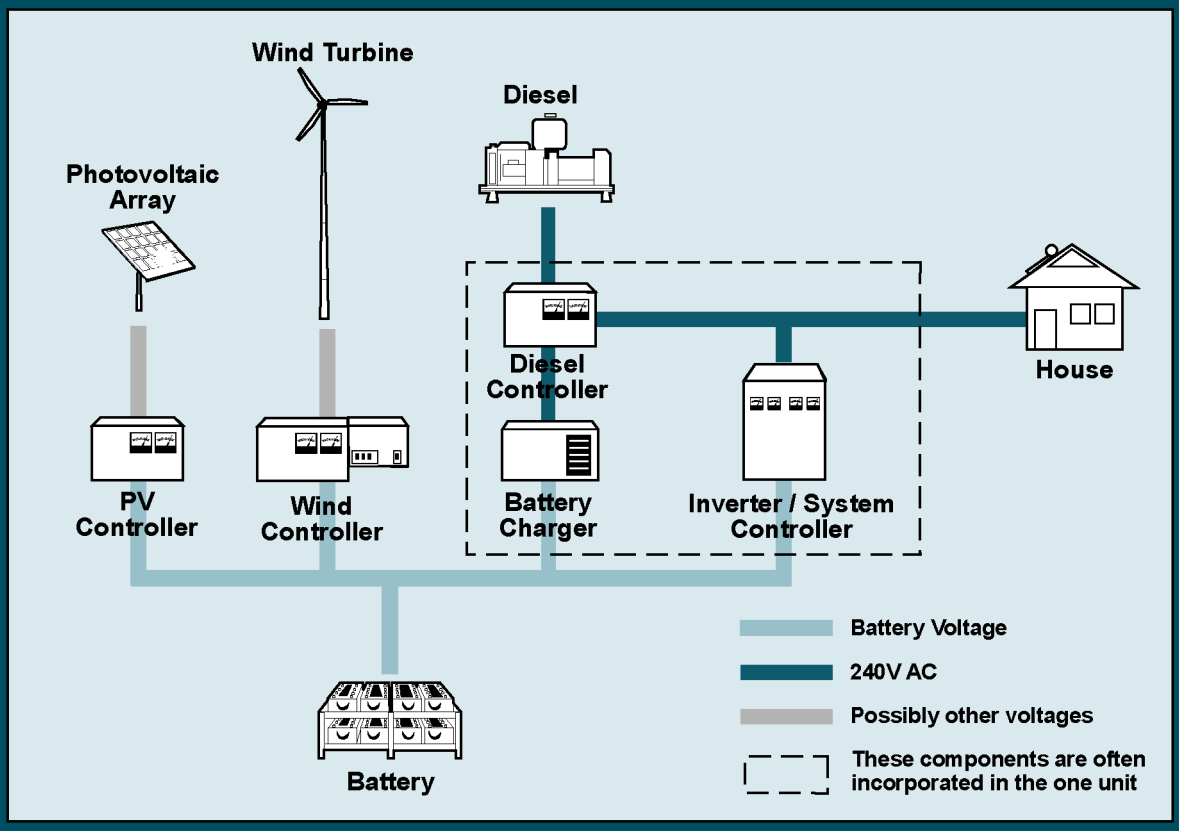
Office of **Energy**

REMOTE AREA POWER SUPPLY SYSTEMS



USER GUIDE and MAINTENANCE ADVICE

GOVERNMENT OF WESTERN AUSTRALIA

CONTENTS

Chapter 1
General maintenance and use of renewable energy RAPS systems.

This is a general guide to give an overview of maintaining typical ***RAPS*** *(note 1)* Systems and their components. It has been developed specifically for Western Australian conditions, but is generally applicable. After each system component is briefly discussed, suggested maintenance tasks are given for that piece of equipment. As with any piece of equipment, performing regular maintenance and inspection of components will help maintain system performance and minimise disruption due to component failure. Some of the information / procedures may be slightly different to that provided by your system supplier. If this is the case refer to the user manual provided with your system and follow the information and procedures outlined there.

This guide is designed for users and those already familiar with the basic components and configuration of a RAPS system. More general information on RAPS systems can be obtained from the brochure 'Renewable Energy Based Remote Area Power Systems' available from the Home Energy Line. Books are also available which can provide further details about these systems and components *(note 2)*.

