ABSOLYTE® GX

SECTION 92.80 2009-04

Installation and Operating Instructions For ABSOLYTE® GX Batteries

EXIDE® TECHNOLOGIES
INDUSTRIAL ENERGY

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SECTION 1: GENERAL

1.0 General Information

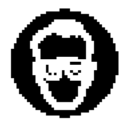
CAUTION!

Before proceeding with the unpacking, handling, installation and operation of this sealed lead-acid storage battery, the following information should be reviewed thoroughly. The safety procedures should be strictly adhered to when working with Absolyte GX batteries.

SECTION 2: SAFETY MESSAGES

2.0 Sulfuric Acid Electrolyte Burns

DANGER!
SULFURIC ACID ELECTROLYTE
BURNS



"Warning: Risk of fire, explosion or burns. Do not disassemble, heat above 50°C or incinerate." Batteries contain dilute (1.295 nominal specific gravity) sulfuric acid electrolyte which can cause burns and other serious injury. **In the event of contact with electrolyte, flush immediately and thoroughly with water. Secure medical attention immediately.**

When working with batteries, wear rubber apron and rubber gloves. Wear safety goggles or other eye protection. These will help prevent injury if contact is made with the electrolyte.

2.1 Explosive Gases

DANGER!
EXPLOSIVE GASES

Hydrogen gas formation is an inherent feature of all lead acid batteries. Absolyte GX VRLA batteries, however, significantly reduce hydrogen formation. Tests have shown that 99% or more of generated gases are recombined within the cell under normal operating conditions. Under abnormal operating conditions (e.g. charger malfunction), the safety valve may open and release these gases through the vent. The gases can explode and cause blindness and other serious injury.

Keep sparks, flames, and smoking materials away from the battery area and the explosive gases.

All installation tools should be adequately insulated to minimize the possibility of shorting across connections.

Never lay tools or other metallic objects on modules as shorting, explosions and personal injury may result.

2.2 Electrical Shock and Burns

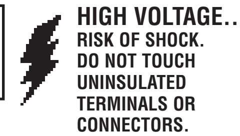
Multi-cell systems attain high voltages, therefore, extreme caution must be exercised during installation of a battery system to prevent serious electrical burns or shock.

Interrupt the AC and DC circuits before working on batteries or charging equipment.

Ensure that personnel understand the risk of working with batteries, and are prepared and equipped to take the necessary safety precautions. These installation and operating instructions should be understood and followed. Assure that you have the necessary equipment for the work, including insulated tools, rubber gloves, rubber aprons, safety goggles and face protection

2.2.1 Static Discharge Precautions for Batteries

DANGER!
ELECTRICAL SHOCK AND BURNS



CAUTION!

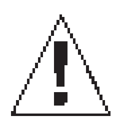
If the foregoing precautions are not fully understood, clarification should be obtained from your nearest EXIDE representative. Local conditions may introduce situations not covered by EXIDE Safety Precautions. If so, contact the nearest EXIDE representative for guidance with your particular safety problem; also refer to applicable federal, state and local regulations as well as industry standards.

When maintaining a connected battery string, care must be taken to prevent build-up of static charge. This danger is particularly significant when the worker is electrically isolated, i.e. working on a rubber mat or an epoxy painted floor or wearing rubber shoes.

Prior to making contact with the cell, discharge static electricity by touching a grounded surface.

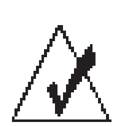
Wearing a ground strap while working on a connected battery string is not recommended.

2.3 Safety Alert



The safety alert symbol on the left appears througout this manual. Where the symbol appears, obey the safety message to avoid personal injury.

2.4 Important Message



The symbol on the left indicates an important message. If not followed, damage to and/or impaired performance of the battery may result.

SECTION 3: DELIVERY INFORMATION

3.0 Receipt of Shipment

Immediately upon delivery, examine packaging for possible damage caused in transit. Damaged packing material or staining from leaking electrolyte could indicate rough handling. Make a descriptive notation on the delivery receipt before signing. If cell or unit damage is found, request an inspection by the carrier and file a damage claim.

3.1 Concealed Damage

Within 10 days of receipt, examine all cells for concealed damage. If damage is noted, immediately request an inspection by the carrier and file a concealed damage claim. Pay particular attention to packing material exhibiting damage or electrolyte staining. Delay in notifying carrier may result in loss of right to reimbursement for damages.

SECTION 4: STORAGE INFORMATION

4.0 Storage Prior to Installation

Do not remove shipping materials if a storage period is planned, unless charging is required per Section 4.2.

4.1 Storage Location

If the battery is not to be installed at the time of receipt, it is recommended that it be stored indoors in a cool (25°C, 77°F), clean, dry location.

4.2 Storage Interval

The storage interval from the date of battery shipment to the date of installation and initial charge should not exceed six (6) months. If extended storage is necessary, the battery should be charged at regular intervals until installation can be completed and float charging can be initiated. When in extended storage, it is advised to mark the battery pallets with the date of shipment and the date of every charge. If the battery is stored at 77°F (25°C) or below, the battery should be given its initial charge (refer to Section 10) within 6 months of the date of shipment and receive a freshening charge (perform per Section 10 Initial Charge) at 6 month intervals thereafter. Storage at elevated temperatures will result in accelerated rates of self discharge. For every 18°F (10°C) temperature increase above 77°F (25°C), the time interval for the initial charge and subsequent freshening charges should be halved. Thus, if a battery is stored at 95°F (35°C), the maximum storage interval between charges would be 3 months (reference Appendix B). Storage beyond these periods without proper charge can result in excessive sulphation of plates and positive grid corrosion which is detrimental to battery performance and life. **Failure to charge accordingly may void the battery's warranty.**

NOTE: **Storage in temperatures above 25°C (77°F) will result in loss of operating life.**

Initial and freshening charge data should be saved and included with the battery historical records (see Section 15).

SECTION 5: INSTALLATION CONSIDERATIONS

5.0 General

Prior to starting installation of the Absolyte GX Battery System, a review of this section is strongly recommended.

5.1 Space Considerations

It is important to know certain restrictions for the area where the battery is to be located. First, a designated aisle space should be provided to permit initial installation as well as for service or surveillance. After installation, any additional equipment installed after the battery should not compromise access to the battery system.

A minimum aisle space of 36 inches from modules / 33 inches from clear covers should be available adjacent to the battery system. See Figure 1 for typical space allocations required. Following the spacing requirements will aid in maintenance of the battery and help maintain air flow to battery surfaces to enhance heat dissipation.

NOTE: When planning system space requirements, allow at least 6 inches past system total length wherever a terminal plate assembly is to be located (Figure 1A). Allow 4.5" minimum between back to back stacks (Figure 1B).

See Figure 1 for typical space allocations required. For total length, width and height dimensions of connected systems, consult layout/wiring diagram for the particular system.

Any modifications, alterations or additions to an Absolyte GX system, without the expressed written consent of EXIDE's Engineering, may void any warranties and/or seismic qualifications. Contact your EXIDE representative for additional information.

5.2 Battery Location & Ambient Temperature Requirements

It is recommended that the battery unit be installed in a clean, cool, dry location. Floors should be level.

A location having an ambient temperature of 24°C (75°F) to 25°C (77°F) will result in optimum battery life and performance. Temperatures below 25°C (77°F) reduce battery charge efficiency and discharge performance. Temperatures above 25°C (77°F) will result in a reduction in battery life (see Table A on Page 9).

TABLE A

TEMPERATURE EFFECTS ON LIFE

Maximum Annual Average Battery Temperature	Maximum Battery Temperature	Percent Reduction In Battery Life
25°C (77°F)	50°C (122°F)	0%
30°C (86°F)	50°C (122°F)	30%
35°C (95°F)	50°C (122°F)	50%
40°C (104°F)	50°C (122°F)	66%
45°C (113°F)	50°C (122°F)	75%
50°C (122°F)	50°C (122°F)	83%

For example: If a battery has a design life of 20 years at 77°F (25°C), but the actual annual average battery temperature is 95°F (35°C), the projected life of the battery is calculated to be only 10 years.

The battery temperature shall not be allowed to exceed 50°C (122°F). Minimum battery temperature is -40°C (-40°F). Temperature records shall be maintained by the user in accordance with the maintenance schedule published in this manual.

