

***FIRST  
NATIONAL  
BATTERY***

**THROUGH CARING WE LEAD**

# **RAYLITE M-SOLAR BATTERIES**

**INSTALLATION AND  
MAINTENANCE INSTRUCTIONS**

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## SAFETY WARNINGS

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**NO SMOKING.** Batteries generate highly explosive gasses during charge. No smoking, sparks or any form of naked flame may be allowed near the battery at any time.

**NO CHILDREN.** Children must be kept away from batteries at all times.

**PROTECTIVE CLOTHING.** Wear eye protection in the form of glasses or a face mask, and rubber gloves at all times whilst working on a battery. An acid resistant (rubber or plastic) apron and thick soled rubber shoes are also recommended.

**CORROSIVE ACID.** Battery electrolyte contains dilute sulphuric acid. This is highly corrosive and can cause severe burns. If spilt or splashed onto clothing, neutralize with a solution of baking soda and water. If splashed into the eyes wash for at least 15 minutes with copious amounts of water and if necessary, consult a medical doctor.

**ELECTRICAL SHOCK.** The battery remains live at all times, even if isolated and discharged. The threshold voltage for fatal electrical shock with Direct Current is lower than with Alternating Current.

**EXPLOSIVE HAZARD.** Keep the battery tops clear from all conductive objects such as tools, chains, watch straps, jewellery and the like, which may cause a spark. Always assume that there is explosive gas present above the cells at all times.

In order to prevent a build up of electrostatic charge, do not use a dry cloth when cleaning the cells. In order to prevent electrical tracking between cell posts, keep cell tops clean and dry at all times.

### MATERIAL SAFETY DATA SHEET

For further information relating to the safety aspects of this battery, refer to the manufacturers Material Safety Data Sheets available from the supplier.

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## HANDLING AND STORAGE

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Batteries should at all times be kept upright to prevent spillage of electrolyte. If electrolyte is spilt for any reason, contact your supplier. Do not add acid, or top up with water.

When moving batteries on a pallet, ensure the batteries are adequately secured. Ensure all safety recommendations are observed when handling batteries.

Display sufficient safety signs in and around the battery storage area to alert people of the presence of charged batteries.

Store cells under roof in a clean, dry place, on a level surface, at a temperature not exceeding 25°Celsius. Higher storage temperatures will increase the rate of self discharge.

Ensure the storage area is adequately ventilated to prevent any build up of hydrogen gas which may be released from the cells whilst in storage.

Ensure all cells are properly secured whilst stored to prevent accidental toppling over.

Ensure all open terminals have a light covering of Swift 500 paste provided with the cells, to prevent corrosion during storage.

Cover all unconnected terminals with the caps provided, to prevent accidental electrical contact.

Store the accessories separately in a dust free enclosure to ensure sensitive items such as electrolyte level indicators are not damaged or soiled. Do not fit the level indicators whilst in storage.

If stored for a prolonged period, the cells must be given a freshening charge at three monthly intervals, or whenever the open circuit terminal voltage drops below 2.05 volts per cell or the specific gravity drops below 1,210. The frequency of recharge will depend on the ambient storage temperature; the higher the temperature, the more frequently recharges will be required.

Charge at a current rate of 3.5% – 5% of the 10 hour capacity of the cell, and terminate the charge only once the specific gravity of the electrolyte in all the cells has risen and remains constant for three consecutive hourly readings. Ensure all the cells are gassing freely at the end of charge. For faster recharge rates, refer to the section on boost charging in this manual.

## INSTALLATION AND ASSEMBLY GUIDELINES

### INSPECTION ON RECEIPT

On receipt, check the contents of your delivery for the following items and ensure there are no signs of damage. Immediately note down and report any damage or shortages to your supplier.

