CHAPTER 4

4 Power

Despite the glamour of the satellite dish and the lap-top personal communicator, they are all 'so-much-junk' without electrical power. As you are reading this now, think how far away you are from its subtle pervasiveness, the lights, your watch. The human mind is designed to flag up unusual or changing things to our consciousness, so no wonder few give thought to something that is always there.

Yet as disaster workers, we are going somewhere where we cannot expect the power sockets to work, for the same reasons as the telephone sockets will not work. The factors causing loss of one will cause loss of the other, so if it is necessary to spend all this money of communications equipment, you can be sure that you will need to bring your own power too.

You will soon become as obsessive about power budgeting as your accountant is about balancing his books. This is no exaggeration, when you have run out of power, you will have egg all over your face. It's a very lonely feeling.

And it's grim news. After the glory of the achievements in communications technology, prepare to come back to earth with a bump.

4.1.1 Batteries

Batteries are not the solution . They merely postpone the problem, not solve it.[54]

On average, they will last for a day's operation, then they will need charging. So you now need a battery charger. Then you need power to feed the battery charger. Without sockets, you need a generator to provide this power, so we are right back to square one, and so soon too.

We will have to discuss generators later, but bearing this important point in mind, let us look at batteries and modes of using them.

4.1.2 Vehicle batteries

We can take it almost for granted that the field team will at some stage or all stages have access to a motor vehicle such as a land rover or a lorry. If so we have our two most important resources, a generator and a battery.

The 12V from the vehicle battery has become an important standard power input for portable electronic equipment and I have seen only a few devices that will not accept this input.

For example, an HF radio can be connected to a thick red and black cable which can be clipped onto the vehicle battery by crocodile clips, **be warned that some lorries use 24V batteries, in which case check with someone who knows how to 'tap off' 12V, polarities also vary so do check**. Batteries give an electrically smooth and well regulated output, so equipment always performs well when so connected.

You could rightly expect a whole day's work from such an arrangement and it has the advantage that no extra money has to be spent and no extra weight is carried as part of the comms gear.

When using satellite gear however, the current drain is much more and extra care is needed not to flatten the battery sooner than expected. Some more modern satellite gear has built in batteries, which if flat, will suck power out of the vehicle battery to replenish themselves.

In addition, if you have a more advanced set up, with computers, printers and FAXes for example, all of these will draw quite a lot of current so that the total power used may come up an amount similar to leaving the headlights on, on the vehicle. We have all experienced the consequences of that.

You will not be able to start the vehicle because the battery is flat.[55] You are now stuck miles from anywhere unable to move and just waiting for someone else to give you a jump start. You will find the AA's response time quite slow in some places in the world and anyway you can't call for help because you let your battery go flat and your communications gear wont work.

Also, it is damaging to allow the Lead Acid type of batteries as used in vehicles to stay flat for very long, as this reduces the life of the battery. Your driver knows this and will think twice before allowing you to ruin his battery again.

Get your power budget wrong and you loose lots of the friends who you came out here to help.

The obvious solution is to make sure that the engine is run regularly, say every one or two hours to keep the battery safely topped up, not only enough to run the radio, but enough to turn over a reluctant and heavy engine (which requires much more power). If in doubt, you can run the engine all the time you have equipment switched on. This however has the problem of noise and fumes which is only a problem if this is done for longer than a few hours.

The other problem is that this is a very inefficient way of using the vehicle's generator, so you will use a lot of fuel very quickly this way. This will bring you to a fuel budgeting crisis and add another headache to the list.

4.1.3 Dual Battery schemes

A good solution is to have two batteries on the vehicle, one connected to the vehicle electrical system and one to your external loads. These two batteries must have a switch between them. This means that you must remember to open the switch when operating the equipment (or else you will flatten both batteries) and remember to close it only when the engine has been started and is running (or you will not be charging the comms battery). Automatic contactors can be fitted to do the thinking for you, but again someone needs to think of that as they are not fitted as standard on most vehicles and retrofitting in the field may be impractical.

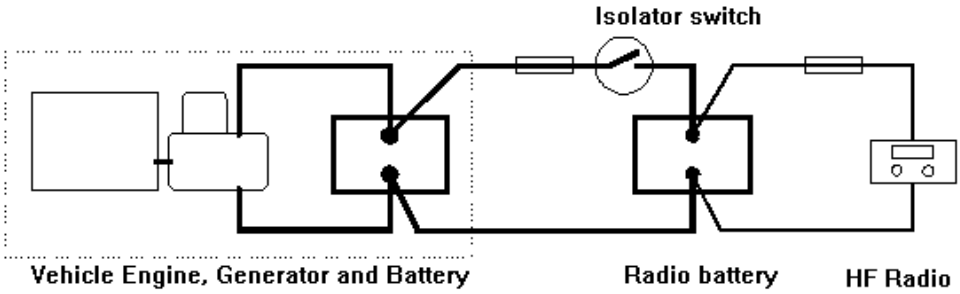


FIG 14 Dual battery schemes prevent vehicle battery flattening but rely on the operator remembering when to operate the switch

4.1.4 Power Banks

A further variant is to use one of the excellent propriety portable 'power banks' sold to handymen and yachtsmen. These are just 'car' batteries in a carry bag, but often have battery chargers or more advanced regulators built in to them. They have the further advantage that they can be carried away from the vehicle and used in a more convenient position, closer to the control tent or better for the antenna.