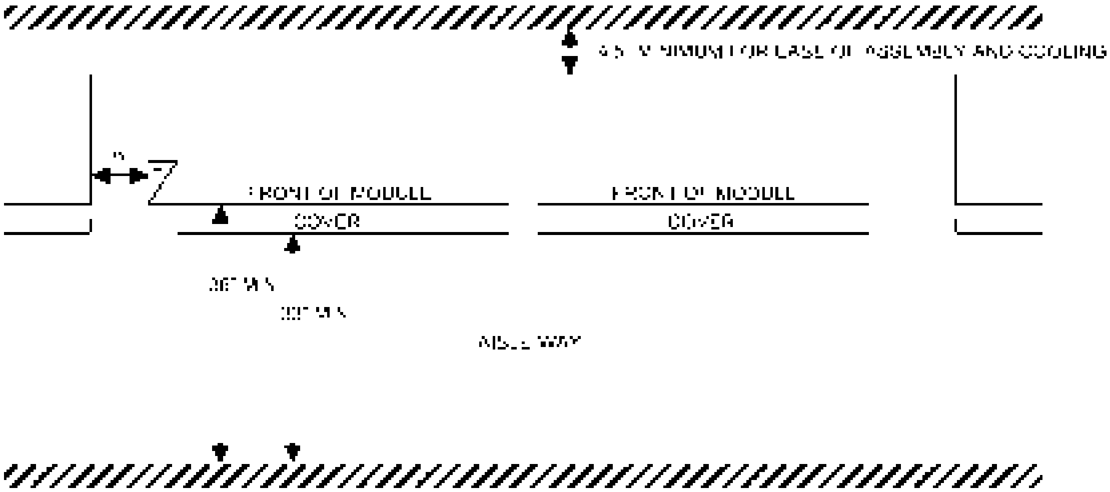


FIGURE 1A - HORIZONTAL END TO END

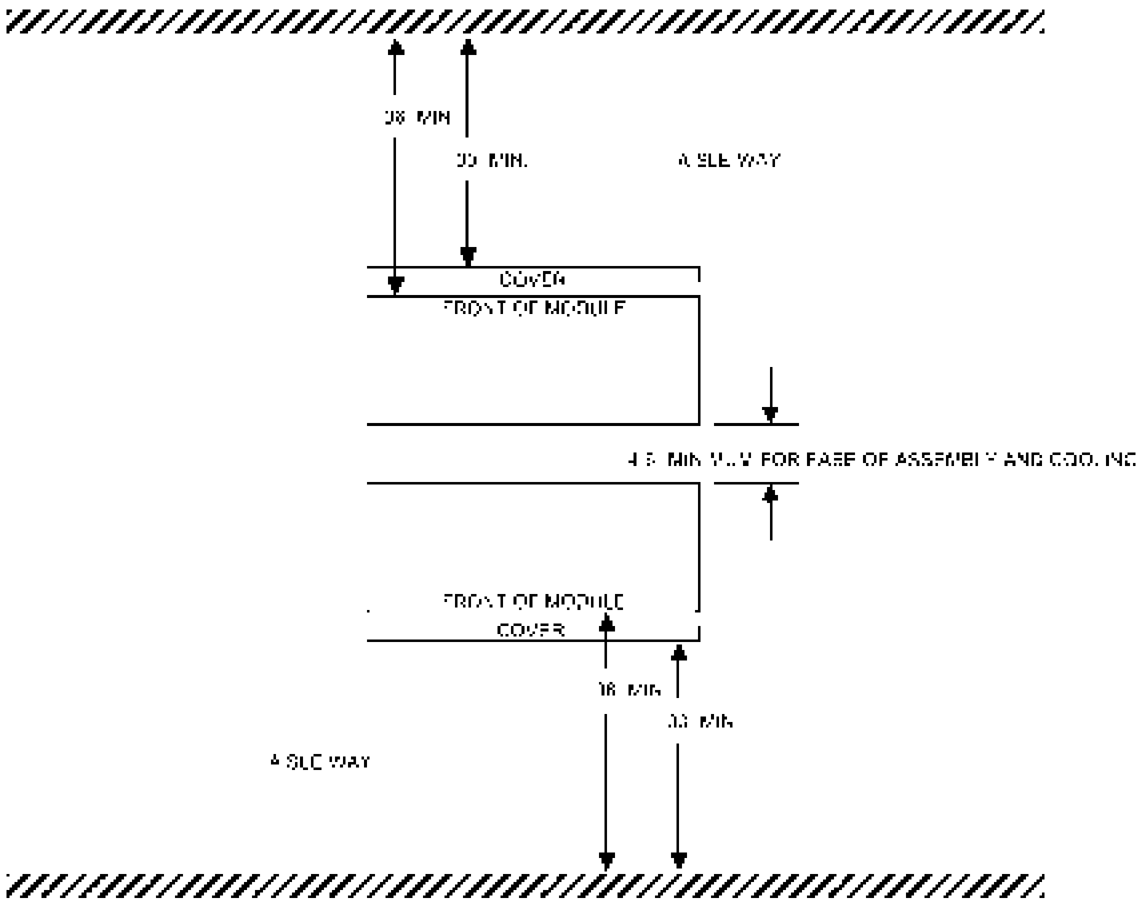


FIGURE 1B - HORIZONTAL BACK TO BACK

FIGURE 1 - TYPICAL SYSTEM SPACING (TOP VIEW)

5.3 Temperature Variations

Sources of heat or cooling directed on portions of the battery can cause temperature variations within the strings resulting in cell voltage differences and eventual compromise of battery performance.

Heat sources such as heaters, sunlight or associated equipment can cause such temperature variations. Similarly, air conditioning or outside air vents may cause cell string temperature variations. Every effort should be made to keep temperature variations within 3°C (5°F).

5.4 Ventilation

The Absolyte battery is a Valve Regulated Lead Acid (VRLA) low maintenance design. Tests have confirmed that under recommended operating conditions in stationary applications, 99% or more of gases generated are recombined within the cell. In most cases, no special ventilation and or battery room is required. Consult your local building and fire codes for requirements that may apply to your specific location.

Hydrogen and oxygen gases can be vented to the atmosphere under certain conditions. Therefore, the battery should never be installed in an air-tight enclosure. Sufficient precautions must be taken to prevent excessive overcharge.

5.5 Floor Loading

The floor of the area where the battery system is to be installed should have the capability of supporting the weight of the battery as well as any auxiliary equipment. The total battery weight will depend on the cell size, number of cells, as well as module configuration involved. Consult layout/wiring diagram for the battery system weight Prior to installation, a determination should be made that the floor integrity is adequate to accommodate the battery system.

5.6 Floor Anchoring

Where seismic conditions are anticipated, floor anchoring should be provided. Such anchoring is the responsibility of the user.

Where non-seismic conditions are anticipated, anchoring is recommended for maximum stability.

Four 9/16" (14.3 mm) holes are provided in the I-Beam for anchoring. To maintain seismic certification, use four anchor bolts per horizontal support. Anchor design is the responsibility of the purchaser/installer.

5.7 Connecting Cables: Battery System to Operating Equipment

The Absolyte cell is a UL recognized component.

Battery performance is based on the output at the battery terminals. Therefore, the shortest electrical connections between the battery system and the operating equipment results in maximum total system performance.

DO NOT SELECT CABLE SIZE BASED ON CURRENT CARRYING CAPACITY ONLY. Cable size selection should provide no greater voltage drop between the battery system and operating equipment than necessary. Excess voltage drop will reduce the desired support time of the battery system.

5.7.1 Paralleling

Where it is necessary to connect battery strings in parallel in order to obtain sufficient load backup time, it is important to minimize the differences in voltage drop between the battery strings in parallel in order to promote equal load sharing upon discharge. Therefore, equal resistance of cable connections for each parallel string is important. When paralleling multiple strings to a load or common bus, please follow these guidelines:

- Each parallel string must have the same number of cells (same string voltage).
- The cables connecting the positive and negative terminals of each string to the load (or bus) should be of the **same size** (i.e. same capacity/cross-sectional area).
- The cables connecting the positive and negative terminals of each string to the load (or bus) should be of the **same length**. Choose the shortest cable length that will connect the battery string that is furthest from the load, and cut all cables used to connect each string to the load to this same length.

5.8 Stacking Limitations

There are recommended limits on stacked (horizontal only) battery configurations, see Table B and consult your layout/wiring diagram.

TABLE B

Absolyte GX Stacking Limitations for the 2-Cell Tray

GX System	Non-Seismic	Seismic
GX2000	6 High	6 High
GX3000	6 High	6 High
GX4000	6 High	6 High
GX5000	6 High	6 High
GX6000	6 High	6 High

3-Cell GX2000 trays provide UBC Zone 4 compliance when stacked 4 modules high and UBC Zone 1 compliance at 8 modules high.

5.9 Terminal Plates

Each system is supplied with a terminal plate assembly for the positive and negative terminations. These should always be used to provide proper connection to the operating equipment and cell terminals. Any attempt to connect load cables directly to cell terminal may compromise battery system performance as well as the integrity of cell post seals.

5.10 Grounding

It is recommended that the modules or racks be grounded in accordance with NEC and/or local codes. See Appendix C for recommended procedure.

SECTION 6: UNPACKING

PACKAGED MODULES
Figure 2

6.0 General

Do not remove shipping materials if a storage period is planned, unless charging is required per Section 4.2.

The battery modules are generally packed in groups. Lag bolts retain the modules to the shipping pallet together with a protective hood bolted in place. Modules are also bolted together at the top adjacent channels. See Figure 2.

6.1 Accessories

NOTE: Check accessory package against packing list to assure completeness. Do not proceed with installation until all accessory parts are available.

Accessories are packed separately and will include the following:

• Layout/wiring diagram
• Installation and operating instructions
• Lifting straps and lifting shackles
• Bottom Supports - I beams
• Hardware bag for I beam installation
• Hardware bag for module to module connections
• Standard clear covers
• Top clear covers
• Clear cover mounting brackets and assembly hardware
• Terminal plates
• Terminal plate mounting bracket
• Terminal plate hardware kit
• Terminal Plate Cover and assembly hardware
• Module tie plates and hardware (where required)
• Lead-Tin Plated copper connectors
• Hardware bag for connectors
• NO-OX-ID® “A” * grease
• Battery warning label
• Battery nameplate
• Cell numerals with polarity indicators
• Shims (leveling)
• Seismic Shims (where required)
• Alignment (drift) pins

*Registered Trademark of Sanchem Inc.

6.2 Recommended Installation Equipment and Supplies

• Fork lift, portable boom crane or A-Frame hoist
— GX2000 Module Weight: 315 kg (695 lb)
— GX3000 Module Weight: 447 kg (985 lb)
— GX2000 3-Cell Module Weight: 478 kg (1050 lb)
— Bottom Support (I-beams) Height: 10 mm (4 in)
• Chalk line
• Line Cord
• Torpedo level (Plastic)
• Plywood straight edge 1/2” x 4” x 48”
• Torque wrenches (100 in-lbs, 35 ft-lbs)
• Ratchet wrench with 10, 13, 17, 19 mm and 1/2 in. sockets
• Box wrenches 10, 13, 17, 19 mm sizes
• Vinyl electrical tape
• Paper wipers
• 3M Scotch Brite® scour-pads™*
• Hammer drill (Floor anchoring)
* Registered trademark of 3M

6.3 Unpacking

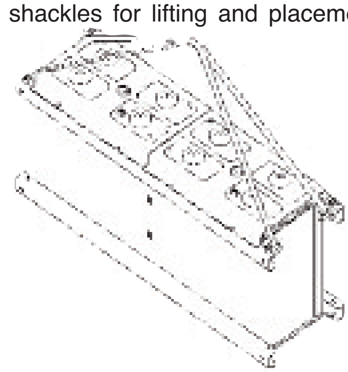
Carefully remove bolts and protective shipping hood. See Figure 3. Remove the bolts holding modules to shipping pallet. Also remove hardware bolting upper channels of modules together. Do not remove modules at this time. Base supports for horizontally stacked modules are more easily attached before removing modules from pallet (see Section 8 System Assembly).