As part of the regular maintenance of a system it is recommended that a ***logbook*** is kept for the recording of system maintenance and performance. In the logbook the type and frequency of maintenance and who performed the maintenance should be recorded. If kept up to date it can be used to provide a history of the system which then can be used in fault diagnosis. With some systems a logbook is required to be kept for the batteries as part of battery warranty conditions. Check with the system supplier concerning any logbook requirements.

Note 1	A definition or explanation of any word which appears in bold italics can be found in Chapter 4, The Glossary.
Note 2	Example books are: The Earth Garden Book of Alternative Energy, by Alan T. Gray. Rural and Remote Area Power Supplies for Australia, published by the Department of Primary Industries and Energy.

Chapter 2
Major system components: Operation and general maintenance.

In most RAPS systems the equipment or components can be classified into the following three categories:

- Energy generation.
- Energy storage.
- Energy conversion and control.

Energy generation equipment

Energy generation equipment includes the solar (***photovoltaic***) array, wind turbines, generator sets and is also considered to include associated equipment such as frames, ***trackers***, towers, and voltage ***regulators***. Technically voltage regulators are energy control equipment but they are discussed in this section as they are an integral part of controlling fluctuating renewable energy inputs and optimising battery charging.

Solar array

The solar array (a number of solar ***modules*** mounted together) is quite often referred to as being maintenance free. This can be the case in many situations. However, with occasional maintenance and inspection, the performance of all the solar modules in the array can be assured.

The most common maintenance task for solar modules is the cleaning of the glass area of the module to remove excessive dirt. In most situations cleaning is only necessary during long dry periods when there is no rain to provide natural cleaning.

To remove a layer of dust and dirt from the modules all that is required is to wash the panel with water. If the panel has thick dirt or grime, which is harder to remove, wash with warm soapy water and a sponge. Washing the modules is similar to washing glass windows.

After the panels have been cleaned, a visual inspection of the panels can be done to check for defects in the panels such as cracks, chips and discolouration. If any obvious defects are found note their location in the system logbook, so they can be monitored in the future in case further

deterioration affects the panel output. In most cases the panel output will not be affected.

If a system has metering for the solar array output, by observing the output current regularly any loss of performance will be noticed. There will be some variation in this current due to changes in ambient temperature, season of the year, angle of the sun and the level of solar radiation incident on the modules. To minimise these effects this observation should be done on fine, cloud free days at around noon. Any significant changes in output which are noticed can be investigated. The most common causes for loss of output would be excessive dirt on the modules or partial shading of the array. Other causes could include wiring problems and/or problems with system regulators - refer to the system supplier for advice if you suspect either of these problems.

The array frames

When inspecting the solar modules the condition of the array mounting frame should also be noted. Items to observe would include the condition of array mounting bolts (eg are the bolts rusting) and checks to ensure that the frame and modules are firmly secured.

The regulator

The regulator (also called the solar regulator / controller) is an electronic device which controls the voltage of the solar array's energy output to charge the battery bank appropriately. Inspect and check the functioning of the regulator to ensure that any indicators or meters are correctly operating for the various regulator modes. Check that when the batteries are fully charged and it is sunny, that the regulator is going into the ***float mode***.

The array wiring and conduit

Inspect the condition of any ***conduit*** and wiring associated with the array and regulator. In particular check for any breaks or deterioration in exposed conduit and wiring.

Wind turbines

With most wind turbines the maintenance required will be specific to the machine and tower installed. The user manual should always be consulted before attempting any maintenance.
Typical checks for the user:

- Inspection of guy wires on guyed tower - check for tension, and excessive fraying or corrosion of guy wires.

- Check the functioning of any ***furling*** mechanisms.

- If a cable twist system is used, check the amount of twist and untwist if required.

- Check that system regulators and dump loads are functioning in windy conditions, (refer to system supplier if suspect).

WARNING: Do not attempt to lower a turbine tower unless you have been trained in this procedure. Also do not attempt this procedure in windy conditions.

