ESAA

Electricity Supply
Association of
Australia Limited

Customer Guide to Electricity Supply

Business Customers

Are you planning a new installation or expanding your operations?
Are you experiencing supply-related problems or interference?
Do you want to improve the quality or performance of your existing installation and processes?

This Guide briefly discusses the common factors likely to affect the capacity, reliability, and quality of your electricity supply and suggests measures you may need to consider or adopt to ensure satisfactory performance.

Do you need three phase supply?

Do you need to correct poor power factor?

Do you need low current starting methods?

Will changes in voltage affect your equipment?

Are you in an area with high lightning activity?

Do you have equipment or processes which could be affected by temporary interruptions?

Do you need stand-by or backup measures?

Do you have equipment sensitive to voltage transients, harmonic distortions, or noise?

The electricity supply network is a large and complex system and there are a great many factors which can affect your electricity supply including:

- the capacity of the existing electricity network to supply large load increases
- weather conditions or vehicle accidents which can interrupt supply
- the use of electrical equipment in your premises or the premises of other customers which can cause interference

Your electricity distributor wants to ensure that you will be satisfied with your electricity supply and will offer every assistance to help you make appropriate decisions. We strongly recommend that you work through this Guide and discuss any concerns with your electricity distributor *before* you make commitments to purchase equipment or make alterations to your installation.

Checklist for Supply

The Checklist for Supply will help you identify issues to discuss with your electricity distributor when you are planning a new or expanded installation or if you are experiencing supply-related problems.

1. Quantity

Will the network be able to supply the electricity you need to operate your equipmemt?

1.1 Load Current

- ☐ What demand will your installation place on the system (current and kVA)?
- ☐ Do you need to correct poor power factor?
- ☐ What need do you have for future capacity and expansion?
- ☐ Does the existing supply network have the capacity to supply your load?

The power requirements of your installation are usually calculated by your electrical contractor or consulting engineer. This tells you how much current you need to draw from the supply and how big the conductors which connect your installation need to be. You should always give some thought to future load growth or expansion when deciding on cable size.

If you're about to change your installation – build a new one or expand an existing one – you should consider two impacts on the current carrying capacity of cables: power factor and demand management.

Power factor correction or maintaining a good power factor helps maximise the use of your existing cable capacity. It may also be a requirement of your distributor's *Service and Installation Rules* (see Section 1.7).

Demand management techniques even out the demand for electricity and, in particular, reduce peak loads. This means either a saving in the cost by installing a smaller cable in the first place or having spare capacity for expansion or load growth without the expense or disruption of replacing existing cables.

1.2 Starting Current

- ☐ How much current will your motor draw when it starts?
- ☐ Does the existing supply network have the capacity to supply this current or do you need a low current starting method?

Electric motors can draw up to eight times their normal load current until they reach their normal running speed. This could take a few seconds or several minutes and may adversely affect other customers.

If this happens or if the existing supply network doesn't have sufficient capacity to start a large motor DOL (direct on line), you may need alternative starting methods such as a "soft" starter.

1.3 Supply Voltage

- ☐ What are the likely variations in supply voltage at your premises?
- ☐ What will be the voltage drop within your installation?
- ☐ What variation in supply voltage can your equipment tolerate?

The nominal voltage for the low voltage system is 240 volts, phase to neutral, and 415 volts, phase to phase. However, supply voltage varies all the time with changing loads. This happens within your installation and also out on the network.

A variation of ± 6% of nominal voltage at the point of supply is permitted by Australian Standards. This means that a single phase low voltage supply could vary between 254 volts and 226 volts and still be within the allowable limit.

Voltage drops also occur within your own installation and Australian Standard AS 3000 (the Wiring Rules) sets a limit to this drop of 5%. This means that your low voltage equipment should be able to operate satisfactorily with an input voltage as low as 214 volts.

Most industrial equipment can tolerate wide variations in supply voltage. However, electronic equipment may not and some form of voltage control will be needed (see Section 3.2).

