Supply Standards:
Electricity Supply Standard

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1 INTRODUCTION

Essential Energy's distribution system is predominantly an overhead network that traverses terrain varying from the eastern seaboard to the open plains in the west and the tropical rainforest in the North to snow-covered mountains in the South. This exposure to such a variety of extreme climatic conditions presents a challenge for construction, operation and maintenance of a reliable network.

Protective equipment is installed on the distribution system to automatically isolate faults as quickly as possible. Faults on the high voltage distribution system are usually cleared within a few seconds, but this can vary depending on the type and location of the fault.

Essential Energy intends to use reasonable and practical efforts to consistently provide its customers with a cost-effective, high-quality, safe and reliable electricity supply. Essential Energy cannot, however, guarantee that electricity will be supplied to customers without interruption or interference. The distribution system is designed to provide a very high level of reliability of supply, but the ways in which other customers use electricity, and the exposure of the distribution system to external influences will affect the quality and reliability of supply.

Furthermore, the supply to customers may be interrupted on occasions due to planned system interruptions for system alterations.

This document explains the objectives which Essential Energy has adopted in relation to the various system characteristics that influence the quality and reliability of electricity supply to its customers. Its purpose is to give customers an insight into the performance and the security of the distribution system, and the actions taken by Essential Energy to manage and minimise interference and interruptions to supply.

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2 WHY THESE INSTRUCTIONS ARE IMPORTANT

This document is intended to provide details of the objectives which Essential Energy has adopted in relation to the various system characteristics that influence the quality and reliability of the electricity supply to its valued customers. Its purpose is to give customers an insight into the performance of the distribution system and the actions taken by Essential Energy to manage and minimise interference and interruptions to supply.

This standard has also been developed to the detail technical service standards for quality and reliability of supply as required by the Electricity Supply (Safety and Network Management) Regulation 2008(NSW). It will supplement Essential Energy's "'Standard Form Customer Connection" Contract and Network Management Plan.

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3 POWER QUALITY STANDARD

3.1 General

This section summarises the characteristics that determine the quality of electricity supply to the customer and Essential Energy's objectives for these characteristics.

The "New South Wales Service and Installation Rules" outline guidelines to facilitate the objectives contained within this document (which is available from local electrical wholesalers). These Rules are intended to provide requirements for connection of customers to the distribution system including equipment and appliances that have the potential to cause disturbances in the supply to other customers.

3.2 Frequency of Supply

Frequency of supply is a measure of the rate in cycles per second (Hertz) at which the alternating voltage and current oscillate between peak forward and reverse values.

The nominal frequency of the supply of electricity through Essential Energy's distribution system is 50 Hz (Hertz).

Essential Energy does not control the frequency of supply and cannot warrant that the frequency will comply with any standard. The frequency is maintained automatically by the generators, and provided that there is a balance between generation and load, the frequency remains stable at or very close to 50 Hz.

The "normal operating frequency band" as provided by the National Electricity Rules is set at 49.85 Hz to 50.15 Hz. Excursions outside these levels will occur from time to time and in rare events the supply may be interrupted if the frequency deviates excessively.

Most customer's equipment will be unaffected by frequency variations unless widespread supply interruptions occur because of excessive sustained frequency variations on the grid.

Essential Energy's objective is to have frequency excursions, that Essential Energy becomes aware of, that are outside the standard provided by the National Electricity Rules reported to AEMO.

Guidance for Embedded Generator frequency settings is contained in the New South Wales Service and Installation Rules. Under-frequency shall not be less than 48Hz and Over-Frequency shall not be greater than 52Hz.

3.3 Range of Supply Voltage

In 1983 the International Electrotechnical Commission initiated a program to achieve an international standard 50Hz supply voltage of 230/400 volts supply by 2003.

On 23rd February 2000, a new voltage standard, AS60038, was published in Australia to replace the previous 240V standard. This requires, under normal service conditions, that the voltage at the point of supply should not differ from the nominal voltage of 230/400V by more than +10%,-6%.

Voltage drops occur within the customer's installation due to load. For low voltage installations, this voltage drop is limited to 5%, in accordance with AS/NZS 3000, therefore the total range of variation at any point within a customer's installation is +10%,-11%.

However, Essential Energy realises that this range of voltage may cause concerns with the satisfactory operation of 240 volt appliances and will therefore endeavour to maintain voltage to the point of supply at 230/400V, +10%, -2% for 95% of the time (10 minute average). This range adheres approximately to the limits of the previous 240V Australian Standard and with AS60038.

Table 1 - Typical Low Voltage Supply Range

Percentage of time (typically 1 week survey)	**Voltage Range (percent)**	**Volts (phase to neutral)**
95 % (preferred range)	+10% to -2%	253 Volts to 225 Volts
99% (AS/NZS 60038)	+ 10% to -6%	253 Volts to 216 Volts

Low voltage supply may be available in certain locations at 230/460V single phase – three wire systems.

Supply may also be available to customers at nominal high voltages of 3300, 11000, 22000, 33000, 66000 or 132000. However these are subject to special negotiations with Essential Energy. Customers taking high voltage are responsible for their own transformers and low voltage apparatus.

Customers connected at distribution voltages of 11000, 22000, 33000, 12700 and 19100 can expect the range to be generally maintained within the limits of ± 10% or as provided by their connection contract (Note the 12700 and 19100 voltages occur on those parts of the network utilising a single wire earth return (SWER) system).