Generators

A petrol or diesel generator will require regular checks of the fuel level and also the oil level. These will need to be topped up as required. In addition regular servicing including complete oil changes and filter changes will be required, at intervals specified in the system manual.

Energy storage equipment

The energy storage equipment consists of the batteries, their housing and any protection equipment. These systems should use batteries which are designed for deep cycling applications and which are better suited to the charging and discharging regime typical of RAPS systems. Car and truck batteries are not suitable. Usually several batteries are connected either in series and/or parallel to form the battery bank which provides the total energy storage required for the system. There are Australian Standards for battery installation and safety which need to be followed in a RAPS system installation.

The relevant Australian Standards for RAPS systems' batteries are:

AS2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in or on buildings. *Part 1:Vented Cells, Part 2: Sealed Cells*
AS3011	Electrical Installation - Secondary batteries installed in buildings. *Part 1: Vented Cells, Part 2: Sealed Cells.*
AS4086	Secondary batteries for use with stand-alone power systems *Part 1: General Requirements.*

In WA there are two main types of batteries used in RAPS systems:

- Wet cell flooded batteries - in which the ***electrolyte*** level must be regularly checked.
- Sealed or gel cell batteries - where there is no access to the electrolyte, a regulated valve is incorporated and the battery is completely sealed.

Other batteries which can be used are nickel cadmium (Nicad) and nickel iron (Nife) batteries - these are used more commonly in the USA. If your system uses one of these types of battery consult your system designer for maintenance advice.

General installation requirements

The batteries should be located in accordance with manufacturer's recommendations. The battery bank should be protected by a suitable enclosure. In sheds a separation wall, between the batteries and any other equipment is required to separate spark sources from explosive vented battery gases. All battery installations should be either naturally or forced ventilated to prevent the build up of explosive gases. The battery enclosure should be clean, dry and lockable to prevent unauthorised access.

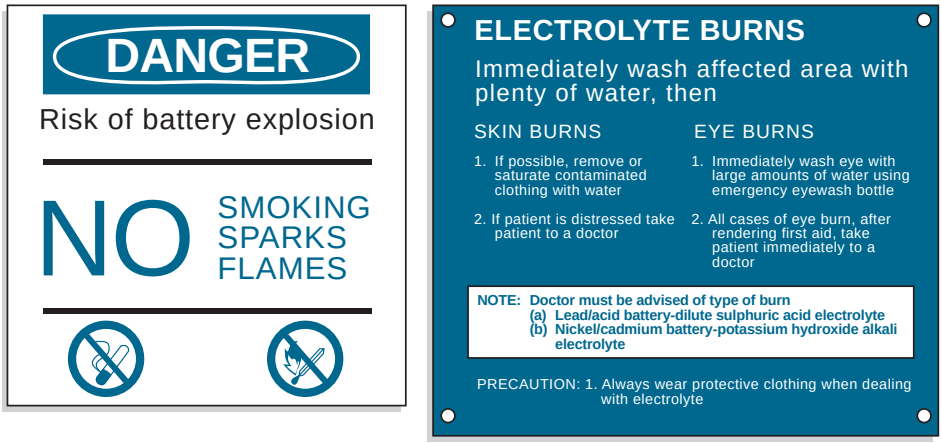
Good access to the battery terminals and electrolyte filler caps is required. Generally, batteries are installed on a battery rack to keep them off the floor and provide the required access to the batteries. There should be no shelves above the batteries because items falling from these shelves onto the batteries could cause a short circuit. Avoid clutter around the battery bank. If a special room or shed is used, it must not be used as a storage area. Minimise the battery bank's exposure to extremes of temperature because this can reduce performance and life. Provision should be made for the containment of any spilled electrolyte.

Cable losses are proportional to cable run lengths. Ensure that distances between batteries, inverters and energy generation equipment are not excessive while considering the safety issues outlined in this booklet. If in doubt consult with your supplier or local Licensed Electrical Contractor.

Safety first!

Remember always that a battery is a form of energy storage which under the right conditions can release its energy instantaneously, with explosive consequences. The battery bank should only be accessible to people who understand its functioning and are responsible for its maintenance. It should have restricted access to other people, especially children. As far as possible, the area should be animal and vermin proof. Restricting access to

the batteries will be the first and often the best safety measure. Suitable safety signs should caution people of the danger, *(see example signage*



Battery Safety Signs

below).
The following safety equipment should always be available and ready to use. People who have access to the battery bank area should all be instructed in its use.

