ESSENTIAL SERVICES COMMISSION

Level 2, 35 Spring St
Melbourne 3000, Australia
Telephone +61 3 9651 0222
+61 3 1300 664 969
Facsimile +61 3 9651 3688

GUIDANCE PAPER:

CALCULATION METHODOLOGY FOR DISTRIBUTION LOSS FACTORS (DLFs) FOR THE VICTORIAN JURISDICTION

14 FEBRUARY 2007

An appropriate citation for this paper is:

Essential Services Commission, *Guidance Paper: Calculation methodology for Distribution Loss Factors (DLFs) for the Victorian Jurisdiction*.

Amendment Record

Issue No.	Date	Amendments
Original issue	14 February 2007	

CONTENTS

1 INTRODUCTION

The Essential Services Commission (the Commission) approves Distribution Loss Factors (DLFs) applicable to the Victorian jurisdiction pursuant to clause 3.6.3(i) of the *National Electricity Rules* (the Rules), which states that:

> *…Before providing the distribution loss factors to NEMMCO for publication, the Distribution Network Service Provider must obtain the approval of the relevant Jurisdictional Regulator for the distribution loss factors it has determined for the next financial year.*

The Rules require that Distribution Network Service Providers (distributors) must obtain the Commission's approval of their proposed DLFs for the next financial year, prior to providing the approved DLFs to the National Electricity Market Management Company Limited (NEMMCO) for publication by 1 April of each year. Full details of this clause are contained in Appendix B of this document.

DLFs are used to adjust customers' metered consumption data to allow for energy losses in the electricity distribution network. They are applied to the consumption of second tier customers[1] in the National Electricity Market. The local retailer[2] is responsible for paying for distribution losses that are not allocated to second tier customers.

DLFs are also used to adjust the price paid to an embedded generator[3] to allow for the cost of energy losses in the distribution networks. This provides a price signal to potential embedded generators to encourage them to take network losses into account when making decisions about where to establish new generation.

---

1 A second tier customer is one who does not purchase electricity directly and in its entirety from the retailer who is the local retailer.

2 A local retailer is the retailer who is responsible under the laws relevant to the participating jurisdiction (in this case Victoria) for the supply of electricity to first tier customers in the supply area of each distribution business.

3 An embedded generator is a generating unit that is connected to the distribution network.

1.1 What is a DLF?

Energy losses are incurred as power is transported along distribution wires. Losses increase with line length and vary in proportion to the amount of power being transported. Overall losses can vary from year to year due to changes in network utilisation level, network configuration, the shape of the load profile and the level of reactive power support (the power factor).

The method of determining a DLF for a distribution network connection point is specified under clause 3.6.3(h)(3) of the Rules:

> *The distribution loss factor for a distribution network connection point… is determined using a volume weighted average of the average electrical energy loss between the transmission network connection point or virtual transmission node to which it is assigned and each distribution network connection point in the relevant class of distribution network connection points assigned to that transmission network connection point or virtual transmission node for the financial year in which the distribution loss factor is to apply.*

Due to the vast number and diversity of customers connected to electricity networks, it is not practical to measure or accurately calculate the distribution losses caused by each individual customer. The Rules requires that DLFs should be allocated to:

- each embedded generator of actual generation of more than 10 MW — individual site-specific DLFs are to be determined according to the generator's actual location within the network
- each large customer consuming more than 40 GWh per annum or with a peak demand of 10 MW — individual site-specific DLFs are to be determined according to the customer's actual location within the network
- all other customers and embedded generators — network average DLFs are to be allocated according to the type of connection points within the distribution network.

Site-specific DLFs for large embedded generators and customers are to be calculated individually according to the actual network and connection point characteristics.

Network average DLFs are calculated using a model that produces loss factors for different types (classification) of distribution network connection points in the distribution system based on relevant network parameters. Different loss factors are also set for long and short sub-transmission lines.[4]

[4] See section 2.3 for definitions of long and short sub-transmission lines.

1.2 Publication of a formal DLF calculation methodology

The application of DLFs is an important part of the electricity market in terms of customers' and retailers' exposures to electricity use (or cost), and how embedded generators should be rewarded for their outputs. All electricity distributors have been using the same DLF calculation methodology since 2003, which has been accepted by the Commission in its annual DLF approval process. However, this methodology has not been published on the Commission's website as a stand-alone regulatory document.

The publication of the DLF calculation methodology, which is based on the existing methodology used by the distributors, will provide transparency and consistency to the market participants on how DLFs are determined. This will assist the market participants in their planning processes. Further, the formalisation of the DLF calculation methodology will streamline the Commission's DLF approval process each year.

The DLF calculation methodology is intended to provide guidance to the Victorian electricity distributors on how to:

- undertake calculations for the DLFs in accordance with clause 3.6.3 of the Rules
- make submissions to the Commission for approval of the DLFs for the next financial year.