Customers connected at subtransmission voltages of 66 or 132 kV should review their connection contract in regards to the possible range of voltages that could be expected at their connection point in the distribution system.

Automatic voltage regulation equipment (tap changing transformers, capacitors and reactors) are employed throughout the transmission and distribution system to maintain the supply voltage within the desired range by compensating for distribution system load variations.

Without this equipment, the voltage would sag to unacceptable levels during times of peak load, or could be excessively high at times of low load. Voltage variations due to distribution system load switching may last a few minutes until the high voltage regulation equipment operates. The magnitude of step changes due to this equipment conforms to Australian Standard AS60038.

Customers must ensure that their equipment can operate reliably within the standard range of supply voltage or take appropriate measures within their installations. See Section 6 for more detail.

Brown outs or voltage levels outside the standard range can occur if a distribution transformer loses supply to one phase, generally through one high voltage fuse blowing. Supply will be maintained to the remaining two phases resulting in low voltage phase to neutral voltages of approximately 100%, 50% and 50%. These reduced voltages will continue until the problem is reported and the high voltage fuse replaced by Essential Energy's operations staff. The ways to prevent damage to equipment is detailed at Section 6.

Essential Energy's objective is to provide a supply voltage within the range of +10%, -2% of the 230 volts between phase and neutral and 400 volts between phases on a three-phase system for low voltage customers measured using 10 minute averaged readings (methodology as provided by Australian Standards) for 95% of the time.

It may however not be possible to maintain the steady state supply voltage within the ranges provided above due to system operational constraints or under abnormal or emergency conditions. (refer table 1)

High voltage customers can expect their supply voltage to stay within ± 10% of the normal voltage or as otherwise detailed in their connection contracts.

3.4 Voltage Fluctuations

Voltage fluctuations are short duration variations in voltage levels due to changes in, or switching of loads within the supply network. Voltage fluctuations are mainly caused by rapid and repetitive variation of customer loads. The voltage falls as load increases and vice versa. Common sources of voltage fluctuation are motors during starting, arc furnaces and welding plant. This fluctuation can be observed as a flickering of lights. Voltage fluctuations can also result from the switching of large electrical loads.

The interference to other customers is assessed at the point of common coupling. This is the first point on the distribution system at which disturbances from a customer's installation may impact on other customers.

Australian Standard AS/NZS61000.3.3, 61000.3.5 and 61000.3.7 prescribes limits for voltage fluctuation caused by equipment under normal operation in order to prevent annoying lamp flicker or, in extreme cases, damage to electronic equipment.

Where Essential Energy receives a complaint that a customer's equipment is interfering with the supply to another customer, it will take reasonable steps within its power to require the affecting customer to rectify the situation.

The range of voltage variations at the customer's point of supply may be affected by the customer's own equipment.

Customers must ensure that their equipment has in-built immunity to voltage fluctuations or take appropriate measures within their installations. Section 7 provides further information.

Essential Energy's objective is to use reasonable and practical efforts to ensure that the quality of supply to customers is not affected by disturbing loads of other customers and to maintain fluctuation levels below those required by AS/NZS61000.3.7.

3.5 Voltage Dips

A voltage dip or sag is a single short duration reduction in the supply voltage level generally due to faults on the distribution system or motor starts. Network faults may be caused by accidents, vehicle collisions, birds, wind, lightning, network equipment failure or the connection of heavy loads.

Customers connected to the faulted network will generally lose supply temporarily (up to 10 seconds for each protection operation) for a transient fault or a longer duration for a permanent fault. Other customers in proximity to the faulted section may experience a momentary reduction in the voltage. This may not be noticed, but may be evident from a dimming of lights or a brief interruption in the operation of appliances. Sensitive appliances such as electronic clocks and computers may be affected by the momentary reduction in supply voltage, depending on the level and duration of voltage reduction. Once the fault is isolated, the voltage on the rest of the distribution system will return to normal, but for customers connected to the faulted section, supply will be interrupted until the fault is cleared or until an alternative supply is switched in (if available).

The voltage levels that are reached during distribution system faults depend on the nature of the fault, where the fault occurred, and the location of the customer relative to the fault. The voltage on the affected parts of the distribution system can collapse to a fraction of its nominal value until protection operates.

Voltage dips are generally more prevalent in rural areas due to the greater exposure of the rural network to environmental faults. Also, the rural network is generally less robust than the urban network due to the increased length of spans; hence voltage dips are more severe and experienced across a wider section of the rural network.

Customers with critical processes or equipment which are susceptible to voltage dips are strongly advised to install appropriate protective measures or devices. Section 7 provides further information.

Essential Energy's objective is to minimise the frequency and severity of voltage dips by offering industry best practice in the continual improvement and augmentation of the distribution system.

3.6 Voltage Differences Neutral to Earth

At low voltage Essential Energy utilises a Multiple Earth Neutral (MEN) system in which the neutral conductor is earthed at multiple points, including within the customer's installation.

Despite this arrangement small steady state voltage differences may occur between neutral and earth. These voltages may rise to higher levels during some fault situations.

Faulty neutral connections on the network or within a customer's installation may cause voltage differences sufficient to cause electric shocks. The correction of faulty or poor connections within the customer installation is the customer's responsibility.

Some electronic equipment may be unable to continue normal operation if the voltage difference between neutral and earth, generated within the customer's premises, exceeds only a few volts.

Essential Energy's objective is to limit steady state voltage differences between neutral and earth to less than 10 volts at the customer's point of supply.

