

Installation and Operating Manual

SAFETY PRECAUTIONS

Only authorized and trained personnel familiar with battery installation, preparation, charging, and maintenance should be permitted access to the battery.

WARNING



SHOCK HAZARD – Do not touch un-insulated battery, connectors, or terminals. Be sure to discharge static electricity from tools and technician by touching a grounded surface near the batteries, but away from the cells and flame arresters. All tools should be adequately insulated to avoid the possibility of shorting connections. Do not lay tools on the top of the battery.



Although msEndur II batteries are sealed and emit no gas during normal operation, they contain potentially explosive gases, which may be released under abnormal operating conditions, such as a charger malfunction. It is the responsibility of the customer to provide adequate ventilation so hydrogen gas accumulation in the battery area does not exceed two percent by volume. However, normal air circulation in a ventilated facility will preclude any hydrogen build-up even during equalize charging. Never install batteries in a sealed cabinet or enclosure. If you have any questions, contact your local C&D representative.



This battery contains sulfuric acid, which can cause severe burns. In case of skin contact with electrolyte, remove contaminated clothing and flush affected areas thoroughly with water. If eye contact has occurred, flush for a minimum of 15 minutes with large amounts of running water and seek immediate medical attention.

IMPORTANT

Follow instructions contained in this manual when installing, charging, and servicing batteries

For Additional Information Contact:
C&D Technologies, Inc.
Technical Service Department
1400 Union Meeting Road
P.O. Box 3053
Blue Bell, PA 19422-0858
Telephone 800-543-8630 FAX 215-619-7899
customersvc@cdtechno.com

Or check C&D's website www.cdtechno.com

NOTE

This manual is to be used for the installation and operating of C&D's msEndur II series of batteries.

WARRANTY NOTICE

This instruction manual is not a warranty. Each standby battery is sold subject to a limited warranty, which is in place of all other warranties, express or implied (including the warranties of merchantability or fitness for a particular purpose) and which limits a purchaser's (user's) remedy to the repair or replacement of a defective battery or parts thereof. The terms of the limited warranty are incorporated herein or a written copy is provided within the shipping materials

Table of Contents

Part 1: Introduction.....	5
1.1 Cell Characteristics	5
Part 2 – Recommended Technical References	6
Part 3 – Safety Precautions	7
3.1 Recommended Tools	8
3.2 Personnel Protection Equipment (Safety).....	8
3.3 Installation Tools and Supplies	9
Part 4 - Receiving	9
4.1 Inspection at Time of Delivery.....	9
4.2 Damage and Shortage Situations.....	9
Part 5 – Storage Prior to Installation	10
5.1 Storage Conditions.....	10
5.2 Storage Temperature and Duration.....	10
Part 6 - Installation	10
6.1 Locating Battery System.....	10
6.2 Ventilation.....	11
6.3 Floor Loading and Anchoring	11
6.4 Spill Containment.....	11
6.5 Module Installation	12
6.5.1 Installation of Modules and Cells Together.....	12
6.5.2 Installation of Modules and Cells Separately	12
6.5.3 Cell Removal and Stack Disassembly	17
6.7 Terminal Plates	19
6.8 Numbering Cells	19
6.9 Interconnection	19
6.10 Tap Connections	20
Part 7 – Initial Charging	21
7.1 Initial Charge	22
7.1.1 Initial Charge – UPS Applications	22
7.2 Initial Charge Records	23
Part 8 – Battery Operation	23
8.1 Float Charging	23
8.2 Equalize or Freshening Charge	24
8.3 Temperature Effects on Batteries.....	24
Part 9 – Maintenance	25
9.1 Monthly Inspection	25
9.2 Quarterly (including the above).....	25

9.3 Semi-Annually (including the above)	25
9.4 Annually (including the above)	25
9.5 Module Assembly Adjustments	26
9.6 Performance Tests	27
9.6a UPS Transfer Tests	27
Part 10 – Battery Degradation	28
10.1 General Information and Precautions	28
10.2 Float Versus Cycle Life	28
10.4 Low Float Voltage and Sulfation	29
10.5 Hydration	29
10.6 Open Circuit – Late Installations	29
10.7 Parallel Battery Strings	29
Appendix A - Connections	30
A.1 Terminal Connections	30
A.2 Reworking Terminal Connections	30
Appendix B – Installation and Operation of Cam Assemblies	31
Appendix C Gap and Module Assembly Details	32
Appendix F – Recycling	36
Figure & Table Index	36

Part 1: Introduction

The msEndur II batteries referenced in this document are stationary, lead-acid batteries. They are constructed with an absorbent glass mat (AGM) and are characterized as Valve Regulated Lead-Acid (VRLA). As VRLA, there is no free flowing electrolyte. They are constructed with lead-calcium alloy grids, dilute sulfuric acid (electrolyte) enclosed in a flame retardant thermoplastic container with a safety vent and a flame arresting disk to prohibit a spark from entering the head space of the cell. This type of battery is nearly 100% recyclable. At the end of life, please dispose of properly or consult C&D for recycling information.

The msEndur II series of batteries are designed to provide reliable service life with minimal maintenance when used in accordance with this manual. They are a single cell unit producing a nominal two volts per cell, which are connected in series for the desired system voltage. The cells are housed in steel modules, coated with acid resistant paint. These modules come in varying widths, depending on the cell size and can be stacked up to eight modules high while maintaining their seismic ratings. The msEndur II series are to be installed in a horizontal position with all connections accessible from the front of the system assembly. These cells are not designed for operation in any other orientation.

The msEndur II is available in two different battery versions. The standard version has the series nomenclature of ATP for systems that can float between 2.25 to 2.30 volts per cell average. For systems where the msEndur II cells will be floated in parallel with flooded battery strings, the ATLP series should be set on float between 2.17 to 2.22 volts per cell average. Check with C&D to determine which ATP/ATLP model offers comparable float characteristics.

1.1 Cell Characteristics

Under normal float operation, msEndur II batteries can be installed in proximity to electronic equipment and in computer rooms with occupied space. However, if subjected to excessive overcharge voltage, hydrogen and oxygen can be vented into the atmosphere. Therefore, lead acid batteries should never be installed in an airtight enclosure. Sufficient precautions must be taken to prevent excessive overcharge and containment of potential explosive off gases. All Lead-Acid batteries, including msEndur II, are capable of generating excessive potentially explosive gases when charged for prolonged periods at voltages higher than initial or equalizing charge.

The msEndur II cells are equipped with a "flash arrestor and pressure relief valve" assembly that seals the cells during normal charge and operation but allows it to safely vent in case of overcharge. Removing the valve assembly can cause the release of potentially explosive gases and such action will void the warranty.

Part 2 – Recommended Technical References

These instructions assume a certain level of competence by the installer/user. Installers must have the appropriate knowledge and experience to safely install the batteries. The design of the battery room, system wiring, protection, environmental, fire, and safety requirements must comply with applicable codes required by the governing enforcement agency.

The following is a partial list of the codes that may have direct impact on your installation. This list is not meant to be comprehensive. Consult with your local building, electrical and fire protection agencies to get proper direction to the local codes that will affect your installation.

- NEC National Electric Safety Code, ANSI C2-1993 (or latest revision)
- UBC Uniform Building Code or locally applied Building Code
- IBC International Building Code

Federal Codes that may directly affect your battery room design and battery installation.

- 29CFR1926.441 Safety Requirements for Special Equipment
- 29CFR1910.151(c) Medical Services and First Aid
- 29CFR1 910.268(g) Telecommunications
- 29CFR1910.305(j) Wiring Methods, Components and Equipment
- STD 1-8.2(e) OSHA Standing Directive

The following references to IEEE documents contain relevant information. They should be consulted for safe handling, installation, testing, and maintaining standby batteries. You may also refer to the battery brochure for additional information, specific to the battery.

- IEEE 1187 “Recommended Practice for Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications”
- IEEE 1188 “Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Application”
- IEEE 1189 “Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Application”
- IEEE 1375 “Guide for Protection of Stationary Battery Systems”
- IEEE 1491 “Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications”
- IEEE P1578 “Guide for Battery Spill Containment”

Copies may be obtained by contacting:
The Institute of Electrical and Electronic Engineers (IEEE), Inc.
IEEE Customer Service
445 Hoes Lane
PO Box 1331
Piscataway, NJ 08855-1331
customer.service@ieee.org
or visit the IEEE web site: www.standards.ieee.org

Part 3 – Safety Precautions

This battery is designed for industrial, stationary use only and is not intended for application in vehicular, starting, lighting and ignition (SLI), and the operation of portable tools and appliances.

Use in accordance with this manual or all IEEE battery procedures. Use of this product other than in accordance with these instructions may produce hazardous and unsafe operating conditions, leading to damage of equipment and/or personal injury.

Do not expose the batteries to open flame or electrical arc. Do not tamper with the vent, as this will void the warranty.

Do not use any petroleum based cleaning or lubrication solution on the battery jar or cover. Failure to follow this warning may result in damage to the container and will void the warranty.

As a notice to all technicians and personnel in the near proximity of the batteries, a BCI warning label is in plain view to indicate the potential hazards of battery systems. In addition an OSHA warning label is placed on the side of each module.

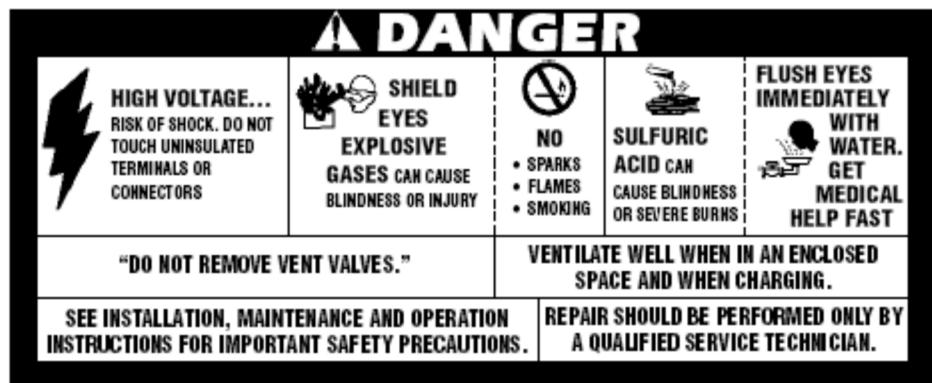


Figure 3-1 BCI warning label



DANGER Contains: Lead, Sulfuric Acid (Electrolyte), Lead Components, Arsenic

Harmful if swallowed, inhaled or in contact with skin.
 Acid causes severe skin burns and eye damage.
 May damage fertility or unborn child if ingested or inhaled.
 May cause harm to breast-fed children.
 May cause cancer if ingested or inhaled.
 Causes skin irritation, serious eye damage.
 Contact with internal components may cause irritation or severe burns.
 Causes damage to central nervous system, blood and kidneys through prolonged or repeated exposure if ingested or inhaled.
 Irritating to eyes, respiratory system, and skin.
 May form explosive air/gas mixture during charging.
 Extremely flammable gas (hydrogen).
 Explosive, fire, blast or projection hazard.
 Obtain special instructions before use.
 Do not handle until all safety precautions have been read and understood.
 Wash thoroughly after handling.
 Do not eat, drink or smoke when using this product.
 Avoid contact during pregnancy/while nursing.

