INSTRUCTION MANUAL

FOR INSTALLATION OF BATTERIES

BATTERY

INDEX

1) DESCRIPTION OF BATTERY BANK (TUBULAR & VRLA)

A secondary electric storage cell stores electrical energy in the form chemical energy when it is charged and delivers electrical energy by commissioning chemical energy when it is discharged.

Lead Acid Battery

A lead acid electronic storage cell consists of a set of positive plates/anode (containing lead dioxide) and negative plates/cathode (containing pure spongy lead) immersed in an electrolyte which is dilute sulphuric acid. Non conducting but permeable separators are used in between positive and negative plates to avoid short circuit.

All these components are housed in a hard rubber or plastics container which is known as the cell box/container. All positive plates are connected in parallel to the outside positive terminal and all negative plates connected in parallel to a negative terminal. Direct current electricity can be delivered to and taken out from the cell through this terminals.

A lead acid cell has an open circuit voltage of 2V. When multiple cells are connected in series the voltage of all cells are added (say 12 cells connected in series will provide a total of 24V) and all these cells together is known as a battery bank or more commonly “Battery”

TUBULAR BATTERY

A tubular battery consists of positive plates which are made of tubes holding lead dioxide – all tubes joined together. The positive plate is a flat pasted plate. It has a flooded electrolyte design where electrolyte in liquid from is stored in the battery cell box. The water in the electrolyte needs replenishment on periodic basis between once in 9 months to a year, depending on the design of the battery. The tubular battery is the steadiest among all lead acid batteries for heavy cycling or deep discharge and recharge operators.

Under repeated 80% depth of discharge these batteries survive at least 1200 cycles of charge and discharge. The life cycle can be increased to 2500 cycles if depth of discharge is reduced to 50% and 5000 cycles if it is reduced to 20% of battery capacity. Generally in solar photovoltaic and wind solar hybrid power plant applications these type of batteries are almost always used and provide a life of around 8-10 years for large battery banks if used and maintained properly.

VRLA BATTERY

Valve regulated lead acid (VRLA) batteries consists of plate pasted positive and negative plates with a glasswool absorbent mat separator in between them. The glasswool mat is partially soaked with electrolyte and there is no free/flooded electrolyte in the battery.

That is why it is also known as an AGM (absorbent glass mat battery). These are housed in a plastic container over sealed from atmosphere but with a relief valve which allows gas to escape if high pressure is developed inside the battery.

Due to the design, the oxygen gas evolving from the battery is recombined and re-forms back into water and no water is lost from battery due to which it does not require any water replenishment.

VRLA is ideally suited for floating or shallow discharge operations. At 80% depth of discharge the cycle life if normally not more than 500 cycles. It also cannot be charged at high voltages and its life is severely affected if exposed to higher temperatures above 350C.

In recent times a modified version of VRLA known as tubular gel battery (the AGM technology is replaced by gel technology) has hit the market. It is supposed to have a cycle life as good as the flooded tubular battery but it suffers from the same problems when charged at higher voltages. Another major problem of AGM/Gel batteries is the extremely difficult/impossible process of reviving battery if kept in discharged condition for a long time.
In this manual where batteries will be exclusively used for wind solar hybrid and solar power plants, we have delt with tubular batteries and operational maintenance aspect only and not for any VRLA battery.

II) BATTERY ROOM AND LAYOUT

Battery Room

A battery room should have sufficient space for installing the battery stands and also for movement of personnel for servicing the batteries. For this purpose, a proper battery installation layout drawing should be prepared first and then the battery room design should be finalized considering the battery installation layout. Sufficient gap should be provided between the wall of the battery room and the adjoining row of batteries to avoid electrical earth leakage. Refer sample drawings attached.