3.7 Transients

Voltage transients are generally caused by lightning and to a much lesser degree by system faults or load switching.

Voltage transients from lightning can occur when lightning strikes the distribution system or the ground nearby. Lightning is the main cause of storm-related voltage transients, however strong winds and debris can cause overhead conductors to clash or to contact trees which can also generate voltage transients.

In most instances a substantial voltage transient will only occur if the lightning strikes the local network or in the immediate vicinity. A lightning strike may also cause a temporary fault on the distribution system which may result in a temporary interruption to supply and/or voltage dip until the fault is cleared.

The voltage on the affected parts of the distribution system can collapse to a fraction of its nominal value until protection operates. The magnitude of the voltage dip at the customer's installation will vary depending on the type of fault and its location in relation to the customer.

Switching transients are short-term distortions (milliseconds) to the voltage waveform caused by switching operations. Transients caused by network switching are attenuated within the distribution system and are not generally a concern at low voltage. The majority of switching transients are generated within customer premises but are generally of lower energy.

Transients will be limited by the installation of lightning protection systems (including surge arresters, and earthing systems) and protective equipment for rapid isolation of faults. In spite of these actions, customers may still experience severe transient overvoltage's resulting from lightning strikes on or near the local supply network.

The customer should install protective devices to protect their equipment against voltage transients on the incoming power supply and telecommunications lines and at sensitive or expensive equipment. Australian Standards AS 1768 'Lightning Protection' and AS 4070 'Protection of Low Voltage Installations' provide greater detail.

Essential Energy's objective is to observe good electricity industry practice in the design of the distribution system to minimise the impact of lightning strikes and protect the customer, where possible, from severe voltage transients or disturbances to supply. System switching transients, where possible, will be limited to less than 2 times normal supply voltage and Essential Energy will ensure that distribution system equipment is appropriately rated to avoid any impact on reliability and quality of supply due to switching transients.

3.8 Step and Touch Voltages

During distribution system faults, substantial voltage differences referred to as step and touch voltages can occur within the ground or between metallic systems and earth, in the immediate area of the fault or associated supply equipment.

These voltage differences diminish rapidly with distance from the fault location.

Essential Energy's earthing system is designed to minimise step and touch voltages in the vicinity of metallic or conductive structures in close proximity to electrical apparatus. Structures such as metallic fences, swimming pools, flammable gas or liquid storage tanks, electric railway lines, medical facilities, communication facilities, pits, pillars, transformer kiosks and metallic plumbing systems are best installed away from the distribution network equipment to assist in limiting the risks from step and touch voltages.

Earthing of electrical apparatus is used to minimise risk to personnel and the public due to step and touch voltages under fault conditions, and must ensure the rapid and correct operation of protective devices in the clearing of distribution system faults.

Essential Energy's objective is to comply with all recognised industry standards and practices in the design, installation and maintenance of its distribution system, in particular the levels outlined in Australian Standard ENA Earthing Guide and AS/NZS 7000 (previously C(b)1) pertaining to step and touch voltages.

3.9 Voltage Unbalance

Voltage unbalance between the phases of the supply system can occur because of unbalance in customer loads, customer generation, unbalance in distribution system phase loads and impedances.

Excessive unbalance in supply voltages is undesirable for three phase customers as it may result in overheating of three-phase induction motors. Nuisance tripping can also occur in motor loads equipped with out of balance protection or embedded generators.

Customers must ensure their load currents are reasonably balanced to assist in preventing voltage unbalance. The NSW Service and Installation Rules state that the loading of an installation which is supplied by more than one phase must be arranged so that the maximum demand in any active service conductor is not more than 25 Amperes above the current in any other active service conductor.

The National Electricity Rules (Clause S5.3.6) requires that a high voltage customer connected at a voltage of less than 30 kV ensure that the load in any phase will not be greater than 105% or less than 95% of the average of the loads in the three phases.

Essential Energy's objective is to limit voltage unbalance to levels as required by the National Electricity Rules. This is generally 2.0% on the high voltage network and up to 6% on the LV network using 10 minute average values. This level may be exceeded occasionally in some rural locations.

3.10 Direct Current

A direct current may flow in the neutral conductor of the low voltage distribution system and in customer installations due to customer equipment with non-linear load characteristics. Any direct current flowing can cause corrosion in the distribution system and customer's earthing systems. Direct current is limited by the initial design of equipment or installation.

Essential Energy's objective is to minimise direct current generated by customer's equipment at the time of connection or by monitoring if the existence of a direct current is suspected.

3.11 Harmonic Content of Voltage and Current Waveforms

Harmonic distortion is created by customer equipment with non-linear load characteristics such as solid state rectifiers and variable speed motor drives. Harmonic distortion in the current drawn by a customer's equipment creates distortions in the supply voltages which may affect other customers.
The presence of harmonics in the distribution system can cause interference to other customer's equipment, overloading of equipment and disruption to communication circuits.

Essential Energy will use reasonable and practicable efforts to ensure that the quality of supply to customers is not affected by other customer's disturbing loads. When notified that a customer's equipment is adversely affected by interference from another customer, Essential Energy will investigate (including any necessary testing) and take reasonable steps within its power to require the affecting customer to rectify the situation.
Essential Energy will comply with the NER levels for THD (8% LV and 3% HV)

Harmonic allocation to any individual customer will be:

- As negotiated following a detailed harmonic study in accordance with the relevant Australian Standards

OR

- In the absence of such a study, one third of the THD limit for that supply voltage under the NER's.

