STEERING COMMITTEE ON NATIONAL REGULATORY REPORTING REQUIREMENTS

WORKING GROUP ON

ELECTRICITY DISTRIBUTION QUALITY OF SERVICE

DRAFT PROPOSALS

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INTRODUCTION

Purpose

This draft proposal for the national alignment of quality of service performance indicators for electricity distribution has been developed by the Distribution Quality of Service Working Group of the Steering Committee on National Regulatory Reporting Requirements.

An overview of the Steering Committee's work is set out in its open letter of August 2001, accompanying this draft proposal.

Review process and scope

The objective of the Quality of Supply Working Group is to review and compare the measures of network service quality currently used by regulators, and develop performance measures that can be collected on a consistent and reliable basis across the jurisdictions.

The measures relate to the performance of distribution networks at high voltage levels (22kV) and below, and therefore exclude isolated or off-grid networks (such as small networks supplied by stand-alone generating plant), and customers supplied at transmission and subtransmission voltage levels (33kV and above).

Quality of service measurement

Performance measures serve as proxies for consumer preferences. The measures selected for inclusion in a regulatory framework should therefore closely relate to the quality of service preferences of customers. They will also depend on the type of regulation of service quality employed, of which there are two major approaches:

- specification of minimum standards, where penalties are set for non-achievement (and there is no incentive for over-achievement)
- incentive-based regulation through comparative benchmarking, in which financial incentives are offered for improved quality of service outcomes.

While decisions on the form of regulation adopted are a matter for individual regulators, the availability of data supporting benchmarking of service quality performance against cost is likely to improve the regulatory processes regardless of the approach adopted.

In determining appropriate quality of service measures for incentive-based regulation, consideration should be given to the measures' suitability for incorporation in a revenue/ pricing model. Desirable characteristics of a model might include that it:

- is a robust methodology that is well understood and widely agreed;
- provides incentives for outcomes that are efficient, equitable and enhance customer welfare;
- is based on a small number of broad measures, rather than many detailed measures, that are cost-efficient to measure/collect, and amenable to auditing.

The operations of network businesses are subject to a range of factors that limit the degree to which the performance of distributors can be directly compared. These include customer demographics, historical investment decisions and the current network infrastructure base, and geographic, climatic and environmental conditions within the distribution service area. While the significance of these factors on the comparability of performance measures can be reduced by means such as disaggregation of data (eg. urban and rural components of a distribution network), or appropriate normalisation of raw data, direct comparisons should be made with caution.

The following chapters consider three categories of network business performance:

- network reliability measures, which indicate how often and for how long customers lose their electricity supply;
- technical quality of supply measures, which relate to the quality of the electricity supply received by customers (eg. voltage levels); and
- customer service measures, which relate to a distributor's responsiveness and timeliness in the provision of services and their interactions with customers.

The final chapter considers descriptors which might be used to characterise a distribution business, such as number of customers or volume of electricity delivered. In some cases these measures are used to normalise a distributor's financial or service performance.

Responding to this discussion paper

The Working Group's terms of reference require it to develop quality of service measures having regard to:

- the costs of measurement and data collection
- their appropriateness as a basis for performance benchmarking
- compatibility with measures currently used by jurisdictions
- the extent to which they reflect and encompass issues of concern to customers
- the availability of data to calculate the measure.

The Working Group has recommended measures that in its view best balance the above objectives. The range of measures is more extensive than those proposed for retail suppliers, reflecting that distributors provide a monopoly service that is not subject to the pressures of a competitive market. However, the Group believes that almost all the measures proposed currently are or should be monitored by distributors in the normal course of their business, and many are already regulated through minimum standards provisions or guaranteed service levels.

The Group recognises that insufficient data is currently available from distributors in relation to technical quality of supply. In contrast to reliability, there is little standardisation of the definition and treatment of technical quality measures such as voltage levels. While possible approaches to technical measurements are considered, the Group is reluctant to recommend particular measures and collection processes until further information is available. The Group therefore proposes to consider how technical quality of supply might be monitored, measured and regulated as the next stage of its work.

NETWORK RELIABILITY

Current reliability reporting practices

Reliability measures

Each regulatory jurisdiction in Australia reports on reliability of electricity supply using performance measures based on the average duration and frequency of interruptions to customers. Some jurisdictions also define an additional measure based on the amount of electrical energy not supplied to customers.

Performance measures based on *interruption duration* represent the average number of minutes each customer is without supply due to an outage of the network. Such measures are divided by a factor such as *customer numbers* or *load* to provide a normalised measure.

The most common normalisers are the *total customer numbers* and the *total number of customer interruptions.* These measures are often called the System Average Interruption Duration Index (SAIDI) and the Customer Average Interruption Duration Index (CAIDI) respectively.[1]

Interruption Frequency measures represent the average number of occasions that a customer could expect to experience an interruption and when normalised by *total customer numbers* forms the System Average Interruption Frequency Index (SAIFI).

In addition to interruption duration and frequency measures, Tasmania and Queensland define a performance measure based on the amount of electricity not supplied. This measure is defined as the *energy not supplied* (in MWh times 60) due to planned and unplanned outages of the network divided by the *annual system maximum demand* (in MW).

Victoria also collects information on energy not supplied but does not publicly report on this measure.

Accuracy of reliability measures

Variations in the definitions of these reliability measures, and in the way data is collected and reported, are such that the results may not be directly comparable.

Factors affecting the accuracy of reliability measures include:

- in parts of NSW, Queensland and Tasmania, distributors do not record the actual number of customers affected by an outage but use an estimate of load lost to derive this figure;
- variations in definitions of a customer, a feeder, a part feeder, the network, and the calculation of outage duration times;
- whether single premise outages and customer-caused outages are included;
- where measurements are taken on the network or feeders;
- how estimated data is calculated.

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[1] SAIDI, SAIFI and CAIDI are used in Victoria, South Australia, Queensland and NSW, while Tasmania uses Total connected load to normalise its reliability measures.

The accuracy of SAIFI is also affected greatly by the inclusion of momentary interruptions, which are often only included to the extent that the data on momentary interruptions is captured. In some jurisdictions, data includes momentary interruptions caused by an auto reclose device fitted at the supplying (zone) sub-station, but excludes auto reclose devices installed outside of the sub-stations.

It is suspected that the accuracy of Energy Not Supplied measures also varies widely, due to differences in the method used to estimate the amount of load lost.

Variations in data collection and reporting

Data collected in each jurisdiction currently includes different levels of information depending on whether some types of outages are excluded from the calculations:

- NSW presently requires reliability measures to be reported for all interruptions (excluding transmission interruptions) and then excluding natural events, momentary interruptions and planned interruptions. Transmission interruptions can include generation and directed load shedding interruptions. A major natural event could include severe thunderstorms, bushfires, earthquakes, flooding or blizzards.
- Victoria, Tasmania and Queensland require reliability measures to be reported for all outages, and for planned outages and unplanned outages.
- Victoria identifies outages due to load shedding, generation and transmission-related interruptions and defined ‘rare events’, which are then excluded from comparisons between distributors.