Also it is impossible to flatten the precious vehicle battery this way, provided it is disconnected from the vehicle battery when supplying the load. Of course, sooner or later they will need charging again.

4.1.5 Portable battery packs

These days, most portable gear has its own built in battery pack. The Lap top computer that I am using right now has quite a good one. It can run the computer for 4 hours before giving up, and can fully charge in one hour.

The very impressive briefcase sized INMARSAT-M satellite phone and INMARSAT C gear is another example. They can give about one hours talk time and 8 hours standby time on one charging and can hold their charge for some months.

The batteries usually used in these devices are a type called Nickel Cadmium batteries, or NiCad's for short (pronounced n-eye-kad).[56] They are wonderful for what they do, very light and compact compared to the lead acid type of car battery, but they have some tendencies that you should be aware of.

With the more expensive type of chargers, NiCads can be safely charged up in one or two hours but you must use only the charger that the maker recommends for each unit. The cheaper type of charger, the trickle charger type, may take up to 8 or 16 hours to charge up a battery pack.

In addition, with the cheaper chargers it is dangerous to the battery's chemistry to leave a battery on charge for over 16 hrs so someone must keep an eye on all the batteries being charged and know when they have had enough. If you don't have the time, or you don't expect the electricity to be on for that long, then you must pay for the proper makers battery charger.

Once charged, the NiCad battery looses about 10% of its charge in the first 24hrs, then about 10% per month. So when in use regularly, it is very good at keeping charge. This type of battery is very forgiving of being allowed to go flat on an occasional basis, as long as it gets charged up again soon.

4.1.6 Maintenance

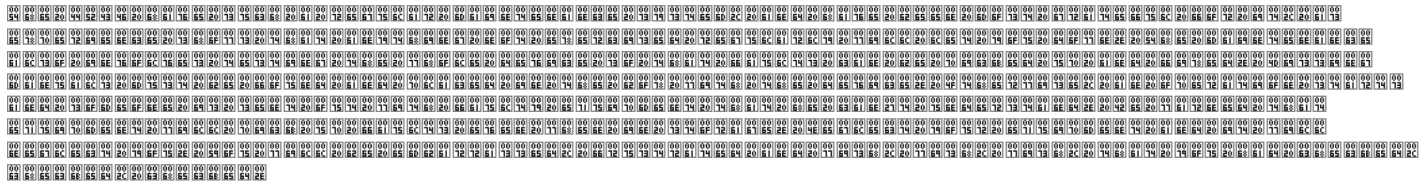
The big problem with this type of battery is when the equipment is in storage. After an exciting and exhausting operation, who wants to go down to the warehouse and charge batteries? yet someone must. NiCads become damaged if they are allowed to be flat for many weeks, and go flat they will at the rate of 10% per month. Someone needs to visit the equipment on a regular basis and 'exercise' the batteries.

Exercising involves a regime of charging the battery, using the device until the battery has been well used, but not absolutely flattened, then charging the battery again. Spare batteries should always be purchased and these too will need exercising.

After exercising, the battery should be disconnected from its device during storage. A clear note to that effect should be put in a prominent place in the device so that if another user grabs the device and tries to use it in a hurry, he will be able to work out why it is not working and fix it.

Sounds silly, but we have come across it.

It is plain that someone responsible must know the devices and their batteries and maintain them faithfully at least every 3 months. Someone in high authority must check that this is being done or you will find your expensive purchase, on which you have pinned so many hopes, lets you down when you need it most. Don't forget that all this applies to the computers, printers and FAXes as well as walkie talkies etc. that you expect to use.



4.2 Power Supply Systems

All of the equipment needed to provide power is called the Power Supply System. The power supply system means such things as the generators, batteries, battery chargers, Power Supply Units, Inverters, voltage regulators[57] and other odds and ends that are not really part of the radios, satellite terminals or other devices as such, but are parts of the system that supply the power to them.

Many devices use electrical current in bursts. An HF radio for example is using a lot of current when you are speaking, but very little when you are breathing and listening. INMARSAT-C terminals send the data to the satellite in short but very powerful bursts, rather like a flash gun.