1.4 Over and Under-Voltage

☐ What levels of over or under-voltage can your equipment tolerate?

Over and under-voltage conditions occur when supply voltages are persistently outside the range of acceptable values (ie, ± 6%). Voltages which are too high can damage equipment unless overload devices such as fuses or circuit breakers operate.

Most electric motors can tolerate quite wide variations in voltage but electronic equipment is more at risk. You may need to install over-voltage protection or some form of voltage control.

Persistent under-voltage conditions are usually due to an overloaded circuit in your installation or out in the network. You may need to rebalance loads, replace circuits with larger conductors to reduce voltage drops, or provide more circuits.

In low voltage networks, a condition known as a “brownout” can occur if a distribution transformer blows just one of its three high voltage fuses. Single phase voltages for many (but not all) customers will fall to half their normal value until the problem is reported and the fuse replaced. Effective phase failure protection can reduce the risk of equipment damage due to “brownout”.

If you suspect an over or under-voltage problem at your premises, contact your distributor so that an appropriate solution can be determined.

1.5 Three Phase Supply

☐ Do you need three phase supply? Is three phase supply available at your location?

Most of the electricity supply system in Australia is three phase. However, there are some locations, particularly in the country, where only single phase supply is available – for example, SWER (single wire earth return) systems.

If you need three phase supply, you should establish, before you make any commitment to purchase equipment, that it is available.

In some locations, a two phase supply can be provided. This is effectively two single phase supplies using a common neutral.

If only single phase supply is available at your location, you will need to consider alternatives such as larger single phase equipment or single to three phase converters (electronic devices which synthesise a three phase supply).

1.6 Voltage Unbalance

☐ Do you have an unbalanced three phase supply?
☐ Can your equipment (mainly motors) tolerate this unbalance?

Low voltage networks predominantly supply single phase loads and it is important that these loads be balanced across all three phases.

These constantly changing loads can produce unbalanced voltages which may affect some three phase electric motors.

Sensitive motors will need out-of-balance protection (phase failure relays).

Your electricity distributor sets limits to the amount of unbalance within your installation. This is usually measured as the maximum difference between the load currents in each phase.

1.7 Power Factor

☐ What is the power factor of your installation?
☐ How is it affected by changing load conditions?
☐ Do you plan to expand your installation or replace items of equipment?

In most installations, equipment such as motors and discharge lamps cause the current and voltage to become out of phase with each other. When this happens, less power is produced. The reduction from theoretical maximum power to actual power is measured by the **power factor**.

The lower the power factor, the greater the current that has to be drawn to produce a given amount of power. This means that existing installations could become overloaded or that larger cables are required in new installations.

Your electricity distributor may also have requirements for you to ensure the power factor of your installation does not fall below certain limits while electricity tariffs based on kVA are an incentive for you to maintain a good power factor.

Power factor correction capacitors can be added to individual items of equipment or installed at the switchboard to correct the overall power factor. They need to be selected with care and matched to the load otherwise they can over-correct and create a new power factor problem.

2. Reliability

Will a constant supply of electricity be available at all times when you want to use it?

2.1 Interruptions

- ☐ Do you have any equipment or processes which could be affected by temporary interruptions?
- ☐ How likely is it that you will experience one or more sustained interruptions in a year?
- ☐ What would be the cost and consequences of these interruptions?
- ☐ What stand-by or backup measures do you need for your installation?

Electricity supply systems are generally so reliable that it's easy to overlook the fact that they can and will be interrupted from time to time.

Your distributor may need to interrupt supply for a number of reasons including connecting new customers or carrying out maintenance or repairs. If the work is planned, prior notice of the interruption will always be given by your distributor. Unplanned interruptions may be due to accidents or "load shedding" which can be required if there has been a significant loss of generation or transmission capacity.

Unplanned interruptions may be temporary or sustained.

Temporary interruptions are caused by faults which have no permanent effects. Supply is usually restored within a few seconds by automatic reclosing circuit breakers. (There may be two or even three attempts to reclose before the fault is cleared and supply is finally restored.)