The Commission is aware that currently there are some levels of differences in the DLF calculation methodologies adopted by each jurisdiction. It understands that the reasons for the differences include historical approaches to loss allocation, tariff structures and the network operational information collection methods of the electricity distributors (both within, and across the states and territories). All the underlying issues must be resolved before national consistency can be achieved.

While one of the Commission's objectives under the *Essential Service Commission Act 2001* is to promote consistency in regulation between states and on a national basis, it believes that, taking into consideration the time required for achieving national consistence through resolving the issues identified above, there is clear benefit to the market participants that the existing DLF calculation methodology be formalised at this stage.

1.3 Amendments to the DLF calculation methodology

The Commission may amend this DLF calculation methodology on its own initiative, in response to changes to the Rules, or following a proposal by a distributor, a retailer or other interested persons, if the Commission considers that the amendment would better achieve its objectives under the *Essential Service Commission Act 2001 (Vic)*.

Submissions on amendments to the DLF calculation methodology must be made in writing to the Commission, including details of the proposed amendments and the reasons and/or benefits of the proposed amendments.

All proposed amendments to the DLF calculation methodology will be processed in accordance with the Commission's consultation procedures.

1.4 Structure of this guidance paper

The paper is structured as follows:

- Chapter 1 provides the background information and the reasons for the introduction of the Commission specified DLF calculation methodology.
- Chapter 2 describes the Commission specified DLF calculation methodology.
- Chapter 3 describes the DLF approval process.

2 DLF CALCULATION METHODOLOGY

The sections below provide the procedures of how site-specific and network average DLFs should be calculated.

2.1 Site-specific DLFs for large embedded generators

The requirements for determining DLFs for large embedded generators are specified in clause 3.6.3 or the Rules. Details of these requirements are set out in Appendix B. In particular, clause 3.6.3 (h) states that:

> *The methodology for the determination of distribution loss factors referred to in clause 3.6.3(g) must be developed having regard to the following principles:*
>
> > *…*
> >
> > *(4): The distribution loss factor for a distribution network connection point described in clause 3.6.3(b)(2)(i) [embedded generator of actual generation of more than 10 MW] is determined using the average electrical energy loss between the distribution network connection point and the transmission network connection point to which it is assigned in the financial year in which the distribution loss factor is to apply.*

Where *average electrical energy loss* is defined as:

> *The volume-weighted average of the electrical energy losses incurred in each trading interval over all trading intervals in a defined period of time.*

A consistent approach to the choice of weighting factor is essential to achieve consistency in regulation and to provide a level playing field for competition in embedded generation. In the past, the Commission has approved some site-specific DLFs for embedded generators where losses have been expressed as a percentage of consumer sales, that is:

DLF = 1 + Losses/Sales *(1)*

where 'Sales' is the total energy sold to all customers connected to the connecting network for the embedded generator.

This is consistent with how network average losses are weighted when determining DLFs for small embedded generators and general customer loads, and is appropriate when the volume of sales is very much larger than the generator's output volume. However, a problem arises when the output volume of the generator is larger than the energy consumed by customers in that part of the network between the generator and the transmission connection point. In such circumstances, there is a net export of energy from the generator into the transmission network connection point and the sign of the second term in formula (1) becomes negative. Should sales be less in magnitude than losses, the second term becomes a large negative number and so the DLF could be less than zero. As a DLF represents losses in a network and losses are always present to some extent; it is evident that a DLF must always be a positive number and therefore expressing losses as a percentage of sales in some circumstances is not an appropriate approach.

The Rules require that the losses be volume weighted. Where a generator is directly connected to a transmission connection point, the generator's output volume can be used as the weighting factor. This makes sense as the DLF represents the average losses resulting from the operation of the generator across the various expected operating conditions. Thus, the average loss weighted by generator output volume approximates the average electrical loss for any particular period that the generator is generating.

However, when sales are very much larger than the generator output, using sales (rather than output volume) as the volume weighting factor would provide consistency with the volume weighting factor used for load customers and smaller embedded generators.

The two cases discussed above represent two extremes of a common weighting factor that can be expressed as 'the magnitude of sales less generator output', or in other words, the net energy flow in the connecting network. Thus the DLF would be found from Formula (2).

DLF = 1 + Losses / (Magnitude of sales less generation) *(2)*

This volume weighting is consistent with treating a generator as a negative load in network load flow modelling and allows a consistent approach to be adopted and an appropriate DLF to be developed in all likely operating conditions.

In calculating the DLFs for each large embedded generator requiring site-specific DLFs, distributors must follow the following steps:

- Model the operations of the generator based on historical record or other relevant information available.