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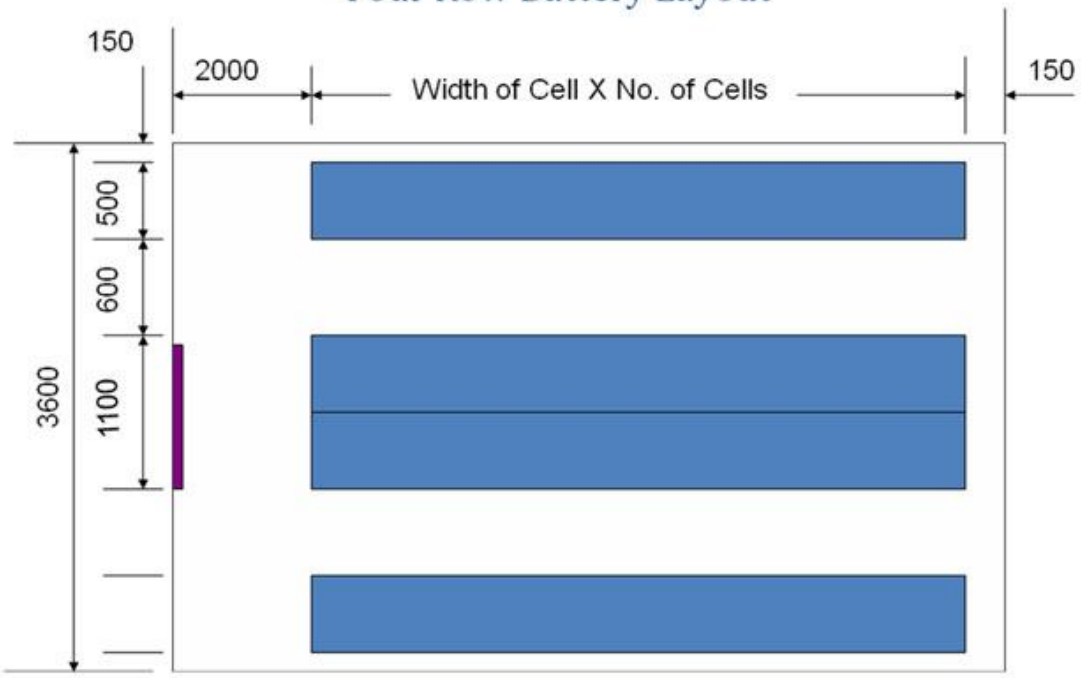
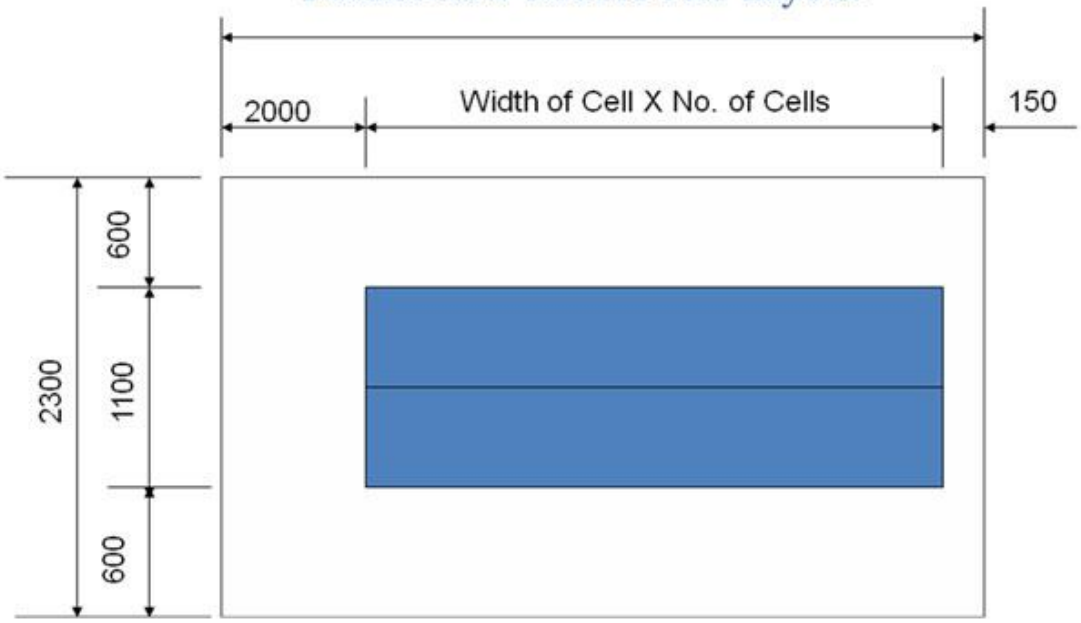
Four Row Battery Layout



Double Row Double Tier Layout



The floor of the battery room should be preferably acid resistant and no inflammable materials are to be used inside the battery room. The room should be well ventilated either by two open windows or by using suitable exhaust fan to enable continuous change of air inside the room.