- Cells are pre-assembled and series connected in 4 volt (2 cell) or 6 volt (3 cell) trays.
- Inter tray connectors, two take off cables and M8 stainless steel Allen head bolts are provided loose for connecting on site.
- One electrolyte level indicator per cell is provided in a separate packet.
- One product brochure
- One Installation and Maintenance Manual (the document you are currently reading)
- One Battery Log Book
- One pair of safety goggles and gloves.
- One packet Swift 500 connector paste.
- One hydrometer.
- One thermometer.

### INSTALLATION AND WIRING STANDARDS

Please refer to your countries standards code of practice for electrical installations that apply to electrical/battery installations. Ensure installations comply with these standards, where appropriate. The applicable wiring rules must be followed for connection to electrical equipment.

Check the polarities of the individual batteries and arrange them in position for series connection.

### BATTERY ASSEMBLY

Remove the caps over the end terminals, wipe the terminals clean and apply a light layer of Swift 500 paste to the outer surface of the terminals.

Connect the trays together using the inter tray connectors and bolts provided. **DO NOT OVERTORQUE THE BOLTS**, as this may damage the terminal thread and render the cell useless. The torque setting should be 32 Nm to 34 Nm.

Fill the cavity above the bolt with Swift 500 paste, and snap the connector caps in place. Before connecting the take off cables, check the overall battery voltage to ensure no blocks are reverse connected.

Connect the take off cables one at a time, terminating both ends of the first cable before connecting the second. Do not leave exposed cable ends loose; the battery is charged and capable of dangerous short circuit currents and sparks, should the exposed cable ends touch.

Connect the positive of the battery to the positive of the charger, and the negative of the battery to the negative of the charger.

Unwrap the float level indicators and check that the floats move freely. Replace one vent cap on each cell with a float level indicator. The indicator has a "low" and "full" level marking; check that all indicators are floating freely and are at the "full" level. If needed, do not top up until after the battery has been fully charged.

### COMMISSIONING

Switch on the charger/Switch on the solar array.

Check that the charger or regulator is set at the correct voltage.

Allow the battery to be fully charged before applying any load. This may require that the battery is first given a freshening charge.

The battery is fully charged once the specific gravities of all the cells stop rising, as measured by three consecutive hourly readings.

Once the battery has reached top of charge, enter the first set of temperature corrected specific gravity, voltage and electrolyte temperature readings in the Battery Log Book supplied. Temperature correction is explained further below.

## BATTERY MAINTENANCE

Proper battery maintenance is a major determinant of the service life achieved from the battery. It is therefore important that you follow the recommendations below closely.

### WEEKLY

Check to ensure that the charging system is operating within the required limits, and reset if necessary.

Visually check that the vent cap holes are clear and inspect the battery for any apparent signs of failure or problems requiring immediate repair.

### MONTHLY

Visually check the cell lids, and connectors for dirt and wipe clean with a damp cloth.

Ensure all vent cap holes are clear and vent caps are tight.

Check for signs of loose electrical connections, and re-tighten if necessary.

Check and record the cell voltages, specific gravities and electrolyte temperatures in the Battery Log Book provided. Top of charge S.G. should be between 1,250 and 1,270 @ 25°C. Correct the specific gravity readings for temperature as described further below. During the initial period after commissioning, the specific gravities of the cells may rise above 1,270 as the cells "cycle up" to full capacity. This is normal, and is not detrimental to the life or performance of the battery.

However top of charge S.G.'s found to exceed 1,300 requires lowering, as described below. Irregular voltages and specific gravities indicate the need for a boost charge. Recommended boost currents are given at the end of this section. If time allows, boost charge until the specific gravities cease to rise when measured at three consecutive hourly intervals.

Check that the electrolyte level indicators move freely and that the levels in all cells are between the low and full marks. Top up where necessary. DO NOT OVER TOP. If electrolyte has been spilled or splashed onto the cells during topping up, check for signs of tracking and clean thoroughly. Ensure only approved water is used for topping up. The manufacturer's specification for topping up water is given on the next page. The use of impure water can reduce battery life dramatically and will nullify the manufacturer's warranty.

