



VRLA Batteries

26-206 Ampere-Hour Capacity

Battery Installation And Start up Guide

(For Rack Mounted Systems)

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12V VRLA BATTERY SYSTEM OPEN RACK INSTALLATION AND SYSTEM CHECKOUT GUIDE

General Information

This document provides a guide for use during receiving, installation and checkout of the 12V VRLA batteries of 25 through 200 ampere-hours capacity on open rack systems.

This guide may not be complete within itself and should be used in conjunction with the following:

1. Rack Installation Drawing (M16285)
2. Specification Sheet for individual battery
3. Self Discharge and Inventory Control technical bulletin #41-7272
4. Integrity Testing technical bulletin #41-7264
5. Operational Qualification and Warranty Registration Checklist technical bulletin #41-7471

Other related C&D Technologies pamphlets which may be of interest include:

1. Impedance and Conductance Testing technical bulletin #41-7271
2. Acceptance and Capacity Testing technical bulletin #41-7135
3. UPS Applications and VRLA Battery Sizing technical bulletin #41-7334
4. Communications Applications and VRLA Battery Sizing technical bulletin #41-7361

C&D Technologies 12V VRLA Battery System General Description

The 12V valve regulated lead acid (VRLA) battery is a lead acid battery which facilitates the recombination of internally generated gasses. As a result the battery vents minimal gas during normal conditions and does not require the addition of water to the electrolyte. The electrolyte is either in a gelled form or is absorbed in the blotter type of separator thus eliminating any free liquid electrolyte. Each cell within the battery contains a self resealing pressure relief vent to relieve any excess pressure generated during overcharge and the battery is otherwise essentially sealed.

The typical 12V battery system is a group of the 6 or 12 VDC individual batteries connected in series to provide a higher voltage and power to a critical load during commercial power outages. Typical system voltages are in the range of 12 through 480 VDC depending on the application. For example 12, 24 and 48 VDC might be used for communications equipment standby power while from 72 to 480 VDC might be used for data center UPS systems.

The lead acid battery has a nominal voltage of 2 VDC per cell. A 6 volt battery has 3 cells. Just as the voltage of a battery system is increased by connecting the individual multicell blocks in series, the ampere-hours and kilowatt capacity of the systems can be increased by connecting strings of series connected batteries, in parallel. Refer to Figures 1 and 2 for examples of series and parallel connected batteries.

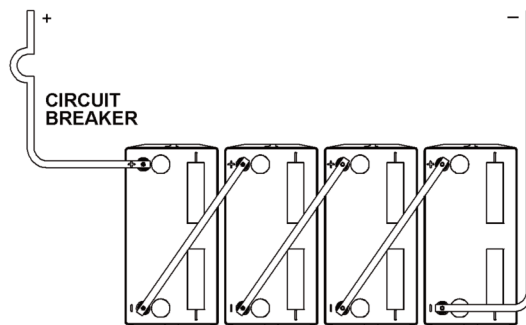


Figure 1-Series Connected Batteries

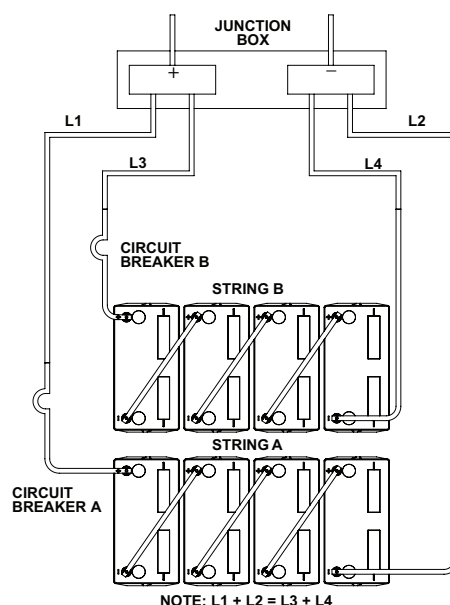


Figure 2-Two Strings of Batteries
Connected in Parallel

VRLA Battery Safety Concerns

Installation and servicing of the 12V VRLA battery should only be performed and supervised by personnel knowledgeable of lead acid batteries and required personal and equipment safety precautions. Keep unauthorized personnel away from the batteries and installation activity.

Electrical Hazards

Battery systems present a risk of electrical shock and high short circuit currents. The following precautions should be observed when installing and maintaining VRLA batteries:

1. Remove all personal metal objects (watches and rings).
2. Use insulated tools.
3. Wear full eye protection and rubber gloves.
4. Observe circuit polarities.
5. Do not make or break live circuits.
6. Prior to handling batteries on a metal rack, assure the battery is not inadvertently grounded by measuring the voltage between the battery and the rack. It should be zero. If not, determine the cause and correct prior to proceeding.

Disposal

Lead acid batteries must be recycled. Batteries contain lead and dilute sulfuric acid. Dispose of in accordance with Federal, State and local regulations. Do not dispose of in a landfill, lake or other unauthorized location.