- Determine the relevant forecast network losses by modelling the distribution network between the generator's connection point and the transmission network connection point for each modelled operating period of the generator.
- Calculate the annual overall DLF utilising a volume weighting factor based on the forecast average electrical energy loss for each modelled operating period of the generator in the financial year in which the DLF is to apply.

2.2 Site-specific DLFs for large customers

The Rules require site-specific loss factors to be derived for large customers with a demand of more than 10 MW or an annual energy consumption of more than 40 GWh. The DLFs for these customers must be based on their locations and connection arrangements.

The energy losses directly associated with a particular customer depend on the point at which the customer is connected to the network. For a customer directly connected to the sub-transmission network, only losses in the sub-transmission lines need to be determined. On the other hand, if a customer is connected to a shared distribution feeder, all the upstream losses need to be fairly allocated between the site-specific customer and all other customers on the feeder.

The following method should be used for determining the DLFs for the next financial year:

(1) Calculate all upstream losses from the site-specific customer's point of supply to the transmission network connection point (being the relevant terminal station).

(2) Determine the total energy sales at each segment of the distribution network upstream from the customer. (see section 2.3 for the details of the classifications of network segments).

(3) Determine the fraction of the total upstream energy sales associated with the site-specific customer. This can be calculated by dividing the energy sales of the customer by the total energy sales at each segment of the distribution network upstream.

> Note: The allocation of losses to site-specific customers based on the proportion of energy sales is consistent with the allocation method for the network average DLF customers and is considered appropriate by the Commission. A demonstration of the reason why allocations based on consumption is considered fair has been included in Appendix A.

(4) Multiply the percentages calculated in (3) by the energy losses calculated in (1) to determine the amount of losses at each segment that are attributable to the site-specific customer. Add these together to get the total distribution network losses attributable to the site-specific customer.

(5) Calculate the site-specific DLF as: 1 + (the total energy losses attributable to the site-specific customer) / (total energy sales to the site-specific customer).

Example: For a large customer supplied from a distribution feeder:

1. The total upstream energy losses (EL) between the customer and the supplying terminal station can be represented as EL_{FEEDER}, $EL_{ZONE\ SUBSTATION}$ and $EL_{SUBTRANSMISSION\ LOOP}$.
2. The total upstream energy sales (ES) can be represented as ES_{FEEDER}, $ES_{ZONE\ SUBSTATION}$ and $ES_{SUBTRANSMISSION\ LOOP}$.
3. Assuming that the site-specific customer energy sales is ES_S, the fraction of feeder sales associated with the site-specific customer is ES_S/ES_{FEEDER}; the fraction of zone substation sales associated with the site-specific customer is $ES_S/ES_{ZONE\ SUBSTATION}$; and the fraction of sub-transmission energy sales associated with the site-specific customer is $ES_S/ES_{SUBTRANSMISSIONLOOP}$.
4. The total site-specific customer losses (EL_S) equals:
$(ES_S/ES_{FEEDER}) \times EL_{FEEDER} + (ES_S/ES_{ZONE\ SUBSTATION}) \times EL_{ZONE\ SUBSTATION} + (ES_S/ES_{SUBTRANSMISSIONLOOP}) \times EL_{SUBTRANSMISSION\ LOOP}$.
5. The site-specific DLF is then: $1+EL_S/ES_S$.

2.3 Network Average DLFs for general customers and small embedded generators

Distribution losses should be grouped into five major segments of the distribution network. Customers should pay for the losses based on which of the five segments are used to supply their power.

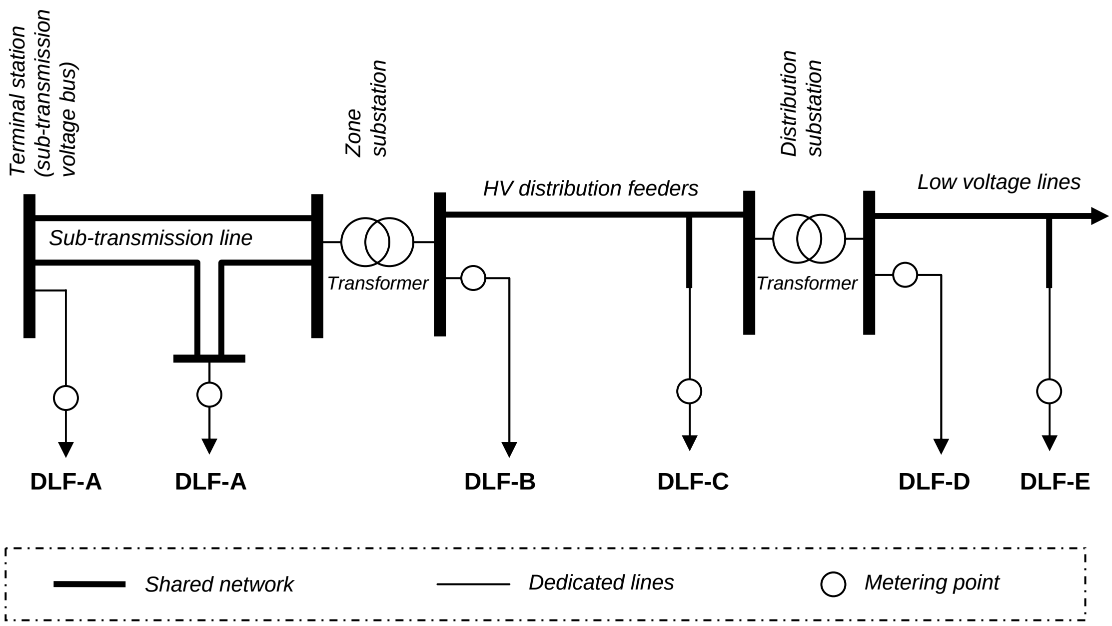
The five network segment categories are:

- Category A: Sub-transmission feeders operating at 66 kV or 22 kV (note: 1 kV = 1000 Volts)
- Category B: Zone substations operating at 22 kV, 11 kV or 6.6 kV
- Category C: High voltage (HV) distribution feeders operating at 22 kV, 11 kV or 6.6 kV
- Category E: Distribution substations operating at 240/415 V
- Category E: Low voltage (LV) feeders operating at 240/415 V.

A customer connected to the low voltage network utilises all upstream assets, causing electrical energy losses in each network segment upstream of its connection point. Customers connected to sub-transmission feeders, however, only cause losses on the sub-transmission network.

Figure 2.1 demonstrates how a customer’s point of supply can be categorised under the five network segments.

Figure 2.1: Diagrammatic representation of the types of network connection points



Each customer should be categorised as A through to E depending on the customer's connection point to the network and the location of the metering point. For example, a customer with a dedicated HV feeder from a zone substation will be category C if the meter is at the customer's premises; but would be category B if the meter was installed at the zone substation.

Energy losses can be calculated for each network segment. Once the losses in each segment are determined, the total losses attributable to a customer class can be determined by combining all upstream losses from the customer's point of supply to the terminal station (transmission network connection point) similar to the calculation process of site-specific DLFs. Distribution loss factors are then calculated for each category A to E.

- DLF-A is the distribution loss factor to be applied to a second tier customer or market customer[5] connected to a sub-transmission line (at 66 kV or 22 kV).

5 Market customers are those customers who purchase their energy directly from the national electricity market.

- DLF-B is the distribution loss factor to be applied to a second tier customer or market customer connected to the lower voltage side of a zone substation at voltages of 22 kV, 11 kV or 6.6 kV.

- DLF-C is the distribution loss factor to be applied to a second tier customer or market customer connected to a distribution line from a zone substation at voltages of 22 kV, 11 kV or 6.6 kV.

- DLF-D is the distribution loss factor to be applied to a second tier customer or market customer connected to the lower voltage terminals of a distribution transformer (at 240/415 V).

- DLF-E is the distribution loss factor to be applied to a second tier customer or market customer connected to a low voltage line at 240/415 V.

Separate DLFs must also be calculated for each of the DLF categories A to E depending on whether the length of the sub-transmission line supplying the customer is 'short' or 'long'. This creates a total of ten DLFs per distributor.

A short sub-transmission line is defined as:

- a radial sub-transmission line where the route length of the line is less than 20 km; or
- a sub-transmission line in a loop where the total route length of all lines in the loop is less than 40 km.

All other long sub-transmission lines are defined as 'long'.

Example:	Assume that a department store is supplied from a distribution substation within its property and that the store is a second tier customer. The store is in an urban area where the sub-transmission network is short and therefore would be classified as 'short D'. Assume DLF-D (short) = 1.0400 as calculated by the distribution company. If this department store consumes 100 MWh of energy in a month (as recorded by the meter), the store's retailer will buy 1.04 x 100 MWh = 104 MWh from the National Electricity Market at the transmission connection point on behalf of the customer. The customer pays for an extra 4 MWh on top of the meter reading because this represents the electrical energy losses on the distribution network.

2.4 Calculation of forward looking DLFs

Clause 3.6.3(i) of the Rules requires that DLFs allocated to customers are based on the 'forward looking' estimate of energy consumption for the next year rather than the actual consumptions and energy losses of the previous year. The estimation of the energy consumption, energy losses and therefore the appropriate DLFs for the next financial year should follow the process below:

(i) Review the historical energy consumption of the entire network (this will inform step (iii) below).

(ii) Review the historical actual overall energy losses of the entire network based on the total energy procured, the total metered energy sales, estimated un-metered energy sales, and allowances for theft and faulty metering equipment (this will inform step (iv) below).

