Through thick and thin
Keep your business on the go with Uninterruptible Power Supplies (UPSs)
Table of contents

1. Sustainable use of electricity is a necessity 2
2. Uninterruptible power 2
3. Criteria for assessing the need for an Uninterruptible Power Supply 2
4. Types of Uninterruptible Power Supplies 3
   4.1 Generator sets 3
   4.2 Standby power supplies 3
   4.2.1 Characteristics 3
   4.3 Battery Powered UPSs 3
   4.4 Line Interactive UPS 4
   4.5 Online/double conversion UPS 4
5. Operating principles 4
6. Operation 4
7. Types of optional equipment 4
   7.1 Continuous vs Peak/surge watts 4
   7.1.1 Pure sine wave inverters 4
   7.1.2 Modified sine wave inverters 5
8. Restrictions 5
9. Uses and benefits 5
10. Savings 5
11. Turning objectives into advantages 5
12. Selection 6
13. Practical suggestions 6
14. What type of battery should I use? 6
   14.1 Small inverters 6
   14.2 300W and large inverters 6
15. How long can I run the appliances from the inverter? 7
16. Determining UPS size 7
17. Can two or more batteries be connected? 8
18. Safety considerations 8
19. Basic safety rules for operating UPSs 8
20. References 8
1. Sustainable use of electricity is a necessity

1. Introduction

In common with most other countries in both the developed and the developing world, South Africa needs more generation capacity. The extent to which Eskom is able to supply the country’s demand for electric power has a direct impact on economic growth.

All sectors of the economy can reap major benefits from implementing energy efficiency policies. By optimising processes and plant efficiency, companies reduce input costs, increase their return on investment and could gain from proposed future tax incentives which are currently being investigated by government. As an added benefit, reduced energy consumption means reduced environmental impact, an important part of the “triple bottom line.”

2. Uninterruptible power

A century ago, a supply of electricity was a luxury and continuity of supply was not assured. People were accustomed to occasional power failures and were well prepared to deal with them.

With the arrival of the electronic age, however, a constant, unwavering power supply became essential. Even in places like remote rural areas or far out at sea, people demand a quality supply of electricity. Computers and other electronic equipment need an uninterrupted supply of power to perform correctly.

To meet this demand, a variety of devices can be used.

3. Criteria for assessing the need for an Uninterruptible Power Supply (UPS)

The UPS is not intended to supply power for the more “power hungry” appliances in the home such as stoves, hot water cylinders, pool or borehole pumps, Jacuzzis, under floor heating, etc. Although you can purchase UPS systems that can supply the needs of a complete home, these are obviously much more expensive, both to purchase and to operate.

The need for a UPS or backup supply will depend on whether the client decides if the use of his equipment/appliances is essential or not. It is here that some clients may need to be advised of the costs versus the “needs”, as these could become too prohibitive.

Some questions and pointers to assist clients in determining what product is best suited to meet their needs:
- What is their budget?
- What are their critical or essential needs, and does their budget allow these needs to be met? A trade-off between perceived need and critical need must be made with reference to budget constraints
- How sensitive is the equipment or the appliances to “noisy” or unstable supplies, e.g. spikes, surges, dips, irregular supply, etc.?
- What unit is best suited to meet their critical needs (i.e. is only enough time required to shut down computers or other appliances to continue operating for the estimated duration of the power outage?) This is another important consideration, as the longer the backup time, the more expensive it becomes
- Where to position the UPS and associated equipment.

4. Types of Uninterruptible Power Supplies

4.1 Generator sets

A manual backup system is, strictly speaking, not a UPS, as there is a time delay between the power out and the standby supply coming online. This manual system consists of a generator with a changeover switch (COS) which can be either manually or automatically operated. The COS can be positioned conveniently for the client, either near the generator or the main distribution board. The manual system requires a cable either to the electrical distribution board or to a socket point (which is “stand alone”, i.e. not connected to the installation’s electrical reticulation system) to which the appliances will be connected. The manual COS normally has three positions – “Off” in the upright position, and then “Main” and “Generator” to the left and right hand positions respectively or vice versa.