### RECORD KEEPING

The Battery Log Book provided is the only reference available to you in the event of a problem or failure. The information entered by you will help the Service Technician to:

- Identify a potential problem before it leads to a system failure.
- Understand why a cell may have failed prematurely.
- Process a warranty claim should this be necessary.

Regular and complete entries in this book are therefore essential to the integrity of your system.

### TEMPERATURE CORRECTION OF SPECIFIC GRAVITY READINGS

Specific gravity varies with temperature. In order to be meaningful, all specific gravity readings should therefore be corrected to the same (25°C) temperature before entering in the Log Book. This correction is done as follows:

For every 1°C measured above 25°C, add 0,7 point (0,0007) to the S.G. reading taken; for every 1°C measured below 25°C, subtract 0,7 point (0,0007) from the S.G. reading taken.

E.g.: A specific gravity reading of 1,240 taken of electrolyte at 39°C, is corrected as follows:

$$1,240 + (39 - 25) \times 0,0007 = 1,240 + 0,0098 = 1,250 \text{ at } 25^\circ\text{C}$$

Likewise, a reading of 1,230 taken at 11°C is corrected to 1,220 at 25°C

Specific gravities are an indication only. They are only accurate during discharge from a fully charged state when the electrolyte is thoroughly mixed. During recharge the specific gravity will only increase markedly once the gassing point has been reached.

## BATTERY MAINTENANCE CONT.

### ADJUSTMENT OF ELECTROLYTE SPECIFIC GRAVITY

The procedure for adjusting specific gravities is as follows:

Charge the battery at the recommended finishing rate or equalising rate until specific gravities have been constant over three successive readings taken at hourly intervals. When observing specific gravity values, these should be corrected for temperature as given above.

At all times observe the necessary safety precautions.

Should the specific gravity be high, remove a little of the electrolyte and replace with an equal volume of distilled or deionised water (to the specification given below).

Add a small amount at a time, forcing it well down into the cell, with the cells gassing, to help mix the water with the acid. When mixed, read the specific gravity (temperature-corrected as before).

Repeat this process (minimum 30 minutes on charge) until the specific gravity is within the specified tolerance.

Likewise, if the specific gravity is too low, remove a little of the electrolyte and replace with an equal volume of stronger sulphuric acid (say, S.G. 1,400) in small amounts while agitating as described above.

Once again, repeat the process until the specified S.G. tolerance is achieved.

When the adjustment has been completed, ensure that the level of the electrolyte in each cell is correct by removing excess acid or topping up to the correct level with acid of the same specific gravity.

### SPECIFICATION FOR PURITY OF TOPPING UP WATER

Topping up water not compliant with the following specification will nullify the warranty.