(iii) Predict the total energy consumption for the next financial year.

(iv) Predict the overall energy losses based on historical data, planned changes to network configurations and customer load patterns — this is the 'top-down' approach and provides an accurate prediction of overall network losses.

(v) Compare the predicted top-down overall losses with the calculated 'bottom-up' estimation of total energy losses by multiplying the individually forecasted energy consumption of site-specific customers and the forecasted consumption of all other customers by the theoretical loss factors calculated in accordance with the steps illustrated in sections 2.2 and 2.3.

(vi) Adjust the theoretical DLFs by scaling so that the bottom-up total losses equal the top-down prediction of overall energy losses.

(v) Confirm that the price impact on customers due to changes in DLFs represents no greater than one per cent increase in energy cost.[6] (Note: The Commission may allow for increases in site-specific DLF of more than one per cent for some large customers if the change would better reflect the actual network loss share of the specific customers.)

The Commission considers that:

- The top-down approach will provide a high level of accuracy in predicting the overall losses of the distribution networks. However, this method cannot provide accurate allocation of losses incurred by individual customers.
- The DLFs calculated based on section 2.2 and 2.3 are the results of the best estimates (engineering model) of what the DLFs should be, and have a good level of relativity amongst all customers of a distributor's network.
- Scaling the modelled DLFs to produce an overall loss that is equal to the top-down estimated overall loss would produce a set of appropriate DLFs, because the DLFs derived in this manner would represent the best estimated overall losses and preserve the relativity of individual contributions to the overall distribution losses of all customers.

Therefore, the Commission concludes that the above process for determining the forward looking DLFs should produce a fair and accurate outcome.

[6] As indicated in previous DLF approval papers, the Commission considers that price increase due to change in DLF value of up to one per cent is not unreasonable.

2.5 Reconciliation of Forecast and Actual Losses

The Rules require each distributor to undertake reconciliation between the total energy losses implied by the DLFs for the previous financial year against the actual energy losses for that period. Mathematically the reconciliation process can be expressed as follows:

$$\left[\sum_{i=1}^{i=n} ME_i + Total\ \ actual\ \ distribution\ \ energy\ \ loss\right] = \left[\sum_{i=1}^{i=n} ME_i \times DLF_i\right] - \left[\ Reconciliation\ error\ \right]$$

Where:

ME_i = Metered Energy flowing out of a distribution network connection *'i'* over the financial year.

DLF_i = The previously approved DLF for distribution connection point *'i'.*

n = Number of distribution network connection points.

The left hand side of the equation represents all energy flowing out from all customers' distribution connection points plus total measured top down energy losses. It is in effect the total net energy (TNE) flowing from transmission connection points into the distribution network.

The first part of the right hand side of the equation represents the total adjusted gross energy (TAGE) flowing out from distribution connection points. It is the metered energy plus distribution losses recovered through the application of the DLFs.

The reconciliation error is the difference between TNE and TAGE. A positive result means that the actual network losses were higher than the losses recovered through the application of the DLFs. Likewise, a negative result means that actual distribution network energy losses were less than the amount recovered through the application of the DLFs.

The Commission will review the reconciliation errors of each distributor to monitor the accuracy of their forecasting process.

3 APPROVAL PROCESS OF DISTRIBUTORS' PROPOSED DLFs

Distributors must submit to the Commission their proposed DLFs for the next financial year prior to 1 March of each year. The following information must form part of a distributor's submission:

- A declaration that the proposed DLFs have been calculated based on the Commission's DLF calculation methodology.
- The proposed site-specific DLFs for large customers and embedded generators requiring site-specific DLFs, and network average DLFs for all other customers and embedded generators in the format specified in section 3.1.
- A statement of the reconciliation result in terms of over/under allocation of losses from the application of DLFs for the previous financial year in the format specified in section 3.1.
- A statement of the overall losses of the distributor's network as specified in section 3.1.

3.1 Distributors' submissions for approval

Distributors must provide the following information to the Commission.

Site-specific DLFs for large embedded generators

- Each generator's title and National Meter Identifier (NMI)
- DLF for the current financial year
- Proposed DLF for the next financial year
- Percentage change in DLF value
- Information on how the operation of the generator is modelled
- Information on how the relevant network losses are modelled
- Information on how the proposed DLF is calculated including the volume weighting factors adopted.

Note: Due to commercial sensitivity concerns, specific information on the operational information of each generator will not be released by the Commission.

Site-specific DLFs for large customers

- Customers' National Meter Identifiers (NMIs)
- DLF for the current financial year
- Proposed DLF for the next financial year
- Percentage change in energy cost due to the change in DLF value.