Wear protective gloves/protective clothing, eye/face protection.
 Use only outdoors or in a well-ventilated area.
 Avoid contact with internal acid.
 Do not breathe dust/fume/gas/mist/vapors/spray.
 Keep away from heat/sparks/open flames/hot surfaces. No Smoking.
 IF SWALLOWED OR CONSUMED: Rinse mouth. Do NOT induce vomiting. Call a poison center/doctor if you feel unwell.
 IF ON CLOTHING OR SKIN (or hair): Remove/take off immediately all contaminated clothing and wash it before reuse. Rinse skin with water/shower.
 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or doctor/physician.
 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 If exposed/concerned, or if you feel unwell seek medical attention/advice.
 Store locked up, in a well-ventilated area, in accordance with local and national regulation.
 Dispose of contents/container in accordance with local and national regulation.
 Keep out of reach of children.



PN: PH04380

Figure 3-2 OSHA Label

3.1 Recommended Tools

The below lists are general recommendation and is not intended as a complete and specific list. Each installation may require special tools that cannot be identified without knowing the specific applications. Review the appropriate industry recommendations, state and local codes for the specific information.

3.2 Personnel Protection Equipment (Safety)

- Use standard battery safety practices
- Rubber or neoprene – acid resistant gloves
- Protective apron
- Face shield/safety glasses or ANSI approved goggles
- Rubber soled safety shoes/boots
- Portable or permanent eye wash station

3.3 Installation Tools and Supplies

- Lifting sling or appropriately sized platform – for lifting cells and modules.
- Insulated steel toed safety shoes & remove all metals, i.e. rings, etc – to ensure no short circuits.
- Sodium bicarbonate, 1 lb per gallon of water – to neutralize and clean up any electrolyte.
- Insulated tools – to ensure no short circuits between connections.
- Insulated torque wrench – to ensure no short circuits between connections.
- Digital voltmeter with three-digits and 0.25% accuracy minimum – to record initial cell open circuit voltages & ensure correct assembly.
- Digital Micro-Ohm meter (DLRO)-to measure connection resistances.
- Optional, one of the following; resistance, conductance or impedance meter – to record initial ohmic measurements.
- Non-metallic brush or pad for cleaning connections – to ensure clean connections for good integrity.
- NO-OX-ID grease and applicator brush – to ensure good connection integrity throughout service life.

Part 4 - Receiving

4.1 Inspection at Time of Delivery

Great care has been taken to pack the battery for shipment to ensure its safe arrival. As soon as you receive the battery, check the packing material for evidence of damage in transit. If the packing material is physically damaged or wet acid stains are present, make a notation on the delivery receipt **before you accept the shipment/delivery.**

NOTE:

Freight carriers generally require that the carriers' representative inspect concealed damage within 15 days from date of delivery to determine responsibility. The resolution of such claims may extend up to nine months.

Verify the number of cartons and skids against the bill of lading and verify their contents against the packing lists. Keep a copy of the verified lists for your installation records. It is important to confirm that the accessory package is present and the quantities are correct. If help is required, call C&D customer service department to report any discrepancies.

4.2 Damage and Shortage Situations

C&D ships FOB Pharr, TX (zip code 78577) (title/ownership passes to the ship-to/end user at the Pharr, TX warehouse). If shipments are damaged or if cartons or skids are damaged or missing, a claim must be filed with the carrier. Place an immediate order for replacement with C&D. Pay both the original invoice and the replacement invoice using the replacement cost as the amount of freight damages or shortages involved as part of your claim. If individual component items are missing, a shortage report should be filed within 30-days from the date of receiving a shipment with the C&D customer service department. Mail (express mail recommended), e-mail customersvc@cdtechno.com, call 1-800-543-8630 or fax a copy of the VERTIFIED component-packing list. This verified list should show both the name of the packer, as well as the quantities of items checked off by the receiver.

Part 5 – Storage Prior to Installation

5.1 Storage Conditions

Store batteries indoors in a cool, well ventilated, clean, dry location and place in service as soon as possible after receiving.

5.2 Storage Temperature and Duration

The recommended temperature for storage is 50°F (10°C) to 77°F (25°C). msEndur II cells may be stored at these temperatures for approximately six months; longer storage is detrimental to the cell and can void the warranty if they are not given a freshening charge within that time period. A convenient measurement to check the condition of the cell during storage is to measure the Open Circuit Voltage (OCV). A fully charged ATP cell has an approximate OCV of 2.16 volts. If the ATP series cell OCV drops more than 0.04 volts from its received voltage or to less than 2.12 volts, a freshening charge is required. A fully charged ATLP cell has an approximate OCV of 2.10 volts. If the ATLP cell OCV drops more than 0.04 volts from its received voltage or to less than 2.06 volts, a freshening charge is required. **Be sure to record dates and conditions (voltage, current and recharge times) for all charges during storage.**

Avoid exposure of a partially discharged cell to temperatures less than 0°F (-18°C), as this may cause the battery electrolyte to freeze. This can permanently damage the battery and can cause potentially hazardous leakage.

Allowable storage temperature range of 20°F (-7°C) to 90°F (32°C) is acceptable. Higher than normal storage temperatures (77°F [25°C] nominal) will accelerate internal self-discharge of a cell by a factor of two for each 18°F (10°C) over the recommended nominal 77°F (25°C) storage temperature. This, in turn, will reduce the allowable time before initial and/or boost charging by a corresponding amount.

If a freshening charge is required, it is very important that boost or freshening charges (2.40 v/c for ATP and 2.34 v/c for ATLP for 12 to 16 hours) be given at the appropriate time to avoid major remedial action or loss of product as noted in Part 7.

Part 6 - Installation

6.1 Locating Battery System

Install the batteries in a clean, cool, and dry location. Avoid areas with direct sunlight and heat sources, including electrical equipment vents or exhausts. The recommended battery room temperature of 77°F (25°C) provides the best combination of performance and life. Lower temperatures will reduce battery performance, while higher temperatures will improve battery performance but reduce battery service life.

Avoid sources of hot or cold air that could cause temperature variations of $\pm 5^{\circ}\text{F}$ (3°C) within the battery assembly. Such variations will compromise optimum battery performance such as the float voltages of individual cells.

For additional information on installing batteries in modular systems, refer to the Section 6.5 for installation details.

6.2 Ventilation

Although the ATP and ATLP series of batteries are valve regulated, they do produce minimal gas emissions during normal operation. If exposed to abnormal high voltage charging, the cells may vent potentially explosive hydrogen gas. Hydrogen gas when accumulated in a confined area that exceeds four (4%) percent by volume in air is explosive. C&D recommends not allowing hydrogen gasses of greater than two (2%) percent by volume to accumulate. Contact the local code enforcement officer to determine what codes and levels are applicable to your battery room installation. **Lead acid batteries should never be installed in a sealed, non-ventilated cabinet or enclosure.**

VRLA batteries subjected to extreme overcharge voltages have the potential to release hydrogen gas at a rate of 0.000269 cubic feet per minute - ampere of charging current at 77°F (25°C). The msEndur II series testing shows that they recombine at nearly 99% efficiency under normal conditions. However, compliance with codes and appropriate safety measures regarding hydrogen evolution is essential for the safety of the equipment and personnel.

6.3 Floor Loading and Anchoring

Floor loading and anchoring requirements are the responsibility of the user/installer and all applicable building codes and regulations must be followed. C&D provides connection drawings, weights, dimensions, and floor loading information on our system drawings for reference.

The msEndur II floor-mounting base has provisions for floor anchoring. Consult the applicable building codes and regulations for specific requirements. In all cases, floor anchoring is considered mandatory with floor anchors to be installed in all locations provided unless otherwise specified. Floor anchor sizing and hardware are the responsibility of the user/installer.

6.4 Spill Containment

Although the msEndur II series of batteries contain no free flowing electrolyte, it is the sole responsibility of the user/installer to follow all local building and fire codes applicable to the battery installation. It is recommended consulting the local fire marshal or building inspector to determine if spill containment is required.

If required, spill containment can be purchased from C&D. Please contact your local C&D representative or C&D Customer Service at 1-800-543-8630 or +1-215-619-2700 or email: customersvc@cdtechno.com

6.5 Module Installation

msEndur II battery systems are typically shipped with the cells pre-installed into the modules for ease of transportation and installation. In some cases it may be necessary to have the cells shipped separately, or to remove the cells from the modules prior to installation.

It is essential and the responsibility of the customer/installer to be properly trained and have suitable equipment to handle these heavy products. It is the responsibility of the customer/installer to provide a room properly designed for a battery system, including appropriate ventilation, aisle space, egress, floor load capabilities and a level mounting surface.

6.5.1 Installation of Modules and Cells Together

- 1) Floor anchoring is required for a safe installation. Mark the location and install floor anchors, matching the anchor holes in the floor-mounting base.
- 2) Install the floor-mounting base. Depending on the system configuration and handling capabilities, the mounting base may already be assembled with stacked modules. See Figure 6-1
 - a) Floor mounting base alone: Lift the mounting base and place it in the designated area over the floor anchors.
 - b) Floor mounting base assembled with stack modules: Assemblies up to four (4) tiers may be carefully moved assembled with the use of a fork lift, pallet jack or other suitable lifting device; see Figure 6-1.
 - c) Assemblies consisting of floor mounting base with one stack module can be moved using the lifting strap or a fork truck, pallet jack or other appropriate lifting device. See Figure 6.2
 - d) Torque floor anchors per manufacturer's recommendations.
- 3) If the assembly requires additional modules, using appropriate lifting equipment, place additional modules, one at a time, on top of modules already in place. Properly align modules and mounting holes, and insert the bolts, washers and nuts as shown in Figure 6-4. Module-to-module bolts should be torqued to 60 ft-lb (81 N-m) using a torque wrench.