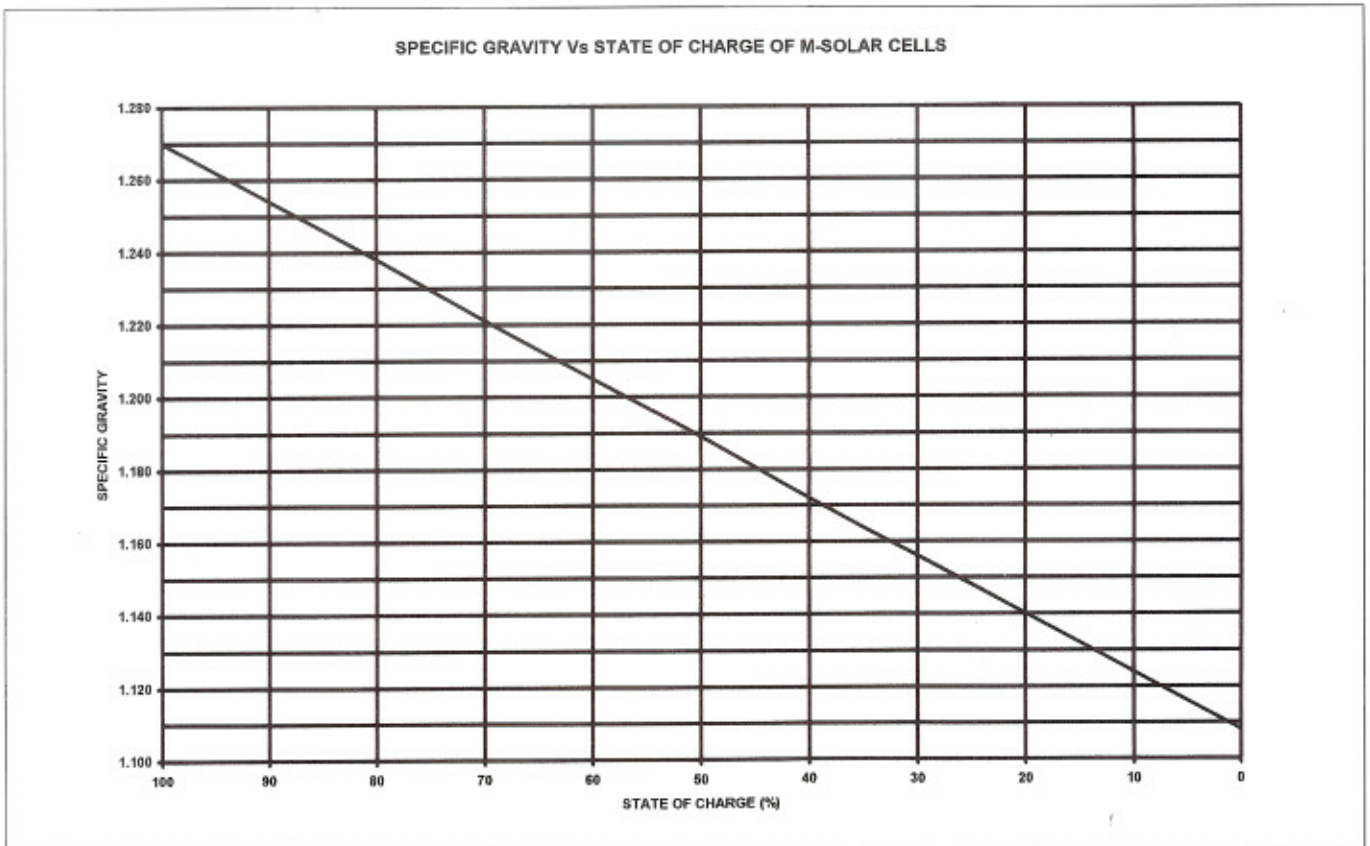
- It shall be clear, colourless and odourless
- The pH shall be between 5 and 7
- Wherever possible, it shall be stored in a sealed glass or plastic container
- Conductivity shall be less than 30  $\mu\text{S}/\text{cm}$
- Impurities shall not exceed the limits tabled hereunder

<b>Impurity</b>	<b>Miligrams per litre</b>
Dissolved solids	25
Arsenic (As)	1
Chloride(Cl)	5
Copper(Cu)	0,1
Iron(Fe)	0,2
Manganese(Mn)	0,1
Nitrogen (as $\text{NH}_4$ )	5
Nitrogen (as $\text{NO}_3$ )	5
HeavyMetals(as Pb)	5
$\text{KMnO}_4$ reducing substances*	10

\* As determined by Raylite test method LTM - 21- 01

## BATTERY MAINTENANCE CONT.

### STATE OF CHARGE versus SPECIFIC GRAVITY @ 25 °C



### BOOST CHARGING OF VENTED LEAD-ACID CELLS

Lead acid batteries in a discharged state undergo two independent reactions when being recharged. In the first stage, the depleted active materials are reconverted into their usable (charged) states. All of the energy from the charger, other than that being used to overcome the ohmic resistance of the battery, is utilised in this reaction, and charging efficiency is very high.