Network average DLFs for other customers and embedded generators

- Values of each DLF types (DLF-A , DLF-B, DLF-C, DLF-D and DLF-E, for long and short sub-transmission lines) for the current financial year
- Proposed DLFs for the next financial year
- Percentage change in energy cost due to the change in DLF value for each proposed DLF category
- The extent to which allowance for theft and metering inaccuracy was included in the calculation.

(Note: The Commission undertook a review of the loss levels of other countries in 2000. Based on the findings of the review, the Commission considers that the allowance for theft and metering inaccuracy in Australia is most likely to be between 0.2 and 1.0 per cent.)

Reconciliation of over/under allocation of losses in the previous financial year

Distributors must provide the following information on the 'over or under allocation of network losses' over the previous financial year due to the application of the previously approved DLFs in its network:

- Overall level of losses recovered through the application of DLFs to customers' actual overall consumption in the previous financial year, in MWh
- Actual overall losses as measured by the distributor, in MWh
- Reconciliation error in overall network losses, being the difference between the total losses recovered through the application of the previously approved DLFs and the actual overall losses, in MWh
- Reconciliation error as a percentage of the total energy sales in the distributor's network, with a positive number meaning over-recovery.

Overall level of network losses for the next financial year

- A statement of the forecast overall losses of their networks as a percentage of the forecast overall energy sales for the next financial year.

3.2 The Commission's approval criteria and process

The Commission will assess the information provided by the distributors as specified in section 3.1. Approval will be based on the following considerations:

- For load customers — that the price impact on customers due to changes in DLFs represents no greater than one per cent increase in energy cost. (The Commission may allow for increases in site-specific DLF of more than one per cent for some large customers if the change would better reflect their share of network losses.)
- For embedded generators — that the calculated DLFs are based on sound assumptions about the operations of the generators.
- That distributors have taken into consideration their previous forecast errors in overall loss levels by examining the trend of reconciliation errors over time.
- That the overall levels of network losses of each distributor are reasonable.[7]

The Commission will, after analysis of distributors' submissions, publish a consultation paper for stakeholders and public comments on its website regarding the DLFs proposed by the distributors. The consultation paper will include an analysis of the trends in forecast error levels and the overall levels of network losses of each distributor over time.

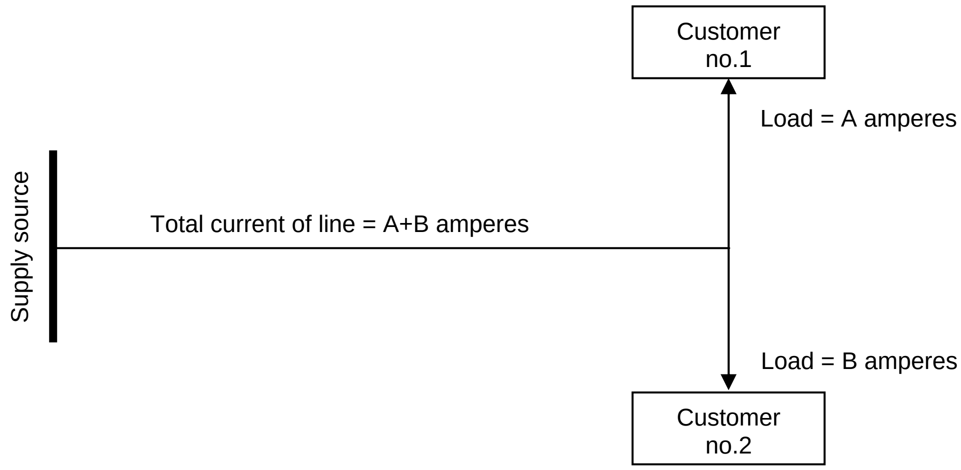
Final approval will take into considerations all comments received by the Commission during the consultation period.

[7] The Commission undertook a review of the loss levels of other countries in 2000. Based on the findings of the review, the Commission considers that the economic levels of losses for Victorian distributors should be in the range of 3 to 5 per cent of sales for urban-based networks and could be as high as 10 per cent of sales for distributors with predominantly rural networks.

APPENDIX A: LOSS ALLOCATION MODEL

Simplified model for the determination of a fair principle for distribution losses allocation to customers

Assuming two customers are connected to a distribution line at the same connection position, and customer no.1 and no.2 have a load current of A and B amperes respectively.



The total loss in the distribution line is $(A+B)^2$ times R, where R = the resistance of the line.

The loss attributable to customer no.1 can be calculated based on a number of allocation principles. As the loss is proportional to the square of the current, the basic levels of loss due to the two customers are A^2R and B^2R respectively. The sum of these two basic losses is less than the actual total loss $(A+B)^2R$. This can be demonstrated by assuming A = 2 amperes and B = 3 amperes. $A^2R + B^2R$ would be 4R + 9R = 13R; but $(A+B)^2R = (2+3)^2R = 25R$.