Figure 6-1 Installation Using Forklift

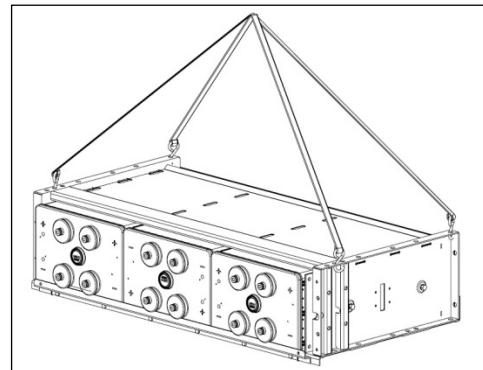


Figure 6-2 Installation Using Hoist and Straps

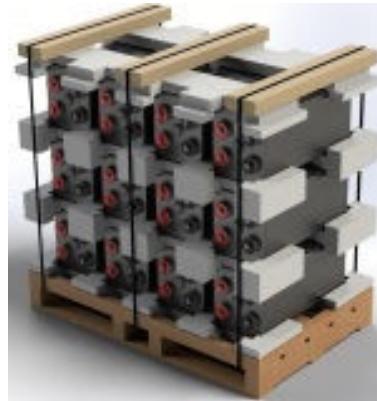
Never attempt to move multiple modules until module-to-module bolts have been properly torqued to 60 ft-lb (81 N-m) using a torque wrench.

6.5.2 Installation of Modules and Cells Separately

In cases where modules must be installed without cells, modules should be installed in the same manner as detailed in Section 6.5.1. Once base and modules have been installed and properly secured in place, cells may be installed. For details on removing cells from modules, see Section 6.5.3.

“Cells out” packaging:

- 1) The msEndur II cells can be shipped “cells out” in custom molded high density EPS foam packaging.
- 2) Transfer cells to be installed onto lift table. The foam can be “broken away” to allow ease of access to the cells. Do not exceed maximum weight limit of lifting equipment or lift table. In many cases, cells will need to be moved one at a time



Cells Packaged in Foam
(Identification cardboard cover not shown for clarity)

To install cells into empty modules:

NOTE: Handling of Individual Cells

- When removing cells from modules or foam, do not allow cells to drop. Cells must be laid down in a controlled manner. A battery dropped may be damaged by the impact of falling even short distances. Some damage may occur to internal components, not visible at installation.
- Batteries should not be laid, slid or dragged across pallets or rough floors. Nails, pebbles, floor imperfections and other obstructions can damage jar, cover or weld.
- If the lift table is not at proper elevation and cells are pushed in at an angle, the jar to cover seal may be compromised by the module’s steel edge.

1. If not already done, remove cell front restraint bars and cell side restraint plates. Refer to Section 6.5.3 for detailed instructions on removal.
2. Prior to cell insertion assemble the two (2) side restraint plate bolts and washers (when required) into the floating flanged nuts through the hex-shaped recessed holes on the right side of the modules (or both sides for the 45”, 49” and 58” wide modules); Ref Figure 6-4A, Flange Nut Detail). Do not completely tighten the bolt/washer/nut assemblies at this time.
3. Transfer cells to be installed onto lift table. Do not exceed maximum weight limit of lifting equipment or lift table.. In many cases, cells will need to be moved one at a time..
4. Position lift table in front of empty modules, starting with the lowest empty module. The top of the lift table should be even with the bottom surface of the module. Cell terminals should face away from the module opening. Any metal surfaces that may come into contact with the terminals should be insulated.
5. After checking the cell polarity/orientation against the system drawing/connection diagram, slide cell from the lift table into the empty module. Cell should slide directly into the module and should not drop or need to be lifted into place. To prevent damage to the cells, do not attempt to install cells into a module that is above or below the surface of the lift table. Slide the cell to the left wall of the module (or to the center partition of the 45”, 49” and 58” wide modules).
6. When the cell is fully inserted into the module, the jar/cover seal will protrude slightly beyond the front lip of the module.

7. Install the remaining cells within the module repeating steps 2-5 until the module is full. After each new cell is installed, insert a metal cell spacer plate between each cell. The spacer plate should be pushed to the back of the module. Slide the next cell over to the previously installed cell. This will ensure that the cells are all biased toward the side opposite of the cell side restraint plate and side restraint hardware. This will allow adequate room for ease of insertion of the cell side restraint plate. When installed properly, cell spacer plates should not reach the jar/cover joint. If the cell spacer plate extends beyond the lower lip of the module, remove it, check for any obstructions and re-install. See Figure 6-4
8. Once all cells are installed within the module and spacer plates are in place, insert the cell side restraint plate as shown in Figure 6-4. The cell side restraint plate should also be pushed to the back of the module. When properly installed, the cell side restraint plate should be fully seated against the back of the module and the front edge of the plate should not reach the jar cover seal. With all cells, spacer plates, and cell side restraint plates installed within the module, the front cell restraint bar should be installed using all supplied hardware. The front restraint bar hardware should not be completely tightened at this time. See Figure 6-4

Note: The cell restraint bar bolts are thread rolling bolts. When re-inserting these bolts, ensure that threads of the bolts are aligned with the formed thread in the module and tighten slowly to avoid damage to the formed thread.

9. Starting with the top module, side restraint plate bolts (installed earlier as described in step 2) should now be tightened. Bolts should be hand-tightened first to ensure they are square against the module and the cell side restraint plate. See Figure 6-4
10. The following steps are to be followed for the completion of the assembly of the side restraint plate bolts:
 - a) Align the cell side restraint plate against the cell while keeping the plate straight and parallel to the module side wall. Adjust bolts so they are both protruding approximately the same amount out from the side of the module.
 - b) Turn each bolt one rotation at a time alternating between the two bolts, ensuring to keep the cell side restraint plate straight and parallel to the module's walls and the protruding bolt length of the two bolts the same.
 - c) Monitor the bolt/washer/nut assemblies to ensure that the flange nut remains nested in the module side panel recess and the bolt perpendicular to the cell side restraint plate.
 - d) Continue to tighten the bolts until the underside of the bolt head is bottomed out onto the floating flange nut or flat washer (where applicable). See Figure 6.4 and 6.4A
 - e) The cells jars are made of polypropylene which will allow the cell jar walls to "bulge" when unrestrained. If the cells have become "bulged" prior to installation into the modules and there are issues with these assembly steps, it may be necessary to refer to the additional guidelines in the section 9.5.
11. The front cell restraint bar hardware should be completely tightened at this time. To maintain seismic ratings, all front cell restraint bar hardware must be installed and torqued to 6 Ft-Lb (8 N-m). See Figure 6-4

For systems using cam assemblies in place of side restraint plate bolts, refer to
Appendix B