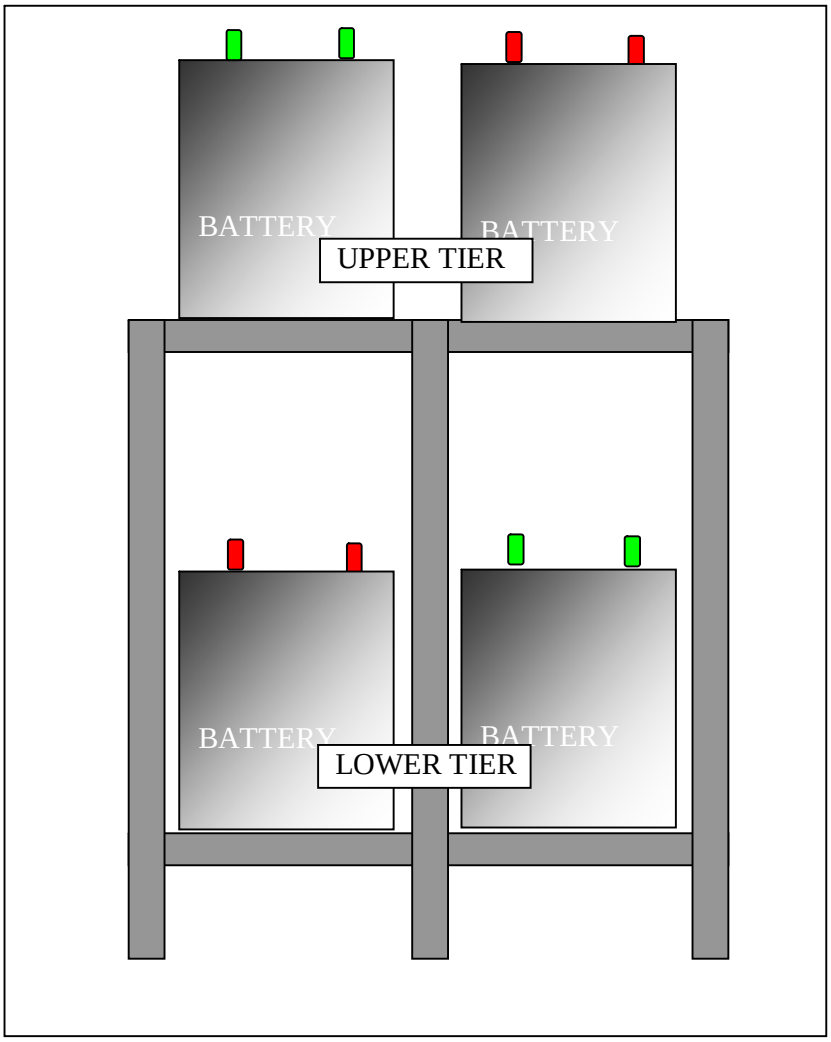
A sink with a water tap is to be preferably located inside the battery room to enable washing away of acid spillage if it happens accidentally. No sensitive electronic equipment is to be located inside the battery room. It is better to avoid harsh direct sunlight to come inside the battery room.