Chemical Hazards

Any gelled or liquid emissions from a VRLA battery is electrolyte which contains dilute sulfuric acid, which is harmful to the skin and eyes; is electrically conductive; and is corrosive.

If electrolyte contacts the skin, wash immediately and thoroughly. If electrolyte enters the eyes, wash thoroughly for 10 minutes with clean water or a special neutralizing eye wash solution and seek immediate medical attention.

Neutralize any spilled electrolyte with the special solutions contained in a spill kit or with a solution of 1 lb. bicarbonate of soda to 1 gallon of water.

Fire, Explosion and Heat Hazards

Lead acid batteries can contain an explosive mixture of hydrogen gas which can vent under overcharging conditions.

Do not short circuit terminals.

Do not smoke or introduce sparks in the vicinity of the battery.

Do not install and charge batteries in a sealed container.

Mount the individual batteries with 0.5 inches of space between the batteries to allow for convection cooling. If contained, assure the container or cabinet and room have adequate ventilation to prevent an accumulation of potentially vented gas.

Refer to the current issue of the National Electric Code.

Caution

Do not attempt to remove the vents (valves) from the 12V VRLA battery or add water. This presents a safety hazard and voids the warranty.

Caution

The individual batteries may weigh from 25 to 180 pounds depending on part number. Exercise care when handling and moving batteries. Assure the use electrolyte which contains dilute sulfuric acid which is of appropriate handling equipment.

Required Installation Tools & Equipment

At a minimum, the following tools and equipment are required to install the 12V VRLA battery.

1. Digital voltmeter.
2. Socket wrench, insulated.
3. Torque wrench calibrated in inch-pounds, insulated.
4. Box end wrench, insulated.
5. Battery lifting equipment (handles) and fork lift to lift pallets of batteries.
6. Rubber gloves.
7. Full face shield.
8. Plastic apron.
9. Portable eyewash.
10. Spill kit.
11. Fire extinguisher (class C).

The following equipment is optional depending on the type of checkout to be performed.

1. Micro-ohm meter.
2. Battery resistance, impedance or conductance test set.
3. 100 amp momentary load test set.
4. System load bank (DC if to be performed at the battery and AC if to be performed by loading a UPS output).

Preparation for System Installation

The installation of the battery system involves a series of activities from planning and initial receipt through final checkout and warranty registration. The sequence of these tasks are presented in Figure 3 and should be thoroughly studied and understood before proceeding. As part of this preparation activity the installer should develop a system schematic diagram which identifies how the individual batteries are to be placed on the rack, interconnected and numbered. Figure 4 is a schematic for a typical system of 30 each 12 volt batteries on a single 3 tier rack while Figure 5 is a schematic for a typical string of 40 each 12 volt batteries on two each 3 tier racks. The cabling received with the system presumes a specific rack and installation configuration.

Obviously the racks must be assembled and installed prior to installation of the batteries. Instructions for the rack assembly are contained in a separate document received with the racks. The batteries are rated at 77°F (25°C). Operation at cooler temperatures will decrease the discharging time. Operation at elevated temperatures will decrease the overall life of the battery. There is a 50% life reduction for each 15°F above 77°F.

Receiving Instructions

Upon receipt the shipment should be thoroughly inspected for any physical damage to the packaging and to assure the proper quantities of items are received. The packages should then be opened and the batteries inspected to assure there is no hidden damage. Special attention should be given to the containers and terminals of the received batteries.

Refer to the bill of material and determine that the items received are complete and as described on the bill of material.

If any damage is noted, or the number of packages is different from the shipping papers, the carrier should be contacted and a claim should be filed with the carrier within 10 days.

The content of the shipment should be inspected and counted to assure the proper instructions, drawings and number of batteries, hardware kits, cables and accessories as identified on the bill of material are received. Should the count be incorrect or the components be of the wrong type, contact C&D Technologies Customer Service as soon as possible.

The batteries are shipped fully charged, however some self-discharge will occur during transit and the degree is a function of the transit time and temperature. The fully charged open circuit voltage is 2.12 to 2.16 volts per cell (6.36 to 6.48 and 12.72 to 12.96 VDC for 6 and 12 volt batteries respectively). Upon receipt the batteries should be a minimum of 2.07 volts per cell or 6.2 and 12.4 volts for 6 and 12 volt batteries respectively. If at these minimum voltages the batteries should be recharged as soon as possible. If at or below 2 volts per cell (6 and 12 volts) the batteries should not be used and the vendor should be contacted immediately.

Storage Instructions

Store batteries in a clean, dry cool area away from radiant heat sources. Elevated storage temperatures increase the self-discharge rate of the batteries and reduces the storage time between required freshening charges. Fully charged batteries with an electrolyte specific gravity of 1.280 or higher can be safely stored at temperatures as low as -20 degrees F.