Note: Placement of modules on shipping pallet has no relationship to final installation and should be disregarded.

UNPACKING MODULES
Figure 3

6.4 Handling of Modules

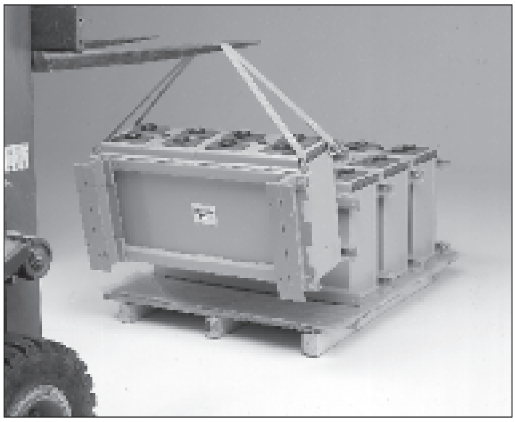
The design of the modular tray permits handling by a fork lift, portable crane or by a hoist sling . Whichever method is used, make sure equipment can safely handle the module weight. See Section 6.2 for module weights. Always use the two lifting straps and four lifting shackles for lifting and placement of modules. See Figure 4.



HANDLING - LIFTING STRAP PLACEMENT
Figure 4

NOTE (for Figure 4):

1) Straps must be criss-crossed.
2) Observe lifting shackle orientation and proper channel hole use.
3) See Figure 13 for handling modules in horizontal orientation.
4) Never lift more than one module with straps and hooks.

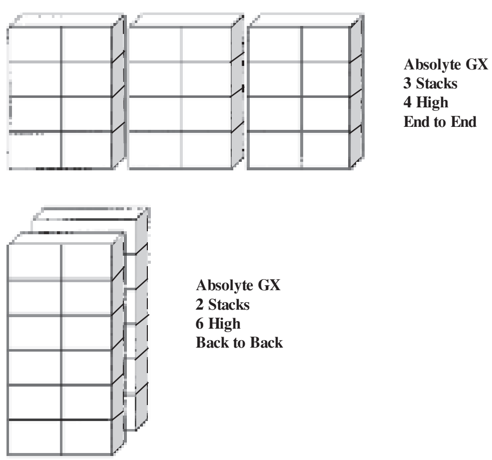


HANDLING MODULE
Figure 5

SECTION 7: SYSTEM ARRANGEMENTS

7.0 Module Arrangements

Absolyte GX batteries may only be arranged horizontally. Figure 6 shows some typical arrangements.



TYPICAL SYSTEM ARRANGEMENTS
Figure 6

Modules are shipped without connectors installed. The wiring diagram enclosed with shipment will show proper battery hook-up. Module stack height limitation depends on cell size and the seismic requirements of the application.

SECTION 8: SYSTEM ASSEMBLY

8.0 Module Assembly Identification

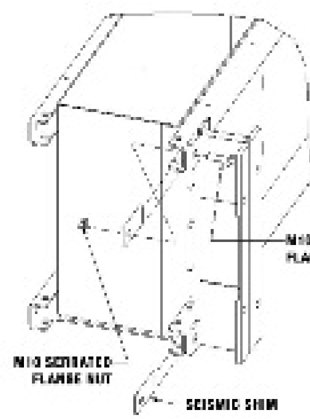
Consult layout/wiring diagram for total number and type of module assemblies in system. Compare required module assemblies called for on layout/wiring diagram with modules in shipment for completeness before continuing further. The Absolyte GX has a standard module configuration of two cells per module. Where application voltage requires, a module may have only one cell in a two-cell tray. For example, a 46 volt system will consist of eleven full modules and one single-cell module. Assemblies can be rotated 180° for proper polarity location.

8.1 Bottom Supports (I-beams)

Locate bottom I-beam supports and M10 serrated flange bolts and nuts. I-beam supports and seismic shims should be attached to the appropriate module assembly shown on the layout/wiring diagram prior to removal from shipping pallet. Consult layout/wiring diagram for proper location of positive/negative terminals relative to I-beam.

NOTE: Failure to use seismic shims (on systems where seismic shims are indicated) will result in the assembly not meeting seismic certification criteria.

Secure I-beam support to a module channel as shown in Figures 7 & 8, with access slots outward. Torque hardware to 47 Newton-meters (35 Ft-Lbs) using insulated tools. The side of the I-beam will be approximately 3.2mm (.125”) away from the end of the channels.



I-BEAM
HARDWARE INSTALLATION
Figure 7

I-BEAM SUPPORT INSTALLED
Figure 8

Similarly, install the remaining I-beam on the other side of the module.

8.2 Handling of Modules

The module/I-beam assembly may now be removed from the pallet using methods outlined in Section 6.5. See Figures 4 and 5. Remaining modules may be removed in a similar manner.

8.3 Tip Over Procedure

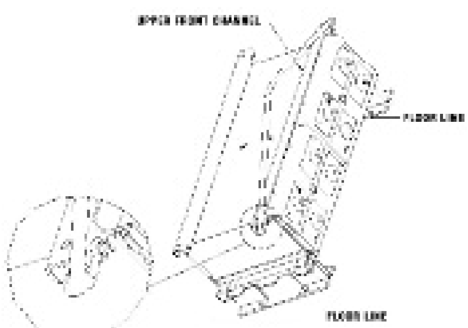
In order to stack modules in the horizontal position, refer to Figures 9 through 11 to perform the tip-over procedure. The module/I-Beam assembly tip-over should be performed first. This procedure can be performed using a portable boom crane or fork lift in conjunction with the lifting straps and lifting shackles supplied.

A. Install lifting strap using lifting shackles in channel base holes at each end of module upper **front** channel as shown in Figure 9.

B. Center the lifting hook onto strap and lift until strap is under tension and raises bottom of module from floor surface.

C. While exerting manual force on the upper **front** of module, lower hoist until module is in horizontal position. See Figures 10 and 11.

D. After tip over procedure when module is horizontal, install the four lifting shackles and two lifting straps as shown in Figure 12 to position and handle battery in horizontal position.

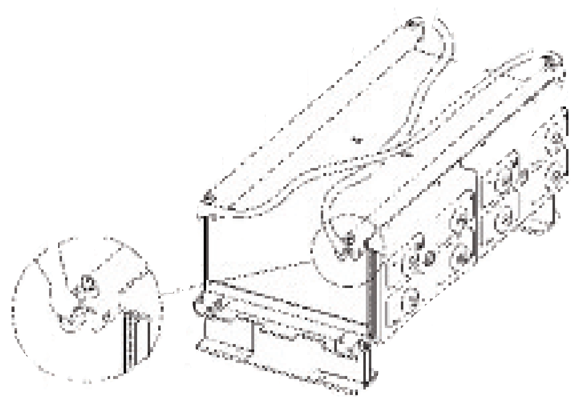


TIP-OVER PROCEDURE - SHACKLE-STRAP USAGE
Figure 9

NOTE (for Figure 9):
1) One strap with shackles used for tip-over procedure.
2) Observe channel hole used as well as direction of shackle insertion.
3) Tip over procedure for single modules only.

TIP-OVER PROCEDURE
Figure 10

MODULE AFTER TIP-OVER
Figure 11



HORIZONTAL STACKING SHACKLE-STRAP USAGE
Figure 12

Where floor anchoring is required, position module/I-Beam assembly in desired location. Mark floor through I-beam holes and remove module/base assembly. Install floor anchoring and reposition module/base assembly over anchoring. Prior to installing nuts and washers, check that assembly is level in both axes. Level using shims provided. When level, fasten assembly and torque nuts to 47 Newton-meters (35 Ft-Lbs).

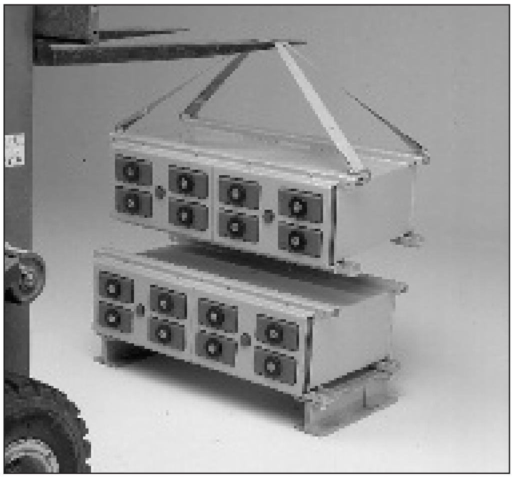
In order to complete stacking of a horizontal single stack refer to Figures 12 to 15 and steps A through C listed below.

NOTE: The use of leveling shims is required when assembling any Absolyte GX system in order to meet seismic requirements. Failure to use the shims to level each module and to fill spaces between tray channels during module assembly will result in the assembly not meeting seismic certification criteria. In extreme cases, stack to stack connectors cannot be installed.

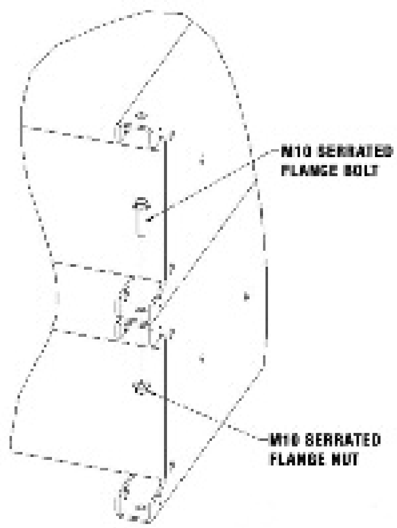
A. Using Section 6.5 and 8.1.3 and the layout/wiring diagram, position the next module on top of first so that channels of each mate with one another. Use drift pins to align channel holes. Make sure channel ends and sides of the upper and lower modules are flush. Remove lifting straps and install M10 serrated flange bolts and nuts in open holes, finger tight. Use leveling shims to fill gaps between trays. See Figures 13, 14 and 15.