- Bucket of clean water - for rinsing acid off.
- Safety goggles or face shield - for face and eye protection.
- Rubber gloves - for protection of hands.
- Eyewash bottle - for rinsing acid splashes out of eyes.
- Overalls or apron - for protection of body and clothing from acid splash.
- ***Baking soda*** - for neutralising acid spills.

Maintenance of battery banks

Generally maintenance of batteries will concentrate on correct charging regimes, electrolyte condition, battery terminals and overall battery safety.

Before you start

Before you start with your maintenance ensure all safety equipment is at hand and ready to use. Listed below are typical equipment you will need for performing these maintenance tasks safely and correctly:

- Safety equipment (refer ***safety first!*** page 5).
- ***Hydrometer*** - for checking ***specific gravity*** of electrolyte and hence battery charge.
- Glass bulb type thermometer - for temperature measurement of

electrolyte.

- Container with clean water to rinse hydrometer and thermometer.
- Handheld voltmeter or multimeter - for checking battery ***voltage***.
- Appropriate tools - correct size spanners and/or screwdrivers with insulated handles.
- Scotchbrite type scourer - for cleaning battery terminals and connectors.
- Anti oxidant coating or vaseline - for coating battery terminals and connectors after cleaning.
- Baking soda - for cleaning of batteries.

Checking your batteries

As part of regular maintenance a thorough visual inspection of the battery bank is required. This inspection should look at the following areas:

- Cleanliness of batteries.
- Level of electrolyte, (not required for gel cell batteries).
- Condition of battery terminals.
- Signs of any electrolyte in the safety trays (if provided) or on the floor, indicating a possible battery leak or overfilling.
- Condition of battery containers.
- Battery voltage level.

Charging your batteries

To maximise the life of a battery bank, it is best to ensure that it is regularly receiving a full charge and ensuring that its state of charge is not allowed to fall excessively, (typically for deep cycle lead acid batteries the recommended maximum depth of discharge is 50%). Each day, at around the same time, the battery voltage should be checked, as this will give you a regular indication of the battery charge condition. Decisions on energy use can be made based on this check to avoid over discharge of the battery. Such decisions may include delaying energy use or using backup generators to charge the batteries. When you become more familiar with the operation of your system this battery check may be carried out less frequently.

Checking the voltage

The table below lists typical voltage levels which indicate the state of

charge for the battery bank. This table is valid when the batteries are at rest, (ie no charge or discharge is occurring). This table should only be used as a guide and for accurate charge levels the specific gravity of each battery should be tested where possible. The table below is typical of Flooded wet cell batteries at 25˚C. At higher or lower temperatures, correction should be made using temperature correction factors from your

Nominal Voltage	Bad	Time to start economising or using backup charger	Good	Caution
2V	< 1.9	2.0	2.2	>2.35
12V	< 11.4	12.0	13.2	>14.1
24V	< 22.8	24.0	26.4	>28.2
48V	< 45.6	48.0	52.8	>56.4

Table 1 Flooded Wet Cell Batteries Typical State of Charge

battery specifications. If you have gel cell batteries check the battery specifications for an indication of state of charge for various voltage levels.

Typical battery maintenance tasks

Preparing the system for battery maintenance

It is important to avoid clutter around the battery bank, so remove all unnecessary items from around the battery bank area leaving only safety gear and equipment required for the maintenance of the battery bank. Before starting to maintain the battery bank, it is extremely important to isolate the battery bank from the system and shut the system down whilst maintenance work is being done. Check the user manual supplied with your system for the correct procedure in shutting down the system and isolating the battery bank.

Ensure there is plenty of ventilation in the battery enclosure or room. If using forced ventilation, check that ventilation systems are functioning correctly and are clean and unobstructed.

Before assessing the condition of a battery it is best to have a fully charged battery bank if possible. It is best to wait for the solar regulator or wind turbine dump load to have finished a ***boost charge*** and then switch to a ***float charge*** mode before continuing.