Batteries in storage should be given a freshening charge at 2.4 volts per cell for 24 hours every 6 months or when the open circuit voltage declines to 2.07 volts per cell (6.2 and 12.4 volts for 6 and 12 volt batteries respectively).

Additional details concerning storage and inventory control are contained in the document "Self Discharge and Inventory Control", technical bulletin #41-7272.

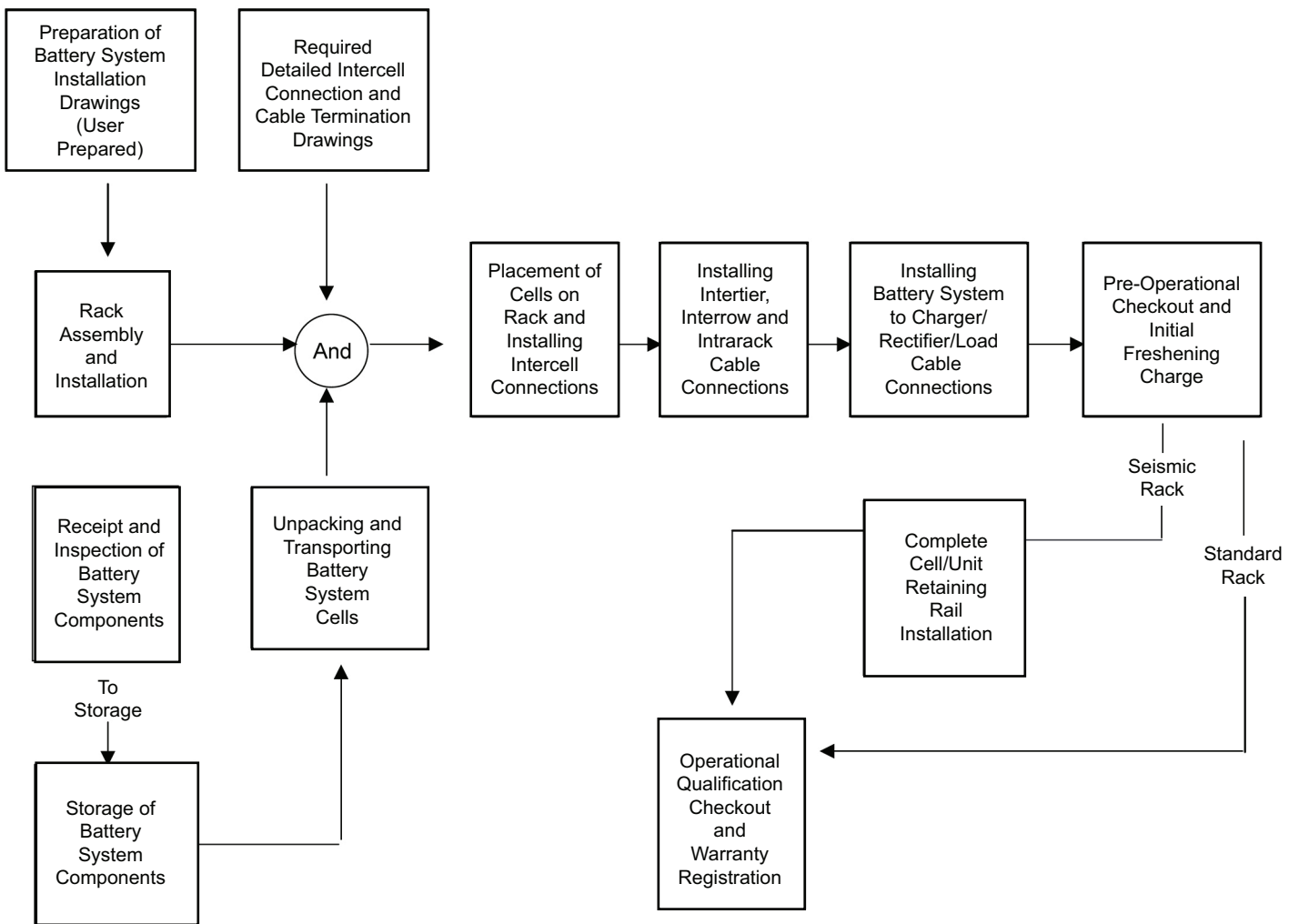


Figure 3 - 12V VRLA Battery System Installation Task Flow Chart

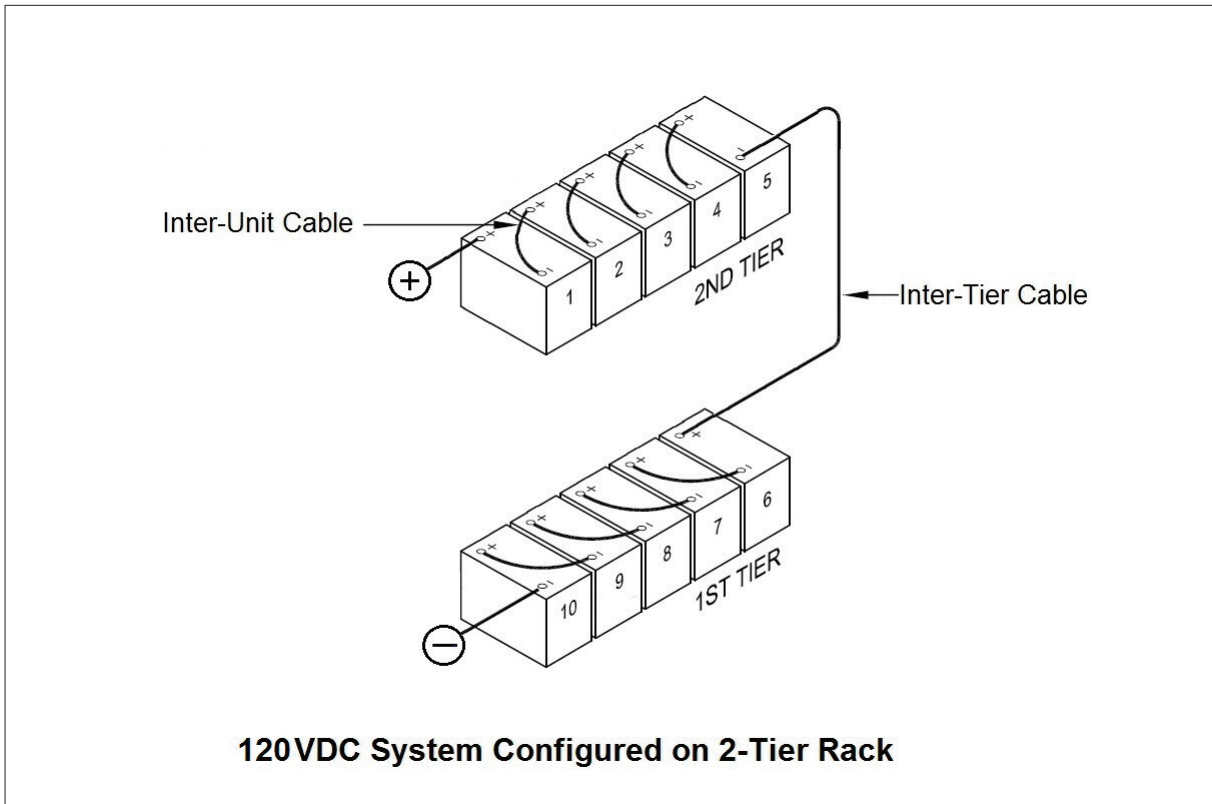


Figure 4 - 1 Two Tier Rack with (10 each) 12 VDC VRLA Batteries for 120 VDC

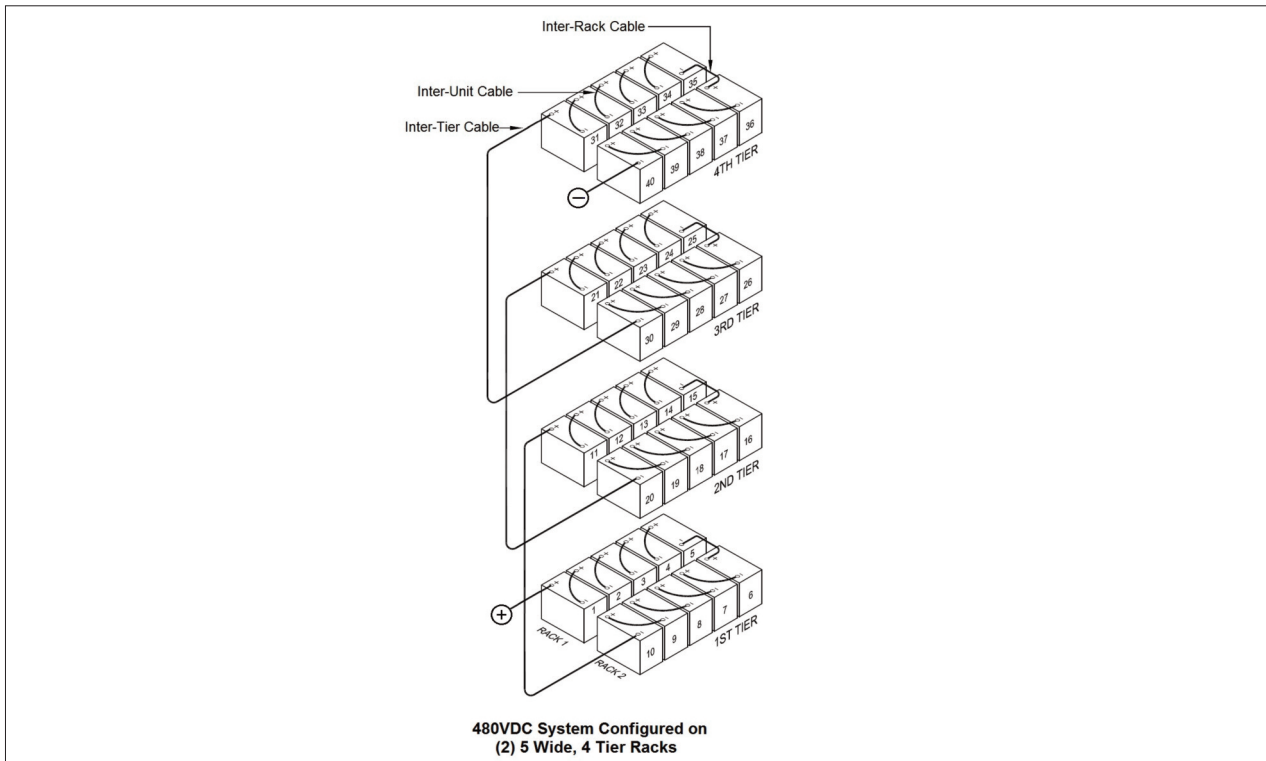


Figure 5 - 2 Four Tier Racks with (40 each) 12 VDC VRLA Batteries for 480 VDC

Locating the Batteries on the Rack

The individual batteries should be placed on the rack tier/shelf with 1/2" (1.27 cm) spacing between the units. This is important to assure the inter-unit connecting cables properly align with the adjacent battery terminals and to allow air space for proper cooling of the batteries. When the batteries are being placed side to side, all the batteries should be placed with the terminals of the same polarity (POS. or NEG.) to the front of the tier/shelf. Refer to Figures 4 and 5.

For stability reasons, the batteries should be placed on the lowest tiers/shelves first.

