. This minimum charge is applicable to larger loads only and is added to costs derived for use of other pressure tiers when calculating charges for smaller consumption bands. The average cost is derived from a simple division of total LTS income by total LTS throughput. The threshold at which the minimum charge becomes applicable is determined during the fitting process when a log log function is calculated to provide the closest approximation of the average costs expected for each consumption band.

Transco has considered the appropriateness of applying a charge that recognises that loads directly connected to the LTS may impose a different level of costs to loads that are transported through the LTS and on to lower pressure tiers. The results of Transco's analysis of use made of the LTS by direct connect and indirect loads is provided in Appendix 3. Direct connect loads are those loads that are connected to the LTS pipeline system. Indirect connect loads are transported through the LTS to pressure reduction stations prior to onward transportation through the lower pressure tiers. The results of the analysis do not provide a consistent national view of system use made by the two categories of load. Direct connect loads may use more or less of an LTS system depending upon which geographic area is under consideration. The major factor would appear to be the geographic location of customers in relation to the NTS offtakes that provide gas for the LTS A consistent theme was gained from scrutiny of larger load data only. Larger customers tend to use approximately 69% of the LDZ asset, when compared to the use made by all other direct and indirect loads. As a result a change to the minimum charge for LDZ capacity and commodity algorithms is proposed that reflects the limited use made of LTS assets by larger customers.

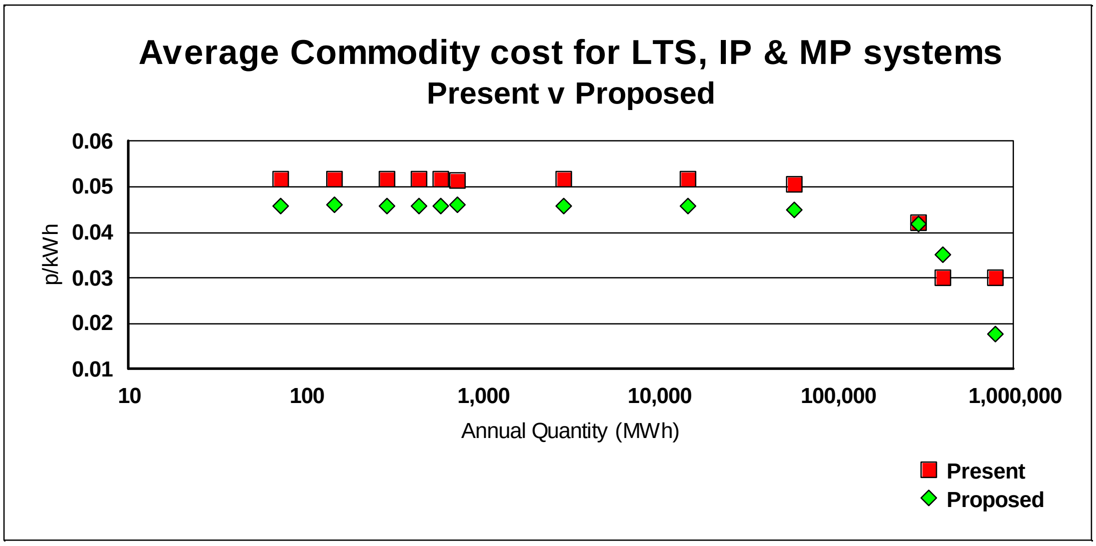
3.3 Impact of revised matrices upon costs for LTS, IP and MP system use

Average revenue for the LTS, IP and MP pressure tiers is calculated by dividing the total revenue for each tier by expected throughput. This calculation will vary for capacity which is dependent upon peak day throughput, and commodity, which is dependent upon annual (including interruptible) throughput. The probability matrices are used to determine which pressure tiers will be used by each consumption band. Within this calculation consideration must be given to the probability of gas being transported through each successive tier. In particular intermediate pressure systems are not in widespread use across the UK. Gas transported to the low pressure tiers therefore has a high probability of bypassing the intermediate pressure pipelines. This feature is therefore represented in the LDZ algorithm.



3.4 Use of Low Pressure system

Analysis of total

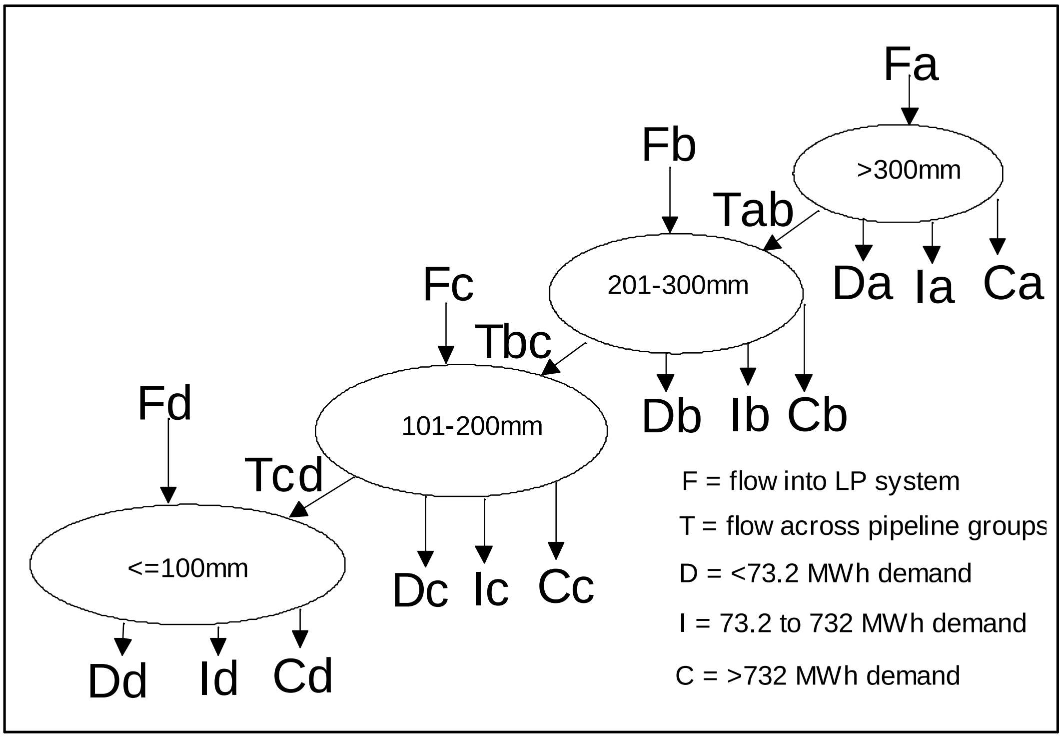


costs for each of the LDZ pressure tiers shows that approximately 60% of total costs are accounted for within the low pressure (LP) tier. Treatment of such a large tier as a single entity may be felt to be unreasonable, particularly in light of the number of different consumption bands that may be fed through the low pressure system. The present algorithm makes a distinction between differing levels of use of the LP system that may typically be made by each consumption band. It is argued that smaller customers will use more LP pipelines than larger customers. The rationale for this is that gas is transported through progressively smaller pipelines within the LP system. Larger loads will tend to be connected to the larger pipelines. After the larger loads have been offtaken, a smaller diameter pipeline would be adequate for transporting the residual load and the pipeline diameter may be progressively reduced after each load is offtaken. Finally the only loads that are transported through the last sections of pipeline will be destined for domestic consumers. The size of pipeline required to transport the gas will be less than that required when gas for other consumption bands is also transported in the pipeline system. Therefore it may be assumed that a small load may be fed by a small diameter transmission pipe, but that pipe is initially supplied through larger diameter transmission pipelines within the LP system. Non-domestic customers (above 73.2 MWh) on the other hand would be supplied with gas that has been transported through larger diameter pipes only.