For consistency in the recording of specific gravity and voltage measurements each battery and cell should have a number written on it with a permanent marker pen. When recording specific gravity or voltage these numbers can be used as a reference label.

Isolating the system for maintenance

A typical process in shutting down a system and isolating the battery bank to make it safe to work on would follow the following steps.

Warning: refer to system user manual provided by system supplier for exact procedures relevant to your system.

1. Shut down all loads on the system starting from the appliances and working back to the inverter.
2. Disconnect all energy generation devices.
3. Shut down the battery bank - this would involve either switching off circuit breakers or removing any fuses on the battery bank. If fuses are used, the fuse on the negative terminal of the battery bank should be removed first followed by the fuse on the positive terminal. When a circuit breaker is used either place a 'Do not operate tag' on the circuit breaker or physically isolate the battery bank by removing the battery cabling first from the negative terminal, then from the positive terminal. If the battery bank contains more than one string of batteries isolate each parallel string.
4. The battery should now be safe for maintenance work.

Cleaning the batteries

Each battery should be clean before removing any battery filler caps to perform maintenance or measurements. This will avoid contamination of the battery by dirt which can cause damage to the batteries. To clean the batteries use either a brush to remove dry material and/or a rag dipped in a solution of baking soda and water and thoroughly squeezed out.

Warning: When cleaning batteries avoid using excess water which may spill into the cell, and always wipe away from electrolyte filler holes.

Checking the charge and condition of the battery bank

There are two main methods for determining the state of charge and condition of the battery bank. The two methods are:-

1. Measuring the voltage of each battery.
2. Measuring the specific gravity of the electrolyte in each cell.

The measuring of specific gravity is the more accurate measure of battery charge when used in conjunction with manufacturer's specifications and data. Frequent recording of the specific gravity of your batteries can be part of their warranty requirements.

Voltage measurement

Once the battery bank is isolated, use a volt meter to measure the voltage across the complete battery bank and across each battery and record in the logbook. If any battery is more than 10% higher or lower than the average battery voltage, an ***equalisation charge*** should be performed and the battery bank rechecked.

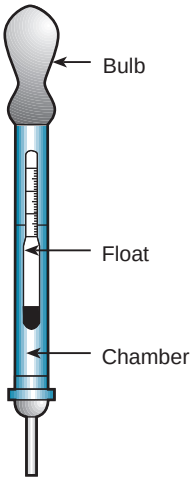
Specific gravity measurement

To measure specific gravity a hydrometer and a glass thermometer are required. Generally the electrolyte is drawn up by the hydrometer and a specific gravity reading is taken from the float level. A typical deep cycle battery which is fully charged will have a specific gravity of approximately 1.250 at 25°C. A reading less than 1.250 indicates a lower state of charge within the battery. The thermometer is required because the specific gravity changes with temperature. A higher temperature decreases the specific gravity, a lower temperature increases the specific gravity of the electrolyte. To convert your actual measurement to a value at the standard temperature of 25°C, a correction factor must be applied.

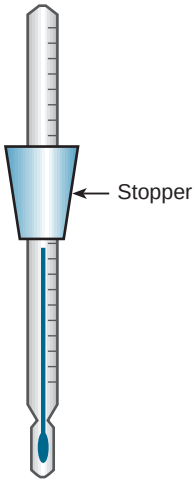
Measure the specific gravity of electrolyte in each cell, (see page 11) and record in the logbook. Apply the temperature correction to the readings and check with battery data to estimate the state of charge. If the specific gravity measurement of any cell is more than 0.025 below the average specific gravity of the battery bank, then an equalisation charge should be performed and the battery bank rechecked.

