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## 1. General Information

PowerSafe® VM is a range of valve regulated sealed lead-acid batteries. The utilisation of gas recombination technology ensures that, in normal operation, the gas evolution is minimal and no topping-up is required during the service life of the battery. As a separate battery room is not necessary, PowerSafe VM is ideally installed alongside or in the same room as the equipment it supports.

## 2. Safety Precautions

### Care for your safety



No smoking, no naked flames, no sparks



Electrical hazard



Electrolyte is corrosive



Shield eyes



Danger

**IMPORTANT NOTE - IT IS MOST IMPORTANT TO READ AND FULLY UNDERSTAND THESE INSTRUCTIONS BEFORE COMMENCING THE UNPACKING AND INSTALLATION OF THE BATTERY. INSTALLATION SHOULD ONLY EVER BE UNDERTAKEN BY SUITABLY QUALIFIED PERSONNEL.**



Clean all acid splash in eyes or on skin with plenty of clean water. Then seek medical help. Acid on clothing is to be washed with water.



Read instructions



Re-cycle scrap batteries. Contains lead



Risk of explosion or fire. Avoid any short circuit. Metallic parts under voltage on the battery, do not place tools or items on top of the battery.

**California Proposition 65 Warning – Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.**

**Batteries also contain other chemicals known to the State of California to cause cancer.**

**WASH HANDS AFTER HANDLING.**

All lead-acid batteries are potentially dangerous and particular care must be taken during their handling and installation.

Personnel undertaking this work must be provided with appropriate equipment to ensure their safety and in addition to exercising routine care and caution they should be additionally made aware of the following:

- A) Sulphuric Acid** - these batteries contain sulphuric acid which is corrosive and will cause burns and injury. In the event of contact with skin or eyes flush immediately with plenty of clean water and seek medical attention.
- B) Explosive Gases** - these batteries can give off explosive gases. It is therefore important to keep sparks, flames and lighted cigarettes away from the battery.  
Isolate the battery circuit before connecting or

disconnecting to avoid sparks. Never lay tools or other metal objects on the modules to avoid shorting. Ensure all connections are tight before switching on and only use insulated tools. Before working on a battery, metal personal effects such as watches, rings, bracelets etc, must be removed. Locations where batteries are kept and charged must be adequately ventilated.

- C) Electric Shock and Burns** - multi-cell systems attain high voltages and extreme caution must be taken to avoid serious shock and burns during installation.
- D) PowerSafe VM cells** are supplied filled and charged and are electrically live at all times so must be treated with great care. Even if a cell container and/or lid is damaged and weeping acid the cell is still capable of delivering high currents.





- i) repeat E, F and G.
- j) attach the two lifting strap/hook assemblies provided to the module and using the lifting device position the module on top of the first and bolt them together using the hardware provided.
- k) repeat D, E etc. until the modules have been fully assembled as shown on the assembly drawing. Carry out a final check to ensure that the modules are correctly orientated with respect to polarity.
- l) discard the lifting strap/hooks - they are not intended for long term use.

## 8. Electrical Connections

**WARNING -**  
BEFORE YOU START WORK - MAKE CERTAIN YOU ARE FAMILIAR WITH THE POLARITY SEQUENCE OF THE CONNECTIONS. SOME SYSTEMS MAY BE CONNECTED SO THAT THE CELL CASE AND/OR THE RACK ARE LIVE RELATIVE TO THE TERMINALS.

INADVERTANT SHORT-CIRCUIT BETWEEN THE TERMINALS AND BATTERY CASE WITH A METAL OBJECT SUCH AS A CONNECTOR OR TOOL COULD CAUSE SERIOUS INJURY OR DEATH.

### 8.1 Inter-tier and inter-row Connections.

- a) before despatch from the factory each individual cell terminal is cleaned and coated with a layer of non-oxide grease.
- b) all the cell terminals have their polarity clearly marked by either a RED ring to denote a positive terminal or a BLACK ring to denote a negative terminal.
- c) the connector contact surfaces should be cleaned and a thin layer of non-oxide grease applied.
- d) taking note of the polarity fit all the inter-tier and inter-row connectors as shown on the battery assembly drawing using the hardware provided. Tighten them in accordance with the torque limit information in Appendix "B".