Testing the validity of the assumptions regarding demand distribution within the LP system has formed a key part of Transco’s review of LDZ charges. The challenge is to identify how gas flows through the pipeline system from a pressure reduction station at the entrance to the LP system through various pipelines to customers premises. This analysis would ideally be required for a sample of all consumption bands. From the results, a measure of relative system use can be made for each consumption band. Gas paths through the pipeline system as described can be identified on an individual basis by network analysis. However this method of analysis is too labour intensive and time consuming to provide a sufficiently large sample for the purposes of this review. It is possible to identify the diameter of pipelines to which a sample of customers is connected. In the same sample areas the diameter of pipelines into which the gas will flow when it enters the LP system can also be identified. From this snapshot of inputs and outputs a picture of gas flow across the pipeline system can be gained. The revised view of gas flow across the LP system has been used as a guide to the appropriate allocation of costs for each consumption band that uses the LP system.

The analysis conducted by Transco into the location of gas entering and gas offtaken from the low pressure pipeline system is used as the basis for calculating the average revenue for the following consumption bands, domestic (less than 73.2 MWh, 73.2 to 732 Mwh and above 732 MWh. The diagram below provides a useful aid to visualising gas flow across the low pressure system.

Schematic of LP system



Analysis of the proportion of gas entering each pipeline group, and the matching quantities that are offtaken demonstrates that the major pattern of gas flow is from the larger pipelines through to smaller diameter pipelines. However customers are spread across all pipeline groups.

The recent analysis identifies how much gas flows into and is offtaken from each pipeline group. This method generates a weighted average revenue for each pipeline group that takes into account the revenue due for use of a pipeline group and the revenue due for use of other pipeline groups through which some of the gas may have previously passed. Application of the average revenue for each pipeline group to customers offtaking gas from a distribution pipeline in that category produces a charge that is reflective of the value of assets used. An average charge for use of the LP pipeline system by each of the three consumption bands is calculated by taking into consideration the proportion of gas offtaken from each pipeline group and the appropriate average revenue for that group. Indicative average charges for use of the LP system, based on the revised methodology, are provided below.

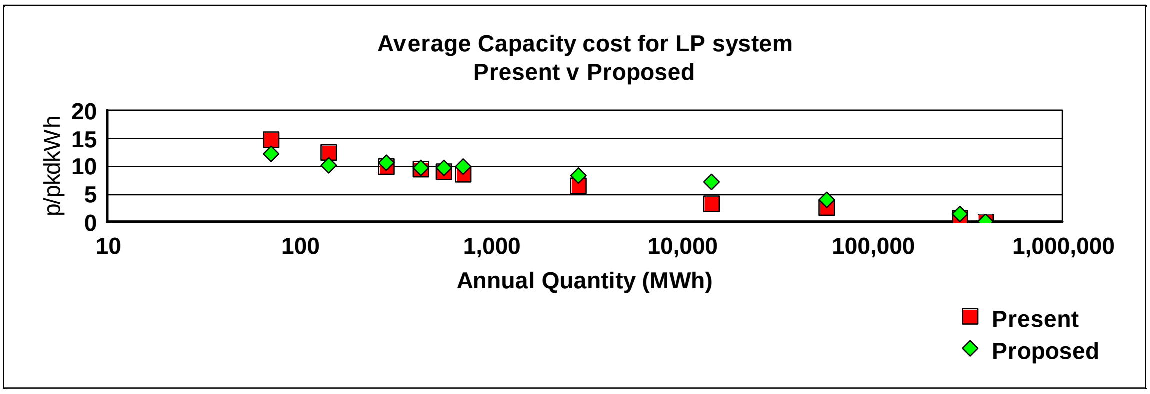
Average Revenue for use of LP system only

Consumption bands	Capacity (p/kWh)	Commodity (p/kWh)
Domestic (less than 73.2 MWh)	13.39	0.0985
73.2 to 732 MWh	11.42	0.0839
Greater than 732 MWh	10.52	0.0771

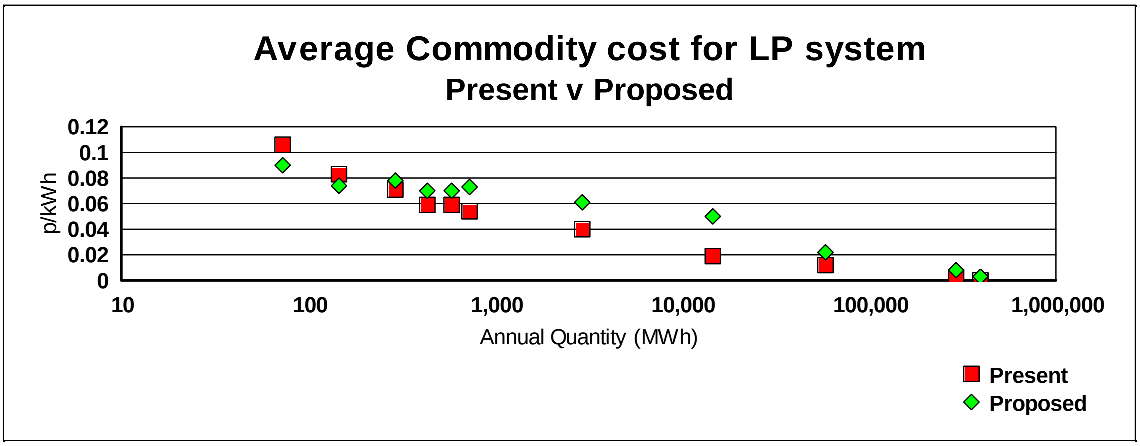
The process of disaggregation from pipeline location must be completed for the entire LDZ in order to produce a charge that closely reflects income attributable to a consumption band rather than pipeline tier. Demand that is offtaken in the LP system is multiplied by the appropriate average revenue identified above. From that calculation the total LP system revenue attributable to each of the ten original consumption bands is identified. Division of total LP revenue for each consumption band by the national total of LDZ demand applicable to each consumption band results in an average revenue for all demand in a consumption band including that proportion of demand that may not be offtaken in the LP system. The table below indicates the average revenue for each consumption band and worked examples are included in Appendix 4

4.0 Data fit using Log/Log function

Average charges for use of the LP system are added to the average charges previously



identified for use of the other LDZ pressure tiers. The results provide raw data points prior to



fitting a function that will provide a smoothed link between each data point. A log log function has been used in this process since the creation of the LDZ charging function. The data point for domestic charges is used to set the maximum unit charge. Minimum unit charges are defined as the average charge identified for using the LTS. Transco does not propose to change this aspect of the methodology at this stage.

Investigation of the appropriateness of the functions demonstrates that an improved fit may be obtained by use of an alternative or two part function. In particular this may produce a redistribution of charges from larger to medium sized consumers. Such changes would require extensive changes to Network Code functionality and therefore could not be introduced in the short term.

Data fit for capacity and commodity charge functions

	Capacity Function			Commodity Function		
Annual Consumption band (MWh)	Data Total	Fit Total	Difference (£m)	Data Total	Fit Total	Difference (£m)

	Charge (£m)	Charge (£m)		Charge (£m	Charge (£m)	
0-73.2 MWh	582	582	0	512	512	0
73.2 - 146.5 MWh	20	22	2	19	21	2
146.5 - 293 MWh	22	22	0	21	20	0
293 - 439.6 MWh	12	12	0	11	11	0
439.6 - 586.1 MWh	9	9	0	8	8	0
586.1 - 732.7 MWh	8	7	0	7	6	-1
732.7 - 2,931 MWh	46	44	-2	46	42	-5
2,931 - 14,654 MWh	51	46	-5	55	47	-8
14,654 - 58,614 MWh	24	25	1	48	50	2
58,614 - 293,071 MWh	13	16	3	47	54	7
> 293,071 MWh	1	2	1	14	18	4

The capacity and commodity functions that provide the best log log fit for the data points derived from the change in methodology are as follows. Note that the changed methodology includes metric calculations throughout - peak day demands do not require division by 29.298 to convert to therms prior to calculating the appropriate charge, the parameters cannot therefore be compared directly with the present ones.