Temporary interruptions have a similar impact to other transient voltage disturbances. The same measures to protect installations and equipment will therefore also be effective (see Section 3.2).

Sustained interruptions are caused by significant damage or other incidents on the system requiring the attendance of a line crew. Supply is interrupted until the problem can be found and attended to. Depending on the location and nature of the fault, this could take up to an hour or significantly more in some country areas. If there is no permanent damage, and if it is safe to do so, supply could be restored quite quickly once the problem has been identified.

Unplanned interruptions can occur at any time. You need to consider the impact this could have on your business and develop an appropriate plan of action. This could be as simple as having a few basic procedures to follow when the power is off or as sophisticated as having automatic changeover to your own backup supply.

Computing and electronic equipment and other critical loads can be provided with a battery-based **uninterruptible power supply** (UPS). The UPS constantly monitors the equipment being protected. If mains power is lost, the UPS switches over to the batteries which maintain a continuous supply for a period of time (10 minutes is a typical figure). The capacity of the UPS needs to be matched to the load and the length of time you want to maintain supply.

In many cases you may only need sufficient time to save data and shut down your equipment in a controlled fashion. A UPS can also be used in conjunction with a stand-by generator to provide power for extended outages.

If your installation has its own **emergency or backup generator**, it will typically just have the capacity to maintain supply to important circuits rather then the entire installation. Loads are divided into essential and non-essential and supplied from separate circuits. Startup and changeover will take time and a UPS can maintain supply until the generator comes on line.

2.2 Restoring Supply

- ☐ How is supply restored to your installation in the event of an interruption?
- ☐ What measures do you need to take to ensure a safe and orderly reconnection of supply?

Restoring supply can have the same effect as switching on all your equipment and appliances at once – overloading circuits and causing its own set of problems (especially if you are trying to start large motors).

Many devices, especially larger equipment in industrial or commercial installations, will disconnect themselves from the supply when it is interrupted (eg, through the operation of no volts or under-voltage relays) to prevent restarting with mechanical loads still connected. Because of the obvious safety and process issues, an orderly restarting sequence is essential.

Resetting digital clocks and timers is undoubtedly the chief nuisance when supply is lost, if only for a few moments. Some manufacturers now incorporate a battery backup. If you have devices like this, make sure a battery is installed (they're often not included) and replace it regularly as part of a scheduled maintenance program.

3. Quality

Will the available electricity supply be suitable for your equipment and applications?

3.1 Supply Frequency

Supply frequency is determined by the speed at which the generators spin. Large load increases tend to slow down the generators which decreases frequency; large load decreases allow the generators to speed up which increases frequency. These load changes can occur anywhere on the transmission or distribution system. Frequency is generally maintained to within ±0.2% of the nominal 50 Hz. However, major events (contingencies) can change the frequency by a significant amount (called an "excursion"). When this happens, NEMMCO, the National Electricity Market Management Company, acts to restore frequency to the normal range within certain time limits.

Most equipment is not affected by normal changes in supply frequency.

3.2 Voltage Transients

- ☐ Do you have equipment sensitive to voltage transients?
- ☐ Do you have equipment which might cause voltage transients within your own or neighbouring installations?
- ☐ What measures do you need to take to protect your equipment against transients?

Transients are temporary disturbances on the distribution network or within the customer's installation.

Voltage Drops (Sags or Dips) are typically caused by high fault currents which flow for a fraction of a second until cleared by protective devices. In most cases they are not noticed and should not affect customer equipment.

Voltage Increases (Swells and Spikes) are short duration increases in voltage above the nominal upper limits; they are often called "surges". **Swells** are moderate increases in voltage usually lasting from milliseconds to perhaps one second. **Spikes** are very high magnitude voltage impulses lasting microseconds.

Certain equipment, such as large motors and welders, can cause rapid changes in the voltage level and interfere with the operation of electrical equipment in neighbouring installations and within your own installation. Effects on other customers are assessed at the "point of common coupling" and Australian Standards prescribe limits for the impact of voltage transients.

