

m-s **endur**[™]

Valve Regulated Lead-Acid Batteries



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™ 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 question, 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.

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

FOR ADDITIONAL INFORMATION CONTACT

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1400 Union Meeting Road
P.O. Box 3053
Blue Bell, PA 19422-0858
Telephone 800-543-8630 FAX 215-619-7899

IMPORTANT

NOTE

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

**MS ENDUR
VALVE REGULATED LEAD-ACID BATTERIES
TECHNICAL MANUAL**

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PART 1 INTRODUCTION

The batteries referenced in this document are stationary, lead-acid batteries. They are constructed with an absorbent glass mat 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, please dispose of properly or consult C&D for recycling information.

The msEndur™ 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 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 is available in two different battery versions. The standard version has a specific gravity of 1.300 and has the series nomenclature of AT-“plate count.” The other version has a lower specific gravity of 1.250 and has the nomenclature of ATL-“plate count.” This nomenclature is based off the 8-hour discharge rate to 1.75 volts per cell.

1.1 Cell Characteristics

Under normal float operation, msEndur batteries can be installed in proximity to electronic equipment and in computer rooms with occupied space. However, should the battery be subjected to excessive overcharge, hydrogen and oxygen can be vented to the atmosphere. Therefore, the battery should never be installed in an airtight enclosure. Sufficient precautions must be taken to prevent excessive overcharge and containment of potential explosive gases.

All batteries, including msEndur, are capable of generating potentially explosive gases when charged at voltages higher than initial or equalizing charge. The msEndur 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
- 29CFR1910.268(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”
(expected publication date – 2004, presently in draft).

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

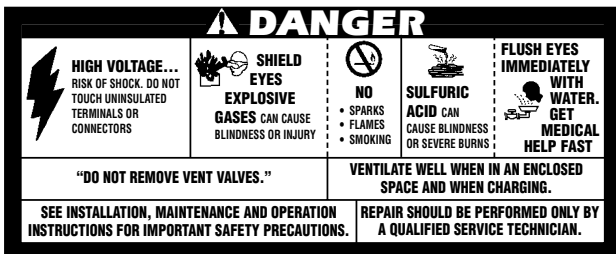


Figure 1 - BCI warning label

3.1 Recommended Tools

This list of tools is a 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 Safety

- Rubber or Neoprene – Acid Resistant Gloves
- Protective apron
- Face shield or ANSI approved goggles
- Rubber soled safety shoes/boots
- Eye wash station with the capability to supply copious amount of water for 15 minutes

3.3 Installation

- Lifting sling or appropriately sized platform
- Insulated tools
- Insulated torque wrench
- Digital voltmeter with three-digit accuracy
- One of the following: Resistance, conductance or impedance meter
- Non-metallic brush or pad for cleaning connections
- NO-OX-ID grease and applicator brush

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 McAllen, TX (title/ownership passes to the ship-to/end-user at the McAllen, 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 C&D customer service department. Mail (express mail recommended) or fax a copy of the VERIFIED 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

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). The batteries may be stored at these temperatures for up to six months; longer storage is detrimental to the battery 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 battery during storage is to measure the open circuit voltage (OCV). A fully charged battery has a OCV of 2.15. If the OCV drops by 0.04 volts, than a freshening charge is required. **Be sure to record dates and conditions for all charges during storage.**

Avoid exposure of the cell to temperatures less than 0.0°F (-18°C), as this may cause the battery electrolyte to freeze. This can permanently damage the battery and can cause potentially hazardous leakage.

Higher than normal storage temperature (77°F [25°C] nominal) will accelerate internal self-discharge of a battery by a factor of two for each 18°F (10°C) over nominal 77°F (25°C) storage temperature. This, in turn, will reduce the allowable time before initial and/or boost charging.

It is very important that boost charges be given at the appropriate time to avoid major remedial action or loss of product.

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 reduce battery life.