Charging function based on revised methodology

Capacity	pence per peak day kWh per annum
Up to 73,200 kWh per annum	19.92
73,200 kWh per annum up to 132,700,564,661 kWh per peak day	41.90-12.00 x LN(LN(PL))
132,700,564,661 kWh per peak day and above	2.99
Commodity	
Up to 73,200 kWh per annum	0.1360
73,200 kWh per annum up to 648,791,323 kWh per peak day	0.3201-0.101 x LN(LN(PL))
648,791,323 kWh per peak day and above	0.0176

5.0 Impact

A revised transportation charge algorithm based upon ABC costs, updated probability matrices and a revised model for gas flow through the low pressure systems would produce changes in charging levels for different consumer groups. In general smaller consumers (by Annual Quantity) will attract a reduction in LDZ transportation charges and larger consumers an increase. The table below summarises the implied charges for selected consumers and compares the results to the level indicated by the present algorithm.

LDZ transportation charges for Typical firm consumers

Annual Demand (kWh)	Load Factor	Unit charge (p/kWh)	% Change from present Algorithm

10,000	36%	0.2876	-14.0%
20,000	36%	0.2876	-14.0%
100,000	39%	0.2670	-8.4%
1,000,000	43.4%	0.2023	4.1%
10,000,000	55.6%	0.1467	15.0%
100,000,000	62.5%	0.1112	28.5%

The majority of LDZ transportation charge income is recovered from shippers providing gas for domestic consumers. The proportion recovered through the present algorithm is 76.6%. This will fall to 69.4% if the proposed methodology change is fully implemented. The reduction in income attributable to domestic consumers implies a matching increase for non domestic consumers to maintain the same level of LDZ transportation income. The number of consumers supplied through the LDZ transportation system is heavily weighted towards the domestic consumer group. This implies that a comparatively small percentage reduction in domestic charges must be offset by a larger percentage increase in charges for non domestic consumers. The break-even point of consumers that experience no change to the level of LDZ transportation charges as a result of the proposed methodology change is 420,000 kWh per annum (14,331 therms), assuming a load factor of 39%. Consumers with a smaller AQ (about 20,600,000 consumers) would attract reductions in LDZ transportation charges as a result of the proposed methodology changes.

LDZ transportation charges to typical interruptible consumers would increase in a range from 16% to 53% when compared with charges under the present algorithm.

Impact on Interruptible consumers compared with present algorithm

Annual Demand (kWh)	Load Factor	Unit charge (p/kWh)	% Change from present Algorithm
10,000,000	60%	0.0816	15.9%
100,000,000	60%	0.0621	31.1%
1,000,000,000	75%	0.0472	52.9%

Transco considers that the changes implied by a full rebalancing of LDZ transportation charges in line with the changed methodology are too great to implement in a single tranche. In order to smooth the impact of the changes, Transco proposes to introduce the changes over a number of years. To that end a partial rebalancing is proposed for the year commencing October 1999. The proposed interim transportation charges are as follows.

Charging function proposed for October 1999

Capacity	pence per peak day kWh per annum
Up to 73,200 kWh per annum	20.62
73,200 kWh per annum up to 93,575,656 kWh per peak day	47.98-15.31 x LN(LN(PL))
93,575,656 kWh per peak day and above	3.43
Commodity	
Up to 73,200 kWh per annum	0.1407
73,200 kWh per annum up to 8,626,206 kWh per peak day	0.3620-0.123 x LN(LN(PL))
8,626,206 kWh per peak day and above	0.0212

Changes to LDZ transportation charges based on the partially rebalanced charges are limited. Transportation charges would be reduced by 4.8% for domestic consumers whilst firm charges for larger users may increase of up to 6% For the largest consumers it is proposed that capacity and commodity unit charges be reduced by 6% Interruptible consumers may attract increases to LDZ transportation charges in the range of -4% to 6% (based on 60% load factor).

Charges for typical firm loads from October 1999

Annual Demand (kWh)	Load Factor	Unit charge (p/kWh)	% Change from present Algorithm
10,000	36%	0.2976	-4.8%
20,000	36%	0.2976	-4.8%
100,000	39%	0.2656	-2.5%
1,000,000	43.4%	0.1884	3.8%
10,000,000	55.6%	0.1261	5.9%
100,000,000	62.5%	0.0848	5.0%

As discussed in an earlier section, further investigation may be warranted regarding the fit of average cost data points to an appropriate algorithm. It may be viewed as desirable to retain LDZ transportation charges calculated on a thermal basis until that investigation has been completed. Calculation of the best fit algorithm on an energy or thermal basis will produce slightly different results. The reason for this is that the use of logarithmic scaling makes it difficult to accurately transpose the units from therms to Kilowatt hours. A partial rebalancing solution based on the existing thermal method and the resulting impact analysis is offered below.

Charging function based on therms for October 1999

Capacity	pence per peak day kWh per annum
Up to 73,200 kWh per annum	20.62
73,200 kWh per annum up to 382,503,462 kWh per peak day	30.99-9.86 x LN(LN(PL/29.298))
382,503,462 kWh per peak day and above	3.43
Commodity	
Up to 73,200 kWh per annum	0.1407
73,200 kWh per annum up to 36,230,552 kWh per peak day	0.2145-0.0732 x LN(LN(PL/29.298))
36,230,552 kWh per peak day and above	0.0212

On a thermal basis transportation charges would be reduced by 4.8% for domestic consumers.

Charges for typical loads from October 1999 based on thermal calculation

Annual Demand (kWh)	Load Factor	Unit charge (p/kWh)	% Change from present Algorithm
10,000	36%	0.2976	-4.8%
20,000	36%	0.2976	-4.8%
100,000	39%	0.2675	-1.8%
1,000,000	43.4%	0.1824	0.5%
10,000,000	55.6%	0.1230	3.3%
100,000,000	62.5%	0.0869	7.6%

Graphical representation of the present, proposed and interim transportation charges is provided in Appendix 5.

6.0 Conclusion

Marginal cost analysis as applied to NTS capacity charges is not feasible on the LDZ given the complexity of providing large quantities of within day storage in addition to a standard transportation service. Marginal costs derived from incremental cost analysis do not provide sufficient data to generate a coherent view of the appropriate charges across the full spectrum of consumer categories and possible locations. The marginal analysis indicates that it is appropriate to reduce the existing differential between charges for consumers located within the distribution system (LP, IP and MP) when compared to the marginal costs of gas transportation on the LTS.

An LDZ transportation charge structure based upon reflection of average costs continues to be an appropriate means of allocating charging levels for different consumer groups whilst delivering a PGT licence requirement. However, cost reflectivity can be improved upon if the distribution of charges for each pressure tier is based upon the differentials between ABC costs for each tier. LDZ cost breakdowns of the level of detail provided by Transco's ABC cost process were not available at the inception of the LDZ algorithm. Use of ABC costs will allow a more reflective breakdown of the distribution of costs between the various pressure tiers. This will produce a shift in the burden of costs away from the low pressure tier.

The breakdown of demand amongst customer groups within the LDZ should reflect that published in Transco's annual Base Plan Assumptions publication. This document provides a breakdown of demand for domestic and non-domestic customers which suggests a change in the balance of total LDZ demand from 72% to 64% (on a peak day basis) for domestic customers.

New analysis of gas flow into and out of the low pressure system demonstrates that the pattern of flow across the pressure tier is not as simple as that assumed in the present algorithm. An updated model has been constructed based on a sample taken from a number of locations on the pipeline system. This model provides a reduced differential between the maximum and minimum charges for use of the low pressure system.

It is possible that an improved, or perhaps a two part, function can be devised that will provide a better fit for the average cost data points. This would be of particular benefit for larger consumers that may otherwise attract higher than fully cost reflective charges. Transco will undertake further analysis of this issue in the coming year. Until that point it is appropriate that the LDZ transportation charges are only partially rebalanced in October 1999.