Using a hydrometer to check the specific gravity of the electrolyte in a battery bank

Before use thoroughly rinse all components of the hydrometer to avoid contamination of the electrolyte by foreign materials. Rinse and clean the



Hydrometer

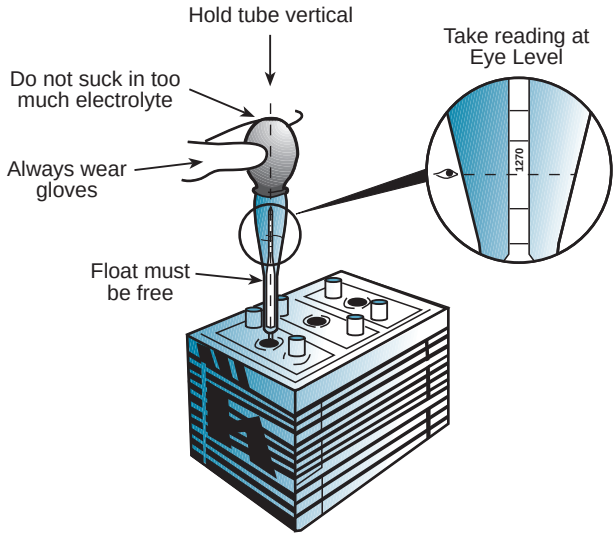


Thermometer with stopper

thermometer. Choose one battery for the measurement of the electrolyte temperature. Insert the thermometer into a cell, being careful not to touch any plate or other internal battery structures. Leave the thermometer in the electrolyte while measuring the specific gravity of the other batteries in the battery bank.

Warning: use only fresh water for rinsing hydrometer and thermometer, use of bore water may introduce contaminants which are damaging to batteries.

Completely deflate the bulb of the hydrometer and insert the tube into the electrolyte, releasing the bulb to draw up the electrolyte. Squeeze the bulb and deflate, squirting electrolyte carefully back into cell. Repeat this three to four times to ensure that the hydrometer is at the same temperature as the electrolyte. Now fill the hydrometer, ensuring that the float is floating in the electrolyte. Holding the hydrometer vertically, ensure the float is not



Reading the electrolyte specific gravity

touching the sides of the chamber, and read the electrolyte level off the float. Return the electrolyte to the cell. Record the reading in the logbook. Rinse the hydrometer in fresh water and test the next cell following the same procedure until all cells are tested.

Neutralising acid spills

To neutralise an acid spill use a solution of baking soda and water. Mix half a cup of baking soda in approximately 10 litres of water for larger spills and use a mop to clean up the spill. This solution can also be used for cleaning the batteries and battery terminals.

Topping up the electrolyte

To top up the electrolyte use distilled water (or de-ionised water) and fill the battery via the electrolyte filler hole until the correct level is reached. There are several types of indicators to show the level is correct. These

indicators vary from simple markings on the side of the battery case indicating high and low levels to systems which use a float indicator. Check the manufacturer's instructions for the type of indicator used in your batteries.
It is preferable to add distilled water when the battery charge is high as the addition of water will decrease the charge of the battery.

Cleaning the battery terminals

If the battery terminals are showing signs of corrosion, or have not had an anti-oxidising coating applied they will require cleaning. This will involve disconnecting the battery leads and cleaning both the battery terminal posts and the battery lead connectors. It is important to ensure the battery bank has been isolated before attempting to disconnect any leads.

Battery terminal corrosion is often seen as a white crystalline or powdery material around or on the battery terminals. A heavily oxidised terminal will have a very dark, almost black coating. If this is between mating faces of the connectors and posts it will need to be cleaned. Before disconnecting, carefully wipe most of the corrosion off using a brush or rag and the baking soda solution, then carefully disconnect the battery lead connector from the battery terminal post and clean both using a scotchbrite type plastic scourer. Once clean, apply the anti-oxidising coating following the manufacturer's recommended procedure and reconnect the battery lead connector onto the battery terminal post. Repeat this procedure for each terminal as required being careful not to contaminate the electrolyte with any foreign material.

Warning: Do not use any metal files or other harsh abrasives (eg sand paper) to remove corrosion or oxidisation from terminals or posts as this may cause a poor fit when connection is remade.

Differences for gel cell type batteries

Gel cell batteries require special attention to the method used for charging as overcharging of a gel cell type battery may cause irreversible damage to the battery. Consult with system supplier for recommendations on charging of gel cell type batteries. Controllers and chargers should be set to the gel cell mode for best performance.

Maintenance of gel cell batteries only relates to the battery terminals and connections. The maintenance required for these is the same as for wet cell flooded batteries.

Energy conversion and control equipment

Energy conversion and control equipment includes the inverter and/or battery charger, the ***direct current*** (DC) switchboard and any associated metering equipment. This equipment requires little maintenance. If this equipment requires any maintenance or repair it will generally need to be done by qualified personnel and the supplier should be contacted for advice.