Reliability measures are calculated by aggregating and averaging data for interruptions usually within a distributor’s network area and again at some lower regional or segregated level.

- Victoria, Queensland, Tasmania and South Australia require feeders to be classified according to whether they serve a CBD, urban, rural or remote area. Classifications can be defined by customer density, load density, feeder length, type of line, or by a coverage map;
- NSW requires feeders with reliability below a threshold level to be identified in exception reporting.

Proposed reliability measures

Overview

It is proposed that regulatory jurisdictions in Queensland, NSW, Victoria, South Australia and Tasmania adopt common reliability performance measures covering:

- minutes off supply per customer;
- sustained interruption frequency;
- momentary interruption frequency;
- interruption duration; and
- energy not supplied.

Table 1 shows definitions for the proposed reliability measures. Customer interruptions from all causes would be included and recorded separately for planned and unplanned interruptions.

Each individual customer interruption is assigned to the high voltage feeder that carries the supply of electricity to that customer. Reliability measures can then be calculated for that high voltage feeder. Data can also be aggregated so that reliability measures can be calculated for a group of feeders originating from a common (zone) substation; to a collection of feeders forming a geographical region; or to a distributor's business as a whole.

It is also proposed to segregate high voltage feeders into categories of CBD, urban, long rural and short rural. Reliability measures reported against these categories will facilitate comparisons and it is recommended that reporting at this level be established as a minimum.

Each of these proposals is discussed in more detail below.

Table 1 – Reliability performance measures

Measure/description	**Index**	**Definition**
Total number of minutes, on average, that a customer on a distribution network is without electricity in a year	**SAIDI** System Average Interruption Duration Index	The sum of the duration of each customer interruption (in minutes), divided by the total number of connected customers averaged over the year. SAIDI excludes momentary interruptions (less than one minute duration).
Average number of times a customer's supply is interrupted per year	**SAIFI** System Average Interruption Frequency Index	The total number of customer interruptions, divided by the total number of connected customers averaged over the year. SAIFI excludes momentary interruptions (less than one minute duration).
Average duration of each interruption	**CAIDI** Customer Average Interruption Duration Index	The sum of the duration of each customer interruption (in minutes), divided by the total number of customer interruptions (SAIDI divided by SAIFI). CAIDI excludes momentary interruptions (less than one minute duration).
Average number of momentary interruptions per customer per year	**MAIFI** Momentary Average Interruption Frequency Index	The total number of customer interruptions of less than one minute in duration, divided by the total number of connected customers averaged over the year.
Energy not supplied		Energy not supplied due to unplanned outages (MWh x 60) divided by Annual system maximum demand (MW)

SAIDI, SAIFI, CAIDI

Customer weighted measures of interruption frequency and duration are often used internationally as reliability performance measures. Regulators prefer them to measures weighted by network data (such as faults per km of line) as they better reflect the impact on customers.

The most commonly used customer weighted measure is the System Average Interruption Duration Index or SAIDI. This measure represents the total minutes on average that a customer could expect to be without electricity in a year. Total SAIDI comprises both planned and unplanned components.

Example of SAIDI calculation

If during an outage of the distribution network, three customers experience an interruption of 60 minutes and one customer experiences an interruption of 120 minutes and the total number of customers on the network segment is 2000, then SAIDI = 3x60 + 1x120 divided by 2000 which equals 0.15 minutes.

The System Average Interruption Frequency Index (SAIFI) represents the number of occasions per year when each customer could, on average, expect to experience an interruption. Total SAIFI comprises both planned and unplanned components.

Example of SAIFI calculation

If during an outage of the distribution network, three customers experience an interruption of 60 minutes and one customer experiences an interruption of 120 minutes and the total number of customers on the network segment is 2000, then SAIFI = 3 + 1 divided by 2000 which equals 0.002 interruptions.

The Customer Average Interruption Duration Index (CAIDI) represents the average time taken for supply to be restored to a customer when an interruption has occurred. Total CAIDI comprises both planned and unplanned components. Unplanned CAIDI is a particularly valuable measure as it represents the time taken by distributors to respond to faults on their networks.

Example of CAIDI calculation

CAIDI = SAIDI divided by SAIFI. For the previous example, CAIDI = 0.15/0.002 which equals 75 minutes.

It is proposed to exclude momentary interruptions from the calculation of SAIDI, SAIFI and CAIDI. Momentary interruptions generally have less effect on customers than long sustained interruptions, and the accuracy of data collection and recording of momentary interruptions is much poorer than for sustained interruptions.[2]

The Working Group considers that there may be some merit in disaggregating the number and duration of sustained interruptions by the cause of interruptions (such as storms or equipment failure) but has not yet developed interruption cause categories. Comments are sought on whether it is feasible to disaggregate SAIDI and SAIFI, and appropriate categories of interruption cause.

MAIFI

Complementing SAIFI is a measure based on the total number of momentary interruptions (less than one minute duration) that a customer could, on average, expect to experience in a year (MAIFI). Momentary interruptions are caused by auto reclose devices, which are installed on the network to restore supply following a transient fault.

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[2] The accuracy of momentary interruption data is poor due to the large number of field devices that need to be visited to collect data, leading to data collection over a long time period and some degree of estimation.

Each operation of an automatic reclose device is counted as a separate interruption. It would be preferable to count a number of recloser operations, which occurred in response to a single event, as one interruption as this would give a better indication of the impact on customers. However, many reclose devices do not contain the time stamp information required to provide this grouping of operations and it is considered that the cost to upgrade field devices to collect the required data is excessive if regulatory performance reporting is the only reason for the upgrade. Sustained interruptions which occur when a recloser locks out after several attempts to reclose should also be deleted from MAIFI calculations.

It is proposed that the reporting of this reliability measure be optional at the discretion of regulators, as some distributors are unable to provide data on momentary interruptions at this point in time.

Energy not supplied

The amount of energy not supplied due to an interruption is a useful measure of the impact of an event and complements customer weighted reliability measures such as SAIDI. Suitable measures can be based on either the connected load interrupted or an estimate of the amount of energy not supplied.

An *Energy Not Supplied* measure would be the amount of energy that may have been consumed in the period when supply was interrupted, calculated from an estimation of load lost, using time of day and time of year load profiles. This measure has the advantage of being able to be used in conjunction with estimates of the value of lost load (Voll) to determine the cost impact of outages.[3] As load lost is estimated, data accuracy is a key issue.

Alternatively, a similar reliability measure based on the connected load interrupted could be used. Such a measure could have two parts:

- *Connected kVA Interrupted* calculated as the connected load interrupted (kVA) divided by the total connected load supplied (kVA), generally determined from the nameplate rating of transformers; and
- *Connected kVA Duration Interrupted* calculated as the connected load interrupted (kVA) times the duration of the interruption divided by the total connected load supplied (kVA).