### 8.2 Main Terminal Assembly

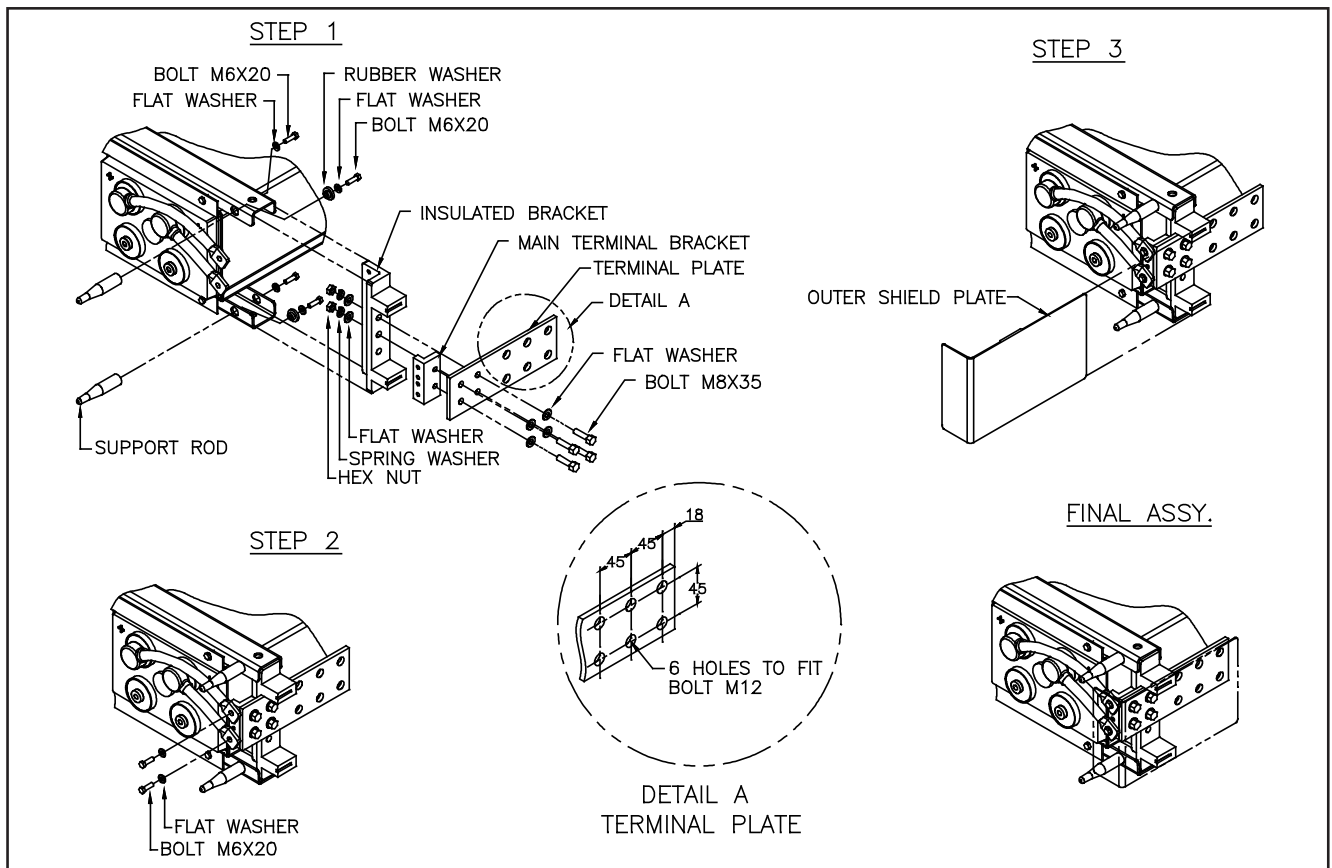
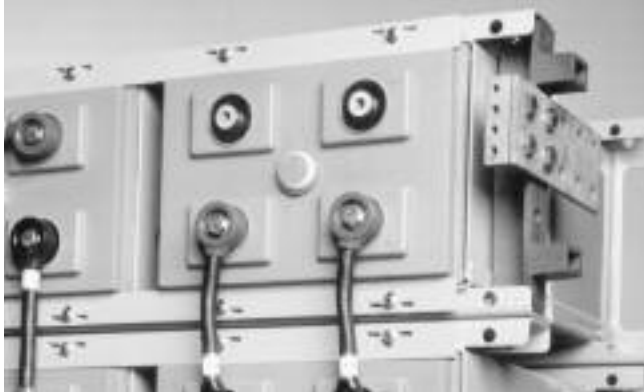