Let's take a closer look at the differences between the units of the Power Supply system.

4.2.1 Battery chargers

Some battery chargers are designed to charge the NiCad battery up to nearly full power in a few hours then switch off when the battery is fully charged, thus preventing overcharging and damaging the battery. This is done by high tech. tricks, such as alternate charge/discharge current pulses and the resulting charger can be quite expensive. However you should do a quick charge only with the charger the manufacturer recommends.

4.2.2 Trickle Charger

Or, you can charge at a quite slow and steady rate. This is called trickle charging. These chargers are much smaller and cheaper. They rarely have automatic shut-off function though, you need to make sure that the batteries are not left on charge for more than 16 hours. On the other hand, Lead Acid types can be trickle charged indefinitely without damage.

If you have a trickle charger, you must make sure that the device that the battery is charging is switched off. Sudden and large bursts of current demand from the device may blow up the trickle charger, meaning that you have just one more day at the most to use your device.

4.2.3 Float Charging

If the battery is kept well charged up, it is safe to leave the charger connected and the device switched on as the battery will supply the bursts of current needed. This is called 'Float Charging' but you should check with the maker if float charging is safe for a particular charger.

4.2.4 Power Supply Units

While float charging is the best from the point of view of reliability, they do require the weight of a battery. If you think that your mains power is reliable enough, then Power Supply Units are much better than trickle chargers. These are designed to provide all of the power that the device needs, as a replacement for batteries (sometimes they are called a battery eliminator).

In some designs of device however, there are hidden automatic switches on the plug where you plug in the PSU , which disconnect the battery from both the device and the PSU. As the battery is now disconnected, it may not be charging, when you would think that the PSU may be charging the battery at the same time as powering the device. The only way to be sure, is to consult the makers instruction book, or if in doubt, charge the battery on its charger while using the device via its PSU.

However you must be aware of one thing when choosing a PSU. If you look at the plate or label on the side of the device, you will see the power rating of that device. But this is the average rating, averaged over several minutes. The power supply needs to have enough 'guts' to power the device at its peak of output power, or else it will blow a fuse.

To illustrate; Suppose I have a very powerful spotlight above my garage, say 1000 watts. Now suppose that I switch it on for only 6 seconds every minute. The average power over that minute is one tenth of the rating of the bulb, 100 Watts. If I were to use a fuse rated for a 100 Watt

load, it would keep blowing every time I switch the light on.

This is just what is happening in the INMARSAT-C unit for example. After you have typed and sent the message, the Transceiver unit chops the message up into small packets, then fires them at the satellite with short but powerful bursts. Just like a flash on a camera, it cannot do this continuously, but must wait before firing another burst.

The power supply unit must be able to supply the Peak Load that the device will demand or else it will keep blowing a fuse. If you do not know the peak load current of a device, ask the manufacturer's technical department or check for a peak load figure on the specification sheet.

Not every manufacturer sells a proper peak load PSU with his device, so you should check your battery charger and make sure the people using the device know if the device should be switched off during charging to protect the battery charger. Check with your manufacturer for details, or better still, specify a good PSU when ordering the equipment.

4.2.4.1 Caveat

Designers sometimes make their devices seem much smaller and lighter, by having an external PSU. A salesman will have to work harder to sell an obviously heavier and larger device than for the smaller one. So ask your salesman awkward questions about chargers and PSUs before he adds up the 'little extras' and you find your costs much larger than you were led to believe.

Another point is that I have seen many very smart looking set-ups with everything in a fashionable briefcase. The problem is that the external PSUs don't always fit in to them so you also have to carry an awkward bunch of cables and chunky black boxes in another heavy bag. Chargers are much lighter and smaller than PSUs and this needs bearing in mind too as PSUs can be nearly as big and heavy as the device they are supposed to power.

On the other hand, if you think that you are going to be using the equipment for short periods of time and charging them most of the time, then a much cheaper trickle charger may be good enough.

4.3.1 Inverter

As I said earlier, there are still some devices that will require Mains AC power, some models of INMARSAT-A for example. This also applies to devices that were never intended to be portable when first designed, such as computer printers or Fax machines. What we need is a device to turn 12V DC into 220V AC in sufficient quantities to drive the power thirsty devices usually associated with mains powered devices.

And here is a warning. When a circuit designer starts his design, he has a power budget just as he has a cost and weight budget and a time scale. His design will be a compromise between theses factors. Mains driven devices usually have power budgeting on a low priority just because mains power is considered a virtual bottomless pit, so beware and check the idle power usage of the device as well as the operating power usage of it.

Remember we are about to connect these devices to a battery, definitely not a bottomless pit of power. When you connect an inverter to a battery, let alarm bells ring in your mind. Budget carefully and also remember that the inverter itself uses some power even if no device is drawing current from it. Another problem is the annoying whining noise they make, like a mad mosquito (jokingly called vintage inverter wine).