The inverter

The inverter should be installed in a clean, dry, and ventilated area which is separated from the battery bank enclosure or room.
While the system is operating the following operational checks can be made:

- Check that the inverter is functioning correctly by observing ***LED*** indicators, metering and/or other displays on the inverter.
- Check to see if the inverter's stand-by mode (if present) is functioning correctly. This can be done by turning off all loads and appliances operating on the system. Once in stand-by mode, switch an appliance on and the inverter should start almost immediately.
- Check that any control functions for remote starting of diesel generators are operating. Ensure that the diesel generator is starting and stopping at correct battery voltage levels as specified by manufacturer, (refer to system supplier or inverter operating manual).

When inspecting the inverter, remove any excess dust from the unit and especially from the heat-sinks. This should only be done with a dry cloth or brush.

Battery chargers

The maintenance required for battery charging equipment is similar to that required for inverters. Check the operation of the unit and any control settings for automatic operation of diesel generators. Any battery charging equipment should be installed in a clean, dry and ventilated area. When inspecting the charging equipment remove any excess dust from the unit and especially from any heat-sinks. This should only be done with a dry cloth or brush.

Switchboards and wiring

Correctly installed switchboards and wiring should require no maintenance. The Licensed Electrical Contractor who installed the system should have checked all existing wiring and switchboards.

As part of your system inspection the switchboards and wiring can be visually inspected for signs of corrosion and/or burning. If this is present consult a Licensed Electrical Contractor to identify and rectify possible faults. All safety switches (Residual Current Devices) which detect current leakage to earth should be tested by pressing the test button provided.

Chapter 3
Maintenance checklist

The following is a sample battery bank logsheet - (refer ***Typical battery maintenance tasks*** page 8) The sample sheet is for a 24 Volt battery bank consisting of twelve 2 Volt cells. The comment section is for recording the condition of the individual cells or batteries and their terminals and other comments such as the amount of electrolyte required, any signs of leaking acid from batteries and any other maintenance required.

Battery / cell number	Comments	Voltage reading (Volts)	Temp-erature (¡ C)	Specific gravity (S.G.)	Temperature corrected S.G.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Total					
Average value					

The maintenance checklist on the next page is provided as an indication of the general tasks required to maintain a RAPS system. It will need to be modified to suit your particular system and once it is finalised it can be copied for repeated use. Some items will need to be checked every month while other items will require less frequent checks.

Date: _____ / _____ / _____ Person performing maintenance :_____

Notify all users that maintenance to the RAPS system is in progress.
If system isolation is required notify all users of time and approximate duration.

Task	Comments	Frequency
General Clean up of system areas		As required
Solar Modules		
Clean and inspect the Solar Modules		As required
Observe output current		3 monthly
Check regulator		3 monthly
Inspect array frames		annually
Check conduit and array wiring		annually
Wind Turbines		
Inspect guy wire tension and condition		annually
Check Furling mechanism		3 monthly
Check cable twist and condition		3 monthly
Check System regulators and dump loads		3 monthly
Generators		
Record hours of operation		Monthly
Check fuel level		As required
Check oil level		As required
Perform any servicing required as specified in diesel operation manual		As per diesel service schedule
Inverters		
Check inverter operation		6 monthly
Remove excess dust from inverter area and heatsinks		6 monthly
Chargers		
Check charger operation		6 monthly
Remove excess dust from charger area and heatsinks		6 monthly
Switchboards		
Inspect condition of conduit and cabling		6 monthly
Test safety switch		Monthly
Battery bank		
Before performing any maintenance on the battery bank ensure it is safe to do so. **(See section Before you start page 6)**		
Check electrolyte level and top up if required		Minimum of weekly initially, then as required.
Check battery voltage and record		Initially daily, then as required
Check individual cell voltages and record		Monthly
Check individual cell specific gravity and record		Monthly
Check condition of terminals		6 Monthly
Check for water or acid spills around batteries and floor		Monthly