CAUTION: Do not lubricate the rack rails or battery containers with grease or other lubricating compounds. Certain lubricating compounds will cause deterioration of the battery plastic container and/or the rack plastic components.

Battery Terminal Preparation

To minimize contact resistance, it is important that the lead terminals of the batteries be cleaned of any oxidation that may have occurred during transportation and storage. It is most convenient to clean them prior to placing them on the rack.

Lightly brush the terminal contact surface areas with a brass bristle brush, or the equivalent, and then apply a light coating of the special antioxidant grease, such as NO-OX-ID or NCP-2, to the surfaces to protect the lead terminal from further oxidation.

Numbering the Batteries

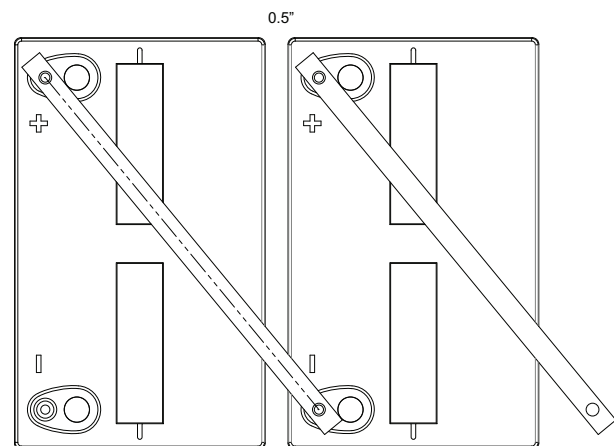
Once the batteries are placed on the racks, they should be numbered for future identification during maintenance, etc.

Refer to the system wiring schematic and starting at the battery that is to be the positive output of the system, label it as #1. Then label the batteries in ascending sequential order as they would be connected in series. The battery at the negative output of the system should be the highest number battery.

If individual strings are to be connected in parallel, each string should be uniquely identified (e.g. A, B and C).

Interunit Connections