Also, in some older designs, the 'waveform' from an inverter may be poor, so some devices will themselves make a whining noise, and a few very sensitive devices may not work at all on an inverter.

4.3.2 Uninterruptable Power Supplies

Uninterruptable Power Supplies (UPS) are a combination of a battery charger, a battery and an inverter. It is not necessary to provide invertors to back-up devices that have their own batteries, so their Power Supply Units can be connected directly to the mains. But if your generator or source of mains power is not very reliable, and you have devices that need mains input then this may be for you.

In fact, short outages of power are not usually a big problem to most communications devices (apart from the nuisance). You will be out of contact until the power is restored, but when it is, your radio or terminal should bring itself back on line with the settings you had before the mains went off. This is possible because the computer memories inside these devices have their own very small battery to keep the memory alive (but sometimes for only a few hours).

Computers have a bigger problem. If you have any messages in the computer memory which have not been saved to disk, then they will be lost. When the power is restored, the computer will need time to boot up and then you will probably need to type in lots of instructions to restart the applications.

You must check that this has been done after every power outage, or you will not be able to receive incoming messages via computer when you may think that the terminal is working. INMARSAT C terminals may bring themselves back on line automatically (if set up so) but your computer may not unless you have written an appropriate 'autoexec.bat' file to make it do so. If you have a disk in drive A, to store the incoming messages, then the computer will fail to boot up because of a non system disk fault unless you place a system disc in drive A. Computers using UNIX operating systems should never be allowed to shut down as this could completely confuse the computer.

This is a nuisance only, if it only happens every few hours, but if the boys are changing the plugs and wires on the generator a lot, as they will in the first few hours of the operation, then you may have to do all of this every 15 mins.

In the UPS, the generator is connected to a battery charger. This in turn charges up a battery. The resulting 12V DC is then lead to an inverter which converts the DC to 220 v AC.

When the mains fails, the battery stops charging, but the inverter is still being fed by the DC from the battery so the AC 'mains' from the inverter is not affected for as long as the batteries hold out, usually about 4 hours. When the battery has discharged to a certain point, a control system will shut off the batteries to protect them from overdischarge.

Another advantage of the UPS is that the battery tends to even out the load on the generator so providing a smooth load current and avoiding 'popping' the circuit breakers on the generator.

UPS are not common under field conditions as they are heavy, expensive and not always robust enough, but there is no reason why you cannot make your own UPS from your separate battery chargers, batteries and an inverter.

4.3.3 Voltage regulators

If you are using the AC power form the city, then you may find that the voltage supplied varies a great deal from the quoted. In India or China, for example, a nominal 220V supply can often be 100V or less. Lights will brown out, tubes will fail to 'strike', so they will blink annoyingly, and your computers will go crazy. To solve that problem, you will have to use a Voltage Regulator, or stabiliser. This consists of a kind of transformer plus control system which keeps the voltage to your vital equipment at least near to the nominal. (of course there are limits). However they are quite large and heavy, and also very expensive. Therefore you would only protect the most sensitive equipment this way. Some UPS's offer similar advantages. In fact you would only go to this trouble if you are intending a fairly long term operation which would prohibit the use of generators, otherwise your own generator is probably more reliable.

There are many excellent books and magazine articles on this subject but as it is rather deep, I will now change subject to the inevitable charging of the battery. For this we need a generator of some sort.

4.4 Generator Sets

If you intend using your equipment more than say half a dozen times, and if you do not have a vehicle available to charge from, then you need one of these. To be very correct, only the part that actually makes the electricity is the generator, the motor turning it is sometimes called the 'prime mover'. The proper name for both together is a 'Generator Set'.

Generators in turn can be Dynamos or Alternators.[58] Dynamos generate only DC and are not very common these days. Alternators generate AC usually at the voltage of 110 V AC or 220-240 V AC. It is common these days for there also to be a rectified 12V DC output from the generator for 'Charging Batteries'.

This means what it says, and while you can charge a battery from this output, you should not directly connect a DC device to this without a battery across it also. This is because the voltage has only been rectified and is too rough to be used by electronics and needs smoothing either by a battery, or a special smoothing circuit and voltage regulator.

Happily our Japanese friends have done a wonderful job in marketing very competitively priced portable petrol or diesel generators. Looking like knobbly red Jerry cans, they can be carried by their built in carry handle by one person quite easily. Honda, Yamaha and Kawasaki for example, have put a lot of effort into the portability, reliability and quietness of their products and buyers can shop with confidence for the best deal. Power ranges are usually from 100 Watts to 3000 Watts, which is quite adequate, but larger than this are not usually considered portable.