QUESTION FOR CONSULTATION
Transco propose to adopt the revised methodology described in this paper as the basis for calculating LDZ. capacity and commodity charges from 1st October 1999. The revised methodology includes use of updated ABC information, revised demand distribution and a new model of low pressure system use.

Transco would welcome respondents views on the following:

Should Transco calculate LDZ transportation charges based on the revised methodology ?

Appendix 1

A1.1 Apportionment of Total Costs to Pressure Tiers

Average total costs for use of each pressure tier are taken as the basis for calculation of the LDZ algorithm. When the algorithm was first created cost information was available for the LTS and distribution system only. These two categories reflect Transco's management structure within each LDZ, whereby work activities are often split into above or below 7 bar activities. Above 7 bar covers operation of the LTS (typically 38 to 7 bar). Below 7 bar covers operation of IP, MP and LP systems. The split is more than academic as the different pressure systems have differing operating characteristics and planning requirements. The distribution system contained Intermediate, Medium and Low pressure pipeline systems. Most costs for IP, MP and LP therefore have to be driven from a common (distribution system) cost pool. The allocations of individual cost objects is generally based on pipeline lengths or numbers of above ground installations attributable to IP, MP or LP systems. The method of allocating costs to each sector of the distribution system and the resulting ratio between each pipeline system has remained unchanged since the inception of the present LDZ algorithm in 1994.

In the present algorithm total cost data is split by transmission, distribution and storage. Transmission costs being for pipeline systems that operate between 38 bar and 7 bar. The distribution system contains all pipelines that operate below 7 bar. The categories of data collected are

Revenue
Value of assets
Depreciation

LDZ charges are allocated to capacity and commodity based on a predetermined split which is calculated elsewhere. The capacity commodity split applicable from October 1998 was determined at 50:50.

Storage costs are allocated to the capacity based transmission and distribution costs. This has been determined by a previous exercise to determine where such costs arise. The outcome is that 2% of costs are allocated to transmission and 98% to distribution.

An estimate of the appropriate split of distribution costs into the subsets, intermediate pressure system (IPS), medium pressure system (MPS) and low pressure system (LPS) is applied to both the capacity and commodity costs.

Basis for fixed allocation of costs

	IPS	MPS	LPS	TOTAL
Revenue split	2.63%	25.26%	72.11%	100%
Return on assets	4.25%	21.88%	73.87%	100%
Depreciation	5.26%	23.29%	71.45%	100%

Costs associated with unaccounted for gas are allocated equally to LPS capacity and commodity costs.

From total costs for transmission, distribution and storage an expression of capacity and commodity costs for each pressure tier can be calculated.

Cost allocation based on a fixed ratio

Tier	Capacity	Commodity
LTS	0.5TClts + 0.02TCstor	0.5TClts
IPS	0.04(0.5TCdist + 0.98TCstor)	0.04(0.5TCdist)
MPS	0.23(0.5TCdist + 0.98TCstor)	0.23(0.5TCdist)
LPS	0.73(0.5TCdist + 0.98TCstor)+0.5UAF	0.73(0.5TCdist)+0.5UAF

Where:
TClts = Total Costs for Local transmission system
TCdist = Total Costs for distribution system
TCstor = Total Costs for Local Storage
UAF = Total costs of unaccounted for gas

A1.2 Revised allocation of costs

As part of its annual review of ABC costs, Transco publishes a summary document. In that document costs are reported for LTS, IP, MP and LP systems. The costs are sub divided into asset costs, work activities and support costs. The ABC reports make available a more detailed account of costs for various activities than had been available when the present LDZ algorithm's were established. In particular the previously reported method of calculating total IP/MP costs has been superseded. The costs reported for 1998 are summarised below.

Summary of 1998 ABC costs

	All costs in £m			
	LTS	IP	MP	LP
Asset Costs	88.3	16.5	62.2	209.7
Work Activities	22.2	0.4	18	80.6
Support Costs	70.5	8.3	38.1	165.4

Costs for unaccounted for (UAF) gas that had previously been itemised as a separate cost continue to be allocated to the LP system tier. The ABC category for UAF gas is included under a work activity sub heading.

Analysis of the ABC costs in the table above indicates a breakdown of costs between IP/MP and LP systems that is different from the assumptions underpinning the present algorithm. Most of the costs in the distribution system continue to be allocated to the LP system. However the proportion of costs allocated to the LP system has changed from 73% to 76% of distribution system costs. The proportion of costs allocated to sub-tiers of the distribution system may be expected to change from time to time. This may depend upon a number of factors including growth rates for different market sectors, technological developments that may change work patterns and continuing efforts by Transco to cut costs wherever appropriate. A split of total costs that reflects the results of ABC cost analysis may be expected to take account of such changes. Continuing use of a fixed ratio of cost distribution between IP, MP and LP systems could not be expected to reflect such developments.

Cost Allocation based on ABC data

Tier	Capacity	Commodity
LTS	0.5 LTS ABC	0.5 LTS ABC
IP	0.5 IP ABC	0.5 IP ABC
MP	0.5 MP ABC	0.5 MP ABC
LP	0.5 LP ABC	0.5 LP ABC

The allocation of costs across the sub tiers of the distribution system is 4%IP, 23%MP and 73%LP in the present algorithm. Based on the ABC analysis above the allocation of costs may now be considered to be 4.2%IP, 19.7%MP and 76.1%LP.

Appendix 2

A2.1 Probability matrix

Estimated use of each pressure tier by demands within eleven consumption bands was calculated in 1991. In 1998 Transco repeated the exercise. A sample of loads in each consumption band was drawn from Transco's Sites and Meters database for each of 32 districts. Transco then identified the pressure tier to which each constituent of the sample was attached.

The LDZ charging functions are based upon the peak day consumption at a customer's site rather than an explicit link to the pressure system to which a load is connected. Such an approach avoids inconsistencies that may arise if neighbouring sites, with similar quantities of gas offtaken, are actually connected to different pressure tiers. The management of location specific charges may also be less efficient in terms of managing the processes for connection and billing. In 1998 a probability matrix of use of each customer tier by a selection of loads across eleven consumption bands was built up for both peak day and annual usage.

Transco undertook a new sampling exercise during 1998. The updated matrices are also provided in Appendix 2. The sampling method was broadly similar to the exercise undertaken in 1991. Sample data was drawn from the Sites and Meters database for each of 32 districts. The sample consisted of 20 sites in each annual consumption band being identified for each district. For some of the larger consumption bands it was not always possible to attain a sample of 20 in each district. The sample was then distributed to district Engineers for identification of the pressure tier to which each site is connected.

Summary of Sample returns

Annual Consumption band (KWh)	Firm	Interruptible
0-73.2 MWh	0.001%	
73.2 - 146.5 MWh	0.030%	
146.5 - 293 MWh	0.026%	
293 - 439.6 MWh	0.738%	
439.6 - 586.1 MWh	0.866%	
586.1 - 732.7 MWh	0.853%	
732.7 - 2,931 MWh	2.256%	
2,931 - 14,654 MWh	6.864%	46%
14,654 - 58,614 MWh	31.245%	63%
58,614 - 293,071 MWh	66.667%	84%
> 293,071 MWh	100.000%	97%

Original Capacity profile matrix

		Pressure tier		
Annual consumption band (MWh)	LTS	IPS	MPS	LPS
0-73.2 MWh	0.00%	0.54%	1.14%	70.21%
73.2 - 146.5 MWh	0.00%	0.00%	0.07%	2.11%
146.5 - 293 MWh	0.00%	0.00%	0.15%	2.78%
293 - 439.6 MWh	0.00%	0.00%	0.10%	1.40%
439.6 - 586.1 MWh	0.00%	0.00%	0.07%	1.02%
586.1 - 732.7 MWh	0.00%	0.03%	0.05%	0.62%
732.7 - 2,931 MWh	0.00%	0.07%	1.20%	6.24%
2,931 - 14,654 MWh	0.04%	0.07%	2.88%	3.95%
14,654 - 58,614 MWh	0.06%	0.21%	2.94%	0.87%
58,614 - 293,071 MWh	0.33%	0.06%	0.52%	0.01%
> 293,071 MWh	0.11%	0.11%	0.05%	0.00%