Essential Energy's objective is to limit the harmonic content of voltage waveforms in accordance with Australian Standard AS/NZS 61000.3.6.

3.12 Interharmonics

Interharmonic interference is caused by the presence of sinusoidal waveforms at frequencies lying between multiples of the supply frequency of 50 Hz.

Interharmonics can cause quite severe resonances and may affect powerline carrier signals, and may induce visual flicker in fluorescent, other arc lighting and computer display devices.

Essential Energy's objective is to limit the interharmonic content of voltage waveforms at any point in the distribution system by ensuring customer's equipment complies with recognised industry limits and practices.

3.13 Mains Signalling Interference

Essential Energy uses signal voltages injected into the distribution system at various frequencies primarily for the control of off-peak appliances.

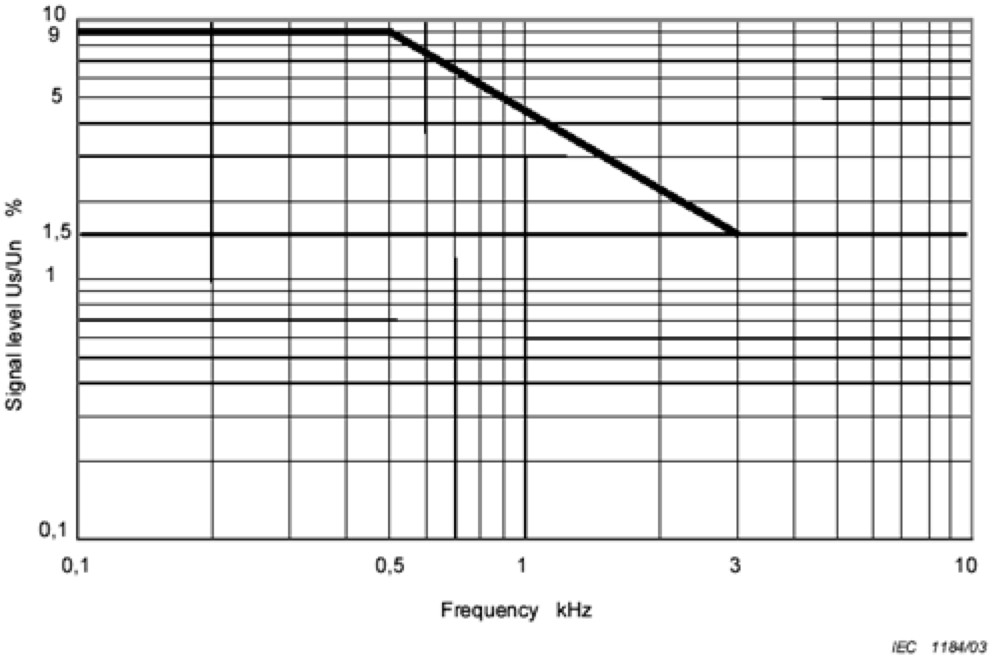
The frequencies presently used by Essential Energy include 158, 167, 183, 206, 217, 225, 270, 283, 297, 317, 390, 435, 492, 494, 500, 580, 750, 760 and 1250Hz. The frequency in use will depend on the location.

The signal can cause interference similar to that generated by interharmonics if the level is excessive, the most common and noticeable problem is noise from ceiling fans.

The modern signalling equipment used by Essential Energy generally requires signal voltage levels of less than 2 volts at the customer's point of supply. However, signal levels will need to be much greater than this to counteract losses in signal that occur through the distribution system.

Essential Energy's objective is to limit voltage levels to the Meister Curve as provided in AS/NZS61000.2.12. See Figure 1 below.

Figure 1 - Meister Curve: used to determine the maximum allowable mains signalling voltage



3.14 Mains Signalling Reliability

Failure to receive appropriate signals at the designated time can result in incorrect switching of off-peak appliances. This can occur due to interference, low signal levels, distribution system faults and signal equipment failure (transmitter or receiver).

Essential Energy's objective is to maintain a high level reliability of mains signalling equipment to ensure that mains' signalling operates at 99.5% reliability or better. Progressive adoption of fail-safe receivers and modern signalling techniques ensure optimum performance.

3.15 Noise

Power system components can cause audible and electronic noise interference. Audible noise can be generated by transformers (cores and/or cooling equipment), by discharges in wet weather and by faulty equipment such as damaged insulators.

Powerline interference can also be generated by discharges occurring in faulty powerline equipment, particularly insulators or connections. Powerline interference can be airborne and/or conducted throughout the distribution system. This generally results in interference to TV and radio reception.

Essential Energy's objective is to minimise audible noise and to ensure powerline interference is limited to levels required by AS/NZS2344. This will be achieved by high quality standards in regard to design, construction and maintenance of the distribution system. Essential Energy will seek to work with customers causing electrical noise that impact on other customers. Referral to the Australian Communications and Media Authority may be necessary.

3.16 Notching

Notching of the voltage waveform (see Figure 2) occurs when solid state rectifiers effectively are short-circuited momentarily across two phases.