B. At this time, check to see that the first two modules are plumb front to back and side to side using wooden or plastic level together with plywood straight edge. This is to insure proper alignment for module interconnection later on. Torque hardware to 47 Newton-meters (35 Ft-Lbs).

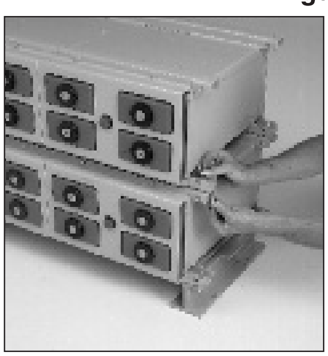
C. Proceed with stacking of remaining modules, checking that stack is plumb in both axes as stacking progresses before torquing hardware. Be certain to check the layout/wiring diagram for correct horizontal orientation to provide proper polarity interconnection as stacking progresses. See Figure 16 for completed assembly.



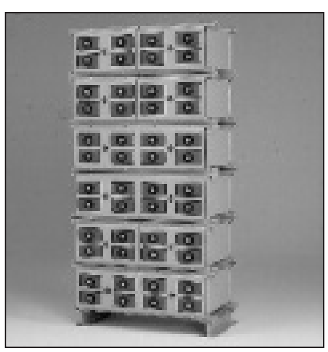
HANDLING AND STACKING HORIZONTAL MODULES
Figure 13



HARDWARE INSTALLATION SEQUENCE
Figure 14



INSTALLING HARDWARE
Figure 15



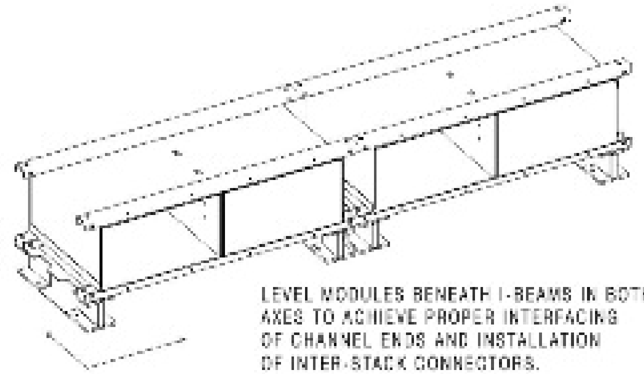
COMPLETED HORIZONTAL STACK
Figure 16

8.3 Horizontal-Multiple Stacks

8.3.1 Stacking Base Modules

It is recommended that all of the first modules with bottom supports attached (see Section 8.1.1) be placed in position first. A chalk line floor mark should be used to assure all stacks will be in a straight line. This applies for stacks end-to-end or end-to-end and back-to-back. Refer to Sections 6.5 and 8.1.3 for handling and tip over procedures.

For stacks end-to-end, module ends should be butted together so that module side channel ends meet (see Figure 17).



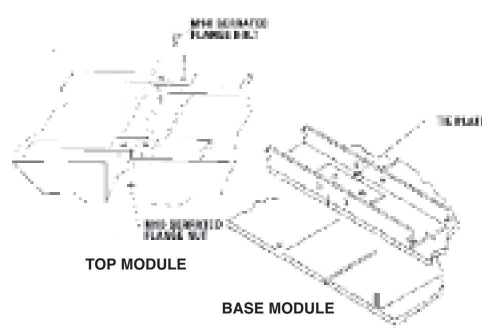
POSITIONING HORIZONTAL BASE MODULES
Figure 17

For stacks back-to-back, the two base modules are positioned to provide a minimum 4.5" spacing between the bottoms of the modules (not I-beam edges). Refer back to Figure 1.

Refer to layout/wiring diagram for seismic shim requirements.

8.3.2 Stack Tie Plates

At this time stack tie plates should be installed. It will be necessary to temporarily remove the hardware fastening the base modules to the I-beams. To achieve maximum stack stability, especially where seismic conditions may exist, as well as proper interfacing of inter-stack connections, metal tie plates are provided. The plates used on stacks end to end are 3" x 1" x 1/8" with two 9/16" holes. Use one tie plate at each interface to connect the module channels of adjacent stacks. See Figure 18.



TIE PLATE ASSEMBLIES - HORIZONTAL STACKS
Figure 18

Position plates on the module channels and secure with hardware as shown. Where stacks have different heights (for example a 3 high stack adjacent to 4 high stack), install plates on shorter stack top module and adjacent module. Torque hardware to 47 Newton-meters (35 Ft-Lbs).

8.3.3 Horizontal Stacking

When all base modules are set in place, continue with stacking of subsequent modules. Procedures for assembly of multiple horizontal stacks are the same as outlined in section 8.1.3. Also consult layout/wiring diagram. Each stack should be built up in sequence to the same level until the top modules in all stacks are the last to be installed. The use of a line chord attached to upper module corners of opposite end modules as stacking progresses aids in alignment.

This completes the mechanical assembly of the battery system.

For installation of intermodular connections and terminal plate assembly, see Section 9.

For installation of protective module cover, see Section 11.

SECTION 9: ELECTRICAL CONNECTIONS

9.0 Post Preparation

All cell posts were greased at the factory. Using either a brass bristle suede shoe brush or 3M Scotch Brite scouring pad, brighten the flat copper terminal surfaces to ensure lowest resistance connections. Apply a thin film of NO-OX-ID “A” grease (supplied) to all terminal surfaces, bolts, and washers. This will preclude oxidation after connections are completed.

9.1 Connections - System Terminals

Each system is supplied with a terminal plate assembly for the positive and negative terminations. These should always be used to provide proper connection to the operating equipment and cell terminals. Any attempt to connect load cables directly to cell terminal may compromise battery system performance as well as the integrity of cell post seals.

Refer to layout/wiring diagram for location of terminal plate assembly in your battery configuration. Assemble Terminal Support Bracket to module channel using hardware indicated, items 3, 4, 5, 6. Hardware will be located in a bag labeled K17-417240P for top termination or K17417256 for side termination. Assemble Terminal Plate to Support Bracket and battery posts. Hardware to attach to Support bracket is also located in the terminal plate kit. It is recommended that all connections be torqued to 11.3 Newton-meters (100 in-lbs). Retorque value is also 11.3 Newton-meters (100 in-lbs). After making cable connections, assemble Terminal Plate Covers, Items 7 & 8, to the Terminal Support Bracket using hardware indicated. Hardware to assemble Terminal Plate Covers will be located in the terminal plate kit. Refer to Sections 9.0 and 9.2 for electrical contact surface preparation of terminal plate components.

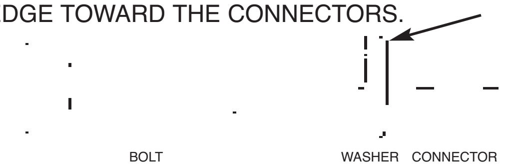
Terminal plate assembly varies with termination location. Refer to layout/wiring diagram termination location on your battery. Figure 20 shows top termination assembly with instructions.
<u>Do not make connections to operating system at this time.</u>

9.2 Connections - Inter-MODULE

Consult layout/wiring diagram for correct quantity of lead-tin plated copper connectors required for each connection. Follow procedure in Section 9.0 and brighten lead-tin plated surfaces coming in contact with copper posts. Apply a thin film of NO-OX-ID “A” grease to these areas.

NOTE: Apply a minimum amount of grease to cover the surface. As a rule: "If you can see it, it's too much".

Where multiple connectors are required across any single connection, brighten both sides of connectors along the entire length. Grease these areas as well. It is recommended when installing connectors on horizontal arrangements that the upper bolts be installed first to reduce risk of accidental shorting.Refer to layout/wiring diagram for connector placement and materials list. Figure 19 shows typical module connections, intrastack connections and interstack connections.

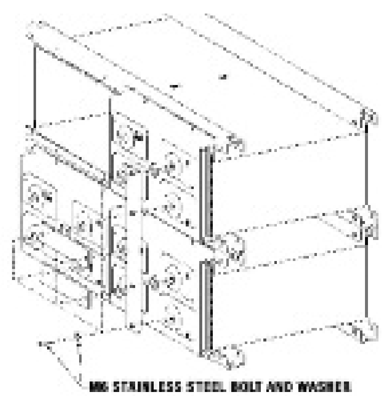


9.3 Connections - Inter-STACK

Multiple stacks end to end are interconnected as shown in layout/wiring diagram. Follow the procedures in Sections 9.1 & 9.3.

9.4 Torquing

When all inter-module and inter-stack connections have been installed, tighten all connections to <u>11.3 Newton-meters (100 in-Lbs)</u> Use insulated tools. Recheck connections after the initial charge due to heating during charge.



STACK CONNECTIONS
Figure 19

9.5 Connection - Check

Again, visually check to see that all module terminals are conected positive (+) to negative (-) throughout the battery. Positive terminals have red cap. Negative terminals have black cap.

Also measure the total open circuit voltage from terminal plate to terminal plate. This should be approximately equal to 2.14 volts times the number of cells in the system, e.g., a 24 cell system would read: 24 x 2.14v = 51.4 volts. An incorrect voltage reading may mean connectors were installed incorrectly.

9.6 Connection Resistance

Electrical integrity of connections can be objectively established by measuring the resistance of each connection. These resistances are typically in the microhm range. Meters are available which determine connection resistance in microhms. Be sure that the probes are touching only the posts to ensure that the contact resistance of connector to post is included in the reading.