These alternative measures have the advantage of ease of calculation and the ability to compare with some international data. However, this method gives a static value unrepresentative of the actual value of the load lost.

Comments are sought as to the relative merits of using connected load lost or energy lost measures.

Definition of terms

A ***Customer*** is defined in Victoria as each separate supply point between the distribution network and an electrical installation; and in New South Wales as an entity having its own

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[3] However Voll will often not reflect the value to customers of an interruption, which will vary depending on the nature of the load supplied and the duration and frequency of interruptions. Knowledge of the value of interruptions is important in determining an appropriate level of additional expenditure to reduce the level of interruptions, but considerable care is needed in assigning a value.

metering which is directly or indirectly connected to the network operator's electrical network, in its distribution franchise area.

The primary issue to be resolved before a common definition of a customer can be agreed is the treatment of inset networks such as private residential estates, shopping centres and caravan parks. An inset network is not owned by the distributor, and is usually only metered by the distributor at the point of common connection (but individual premises or sites within the inset network may be sub-metered by the owner of the inset network). However, in some cases the distributor does separately meter sites within an inset network (such as individual houses in an estate).

The definition of a customer potentially affects a distributor's reliability measures such as SAIDI and SAIFI if the reliability of the inset network differs from the reliability of the network as a whole.

The Working Group's preferred position is to define a customer in terms of a supply point. However, the Group has not reached agreement on this issue and seeks comments on the circumstances under which inset networks should be treated as one customer, and the circumstances under which distributed load points or separately metered points within an inset network should be counted as individual customers.

In either case, a distribution customer is likely to be different to a retail customer. A retail customer is necessarily defined in terms of a metered point (whereas a supply point may not be metered), and a retail customer is generally defined in terms of an account holder, where an account may encompass supply to a number of geographically separate premises (which may be in different distribution areas).

The number of Customers should be based on actual records of customers and not estimated using average loadings or other means. Inactive accounts and unmetered public lighting supplies are excluded.

Subject to obtaining confirming data from distributors, it is proposed that unmetered supplies other than public lighting may be either included or excluded in the definition of a customer. [4]

Customer Interruption is any loss of electricity supply to a customer associated with an outage of any part of the electricity supply network of more than 0.5 seconds, including outages affecting a single premise. An interruption may be planned or unplanned. [An outage of less than 0.5 seconds is considered to be a technical quality of supply issue.]

The customer interruption starts when recorded by recording equipment such as SCADA or, where such equipment does not exist, at the time of the first customer call relating to the network outage.

Distribution Network means a system of electric lines and associated equipment at nominal voltages of 66kV and below used for the distribution of electricity.

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[4] Most distributors are currently unable to separately identify metered from unmetered supplies (other than public lighting). Limited data supplied by the Victorian jurisdiction indicates that unmetered supplies other than public lighting represent about 2% of total customers and are spread reasonably evenly across the network. Thus the impact of including unmetered supplies on the accuracy of a customer weighted reliability measures such as SAIDI should be negligible.

The distribution network generally ends at the consumer's terminals (the first connection on the customer's property), with the exception of underground services supplied from a pit or pillar on public land at or just outside a customer's property in which case the network ends at the service connection in the pit or pillar. The distribution network for this purpose does not include the meter, service fuses or other service equipment on the customer's side of the consumer's terminals.

High Voltage Feeder is a line used to distribute electricity from a (zone) substation to a customer, generally operating at a nominal voltage between 1kV and 33kV.

Momentary Interruption means an interruption of less than one minute in duration, and a ***Sustained Interruption*** is an interruption of more than one minute's duration.

Proposed Network Categories

When making assessments of relative performance, it is important to be able to make valid comparisons. This can be achieved by separating an electrical network into segments that can reasonably be expected to have similar levels of performance, and applying the reliability measures to each segment.

The segregation proposed is based on classifying[5] individual high voltage feeders as supplying predominantly CBD, Urban or Rural areas with rural feeders further segregated into Short and Long.[6]

Individual customer interruptions (whether caused by faults on the low voltage, high voltage, subtransmission or transmission systems) are recorded against the high voltage feeder supplying the customer.[7] Data can then be aggregated to the feeder category or to a region consisting of a group of feeders or to the distributor's entire supply area.

CBD feeders are identified as those feeders supplying into the CBD areas of capital cities or similar. The CBD area is identified as that area having the following attributes:

- predominantly a commercial precinct consisting of high rise buildings;
- supplied by a predominantly underground distribution system containing significant interconnection and redundancy at the high voltage level when compared to urban areas.

It is recognised that the definition of CBD leaves some scope for different interpretations and comment is sought on ways of improving the consistency in identifying CBD feeders.

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5 The proposed categories are based on those used by ORG in Victoria. Further information about the origin of these categories can be found from the ORG website at www.reggen.vic.gov.au/docs/ electric/pbserstan.pdf

6 Some distributors define a remote rural category, however an analysis of Victoria data does not support a further rural category. This proposal can be reviewed on obtaining data from other jurisdictions.

7 Note that interruptions to customers connected directly to the subtransmission or transmission system are not captured in these categories

Table 2 – Feeder classifications

Feeder category	Description
CBD	A feeder supplying predominantly commercial, high-rise buildings, supplied by a predominantly underground distribution network containing significant interconnection and redundancy when compared to urban areas.
Urban	A feeder, which is not a CBD feeder, with maximum demand per total feeder route length greater than 0.3 MVA/km.
Rural Short	A feeder which is not a CBD or Urban feeder with total feeder route length less than 200 km.
Rural Long	A feeder which is not a CBD or Urban feeder with total feeder route length greater than 200 km.

Note: Rural Short feeders may include feeders in urban areas with low load densities.

When classifying feeders, care needs to be taken to account for unusual situations.

- back up feeders should be given the same classification as the normal supply feeder.
- feeders with reserve capacity – the reserve capacity should be added to the feeder's maximum demand when determining the load density.

Reporting of poor reliability

The reliability performance measures proposed in this report are system averages. The measures can be applied to individual high voltage feeders or parts of these feeders when they are sectionalised, but it is not practical to apply these measures to smaller parts of the network (e.g. low voltage distributors). As such, the measures can show low reliability to a (relatively large) area but do not give an indication of poor performance experienced by individual customers or small groups of customers, as they are an average for all customers on the larger network segment.

However, most distributors are unable to provide accurate data on reliability to individual customers, as their databases do not currently contain information on the connection of customers to the low voltage system. Customers are typically recorded against the (distribution) substation or high voltage feeder supplying the particular area rather than the low voltage line to which they are connected[8].