4.4.1 Rating

The main factor to consider when choosing a generator is it's Rating, this is usually quoted in watts, such as 1000W. This is the average continuous electrical power that it will supply without damage. In fact it is more brutal than that. The generator will have a circuit breaker or fuse on the generator output. This will trip or blow when the current is too high,(thus protecting the generator) so the peak load must be less than the rating of the circuit breakers.

As rating is what it really boils down to, there is no point in going to the salesmen until you have a clear idea about how much power you will need.

The course of greatest wisdom is to add up all of the devices and chargers you intend to carry, add the lighting bulbs you may be using at night, and then multiply by at least 150%. The cheapest and best thing to do is purchase a single generator that is in the power output range above this figure.

4.4.2 Redundancy strategies

But there are alternative strategies. Buying only one generator is putting all your eggs in one basket, so it may also be good to buy two generators. This has the obvious advantage that you have a standby in case one generator fails. If you wish, you could buy two generators, both capable of carrying the whole load each, in which case you have a standby to hook up if the first one fails. This is called 'Cold Standby

Redundancy' strategy, but has the disadvantage of wasting half of your money.

Alternatively, you may decide to have the load split up into two separate sections of load, with one generator supplying half of the lights and half of the coms equipment, and the other side the same so that the whole load is covered by two generators, each of a rating of half of the total load. This is called Load Splitting.

The advantage is that you have now purchased two cheaper generators, (but this is still more expensive than one large one).When the failure occurs, now only half of the systems need resetting. Wise juggling of the loads can bring the most important loads back on line but some loads will have to wait until the first generator is restored.

If you have two identical generators, and they both fail but for different reasons, then you have the option to cannibalise one of them to keep the other running, (if you have the right tools and the manual).

A popular and practical strategy is to have one generator and distribution system for 'Dirty loads' and one smaller one for 'Clean loads'. On the dirty system you could hook up battery chargers, devices with built in batteries, which will be protected from power outages by their own power, and all of the miles of spaghetti of wiring slung over trees and dragging on floors and getting kicked about carrying lighting to other sites. These are the ones most likely to fail, so we connect 'Don't Care' services to this generator.

We then have a separate, usually smaller generator for sensitive devices such as devices with no battery back-up, or especially computers (which HATE rough mains). This will be your 'Clean line' and you should guard what goes on it with jealous zeal. Then when one of the generators fails, you can haggle with the other team members as to which load is the most worthy cause to be restored while the other is being fixed. The whole issue of connecting consumers to a generator is much trickier than it looks. For generators of above about 3kVA, an electrician should supervise the installation.

Storing the two generators at separate locations and sending them out with different teams and on different vehicles also adds to security, as the chances of at least one getting through without being lost, damaged, delayed or stolen are greater. The very smallest generators can even be carried as hand luggage on a plane (but only with empty tanks)[59] and be subsequently carried by a person of moderate build if needed. No precaution is too much to make sure one of them arrives at the scene in tact.

4.4.3 Observing the Load

Remember the parable of the wise virgins in the Bible?(Matt 25:1-13). Many do not and so when they arrive on site with flat batteries, the happy humming from your generator will attract them from all directions.

Naturally this is fine, we are in the business of helping people, so it would be unbelievably possessive to refuse to let people hook up to your generator. However you do need to keep an eye on the total load, which will creep up slowly but surely as the operation goes on, until eventually your circuit breaker keeps popping off more frequently, leading you to think there is a fault on it. If this is happening to you, check all the hidden wiring right to the very end, in case someone sneaked an extra load on the line and didn't have time to tell you.

4.4.4 Frequency stability

These days it is rare to find devices that are sensitive to mains frequency. For example, in the days before quartz clocks, electric clocks were the most accurate. They worked by counting the cycles of the incoming mains. Obviously that will be no good when connected to a small generator with a varying load. As load goes up and down, generator speed will go up and down and so will frequency from the generator. Electric motors for example, will not stay at a stable speed. (Do you remember the music from record players at fairgrounds?). Today, quartz crystals are installed in most devices that are sensitive about timing, but if you have trouble with something that works perfectly well on the mains, try it on its own on a bigger generator to see if that works.

Generators are fitted with governors to keep the output frequency at least near to a nominal 50HZ, or 60HZ for 110V designs.. When there is little load on the generator, this could cause the generator to go too fast, so the governor detects this and throttles back on the fuel. The reverse is true when the load increases. The generator slows down and the governor responds by throttling up on the fuel to keep the frequency near to 50HZ. The manufacturer will specify the frequency stability of the generator in the specification book.

4.4.5 Don'ts

You may say, why not connect the two generators together in parallel and power everything from both of them, in a 'Full Parallel Redundancy' scheme This would mean that when a generator fails, there would be no loss of power at all.