The various batteries may be of different dimensions and with different terminal configurations. This and the anticipated load determine the wire size, lugs and length of the cable to be used for the interunit connectors. Refer to Table 1 and Figure 6 for the typical connection configuration and cable to be used for each part number of 12V VRLA battery.



**Figure 6-Typical Inter-Unit Connections
(See page 11 for Specific Battery Models)**

In general, the wire size to be used is:

1. AWG #6 for loads of up to 90 amperes.
2. AWG #2 for loads of up to 150 amperes.
3. AWG #1/0 for loads of up to 250 amperes.
4. AWG #4/0 for loads of up to 400 amperes.
5. 2 each AWG #2/0 for loads of up to 600 amperes.

Lightly brush and coat with the protective grease the contact surface area of the battery terminal and interunit cable lug and assemble the interunit connection per the relevant connection diagram of Table 1. Torque the connection hardware to that specified in Table 1.

As all the batteries are interconnected on each tier/shelf the total open circuit voltage (OCV) of the batteries on the tier/shelf should be verified as:

$$\text{OCV per Tier} = \text{number of batteries per tier} \times \text{voltage per battery}$$

If the measured voltage is not as expected, determine the cause and correct before proceeding.

If a battery is installed with reverse polarity, the measured voltage for the tier of batteries will be reduced from the expected value by twice the open circuit voltage of the individual battery.