The identification of areas of poor performance is therefore limited to fairly large areas. For example:

- in NSW 'black' spots are determined using 'standard' data and comparing this with stated objectives for the average number of sustained outages by region. A detailed review of the contributing feeders in each region is then undertaken to identify problem feeders and the best solution. This review looks at those customers / feeder sections that are well below stated average performance; and

8 The limited amount of information on low voltage connectivity is mainly due to historical limitations of older databases. Modern databases are now capable of recording such information at a reasonable price but it is doubtful if the benefits of collecting and maintaining such information solely for reporting purposes would outweigh the costs.

- in Victoria, low reliability feeders are identified as those that exceed a threshold number of minutes off supply. The threshold was set in 1999 to capture 5% of customers and the expectation is that the number of feeders exceeding the threshold will decrease over time.

Low reliability could also be defined in statistical terms eg two standard deviations beyond the average for a region or class of feeders.

In addition to system average measures, some jurisdictions also specify reliability targets based on an excessive duration of interruptions or the number of interruptions in a certain time period. These measures are more in the form of guaranteed levels of service and have not been considered in this paper.

At present, it is not proposed to establish a common form of reporting on areas of poor performance.

Limitations of current data collection

The accuracy of customer weighted reliability measures depends largely on the availability of information about the number of customers connected to sections of the electricity network. However, not all distributors' databases hold such information.

All jurisdictions have acknowledged the need to implement plans to capture accurate customer interruption data. Until then, it is acknowledged that in some jurisdictions the number of customers affected by an interruption can only be estimated. Typical estimation techniques are:

- an average number of customers per low voltage distribution line can be assessed by combining a customer count by postcode (from a customer information system) with the number of low voltage distribution lines by postcode (from a technical information system). Errors arise from the accuracy of the databases and from edge effects (feeder supply areas seldom align with postcode boundaries); or
- customers on a feeder can be estimated by assuming a fixed allocation of load (kVA) per customer and dividing this into the maximum observed feeder load. This methodology also suffers from the problems noted above.

Information provided by EnergyAustralia of six poorly performing feeders (from a sustained outage point of view) supplying predominantly domestic customers indicates errors in the number of customers ranging from –38% to +64%, although errors quickly become smaller as data is aggregated.

Adopting a common methodology and definitions will therefore drive improvements in measurement and recording of data.

Reporting guidelines

The presentation of reliability performance measures can affect the interpretation of the data and the perception of what the data means. It is therefore proposed to adopt a set of guidelines for the reporting of data.

Minimum Reporting Requirements

It is proposed that the reliability performance measures be reported in the data sets shown in Table 3.

Firstly, performance measures should be reported including all supply interruptions regardless of cause. This represents the reliability performance as seen by customers.

Secondly, outages relating to events outside of a distributor's control should be excluded. This level of reporting represents the basic performance of a distributor's network and is the level at which comparisons between distributors should be made.

Finally, it is proposed that supply outages due to natural causes that exceed a specified threshold should be excluded. Major natural events such as floods, earthquakes and destructive storms can have a major impact on reliability data in some years, distorting the underlying network reliability trends. Examples would be: a storm causing large branches to be blown considerable distances, trees to fall or roofing material to be blown into power lines; or a flood requiring de-energisation and restricting access for repair crews.

It is considered worthwhile to have a normalised measure that represents what the distribution network unplanned sustained interruption performance would be if the effects of defined major natural events were deleted. This level of reporting will provide a more realistic assessment of network operator performance trends.

Table 3 – Levels of reporting

Type of reporting	Data Set	Purpose
Total	All interruptions including transmission, directed load shedding, planned and unplanned, momentary and sustained.	Overall reliability reporting of a jurisdiction or large area
Distribution Network	**Excludes:** ▪ transmission outages ▪ directed load shedding	Basic performance of a distributor's network
Normalised Distribution Network	Further excludes: ▪ outages which exceed a specified threshold	Comparison of distributors performance

However, the threshold for excluding such events is difficult to set. It is important that it have consistent application across distributors having vastly different supply area geography and weather conditions. Thresholds set on customer weighted values such as SAIDI or percentage of customers impacted do not necessarily provide for a consistent application.

It is also important that the threshold be simple and cost effective to apply. Thresholds set on an examination of events against a set of criteria such as rare, widespread etc are somewhat subjective and are more appropriate as part of an financial incentive scheme.

One option under consideration by the Group is to set two simple threshold-based criteria:

- the number of customers affected by an incident or related series of incidents must exceed 70,000; and
- the incidents must relate to natural causes, such as storms, floods, bushfires.

However, it may be that other thresholds, including relative measures, are possible, and comment is sought on the appropriate form and value of the threshold.

It is recommended that the performance measures shown in Table 4 should form the basis of comparative performance reports issued by regulators, with each item categorised by feeder category (CBD, urban, rural short and rural long).

Some jurisdictions may decide to further break down the reporting by region and may require additional measures from the full set.

Table 4 – Recommended measures to be reported

Measure	**Level to be reported**
SAIDI	▪ Total ▪ Distribution network - Planned ▪ Distribution network - Unplanned Sustained ▪ Normalised Distribution network - Unplanned Sustained (Allow reasonable introduction period)
SAIFI	▪ Total ▪ Distribution network - Planned ▪ Distribution network - Unplanned Sustained ▪ Normalised Distribution network - Unplanned Sustained (Allow reasonable introduction period)
MAIFI (optional)	▪ Distribution network
CAIDI	▪ Total ▪ Distribution network - Planned ▪ Distribution network - Unplanned Sustained ▪ Normalised Distribution network - Unplanned Sustained (Allow reasonable introduction period)
Energy not supplied	▪ Total

Reporting by region

The same reporting set may be applied across the whole distribution franchise area or across several defined regions for each distributor. For example, some NSW distributors have a similar geographical area to that of the whole of Victoria, and cover several very different land use types (e.g. coastal areas with many large towns, small farms and high accessibility; highland areas with medium farm sizes, and many areas with difficult access; various types of plains areas with much larger farm sizes, large distances between towns and subject to regular flooding). It may therefore be appropriate to report these performance measures for the organisation as a whole, as well as for well defined geographical regions.

This is a matter of choice for each regulator in conjunction with the relevant distributors, but the proposed reporting measures allow for either approach.

QUALITY OF SUPPLY

Technical characteristics of supply

Supply reliability, in particular the frequency and duration of power supply interruptions, remains the primary determinant of quality of a utility power supply. However, the technical quality of the power supply is becoming a major point of interest to customers. The term "Technical Quality of Supply" refers to the impact of dips, surges and voltage waveform distortions on the supply network, as opposed to power interruptions which determine the reliability of supply.

A range of codes, licence conditions and standards impose requirements on distributors regarding many aspects of technical supply quality. However, the definition and determination of 'adequate supply quality' remains elusive, due mainly to the fact that inadequate supply quality is reflected only in the variable performance of electrical devices and equipment to changes in supply voltage.