Figure 2 – Notching of the Voltage Waveform (Reference AS2279.2)

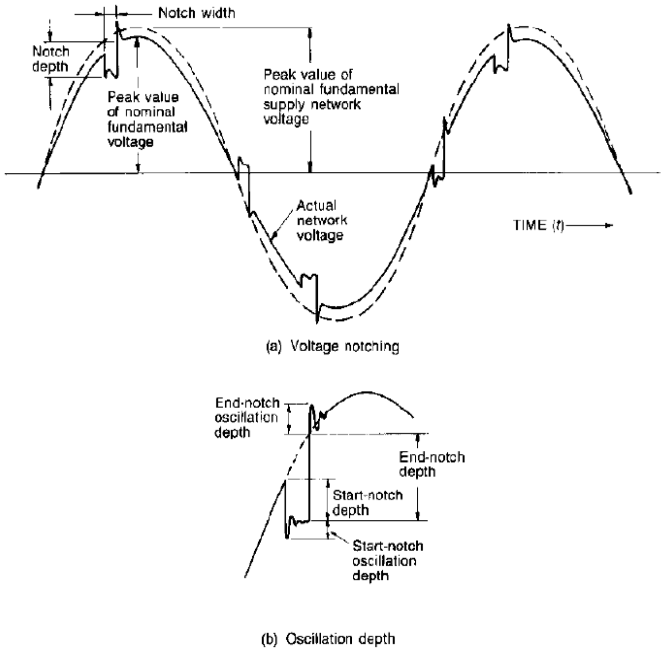


FIGURE 2 SHORT-TIME VOLTAGE CHANGES

As a result, interference can be caused to other customers connected to the distribution system.

Essential Energy's objective is to limit notching due to customer equipment by requiring offending customers to correct notching levels outside limits. These limits are as follows from Australian Standard AS/NZS 2279.2:

- harmonic voltage distortion limits (Table 1 of the standard) are not exceeded at the point of common coupling
- the maximum depth of the notch, ie. the average of start notch depth and end notch depth, does not exceed 20% of the nominal fundamental peak voltage; and
- the peak amplitude of oscillations due to commutation at the start and end of the voltage notch does not exceed 20% of the nominal fundamental peak voltage.

4 RELIABILITY OF SUPPLY STANDARD

4.1 Supply Reliability

Supply availability is the time that supply is available to customers after taking into account planned and unplanned interruptions to supply.

Absolute reliability of supply (no interruptions) cannot be achieved because of factors such as distribution system equipment failures and random environmental influences (which are generally outside Essential Energy's control). Planned outages are also needed to maintain or repair the network even though Essential Energy use live line techniques more than ever before. Essential Energy will use reasonable and practical efforts to consistently provide the customer with a cost-effective, high-quality, safe and reliable electricity supply.

Reliability of supply varies in different parts of the distribution system mainly due to the characteristics of the various parts of the network, variations in storm activity, and the circuit length of network exposure.

Other factors which determine supply availability are geographical, social and technical in nature and are listed as follows:

a Powerline Exposure
The length of network per customer in rural areas increases the exposure of the distribution system in these areas to environmental faults and the response time required to locate and rectify faults. Little may be done to some powerlines to improve the reliability performance due to the inherent reliability of the feeder due to exposure length.

b Population Centres
The population distribution in rural areas is such that towns and cities are separated by considerable distances. The distribution systems supplying these towns are often radial or even if duplicated are often exposed to the same severe weather conditions.

In built-up areas, it is usually possible to restore supply through alternative connections if part of the distribution system is damaged. Urban and city networks consist of a mixture of underground and overhead lines. Underground cables in the urban network are affected to a lesser extent, however if a cable is damaged by excavation, the time to repair it may be much longer than for overhead lines.

Supply reliability is generally lower in rural areas due to the dominance of longer overhead lines. The rural network has greater exposure to environmental influences which are outside Essential Energy's control (such as storms, wind, rain, hail, snow), lack of alternative connections, and the time to locate and rectify faults due to access and/or distance involved. Repairs can take longer in remote areas because of the time involved to get to the damaged part of the network.

c Terrain
The terrain can vary from the coast to mountains to black soil plains. Access for construction, routine inspection, maintenance and emergency repairs can present challenges in the provision of cost-effective and reliable service. In rural areas the network is often some distance from the nearest road.

d Climate

Weather extremes can vary from snow and hail to mini-cyclones and severe lightning storms. Storms in rural areas may not interrupt the number of customers sometimes affected in metropolitan or urban areas, however, the impacts can be widespread and difficult to locate and repair. Weather conditions can adversely affect access for repair crews over the terrain described above.

e Underground and Overhead Networks

The ideal network would be a totally duplicated underground cable system which would provide reserve capacity and alternative supply under all fault conditions. Whilst this ideal is approached in some urban areas, it is simply not cost-effective in rural areas where the majority of the network is overhead and radial. An overhead system is exposed to the environmental conditions indicated above.

f Historical Development

The development of the distribution system over time has seen significant changes in customer load requirements and expectations in relation to levels of supply quality and reliability. It was common in the 1950's and 1960's for the standard transformer rating in rural areas to be 2.5 kVA or 5 kVA. This supplied a few lights and small appliances which were not affected by supply disturbances.

The typical rural supply is now 16 or 25 kVA and the appliances may include a wide variety of modern electronic devices and computers.

g Design and Maintenance Standards

Design and maintenance standards have improved, however, the existing rural distribution systems were predominantly constructed in the 1950's and 1960's. These lines are maintained to a high standard but some are approaching the end of their useful life. Essential Energy is following good electricity industry practice in identifying problem areas and investing in distribution system augmentation and refurbishment as required.

5 MISCELLANEOUS

5.1 Levels of Supply Capacity

Essential Energy must provide a customer with customer connection services on terms as set out in the Standard Form Customer Connection Contract. Essential Energy is entitled to require a customer to contribute towards the cost of extending or increasing the capacity of the distribution system. Any contribution must be in accordance with Section 25 of the Electricity Supply Act and Essential Energy's Standard Form Customer Connection Contract as amended from time to time.