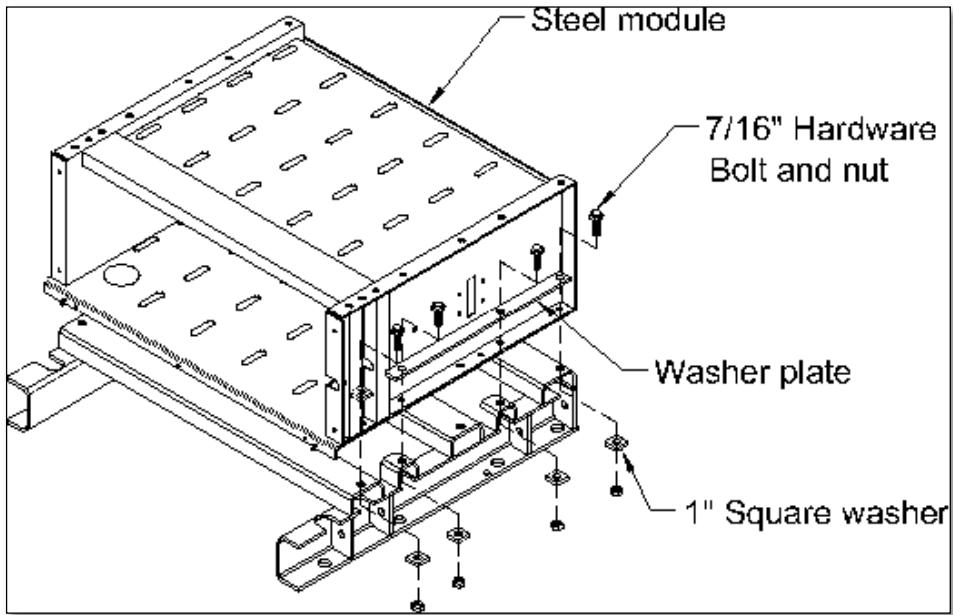


Figure 6-3 Base to Module Assembly

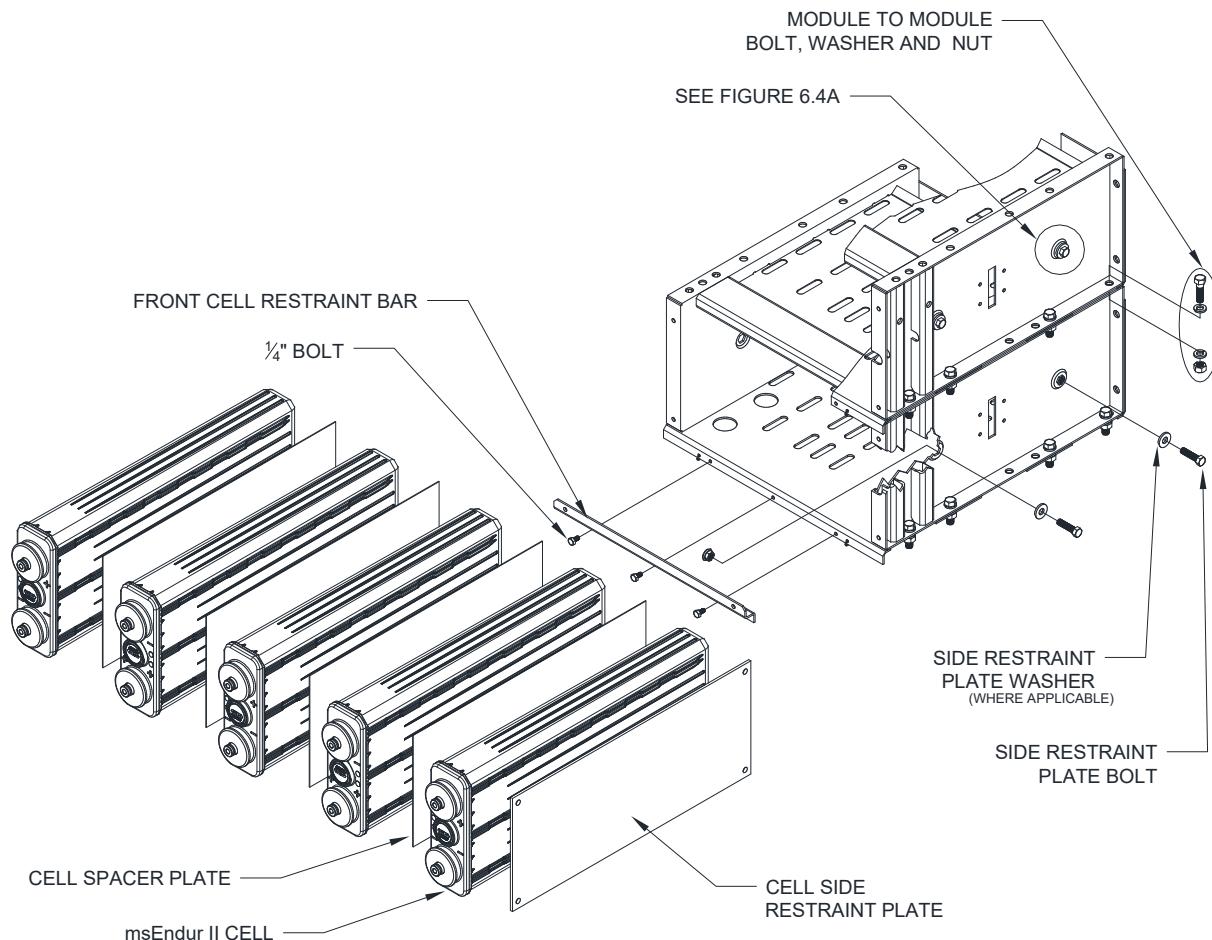


Figure 6-4 Spacer and Front Cell Restraint Assembly

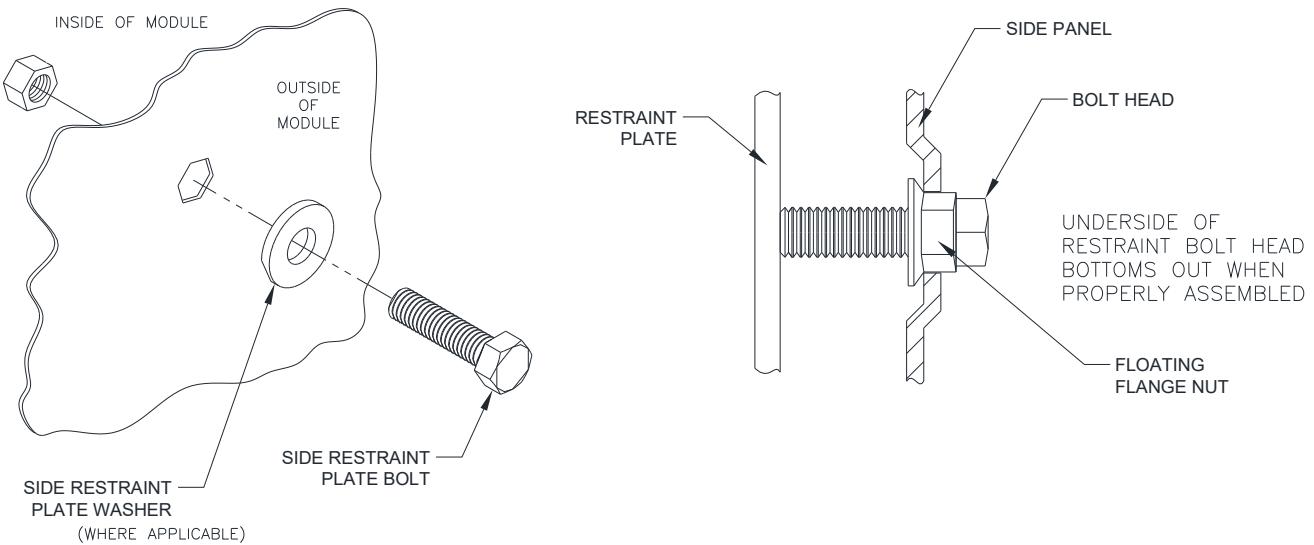


Figure 6-4A Floating Flange Nut Detail

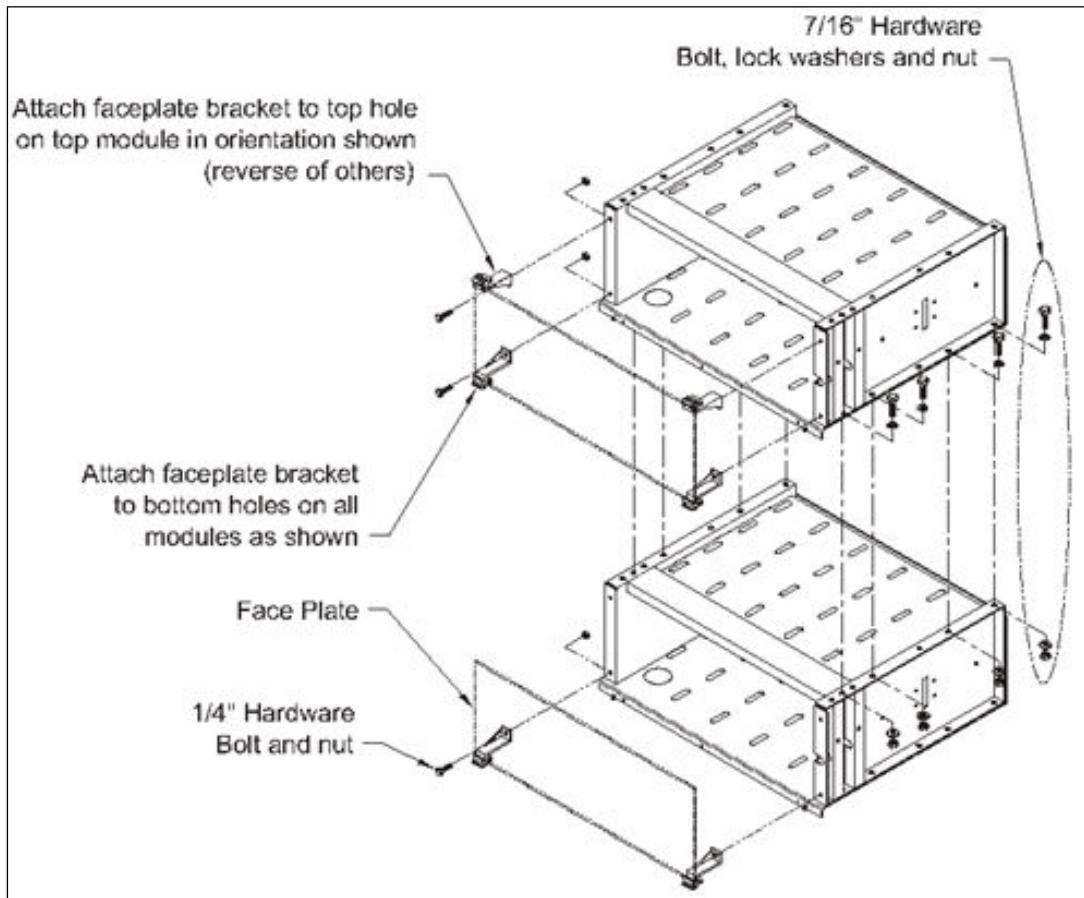


Figure 6-5 Module and Faceplate Assembly

6.5.3 Cell Removal and Stack Disassembly

If a requirement to disassemble a module stack arises, it is recommended to remove the cells before disassembly. Once the battery string has been removed from service, the technician must use properly insulated tools and all appropriate battery safety methods. If removing cells from a new system in preparation for installation, skip to step 5.

1. Remove the faceplate from the subject module.
2. Disconnect the system ground connection.
3. For each connector attached to the cell, loosen (but do not remove) the terminal bolts at either end.
4. While holding the connector in one hand, remove the terminal bolts completely. Remove the connector and set aside. Repeat for other connectors.
5. After performing the electrical preparation described above, the steps to physically remove the cell or cells can be performed as follows: Starting with the top module, loosen cell side restraint plate bolts until cell side restraint plate is loose. **Do not remove bolts completely.** For systems with Cam assemblies, see Appendix B.
6. Remove front cell restraint bar bolts, shown in Figure 6-4. Restraint bar may be left attached to modules using retaining rings to prevent it from being misplaced.

Note: The cell restraint bar bolts thread rolling bolts. These bolts should be removed slowly to avoid damage to the formed thread.

7. The cell side restraint plates can now be removed. This will allow the cells to be moved apart for ease of removing the cell spacer plates and the cells. The cell spacer plates can now be removed.
8. Attach the “cell puller tool”, part number RE03197. This tool, shown in Figure 6-6, is available from your local C&D TECHNOLOGIES representative.
9. Prepare for cell removal by moving an insulated platform lift or equivalent lifting apparatus in proximity to the bottom of the stack module from which the cell is to be removed as shown in Figure 6-8. Make sure all exposed metal on the platform is insulated. Verify the capacity of the lifting apparatus is sufficient to safely lift the cell. Before removing the cell, note the orientation of the cell in the module, i.e., positive terminal up or down.
10. Pull the cell straight out onto the platform, shown in Figures 6-7 and 6-8.
11. Store removed cell for re-installation or disposal.
12. Repeat steps 6-10 for all cells within a module before removing a module from the stack
13. Disassemble the stack modules by removing module-to-module bolts.
14. For re-installation of modules and cells, refer to sections 6.5.1 and 6.5.2
15. Prior to final installation it is recommended that the jar to cover seal be tested to make sure it was not damaged during handling. Please contact C&D Field Services for a copy of the most current version of FSP-0136 “Megohmmeter Test Procedure.”

**Note: msEndur II cells should never be lifted by the terminals.
Do not use the cell puller tool as a lifting device.**

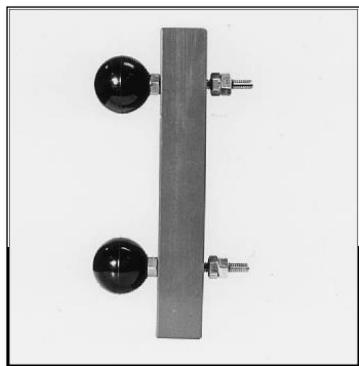


Figure 6-6 Cell Removal Tool

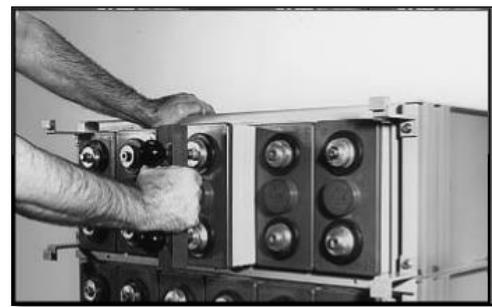
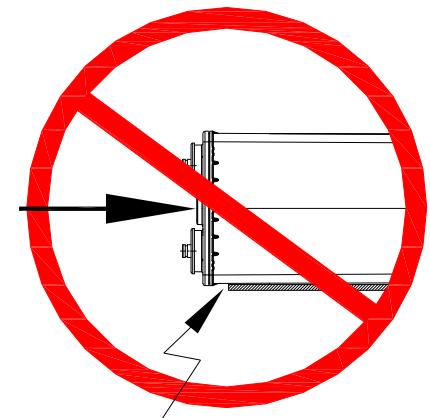
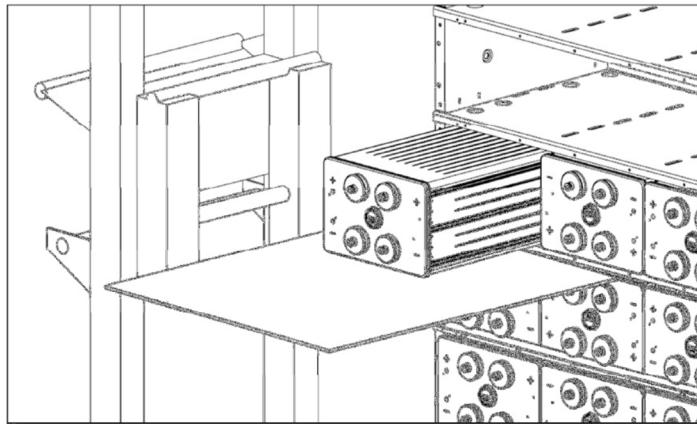