Quality of supply issues have become important in recent years due to the poor performance or failure of a wide range of electrical equipment in domestic, commercial and industrial applications. Technical advances – especially in the widespread use of electronics and microprocessors – introduce a myriad of new features and benefits but result in the equipment being sensitive to fluctuations and disturbances in supply that had previously gone unnoticed.

The nature of technical supply quality fall into five main areas:

- *Low supply voltage*, outside normal limits for some minutes or longer;
- *Voltage dips*, where supply briefly drops by 20 to 80% or more, usually noticeable as lights flicker, and electrical equipment may be affected;
- *Voltage swells*, also known as a voltage surge, in the form of a small increase (up to 20%) in the supply voltage that may exist for some minutes;
- a very short impulse or high magnitude increase in voltage well above normal limits, known as a *Voltage Spike*; and
- *Waveform Disturbances*, where voltage is within limits but another technical parameter associated with the nature of the voltage supply waveform is present.

Standards of technical supply quality

Power quality standards are included in the National Electricity Code (NEC). Derogations have provided some variations for local conditions, but the essential elements are the same nationally. The NEC has set out minimum standards for power quality.

It should be noted that there are yet no specific minimum standards for short duration voltage transients. Generally, such occurrences are often beyond the control of the utility, and their propagation throughout the network is usually a characteristic of the type of network and not a function of good or bad practice.

Possible causes of supply problems

Overview

Fluctuations and disturbances come from four main sources:

- the operation of equipment in the customer's own installation;
- the operation of equipment in other customers' installations;
- the operation of the electricity supply network; or
- environmental factors such as storms or other sources of damage to the power supply network.

Voltage fluctuations tend to have obvious effects whilst waveform disturbances can be far more subtle in their cause and effect and much more difficult to diagnose.

The following table is a guide to the link between the nature of technical supply quality problems and their causes. Note that the "Possible Cause" is indicative only, and can only be determined following investigation into the incident.

Table 5 – Categories and possible causes of Technical Quality of Supply concerns

Nature	Description	Possible Cause
Low supply voltage (voltage sag)	Supply is available, but falls below the allowable limit	Adjoining property also affected – may be a voltage regulation problem, reflected in network design, operation or control system settings Only one property affected – may be a problem with the customer's installation
Voltage dips	Supply voltage briefly drops by 20 to 80% or more, without actual loss of supply.	Generally either a sharp increase in load on a customer's premise, or the impact of a fault on the power supply network
Voltage swell	Moderate (up to 30%) increase of supply voltage above allowable limit	More than one property affected – likely to be a voltage regulation problem, reflected in network design, operation or control system settings
Voltage spike (impulse)	Very high magnitude (greater than 30%, often over 300%) increase in voltage for a very short duration	Generally an external influence on the network, either lightning (known as a *lightning surge*) , or a network equipment failure resulting in components of the distribution system accidentally contacting conductors at a higher voltage (known as a *High Voltage Injection)*
Waveform disturbances	Supply is on and voltage is within limits, but equipment performance is	Generally caused by other equipment connected to the network – belonging to other customers or the network operator – generating harmonics or other disturbances

Nature	Description	Possible Cause
	unsatisfactory or erratic.	that are superimposed onto the supply voltage waveform.

Causes of Voltage Dips

Voltage dips are often of greatest impact to the widest number of electricity customers. The causes of voltage dips may be grouped as follows:

- irregularities in electricity generation or transmission that are beyond the control of electricity distributors;
- natural causes beyond the control of electricity distributors, eg. storms, wind-blown debris, cyclones, earthquakes, lightning strikes, and birds or animals coming into contact with power lines – often referred to as "acts of God";
- other causes beyond the control of electricity distributors such as motor vehicle accidents, or vandalism;
- causes within the control of electricity distributors such as failure to carry out proper maintenance on electricity systems resulting in plant or equipment failure; and
- other electricity customers not observing their obligations with respect to a safe, efficient and reliable electricity delivery, eg. a failure to clear their own vegetation near power lines or to ensure that the electrical equipment used by them is compatible with electrical system requirements.

Faults on the power transmission and distribution system that are automatically cleared by protective switchgear often depress the supply voltage in adjacent parts of the network until the fault is disconnected. Consequently, a voltage dip in one part of the network can be associated with a permanent fault or loss of supply in another electrically adjacent segment of the network.

The severity of the voltage dip experienced by customer equipment is dependent upon the system fault level, position and type of fault, and fault impedance. For the majority of faults on the distribution system, customers connected in the immediate vicinity of the fault will experience the greatest voltage sag. The voltage at the customer's equipment will typically not fall below 70 to 80% of nominal voltage.

The number of voltage sags experienced by an individual customer is difficult to quantify because the frequency and severity of faults on the system vary with location and system voltage level.

Overview of current reporting regimes

Current reporting in most utilities centres on the monitoring of the number of customer complaints received with respect to technical quality problems.

For the 1999-2000 reporting period, NSW distributors agreed to report on the number of complaints received relating to supply quality, and the results of complaint investigations completed, categorised in accordance with the Service Standards Code. Distributors reported on the number of supply quality complaints against the following headings:

- Voltage – complaints related to sustained over-voltage/under-voltage; voltage fluctuations; voltage dips, switching transients, neutral to earth voltage difference, ground fault voltage, voltage unbalance, mains signaling, high voltage injection and notching.
- Current – complaints related to direct current and harmonic content.
- Other quality issues – complaints related to mains signaling reliability, noise and interference, level of supply capacity, supply frequency and levels of electromagnetic fields.

It is important to note that not all complaints are valid complaints. A complaint is valid if the circumstances indicate non-compliance with published service and network standards.

Current network voltage studies

Recent work has taken place in New South Wales to carry out a benchmark power quality survey. This work, with some distributors, involved the Australian Power Quality Centre in Wollongong. This survey is restricted to eight locations within eight distributor's networks. A report on the technical survey was due in March 2001.

Significant work has taken place in the US with respect to indices used to assess voltage variations. Recommendations centre on the use of standard voltage variation magnitude and duration measurement, benchmarked against allowable performance curves such as SARFI%V[9] or CBEMA.[10]

Proposed complaints reporting framework

It is proposed to continue the framework of reporting by number of customer complaints, until a robust framework of monitoring of technical supply quality by distributors is implemented in the next few years.

A two-pass reporting framework is to be implemented, initially capturing the number of customer complaints classified by the nature of impact on the customer. Following validation and investigation by the distributor, a second reporting mechanism shall indicate the number of complaints that have been verified, classified by the nature and likely cause of the quality problem.

The features of such a system are:

1. The record of a complaint at initial contact, either perceived or real (Table 6).
2. The record of investigations into the cause and completion details of the complaint for reporting and reconciliation (Table 7).
3. The provision of a comprehensive analysis of complaint trends and causes in order to facilitate improvement of overall utility performance.