Original Commodity profile matrix

		Pressure tier		
Annual consumption band (MWh)	LTS	IPS	MPS	LPS
0-73.2 MWh	0.00%	0.12%	1.24%	58.35%
73.2 - 146.5 MWh	0.00%	0.00%	0.06%	1.89%
146.5 - 293 MWh	0.00%	0.00%	0.10%	2.31%
293 - 439.6 MWh	0.00%	0.00%	0.09%	1.33%
439.6 - 586.1 MWh	0.00%	0.00%	0.06%	0.93%
586.1 - 732.7 MWh	0.00%	0.02%	0.06%	0.58%
732.7 - 2,931 MWh	0.00%	0.07%	1.11%	5.58%
2,931 - 14,654 MWh	0.04%	0.12%	3.27%	4.14%
14,654 - 58,614 MWh	0.29%	0.41%	5.91%	1.85%
58,614 - 293,071 MWh	1.16%	1.13%	3.01%	0.15%
> 293,071 MWh	2.93%	1.06%	0.65%	0.00%

Revised Capacity Profile matrix

Peak day matrix				
Annual Consumption band (MWh)	LTS	IP	MP	LP
0-73.2 MWh	0.00%	0.00%	4.23%	63.24%
73.2 - 146.5 MWh	0.00%	0.00%	0.25%	2.37%
146.5 - 293 MWh	0.00%	0.00%	0.12%	2.68%
293 - 439.6 MWh	0.00%	0.01%	0.20%	1.36%
439.6 - 586.1 MWh	0.00%	0.01%	0.15%	1.01%
586.1 - 732.7 MWh	0.00%	0.00%	0.11%	0.89%
732.7 - 2,931 MWh	0.00%	0.09%	1.10%	5.42%
2,931 - 14,654 MWh	0.05%	0.08%	2.29%	5.56%
14,654 - 58,614 MWh	0.08%	0.23%	2.64%	1.86%
58,614 - 293,071 MWh	0.18%	0.51%	2.22%	0.51%
> 293,071 MWh	0.10%	0.17%	0.22%	0.01%
Total	0.40%	1.11%	13.52%	84.91%

Revised Commodity profile matrix

Annual matrix				
Annual Consumption band (MWh)	LTS	IP	MP	LP
0-73.2 MWh	0.00%	0.00%	3.23%	48.21%
73.2 - 146.5 MWh	0.00%	0.00%	0.20%	1.93%
146.5 - 293 MWh	0.00%	0.00%	0.09%	2.18%
293 - 439.6 MWh	0.00%	0.01%	0.17%	1.10%
439.6 - 586.1 MWh	0.00%	0.01%	0.12%	0.82%
586.1 - 732.7 MWh	0.00%	0.00%	0.09%	0.72%
732.7 - 2,931 MWh	0.00%	0.08%	0.97%	4.80%
2,931 - 14,654 MWh	0.05%	0.12%	2.45%	5.22%
14,654 - 58,614 MWh	0.18%	0.64%	6.04%	2.92%
58,614 - 293,071 MWh	1.01%	2.70%	7.62%	1.48%
> 293,071 MWh	1.58%	1.62%	1.41%	0.22%
Total	2.83%	5.18%	22.39%	69.61%

Customer Numbers

Annual Consumption band (MWh)	Firm	Interruptible
0-73.2 MWh	20,387,855	
73.2 - 146.5 MWh	174,466	
146.5 - 293 MWh	93,044	
293 - 439.6 MWh	31,434	
439.6 - 586.1 MWh	16,741	
586.1 - 732.7 MWh	11,015	
732.7 - 2,931 MWh	28,763	
2,931 - 14,654 MWh	7,212	565
14,654 - 58,614 MWh	1,325	743
58,614 - 293,071 MWh	231	292
> 293,071 MWh	16	62

A2.2 Probability of use for each pressure tier

Gas is not necessarily transported through each successive pressure tier on a route from the NTS. to a customers premises. In some cases it has proved to be more efficient for the development of the system to connect to pressure tiers other than the adjacent pressure regimes. This may be for reasons of physical location of the available pipeline systems, with the next logical pressure regime being further away than a higher pressure pipeline. Not all areas have developed Intermediate pipeline systems. The probability table below reflects these factors and is used in the calculation of LDZ gas transportation charges.

	Peak day kWh	Annual kWh
% total LPS offtake kWh using MPS	94.00%	93.90%
% total LPS offtake kWh using IPS	44.80%	44.10%
% total LPS offtake kWh using LPS	97.90%	97.90%
% total MPS offtake kWh using IPS	43.00%	35.30%
% total MPS offtake kWh using LTS	95.60%	97.80%
% total IPS offtake kWh using LTS	97.70%	99.20%

Appendix 3

A3.1 LTS system use

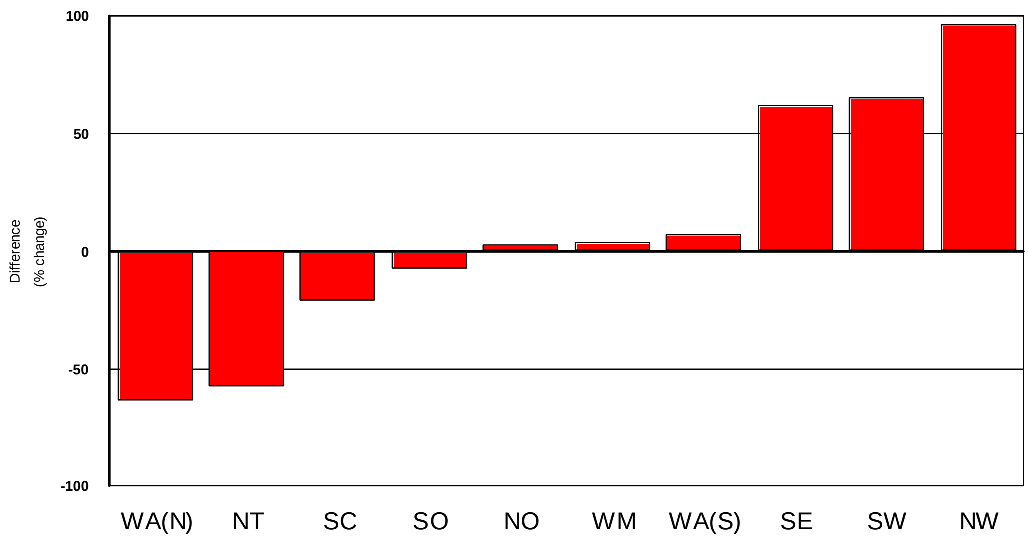
The LDZ algorithm is based on a single average cost for use of the LTS The cost is calculated by dividing income expected from the LTS by total throughput on the LTS Such a calculation does not differentiate between loads that are connected directly to the LTS and those that are transported onwards through lower pressure tiers. Transco have undertaken a review of the assumption in the LTS average cost calculation that loads of all types, either those connected directly to the LTS or those that are transported on to lower pressure tiers, should be treated the same. The simplest method of testing the assumption is to find the average distance travelled within a local distribution zone. Distance travelled from the NTS offtakes to the exit points has been logged using network analysis tools. The data was further refined to provide the average distance travelled to LTS direct connections only and a further category of loads transported on to the LDZ lower pressure tiers (indirect loads). This exercise was repeated for 9 Local distribution zones. A table of results is included below.