It appears that allocation based on load current is not appropriate. A more in-depth assessment is therefore necessary.

The lowest level of its share of the total loss attributable to customer no.1 would exist under the assumption that this customer is the first customer who uses the capacity of the line. The loss under this assumption is therefore A^2R.

On the other hand, the highest level its share of the total loss attributable to customer no.1 would be under the assumption that this customer is the last customer who uses the capacity of the line. The loss under this assumption is the marginal loss, i.e. total losses less the losses due to all other customers (in this case customer no.2). This is equal to:

$(A+B)^2R - B^2R$.

Note: B^2R being the loss due to customer no.2, if customer no.2 was the sole customer.

Since no one single customer can be considered as the first or last customer who uses the capacity of any distribution line, the fair way of loss allocation is at the mid-level of the two extreme cases above.

The loss that can be considered fairly allocated to customer no.1 is

$= [A^2R + (A+B)^2R - B^2R] / 2 = A^2R + ABR$

The portion of the total loss attributable to customer no.1 is its allocated 'fair loss' divided by the total loss of the line,

$= (A^2R + ABR) / (A+B)^2R = A(A+B)R / (A+B)^2R$

$= A / (A+B)$

= same proportion of the share of current due to customer no.1 of the total line loading.

Therefore it can be concluded that allocation of line losses to customers based on each customer's energy consumption is a fair and reasonable approach.

APPENDIX B: EXTRACT FROM THE NATIONAL ELECTRICITY RULES

Note: The following extract from the National Electricity Rules is based on the version of the Rules published on 14 February 2007. The Rules may change from time to time. The latest version of the Rules can be viewed on the Australian Energy Market Commission's website at www.aemc.gov.au.

3.6.3 Distribution losses

(a) *Distribution losses* are *electrical energy losses* incurred in the conveyance of electricity over a *distribution network*.

(b) *Distribution loss factors*:

(1) notionally describe the *average electrical energy losses* for electricity transmitted on a *distribution network* between a *distribution network connection point* and a *transmission network connection point* or *virtual transmission node* for the financial year in which they apply;

(2) will be either:

(i) a site specific *distribution loss factor* derived in accordance with the methodology determined by the *Jurisdictional Regulator* or the *Distribution Network Service Provider* pursuant to clause 3.6.3(h), for each *distribution network connection point* of the following types:

A. a *connection point* for an *embedded generating unit* with actual *generation* of more than 10MW, based on the most recent data available for a consecutive 12 month period at the time of determining the *distribution loss factor*. Where relevant data is not available for a consecutive 12 month period as a *transmission network connection point* is newly established or has been modified, a *Network Service Provider* may determine whether an *embedded generating unit* has *generation* of more than 10MW, based on its best projection of *generation* in the *financial year* in which the *distribution loss factor* is to apply, taking into account the terms of the relevant *connection agreement*;

B. a *connection point* for an end-user with actual or forecast *load* of more than 40GWh or an electrical demand of more than 10MW, based on the most recent data available for a consecutive 12 month period at the time of determining the *distribution loss factor*. Where relevant data is not available for a consecutive 12 month period as a *transmission network connection point* is newly established or has been modified, a *Network Service Provider* may determine whether an end-user has *load* of more than 40GWh or forecast *peak load* of more than 10MW, based on its best projection of *load* in the *financial* *year* in which the *distribution loss factor* is to apply, taking into account the terms of the relevant *connection agreement*;

C. a *connection point* for a *market network service provider*; and

D. a *connection point* between two or more *distribution networks*; OR

(ii) derived, in accordance with the methodology determined by the *Jurisdictional Regulator* or the *Distribution Network Service Provider* pursuant to clause 3.6.3(h), using the volume weighted average of the *average electrical energy loss* between the *transmission network connection point* or *virtual transmission node* to which it is assigned and each *distribution network connection point* in the relevant *voltage class* assigned to that *transmission network connection point* or *virtual transmission node*, for all *connection points* on a *distribution network* not of a type described in clause 3.6.3(b)(2)(i);

(3) are to be used in the settlement process as a notional adjustment to the electrical *energy*, expressed in MWh, flowing at a *distribution network connection point* in a *trading interval* to determine the *adjusted gross energy* amount for that *connection point* in that *trading interval*, in accordance with clause3.15.4.

(c) Each *Distribution Network Service Provider* must assign each *connection point* on its *distribution network*, of a type described in clause 3.6.3(b)(2)(i), to a single *transmission network connection point* taking into account normal *network* configurations and predominant *load* flows.

(a1) **[Deleted]**

(d) Each *Distribution Network Service Provider* must assign each *connection point* on its *distribution network*, not of a type described in clause 3.6.3(b)(2)(i):

(1) where practicable, to a single *transmission network connection point* or otherwise, to a *virtual transmission node*, taking into account normal *network* configurations and predominant *load* flows; and

(2) to a class of *distribution network connection points* based on the location of, *voltage* of and pattern of electrical *energy* flows at the *distribution network connection point*.