Unfortunately it is not so simple as that. Remember that we are generating AC voltage here. This means that one generator could be making +240V while the other makes -240V. Result, BOOM! you have lost both of your generators. It is only possible to connect two generators if they are synchronised.

This in turn, is only possible if the generator is designed for this and in conjunction with special equipment called a synchroniser. Even then, synchronising generators has to be done by someone who has been shown what to do as it is quite tricky. I have never seen synchronisation

available on a portable generator of the type we are likely to use, so..

NEVER CONNECT TWO GENERATORS TOGETHER.

NEVER CONNECT A GENERATOR TO THE MAINS.

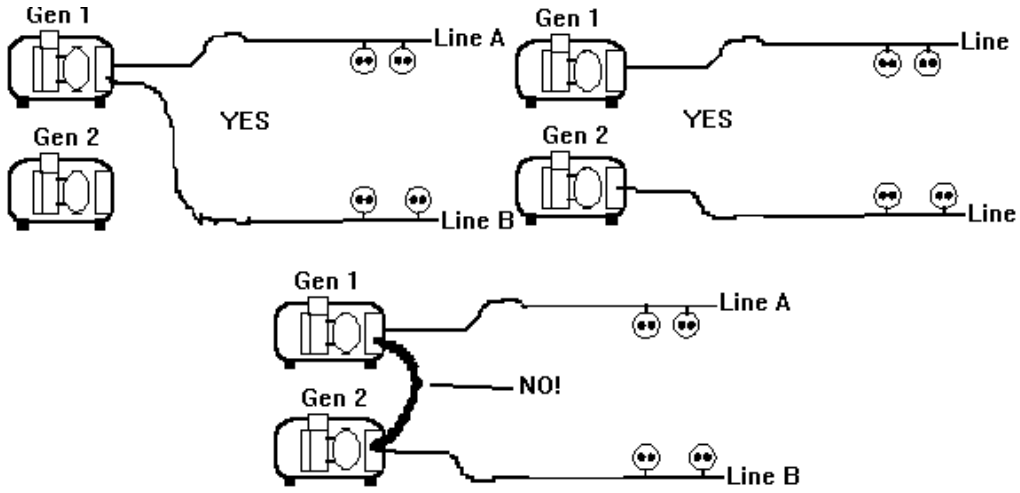


Fig 15 In case of gen failure, or to save fuel when loads are light, one genny can be connected to both lines but two gennys must never be connected together

Interlock box, built such that it is only possible for two switches at a time to be closed

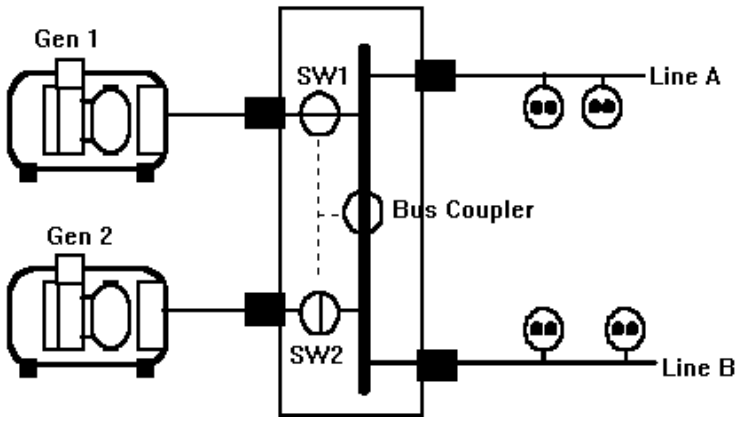


FIG16 A more professional method for a permanent installation is to use a special interlock box interlock box *making a mistake impossible..*

The only reliable solution is an Interlock.[60] This is a box in which the switches are mechanically coupled together in such a way that only two switches at a time can be closed. In another design, each switch needs a copy of the same key before it can be closed. The key is then captured in the switch until the switch is opened. However we arrange that there are only two keys available, thus making sure that three at a time can not be closed.

4.4.6 Fuel

As sure as your battery will need charging up in about one day, your generator will need re-fueling usually in one day. The portable generators usually on sale these days have a 'service' tank built in to them which will sustain them for about 8-16 hours of continuous use at full output.

As the governor will decide how much fuel is used, it is rather hard to guess exactly when fuel will run out. If you just wait for the generator set to stop, then look for fuel in the dark, you can expect hours of trouble bleeding the air out of the system. A better move is to take a dip stick reading of the service tank every hour or so and top it up when convenient. This is easier if the tank is fitted with a fuel gauge of course, but in any case it is wise to record in a log book, how much fuel is used, so that you can estimate how much fuel to find for each day's work.

Modern generators come in a choice of petrol or diesel models, four stroke or two stroke. Finding the fuel you may need locally could be a problem and you will become more desperate as the days wear on. Even when you find a supply of fuel, you frustrations will not end there.