Figure 6-7 Removing a Cell

NOTE: Removing cells from modules and/or foam packaging

- When removing from the module, do not allow cells to drop onto the lift table. The lift table must be at the same level as the bottom of the cell. A battery dropped may be damaged by the impact of falling even short distances. Some damage may occur to internal components, not visible at installation.
- If the lift table is not at proper elevation and cells are dropped onto the table, the jar to cover seal may be compromised by the impact.
- Prevent the Jar to cover seal from hanging over the edge of the lift table at all times. Never slide a cell in a manner that would cause the jar to cover seal to be snagged or otherwise forced to change direction or elevation
- If cells are to be staged outside of the module or packaging foam they are to be placed on clean, hard, level non-conductive surfaces such as hardboard, plywood, etc..



DO NOT PUSH CELL
JAR/COVER JOINT INTO ANY
EDGE

6.6 Electrical Connections

- Always use protective insulating equipment, such as gloves, shoes, eye and face protection. Wrenches and other tools must be properly insulated.
- Observe local, state, and national electric codes at all times. Always work with the battery ungrounded. Battery ground connections, if required, should be made last.
- To avoid working with high voltages, break the battery down into convenient lower-voltage modules, equal to or less than 48-volts.
- Always maintain a firm grasp on tools and hardware when working on the battery. Dropped hardware can cause a short circuit, possibly resulting in serious personal injury and/or damage to the equipment.
- Before working on the battery, be sure to discharge static electricity that can build up on tools or the technician by touching a grounded surface in the vicinity of the battery.

6.7 Terminal Plates

For reasons of safety, it is recommended that terminal plates be installed before connector installation as described in section 6.9. Interconnect cells with the tin-plated (standard) copper connectors and stainless steel hex head bolts and washers in accordance with the connection diagram supplied with each battery shipment.

Prior to installation, lightly brush with a brass brush or Scotch brite™ type pad the battery terminals and terminal plate contact surfaces. Then apply a thin coating of NO-OX-ID type grease. The ATP and ATLP msEndur II series of battery terminals are made of a copper alloy with a thin lead coating. Terminal plates are made of copper with a thin lead or tin coating. Once coated with protective NO-OX-ID type grease, any “exposed”, “un-tinned” or “un-leaded” areas, no matter if from the factory or due to over brushing, will be protected from oxidation by the grease thus not require reworking. Optional: preheat the NO-OX-ID type grease and apply warm. After working with any lead component, wash your hands.

NOTE:

For application in which cables exit the post mounted terminal plate and are routed horizontally across the top of the module; C&D recommends the use of the optional horizontal top termination kit.

6.8 Numbering Cells

For ease of identification and for record keeping, all cells of a battery should be numbered. Plastic peel-and-stick numbers are furnished in the accessories carton. Common practice is to start with “1” on the cover of the incoming (+) positive terminal of the battery and follow the electrical circuit with succeeding numbers on the cell covers.

6.9 Interconnection

Cell series connection is made from the negative post of one cell to the positive post of the next cell. It is essential that the cell location and orientation match the included drawing. All connections must be made as indicated on the drawing with no deviations. If no drawing is provided or it is lost, contact C&D before making any connections.

The cells ship with NO-OX-ID grease applied by the factory to the terminals, however it may be necessary to rework prior to connecting the cells with the supplied inter-cell connectors. Refer to Appendix A for additional instructions for reapplying NO-OX-ID grease.

Prior to installation, lightly brush with a brass brush or Scotch Brite™ type pad the battery terminals and any contact surfaces of the inter-unit connections. Then apply a thin coating of NO-OX-ID type grease to both the battery terminals and contact surfaces of the inter-unit connectors prior to installation. The ATP and ATLP msEndur II series of battery terminals are made of a copper alloy with a thin lead coating. The inter unit connectors (cables and bus bars) are made of copper and have a thin lead or tin coating. Once coated with protective NO-OX-ID type grease, any "exposed", "un-tinned" or "un-leaded" coated areas, no matter if from the factory or due to over brushing, will be protected from oxidation by the grease thus not require reworking. Optional: preheat the NO-OX-ID type grease and apply warm.

After working with any lead component, wash your hands.

The top row of connectors is to be installed first, then the second down and so on, working from the top down. When installing connectors, install the top (upper most) bolt first. Complete connector installation by torqueing all connections to 160 in-lb. [18 N-m], using an insulated torque-wrench.

NOTE:
Over-torquing can damage the post seal and degrade connection integrity.

After torqueing all connections and with the battery still on open circuit (not connected to the charging source), take post-to-post resistance measurements. Start at one end of the string and work to the other end, recording micro-ohm resistance of each inter-cell connection between cells. Clean and re-torque connections (see Appendix B) of similar size connectors which exceed $\pm 10\%$ percent of the average resistance of battery connections or five micro-ohms, whichever is greater.

IMPORTANT:
Record and retain the resistance readings with the initial charge information for future reference. See Appendix E.

CAUTION:
It is the sole responsibility of the user to check connections.
Never operate a battery with loose or corroded connections.

When checking connections, disconnect the battery from the load and the charging equipment and follow all the precautionary measures outlined above and in the general safety references. Some resistance measurement equipment may cause a spark when the probes are applied to the cell posts. Use appropriate safety precautions when conducting this measurement.

After connecting all cells of the battery, check the battery voltage using a calibrated digital DC voltmeter with at least three digits and 0.25% accuracy minimum. Battery voltage should equal the open circuit voltage of an individual cell multiplied by the number of cells in the battery. Example: (24 cells) x (2.16 VPC) = 51.84 OCV. If the OCV does not equal the expected value, inspect the sequence of positive (+) to negative (-) connections. Further investigation may require re-inspecting each cell voltage to confirm an acceptable value.

6.10 Tap Connections

Tap connections may electrically unbalance the battery system and may void the warranty. If a center tap is used, each side must have its own charging unit.

Part 7 – Initial Charging

General Information and Precautions

To safely charge the msEndur II batteries and avoid damaging the battery and/or connected equipment, observe the following:

- Use a constant voltage charger with only direct current (DC). AC ripple current from charger shall not exceed five (5%) percent of the 8-hour (ampere-hour) rating of the battery in amps.
- Be sure charger is turned off before making electrical connections between the battery and system.
- Connect via the appropriate size cable. Verify proper polarity with a volt meter before making final charger connections and turning on the charger.
- Be certain that all connections are tight and secured before turning on the charger.

The recommended method of providing an initial/freshening charge (section 5.2 and section 7.1 & 7.2) is to first determine the maximum allowable voltage that may be applied by the connected equipment. Divide this by the number of cells in the battery to obtain maximum average voltage per cell allowed by the equipment. Adjust this number to a recommended value found in Table 1 and continue charging at this voltage.

NOTE

Charging current to the battery should be limited to 25 amperes per 100-Ampere Hour battery rating at the 8-hour rate. Higher charging current can cause overheating that subsequently increases the internal resistance of the battery, which requires additional current to compensate for the increased internal resistance. This cycle is referred to as “thermal runaway”, which has the potential to destroy the battery and cause damage to equipment.

7.1 Initial Charge

All cells are shipped fully charged from the factory with no need for an initial freshening or equalization charge. The cells should be constant voltage charged at the average float voltages as noted in Table 1 below. However, when in storage or transit for an extended period (especially at temperatures above 77°F/25°C) or when the number of cells is greater than 24 cells; it is recommended the battery system be given an initial freshening charge (see Table 1) at installation.

Table 1 – Initial Charge at 77°F (25°C)

Cell Type	Average String Float Voltage 77°F (25°C)	Average String Freshening Voltage	Freshening / Equalization Charging Time
	VPC	VPC	Hours
ATP	2.25 to 2.30	2.40 +/- 0.02	12 – 16
ATLP	2.17 to 2.22	2.34 +/- 0.02	12 – 16

Notes:

- a. Battery float voltage should be set at Table 1 average cell voltage multiplied by the number of cells in the battery string.
Individual cell float voltages may vary by +0.10/-0.05 volts from the average in a single string.
- b. Initial battery charge current on the constant voltage recharge should not exceed 25 amps per 100 amp-hour battery rating.
- c. Average string float voltage must be adjusted based on temperatures which are above or below 77°F (25°C) - see section 8.3.
- d. Charging time will vary due to temperature if cell temperature is below 60°F (16°C), double the charge time for initial or equalize charge.
- e. For high voltage strings, see Section 7.1.1.
- f. If a battery load test will be performed within 90 days of installation, an initial freshening charge followed by a 72 hour float charge (per IEEE 1188) is required to ensure full capacity.

7.1.1 Initial Charge – UPS Applications

UPS battery strings typically contain many more cells connected in a series string versus Telecommunications lower voltage applications. A UPS application may consist of 240 cells (480 VDC) in a series as compared with 12 to 24 cells (24 to 48 VDC) for the typical Telecom application. It is recommended in High Voltage UPS applications, the ATP and ATLP series of msEndur II batteries be given a freshening charge at installation (see Table 1). This initial charge will assure higher initial performance and reduce the time period required for the battery to achieve proper voltage balance between the individual units.

7.2 Initial Charge Records

At the completion of the initial charge and after the cells have been on float charge for approximately one week, record voltages of the individual cells, the total battery voltage and ambient temperature. Retain this information in your files for future reference. This information establishes a baseline for future reference. The information below must be recorded or refer to RS-1992 found in Appendix E. Make a photocopy of the form and use it whenever necessary to record readings taken on the battery.

Battery identifications

1. Date of readings
2. Battery total float voltage
3. Ambient operating temperature
4. Date and description of initial or last equalizing charge
5. General observations from visual inspection
6. Individual cell voltages
7. Connection resistance measurement
8. *Optional: One of the following for cell ohmic testers: Impedance, Conductance or Resistance
9. Name of inspection technician

If you observe any unusual readings or visual indications, consult your C&D Technologies representative and send a copy of your latest maintenance report to your local C&D representative or the technical services department at C&D.