Avoid sources of hot or cold air that could cause temperature variations of ±5°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 Appendix for installation details.

6.2 Ventilation

Although these batteries are valve regulated and produce virtually no gas emissions during normal operation, they can vent potentially explosive gases under abnormal operating conditions. Hydrogen gas when accumulated in a battery area that exceeds two percent by volume is explosive. C&D recommends contacting the local code enforcement officer to determine what codes and levels are applicable to your battery room installation. **Batteries should never be installed in a sealed, non-ventilated cabinet or enclosure.**

VRLA batteries subjected to extreme over-charge 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 series testing shows that they recombine at nearly 99% efficiency under normal conditions. However, compliance with appropriately safety measures regarding hydrogen evolution is essential for the safety of equipment and personnel.

6.3 Floor Loading and Anchoring

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

6.5 Electrical Connections

WARNING

- **Always use protective insulating equipment, such as gloves, shoes, and eye and face protection. Wrenches and other tools must be 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.**

6.6 Terminal Plates (If part of the battery system)

For reasons of safety, it is recommended that terminal plates be installed before connector installation as previously described in section 6.8. Interconnect cells and modules 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.

6.7 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 positive terminal of the battery and follow the electrical circuit with succeeding numbers on the cell covers.

6.8 Interconnection

Cell connection is made from the (+) of one cell to the (-) of the next sequential 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 reapply prior to connecting

the cells with the supplied inter-cell connectors. Refer to the Appendix for additional instructions for reapplying NO-OX-ID grease.

The top row of connectors are 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 torquing 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 torquing 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 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.**

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.

Typical cell and connection resistance values are provided in the Appendix according to cell type. In addition, a listing of short circuit current in amperes is provided to further inform the user of the potential energy available from these batteries.

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. 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 (2.15 VPC) = 51.6 OCV. If the OCV does not equal the expected value, inspect the sequence of (+) to (-) connections. Further investigation may require re-inspecting each cell voltage to confirm an acceptable value.

6.9 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 batteries and avoid damaging the battery and/or connected equipment, observe the following:

- Use only direct current. AC ripple current from charger shall not exceed five percent of the 8-hour (ampere-hour) rating of the battery.
- Be sure charger is turned off before making electrical connections between the battery and system.
- Connect battery positive terminal to charger positive terminal and battery negative terminal to charger negative terminal. Grounding battery may be either to positive or negative terminal of the battery.
- Check system design requirements. Verify polarity with a volt meter before making final charger connections and turning on the charge.
- Be certain that all connections are tight and secured before turning on the charger.

The recommended method of providing an initial/equalize charge is to first determine the maximum allowable voltage that may be applied to 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 initial value found in Table 1 and continue charging at this voltage. Once the initial charge is completed, put the battery at the recommended float voltage for a minimum of 72 hours before any load is placed on the system. The battery is now considered fully charged and is ready for either initial acceptance testing or regular service.

NOTE

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. There is also the potential for cells to give off hydrogen gas.

7.1 Initial Charge

All cells are shipped fully charged from the factory, but lose some charge in transit or storage before installation. At the first opportunity, provide an initial charge before six months from the time of the shipment date or if open circuit voltage drops to 2.20 volts per cell.

TABLE 1 - INITIAL CHARGE AT 77°F (25°C)

| Cell Type | Specific Gravity | Open Voltage | Minimum Cell Voltage | Initial / Float Voltage | Typical Equalize for Initial/Equalize | Charging Time |
|-----------|------------------|--------------|----------------------|-------------------------|---------------------------------------|---------------|
| | | Vpc | Vpc | Vpc | Vpc | Hours |
| AT | 1.300 | 2.15 | 2.20 | 2.26 +/- 0.01 | 2.35 +/- 0.02 | 12 - 16 |
| ATL | 1.250 | 2.10 | 2.14 | 2.19 +/- 0.01 | 2.29 +/- 0.02 | 12 - 16 |

Notes:

- Applies to average cell voltage. Battery voltage should be set at average cell voltage multiplied by the number of cells in battery string. Individual cell voltages may vary by +0.10/-0.05 volts from the average.
- Charging time will vary due to open circuit stand, temperature and charger voltage available.
- If cell temperature is below 60°F (16°C), double the charge time for initial or equalize charge.
- For high voltage strings, see Section 7.1a.