The possessor of the fuel knows that he is in a strong position, and will want either hard cash in US dollars, or barter for something he can't buy

at any price locally. So you may need the cunning of a camel haggler and connections of sergeant Bilko to get what you want. It is a good idea to get a few goodies from the duty free shop at the airport to barter from a strong position. The smart move is not to let this happen to you, and always arrange your own supply of fuel.

4.4.7 Diesel

Diesel models have the advantage that you can probably find diesel almost anywhere, it can be syphoned out of a truck for example. Most large vehicles are diesel powered and have very large tanks, so you have a large and ready supply if such vehicles are around or if they regularly pass through an area, in which case works areas may have many barrels of it somewhere, (ask very nicely).

Failing that, you can carry some around in Jerry cans with you. Diesel is quite safe to store, so few places will refuse to transport or store it in metal cans.[61]

Diesels do not have an ignition system (spark plugs), so this makes them less prone to failure than the more complicated petrol engine. Diesels are famously reliable (once you get them started) and are unlikely to pose any kind of fire or explosion hazard. However it is rare to find a Diesel generator set rated below 3kVA

4.4.8 Petrol (gasoline, Benzine)

Petrol models have the advantage of being cheaper and lighter than their diesel counterparts, which is important for portable equipment. As they have ignition systems, this is potentially a source of problems so they are marginally less reliable than diesel.

The problem may be transporting the fuel. **It is forbidden to transport petrol on an aircraft** so you will arrive at the operation with empty tanks.(not usually such a big problem with diesel which has less dangerous fumes, although you must seek permission first).

You must therefore go and look for petrol when you land and before you need your generator, (if you have the time). Don't allow yourself to be hustled into the back of a truck and rushed off, until you have filled your service tank and as many cans as possible.

If there are plenty of cars and mopeds in the area of operation, then finding petrol should not be a problem, but the manufacturers manual should be checked to see what grade of fuel is required.

Two stroke engines have the additional problem that the fuel needs be mixed with oil. Again if there are plenty of mopeds in the area, then a source of mixed fuel will be available. If not you will need to bring or find the correct oil, and remember to add it in the right proportion yourself when fuelling the generator.

4.4.9 Cleanliness

It may not be easy to keep the generator area clean, but if the area gets dusty or sandy, then there is a high chance of getting sand or dust in the fuel. This will block the fuel lines and very tiny jets in the carburetter of a petrol motor, so careful filtering of all fuel going into the service tank is a must. Pour it through a clean cloth if in doubt.

4.4.10 Siting

Generators are anti-social, noisy,[62] and smelly. No-one wants to have to sleep next to one. Working near them gives you a headache from the noise and fumes, and makes trying to read, write or rest very demanding. Worst of all, the noise will make telephone calls difficult for the persons at both ends, and increase the likelihood that a radio call will be missed even if the radio volume is at is maximum (which it will have to be, giving a distorted barking sound sure to stress the operator).

The proper thing to do is designate a generator area, in common with the other groups in the same camp. This should be behind something to baffle the sound, such as a wall. Failing that, try to use a lorry or build a sound baffle from bricks, stones, wood or anything else around.

Do not totally enclose the generator or mount in an inside room. It will choke on its own exhaust fumes, and also overheat and become damaged. So it needs to be somewhere well ventilated.

Security can then be a headache as now you cannot see who is near it at all times. So the eventual site will be a compromise between perceived operator fatigue and security.

Of course if you are running the generator for a short time only, then none of those problems are serious enough to add complications, and you can just place the generator near to the device.

4.5.1 Distribution

A further problem is Distribution. You will need a long enough wire to reach from the generator to the place where the power is needed, about 50-100m away.

In fact, once a generator is running, and dark sets in, many places will be found where power is needed, for lighting among other things. So you may need enough wires to get power to half a dozen tents.

We have already mentioned the dangers of overloading the generator but as the only result of doing this is to trip the circuit breaker and thus shut off all of the power, so there is little danger of an overload fire.

A wise precaution is to install an Earth Leakage breaker(ELCB), or Residual Current Breaker (RCB) in the line also (if not already fitted to the 'genny') to protect you from electric shock . If recommended by the manufacturer, a protection earth can be installed with a ground spike which should be driven in with a heavy hammer.

There may be many hazards associated with the distribution as everything is done in a hurry so wires are left on the ground where they can trip people up and also become snagged on vehicles which then drag the whole camp down, rattling expensive electronics along the ground with it.

Slinging wiring overhead can be just as bad, because passing higher-than-expected vehicles can drag the cables down as well.

At places where one wire joins another or another line is teed off. there will be a multi way plug and socket arrangement. It is important to keep them free from mechanical damage and water, so a quiet corner in a tent is usually best.