Figure 6: Main terminal assembly detail

- a) fit the inner-shield to the module.
- b) bolt the terminal plate insulating bracket to the frame of the steel module.



**Figure 7:** Main terminal bracket and terminal plate bolted to the mounting bracket

- c) bolt the main terminal bracket and terminal plate to the mounting bracket, see Fig 7.



**Figure 8:** Take-off connectors between cell terminal and main terminal plate

- d) fit the take-off connector(s) between the cell terminal(s) and the main terminal plate, see Fig 8.
- e) where cable connectors are used, fit the insulating lids to each of the terminals.

## 9. Final Assembly Connections, Checks and Commissioning Charge

- a) in order to identify each cell within the battery, a set of self adhesive numbered labels are supplied for fixing to the cell lids.  
It is normal practice to identify the positive end cell as No.1 with the remaining cells being numbered consecutively following the path of the electrical connections throughout the battery.
- b) once all the connections have been tightened to the correct torque and with the battery on open circuit, read and record the individual cell and the total battery voltage using a DC voltmeter. The total battery voltage should be approximately equal to the number of cells multiplied by the reading of one cell. If it is less, re-check the connections for the correct polarity.
- c) fit the four support rods (see illustration Fig 6) to each of the module frames.

The assembly of the battery is now completed to the stage where external electrical connections can be made to commence the Commissioning Charge.

The connections between the battery and it's associated charger are made at the main terminal plates. Ensure that the charger POSITIVE lead is connected TO the main battery POSITIVE terminal and that the charger NEGATIVE lead is connected TO the main battery NEGATIVE terminal. Care should be taken in selecting the size of these connecting cables to optimise the voltage drop between the charger output terminals and the main battery terminals.

Where battery strings are to be connected in parallel, this voltage drop should be equalised in each of the circuits to avoid imbalances in the charging/discharging circuits of the different strings which may result in damage to the battery system and a reduction in operating life.

Once these connections have been made:



**Figure 9:** Outer shield attached to the main terminal take-offs

- d) attach the outer shield to both the positive and negative main terminal take-offs, see Fig 9.



**Figure 10:** Front panel attached to the four support rods

- e) attach a front panel to the four support rods on each of the modules with the connector sheaths provided, see Fig 10.
- f) with NO LOAD attached to the system, switch on the charger and record readings of cell voltage and charge current to form the very important Commissioning Charge Record for future reference. It is intended that the example Battery Record Sheet shown on page 12 of this manual be photocopied and used for recording purposes.
- g) continue the charge until the current flow into the battery has fallen to a minimum and remained constant for 3 consecutive hourly readings.

- h) if the battery is to be immediately put into service, continue the commissioning charge for a minimum total continuous time of 72 hours.
- l) if the battery is to be subjected to a site acceptance test before being put into service, continue the commissioning charge for a minimum total continuous time of 144 hours.

**N.B.** when a site acceptance test is required, it must be completed following the commissioning charge **BEFORE** any operating load is introduced into the system.