7.1a Initial Charge – UPS Applications

UPS strings of batteries are typically much larger than those used for telecommunications applications, with as many as 240 cells in series as compared with 12 to 24 cells for the typical telecom string. Large strings of cells that have been off charge for a period of more than a few months prior to being installed may see a large variation in cell voltages when first put on initial charge. This occurs when a few cells are in a higher state of charge than the majority in the string (typically due to storage temperature variations or minor differences in cell age/processing). The majority of the cells control and require a higher float current to keep the cells at the initial charge voltage. However, if this current is higher than the few cells that are in a higher state of charge require, the higher current will drive the voltages for those cells high enough (in excess of 2.4 volts per cell) to cause frequent out gassing. With the outgassing, there is the possibility of electrolyte droplets being expelled from the cells. We are therefore recommending that for UPS applications, the initial charge be performed at 2.30 volts per cell for 24 hours.

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 the Appendix. Make a photocopy of the form and use it whenever necessary to record readings taken on the battery.

-
1. Battery identifications
 2. Date of report
 3. Battery float voltage
 4. Ambient operating temperature
 5. Date and description of initial or last equalizing charge
 6. General observations from visual inspection
 7. Individual cell voltages
 8. Connection resistance measurement
 9. *One of the following for cell condition: Impedance, Conductance and Resistance
 10. 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.

*If your cell readings are outside $\pm 10\%$ of the published values, you may contact technical services, however these initial tests do 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. 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 Charge

Under normal operating conditions, it should not be necessary to equalize batteries when used at the recommended voltage in Table 1. An equalizing charge delivered at a voltage higher than the nominal float voltage is used to restore uniform cell voltage to a battery.

NOTE
**Some hydrogen gas may be liberated
at equalize charging voltage.**

An equalizing charge should be provided when individual cell voltages go below the minimum value shown in Table 1 or 0.05 volts below the float voltage 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
**Minimum voltage is the point at which plans should
be made to provide an equalizing charge. Use the equalize
voltage setting as 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) ± 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 indicate 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, which must be compensated for during initial system sizing.

PART 9 MAINTENANCE

The msEndur is a VRLA battery and will not require the addition of water throughout its life. However, we recommend the following maintenance procedure. By properly following the maintenance schedule below, this will assure that the batteries are well maintained and ready for operation when needed. A blank inspection report is shown in the Appendix.

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
2. Measure and record the system voltage
3. Measure and record the system float current

9.2 Quarterly (including the above)

4. Measure and record one of the following: conductance, impedance or internal resistance of each battery. Changes less than $\pm 10\%$ are acceptable
5. Measure and record the temperature of the negative terminal on each battery

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 bolts to 125in-lbs (14 N-m)
8. Measure and record connector resistance reading, *if a value exceeds the average by $\pm 10\%$, maintenance is required.
9. Measure and record AC ripple current or voltage on each cell.
10. Clean products with a solution of 1 lb of bicarbonate soda to 1 gallon of water, if necessary.

| |
|---|
| <p style="text-align: center;">CAUTION</p> |
|---|

| |
|--|
| <p style="text-align: center;">Never use solvents to clean a battery system. Only use a solution of water and bicarbonate soda, 1 gallon to 1 lb.</p> |
|--|

*Connector Maintenance

- De-energize battery string
- Adhere to all personal safety rules/codes as dictated by OSHA and all governing bodies
- Remove hardware and connector
- Clean the cell post
- Apply NO-OX-ID grease
- Re-install connector and hardware
- Torque to 125 in-lbs (14 N-m)
- Measure connector resistance, if value is still $\pm 10\%$ from the average, consult Technical Services

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

9.5 Performance Tests

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

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

9.5a 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, msEndur 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 are designed and constructed to provide long life in continuous float service. They differ in their design from "cycling batteries," such as "starting" 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 repeated 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, to complete battery failure due to hydration. If recharging at equalize voltage is impractical, recharge at float voltage.