Intertier, Interrow and Interrack Connections

Cables used to interconnect tiers, rows and racks of batteries should be of at least the same size as the interunit connecting cables. Cables supplied as a system meet specific dimensions required for racks designed by C&D. This includes consideration for spacing, maximum load and cable configuration.

Refer to the battery system schematic diagram and the battery numbers to determine the location of the various cables interconnecting the tiers of batteries.

Refer to systems drawings for the specific cable to be used to interconnect the tiers and rows of batteries and figures 6, 7, 8 and 9 for the typical connection techniques.

Prepare, assemble and secure the intertier cabled connections in the same manner as the interunit cabled connections.

Measure the open circuit voltage of the completely interconnected system. The expected voltage should be:

System OCV = number batteries x battery OCV

If the measure voltage is not the expected voltage, determine the cause and correct before proceeding.

Figure 6 -INTERUNIT CABLE CONFIGURATIONS

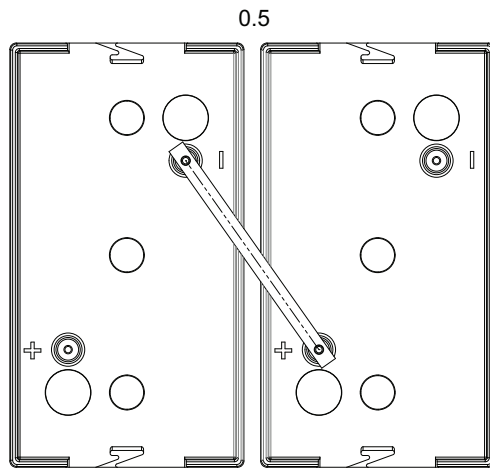


Figure 6-1
Typical 6V VRLA
Single Cable Connection

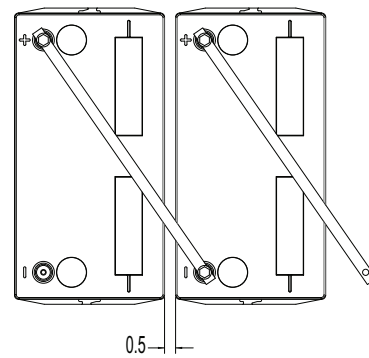


Figure 6-2 -
Typical 12V VRLA
Single Cable Connection

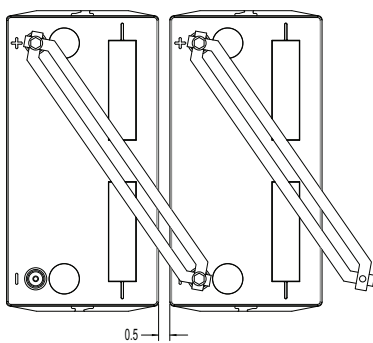


Figure 6-3 -
Typical 12V VRLA
Dual Cable Connection

Figure 6 - (Continued) INTERUNIT CABLE CONFIGURATIONS

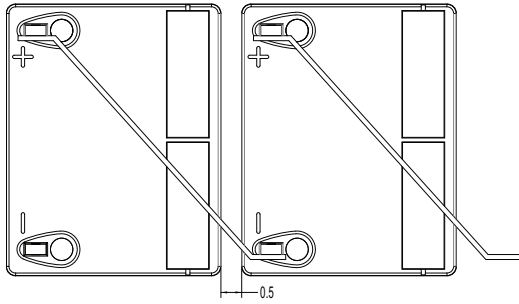


Figure 6-4 -
UPS12-100MR

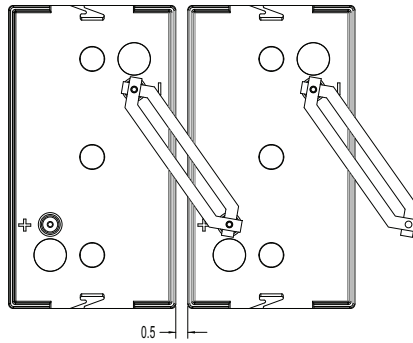


Figure 6-5 -
Typical 6V VRLA
Dual Cable Connection

FIGURE 7 - INTERTIER CABLE CONFIGURATIONS

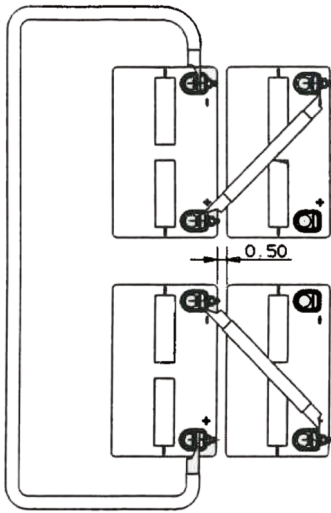


Figure 7-1 - Typical Single Cable Intertier Connection for Flag Terminal Batteries