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9 SARFI - System Average RMS Variation Frequency Index for a voltage threshold V

[10] CBEMA – Computer and Business Equipment Manufacturers Association (US)

Table 6 - Power Quality Complaint Reporting – Part 1 - Symptoms

	Category	**Symptom**
1	Low supply voltage	dim lights, overheating motors
2 (a) & (b)	Voltage dips	two categories based on impact – • minor or nuisance, such as flickering lights or resetting digital clocks or; • severe dips that interrupt production, contactors drop out, and direct financial loss will result.
3	Voltage swell	• blown lights, motor protection operates, minor equipment damage • no clear initiating event likely to cause an impulse (spike)
4	Voltage spike	• obvious damage to appliances & wiring • clear initiating event, such as lightning
5	Waveform distortion or unbalance	Equipment performing erratically
6	TV or Radio interference	
7	Noises from appliances or lights	Audible noise, other than normal operation of the appliance, or audible audio-frequency interference on audio systems and telephones
8	Other	

Table 7 - Power Quality Complaint Reporting - Part 2 – Possible Cause and Response

	Category	**Likely Cause and Response**
1	Network Equipment Faulty	Network element failed, including clamps, fuse carriers, insulators & attachments. Action required by the NSP.
2	Network Interference – Standard breached by NSP equipment	The operation of NSP plant or equipment is creating problems. Action on the part of the NSP is required to change the equipment or mode of operation.
3	Network Interference caused by another customer	The operation of customer equipment is generating technical quality problems onto the supply network. The NSP is to take action to ensure that the customer operates the equipment to required standards.
4	Network limitation	NSP is required to carry out investment on their own network to improve performance and remove limitation – network capacity increase, upgrade plant, alter control settings
5	Customer internal problem	Fault lies within the customer power supply installation, and the customers are required to rectify their own system.
6	Environment	External influences outside the NSP's control eg lightning, wildlife
7	Other	
8	No problem identified (all measurements are within limits)	No problem evident on arrival, equipment is performing within specification, or is faulty.

Proposed future work on voltage measurement

The Electricity Distribution Price Determination in Victoria in September 2000, outlined a proposal for network service providers to develop a framework for the establishment of voltage standards and monitoring. This proposal in general has met a positive response by many distributors, and it is proposed to consider the application of Victorian proposal in a wider application across the industry.

The proposal builds on the current obligations under the Victorian Distribution Code on distributors to maintain voltage quality within prescribed standards.

To consider future work on voltage measurement that could be incorporated into regulatory regimes, it is suggested that three key areas be considered.

Firstly, it is proposed that distributors should be encouraged to monitor and record steady state voltages at each zone substation and at the extremity of one feeder supplied from each substation. This will facilitate the survey of voltage dips and swells in order to set benchmarks and targets for such events through the next regulatory period. Additional benefits such as improved information gathering for momentary interruptions to supply (MAIFI) and automated loss-of-supply notification exist.

Secondly, a similar initiative should be encouraged through the installation of appropriate metering at zone substations and other key sites to allow the monitoring and recording of other technical quality of supply parameters, such as harmonics and unbalance. This again will facilitate the survey of such quality parameters in order to set benchmarks and targets for such events through the next regulatory period.

Thirdly, the matter of establishing a more adequate and universal set of technical quality supply standards should be considered in preparation for the next regulatory period. The major point for consideration is the framework and benchmark limits of acceptance for voltage dips and swells. Consideration should be given to the application of quality of supply envelopes, such as SARFI%V or CBEMA for magnitude and duration of voltage dips.

Finally, the adoption of common voltage surge standards is desirable, in a manner similar to the ORG requirement for distributors in Victoria to adopt the relevant IEC for surge (impulse) voltage levels, including the installation of lightning protection on low voltage networks in some areas. This will provide indications and benchmarks on which future consideration of compensation for voltage variations can be made.

CUSTOMER SERVICE

Customer service is concerned with the manner in which a distributor conducts its dealings with customers. The purpose of customer service indicators is to establish measures of efficiency and responsiveness to enable distributors' interactions with their customer to be monitored and compared.

A number of jurisdictions have established reporting against customer service indicators as a component of distribution licensing regimes. The activities most commonly monitored are call centre performance, timely provision of connections, complaints management, appointment punctuality and street light maintenance.

There are several means by which regulators can use the customer service indicators to create customer service incentives:

- comparative reporting of service quality, whereby licensees are encouraged through the publication of performance data to improve their service quality or match that of similar businesses;
- Guaranteed Service Levels, which require a fixed compensation payment to be made to affected customers if a minimum specified standard is not met
  - current examples include (in New South Wales) a payment of $60 for each day the distributor does not provide a connection by the agreed date, and (in Victoria) a payment of $80 to a customer if a supply interruption exceeds 12 hours; and
- statutory penalties, imposed on a licensee by the regulator for the licensee's failure to meet a prescribed target. The target would generally relate to aggregate or average performance rather than the provision of a service to a single customer.

The introduction of competitive retail markets in some states has required a clearer distinction between the roles of distributors and retailers, which have traditionally been performed by a single entity. Separation of functions is driven by the need for accounting separation for the determination of regulated prices of monopoly services (retail and distribution), and competitive neutrality requirements that a distributor's retail arm does not have an unfair advantage over new entrants to the competitive retail market.

However accounting or legal separation does not automatically determine responsibility for customer service functions. It is not clear whether in competitive retail markets customers will have separate contracts and direct relationships with both a retailer and distributor. For the purposes of this review and based on emerging market trends, it is assumed that the primary customer interface will be through the retailer. This means that customer service indicators relating to billing services, such as payment of security deposits and provision of instalment plans, are retail supply measures.

While services are connected and disconnected by the distributor, this occurs at the request of a retailer. The customer service indicator 'Number of unrequested disconnections' is therefore also a retail supply measure.

Proposed customer service indicators

Timely provision of services

Measure : Number and percentage of connections not provided on or before the agreed date

Not all jurisdictions' regulatory frameworks specify a time limit from the date of request for a distributor to provide an electricity connection (and a request for connection may be received well in advance of when the connection is required). However distributors are generally required to specify or agree to a date by which the connection will be made when a connection request is received from a customer.

The number of connections not provided on or before the agreed date includes connections not provided within any regulated time limit for the provision of a connection, and connections not provided by the date agreed with a customer.

Timely repair of faulty street lights

Measures : Number and percentage of street lights 'out' during each month
: Number of occasions that the distributor failed to repair a faulty street light on or before the agreed or required date
: Average number of days to repair faulty street lights

The time within which a faulty street light must be repaired is not generally specified in regulatory frameworks. However a number of jurisdictions have a guaranteed service standard requiring a compensation payment to an affected customer if a street light is not repaired within a specified time of the customer notifying the distributor of an outage.