Distance travelled

LDZ	Base (km)	No Direct (km)	Direct Only (km)	% difference
WA(N)	53.35	63.35	19.35	30.5%
NT	40.05	40.75	17	41.7%
SC	35.15	35.6	27.75	77.9%
SO	39.55	39.8	36.6	92.0%
NO	27.5	28.05	28.25	100.7%
WM	44.65	44.45	46.45	104.5%
WA(S)	105.2	102.3	112.9	110.4%
SE	51.6	50.65	83.7	165.3%
SW	118.2	119.4	195.7	163.9%
NW	27.7	27.7	54.4	196.4%
Total	54.3	55.2	62.2	112.7%

Use of LTS

Direct v Indirect connections



The results above do not provide conclusive evidence regarding use made of the LTS by direct connect loads when compared to other gas supplies that are transported on to lower pressure tiers.

A refinement of this analysis can be added if the largest customers only are considered. For annual loads above 1,200 Gwh, the use made of all LTS assets is consistently less than the average displayed for the zone in which they are located. On average larger loads use 69% of LTS asset in the LDZ to which they are connected.

The graph above provides a clear indication that the comparative use of the LTS is very much location specific. Factors that drive the results would appear to be the location of population centres and industrial areas with respect to the location of NTS offtakes and the design of the LDZ pipeline networks. Larger industrial users of gas may be expected to be located on the periphery of London and thus be located nearer to NTS offtakes. However this does not appear to be the case in the North West, where the NTS offtakes are located on the edge of the Manchester conurbation , but some distance away from Merseyside where the heavier industries may be expected to be located. The inconclusive evidence of any distinct trends supports the maintenance of a single average cost for all types of loads that use the LTS. However, if larger loads only are considered, then it is apparent that fewer assets are used for transportation of gas through the LDZ.

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Appendix 4

A4.1 Review of use of LP system.

In the period since the 1993 review of LDZ charges a number of new tools have come into use for the management and design of LP systems. In particular database management and planning for system developments has been enhanced by the development of a demand derivation system (DDS) and a graphics based network analysis tool (GBNA).

DDS maintains network data sourced from Transco's Sites and Meters Database (S&MD) and accepts data defining new meters. The model then produces gas demand forecasts in digital form for a defined set of nodes in a polygon - a polygon being a group of nodes that have common demand and forecasting characteristics. More than one demand may be allocated to each node - most commonly this means that a number of domestic demands will be grouped around a single node.

GBNA is a graphic based system that uses pipeline data in addition to demand data from DDS to validate and analyse a network. Each DDS node is assigned a pipeline location within the GBNA network. The size and complexity of the pipeline system make it necessary to maintain and operate many smaller database models of discreet areas rather than a single national database. For example, a typical market town may occupy a single GBNA network. However , larger towns and cities, especially in conurbation's, may require that a single physical network is divided into a number of sub-networks. This procedure is required to simplify already complex analytical problems and restrict individual databases to a manageable size.

An insight into demand distribution in a typical LP system can be gained by extracting from DDS individual demand data and details of the node to which each demand is allocated. From GBNA, details can be obtained of each node and the pipeline diameter to which each is connected. Combining data from DDS and GBNA enables further analysis to proceed. The use of the same nodes in each model enables a common link to be established between the DDS demand information and GBNA pipeline data.

Information regarding gas flow into the LP system can also be obtained from GBNA. Pressure Reduction Stations (PRS) connect the LP system with higher pressure tiers. It is through such sites that all gas must flow when entering the LP system. The identification of each PRS, its flow rate and details of the diameters of downstream pipelines to which it is connected can be obtained from GBNA. Design of below 2 bar pipeline systems is carried out to ensure that a peak 6 minute flow rate can be met. That is the highest flow rate in any 24 hour period. It is the peak 6 minute rate that has been used when gathering information regarding gas flow into the LP system

A4.2 Locations for Low Pressure analysis

Analysis of all pipeline supplies to all of Transco's 20,000,000 plus offtakes is not feasible in the short term. The constraints are the amount of resources that would need to be deployed to carry out such an activity, and the data quality issues that arise when analysing such large numbers of variables. Transco have concentrated on focusing a number of expert users of DDS and GBNA, providing analysis of specific geographic areas that it is thought will provide a reasonable representation of LP system use. The areas that have been chosen for analysis, and their customer numbers, are provided in the table below.

Sample size

Location	Customer numbers
Cardiff	80,424
Gloucester	37,587
Ross-on-Wye	3,240
Wolverhampton	88,424
East London	502,884
Total	712,559

The statistics above might best be considered against a national total of 20,753,764 customers. The sample size therefore represents 3.4% of the national total. To achieve such a large sample size a development tool called LINAS, large area integrated network analysis system, was used to provide data from an area of the East London low pressure pipeline systems. LINAS will eventually provide a mechanism for merging the many discrete networks monitored using GBNA into fewer larger networks. This process will prove particularly appropriate for gas flow analysis in cities and conurbation's. At the present time East London is the only area that has networks that have been made compatible for analysis using LINAS.

The areas identified are thought to provide a cross-section of areas from urban through to relatively rural locations. They include a mix of process industries and lighter industrial and commercial enterprises. Gloucester was initially chosen as an area to prove the viability of identifying gas inputs and outputs on the LP system. For this reason Gloucester has a smaller sample size than the other chosen areas. The customer numbers represent the number of customers captured in the sample rather than the number of customers that may be expected for the whole of that geographic area or town. A difference occurs because boundaries have to be placed on each sample to ensure that the available software would be able to handle all the data loaded for analysis. The East London network actually represents a number of separate GBNA networks that have been merged in order to test LINAS. The pipeline and demand data that is used on LINAS provides access to a much larger sample size than would be otherwise possible if only fully developed models were used. Transco anticipates that more networks will be adapted for use on LINAS through the course of 1999.

Taken together the analysis of gas flow into and out of the LP system can also inform gas flows across the pipeline system. Consequently if gas flows for distinct customer groups can be identified, then an appropriate share of average costs can be found for each group. The analysis in this paper is based on three groups, each identified by a range of demands. They are 0 to 73.2 MWh, 73.2 Mwh to 732 Mwh and demands above 732 MWh. All the demand groups are defined by annual quantity (AQ). Conducting the analysis on a greater number of groups would require further sub division of the three previously identified groups. Such an action would of necessity diminish the sample size available for each group to levels that may not be acceptable.

The low pressure networks have been constructed from a range of pipeline materials over many years. Some sections of pipeline are known to be over 100 years old. Many of the networks were originally built to transport manufactured or “town” gas from local production facilities to the surrounding populations. The systems have been developed over time to transport supplies of natural gas and to meet the evolving needs of a growing population. The long life of the assets (60 years for below 7 bar pipelines) and the development of our towns and cities ensures that a complex pipeline network has grown up. This may not represent the idealised network that would be designed if such a network was to be designed from scratch. It is often assumed that construction of a pipeline system will entail transportation of gas through a series of pipelines that have progressively smaller diameters as demands are netted off. Thus when gas first enters the pipeline system a bulk transportation service might be offered for the aggregate load of customers. Pipeline diameters are progressively reduced for the residual throughput after each individual (or group) demand is offtaken. Ultimately a pipeline of sufficient diameter is required to deliver the last demand. However the long life of pipeline assets and the piecemeal development of towns and cities ensures that the reality is far more complex and less linear than the idealised network.

When testing the theory that gas passes through progressively smaller pipelines it is appropriate to group pipeline diameters into categories of similar diameter rather than reporting demands connected to every individual pipeline diameter. Such an approach overcomes the differing design standards used over time. This most notably applies to metrification and specifications associated with differing materials. Grouping results for closely related pipeline diameters also overcomes discrepancies that can be caused by Transco’s replacement policy. Under this policy the most economic method for replacing a pipeline is often to insert a new pipeline inside an older pipeline that has been identified for replacement. If demands connected to each pipeline diameter are reported and the theory that gas flows through progressively smaller pipelines holds, then it may be possible to create changes in charges for customers by accelerating or decreasing the rate of replacement. The model may also fail to recognise basic similarities in performance of pipelines constructed from differing materials if absolute diameter is the only criterion.