Resistance measurements or microhm measurements should be taken at the time of installation and annually thereafter. Initial measurements at installation become the benchmark values and should be recorded for future monitoring of electrical integrity.

It is important that the benchmark value for all similar connections be no greater than 10% over the average. If any connection resistance exceeds the average by more than 10%, the connection should be remade so that an acceptable benchmark value is established.

Benchmark values for connection resistances should also be established for terminal plates, where used, as well as cable connections. Benchmark values should preferably be established upon installation.

All benchmark values should be recorded. Annually, all connection resistances should be re-measured. Any connection which has a resistance value 20% above its benchmark value should be corrected.

SECTION 10: IDENTIFICATION LABELS

10.0 Surfaces

Make sure surfaces are free of dirt and grease by wiping with clean, dry wipers (isopropyl alcohol may be used) to ensure proper label adhesion.

10.1 Cell Numerals

A set of pressure sensitive cell numerals and system polarity labels are supplied and should be applied at this time. Cell numerals should be applied to the cell being identified. Designate the positive terminal cell as #1 with succeeding cells in series in ascending order.

10.2 System Polarity Labels

The system polarity labels should be applied next to the positive and negative system terminals.

10.3 Warning Label

Apply pressure sensitive warning label provided on a prominently visible module side or end.

10.4 Battery Nameplate

For future reference and warranty protection, apply pressure sensitive nameplate on a prominently visible module. Fill in date of installation and the specified capacity and rate.

SECTION 11: PROTECTIVE MODULE COVERS

11.0 General

Each module is provided with a transparent protective cover to help prevent accidental contact with live electrical connections, and to provide easy visual access to the system.

When all system assembly has been completed, as well as initial testing, including initial charge and cell float voltage readings, all covers should be installed. Covers should remain in place at all times during normal operation of the battery system.

11.1 Module Clear Cover Installation

Refer to Figure 21 for Module Clear Cover installation. Install standoff legs and standoff keys first, as shown.

The cover is then installed by grasping it so that the EXIDE logo is upright. Locate slots at bottom of cover to the bottom standoff legs and slide in place. Locate holes at top of cover and install to top standoff legs. Refer to Figure 21.

SECTION 12: BATTERY CHARGING

12.0 Initial Charge

Batteries lose some charge during shipment as well as during the period prior to installation. A battery should be installed and given its initial charge as soon after receipt as possible. Battery positive (+) terminal should be connected to charger positive (+) terminal and battery negative (-) terminal to charger negative (-) terminal. **Failure to perform the initial charge within the time limits stated in section 4.2 will affect the performance and life of the battery and may void the warranty.**

12.1 Constant Voltage Method

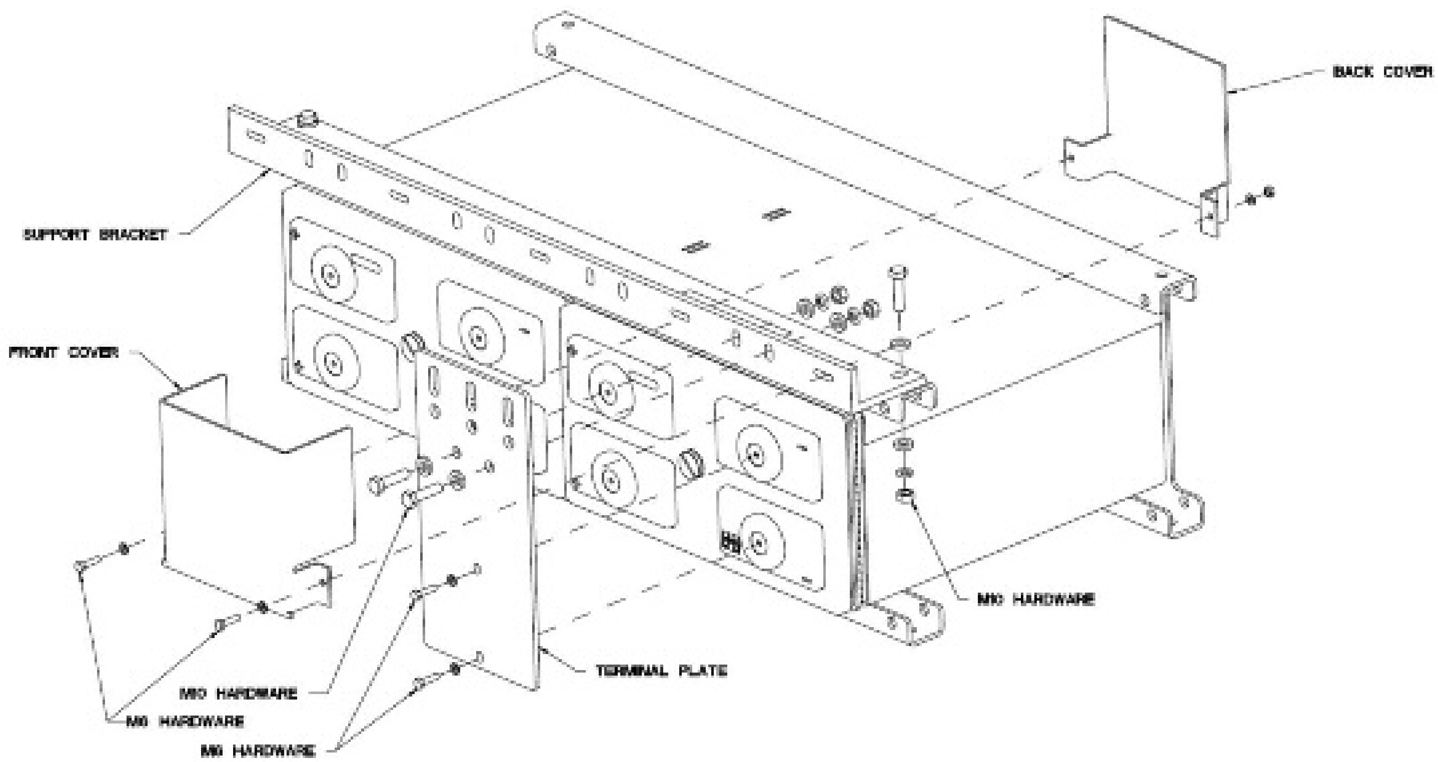
Constant voltage is the only charging method allowed. Most modern chargers are of the constant voltage type. Determine the maximum voltage that may be applied to the system equipment. This voltage, divided by the number of cells connected in series, will establish the maximum volts per cell (VPC) that is available. Table C lists recommended voltages and charge times for the initial charge. Select the highest voltage the system allows to perform the initial charge in the shortest time period.

Temperature Correction of Charger Voltage

V corrected = V25°C - ((T actual -25°C) x (.0055 V/°C))

BILL OF MATERIALS — TOP TERMINAL PLATE ASSEMBLY

ITEM	DESCRIPTION	QTY PER SYSTEM
1	PLATE, TOP TERMINAL	2
2	BRACKET, TERMINAL SUPPORT	2
3	LOCK WASHER, M10	8
4	FLAT WASHER, M10	16
5	NUT, M10 X .8D	8
6	BOLT, M10 X 40	8
7	COVER, FRONT	2
8	COVER, BACK	2
9	NUT, M6 X .8D	4
10	BOLT, M6 X 25	VARIES
11	WASHER, M6	VARIES



Terminal Plate Kit Materials & Assembly
Figure 20

or

V corrected = V77°F - ((T actual - 77°F) x .003V/°F))

Please refer to Appendix A for standard values.

STEP 1

1. Set constant voltage charger to maximum setting without exceeding 2.35 VPC.
Example: For a target charge of 2.35 VPC on a 24-cell system, you would set the charger voltage to 56.4 volts.

Depending on the battery's state of charge, the charger may go into current limit at the beginning and decline slowly once the target charge voltage is reached.

2. Record time and current at regular intervals – every hour as a minimum.

3. Continue charging the battery until there is no further drop in charge current over 3 consecutive hours. This could take days if the battery has been in storage for a long time.

4. When the current has stabilized, proceed to step 2.

STEP 2

1. Continue the charge for the time listed in Table C depending on the charger voltage setting. The time is IN ADDITION to the time spent charging in Step 1.

Example: charge for 12 hours if the charger voltage is set to 2.35 VPC.

TABLE C
EQUALIZE CHARGE (77°F)

CELL VOLTS	TIME (HOURS)
2.30	24
2.33	18
2.35	12

2. Record cell voltages hourly during the last 3 hours of the charge time. If, after the charge time has completed, but the lowest cell voltage has continued to rise, you may extend the charge, monitoring cell voltages hourly, until the lowest cell voltage ceases to rise.

3. Proceed to Step 3.

STEP 3

1. The initial charge is complete. Charger voltage can now be reduced to float voltage setting per Section 13.2. For a target float charge of 2.25 VPC on a 24-cell system, you would set the charger voltage to 54 volts.

SECTION 13: BATTERY OPERATION

13.0 Cycle Method of Operation

In cycle operation, the degree of discharge will vary for different applications. Therefore, the frequency of recharging and the amount of charge necessary will vary. Generally, Absolyte GX cells require approximately 105-110% of the ampere-hours removed to be returned to a full state of charge.

The upper voltage settings recommended, given that the maxium charge current is 5% of the nominal C100 Amp-hour rating and the ambient temperature is 25°C (77°F), are as follows:

2.28 ± 0.02 VPC @ 0-2% DOD
2.33 ± 0.02 VPC @ 3-5% DOD
2.38 ± 0.02 VPC @ >5% DOD

Due to the variety of applications and charging equipment (particularly in photovoltaic systems) it is recommended that you contact an EXIDE representative when determining proper recharge profiles.

13.1 Floating Charge Method

In this type of operation, the battery is connected in parallel with a constant voltage charger and the critical load circuits. The charger should be capable of maintaining the required constant voltage at battery terminals and also supply a normal connected load where applicable. This sustains the battery in a fully charged condition and also makes it available to assume the emergency power requirements in the event of an AC power interruption or charger failure.