The 'number of days' taken to repair a street light is counted from the date of notification rather the date the street light ceased working (which is not likely to be known). Street light repair practices appear to vary, with some distributors replacing lights according to a regular maintenance schedule rather than responding to individual outages.

Customer complaints

Measures : Number of customer complaints (per 1000 customers)
: Reason for complaint (as number, and percentage of total number of complaints)
: Number and percentage of complaints not investigated and responded to within 20 days
: Average number of days to investigate and respond to a complaint

A complaint is defined by Australian Standard 4269:1995 as any expression of dissatisfaction with a product or service offered. Complaint handling procedures are generally specified in regulations, and allow for unresolved complaints to be taken to an Ombudsman in those states where an electricity Ombudsman's office has been established. In some states data on the number of complaints and the nature of the complaints against each distributor is published by the Ombudsman. The purpose of the proposed measures is to monitor trends in customers' satisfaction with a distributor's services, and the distributor's efficiency and responsiveness in handling complaints.

Notification of planned interruptions

Measures : Number and percentage of occasions on which the required notice of a planned interruption to supply was not given
: Number and percentage of occasions on which the duration of a planned interruption exceeded the time specified in the notification.

Supply interruptions are classified as either 'planned' or 'unplanned', depending on whether affected customers have been given sufficient notice of the interruption and the notice is in a form specified by relevant codes or regulations. Planned interruptions allow distributors to undertake scheduled maintenance or essential repairs to the network.

Notification of when and for how long an interruption is to occur allows customers to schedule their activities around or otherwise plan for the supply interruption where possible, and to a large extent removes the ‘unknown’ factor of when supply will be returned. Surveys indicate that customers are far more tolerant of planned than unplanned interruptions.

The minimum period of notice required varies between jurisdictions, but is commonly between two and four days.

Call centre performance

Measures : Number and percentage of times a call from a customer was not answered within 30 seconds
: Average waiting time before a caller was able to speak to a human operator
: Percentage of calls abandoned
: Number of overload events

A call is ‘answered’ when the caller speaks to a human operator, but not when the call is placed in an automated queuing system. For the purposes of these measures, the number of telephone calls does not include calls to payment lines and automated interactive services.

Major supply interruptions or emergencies often result in a larger number of calls than a distributor’s telephone system is able to manage. This ‘excess’ of calls is not reflected in measures of abandoned calls or call waiting time, but is captured by the number of call system overload events.

Punctuality in keeping appointments

Measure : Number and percentage of occasions on which the distributor was more than 15 minutes late for an appointment

Appointment punctuality is subject to a guaranteed minimum standard in New South Wales and Victoria.

DISTRIBUTION BUSINESS DESCRIPTORS

A distribution business operates within a range of constraints over which the distributor has limited control. These external factors may largely determine the distributor's short-term financial or service quality performance, with managerial or internal factors only influencing performance at the margin. The costs of operating and maintaining a distribution network, for example, are to a large extent determined by the number of customers and total length of lines. Similarly the quality and reliability of supply of an individual feeder or part of a network are influenced by factors such as network construction and design, customer density, and environmental conditions.

An important issue in comparing distributors' quality of service is the extent to which inherent differences in exogenous factors are reflected in distributors' relative performance. In some cases it may be reasonable to accommodate differences between distributors' circumstances by adjusting or normalising raw data and expressing performance on a 'per kilometre of line' or 'per MWh delivered' basis. In other cases it may only be appropriate to compare performance where, for example, distributors have a similar number of customers.

The purpose of business descriptors is to provide raw measures of the fundamental parameters of a distribution business. The descriptors serve a number of potential purposes, including:

- enabling direct comparison or benchmarking of similar distribution businesses
- to normalise quality of service and financial performance data and derive efficiency indicators – eg. cost per MWh delivered
- to identify trends in a distributor's performance by excluding effects such as marginal changes in consumption or customer numbers
- as cost drivers in price determinations.

Proposed descriptors

Number of customers (connections)

As discussed in Chapter 2, not all distributors' databases hold accurate information on the number of customers connected to sections of the electricity network. Many distributors do not have 'connectivity' information and must rely on surrogates for the number of customers affected by an event (eg assets and customers on a postcode basis). While data on total customer numbers is reliable, disaggregated customer numbers can therefore exhibit significant errors.

All Network Operators are moving towards having the National Market Identifier (NMI) as the basis for defining a customer. However, this is not currently in place and is subject to the roll-out of full retail contestability.

There are also differences between jurisdictions' definitions of a connection, primarily relating to the inclusion or exclusion of unmetered supplies, inactive accounts and inset networks.

In theory, the inclusion or not of unmetered supplies, inset networks and inactive accounts should not be significant to customer-weighted performance measures such as SAIDI and

SAIFI. This is because the number of such accounts is small compared to the total number of customers, and they are either included or excluded from both the numerator and the denominator of the calculation. However, the impact may be significant when absolute customer numbers are used to normalise financial data or derive efficiency indicators for comparison with distributors using a different definition of a connection.

As discussed in Chapter 2, further consideration is required before the Working Group can form an opinion on whether an inset network should be considered one customer, or each inset network metering point should be included as a separate customer. The Group's initial view on inactive accounts and unmetered supplies is that:

- inactive accounts should be excluded from number of connections; and
- the inclusion or not of unmetered supplies can be ignored without affecting the validity of comparisons made using customer weighted performance measures. (Public lighting is not included in the calculation of reliability performance measures in any jurisdiction.)

Disaggregation of number of connections

Number of connections is to be disaggregated by:

- geographic region – CBD, urban, short rural, long rural – in accordance with feeder classifications;
- whether the customer is residential or non-residential, where residential means that the electricity is used primarily for domestic purposes; and
- (for non-residential customers) the voltage level of the connection – sub-transmission (ST), high voltage (HV), or low voltage (LV).

Energy delivered

Energy delivered is defined as annual gigawatt hours (GWh) of electricity consumed by end customers of the distribution network. This includes energy produced by embedded generators and consumed within the distribution area, unread meters, and unmetered consumption (including theft). Energy delivered by the DNSP differs from energy purchased due to system losses.

Total energy delivered is to be disaggregated on the same basis as number of customers:

- customer type – residential, non-residential
- feeder classification – CBD, urban, short rural, long rural
- supply voltage – ST, HV, LV (for non-residential customers)

Distribution losses
(Electricity purchased – electricity delivered) x 100%/(electricity purchased)

Distribution losses are defined in the National Electricity Code as electrical energy losses incurred in the conveyance of electricity over a distribution network (Section 3.6.3). There are two types of losses:

- series losses, arising from the network's resistance to electrical flow; and
- shunt losses, which are 'leakages' of energy mainly associated with the connection of transformers and other equipment to the network.