Battery Stand

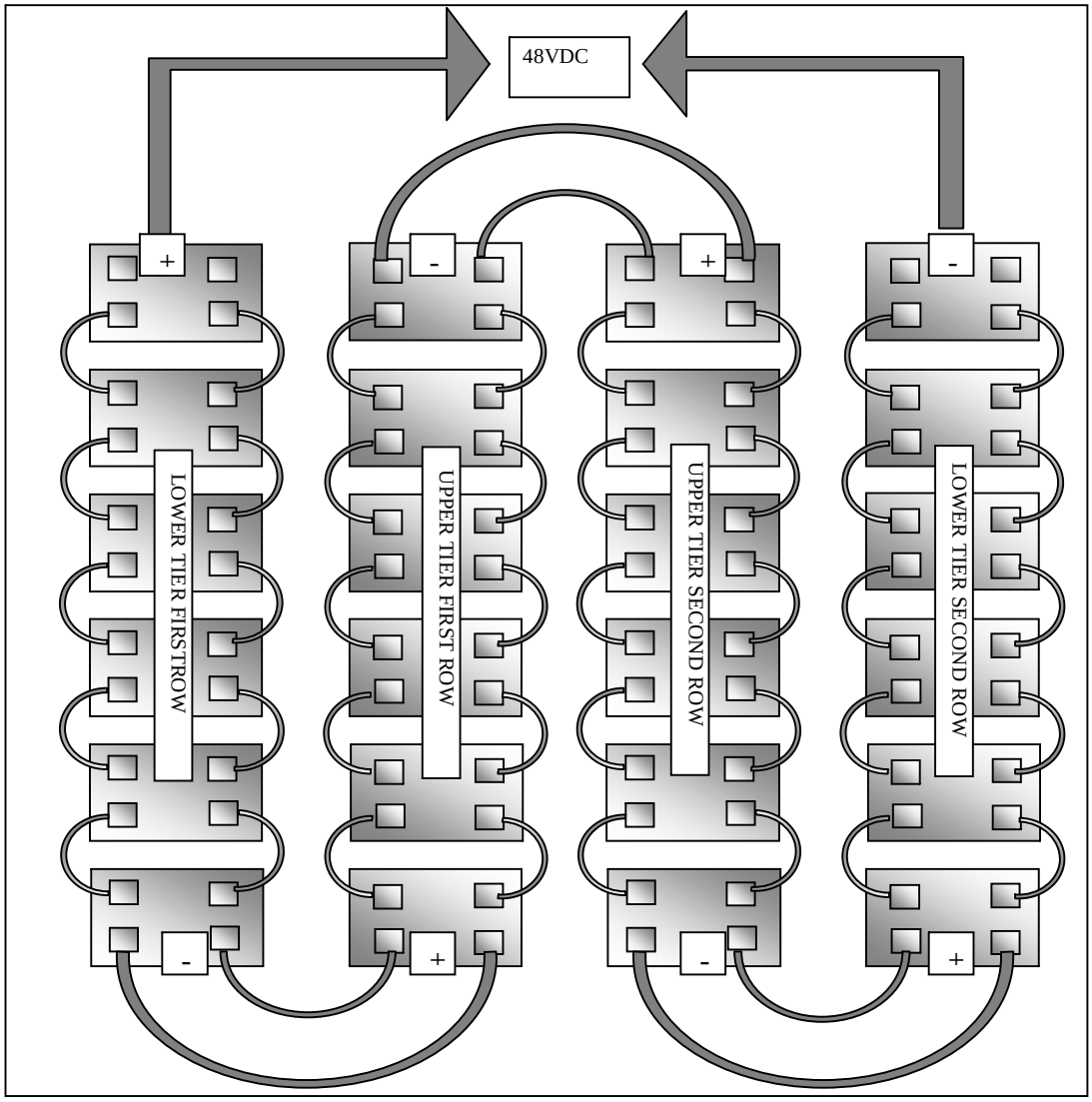
Battery stands are ideally made from good quality wood, coated with atleast two layer of anti sulphuric paint. Alternatively mild steel battery stands can also be used if suitably coated with rubber/rubberized paint/good quality and thickness of epoxy.

It is preferable to use porcelain or hard plastics insulators between the battery stand and the floor to avoid earth leakage. While it is preferable for batteries up to 48V, it is an absolute must for high voltage batteries like 96V, 120V, 240 and above.

The battery stand is to be assembled and installed exactly as per the battery installation layout drawing provided for the particular site.