The distribution cables are quite heavy things, counting the plugs and sockets, so a reasonable balance needs be struck between perceived need and cost, size, weight. Carrying two or three reel-in extension leads is usually sufficient and cheap, but extension reels must be **fully unwound** when in use, or heat could build up in the reels and cause a fire. In some cases several small generator sets may be better than one large one.

4.6 Other Auxiliaries

You should also carry enough tools, such as wire cutters, screwdrivers and knives to make and splice cables as required. You should also carry spares, such as spark plugs, mains plugs and sockets etc.

It may also become necessary to think of adapter kits for powering devices with strange plugs.

You will need to find out how many different types of fuse are present in all the devices and power supply systems you have. It is wise to carry at least 2 to 5 of each.

Take a voltmeter capable of measuring AC Volts up to 500V and resistance. An audible continuity 'beeper' is also very helpful. Always check a suspect power source before plugging in your precious devices, by testing it with your voltmeter.

4.6.1 Transformers

Devices with American plugs will usually need 110V and should never be connected to a 220V generator or both will damaged. There is often a hidden control inside or round the back of the device to change the voltage but if you have any 110V devices without voltage 'tappings' you will need a Transformer to convert 240V to 110V. Try to do without this though as transformers are very heavy and expensive.

4.7 Alternative energy

If you think that fuel is going to be a real problem, or there are environmental or economic considerations, then you have two other options.

- Wind power
- Solar power

Of course there are others too, but as we are talking about disaster and aid communications, let's keep to solutions that can be put up immediately.

There are shelves of better books than this one about just this subject alone, so I propose only to highlight the points important to disaster Communication. For a more full consideration, consult the book "Where there is no Telephone", (see Bibliography)

4.7.1 Wind Turbines

These are a great favourite with yachtsmen who spend a lot of time in quiet harbours. They need power for radios and lights, but will be 'black balled' if they make noise with their generator or run their stinky main engine. The Wind Turbine generator set is very quiet, and runs for years with hardly any attention required. They can be purchased ready made at reasonable prices.

Of course they will not generate any power if there is not enough wind. This means that you cannot afford to power the radios direct from the wind turbine. You can bet that you would need to make that call when there is not enough wind.

It is more sensible to think of them as battery chargers, charging up batteries off line, batteries which are then used to power the radios as required. Therefore, they are more suited to aid applications, which do not require 24hr operation, but will be making a call to base say once every evening.

This approach also means that a lower rating of turbine is needed, making for a smaller, lighter, easier to carry turbine. A further point is that they continue to do their stuff by night as well as by day (if there is wind), so a convenient overnight charge is possible.

The turbine needs to be sited where it will catch the wind, and atop a pole at least head height, the erection of which is a tricky job for at least 4 people, taking about 1 hour.

4.7.2 Solar Panels

If you think that the wind may not be reliable enough, then think of solar panels. These can be purchased from any good yachting chandlers and many models fold down into compact portable units. Some radio manufacturers even sell a suitable kit of solar panels and their control circuits to suit a particular model of radio. This is another subject covered very well in the book, 'Where There Is No Telephone', but here are some important points.

Panels have very low ratings however, and so while it is possible to power devices directly from them, it is not practical. Therefore, these too should be treated as battery chargers.

Three problems. They are less effective in northern cloudy countries in the winter. They are easily damaged and so should be cared for well. They work only during the day, so a convenient overnight charge is not possible.

As with the Wind turbine, I feel that it is best suited to aid applications rather than disaster Relief applications.

4.8 Summary

So all you wanted was a telephone, but now you are up to your neck in Power Supplies and the money if flying out of your pocket. But do not despair. As I said at the start of this section, if you think small at the start, and budget power wisely, you can provide affordable and reliable power. Make sure you or someone in high authority in your organisation is designating someone to keep an eye on the devices, their batteries and their power needs and being well prepared for the eventual day when it will be put to the test. Whenever thinking of a more elaborate communications system, you should think of the power implications also.

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[54]IATA regulations restrict the air transport of most types of batteries.

[55]The only reliable method of knowing battery charge is to use a Hydrometer. Looking like syringes with a rubber bulb at one end, they suck a sample of battery acid up into a sight glass where a calibrated float will read off the electrolyte density.

[56]But not necessarily, some experts say that gel type lead acid batteries are better and easier to charge.

[57]Many modern portable devices have voltage regulators built-in, but if they don't the regulator will help protect the device against damage from overvoltage spikes and reduce risk of interference from one device to the other down the power cable.

[58]There are others but they are out of the scope of this consideration.

[59]and officially no engine oil either.

[60]Or a 'fool proof' plug system if loads are light.

[61]Diesel can be carried in aircraft but you must ask permission.

[62]Units rated below 250W are often very quiet.