Where a complaint or notification is received that a customer's equipment is having adverse effects on other customers' electricity supply, the distributor will take whatever reasonable steps are within its power to rectify the situation.

No restriction is placed on customers using equipment which does not cause interference at the point of common coupling. However, you may find problems within your own installation.

Voltage transients can cause electronic equipment to malfunction but problems usually indicate that the equipment does not have adequate in-built immunity to voltage changes or protection against typical disturbances.

If voltage transients present problems for the operation of your equipment, you should consider some form of voltage regulation or control, either as a stand-alone solution or (more likely) as part of an overall power quality strategy.

Line conditioners and **uninterruptible power supplies** both include voltage regulation features to maintain a near constant voltage output over a range of input voltages, both high and low.

Surge Diverters are the most common form of protection against transient increases in voltage. However, if they are not properly selected and installed, they may not provide adequate protection. The earth connection must be sound and of low resistance to ensure the diverter functions as it should. Your installation may require different levels of surge protection with the highest level at the main switchboard and lower levels at individual items of equipment.

Power filters are robust devices which minimise the effect of rapid voltage increases. Power filters can also remove or reduce electrical noise that can interfere with the operation of equipment.

3.3 Switching Transients

- ☐ Do you have equipment likely to produce switching transients within your own or neighbouring installations?
- ☐ Do you have equipment susceptible to switching transients?
- ☐ What measures do you need to take to protect your equipment against switching transients?

Any mechanical or electronic switching device can cause transient distortion of the voltage waveform. Switching transients can generate over-voltages several times the normal voltage.

The most significant cause of transients is the switching of highly inductive or capacitive loads within your own installation. Switching transients are also produced by operations on the network but the system is designed to limit their peak values. Unless you are right alongside the piece of switching equipment, the impedance of the network is usually sufficient to attenuate switching transients before they can enter your installation.

If your equipment does not have adequate inbuilt immunity against switching transients, you may need to install protective devices to ensure that the equipment operates satisfactorily. Basically, a switching transient is a combination of spikes and dips and the suggested measures in Section 3.2 would also be appropriate for this problem.

A **dedicated power circuit**, from the main switchboard, and physically separated from other power cables, should be used to supply sensitive equipment. This will reduce or eliminate potential problems caused by disturbances such as switching transients and noise generated within your own installation.

3.4 Lightning

- ☐ Are you in an area with high lightning activity?
- ☐ Is your installation able to withstand the high transient voltages which might be caused directly and indirectly by lightning strikes?

Lightning can cause voltage transients when it strikes an overhead conductor or network component or when it strikes the ground nearby. Lightning transients are typically extremely short in duration (less than 200 microseconds). They can have high magnitudes but attenuate rapidly. These high voltages cause a breakdown of the insulation between the line and earth so the current of the strike can flow into the earth.

If you live in an area with a high exposure to lightning, you will obviously have an increased risk of equipment damage and you will need to install protective devices.

A **lightning arrestor** contains a spark gap or a solid state device which flashes over when it detects a lightning transient, providing a path to earth. However, the line voltage may still rise to several kilovolts and a second line of defence – a surge diverter —may be required at the main switchboard and on individual items of equipment. You need to ensure that these devices are capable of providing an appropriate level of protection.

It may also be prudent to turn off and unplug sensitive electronic equipment during periods of lightning activity.

3.5 High Voltage Injection

- ☐ Do you need to protect your installation or equipment against accidental high voltage injection?

In many cases low voltage mains are built under high voltage mains to make use of the same poles. As a result there is some possibility that, under severe storm conditions or because of equipment failure, the high voltage mains can come into contact with the low voltage mains. These problems are usually cleared within seconds by the operation of the distributor’s protection equipment. However, the momentary injection of high voltage can create safety hazards and result in damage to a customer’s installation.

Installations are not normally designed to withstand accidental high voltage injection. Although distributors make every effort to minimise the occurrence of high voltage injection, there is a possibility that it may occur and additional protection — such as a surge diverter at the main switchboard and on individual items of equipment — may be warranted.