At the end of this stage, electrolysis of the water in the electrolyte begins, with the liberation of oxygen and hydrogen gas. In this gassing stage, the further reconversion of active material continues at a progressively slower rate with an increasing amount of charging energy used preferentially in driving the gassing process. Heat is generated and it becomes necessary to lower the rate of charge to protect the battery. Uncontrolled charging results in temperatures high enough (>50°C) to destroy the battery.

It is now recognised worldwide that fast charging is beneficial in terms of battery life and retention of capacity, and batteries can be charged at rates up to 6 times the capacity of the battery. This is impractical, however, because of the enormous cost of such sophisticated chargers, and it is normal to restrict charging rates to 40% of capacity. At this rate (40A per 100Ah), all batteries may be safely charged **up to the gassing voltage** only. At this rate, the temperature increase will be moderate, of the order of 10°C.

The disadvantage of charging at high rates is that the state-of-charge when reaching the gassing voltage is lower, the higher the rate. As an illustration of this, when charging a 100Ah traction cell at 10A to 2.4V, state-of-charge at the gassing voltage will be 85%; when charging at 40A, state-of-charge at the gassing voltage will only be 57%.



## BATTERY MAINTENANCE CONT.

In the context of solar systems, fast recharging is useful where batteries have been allowed to operate continuously in a partial state-of-charge because of inadequate charging, or when the solar charging system has become inoperative. It is worth remembering that batteries which have remained below 50% state-of-charge for any length of time will have sulphated and be in need of a **slow** recharge. In the final analysis, because solar systems do not normally have excess charging capacity, it is usual to charge solar batteries in the most **efficient** manner possible, that is, at low rates, for most of the time below the gassing voltage.

For convenience, our recommendations on charging are given below.

### Parameters for Boost Charging Raylite M-Solar Cells

Cell Type	MIL15P OHT15/19P	MIL17P OHT17/21P	MIL21P OHT21/25P	MIL25P OHT25/29P	MTL25P TLP25/29P	MTE21P TEP21/25P						
C100, Ah	490	560	700	840	1010	1330						
Gassing Voltage/cell V	2,35 - 2,38	2,35 - 2,38	2,35 - 2,38	2,35 - 2,38	2,35 - 2,38	2,35 - 2,38						
Max. charge current, A	140	160	200	240	288	380						
<b>Approximate charging current &amp; time to achieve given state of charge at gassing voltage, from 80% depth of discharge</b>												
State of Charge	A	Hrs	A	Hrs	A	Hrs	A	Hrs	A	Hrs	A	Hrs
57%	140	1,9	160	1,9	200	1,9	240	1,9	288	1,9	380	1,9
60%	126	2,2	144	2,2	180	2,2	216	2,2	259	2,2	342	2,2
65%	105	2,8	120	2,8	150	2,8	180	2,8	216	2,8	285	2,8
70%	88	3,6	100	3,6	125	3,6	150	3,6	180	3,6	238	3,6
75%	70	4,9	80	4,9	100	4,9	120	4,9	144	4,9	190	4,9
80%	53	6,7	60	6,7	75	6,7	90	6,7	108	6,7	143	6,7

## TROUBLE SHOOTING NOTES

The following notes are provided to serve as a guide to assist in identifying possible symptoms and causes of premature battery failure.