The results for input and output from the low pressure pipeline system are presented below. It should be noted that, in order to provide clarity, the sample results have been scaled to be representative of the national distribution of demands by consumption band. This can be achieved by taking the revised probability matrices of loads (see Appendix 2). Which indicate that 85% of all peak day loads are supplied via the Low Pressure system. On a commodity basis, the proportion is 70% of annual loads. Having established the proportion of peak flow (or annual for commodity) that is supplied through the low pressure system, it can be further deduced by scrutiny of the probability matrix that:

$\sum$ demand less than 73.2 MWh = 64% Peak & 48% Annual LDZ demand
$\sum$demand from 73.2 to 732 MWh = 8% Peak & 7% Annual LDZ demand
$\sum$demand above 732 MWh = 13% Peak & 15% Annual LDZ demand

The analysis of links between groups of demands and pipeline sizes within the LP system can be expressed in terms of percentage of peak day demand.

Peak Day Entry to LP System

	Pipeline diameter

	<=100 mm	101-200mm	201-300mm	>300mm
	0.32%	9.07%	22.67%	52.85%

Peak Day Exit from LP System

	Pipeline diameter			
	<=100 mm	101-200mm	201-300mm	>300mm
0 - 73.2 MWh	36.79%	19.96%	4.87%	1.62%
73.2 to 732 MWh	3.37%	2.72%	1.38%	0.83%
> 732 MWh	3.35%	5.49%	3.72%	0.80%

Annual Entry to LP System

Pipeline diameter				
	<=100mm	101-200mm	201-300mm	>300mm
	0.27%	7.43%	18.58%	43.33%

Annual Exit from LP System

Pipeline diameter				
	<=100mm	101-200mm	201-300mm	>300mm
0 - 73.2 MWh	28.05%	15.21%	3.71%	1.23%
73.2 - 732 MWh	2.74%	2.21%	1.12%	0.68%
> 732 MWh	3.68%	6.02%	4.07%	0.88%

Data collected regarding gas flow into the low pressure pipeline system demonstrates that whilst gas does tend to enter through larger diameter pipelines, this is not always the case. A significant proportion of gas enters directly into pipelines in the range 101 to 300 mm diameter. The smaller diameter pipeline group (up to 100mm) does not accept a significant quantity of gas directly from other pressure tiers. The analysis supports the contention that the majority of gas enters larger diameter pipelines and flows through to smaller diameter pipelines prior to being offtaken, but this is not a universal law. The analysis has been conducted for gas flow at periods of high demand. It is probable that a similar ratio of gas flow into the pipeline system will also be evident at times of lower demand. The high demand ratio of gas flow into the LP system is therefore assumed to be appropriate for both capacity and commodity analysis.

At exit, all connections in each of the consumption groups are mapped against the appropriate pipeline group. Thus a flow weighted distribution of demands within each consumption band is produced. The distribution in each consumption group was then scaled to match the proportion of total LDZ demand anticipated in the LP system for that consumption band. The scaling factors required to complete this process are based on the peak day and annual matrices as appropriate. This methodology overcomes the variance in load factor that occurs between consumption bands. As expected the results show a clear bias of domestic customer connections to the smaller diameter pipelines. However not all domestic premises are connected to smaller diameter pipelines, demonstrating a degree of complexity that is not reflected in the present LDZ. charging algorithms. It is also noteworthy that 41% of customers in the 73.2 to 732 Mwh and 25% of customers above 732 Mwh are connected to the smallest diameter pipeline category. In these two consumption bands a more even distribution across the pipeline groups is discernible. The returns for the domestic customer group are skewed towards the smaller pipeline groups.

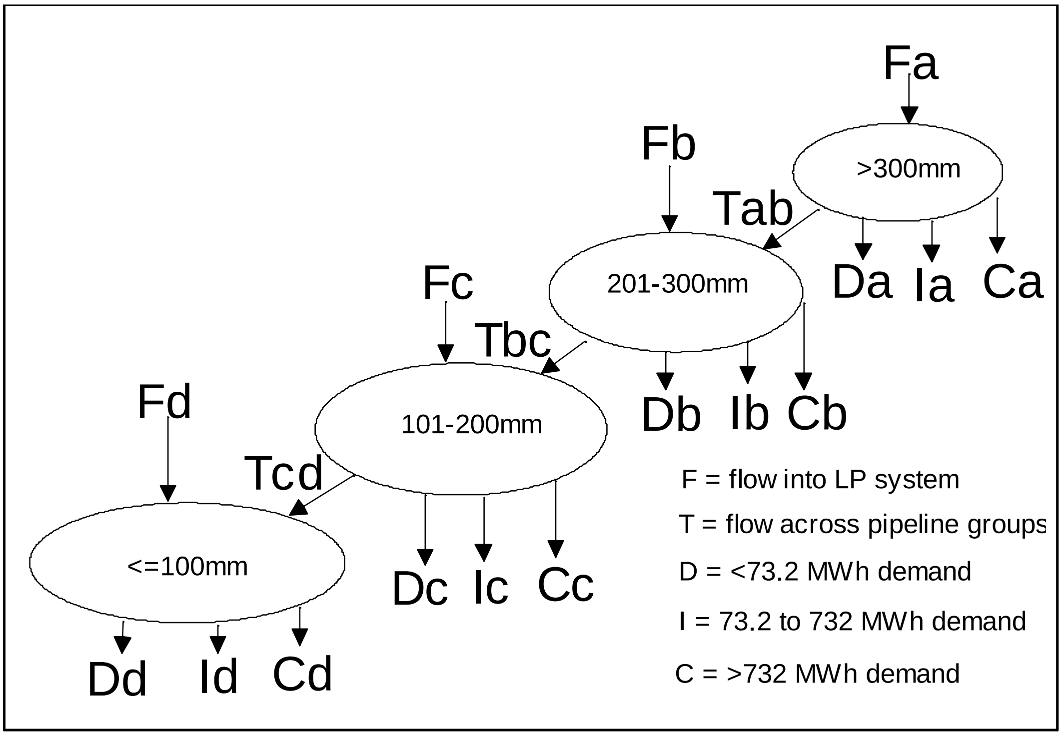
Demand distribution within each consumption band

	Pipeline diameter			
	<=100mm	101-200mm	201-300mm	>300mm
0 - 73.2 MWh	58.2%	31.6%	7.7%	2.6%
73.2 - 732 MWh	40.6%	32.8%	16.6%	10.0%
> 732 MWh	25.1%	41.1%	27.8%	6.00%

The table above provides a summary of demand distribution across the low pressure pipeline system for each consumption band. It is clear from the results of the analysis that the location of individual consumption bands on the pipeline system is not as straightforward as is implied by the LP cost model.

The reason for such complexity may be due to the piecemeal nature of system development over a protracted period of time. Many towns had a pipeline system that was constructed to take manufactured gas away from local production facilities to the nearby customer base. The introduction of natural gas changed the location at which gas entered the LP systems to coincide with bulk transmission of gas from the beach. In addition the higher calorific value of natural gas (compared with manufactured gas) implied that smaller diameter pipelines could be constructed to transport a given energy value of gas. A picture now forms of LP systems at the time of the conversion to natural gas of larger pipelines in some areas of the LP system that had been associated with the production of manufactured gas and new pipelines constructed to supply the same location with natural gas, from different sources. Over time the population centres have tended to expand on to green field sites on the outskirts of towns. This expansion has been met by new gas distribution pipelines that have been sized to meet the demands of new homes and newer, more energy efficient, premises. In recent years some older energy intensive firms have closed, releasing pipeline capacity in the locality. It is possible that some of these businesses will have been located in the inner city areas supplied by LP systems that had originally been built to transport manufactured gas (eg London Docklands). A small housing or office development in the said area may well be connected to the nearest distribution main. That main may require some reinforcement depending upon its size, but what is clear is that the size of main was coincidental to the type of new load connected rather than a function of the load type. Older pipelines are progressively replaced whenever appropriate. This may occur if a pipeline fracture or some such failure has been identified. When replacing the pipeline, Transco will determine the size of pipeline required to meet the existing load and future projections, rather than merely replacing with like for like diameters. This procedure adds to the complexity of the network, whereby an apparently straightforward pipeline route may involve a number of changes in diameter both up and down as different generations of pipeline are encountered. It is clear from this brief history of the development of low pressure networks that it is inevitable that the link between the size of customer load and the transportation pipeline diameter that feed it are more complex than is implied by a simple, static, tree and branch network.