DOUBLE ROW DOUBLE TIER LAYOUT (Front View)



48V (24NOS X 2CELLS) BATTERY CONNECTION DIAGRAM (Top View)

(III) RECEIVING, INSPECITON AND STORAGE OF BATTERY AT SITE.

Battery received in dry and in charged condition:

(1) Open out packing cases and check individual battery cells for any physical damage.

(2) Check the no. of battery cells received as per packing list/Challan/Invoice. Check name plate of each cell for its capacity.

(3) Electrolyte and battery grade water is normally supplied alongwith a dry uncharged battery cells. The manufacturer indicates the quantity of electrolyte required per cell from which total electrolyte quantity/volume can be collected. Check whether adequate electrolyte has been received.

(4) The manufacturer indicates the fill in electrolyte specific gravity. Normally this is between 1.200 to 1.230 specific gravity @ 27^0C. Check specific gravity and temperature of electrolyte delivered.

(5) Battery grade water is required for final adjustment of specific gravity of the cells. Order for & receive adequate water equivalent to 10% of the required volume of electrolyte.

(6) If the battery is not installed immediately, store the battery cells in cool and dry place and avoid direct sunlight. The electrolyte and water should be stored away from any sensitive electrical or electronic equipment.

Battery received in charged condition:

Some manufacturers supply batteries or cells in fully charged condition.
(1) Inspect each battery cell for any physical damage.

(2) Check electrolyte level in each cell and top up electrolyte of same specific gravity if the level is found low.

(3) Check specific gravity of electrolyte of all cells. If it matches with the value given by the manufacturer for specific gravity in fully charged condition, the battery is deemed to have been received in fully charged condition.
In case, the specific gravity is lower than recommended, the battery will require a charge to increase the specific gravity to required level and fully charge the batteries.

(4) Check the voltages of each individual cell and it should be between 2V and 2.1V per cell. If the voltage of any cell is less than 2V, it is possible that there is a defect in that cell.

(5) If not installed immediately, store the batteries/cells in a cool and dry place.

(IV) ERECTION AND IN TERCONNECITON OF BATTERY BANK

(1) Install the batteries/cells on the battery stand as per battery stand/battery erection drawing attached. In a row, the cells are to be postponed in such a way that positive terminal of one cell faces the negative terminal of the next cell and so on to enable connection in series.

(2) Ensure that each row of cells on the stand are positioned in an absolute straight line by matching the edge of all the cells in a row in a single line. A piece of string can be used for aligning all cells in a row in a straight line. There should be a small gap of about 10/20 mm between each cell in a row.

(3) Check polarity of each cell by a center zero voltmeter or any voltmeter and ascertain that when the positive of the voltmeter is connected to the positive terminal and negative of voltmeter is connected to negative terminal of battery, the deflection from needle should be the same direction for all cells in series.

(4) Connect all cells in a row in series connection by connecting the positive terminal of one cell to the negative terminal of the next cell. Repeat this for all other cells.

(5) For intercell connection, use cables of adequate core size/cross section supplied alongwith the battery. The interconnecting cables of suitable length are supplied with the battery with both ends duly provided with cable lugs for fixing to the terminals with nuts and bolts. If there are two positive terminals and two negative terminals of each cell, use two cables for series connection from one cell to the next. One cable to be connected to each set of positive and negative terminals of the adjoining cell.

(6) Before fixing the intercell cable connectors with nuts and bolts to the terminals, smear petroleum jelly on the nuts and bolts and also on the terminals before tightening the fasteners.

(7) If the battery bank is installed in a double row double tier configuration, the top two rows in the top tier should be connected in series and two rows in the bottom should be connected in another series.

Then the top tier and the bottom tier should be connected in series so that the positive terminal of the battery bank is available at the starting of upper tier and negative terminal of the battery bank is at the end of lower tier.
In case two battery banks are to be connected in parallel for doubling the capacity, the top tier and the bottom tier will be connected in parallel that is positive end of top tier will be connected to the positive end of bottom tier which is just below it and same shall be done for the negative terminal parallel. Here the positive terminal of the battery will be at one end of the top tier and the negative terminal will be at the other end of the top tier. Please refer attached figure.