### UNDERCHARGING/OVER DISCHARGING

#### SYMPTOMS

No gassing at end of boost charging  
 Specific gravities low and/or irregular  
 Irreversible loss of cell capacity  
 High cell temperature when charged  
 Low charging current

#### CAUSES

Low charge voltage  
 Battery undersized/load increased  
 Insufficient boost charging  
 Faulty regulator cut-out setting  
 System undersized for the load

### OVERCHARGING

#### SYMPTOMS

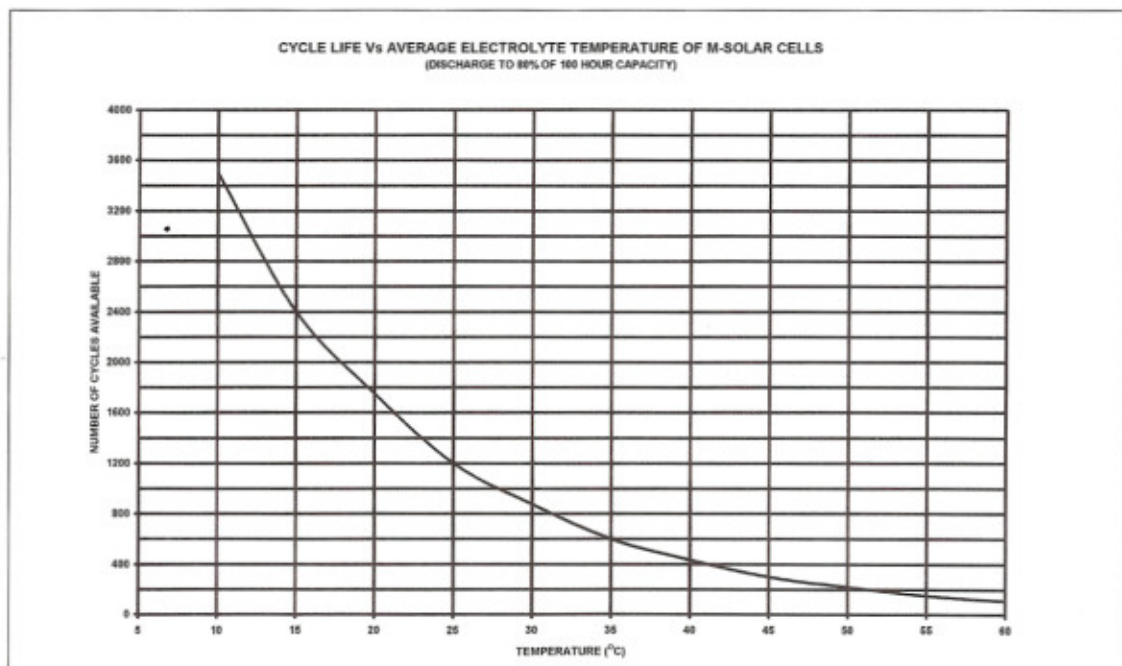
Low electrolyte levels/high water  
 consumption  
 Dislodged positive active material/murky  
 electrolyte  
 Excessive gassing on float charge  
 Heavy blackening of filler caps

#### CAUSES

Float and/or boost rates too high  
 Excessive boost periods and/or frequency  
 High ambient temperatures  
 Impurities in topping up water