It should not be assumed that sufficient capacity, or the required number of phases, will be available at the proposed point of supply, particularly in rural locations. In most urban and some rural areas a three-phase 230/400 volt connection may be available. The typical supply in most rural areas is a single-phase 230 volt connection. The typical transformer capacity installed for rural customers is 16 kVA single-phase.

A typical urban customer will be provided with a single phase 63 amp supply or a three phase 32 amps supply.

It is essential that customers provide adequate notice of their connection requirements to ensure that details of the basic supply available and arrangements for any necessary augmentation and customer contributions can be advised.

Any additional loads connected by the customer must be connected in accordance with the NSW Service and Installation Rules. The customer may be required to contribute to an increase in capacity if the capacity of the existing network is not adequate.

Essential Energy's objective is to provide the customer with timely, high quality customer connection services in accordance with statutory requirements (National Electricity Consumer Framework or NECF) and good electricity industry practice.

5.2 Levels of Electromagnetic Fields

Low level electric and magnetic fields are produced in and around all electrical equipment including wiring and appliances within the customer's installation, and the transmission and distribution system.

The close proximity of electric wiring and electronic equipment to electronic equipment such as computer monitors, can result in electromagnetic interference. This interference can generally be avoided by increasing the separation, screening the equipment or the use of alternate technologies eg. flat screens.

Essential Energy will endeavour to work with customers and the public to address any concerns in relation to electromagnetic fields and exercise prudent avoidance in the design and location of the distribution system. The magnetic fields directly under power lines are typically much less than requirements and decrease rapidly as you move away from the power line.

Essential Energy's objective is to ensure electromagnetic fields generated by its distribution system are maintained within the limits prescribed by the Australian Radiation Protection and Nuclear Safety Agency.

6 GUARANTEED SERVICE LEVEL SCHEME

Essential Energy is committed to delivering high standards of customer service by meeting our Guaranteed Service Level (GSL) scheme obligations under the National Energy Retail Rules (NSW) and the Electricity Supply Act 1995 (NSW).

If you are a customer who we provide customer connection services to, (conduct a new connection, connection alteration, energisation, re-energisation or de-energisation at your request), and we fail to meet certain GSLs, you may be eligible to receive a compensation payment. Some GSLs require you to apply to Essential Energy and have your eligibility for a compensation payment assessed.

For more information refer to
http://www.essentialenergy.com.au/content/customer-service-standards

7 SENSITIVE EQUIPMENT

7.1 General

Supply quality has become a growing concern for a wide number of customers due to advances in equipment technology, and the accompanying increase in the sensitivity of this equipment to power disturbances.

This is particularly a concern in rural areas with the increasing use of computers, household electronic appliances and business equipment. The introduction of electronic control and automation systems is also growing in many intensive rural industries.

In industrial applications, the use of highly automated process control systems is also increasingly dependent on high-quality electricity supply.

This section provides information on the more common sensitive loads and provides customers with an understanding of the impact of electricity supply disturbances and action that can be taken to minimise these impacts.

7.2 Computers

Computers and other microprocessor based equipment are increasingly common in households, commercial, industrial and rural applications. They are very sensitive to voltage disturbances, particularly voltage sags and supply interruptions. These disturbances can cause errors, shutdowns and component damage, loss of valuable data, all of which can result in losses far exceeding any short-term inconvenience.

Computers can be damaged by lightning transients. However, they can also be damaged by switching transients within the customer’s installation from normal everyday use of equipment such as air conditioners and motors.

Some form of power protection equipment is recommended for critical computer installations and for reliable operation, particularly in rural areas.

Consideration should be given to the installation of surge protection, power conditioner or an uninterruptable power supply or a combination of these devices. For more detailed information see Section 8 and for more detailed guidance on lightning and other voltage transient protection refer to AS 1768 “Lightning Protection” and AS 4070, ‘Protection of Low Voltage Installations’.

7.3 Variable Speed Drives

Variable speed drives (VSD) are becoming increasingly prevalent in industrial applications. They can be susceptible to high levels of harmonic distortions present in the supply voltage, particularly when resonance may occur in conjunction with local power factor correction capacitors.

VSD’s may also contribute significantly to this harmonic distortion, therefore models that output low levels of harmonics should be purchased when installing or updating equipment. This will prevent harmonics being generated into the supply system and interfering with other equipment within or external to the premise.

Voltage transients can be blocked from entering VSD’s by series inductor (choke) and/or surge diverters.

Nuisance tripping on voltage sags and momentary supply interruptions can be addressed by providing a ride through capability or an uninterruptable power supply (UPS) installed on the control circuit of the VSD. The manufacturer of the VSD should be able to verify these methods for the application or suggest other more suitable methods.

7.4 Process Control Equipment

Industrial and commercial process control facilities are increasingly dependent on computers and small VSD’s for integrated production processes. Momentary losses of supply can shut down the process often with significant start up delays or costs. Critical equipment should be protected with power conditioners and/or uninterruptable power supplies.

7.5 Inverters and Converters

Inverters transform DC into AC and are commonly used on small-scale grid connected generators such as Solar PV and wind turbines. Converters transform a single phase supply to three phases. Both groups of devices generate an AC waveform that is not perfectly sinusoidal. They also generate harmonics that can affect other equipment in the installation, or be 'exported' to the network.