Chapter 4
Glossary

Alternating Current (AC)	Current which reverses its flow direction in regular cycles. Most petrol and diesel generators produce alternating current.
ampere	The unit of electrical current also known as amps (A).
ampere hour	Used to indicate battery size or capacity. One ampere of current flowing for one hour equals one ampere hour (Ah).
baking soda	This is the common name for Sodium Bicarbonate sometimes called Bi-carb of Soda.
battery charger	This device typically converts electricity from AC to DC and supplies a voltage and current suitable for charging of batteries.
boost charging	Is the process of charging the batteries up to a fully charged level using either renewable or backup generation.
cables	Conducting wires wrapped in a protective, insulating covering.
conduit	A protective tube, commonly PVC plastic, used to protect electrical cables.
current	The flow of electricity through a conductor from positive to negative. The symbol for current is I and its unit of measurement is the ampere, (A).
Direct Current (DC)	Current which flows in one direction only. It is produced by photovoltaic modules, batteries and some wind turbines.
electrolyte	The fluid in a wet cell battery. In a lead-acid battery, the electrolyte is sulphuric acid.
equalisation charge	This is a special charging process where the battery bank is slightly over charged to equalise the charge level in all cells of the battery bank. Some systems do this automatically while others require you to set your battery charge controller to equalisation mode. Make sure you switch battery charge controller back to normal operation after equalisation.

float charge	Is the process which maintains the batteries at a fully charged level, once the boost charge has completed. The float charge indicator light will come on when the controller is in this mode. If the battery charge level falls too much boost charging should resume.
float mode	An operational mode of regulators and chargers which ensures a float charge is performed once batteries are fully charged.
furling	The process that is incorporated to protect a wind turbine from damage during high wind conditions.
hydrometer	A specially designed tool for the measurement of specific gravity of solutions. Hydrometers used for batteries usually have a range from 1.100 to 1.300 kg/l.
LED	Light Emitting Diode - a small indicator light.
load dump	A device that is used when abundant electricity is being produced by parts of the system.
logbook	A notebook which is kept for recording maintenance and system performance information.
module	A photovoltaic module or solar module is also sometimes called a solar panel. It is an assembly of solar cells connected together and protected by a transparent cover and a weather proof backing.
photovoltaic	The process of producing electric current from light. Often abbreviated to PV.
RAPS	Remote Area Power Supply.
regulators	Also called controllers, this item regulates the current and voltage from an energy source usually to control the charging rate of batteries.
specific gravity	A measure of the density of a liquid (kg/l) relative to the density of water 1.000 kg/l.
tracker	A device on which a solar array can be mounted to follow the sun throughout the day.
voltage	Unit of potential difference, (the electrical pressure) that causes electricity to flow measured in volts (V).
watt	Unit of electrical power. Power is the rate of doing work. Power (Watts) = voltage (Volts) x current (Amps).
watt-hour	Unit of electrical energy. Energy equals the power multiplied by the time it is applied. A 1000 watt appliance used for one hour consumes 1000 watt-hours or 1 kWh of energy, this is also commonly referred to as a unit of energy.

Further information

If you are seeking information from areas outside of Western Australia, please phone your relevant state agencies.

The Murdoch University Energy Research Institute (MUERI) can provide technical advice on renewable energy sources. There is a display at Murdoch University which demonstrates renewable energy applications. For further information contact:

The Advisory Officer
Murdoch University Energy Research Institute
Murdoch WA 6150
Ph (08) 9360 6330
Fx (08) 9310 6094

For the cost of a local call, information on domestic energy efficiency and general information on the Renewable Energy Remote Area Power Systems Rebate Scheme is available from:

Home Energy Line
Ph 1300 658 158

Renewable Energy Remote Area Power Systems Rebate Scheme guideline interpretations can be discussed with the Administration officer of this scheme. Contact:

Office of Energy
Energy Innovation Division
9th Floor, Governor Stirling Tower
197 St Georges Terrace
Perth WA 6000
Ph (08) 9420 5600
Fx (08) 9420 5700

Office of **Energy**

The Technical & Safety Division of the Office of Energy can provide advice on safety matters relating to both RAPS installations and general electrical and gas safety issues. For further information contact:

Office of Energy
Technical & Safety Division
20 Southport St
Leederville WA 6007
Ph (08) 9422 5200
Fx (08) 9422 5222

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