Upon completion of the commissioning charge or recharge following a site acceptance test, the load circuit may be introduced into the system and the battery maintained thereafter in the normal operating "float charge" mode.

## 10. Charger Selection

These batteries are designed to be connected in parallel with a load that is normally powered by a charger. The charger **MUST** be of the constant potential type with a characteristic to give an applied charging voltage, at the main battery terminals, equivalent to a minimum of 2.25 volts per cell and a maximum 2.28 volts per cell at an ambient temperature of 25°C (77°F). For further details of the float voltage to be applied to those installations where the mean operating temperature is other than 25°C (77°F), consult Appendix "A".

For optimum charge efficiency the **MAXIMUM** charge current available to the battery should be limited to 8% C<sub>8</sub> capacity expressed in amps eg 80.64 amps for the VM-1000, 124.80 amps for the VM-1500, with a **MINIMUM** charge current output equivalent to 5% C<sub>8</sub> capacity expressed in amps eg 50.4 amps for the VM-1000. 78 amps for the VM -1500.

The battery will accept, without damage, higher values of charge current provided that the applied charge voltage does not exceed the recommended float charge level.

The ripple content of the charging current affects the life of a battery. The rms value of the a.c. component of the charging current (fundamental and harmonic) must not exceed 0.10 C<sub>8</sub> (Amps).

Transient and other ripple type voltage excursions can be accommodated provided that, with the battery disconnected, the system peak to peak voltage including regulation limits falls within ±2.5% of the recommended float voltage.

## 11. Routine Operation

### 11.1 Charging

The normal operating procedure is for the battery to be subject to a "float charge" in parallel with the charger as described above.

It is important that the level of the applied voltage is adjusted in accordance with the value(s) given in Appendix "A". Select a temperature that most nearly represents the actual mean operating temperature of the particular installation in order to optimise the battery performance.

It is important that the applied voltage does not fall below the minimum value shown.

Equally, any excursion of "battery voltage" above the recommended float charge voltage for more than one minute should either trigger an alarm or cause immediate termination of the charge (except under controlled elevated voltage charging, see 11.2).

It is recommended that batteries should be recharged within 24 hours following a discharge.

It is recommended that this level of float voltage also be used for:

- a) the freshening charge procedure - see Section 5,
- b) the commissioning charge procedure - see Section 9
- c) for the normal recharging of the battery following a discharge in order to minimise any possibility of overcharge.

### 11.2 Faster Charging

Recharge times can be reduced by increasing the level of the applied charging voltage.

The **MAXIMUM** applied voltage should never exceed that equivalent to 2.4 volts per cell at 25°C (77°F) **AND** when using this charge regime:

- a) reduced service life will result from frequent use.
- b) the available charging current **MUST** be limited to 8% C<sub>8</sub> capacity expressed in amps.
- c) the charge **MUST** be terminated when the charge current reaches a constant value.
- d) this elevated applied charging voltage may be used for a **MAXIMUM** of 12 hours.

**IF THIS METHOD IS SELECTED IT IS VITAL THAT THE CHARGER IS RE-SET TO THE "NORMAL" FLOAT VOLTAGE SETTING AT THE END OF USE TO AVOID SERIOUS DAMAGE TO THE BATTERY.**

### 11.3 Discharging

The minimum average voltage per cell should not be reduced to below 1.60V for longer than 2 minutes on a battery designed for a standby time of up to 1 hour or for longer than 5 minutes on a battery designed for a standby time in excess of one hour. It is recommended that a low voltage disconnect feature is included in the system to ensure compliance with the above.

**N.B.** momentary dips in voltage below 1.6Vpc as experienced in switchgear closing operations are not detrimental.

### 11.4 Operating Temperature

The nominal operating temperature for a lead acid battery is 20-25°C (68-77°F) Operating at temperatures above 25°C (77°F) will reduce the operating life of a battery.