Inverters raise the voltage on the connected phase above the supply voltage, in order to 'feed-in' to the grid (network). This can cause imbalance in multi-phase installations and/or may exceed the voltage "set points" in the inverter, causing it to "trip off". It is the customer's responsibility to manage their installation to ensure that the requirements of AS/NZS 3000 and the NSW Service and Installation Rules are met.

7.6 Telecommunications

The telecommunications network and the power system are both exposed to lightning transients. Cordless telephones, fax machines and computer modems should therefore be protected with surge diverters on both the incoming power and telecommunications systems as well as at these sensitive pieces of equipment.

8 POWER PROTECTION OPTIONS

Most disturbances on the supply system cannot be easily or practically reduced to levels which do not affect sensitive equipment. It is the customer's responsibility to provide the required level of protection for their equipment, taking into account the consequences of disruption or damage to this equipment.
Essential Energy recommends that special power protection equipment be installed as a normal part of customer installations containing sensitive equipment. A wide range of devices are now available on the market, all offering varying degrees of effectiveness.

The following table 2 lists various protective devices and measures which customers should use to avoid problems due to supply voltage disturbances arising from the distribution system or from within the customer's installation.

Good quality equipment and appliances will have many of these protective features built-in.

An electrical contractor may be required to install some of the measures.

Table 2 – Power Protection Equipment and Recommended Application

Condition	Protective Measures and Comments
Voltages too low or too high	Use line conditioning equipment and/or equipment designed to operate at a wider range of voltage levels. Some Un-interruptible Power Supplies (UPS'S) have voltage regulating equipment. Under and over voltage protection equipment should be installed. This can be installed at the main switchboard or at critical equipment.
Brown-out (sustained low voltage condition)	Use any of the following protection options: • Equipment designed with a wide operating voltage range; • Protect with an under voltage relay to isolate the supply at the main switchboard or at critical equipment. Brownout boards are available to protect refrigerators or low energy use devices;

	• Protect three phase installations with a phase failure relay; • Use UPS's for critical equipment such as computers; and/or • Switch off equipment if you do not have under voltage protection.
Voltage dips	Use equipment designed to ride through short voltage dips such as those with an internal battery backup or use a UPS. Digital clocks are particularly prone to voltage dips but can be purchased with battery backup.
Voltage fluctuations or flicker	Various options are available including the use of compact fluorescent bulbs to prevent or reduce light flicker. UPS's can help to protect sensitive electronic or computerised equipment. Essential Energy will generally seek to minimise interference from other customers.
Lightning transients	Use a surge diverter or better still surge filters on switchboards and at sensitive or expensive equipment. Recommended for all installations given the relative affordability of basic protection. Telecommunication lines must also be protected and don't use the phone in lightning storms. The most basic protection is to unplug equipment before the storms get too close.
Voltage transients generated within customer's installation	Use surge diverters or better still surge filters at the source of the transients and at sensitive equipment Most transients are generated within customer premises but most are low energy.
Harmonic distortion	Use line filters especially designed to reduce harmonic distortion. Industrial or commercial premises should purchase low harmonic output equipment. Essential Energy will generally seek to minimise interference from other customers.
Short interruptions (seconds)	Use equipment designed to ride through short interruptions, UPS and/or internal battery backup equipment.
Long interruptions	Backup generators provide the best protection for sustained interruptions. Some embedded generation systems with batteries can provide a "back-up" supply. Alternatively have candles, torch, battery radio, gas for the BBQ, etc ready.
Voltage unbalance	Use unbalance protection for motors to isolate the supply and protect the motor.

9 GLOSSARY OF TERMS

In this document unless the context requires otherwise:

AEMO: means the Australian Energy Market Operator. This is the company that manages the National Electricity Market.

Current: can be thought of as the 'flow' of electricity in a wire or conductor. It can be compared to water flow in a pipe. Current is measured in Amperes or as abbreviated to amp or the symbol 'A'.

Customer: means any person to whom Essential Energy's 'Standard Form Customer Connection Contract' applies.

Customer connection services: means the connection of any premises situated within Essential Energy's distribution district to Essential Energy's distribution system; or as otherwise detailed in the Electricity Supply Act.

Customer's installation: means the electrical wiring and associated equipment used to convey and control the conveyance of electricity within premises supplied electricity from

Essential Energy's distribution system. This does not include anything connected to, extending, or situated beyond a powerpoint.

Customer's premises: means premises owned or occupied by the customer which are connected to Essential Energy's distribution system.

Distribution system: means the electricity distribution system owned and operated by Essential Energy which extends throughout Essential Energy's distribution district and sometimes referred to as a 'network'.

Electricity Supply Act: means the Electricity Supply Act (NSW) 1995.

Fault: is a failure or breakdown of the distribution system. Faults may be caused by accidents, vehicle collisions, birds, wind, lightning, network equipment failure or the connection of heavy loads.

Good electricity industry practice: has the meaning set out in the National Electricity Rules.

Harmonic distortion: means a distortion of the normally sinusoidal 50 Hz voltage and/or current waveform, which may cause interference to electronic equipment.

Hertz: means the frequency of the alternating supply voltage measured in cycles per second and has the symbol Hz.

Impedance: means that property of a conductor or transformer that retards the flow of current when a voltage is applied to the conductor.

Interruption: means a temporary and total loss of supply of electricity.