(8) After connection, ensure that the vent plugs and electrolyte level indicator are normally fixed in place on each cell.

(9) Check the normal battery bank voltage.

(V) INITIAL CHARGING/FIRST CHARGE OF BATTERY/COMMISSIONING OF BATTERY BANK:

This is done for battery/cells received in dry and uncharged condition.

(1) Fill the cells with dilute sulphuric acid supply alongwith the battery.

(2) Allow between 12-24 hours rest period for soaking acid in the plates and for cooling down to room temperature approximately. Shorter time can allowed in winter when the cooling is fast. Further more than 24 hours should not be allowed.

(3) Start charging with constant current at the finishing rate as given fin the chart here under:-

(4) Obtain hourly specific gravity temperature and voltage readings of all cells as per sample sheet attached.

(5) Continue charging till the battery is fully charged. Full charge set can be ascertained by ensuring the following parameters.

(a) Cell voltages remain constant for three consecutive hourly readings.
(b) Cells specific gravity readings remain constant for three consecutive hourly readings.
(c) Free gassing is observed in all the cells.
(d) Total cumulative amphere hour charge delivered to the battery is atleast 4-5 times of the amhere hour capacity of the battery.

(6) Once the battery is fully charged, most of the cells will show specific gravity more than that specified for full charge battery by the manufacturer. Normally it is recommended specific gravity at full charge is 1.250. However, many cells will have specific gravity above 1.250.
The specific gravity of all cells are to be adjusted to 1.250 by taking out some electrolyte from the cell and adding some battery grade water. While continuing the initial charging to allow the electrolyte and water to mix properly. While adding water, fill to the topmost level allowed. This will make up for the evaporation loss and electrolysis loss of water during charging.

(7) Fix vent plugs and electrolyte level to indicators firmly on each cell.

(8) Clean all the cells especially the top portion with water and cloth so that all traces of acid is removed from the external part of the cells.

(9) If adequate time is available it is always better to discharge battery bank at C10 rate (see the battery specs chart) to 100% discharge level and charging back fully. This increases the battery effective capacity.

(10) The battery bank is now ready for connecting to the load/commissioning.

(VI) PREVENTATIVE MAINTENANCE PROCEDURE

(1) Clean the battery cells and keep the cells tops in clean and dry conditions – once in six months.

(2) Top up the battery cells with battery grade water up to the required level given once in 6-9 months. Please watch the cell electrolyte indicator and top up level indicator reaches its lowest level. From this you will get an indication regarding the frequency of topping up.

(3) Clean the battery terminals with cloth/wire brush soaked in water and re-apply petroleum jelly – once in a year. In corrosive atmosphere like near the sea side, the frequency may be more.

(4) Check all inter cell, inter row and inter tier cable connectors for the tightness of connection and tighten if found loose.

(5) Check battery stand for any sign of sulfation or corrosion and clean with cloth and water.

(6) Check voltage and specific gravity of each cell once in a month and record in the battery.

EQUALISING CHARGE FOR CYCLING BATTERIES

(1) Tubular flooded battery cell regularly cycled (charged & discharged deeply) - few cells fall out of step for a period of time.

(2) After a period some cells have high voltage and high specific gravity and some cells are not fully charged and have low specific gravity and voltage.

(3) The cells which have low state of charge have a sharp voltage increase on constant current charge due to which the charger is automatically switched OFF even if your battery is not fully charged.

(4) To avoid this, equalizing charge is to be imparted to battery on a periodic basis say between once in 45 days to 60 days.

(5) The proposal l involves charging the full battery but at low approximately constant current of not more than 5% of battery capacity in amps. This means, for a battery of 1200 Ah max equalizing charge current will be 60 amps.

(6) Equalizing charging at above rate is to be continued till all cells show full charge voltage of 2.65 to 2.75/48V battery shows 66V and all the cells specific gravity become equal at around 1.250 for each cell.

(7) Equalizing charge increased the efficiency and life of battery and should be imparted once in 45-60 days during the entire life time of battery.