An automatic COS would normally be connected directly to the electrical distribution board. In the case of a generator with a manual COS there will be a delay between the mains supply going off and the generator starting up, as the person responsible will have to go and switch manually between the mains supply and the generator supply, and then start the generator.

In both cases these installations must be carried out by a qualified registered electrician in accordance with the requirements laid out in the SABS specifications (SANS 10142:2006) and the Occupational Health and Safety Act with an emphasis on safety, as any common simultaneous connections between the grid and standby supplies will have dangerous and explosive consequences.

4.2 Standby power supplies

Equipment generally used to ensure an uninterrupted supply of electricity includes:
- Diesel or petrol driven generators
- Fuel cells
- Pumped storage schemes
- Battery powered UPSs
- Other.

4.2.1 Characteristics

- Standby generators have been used for many years, but they are noisy, consume fossil fuels and emit environmentally undesirable gases during operation
- Pumped storage schemes are generally only available to large utilities because of their cost and the amount of land they "sterilise"
- Fuel cells are not yet generally available and the technology is still comparatively expensive at this time.

4.3 Battery powered UPSs

Battery powered UPSs have gained significant acceptance in all sectors of society where a reliable power supply is needed, i.e. virtually everywhere. From small 650 VA units in homes and small businesses to huge 100 kVA installations in data centres and server farms, the UPS has become the technology of choice.
4.4 Line interactive UPS

The line interactive UPS operates on a similar principle to the offline/standby one, but normally includes a greater degree of protection. The backup time of these systems is also limited, but in some units this can be increased. Depending on the degree of protection of the specific model, this type could be used for more sensitive equipment.

4.5 Online/double conversion UPS

This type of UPS offers the best features of all the UPS systems. It is also the most expensive. This system's output runs continuously from the inverter circuit, so in the case of a power outage no switching between the grid and standby supplies takes place. This means there is no interruption in the supply to the equipment. The system also has more protection against noisy lines, spikes, surges, etc. For installations that incorporate sensitive equipment, this is the system to use.

5. Operating principles

The technology is based on inverters that produce an alternating current (AC) voltage from a (direct current) DC input and, more specifically, to an inverter with a heat sink configuration that facilitates efficient thermal dissipation.

6. Operation

Inverters create an alternating current (AC) from a direct current (DC) power source. For example, one type of inverter converts a 12 V DC battery voltage to a 230 V AC voltage that will power load items such as common household appliances.

7. Types of optional equipment

There are similarities and differences between backup systems. Both solutions provide electricity when the grid power is unavailable. How they go about achieving this goal differs significantly.

7.1 Continuous vs Peak/surge watts

Inverters are rated in continuous power and peak/surge power. Continuous power is the total watts the inverter can support indefinitely, while peak/surge power is the amount of power that the inverter can provide for a brief period, usually when the equipment/appliance starts up, e.g. refrigerators and air conditioners.

Inverters have either modified sine wave (also known as square wave) or pure sine wave output. The differences between modified sine wave inverters and pure sine wave inverters are:

7.1.1 Pure sine wave inverters

This is the best output waveform an inverter can produce, and all appliances are able to run off it without interference or overheating. Some of the advantages are:

- Output voltage waveform is a pure sine wave with very low harmonic distortion, identical to the mains supply
- Inductive loads like microwave ovens are completely matched to the power supply
- Motors run correctly, quietly and without overheating
- Audible and electrical noise in fans is noticeably reduced
- Fluorescent lights, audio amplifiers, TVs, game consoles, faxes and answering machines run correctly and efficiently, completely unaffected by the supply
- The inverter can be protected efficiently via electronic means in overload, over voltage, under voltage and over-temperature conditions.

7.1.2 Modified sine wave inverters

The modified sine wave type of inverter is usually less costly than the alternatives but has limitations. These are some of the appliances that may experience problems when they are supplied by modified sine wave inverters:

- Laser printers, photocopiers, magneto-optical hard drives
- Some fluorescent lights with standard ballasts
- Power tools employing "solid state" power or variable speed control
- Some battery chargers for cordless tools
- The images produced by some television sets display interference
- Digital clocks and clock radios
- Sewing machines with speed control and/or microprocessor control
- Medical equipment such as oxygen concentrators.