13.2 Float Charge - Float Voltages

Following are the float voltage ranges recommended for the Absolyte Battery System. Select any "volts per cell" (VPC) value within the range listed that will result in the series string having an average volts per cell equal to that value.

RECOMMENDED FLOAT RANGE (@77°F)
2.23 to 2.25 VPC

NOTE: Recommended float voltages are for 77°F. For other temperatures a compensation factor of .003 V/°F (.0055 V/°C) per cell is recommended. The minimum voltage is 2.20 VPC, temperature correction does not apply below this voltage. The maximum voltage is 2.35 VPC, temperature correction does not apply above this voltage.

TEMPERATURE CORRECTION

V corrected = V25°C - ((T actual-25°C) x (.0055V/°C)) or
V corrected = V77°F - ((T actual-77°F) x (.003V/°F))

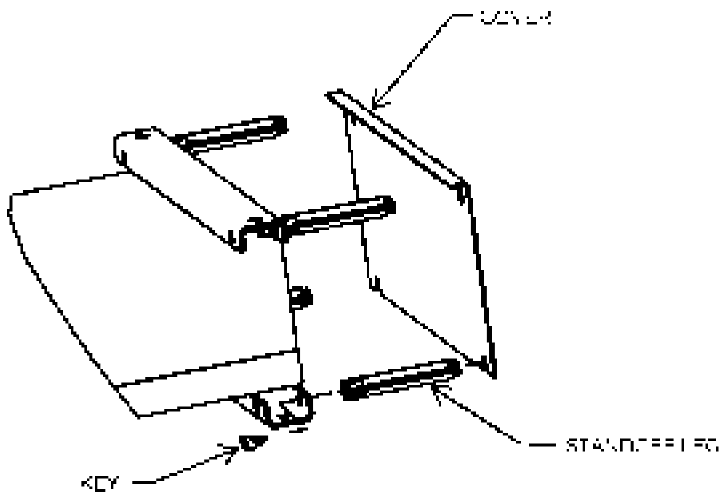
See Appendix A for standard values.

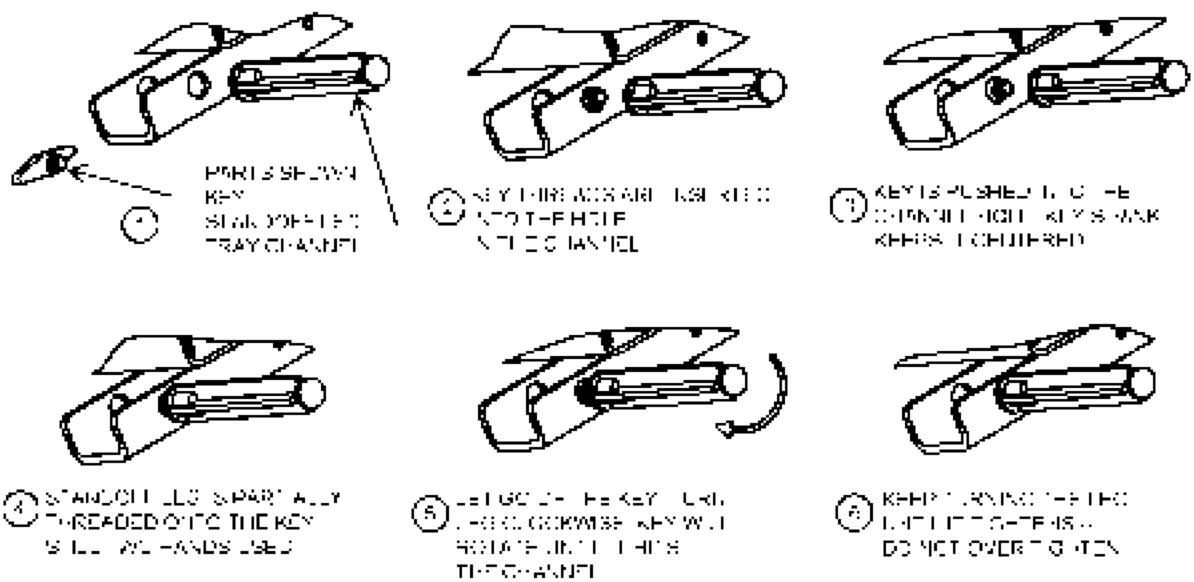
Modern constant voltage output charging equipment is recommended for the floating charger method of operation of EXIDE Absolyte batteries. This type of charger, properly adjusted to the recommended float voltages and following recommended surveillance procedures, will assist in obtaining consistent serviceability and optimum life.

After the battery has been given its initial charge (refer to Section 12), the charger should be adjusted to provide the recommended float voltages at the battery terminals.

BILL OF MATERIALS — MODULE CLEAR COVER MATERIALS

ITEM	DESCRIPTION	QTY PER SYSTEM
1	Cover	1
2	Standoff Leg	4
3	Standoff Key	4





Assembly Instructions:

Install standoff legs and standoff keys to module channel as shown. The cover is then installed by grasping it so that the EXIDE logo is upright. Locate slots at bottom of cover to bottom standoff legs and slide in place. Locate holes at top of cover and install to top standoff legs.

Standoff legs need not be removed to access cells, simply remove protective cover.

Module Clear Cover Materials and Assembly
Figure 21

Do not use float voltages higher or lower than those recommended. Reduced capacity or battery life will result.

Check and record battery terminal voltage on a regular basis. Monthly checks are recommended. See Section 15.0, Records. If battery float voltage is above or below the correct value, adjust charger to provide proper voltage as measured at the battery terminals.

13.3 Recharge

All batteries should be recharged as soon as possible following a discharge with constant voltage chargers. To recharge in the shortest period of time, raise the charger output voltage to the highest value which the connected system will permit. Do not exceed the voltages and times listed in Table E in Section 14.2.

13.4 Determining State-of-Charge

If the normal connected load is constant (no emergency load connected), the following method can be used to determine the approximate state-of-charge of the battery. The state-of-charge can be identified to some degree by the amount of charging current going to the battery. When initially placed on charge or recharge following a discharge, the charging current, read at the charger ammeter, will be a combination of the load current plus the current necessary to charge the battery. The current to the battery will start to decrease and will finally stabilize when the battery becomes fully charged. If the current level remains constant for three consecutive hours, then this reflects a state-of-charge of approximately 95 to 98%. For most requirements, the battery is ready for use.

If the normal connected load is variable (i.e. telecommunications), the following method may be used to check the state-of-charge of the battery. Measure the voltage across a pilot cell (See Section 15 for definition of pilot cell). If the voltage is stable for 24 consecutive hours, the battery reflects a state of charge of approximately 95%.

13.5 Effects of Float Voltage

Float voltage has a direct effect on the service life of your battery and can be the cause of thermal instability.

A float voltage above the recommended values reduces service life. Table D shows the effects of float voltage (temperature corrected) on battery life.

TABLE D

FLOAT VOLTAGE EFFECTS ON LIFE

| Temperature corrected 25°C (77°F) Float voltage per cell | | Percent Reduction |
Minimum	Maximum	in Battery Life
2.23	2.25	0%
2.28	2.30	50%
2.33	2.35	75%

Voltage records must be maintained by the user in accordance with the maintenance schedule published in this manual. To obtain the optimum service life from the battery, it is important to make sure the battery's float voltage is within the recommended range.

13.6 Float Current and Thermal Management

Increased float current can portend a condition known as thermal runaway, where the battery produces more heat than it can dissipate. VRLA batteries are more prone to thermal runaway because the recombination reaction that occurs at the negative plate, and reduces water loss, also produces heat. High room temperature, improper applications, improper voltage settings, and incorrect installation practices can increase the chances of thermal runaway.

As with good record-keeping practices, monitoring float current can prevent a minor excursion from becoming a major issue.

13.7 AC Ripple

AC ripple is noise or leftover AC waveform riding on the DC charge current to the battery that the rectifier did not remove. It is usually more pronounced in UPS than telecom systems. Proper maintenance of the UPS capacitors will reduce the amount of ripple going into the battery.

Establishment of absolute limits for AC ripple has always been problematic because the degree of damage it causes depends on the wave shape, peak-to-peak magnitude and frequency. Accurate characterization of AC ripple requires an oscilloscope and even then, only represents a picture of the ripple at that moment in time.

Whatever its exact characteristics, AC ripple is always harmful to batteries. Depending on its particular properties, ripple can result in overcharge, undercharge and micro-cycling that can prematurely age the battery. The most common and damaging result of AC ripple is battery heating which can lead to thermal runaway. AC ripple will decrease battery life and should be reduced as much as possible.

13.8 Ohmic Measurements

Impedance, resistance and conductance testing is collectively known in the industry as ohmic measurements. Each measurement is derived using a manufacturer-specific and proprietary algorithm and / or frequency. This means that one type of measurement cannot be converted or related easily to another.

"Reference" ohmic values are of dubious value because so many factors can affect the way the readings are made and displayed by the devices. Connector configuration and AC ripple as well as differences between readings of temperature and probe placement will prevent the ohmic devices from generating consistent and meaningful data. The meters work better with monoblocs and small capacity VRLA products and less well with large (>800-Ah) VRLA and flooded battery designs. Users should be particularly skeptical of data taken on series-parallel VRLA battery configurations as the feedback signal to the device may follow unforeseen paths that can overwhelm it.

It is best for users to establish their own baseline values for their battery as specifically configured. Do not rely on reference values.

If users wish to enhance normal maintenance and record-keeping with ohmic measurements, EXIDE recommends the trending of this data over time. Use a first set of readings taken 6 months after initial charge and installation as the baseline data. Because cell positioning within the string (connector configuration to a particular cell) can affect the reading, always compare each cell at baseline to itself in the new data. Standalone ohmic data is not sufficient to justify warranty cell replacement.