(e) So far as practicable, the assignment of *connection points* on the *distribution network* to:

(1) *transmission network connection points* under clause 3.6.3(c); or

(2) *transmission network connection points* or *virtual transmission nodes* and a class of *distribution network connection points* under clause 3.6.3(d),

must be consistent with the geographic boundaries of the *pricing zones* determined in accordance with clause 6.13.2 for use in *distribution service* pricing, and the *voltage* levels incorporated within these *pricing zones*.

(f) The assignment of *connection points* on a *distribution network*:

(1) to a single *transmission network connection point* under clause 3.6.3(c); or

(2) to a *transmission network connection point* or *virtual transmission node* and a class of *distribution network connection points* under clause 3.6.3(d),

is subject to the approval of the relevant *Jurisdictional Regulator* and the *Distribution Network Service Provider* must inform *NEMMCO* of such approved assignments.

(g) *Distribution loss factors* must be determined by a *Distribution Network Service Provider* for all *connection points* on its *distribution network* either individually, for all connection points assigned to a single *transmission network connection point* under clause 3.6.3(c), or collectively, for all *connection points* assigned to a *transmission network connection point* or a *virtual transmission node* and a particular *distribution network connection point* class under clause 3.6.3(d), in accordance with:

(1) the methodology developed, *published* and maintained by the *Jurisdictional Regulator* for the determination of *distribution loss factors*; or

(2) where the *Jurisdictional Regulator* has not *published* a methodology under sub-paragraph (1) above, the methodology developed, *published* and maintained by the *Distribution Network Service Provider* for the determination of *distribution loss factors*.

(h) The methodology for the determination of *distribution loss factors* referred to in clause 3.6.3(g) must be developed having regard to the following principles:

(1) The aggregate of the *adjusted gross energy* amounts for a *distribution network*, determined in accordance with clause 3.15.4 using the *distribution loss factors* for the *financial year* in which the *distribution loss factors* are to apply should equal, as closely as is reasonably practicable, the sum of:

A. the amount of electrical *energy*, expressed in MWh, flowing at all *connection points* in the *distribution network* in the *financial year* in which the *distribution loss factors* are to apply; and

B. the total *electrical energy losses* incurred on the *distribution network* in the *financial year* in which the *distribution loss factors* are to apply.

(2) The methodology used to determine *distribution loss factors* for a *financial year* should incorporate provisions requiring a *Distribution Network Service Provider* to undertake a reconciliation between the aggregate of the *adjusted gross energy* amounts for its *distribution network* for the previous *financial year* determined in accordance with clause 3.15.4 using the *distribution loss factors* that applied for *connection points* in that *distribution network* in the previous *financial year* and the sum of:

(i) the amount of electrical *energy*, expressed in MWh flowing at all *connection points* in its *distribution network* in the previous *financial year*; and

(ii) the total *electrical energy losses* incurred on its *distribution network* in the previous *financial year*.

(3) The *distribution loss factor* for a *distribution network connection point*, other than those described in clause 3.6.3(b)(2)(i), is determined using a volume weighted average of the *average electrical energy loss* between the *transmission network connection point* or *virtual transmission node* to which it is assigned and each *distribution network connection point* in the relevant class of *distribution network connection points* assigned to that *transmission network connection point* or *virtual transmission node* for the *financial year* in which the *distribution loss factor* is to apply.

(4) The *distribution loss factor* for a *distribution network connection point* described in clause 3.6.3(b)(2)(i) is determined using the *average electrical energy loss* between the *distribution network connection point* and the *transmission network connection point* to which it is assigned in the *financial year* in which the *distribution loss factor* is to apply.

(5) In determining the *average electrical energy losses* referred to in clause 3.6.3(h)(3) and (4) above, the *Distribution Network Service Provider* must use the most recent actual *load* and *generation* data available for a consecutive 12 month period but may adjust this *load* and *generation* data to take into

account projected *load* and / or *generation* growth in the *financial year* in which the *distribution loss factors* are to apply.

(6) In determining *distribution loss factors*, flows in *network elements* that solely or principally provide *market network services* will be treated as invariant, as the methodology is not seeking to calculate the *marginal losses* within such *network elements*.

(i) Each year the *Distribution Network Service Provider* must determine the *distribution loss factors* to apply in the next *financial year* in accordance with clause 3.6.3(g) and provide these to *NEMMCO* for *publication* by 1 April. Before providing the *distribution loss factors* to *NEMMCO* for *publication*, the *Distribution Network Service Provider* must obtain the approval of the relevant *Jurisdictional Regulator* for the *distribution loss factors* it has determined for the next *financial year*.