Schematic of LP system



Allocation of revenue across four low pressure pipeline groups (up to 100mm, 101 - 200mm, 201 - 300mm, above 300mm) can be split according to the proportion of Regulatory Asset Value (RAV) represented by each of the pipeline groups. The breakdown of the RAV is not a strict ratio of length, because the valuations also take into account the costs of pipeline materials and age of pipelines. Analysis of the share of Transco's regulatory asset value that is ascribed to the low pressure system shows the following split by pipeline group.

Distribution of LP system costs

Percentage of LP RAV	Pipeline Group
41%	<= 100mm
26%	101-200mm
18%	201-300mm
15%	>300mm
100%	Total

A4.3 Worked example of LP Capacity charge calculations

Initially an average charge for each of the pipeline groups must be calculated. The calculation is based upon the revenue allocated to each pipeline group divided by the gas entering that group. Revenue has been allocated to match the ratio of Regulatory asset Base (RAB) valuations for each group of pipelines.

Average charge AC1 for use of pipelines > 300mm

$$AC1 = \frac{15\ \%\ \text{LP revenue}}{Fa}$$

Average charge AC2 for use of pipelines 201 to 300mm

AC2 = 18% LP revenue

Fb + Tab

Average charge AC3 for use of pipelines 101 to 200mm

$$AC3 = \frac{26\% \text{ LP RAB}}{Fc + Tbc}$$

Average charge AC4 for use of pipelines <= 100mm

$$AC4 = \frac{41\% \text{ LP RAB}}{Fd + Tcd}$$

Where:

$Tab = Fa - (Da + Ia + Ca)$

$Tbc = Fb + Tab - (Db + Ib + Cb)$

$Tcd = Fc + Tbc - (Dc + Ic + Cc)$

To the average charge for each pipeline group must be added the average charge for gas flowing into that group from an adjacent pipeline group. Analysis of the quantities flowing into and being offtaken from each pipeline group indicates that gas tends to flow into larger diameter pipelines before transmission into smaller pipelines.

$$AC1 = \frac{15\% \text{ LP revenue}}{52.85\% \text{ pk demand}} = 2.94 \text{ p/pdkWh}$$

$$AC2 = \frac{18\% \text{ LP revenue}}{72.27\% \text{ pk demand}} + \frac{49.60\%}{72.27\%} * AC1 = 4.60 \text{ p/pdkWh}$$

$$AC3 = \frac{26\% \text{ LP revenue}}{71.37\% \text{ pk demand}} + \frac{62.30\%}{71.37\%} * AC2 = 7.78 \text{ p/pdkWh}$$

$$AC4 = \frac{41\% \text{ LP revenue}}{43.52\% \text{ pk demand}} + \frac{43.20\%}{43.52\%} * AC3 = 17.48 \text{ p/pdkWh}$$

From the above calculations a unit charge for Domestic, 73.2 to 732 Mwh and loads above 732 Mwh can be calculated for use of the Low Pressure system. The unit charge is based upon the proportion of gas flow into each pipeline group for each of the 3 demand categories.

Domestic = 1% AC1 + 8% AC2 + 30% AC3 + 61% AC4 = 13.39 p/pkd kWh
73.2 - 732 MWh = 8% AC1 + 19% AC2 + 27% AC3 + 47% AC4 = 11.42 p/pkdkWh
> 732 MWh = 5% AC1 + 22% AC2 + 35% AC3 + 38% AC4 = 10.52 p/pkdkWh

The unit charges for use of the Low Pressure system are multiplied by the peak day LP demand for each consumption band. The result is a total sum of LP charges that is expected to be collected from each consumption band. The Total sum for each consumption band is divided amongst the LDZ throughput identified for each consumption band. This procedure completes the process of disaggregation from charges based upon use of pressure tier to charges that are determined by the size of load. Such a process is necessary to avoid having to identify the connected pressure tier before identifying the applicable charge.

Distribution of LP capacity charges amongst all LDZ. demand

Annual Consumption band (MWh)	LP Peak day	LP capacity	LDZ. Peak day	LP charge (p/pdkWh)

	demand (GWh)	revenue (£,000)	demand (GWh)	
0-73.2 MWh	2,740	366,947	2,740	12.01
73.2 - 146.5 MWh	103	11,747	103	9.9
146.5 - 293 MWh	116	13,258	116	10.47
293 - 439.6 MWh	59	6,715	59	9.42
439.6 - 586.1 MWh	44	5,007	44	9.42
586.1 - 732.7 MWh	38	4,391	38	9.76
732.7 - 2,931 MWh	235	24,711	235	8.25
2,931 - 14,654 MWh	242	25,348	242	7.01
14,654 - 58,614 MWh	90	8,489	90	3.89
58,614 - 293,071 MWh	29	2,325	29	1.5
> 293,071 MWh	3	49	3	0.22

A4.4 Worked example of LP Commodity charge calculations

$$AC1 = \frac{15\%\ \text{LP revenue}}{43.3\%\ \text{annual demand}} = 0.021\ \text{p/kWh}$$

$$AC2 = \frac{18\%\ \text{LP revenue}}{59.12\%\ \text{annual demand}} + \frac{40.54\%}{59.12\%} * AC1 = 0.033\ \text{p/kWh}$$

$$AC3 = \frac{26\%\ \text{LP revenue}}{57.65\%\ \text{annual demand}} + \frac{50.21\%}{57.65\%} * AC2 = 0.057\ \text{p/kWh}$$

$$AC4 = \frac{41\%\ \text{LP revenue}}{34.47\%\ \text{annual demand}} + \frac{34.20\%}{34.47\%} * AC3 = 0.129\ \text{p/kWh}$$

Domestic = 1% AC1 + 8% AC2 + 30% AC3 + 61% AC4 = 0.0985 p/kWh
73.2 - 732 MWh = 8% AC1 + 19% AC2 + 27% AC3 + 47% AC4 = 0.0839 p/kWh
> 732 MWh = 5% AC1 + 22% AC2 + 35% AC3 + 38% AC4 = 0.0772 p/kWh

Distribution of LP capacity charges amongst all LDZ demand

Annual Consumption band (MWh)	LP Annual demand (GWh)	LP commodity revenue (£,000)	LDZ. Annual demand (GWh)	LP charge (p/kWh)
0-73.2 MWh	352,850	347,673	352,850	0.0878
73.2 - 146.5 MWh	14,118	11,846	14,118	0.0722
146.5 - 293 MWh	15,934	13,370	15,934	0.0764
293 - 439.6 MWh	8,071	6,772	8,071	0.0688
439.6 - 586.1 MWh	6,017	5,049	6,017	0.0688
586.1 - 732.7 MWh	5,283	4,428	5,283	0.0713
732.7 - 2,931 MWh	35,068	27,100	35,068	0.0601
2,931 - 14,654 MWh	38,314	29,499	38,314	0.0488
14,654 - 58,614 MWh	23,013	16,516	23,013	0.0219
58,614 - 293,071 MWh	12,806	8,377	12,806	0.0085
> 293,071 MWh	2,450	1,250	2,450	0.0034