Responsible ohmic device manufacturers acknowledge that there is no direct relationship between percent ohmic change from baseline and battery capacity. A change from baseline of 25% or less is in the normal noise or variability range. Changes between 25% and 50% may call for additional scrutiny of the system. An IEEE compliant discharge test is usually warranted on systems exhibiting more than a 50% change from baseline. Consult an EXIDE representative for specific questions about ohmic data.

SECTION 14: EQUALIZING CHARGE

14.0 General

Under normal operating conditions an equalizing charge is not required. An equalizing charge is a special charge given a battery when non-uniformity in voltage has developed between cells. It is given to restore all cells to a fully charged condition. Use a charging voltage higher than the normal float voltage and for a specified number of hours, as determined by the voltage used.

Non-uniformity of cells may result from low float voltage due to improper adjustment of the charger or a panel voltmeter which reads an incorrect (higher) output voltage. Also, variations in cell temperatures greater than 5°F (2.78°C) in the series string at a given time, due to environmental conditions or module arrangement, can cause low cells.

14.1 Equalizing Frequency

An equalizing charge should be given when any of the following conditions exist:

A. The float voltage of any cell is less than 2.18 VPC.

B. A recharge of the battery is required in a minimum time period following an emergency discharge.

C. Individual cell(s) float is more than +/- 0.05 volts from average.

D. Accurate periodic records (See Section 15) of individual cell voltages show an increase in spread since the previous semi-annual readings.

An annual equalize charge is recommended to help ensure uniform cell performance.

14.2 Equalizing Charge Method

Constant voltage charging is the method for giving an equalizing charge. Determine the maximum voltage that may be applied to the system equipment. This voltage, divided by the number of cells connected in series, will establish the maxi-mum volts per cell that may be used to perform the equalizing charge in the shortest period of time (not to exceed 2.35 VPC applicable at 77°F, 25°C). Refer to Table E for voltages and recommended time periods.

NOTE: Charge volts listed in Table E are for 77°F. For other temperatures a compensation factor of .003 V/°F (.0055 V/°C) per cell is recommended. The minimum voltage is 2.20 VPC. The maximum voltage is 2.35 VPC. Temperature correction does not apply outside of this range.

V corrected = V25°C - ((T actual-25°C) x (.0055 V/°C)) or V corrected = V77°F - ((T actual-77°F) x (.003 V/°F))

See Appendix A for standard values.

STEP 1

A. Set constant voltage charger to maximum setting without exceeding 2.35 VPC.

Example: For a target charge of 2.35 VPC on a 24-cell system, you would set the charger voltage to 56.4 volts.

B. Record time and current at regular intervals – every hour as a minimum.

C. Continue charging the battery until there is no further drop in charge current over 3 consecutive hours.

D. When the current has stabilized, proceed to step 2.

STEP 2

A. Continue the charge for the time listed in Table E depending on the charger voltage setting. The time is IN ADDITION to the time spent charging in Step 1.

Example, charge for 12 hours if the charger voltage is set to 2.35 VPC.

TABLE E
EQUALIZE CHARGE (77°F)

CELL VOLTS	TIME (HOURS)
2.30	24
2.33	18
2.35	12

B. Record cell voltages hourly during the last 3 hours of the charge time. If, after the charge time has completed, but the lowest cell voltage has continued to rise, you may extend the charge, monitoring cell voltages hourly, until the lowest cell voltage ceases to rise.

C. Proceed to Step 3.

STEP 3

The Equalize charge is now complete. Charger voltage can now be reduced to float voltage setting per Section 13.2. For a target float charge of 2.25 VPC on a 24-cell system, you would set the charger voltage to 54 volts.

SECTION 15: RECORDKEEPING

15.0 Pilot Cell

A pilot cell is selected in the series string to reflect the general condition of cells in the battery. The cell selected should be the lowest cell voltage in the series string following the initial charge. See Section 12.0 - Initial Charge. Reading and recording pilot cell voltage monthly serves as an indicator of battery condition between scheduled overall individual cell readings.

15.1 Voltmeter Calibration

Panel and portable voltmeters used to indicate battery float voltages should be accurate at the operating voltage value. The same holds true for portable meters used to read individual cell voltages. These meters should be checked against a standard every six months and calibrated when necessary.

15.2 Records

The following information must be recorded at installation, and annually for every year of operation after installation. These records must be maintained throughout the life of the battery and made available for review by EXIDE representatives for capacity or life related warranty claims. Failure to collect and store these maintenance data will void the warranty. Please review the warranty statement specific to the application for any additional requirements.

- Individual cell voltages
- Overall string voltage
- Ambient temperature immediately surrounding battery
- Battery temperature at several places throughout the string. Recommend 1 reading per battery stack. More data points are recommended for larger batteries and to check for temperature gradients. Readings on the tray, cell cover or negative terminal are good places to measure battery temperature. Take readings away from HVAC sources.
- Float current measured at stack to stack connections (optional)
- Ohmic measurements (optional). Baseline ohmic readings of individual cells should be taken 6 months from the date of initial charge.
- Retorque connectors as part of annual maintenance.

ONCE PER YEAR READINGS ARE THE ABSOLUTE MINIMUM REQUIRED TO PROTECT WARRANTY. More frequent readings are recommended, especially for critical sites. Good record-keeping will prevent minor issues from escalating into more serious problems over time. See Figure 22 for a sample record-keeping form.

SECTION 16: TAP CONNECTIONS

16.0 Tap Connections

Tap connections are not to be used on a battery. This can cause overcharging of the unused cells and undercharging of those cells supplying the load, thus reducing battery life.

SECTION 17: TEMPORARY NON-USE

17.0 Temporary Non-Use

An installed battery that is expected to stand idle longer than the maximum storage interval (see Section 4.2), should be treated as stated below. The maximum storage interval is 6 months if stored at 25°C, 77°F.

Give the battery an equalizing charge as per Section 14. Following the equalizing charge, open connections at the battery terminals to remove charger and load from the battery.

Repeat the above after every 6 months (25°C, 77°F) or at the required storage interval. See Section 4.2 for adjustments to storage intervals when the storage temperature exceeds 25°C, 77°F.

To return the battery to normal service, re-connect the battery to the charger and the load, give an equalizing charge and return the battery to float operation.

SECTION 18: UNIT CLEANING

18.0 Unit Cleaning

Periodically clean cell covers with a dry 2" paintbrush to remove accumulated dust. If any cell parts appear to be damp with electrolyte or show signs of corrosion, contact your local EXIDE representative.

CAUTION!

Do not clean plastic parts with solvents, detergents, oils, mineral spirit or spray type cleaners as these may cause crazing or cracking of the plastic materials.

SECTION 19: CONNECTIONS MAINTENANCE

19.0 Connections

Battery terminals and intercell connections should be corrosion free and tight for trouble-free operation. Periodically these connections should be inspected.

CAUTION: DO NOT WORK ON CONNECTIONS WITH BATTERY CONNECTED TO CHARGER OR LOAD.

If corrosion is present, disconnect the connector from the terminal.

Gently clean the affected area using a suede brush or Scotch Brite scouring pad. Apply a thin coating of NO-OX-ID "A" grease to the cleaned contact surfaces, reinstall connectors and retorque connections to 11.3 Newton-meters (100 inch pounds).

All terminal and intercell connections should be retorqued at least once every year to 11.3 Newton-meters (100 inch pounds).

NOTE: Design and/or specifications subject to change without notice. If questions arise, contact your local sales representative for clarification.

SECTION 20: CAPACITY TESTING

20.0 Capacity Testing

When a capacity discharge test is desired, it is recommended that it be performed in accordance with IEEE-1188*, latest revision.

An equalizing charge, as described in Section 14.2, must be performed within 7 days prior to the capacity test. The batteries must be returned to float charging immediately after the equalize charge completes.

After the capacity discharge has completed, the batteries can be recharged in the shortest amount of time by following the equalize charge procedure described in Section 14.2.

*IEEE-1188: Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.

DATE: ____________

ABSOLYTE BATTERY MAINTENANCE REPORT

COMPANY: ____________ SERIAL NUMBER: ____________ PAGE 1 OF ______

ADDRESS: ____________ BATTERY LOCATION / NUMBER: ____________

No. of CELLS: ______ TYPE: ______ MANUF. DATE: ______ INSTALL DATE: ______

SYSTEM VOLTAGE: ______ TEMPERATURE: ______ CHARGER VOLTAGE: ______ CHARGER CURRENT: ______

Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp
1					31					61					91				
2					32					62					92				
3					33					63					93				
4					34					64					94				
5					35					65					95				
6					36					66					96				
7					37					67					97				
8					38					68					98				
9					39					69					99				
10					40					70					100				
11					41					71					101				
12					42					72					102				
13					43					73					103				
14					44					74					104				
15					45					75					105				
16					46					76					106				
17					47					77					107				
18					48					78					108				
19					49					79					109				
20					50					80					110				
21					51					81					111				
22					52					82					112				
23					53					83					113				
24					54					84					114				
25					55					85					115				
26					56					86					116				
27					57					87					117				
28					58					88					118				
29					59					89					119				
30					60					90					120				

ADDITIONAL COMMENTS: ____________

Figure 22.1

DATE: ____________

ABSOLYTE BATTERY MAINTENANCE REPORT

COMPANY: ____________ SERIAL NUMBER: ____________ PAGE 1 OF ______

ADDRESS: ____________ BATTERY LOCATION / NUMBER: ____________

EXIDE TECHNOLOGIES INDUSTRIAL ENERGY

No. of CELLS: ______ TYPE: ______ MANUF. DATE: ______ INSTALL DATE: ______

SYSTEM VOLTAGE: ______ TEMPERATURE: ______ CHARGER VOLTAGE: ______ CHARGER CURRENT: ______

Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp	Cell No.	Volts	Conn. Resist.	Ohmic C / R / I	Temp
121					151					181					211				
122					152					182					212				
123					153					183					213				
124					154					184					214				
125					155					185					215				
126					156					186					216				
127					157					187					217				
128					158					188					218				
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139					169					199					229				
140					170					200					230				
141					171					201					231				
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143					173					203					233				
144					174					204					234				
145					175					205					235				
146					176					206					236				
147					177					207					237				
148					178					208					238				
149					179					209					239				
150					180					210					240				