*Cell ohmic readings may vary by $\pm 20\%$ of the C&D Technologies published values. This variation does not necessarily indicate a problem with the condition of the battery.

IMPORTANT:

Initial charge records are essential for review by C&D Technologies' sales/service representatives in the event of a problem. Since records can materially affect your warranty, be sure to maintain clear, signed, and dated copies.

Part 8 – Battery Operation

8.1 Float Charging

Standby batteries are connected to control circuits, which must be energized at all times.

msEndur II batteries must be constant voltage charged as described in section 7. Connected to a load in parallel with a continuously operating power supply, these batteries assure instantaneous support of the load in the event of a power failure or brownout. In addition to operating the connected load, the power supply keeps the standby battery fully charged. This parallel interconnection and operation is called float service. Maximum battery life can be expected in full float service, in which the frequency and depth of discharges are kept at a minimum. Deep and/or frequent discharges can shorten service life, even with proper battery maintenance.

8.2 Equalize or Freshening Charge

Under normal operating conditions, it is not necessary to equalize or refresh the ATP and ATLP series of msEndur II batteries when used within the criteria described in sections 5.2 and 7.

NOTE:
Some hydrogen gas may be liberated at equalize voltage.

An equalizing charge should be performed if individual cell voltages fall 0.05 volts below the average float voltage as specified in Table 1. Presence of a minimum voltage does not imply a battery is malfunctioning or that it will not provide the necessary power when called upon.

NOTE:
Chargers should be current limited to 25 amperes per 100-Ampere Hour battery rating.
Higher charging current could potentially destroy the battery by overheating that subsequently causes more current to flow creating a vicious cycle sometimes referred to as “thermal runaway”.

NOTE:
Use the equalize voltage setting shown in Table 1 for a period not exceeding 16 hours.
Consult your C&D Technologies representative for answers to specific questions.

8.3 Temperature Effects on Batteries

C&D recommends that the battery be operated at 77°F (25°C) \pm 10°F (5.5°C). For ambient temperatures outside the recommended temperature range, the float voltage must be adjusted by 2mV per °F or 3.6mV per °C. Adjust as indicated below.

Add 2mV (0.002 volts) per °F or 3.6mV per °C below 77°F (25°C).
Subtract 2mV (0.002 volts) per °F or 3.6mV per °C above 77°F (25°C).

If the battery is operated at temperatures below the recommended range, the capacity will be reduced even with temperature compensated charging, which must be compensated for during initial system sizing.

Part 9 – Maintenance

The msEndur II is a VRLA cell which does not require water addition and no specific gravities or water levels need to be checked throughout its life. However, it is recommended to properly follow the below maintenance procedure, this will assure that the batteries are well maintained and ready for operation when needed. A blank inspection report (RS-1992) is shown in Appendix E.

9.1 Monthly Inspection

1. Visual inspection of the battery for general appearance and connector conditions. Check for bulging jars, corrosion build up or any signs of heat damage to the jars/covers and connectors. Visually check cell spacing and cell side restraint plate gap as noted in Appendix C, Table 2.
2. Measure and record the total system float voltage.
3. Measure and record the total system float current.

9.2 Quarterly (including the above)

4. Optional; measure and record one of the following: conductance, impedance, resistance or internal resistance of each battery. Changes over time of less than $\pm 20\%$ are acceptable, changes of greater than 50% require further attention (such as a load test).
5. Measure and record the temperature of the negative terminal on each cell.

9.3 Semi-Annually (including the above)

6. Measure and record the individual cell voltages.

9.4 Annually (including the above)

7. Re-torque cell connector bolts to 125in-lbs (14 N-m).
8. Any disassembled connections should be re-torqued to 160 in-lb (18 N-m).
9. Measure and record connector resistance reading. If a value exceeds the average by 10% for similar connections, see Appendix B and reference IEEE 1188 for more information.
10. If possible, measure and record the total and individual AC ripple current or voltage.
11. Clean products with a solution of 1 lb of sodium bicarbonate to 1 gallon of water, if necessary.

CAUTION:

**Never use solvents to clean a battery system.
Only use a solution of water and sodium bicarbonate, 1 gallon to 1 lb.**

For more information, IEEE 1188 discusses the significance of connection integrity, further maintenance techniques and testing information.

9.5 Module Assembly Adjustments

A module assembly that has been incorrectly assembled in the field should be adjusted to ensure all cells, cell side restraint plates, cell spacer plates, connectors and hardware are properly aligned and installed.

Common assembly issues (see Figure 9-1):

1. Connectors not plumb and vertical (due to large cell cover spacing) and the gap is not within specifications noted in Table 2 in Appendix C
2. Side restraint bolts not straight
3. Cell side restraint plates and/or cell spacer plates extending beyond the lower lip of the module
4. Cell side restraint plates contacting the jar/cover seal of the cell (too far forward)

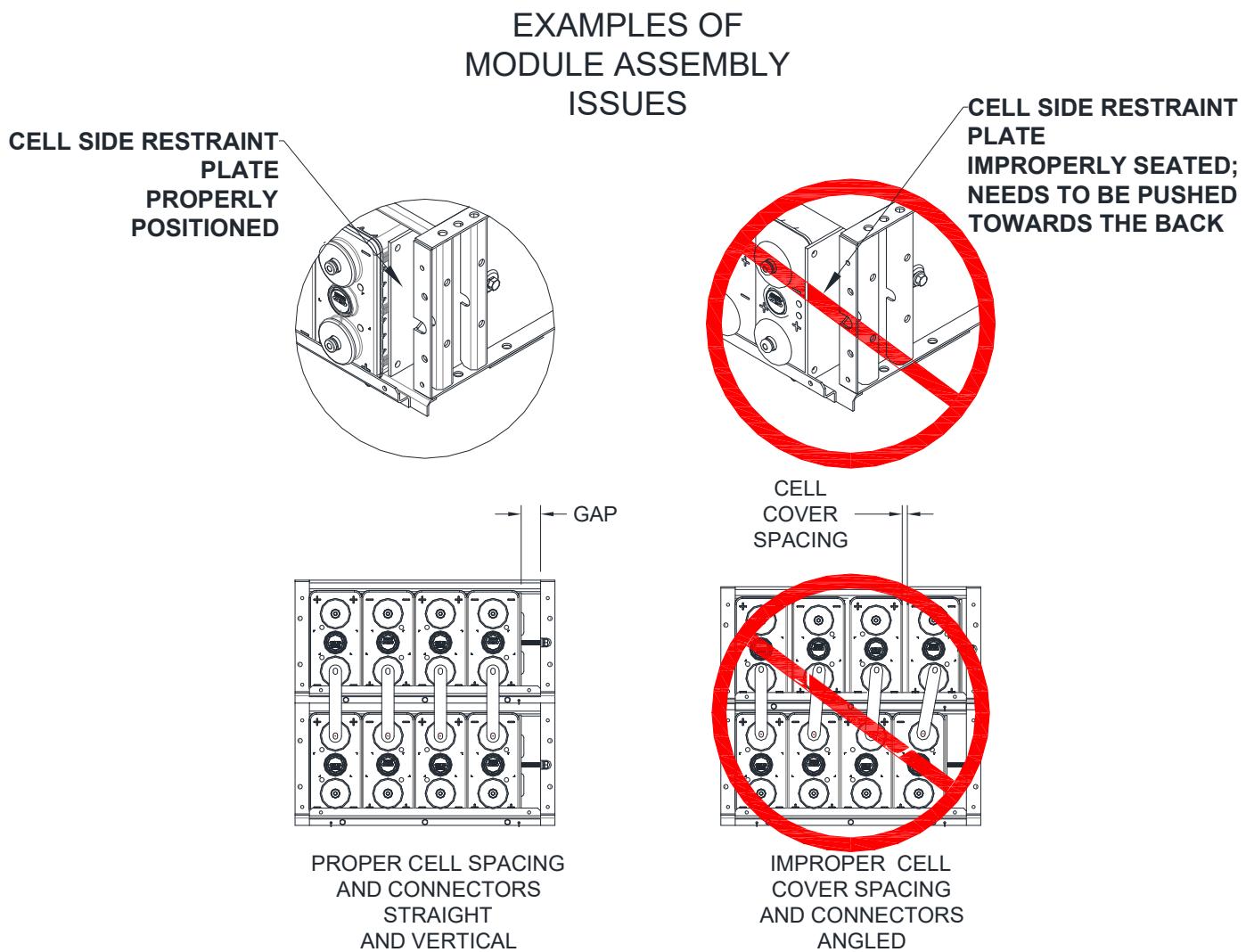


Figure 9-1 Module Assembly Issues

If the side restraint plate or the cell cover spacing in a module needs to be adjusted follow the steps below. The technician must use properly insulated tools and all appropriate battery safety methods.

For improper cell side restraint plate positioning:

- Loosen – do not remove - the side restraint bolts to allow the cell side restraint plate to be moved to the proper location
- Push the cell side restraint plate to the back of the module and away from the jar/cover seal joint
- Hand-tighten the side restraint plate hardware while ensuring the bolts are perpendicular to the cell side restraint plate. This can be accomplished by turning the bolt while simultaneously pulling the bolt towards the outside of the module.
- Complete the assembly as noted in 6.5.2 notes 10 and 11
- Check the torque on all the terminal bolts as noted in section 6.9

For excessive cell spacing resulting in gap values not to specification:

- The cell cover spacing can be reduced by tightening the side restraint hardware to move the cell side restraint plates. Start at the top tier module following the steps noted in section 6.5.2.
- Refer to Table 2 in Appendix C for a guide on allowable gap between the inside of the module and the outside of the cell side restraint plate.
- After setting the gap on all tiers as required, check the torque on all the terminal bolts as noted in section 6.9

NOTE: Additional Module Assembly Adjustment Guidelines

- **Follow the spacing guidelines detailed in Table 2 in Appendix C and noted in section 6.5**
- **It is not a requirement that the cell covers touch**
- **It is not a requirement that the cell cover spacing is exactly the same**
- **It is not a requirement that the side restraint plate bolts bottom out**
- **Torque not to exceed 15 Ft-Lbs for the side restraint bolt/washer/nut assemblies**

9.6 Performance Tests

If desired by the customer, a full-load performance test can be conducted at the user's original specified discharge rate or the appropriate rate based on connector sizing per the following procedure:

- Equalize charge the batteries if necessary, refer to section 8.2 equalization notes.
- Let batteries float charge for 72-hours.
- Perform the annual inspection.
- Run a discharge test at the system designed rate per IEEE 1188.