Distribution losses are an important input to the calculation of distribution loss factors (DLFs), which apportion the total losses to different groups of customers. Assignment of losses is dependent on the losses in the network assets utilised in the supply of electricity to each group of customers. Distribution losses are defined as electrical losses and therefore exclude losses due to theft.

The National Electricity Code requires that DLFs must be calculated by each distributor and then approved by the jurisdictional regulator for that state. The calculation of DLFs relies on assessing the losses in various distribution assets as energy passes through the distribution network from the points of supply to the points of consumption.

Network service area

Network service area is the area in square kilometres covered by the network service provider's distribution district. Areas within the distribution area to which a service is not provided by the distributor (eg. national parks, inset areas) are included in the service area.

Peak (maximum) demand

Peak demand refers to the maximum co-incident demand on each network type at the terminal stations feeding the subtransmission network, and at the zone substations feeding the HV network. The total peak demand is the maximum co-incident demand in each of the network types. The total network peak demand is the maximum co-incident demand of the licensee's network.

The peak demand should be stated in both MW and MVA with the MW being stated at the time of maximum MVA demand.

Maximum demand is either the expected or actual demand for the relevant period, and can be reported for summer and winter. A licensee's network peak demand does not necessarily coincide with system maximum demand.

Line length

Line length is the route length in kilometres of lines in service, including overhead lines, underground cables, or a combination of the two. Line length does not include low voltage service connections. A double circuit line count as two lines, and each three phase line, single phase line and SWER line counts as one line.

Total line length is to be disaggregated by:

- feeder classification – CBD, urban, short rural, long rural
- line voltage – sub-transmission, high voltage, low voltage
- line type – overhead, underground

Number of poles

Within a given physical environment, the operating & maintenance expense in the medium term for a distributor is largely a function of the 'amount' of asset – generally the length of line (mainly overhead) and the number of poles.

The length of line and number of poles (and the intervening spans) indicate the amount of conductor that requires vegetation management, pole inspection and refurbishment or replacement, and the amount of asset exposed to environmental influence. This is relatively independent of the number of customers connected to the line, or the amount of energy delivered.

Transformer capacity

The number and installed capacity of transformers is required as an input to calculation of asset utilisation and to benchmark other measures. The number of transformers and the total installed capacity of transformers are to be reported by voltage level – subtransmission (ST/HV), and distribution (HV/LV).

Asset utilisation

Sub-transmission transformer utilisation factor

= electricity sold in MWh (at 33kV and below)/(zone substation transformer capacity (MVA) x no. of hours per year) x 100%

Distribution transformer utilisation factor

= electricity sold at 415 V in MWh/(aggregate distribution transformer capacity (MVA) x no. of hours per year) x 100%

Transformer utilisation factors are a measure of the use made of the relevant assets, which in turn indicates the effectiveness of sub-transmission and distribution investment decisions.

An alternative to utilisation factors as a measure of investment effectiveness is installed transformer capacity/maximum demand.

Weighted average remaining life of assets

This term means the weighted average of the remaining lives of the assets for each network type (CBD, urban, rural short, rural long), and at each voltage level (subtransmission, high voltage and low voltage), expressed as a percentage. The weighted average remaining life (WARL) is calculated as follows:

$$WARL = \sum\{RL/EL \times (N \times UC)\}/\sum(N \times UC) \times 100$$

where: *RL* is the average remaining life of the asset in years
EL is the number of years an asset is expected to remain in service from the date of installation (engineering life)
N is the quantity of each asset type (eg. number of transformers)
UC is the cost of replacement of the unit quantity of each asset type

SUMMARY OF DISTRIBUTION SERVICE REPORTING REQUIREMENTS

1. RELIABILITY

The defined reliability measures are:

- Minutes off supply per customer (SAIDI)
- Sustained interruption frequency (SAIFI)
- Momentary interruption frequency (MAIFI)
- Interruption duration (CAIDI)
- Energy not supplied

Feeders are to be categorised under the following network types:

CBD - feeders supplying predominantly commercial, high-rise buildings

Urban - feeders with load density greater than 0.3 MVA/km

Rural Short - feeders of total length < 200 km

Rural Long - feeders of total length >= 200 km

For sustained interruptions (ie. excluding MAIFI), distributors are to report performance against each reliability measure, for each network type and for each of the following data sets:

Title	**Data Set**
Overall interruptions	All interruptions including transmission, directed load shedding, planned and unplanned, momentary and sustained.
Distribution Network interruptions	Excludes: • transmission outages • directed load shedding
Normalised Distribution Network	Further excludes: • outages which exceed a specified threshold

MAIFI is to be reported for each network type.

2. QUALITY OF SUPPLY

- The number of complaints received about technical quality of issues is to be reported for each of the following complaints categories:

Low supply voltage	Waveform distortion or unbalance
Voltage dips	TV or Radio interference
Voltage swell	Noises from appliances or lights
Voltage spike	Other

- Technical quality complaints are also to be categorised by the likely cause of the problem:

Network Equipment Faulty	Customer internal problem
Network Interference – Standard breached by NSP equipment	No problem identified (all measurements are within limits)
Network Interference caused by another customer	Environmental
	Other
Network limitation	

3. CUSTOMER SERVICE INDICATORS

Timely provision of services

- Number and percentage of connections not provided on or before the agreed date

Timely repair of faulty street lights

- Number of street lights 'out' during each month
- Number of occasions that the DNSP failed to repair a faulty street light on or before the agreed or required date
- Average number of days to repair faulty street lights

Punctuality in keeping appointments

- Number and percentage of occasions on which the DNSP was more than 15 minutes late for an appointment

Notification of planned interruptions

- Number of occasions on which the required notice of a planned interruption to supply was not given
- Number and percentage of occasions on which the duration of a planned interruption exceeded the time specified in the notification.

Call centre performance

- Number of times a call from a customer was not answered within 30 seconds
- Average waiting time before a caller was able to speak to a human operator
- Percentage of calls abandoned
- Number of overload events

Customer complaints

- Number of customer complaints (per 1000 customers)
- Reason for complaint (as number and percentage of number of complaints)
- Number of complaints not investigated and responded to within 20 days
- Average number of days to investigate and respond to a complaint

4. BUSINESS DESCRIPTORS

Data categories and levels of disaggregation to be reported against:

- Number of customers
  - (CBD/urban/rural short/rural long, type of customer, ST/HV/LV)
- Energy delivered
  - (CBD/urban/rural short/rural long, type of customer, ST/HV/LV)
- Distribution losses
- Network service area
- Peak demand
- Line length
  - (CBD/urban/rural short/rural long, overhead/underground, ST/HV/LV)
- Number of poles
- Number and capacity of transformers
- Asset utilisation (electricity sold/transformer capacity)
- Weighted average remaining life of assets

where: type of customer is either residential or business

ST means subtransmission lines of 33kV or greater

HV means high voltage lines of 22kV or less

LV means low voltage lines of 1kV or less