## 12. Routine Maintenance Procedures

### 12.1 Three Monthly Inspection.

- a) complete a visual check of the overall installation looking for signs of electrolyte leakage and corrosion around the terminal posts.
- b) check and record the overall applied voltage across the battery and adjust as necessary.
- c) record the individual cell voltages on the battery record sheet under float charge and compare them with the last set looking for any adverse trends in the reading of any individual cell(s).

### 12.2 Six Monthly Inspection

- a) repeat the three monthly inspection.
- b) if any cell is continuing to show adverse trends in it's voltage reading contact your EnerSys® representative.

### 12.3 Yearly Inspection

- a) repeat the six monthly inspection.
- b) check the torque settings of the various nuts and bolts correcting as necessary.

### 12.4 General

It is considered as good practice to record details of emergency and accidental discharges. During the re-charge, record the voltage at the terminals of the battery and the value of the charge current, if possible, towards the end of the charge.

### 13. Cell Removal / Replacement Procedure

In the event of it becoming necessary to replace any single cell within a battery/module then the following procedure should be adopted having first contacted your local EnerSys® representative and obtained the necessary tools:

- a) turn off the charger and disconnect it from the battery.
- b) remove the front panel from the module containing the cell to be replaced.
- c) disconnect the inter-cell connectors from the cell.
- d) remove the cell retainer bar from the top and bottom of the module.
- e) flip the cover off the valve assembly.
- f) using the key provided by your EnerSys representative slowly undo the flame arrestor/valve assembly just sufficiently to allow the gas to escape releasing the positive pressure from within the cell casing and then immediately re-tighten the flame arrestor/valve assembly.
- g) screw the tools obtained from your local EnerSys representative into the terminals of the cell and pull it from the steel module onto a lift truck or suitably positioned support assembly.
- h) push the fully charged replacement cell into the steel module, re-fit the cell retaining bars, the inter-cell connectors and the front panel. Re-connect the charger to the battery system and switch it on.

### 14. Good Housekeeping

- a) keep the battery and it's surrounding area clean and dry.
- b) keep the connectors (solid), terminals and terminal bolted connections covered with the non-oxide grease supplied.
- c) occasionally, carefully wipe any dust or other deposits from the modules with a soft cotton cloth dampened with clean water. SCOURING CLOTHS AND CLEANING FLUIDS/SOLVENTS SHOULD NEVER BE USED TO CLEAN THE BATTERY TO PREVENT ANY POSSIBLE DAMAGE TO THE PLASTICS.

### APPENDIX 'A'

#### Recommended applied Float Voltage

Temperature	Voltage per cell
0°C (32°F)	2.33 - 2.36V
10°C (50°F)	2.30 - 2.33V
20°C (68°F)	2.27 - 2.30V
25°C (77°F)	2.25 - 2.28V
30°C (86°F)	2.24 - 2.27V
35°C (95°F)	2.22 - 2.25V
40°C (104°F)	2.21 - 2.24V

### APPENDIX 'B'

#### Torque Settings

Connection Type		Torque Nm (lbf in)
Stainless steel bolt (Terminal)	M6	6 (53)
Stainless steel bolt (Terminal)	M8	10 (88)
Stainless steel bolt (Terminal)	M10	15 (132)
Stainless steel bolt (Terminal plate to Insulated bracket)	M8	10 (88)
Stainless steel bolt (External cable connection to terminal plate)	M12	16 (141)
Zinc galvanised bolt for connecting base and module	M10	22 (194)
Zinc galvanised bolt for inter-module connections	M10	22 (194)









## Battery Record Sheet

Works Order No:		Customer Ref:	
Installed At:		Battery Title:	
No. of Cells:	Type	Date Installed:	
Total battery voltage across terminals:		V	Ambient Temperature: °C
Battery Charging Current:		A	Average Vpc:
Remarks/Recommendations:			
Engineer in Charge:		Date of Service:	

### Individual cell readings

Cell No.	Serial No	Volts per Cell
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Cell No.	Serial No	Volts per Cell
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

Cell No.	Serial No	Volts per Cell
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
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