9.6a UPS Transfer Tests

A monthly transfer test for UPS systems should not exceed 30 seconds of the battery discharge time at the user's originally specified discharge rate to verify system load transfer and electrical system performance. The time that is required to synchronize the UPS and return to rectifier power must be taken into account when calculating total discharge time.

Part 10 – Battery Degradation

10.1 General Information and Precautions

When properly maintained and charged, the ATP and ATLP series of msEndur II batteries should provide many years of trouble-free service. However, despite their inherent dependability, failure to operate and maintain them correctly can lead to damage, shortened service life and possible loss of service. The following sections address some of the most frequently encountered errors.

10.2 Float Versus Cycle Life

Standby batteries such as the msEndur II are designed and constructed to provide long life in continuous float service. They differ in their design from cycling batteries, such as engine starting, solar or traction types. Standby batteries are continuously charged at a comparatively low float voltage in parallel with the load, ready to supply instantaneous DC power either directly to the load or by way of interfacing electronics, such as an uninterruptible power supply (UPS) system. The name “stationary” implies the battery is usually permanently placed in a given location and not transferred from place to place in its service life.

As such, standby battery life is directly affected by and will be degraded if subjected to repeat cycling. Depth of discharge, number of discharges, rate of discharge, and the interval between discharges are all determining factors in battery life. Cycling should therefore be kept to a minimum.

To ensure that the battery will perform during power outages and other emergencies, it is strongly recommended that testing be kept to a minimum in accordance with the following practices:

- The performance of an initial acceptance test not to exceed user's originally specified system reserve time.
- A full-load service test should be performed not more than once every 12 months to verify battery capacity at user's originally specified discharge rate.
- A monthly transfer test not to exceed 30 seconds of battery discharge time at user's originally specified discharge rate to verify system load transfer and electrical system performance.
- The time that is required to synchronize the UPS and return to rectifier power must be taken into account when calculating total discharge.

The user is expected to maintain complete records of all battery testing and emergency discharges in order to comply with the requirements of the warranty.

CAUTION:
RECHARGE BATTERIES AS SOON AS POSSIBLE AFTER AN EMERGENCY DISCHARGE.

Failure to recharge batteries immediately after emergency discharge may lead to sulfation, or in the case of deep discharge, a complete battery failure due to hydration. If recharging at freshening/equalize voltage is impractical, promptly recharge at float voltage.

10.3 High Temperature Operation

Operating a battery at temperatures exceeding 77°F (25°C) will reduce the battery life. Elevated temperatures accelerate the electrochemical reaction within the lead acid battery. For additional information, refer back to Section 8.3.

10.4 Low Float Voltage and Sulfation

Either because of incorrect charger voltage adjustment, excessive intermittent or static loads paralleling the charging source, low operating temperature or simply not fully recharged; a battery may not receive adequate charging voltage. In some cases, the charger may even be turned off, erroneously or by choice. The net result is a battery left in a partially discharged or undercharged condition. The first observable signs may be erratic cell voltages. Although not visible to the observer, the plates will become sulfated.

If you suspect sulfated plates, contact the C&D Technical Services Department 1-800-543-8630 or 215-619-2700 for assistance. Sulfated batteries are not fully charged batteries thus have not completed the electrochemical reaction of recharge. Accordingly, they will have reduced capability. If allowed to remain in a partially charged condition for an extended period of time, sulfated batteries may suffer irreversible damage, requiring replacement.

10.5 Hydration

A battery that has been severely over-discharged and left in a discharged condition without immediate recharge is subject to damage known as hydration. This is a phenomenon in which the electrolyte specific gravity has been reduced to a value so low it permits the lead components to dissolve into the electrolyte.

The reaction of dissolution forms many compounds and salts, generically referred to as hydrate. On recharge these compounds react to clog separator pores and form metallic lead. As time passes thousands of short circuit paths are created in the separators placed between the positive and negative plates to provide electrical insulation. Very often, the effect of these short circuits goes unnoticed except for a slight increase in charging current. As the reaction continues, however, short circuits become so extensive it is almost impossible to keep the cells charged. Finally, the cells experience total failure. msEndur II batteries are more resistant to hydration than typical wet cells, largely because of the thick absorbent glass mat separator between the plates. However, in severe cases of hydration, internal short circuits can form.

10.6 Open Circuit – Late Installations

As soon as a battery is disconnected from a charger, local action (discharge) begins. This is caused by inherent internal losses within the cell. In the case of msEndur II cells, a self-discharge is expected to occur at a rate of “up to 3.0 percent” of full charge per month at 77°F (25°C). Therefore, if cells remain, for whatever reason, on open circuit (with no charge supplied) for prolonged periods of time, the affected cells may become sulfated and require corrective action in the form of a freshening charge, see Sections 5.2, 7.1 & 7.2.

10.7 Parallel Battery Strings

When strings of batteries of equal voltage are connected in parallel, the overall capacity is equal to the sum of the capacities of the individual strings. When paralleling valve-regulated batteries is necessary, the external circuit resistance should be matched for each battery. A wide variation in battery circuit resistance can result in unbalanced discharge (i.e., excessive discharge currents in some batteries and less discharge in others). As a consequence, cell failures in one battery string and the subsequent loss of performance capacities of that string will result in higher loads in the lower resistance interconnections of some parallel strings that may exceed the ratings of the battery interconnections and/or cables. C&D recommends paralleling strings to obtain higher capacity, to increase system reliability and with properly installed disconnects, perform maintenance on one string at a time.

Appendix A - Connections

A.1 Terminal Connections

1. Remove any remaining factory-applied grease coating from the terminals with a dry cloth.
2. Lightly brush the terminal, cable lug and terminal plates contact surfaces with the supplied brass bristle brush or scotch brite type pad.
3. Coat all electrical surfaces with NO-OX-ID. (Optional: Use heat gun or hot plate to melt and then apply the NO-OX-ID grease, no open flames).
4. (Optional) - Re-flow excess NO-OX-ID with heat gun and wipe excess.
5. Install hardware and torque to 160 in. lb. (18 N-m).
6. Wash hands after working with lead.

A.2 Reworking Terminal Connections

If a terminal connection needs to be reworked (for any reason) follow the below steps:

Once the battery string has been removed from service using properly insulated tools and all appropriate battery safety methods remove the suspect connection(s).

1. Remove any existing grease using a dry cloth.
2. With a neutralizing solution consisting of one-pound sodium bicarbonate mixed with one gallon of water, wipe the cover and terminal seal area with a cloth moistened with the neutralizing solution. Do not allow the neutralizing solution to enter the cell. Rinse with clear water and dry thoroughly.
3. Lightly brush the terminal, cable lug or terminal plate contact surfaces with the supplied brass bristle brush or Scotch brite™ type pad removing any oxidized or corroded areas.
4. Coat all electrical surfaces with NO-OX-ID. (Optional: Use heat gun or hot plate to melt and then apply the NO-OX-ID grease, no open flames).
5. (Optional) - Re-flow excess NO-OX-ID with heat gun and wipe excess.
6. Re-Install hardware and torque to 160 in. lb. (18 N-m) and measure connection resistance.
If still $> \pm 10\%$ consult C&D.

NOTE:

The ATP and ATLP msEndur II series of batteries terminals, bus bars, cable lugs and terminal plates are made of copper and have thin layer of either tin or lead.

Once the terminal connection is coated with protective NO-OX-ID type grease, any “exposed”, “un-tinned” or “un-leaded” areas, no matter if from the factory or due to over brushing, will be protected from oxidation by the grease and not require reworking.

Optional: preheat the NO-OX-ID type grease and apply warm. After working with any lead component, wash your hands.

Appendix B – Installation and Operation of Cam Assemblies

In some cases, the side restraint plate bolts will not be accessible once the battery stack has been installed. For these installations, C&D Technologies offers cam assemblies that mount to the side of the module and provides a way to tighten and loosen cell side restraint plates from the front of the module.

To install cam assemblies:

- 1) Slide hex shaft through front lip of side flange & front channels See Figure B-1
- 2) Slide hex shaft into cam lobe and install retaining clip on each side of cam lobe See Figure B-2
- 3) Locate position brackets over the cam assembly and line up holes with threaded holes in the module.
 - a) Refer to Cam systems drawing M14043 for quantity of shims where required.
- 4) Bolt position brackets in place using (4) 1/4-20 bolts. Torque to 60 in-lbs.
- 5) Rotate hex shaft 3/4 turn so that the flat edge of the cam lobe bears against the cell side restraint plate.
 - a) Cam assemblies installed on the right – Counterclockwise to set / Clockwise to release
 - b) Cam assemblies installed on the left – Clockwise to set / Counterclockwise to release

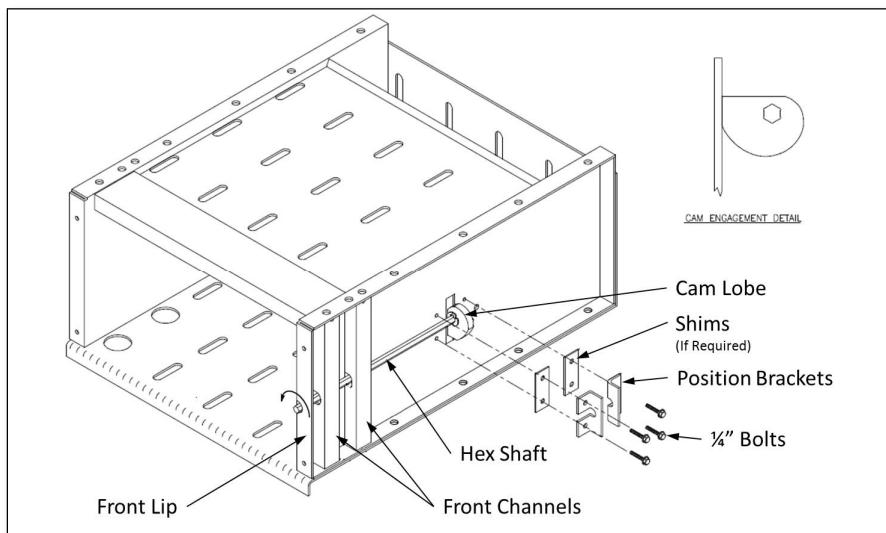


Figure B-1 Cam Assembly Diagram

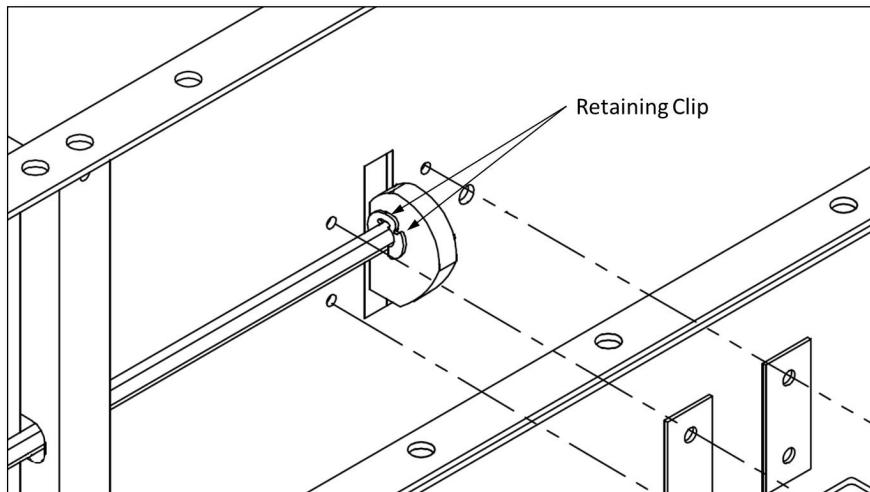


Figure B-2 Cam Assembly Detail

Appendix C Gap and Module Assembly Details

Under normal installation conditions, following the guidelines provided in section 6.5 regarding bottoming of the side restraint bolt is applicable. This following table is provided for reference when modules have been incorrectly field installed or when installing cells that have bulged for various reasons (shipped separately out of steel, not stored in a controlled environment, removed from the module and not restrained). The gaps specified in Table 2 are acceptable limits for maintaining sufficient compression without damaging the cells. Reference Figure C-1 for gap definition. Torque to tighten side restraint bolts should not exceed 15 Ft-Lbs when establishing gap.