Phase and **neutral** conductors refer to the four conductors in a three-phase low voltage network. There are three-phase conductors, which are at voltages above earth potential, and the neutral which is generally at or near earth potential. Customer's installations may be connected to one phase and neutral, two phases and neutral or three phases and neutral. High voltage networks can have either a single phase conductor (SWER), two phase conductors or three phase conductors.

Point of supply: means the point or points of connection between the customer's premises and Essential Energy's distribution system.

Point of common coupling: means the first point on the network at which disturbances from a customer's installation may impact on other customers, and will generally be the same as the customer's point of supply.

Premises: includes any building or part of a building, any structure or part of a structure, any land (whether built on or not) and any river, lake or other waters.

Power conditioner: means a device used to improve the quality of electricity supply by filtering out transients and harmonic distortion.

SAIDI: means the System Average Interruption Duration Index and is a measure of the average minutes without electricity supply per customer per year.

SAIFI: means the System Average Interruption Frequency Index and is a measure of the average number of electricity supply interruptions per customer per year.

Standard Form Customer Connection Contract: means the Standard Form Customer Connection Contract prepared by Essential Energy under the Electricity Supply Act 1995.

Transient: means a momentary sharp increase in voltage due to lightning or system switching.

Surge diverter: means a device to limit very fast transient overvoltages such as those caused by lightning or system switching.

SWER: means single wire earth return system normally constructed in remote rural areas to distribute electricity to customers.

Uninterruptible power supply (UPS): means a device to maintain the supply to equipment from a standby battery during interruptions to the electricity supply.

Voltage: can be thought of as the 'pressure' that forces current to flow in a wire or conductor similar to the way in which pressure forces water to flow in a pipe. The higher the pressure the greater the flow. Voltage is measured in Volts and has the symbol "V".

Voltage dip: means a sudden decrease in voltage for a fraction of a second. Sometimes called voltage sag.

10 REFERENCES

AS/NZS 3000 Australian/New Zealand Wiring Rules

AS 1768 – Lightning Protection

AS 2279.2 Disturbances in mains supply networks Part 2: Limitation of harmonics caused by industrial equipment

AS/NZS 2344 Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 to 1000 MHz

AS 4070 – Protection of Low Voltage Installations

AS 60038 Standard Voltages

AS/NZS 61000 Electromechanical Compatibility Standards

AS/NZS61000.2.12 Electromagnetic compatibility (EMC) – Part 2.12: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems

AS/NZS 61000.3.2 Electromagnetic compatibility (EMC) – Limits – Limits for harmonic current emissions (equipment input current less than or equal to 16 A per phase)

AS/NZS 61000.3.3 Electromagnetic Compatibility (EMC) - Limits - Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current less than or equal to 16A

AS/NZS 61000.3.5 Electromagnetic compatibility (EMC) – Limits –Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16A

AS/NZS 61000.3.6 Electromagnetic compatibility (EMC) – Limits – Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1996)

AS/NZS 61000.3.7 Electromagnetic compatibility (EMC) – Limits – Assessment of emission limits for fluctuating loads in MV and HV power systems

Australian Standard AS/NZS 7000 – Design of Overhead Powerlines

Australian Radiation Protection and Nuclear Safety Agency Guidelines

Essential Energy's Standard Form Customer Connection Contract

Electricity Association of NSW 'Code of Practice – Electricity Service Standards'

Electrical Power Systems Quality, Second Edition. Dugan, et al. McGraw Hill

Electricity Supply Act 1995 (NSW)

Electricity Supply (General) Regulation 2001 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2008 (NSW)

New South Wales Service and Installation Rules

National Electricity Rules

Trade Practices Act 1974 (Commonwealth)

National Energy Retail Rules (Version1)

http://www.essentialenergy.com.au/content/customer-service-standards

11 REVISIONS

Revision Number	Section	Details of Changes in this Revision
2	Whole Document Glossary of Terms	Reformatted to new Code of Practice layout and minor changes throughout. Updated
	4.19 Supply Availability	Section “h” re-written
3	Whole Document	Major revision to include reference to the latest power quality standards, new reliability performance standards and guaranteed customer service standards for network reliability performance
4	2 Preamble	Removed
	Section 4.2	Removed
	Whole document	1 Purpose: Reference to Electricity Supply (Safety and Network Management) Regulation 2001 changed to 2008 3.3 Range of Supply Voltage: Table 1 Typical Low Voltage Range of Supply added with reference to 95% of time, 10 minute averaged intervals. 3.5 Voltage Dips: Second paragraph (up to 10 seconds each) added 3.8 Step and Touch Voltages: last paragraph reference to ENA Earthing Guide and AS/NZS 7000 3.9 Voltage Unbalance: reference to HV and LV percentages 3.11 Harmonic content of Voltage and Current Waveforms: reference to NER added 5.1 Levels of Supply Capacity: Third paragraph “A typical urban customer will be provided with a single phase 63 amp supply or a three phase 32 amps supply” added. 7.5 Inverters and Converters: section added References updated
5	Whole document	Updated to new Essential Energy template
6	Table 1	Removal of reference to 100%
7	Section 6.4 (b)	Phone number updated and reference to customer accounts and connections removed.
8	Section 6	6.1, 6.2, 6.3, 6.4 and 6.5 removed Changed heading to Guaranteed Service Level Scheme Updated to refer to National Energy Retail Rules (NSW) Version 1 and the Electricity Supply Act 1995 (NSW)
	Section 2	PO Box details changed to Port Macquarie
	Section 3.13	Relocated Figure 1 from section 3.15 to section 3.13
	Various	Additional reference to embedded generation throughout document.