### LIFE CYCLE versus TEMPERATURE

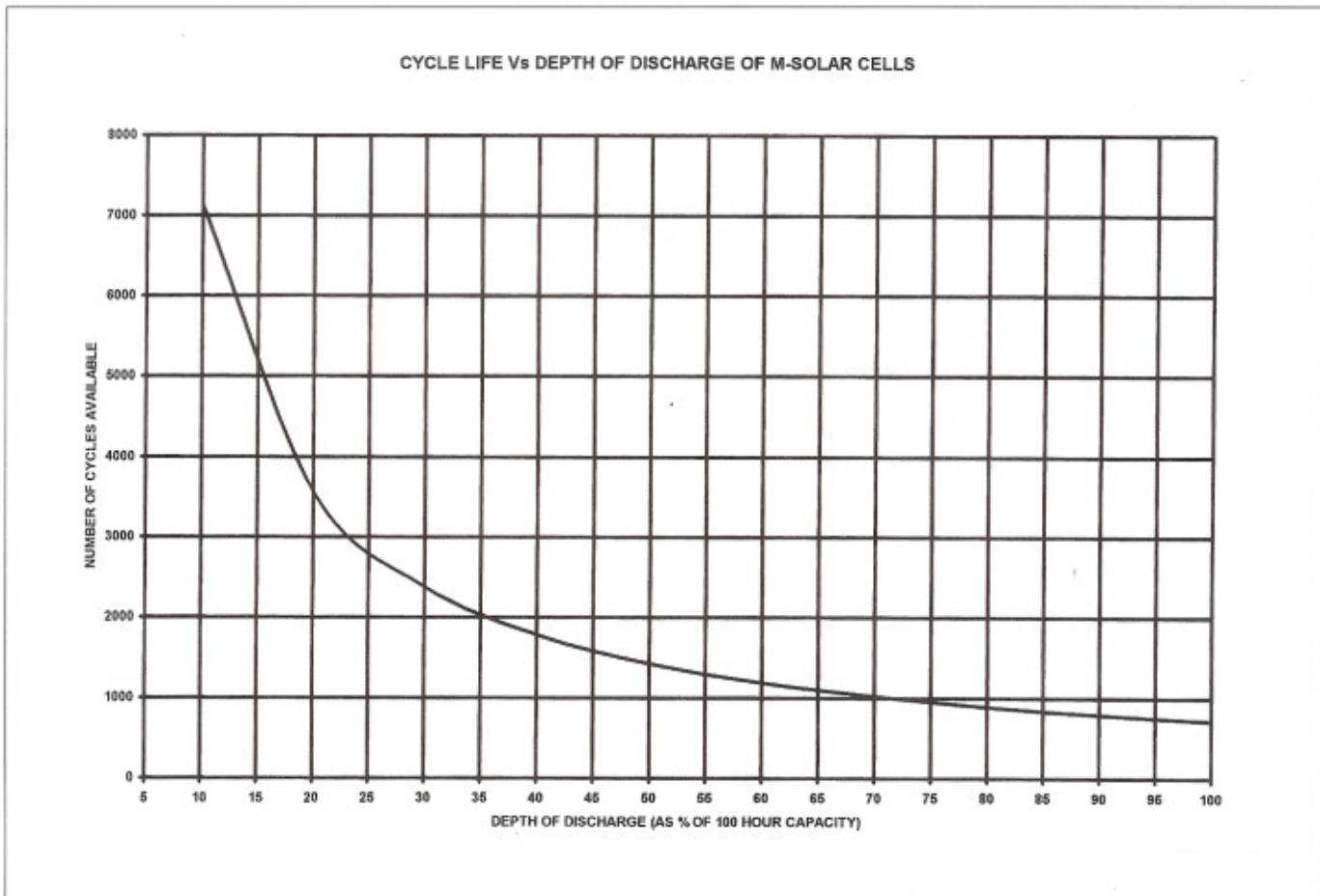
A lead acid cell is a chemical device containing highly corrosive sulphuric acid. The rate at which the lead components within the cell corrodes is, inter alia, dependent on the temperature of the electrolyte within the cell. High electrolyte temperatures result in premature cell failure, as indicated on the graph below. Resistive losses from the conducting elements within the cell generate heat when the cell is operating. During the charge cycle, chemical resistive losses add to these to generate additional heat. It is therefore important to ensure that the battery is installed in as cool area as possible and that good ventilation is provided to ensure a low operating temperature.



# TROUBLE SHOOTING NOTES CONT.

## LIFE CYCLE versus DEPTH OF DISCHARGE

Battery life depends, inter alia, on the depth of discharge during cycling duty, as shown below. In solar duty the daily discharge is roughly 15% of nominal battery capacity. This is to allow for autonomy in cases where solar insolation is limited such as during cloudy weather, rain, etc. A solar battery gradually loses capacity over its cycle life, and solar systems are sized to accommodate the battery's end of life capacity which is normally accepted as 80% of nominal battery capacity.



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