Table 2 – Gap and Module Assembly Details

Module Size	Module Width (Reference)	Cell Size	# of Cells Wide	GAP
				Range (inches)
16	16.04"	AT(L)-07P	4	0.5 to 1
16	16.04"	AT(L)-15P,-17P	2	0.5 to 1.1
19	19.32"	AT(L)-07P	5	0.6 to 1.3
19	19.32"	AT(L)-09P	4	1.9 to 2.9
22	22.61"	AT(L)-07P	6	0.8 to 2
22	22.61"	AT(L)-11P,-13P	4	2.2 to 3.7
22	22.61"	AT(L)-15P,-17P	3	0.8 to 1.3
22	22.61"	AT(L)-23P, -25P	2	1.5 to 2.2
26	26.13"	AT(L)-19P, -21P	3	0.1 to 1.1
26	26.13"	AT(L)-27P, -29P	2	1.2 to 1.7
27	27.86"	AT(L)-09P	6	1.8 to 2.4
27	27.86"	AT(L)-11P,-13P	5	0.6 to 1.3
27	27.86"	AT(L)-15P,-17P	4	0.8 to 1.7
30	30.44"	AT(L)-07P	8	0.9 to 1.2
30	30.44"	AT(L)-23P, -25P	3	1.2 to 1.6
30	30.44"	AT(L)-35P, -39P	2	0.3 to 0.7
31	31.37"	AT(L)-11P,-13P	6	0.6 to 1.2
34	34.44"	AT(L)-09P	8	0.8 to 1.5
34	34.44"	AT(L)-15P,-17P	5	0.7 to 1
34	34.44"	AT(L)-19P, -21P	4	1.4 to 1.8
34	34.44"	AT(L)-27P, -29P	3	0.4 to 0.8
35	35.76"	AT(L)-07P	10	2.1 to 2.4
39	39.54"	AT(L)-23P, -25P	4	1 to 1.4
40	40.86"	AT(L)-13P	8	1.2 to 1.7
40	40.86"	AT(L)-15P,-17P	6	0.9 to 1.3
43	43.62"	AT(L)-07P	12	3 to 3.2
43	43.62"	AT(L)-35P, -39P	3	1 to 1.4
45 *	45.53"	AT(L)-27P, -29P	4	0.8 to 1.1
49 *	49.40"	AT(L)-19P, -21P	6	0.9 to 1.1
58 *	58.37"	AT(L)-23P, -25P	6	0.6 to 1
58 *	58.37"	AT(L)-35P, -39P	4	0.7 to 1

*These modules have cell side retention plates on both sides of the module

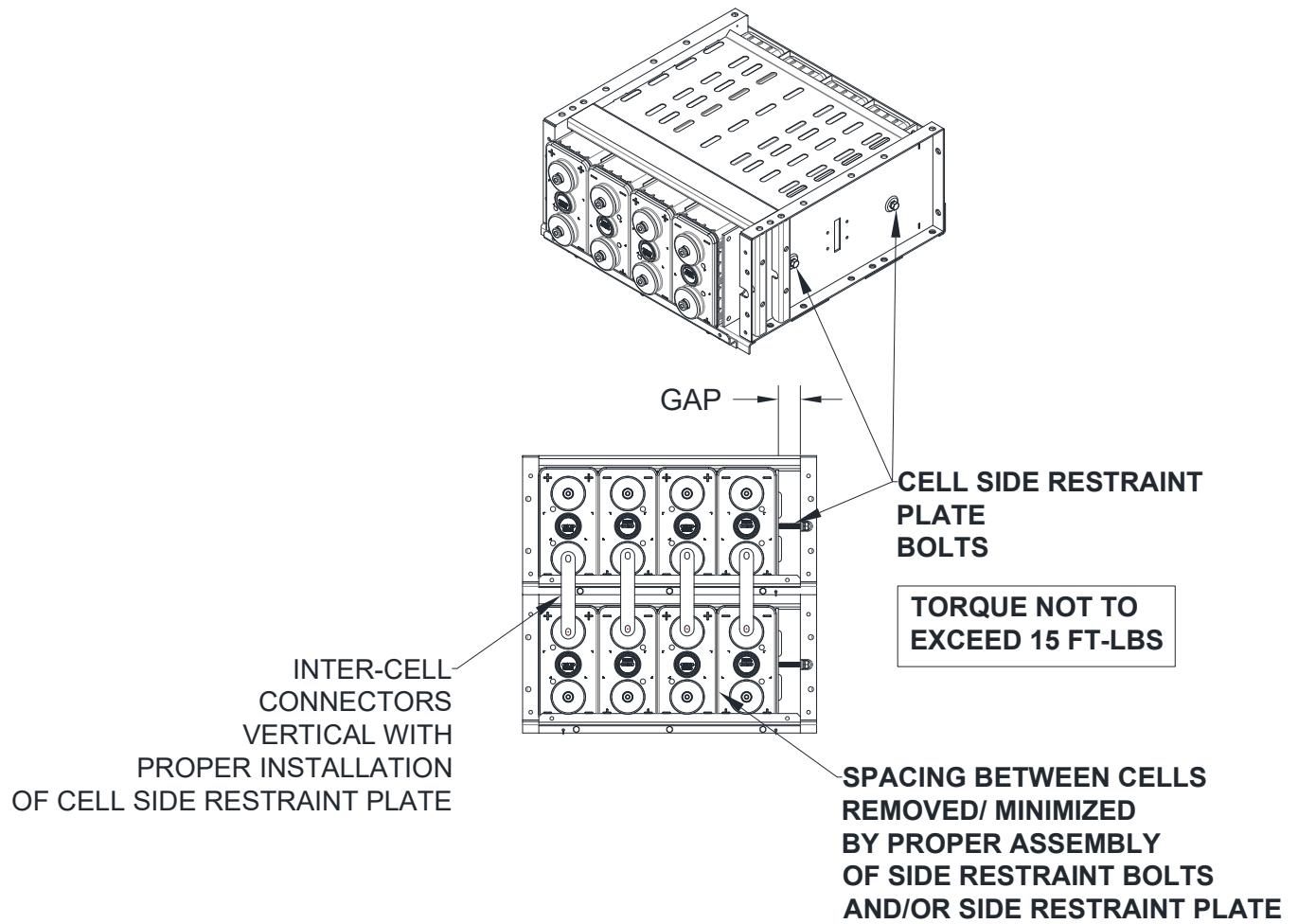


Figure C-1 Module Assembly Details

Appendix E – Battery Inspection Report



RS-1992

BATTERY INSPECTION REPORT

TECHNICAL SERVICE DEPARTMENT
1400 UNION MEETING ROAD
BLUE BELL, PA 19422

Inspection by: _____

Date of Inspection: _____

C&D TECHNOLOGIES' 2-VOLT BATTERY AND CHARGER INSPECTION REPORT

User's Name: _____

Authorized Site Contact: _____

Installation Location: _____

Phone Number: _____

System OEM: _____

Other: _____

System OEM: _____

Installation by: _____

BATTERY & CHARGER SYSTEM INFORMATION

C&D Order #: _____

Appearance of Following Battery Items

C&D Ship Date: _____

Positive Posts: _____

Date Installed: _____

Negative Posts: _____

Battery Model: _____

Cell Covers: _____

Cells X Strings: _____

Presence of Lubricant on cells? _____

Yes No

Application: _____

Cell Covers: _____

Bus Voltage, Portable Meter: _____

Presence of Lubricant on cells? _____

Bus Voltage, Equipment, Final: _____

Yes No

Charger Size: _____

Cell Covers: _____

Charger Type: _____

Presence of Lubricant on cells? _____

Charger Serial #: _____

Yes No

Charger Mfg: _____

Cell Covers: _____

Ambient Room Temperature: _____

Presence of Lubricant on cells? _____

Last Discharge: _____

Yes No

Peak Load Current Amp. Or KW: _____

Cell Covers: _____

Typical Load Current/KW: _____

Presence of Lubricant on cells? _____

Cell Arrangement: _____

COMMENTS AND RECOMMENDATIONS:

BATTERY CHARGE STATUS

Open Circuit

Float

Equalize

BATTERY BUS VOLTAGE

V_{dc}

V_{dc}

V_{dc}

LOCATION:

Appendix F – Recycling

Lead-acid batteries are recyclable and C&D Technologies currently has a low cost, convenient, and environmentally safe collection and recycling program. Visit the C&D Web site at www.cdtechno.com for further information.

Figure & Table Index

Figure 3-1 BCI warning label	7
Figure 6-1 Installation Using Forklift.....	12
Figure 6-2 Installation Using Hoist and Straps	12
Figure 6-3 Base to Module Assembly.....	15
Figure 6-4 Spacer and Front Cell Restraint Assembly.....	15
Figure 6-4A Flange Nut Detail	16
Figure 6-5 Module and Faceplate Assembly.....	16
Figure 6-6 Cell Removal Tool	18
Figure 6-7 Removing a Cell	18
Figure 6-8 Cell Installation and Removal Using Lift Table	17
Table 1 – Initial Charge at 77°F (25°C)	22
Figure 9-1 Module Assembly Issues.....	26
Figure B-1 Cam Assembly Diagram	31
Figure B-2 Cam Assembly Detail	31
Table 2 – Gap and Module Assembly Details	32
Figure C-1 Module Assembly Details	33