If you suspect your installation or equipment has been damaged by high voltage injection, contact your distributor immediately.

3.6 Harmonic Distortion

- ☐ Do have equipment likely to produce harmonic distortions within your own or neighbouring installations?
- ☐ Do you have equipment susceptible to harmonic distortions?
- ☐ What measures do you need to take to protect your equipment against harmonic distortions?

Harmonic distortion is the presence of sine waves of varying magnitudes which have frequencies that are integer multiples (harmonics) of the normal 50 Hz frequency. It is caused by the operation of appliances or equipment such as variable speed drives and fluorescent lights that draw non-sinusoidal currents from the supply.

Limits need to be placed on the generation of harmonic distortions so that the appliances and equipment of other customers, and network components, are not affected or damaged.

Some devices can protect computers against problems such as voltage increases but won't address harmonic distortion. The best protection is provided by an **uninterruptible power supply** (UPS) which will smooth out harmonic distortions and other mains-borne irregularities as well as providing protection against supply interruptions.

There are also other factors which can distort the supply waveform and cause similar problems. They can be addressed by the same measures taken to protect against harmonic distortion.

3.7 Noise

- ☐ Do you have equipment likely to produce noise or electromagnetic interference within your own or neighbouring installations?
- ☐ Do you have equipment susceptible to noise or interference?
- ☐ What measures do you need to take to protect your equipment against noise or interference?

Electrical noise is a waveform disturbance with a broad frequency distribution up to about 200 000 Hz. It can be carried by the conductors of the customer's installation or the network (mains-borne) or it can be induced by electromagnetic fields. Mains-borne noise is similar to harmonic distortion but consists of a mixture of higher frequencies (not necessarily harmonics of 50 Hz).

Mains-borne noise can be caused by electronic control devices which reshape the supply waveform – eg, dimmers or speed controllers. Small motors, particularly those in some portable appliances, are often a source of noise with loose connections, inadequate earthing, or low manufacturing standards causing problems.

The same measures which protect against transients and harmonic distortion can also be applied where electrical noise is a problem.

Power filters are usually used to minimise the effect of rapid voltage changes but they can also remove or attenuate electrical noise. A **line conditioner** can also protect against electrical noise and voltage transients.

Mains frequency electromagnetic fields can cause problems with audio/video circuits and computer screens. Audio/video circuits and computer screens affected by 50 Hz electromagnetic fields need to be shielded or separated from the source.

3.8 Other Potential Noise Problems

- ☐ Are you concerned about audible noise from electrical equipment?
- ☐ Are you experiencing interference with broadcast or communications equipment?

Audible noise includes the 50 Hz hum normally produced by electrical equipment such as transformers and the crackle of electrical discharges from insulators and other high voltage equipment. These discharges can, in turn, produce radio frequency interference which affects communications equipment. Your electricity distributor will comply with noise abatement and other relevant regulations, usually contained in Environmental Protection legislation.

The source of noise caused by electrical discharges may be harder to locate, especially if it is caused by an intermittent fault. Insulator pollution problems can be addressed and damaged equipment, once found, can be repaired or replaced.

Complaints about **radio frequency interference** with radio, television and other communication equipment can be referred to the Australian Communications Authority (ACA). The ACA can assist customers in determining the likely cause of reception interference. If the problem is caused by the distribution system, your distributor will address the problem in consultation with the ACA.

This Guide is produced by the Electricity Supply Association of Australia which represents all Australian electricity distributors.

Customers who would like more information about electricity supply should contact their electricity distributor and ask for a copy of the 60 page booklet, "Customer Guide to Electricity Supply".

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Electricity Supply Association of Australia Limited
Level 6, 280 Pitt Street Sydney
PO Box A2492 Sydney South NSW 1235

Telephone (02) 9261 0141   Facsimile (02) 9261 3153

Email: mcmullan@esaa.com.au

www.esaa.com.au