ADDITIONAL COMMENTS: ____________

Figure 22.2

APPENDIX A

Temperature Corrected Float Voltages

Expressed in Volts per Cell

Battery Temperature (°C)	Float Voltage at 25°C				
	2.23	**2.24**	**2.25**	**2.26**	**2.27**
3	2.35				
4	2.35	2.35			
5	2.34	2.35			
6	2.34	2.35			
7	2.33	2.34	**2.35**		
8	2.33	2.34	**2.35**		
9	2.32	2.33	**2.34**	2.35	
10	2.32	2.33	**2.34**	2.35	
11	2.31	2.32	**2.33**	2.34	2.35
12	2.31	2.32	**2.33**	2.34	2.35
13	2.30	2.31	**2.32**	2.33	2.34
14	2.30	2.31	**2.32**	2.33	2.34
15	2.29	2.30	**2.31**	2.32	2.33
16	2.28	2.29	**2.30**	2.31	2.32
17	2.28	2.29	**2.30**	2.31	2.32
18	2.27	2.28	**2.29**	2.30	2.31
19	2.27	2.28	**2.29**	2.30	2.31
20	2.26	2.27	**2.28**	2.29	2.30
21	2.26	2.27	**2.28**	2.29	2.30
22	2.25	2.26	**2.27**	2.28	2.29
23	2.25	2.26	**2.27**	2.28	2.29
24	2.24	2.25	**2.26**	2.27	2.28
25	2.23	2.24	**2.25**	2.26	2.27
26	2.23	2.24	**2.25**	2.26	2.27
27	2.22	2.23	**2.24**	2.25	2.26
28	2.22	2.23	**2.24**	2.25	2.26
29	2.21	2.22	**2.23**	2.24	2.25
30	2.21	2.22	**2.23**	2.24	2.25
31	2.20	2.21	**2.22**	2.23	2.24
32	2.20	2.21	**2.22**	2.23	2.24
33		2.20	**2.21**	2.22	2.23
34		2.20	**2.21**	2.22	2.23
35			**2.20**	2.21	2.22
36			**2.20**	2.20	2.21
37				2.20	2.21
38					2.20
39					2.20

Battery Temperature (°F)	Float Voltage at 77°F				
	2.23	**2.24**	**2.25**	**2.26**	**2.27**
55	2.30	2.31	**2.32**	2.33	2.34
56	2.29	2.30	**2.31**	2.32	2.33
57	2.29	2.30	**2.31**	2.32	2.33
58	2.29	2.30	**2.31**	2.32	2.33
59	2.28	2.29	**2.30**	2.31	2.32
60	2.28	2.29	**2.30**	2.31	2.32
61	2.28	2.29	**2.30**	2.31	2.32
62	2.28	2.29	**2.30**	2.31	2.32
63	2.27	2.28	**2.29**	2.30	2.31
64	2.27	2.28	**2.29**	2.30	2.31
65	2.27	2.28	**2.29**	2.30	2.31
66	2.26	2.27	**2.28**	2.29	2.30
67	2.26	2.27	**2.28**	2.29	2.30
68	2.26	2.27	**2.28**	2.29	2.30
69	2.25	2.26	**2.27**	2.28	2.29
70	2.25	2.26	**2.27**	2.28	2.29
71	2.25	2.26	**2.27**	2.28	2.29
72	2.25	2.26	**2.27**	2.28	2.29
73	2.24	2.25	**2.26**	2.27	2.28
74	2.24	2.25	**2.26**	2.27	2.28
75	2.24	2.25	**2.26**	2.27	2.28
76	2.23	2.24	**2.25**	2.26	2.27
77	2.23	2.24	**2.25**	2.26	2.27
78	2.23	2.24	**2.25**	2.26	2.27
79	2.22	2.23	**2.24**	2.25	2.26
80	2.22	2.23	**2.24**	2.25	2.26
81	2.22	2.23	**2.24**	2.25	2.26
82	2.22	2.23	**2.24**	2.25	2.26
83	2.21	2.22	**2.23**	2.24	2.25
84	2.21	2.22	**2.23**	2.24	2.25
85	2.21	2.22	**2.23**	2.24	2.25
86	2.20	2.21	**2.22**	2.23	2.24
87	2.20	2.21	**2.22**	2.23	2.24
88		2.21	**2.22**	2.23	2.24
89		2.20	**2.21**	2.22	2.23
90		2.20	**2.21**	2.22	2.23
91			**2.21**	2.22	2.23
92			**2.21**	2.22	2.23
93			**2.20**	2.21	2.22
94			**2.20**	2.21	2.22
95				2.21	2.22

APPENDIX B

MAXIMUM STORAGE INTERVAL BETWEEN FRESHENING CHARGES VERSUS AVERAGE STORAGE TEMPERATURE

Average Ambient Storage Temperature (°C)	Maximum Storage Interval Months	Maximum Storage Interval Days
25	6	0
26	5	18
27	5	7
28	4	26
29	4	16
30	4	7
31	3	29
32	3	21
33	3	13
34	3	7
35	3	0
36	2	24
37	2	18
38	2	13
39	2	8
40	2	4
41	1	29
42	1	25
43	1	22
44	1	18
45	1	15

Average Ambient Storage Temperature (°F)	Maximum Storage Interval Months	Maximum Storage Interval Days
77	6	0
78	5	23
79	5	17
80	5	10
81	5	4
82	4	29
83	4	23
84	4	18
85	4	12
86	4	7
87	4	3
88	3	28
89	3	23
90	3	19
91	3	15
92	3	11
93	3	7
94	3	4
95	3	0
96	2	27
97	2	23
98	2	20
99	2	17
100	2	14
101	2	11
102	2	9
103	2	6
104	2	4
105	2	1
106	1	29
107	1	27
108	1	25
109	1	23
110	1	21
111	1	19
112	1	17
113	1	15

APPENDIX C

BONDING & GROUNDING OF BATTERY RACK

INTRODUCTION

1. To insure personnel safety, and equipment protection, operation, and reliability, the battery rack should be connected to the Common Bonding Network (CBN).

2. Electrical continuity between modules is provided through the use of serrated hardware. Testing has shown that standard systems are compliant with the GR-1089-CORE, Issue 4, Section 9 requirements of the Bonding and Grounding tests.

GROUNDING KIT INSTALLATION (OPTIONAL)

1. Each kit consists of the following components:
   (2) #6 AWG, 12 in. 90°C cables
   (4) “C” shaped beam clamps
   (4) 1/4-20 x 0.75 in. bolts
   (4) 1/4-20 x 1.00 in. bolts

2. Using (1) 1/4-20 x 1.00 in. bolt per beam clamp, connect (1) beam clamp to the I-beam flange and (1) beam clamp to the back flange of the module (see Figure 1). Be sure to securely tighten the bolts such that the paint is penetrated (see Figure 2).

3. Attach each end of cable assembly to a beam clamp using (1) 1/4-20 x 0.75 in. bolt per end (see Figure 3). Tighten hardware securely.

4. Repeat Steps 2 and 3 for the second horizontal support (I-beam).

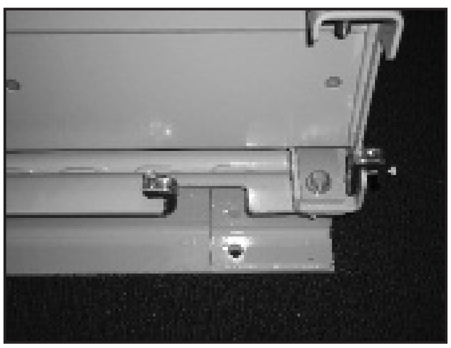

Figure 1: Beam Clamp Installation

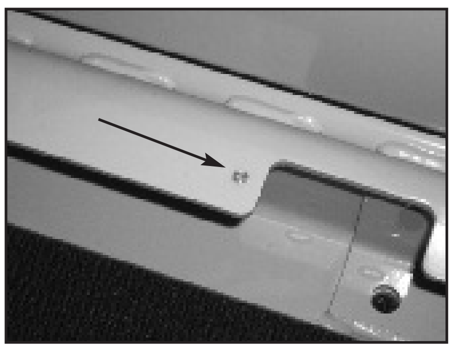

Figure 2: Adequate Paint Penetration

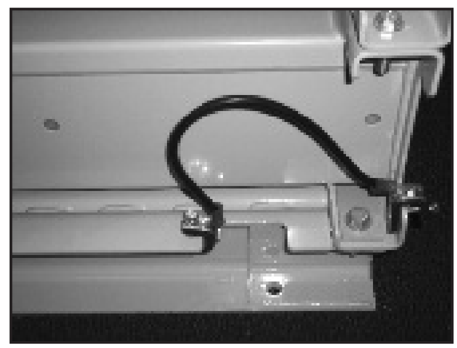

Figure 3: Cable Assembly Installation

CONNECTING TO THE CBN

1. The recommended location for attaching the frame ground is the back “C” channel on the upper module of the stack (see Figure 4).

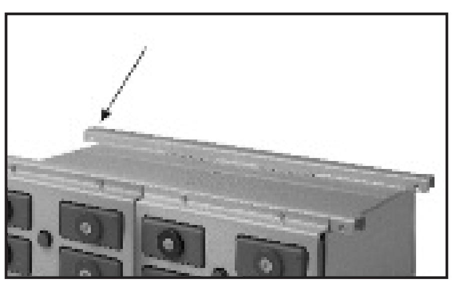

Figure 4: Recommended Frame Ground Location

2. Once the location is determined, it will be necessary to drill (2) holes for the frame ground conductor/lug (installer supplied). Note, hole size and spacing will be dependent on the lug.

3. Using a grinder, etc., remove the paint from around the holes drilled in Step 2. Apply a thin film of NO-OXID grease to the bare metal and attach the frame ground conductor/lug.

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