8. Restrictions

Because they are designed as low cost equipment, modified sine wave inverters are usually only protected by standard fuses. Under normal circumstances these fuses are not always fast enough to prevent surges from reaching the vulnerable electronic components, therefore they are more vulnerable to failure than other types.

It is definitely advantageous to use a pure sine wave inverter which can run virtually any type of equipment, in contrast to a modified sine wave/step square wave inverter, which cannot.

9. Uses and benefits

Inverters have long been used in environments such as boats or recreational vehicles, or in other remote areas where AC power is not otherwise readily available.

Inverters can provide power for items such as refrigerators, microwaves, hair dryers, coffee makers, Toasters and so on. Inverters are generally smaller, lighter and less expensive than built-in generators, and produce no noise, no vibrations, no fumes and use no fossil fuel. An inverter generally works by using a series of switches to produce an AC waveform from a DC source such as a battery.

10. Savings

Inverter-based UPSs:

- Have no moving parts and need no mechanical maintenance
- Consume no fuel, so are impervious to fuel price rises
- Have a negligible "carbon footprint", so do not affect the climate
- Are silent in operation, and therefore cause no noise pollution.

11. Turning objections into advantages

The initial purchase price of an inverter-based system is regarded as high, but;

- The extremely low running costs mean that the equipment "pays for itself" in a relatively short time
• This pay-back time grows shorter as fuel prices increase and make generators costlier to run.

The avoided cost of no downtime is far greater than the equipment’s original cost.

12. Selection

The size of the inverter that you choose depends on the power of the watts (or current in amps) of the equipment you want to run. Find the power consumption by referring to the specification plate on the appliance or equipment. You will need to know both the continuous rating in watts or amps, and the peak/surge rating in watts or amps. Without this information any further calculation is not possible.

The prices of inverter systems are directly related to their capacity. You must consider these questions in order to pick up the best backup solution:

• What loads do you want to operate during an outage?
• How long do you want those loads to continue operating?

To work out these values, multiply the equipment/appliance’s power draw in amps by 230 volts (AC voltage) = watts.

For example, in a home or small office setup, the following values are typical:

PC 2 A
Monitor 1.1 A
Modem/router 0.09 A
Total 3.39 A

3.39 A x 230 V = 780 W. So an 800 VA UPS should keep the system “powered up” until you can save your work and shut everything down and switch off. But to be on the safe side, most people would invest in a 1000 VA UPS for a system this size.

13. Practical suggestions

Do not connect your printer, cordless phone, fax machine and other devices to your UPS, because these items are not “mission critical”. Leaving them off the system reduces the size of the system you need and saves initial purchase costs.

Remember that the VA rating of a UPS is an indication of the size you need to keep your essential equipment going until you can save your work and shut the equipment down safely. That time allowance is usually 10-15 minutes. If you want a UPS that will keep everything running for longer, you should consult your supplier for advice on a larger size.

14. What type of battery should I use?

14.1 Small inverters

For outdoor/leisure applications, most vehicle and marine batteries will provide an ample power supply for 30 to 60 minutes, even when the engine is off. The actual time may vary depending on the age and condition of the battery, and the power demand being placed on it by the equipment being operated on the inverter. If the inverter is in use while the engine is off, start the engine every hour and let it run for 15 minutes to recharge the battery.

14.2 300W and large inverters

It is advisable to use “deep cycle” (marine or solar) batteries that will give you several hundred complete charge/discharge cycles. If the normal vehicle starting batteries are used, they will wear out after about a dozen charge/discharge cycles. Vehicle batteries are not designed to do this type of work.

When the inverter operates appliances with high continuous load ratings for extended periods, it is not advisable to power the inverter with the same battery used to power your car or truck. If the vehicle battery is utilised for an extended period, it is possible that the battery voltage may be drained to the point where the battery has insufficient reserve power to start the vehicle. In this case, it is a good idea to have an extra “deep cycle” battery for the inverter connected to the starting battery. In this type of installation, specialists recommend that you install a battery isolator between the batteries with a separate regulator.