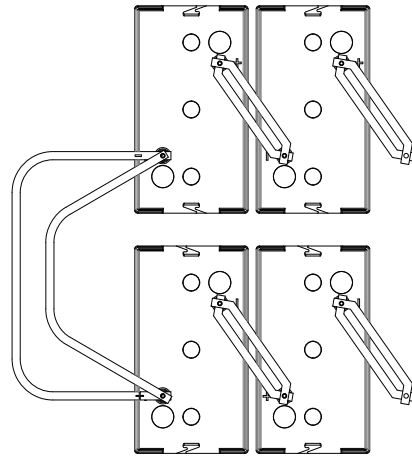


Figure 7-2 - Typical Dual Cable Intertier Connection for 6V Threaded Insert Terminal Batteries

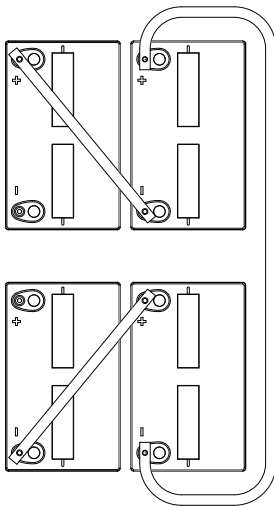


Figure 7-3 - Typical Single Cable Intertier Connection for Batteries with Threaded Insert Terminals

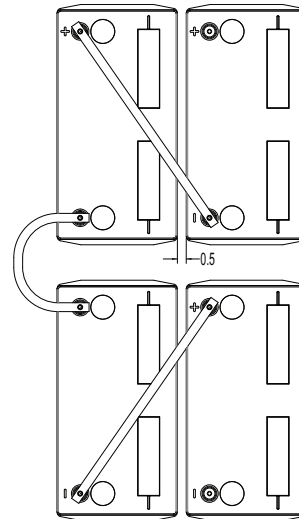


Figure 7-4 - Typical Large BCI Group Size Intertier Connection Using 4/0 Cable

**Figure 8 - INTERROW CABLE CONNECTIONS
BETWEEN RACKS INSTALLED BACK TO BACK**

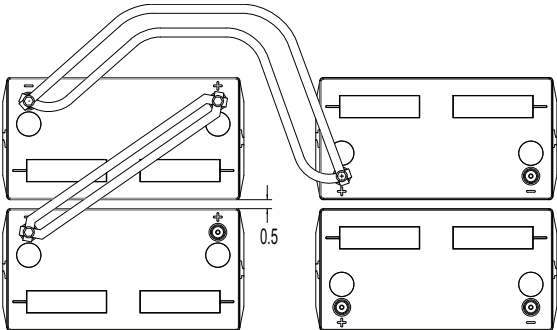


Figure 8-2-Typical Dual Cable Interrow Connection for Batteries with Threaded Insert

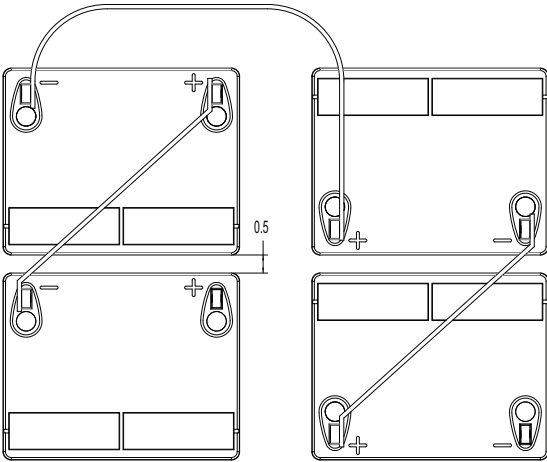


Figure 8-3-Typical Single Cable Interrow Connection for Batteries with Flag Terminals

**Figure 9 - INTERRACK CABLE CONFIGURATIONS
BETWEEN RACKS PLACED END TO END WITH 4" SPACING**

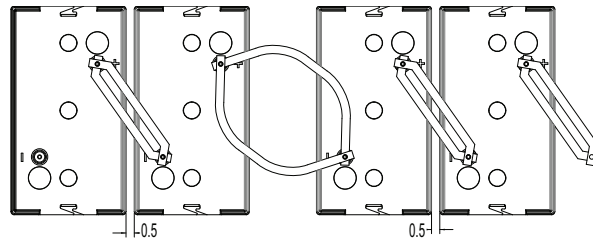


Figure 9-1 - Typical Dual Cable Interrack Connection for Batteries with Threaded Insert Terminals

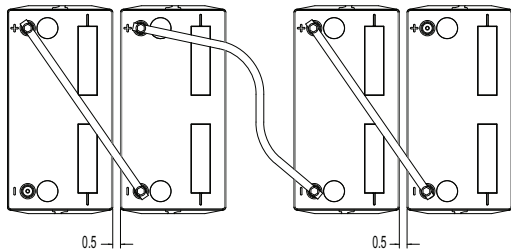


Figure 9-2 - Typical Single Cable Interrack Connection for Batteries with Threaded Insert Terminals