15. How long can I run the appliances from the inverter?

This depends on the battery size selected and the type of batteries used.

Deep cycle (marine/solar) batteries generally have the highest reserve ratings. They are specifically designed to withstand repeated drains of power and recharging.

Vehicle batteries should not be discharged below a 90% charged state. Marine/solar deep cycle batteries should not be discharged below 50% charged state. Doing so will shorten the life of the battery. This advice is based on most battery manufacturers’ recommendations.

16. Determining UPS size

The size of an UPS is determined by calculating the total connected load, i.e. all the appliances connected to it. To do this, the load of each appliance must be added to get the total load. The load of the appliance is normally found on an information plate or label at the back, on the side, or underneath the appliance.

If the current value is given, it must be multiplied by the voltage to get the wattage.

It would be prudent to add the load of any foreseeable additional equipment/appliances and also add in a safety factor (typically 20%), so that the UPS does not run at its maximum load continuously. See Table 1 for an example.

If there are any critical motor-driven loads (not normally recommended, but perhaps a medicine refrigerator would qualify), they should be rated according to their starting current load, not their normal operating load for the rating of the UPS, but battery life may be calculated on the operating load.

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Load (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer, Monitor &amp; Printer</td>
<td>600 W</td>
</tr>
<tr>
<td>TV/Video/DVD</td>
<td>200 W</td>
</tr>
<tr>
<td>Essential Lights</td>
<td>100 W</td>
</tr>
<tr>
<td>Total connected load</td>
<td>900 W</td>
</tr>
<tr>
<td>Safety factor (20%)</td>
<td>180 W</td>
</tr>
<tr>
<td>Total load</td>
<td>1080 W</td>
</tr>
</tbody>
</table>

Table 1

In this case, the UPS size should be a 1100W unit or the next available size, i.e. 1200W.

Note

If you intend to use power tools for commercial use, or any load of 200W for more than one hour regularly (between battery recharges), the use of an auxiliary battery to provide power to the inverter is recommended. This battery should be a “deep cycle” type of a size that can meet your run-time expectations with the vehicle engine off. The auxiliary battery should be connected to the alternator through an isolator/regulator module to prevent the inverter from discharging the vehicle start battery when the engine is off.
It may be advisable to operate the inverter from a bank of 12V, 24V or 48V batteries of the same type in a series and/or parallel configuration.

If you connect two such batteries in parallel it will generate twice the amp-hours (hence twice the operating time) of a single battery.

Three batteries will generate three times the operating time, and so on. This will lengthen the time before your batteries will need to be recharged, allowing you a longer time to run your appliances. But remember that the equipment used to recharge the batteries must be able to cope with the total number of batteries in the system. Consult your supplier!

You can also connect 12V batteries together in a series configuration to double the voltage to 24V or 48V. Connecting batteries in series or parallel doesn’t damage the batteries, but the final output voltage of the system must match the voltage requirements of the equipment it is driving.

Whenever electrical work is to be carried out, it is important that the person doing the work is suitably qualified and is registered with the relevant authorities. This is to ensure that the work is carried out in accordance with the latest edition of the relevant SABS standards (SANS 10142-1:2006) and the Occupational Health and Safety Act. It is also a requirement for insurance purposes.

It must be kept in mind that UPSs are in themselves stand-alone electrical supplies and can be dangerous if not managed, installed and handled carefully. They can deliver serious shocks, as can the electrical supply in a house or business.

All installation work must be carried out by a registered and qualified electrician and a Certificate of Compliance must be issued on completion of the work.

For the basic units that are plugged into a socket outlet of the home or business, the manufacturer’s instructions must be followed. These units usually come complete and are positioned next to the appliance that they are to supply.

For the more sophisticated and larger types of units that include a number of ventilation, the unit and batteries must be housed on a firm, level base.

Access to the unit must preferably be kept locked.

Call the Eskom Contact Centre on: 08600 ESKOM (08600 37566) and log a query for an energy advisor in your area to contact you. Or visit www.eskom.co.za/dsm for information on energy efficient technologies and adaptations.

Eskom commissioned research 2008
Eskom Demand Side Management
National UPS Guidance – Product Package – Version 1.2