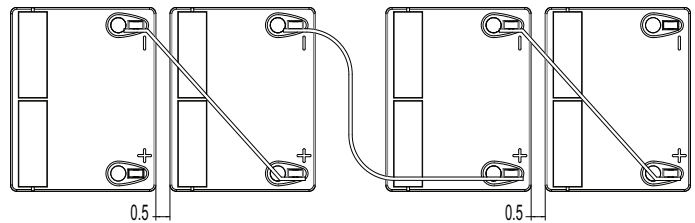


Figure 9-3 - Typical Single Cable Interrack Connection for Batteries with Small "Flag" Terminals

Battery Connection to the Load/Charger

Select the proper size and type of cable per the NEC or other applicable code which can handle the charge and discharge current related to the battery. The cable size selected should also consider the cable resistance per foot and the voltage drop allowed between the battery output terminals and the load.

The output circuit of the battery should contain a DC rated fuse or circuit breaker to protect the wiring and where appropriate a disconnect to facilitate service to the battery in an open circuit condition.

With the load/charger fuse, circuit breaker or disconnect in the open condition, connect the battery output cables to the load/charger circuit.

Parallel Connection of Individual Battery Strings

When individual strings of batteries are to be connected in parallel, each of the individual battery strings should be cabled separately to a common junction point or box. They should not be daisy chained in parallel.

Each of the individual battery strings output circuits should contain a fuse, circuit breaker or disconnect prior to the common connection at the junction point to protect the wiring and facilitate battery maintenance.

When the separate strings of batteries are to be initially connected in parallel their open circuit voltages should be within 1 VDC of each other prior to making the paralleling connection.

Battery System Pre-Operational Checks

Prior to application of any freshening charge or load to the battery system the following checks should be performed as defined in the document Operational Qualification and Warranty Registration Checklist, Form #41-7471.

Battery Room and General Equipment Checks.

1. Battery Charger/Rectifier Checks.
2. Battery Rack/Enclosure Checks.
3. Battery Open Circuit Checks.

Initial Freshening Charge

When the batteries have been in storage or transit for an extended period or the battery system is intended for use at the minimum float charging voltage or when the number of cells in series is greater than 24, it is recommended the battery system be given a freshening charge at 2.4 volts average per cell for 24 hours. This will assure higher initial performance and will reduce the time period required for the cells to achieve proper voltage balance between the individual units.

Document the progress of the freshening charge in Section V of the document "Operational Qualification and Warranty Checklist", Form #41-7471.

To apply a freshening charge:

1. Confirm the freshening (equalization) voltage from the charger/rectifier is set to a value equal to 2.4 volts per cell x number of cells connected in series (7.2 and 14.4 volts respectively for 6 volt and 12 volt batteries).
2. Close the circuit from the charger/rectifier to the battery system and note that the battery accepts current.
3. Monitor the battery periodically and note that the operation is proceeding normally and that the current acceptance is declining, the batteries are not overheating (within ± 5 F of each other and the ambient) and that the individual battery voltages on equalization charge are 7.2 ± 0.25 and 14.4 ± 0.50 volts for 6 and 12 volt batteries respectively.
4. Terminate the freshening charge in the event of any extraordinary situations or after 24 hours.

Initial Float Charging

Following the freshening charge the battery system should be placed on float charge at an average voltage of 2.25 to 2.30 volts per cell (6.75 to 6.90 and 13.5 to 13.9 volts for 6 and 12 volt batteries respectively).

Prior to placing on float charge, assure the charger/rectifier is set to the proper output voltage.

After the battery system has been on float for approximately 24 hours, the float current acceptance should be approximately to .005 amperes or less per rated ampere hour capacity of the battery string but greater than zero.

The individual battery float charging voltages should be within the following range:

- 12 volt batteries 13.3 min. to 14.5 max.
- 10 volt batteries 11.10 min. to 12.1 max.
- 6 volt batteries 6.65 min. to 7.25 max.
- 4 volt batteries 4.43 min. to 4.85 max.

Document the results of these measurement activities in Section VI, Float Charging Checks, of the Operational Qualification and Warranty Registration Checklist, Form #41-7471.

If any special battery monitoring equipment is to be utilized, it should be installed and calibrated at this time.

The 12V battery system installation is now complete and the system is available for acceptance testing and operational service.

Optional Battery Tests and Checks

While not a requirement of the warranty registration the following checks are recommended to assure maximum reliability of the battery system over time.

1. High rate momentary load test as described in the document Integrity Testing Form #41-7264.

While this test does not indicate the actual capacity of the battery it does indicate it is functional.

2. Individual battery measurements of resistance/conductance/impedance as described in the document Impedance and Conductance Testing Form #41-7271. Again, while this test does not indicate the actual capacity of the battery it does provide base line data from which changes can be trended over time as the battery normally deteriorates. This can be very useful in trouble analysis during the periodic maintenance activities.

3. Battery performance test as described in the document Acceptance and Performance Testing Form #41-7135.



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