10.3 Low Float Voltage and Sulfation

Either because of incorrect charger voltage adjustment or excessive intermittent or static loads paralleling the charging source or low operating temperature, a battery may not receive adequate charge. 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 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 for assistance. Sulfated batteries are partially charged batteries and have not completed the electrochemical reaction of recharge. Accordingly, they will have reduced capability and available capacity. If allowed to remain in a partially charged condition for an extended period of time, sulfated batteries may suffer irreversible damage, requiring replacement.

10.4 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 batteries are more resistant to hydration than typical wet cells, largely because of the thick absorbent glass mat between the plates. However, in severe cases of hydration, internal short circuits will form.

10.5 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 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.

10.6 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. Paralleling cells is not recommended due to potential safety and maintenance problems.

10.7 High Temperature Operation

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

Appendix

APPENDIX A INSTALLATION OF MODULES

The msEndur battery systems are shipped with the cells installed into the modules. These modules are stacked and bolted to pallets for ease of transportation. See Figure A1. 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.



Figure A1.

Stack Module Assembly

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.
 - 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; see Figure A2.
 - c. Assemblies consisting of floor mounting base with one stack module: can be moved using the lifting strap or a fork truck
 - 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 Figures A3 and A4.



Figure A2.

Stack Module Disassembly and Re-assembly Procedure

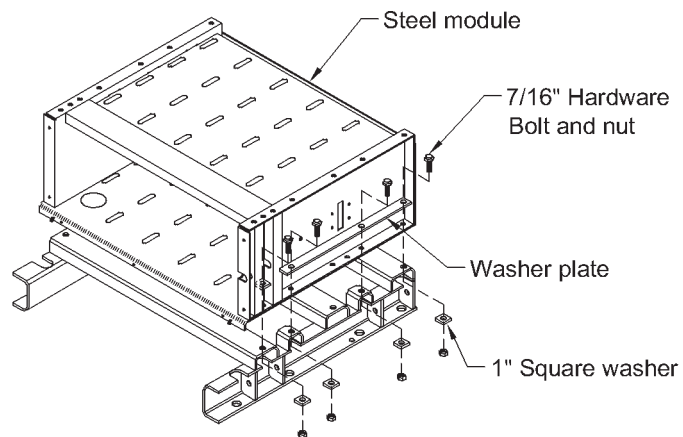
If a requirement to disassemble and re-assemble a module stack arises, follow the following procedure.

1. Starting with the uppermost module in the stack, remove the individual cells following the instructions shown in Figure A5 and Appendix F.
2. Repeat until all the cells have been removed.
3. Disassemble the stack modules. Transport the bottom stack module, with the base attached, to the desired installation location. Mark the location of the floor anchors and install, matching the anchor holes in the floor-mounting base.
4. Be sure the floor mounting base or assembly is in position and level, then torque the floor anchors. If the base is not level, use shims to level. A level base is particularly important for the stability and safety of high, narrow stacks.

-
5. If the assembly requires additional modules, use the lifting slings. Place additional modules, one at a time, on top of modules already in place. Properly align modules and mounting holes, and insert the 7/16" bolts, washers and nuts as shown in Figures A3 and A4. When all bolts are in place, check that assembly is plumb and level, then tighten the bolts to 60 ft-lb (81 N-m). using a torque wrench.
 6. Reinstall the cells starting with the bottom module and working up. Perform the electrical connections last

Exploded Module Assembly

Base to Module Assembly
Figure A3.



Exploded Module Assembly

Module to Module Assembly

Figure A4.

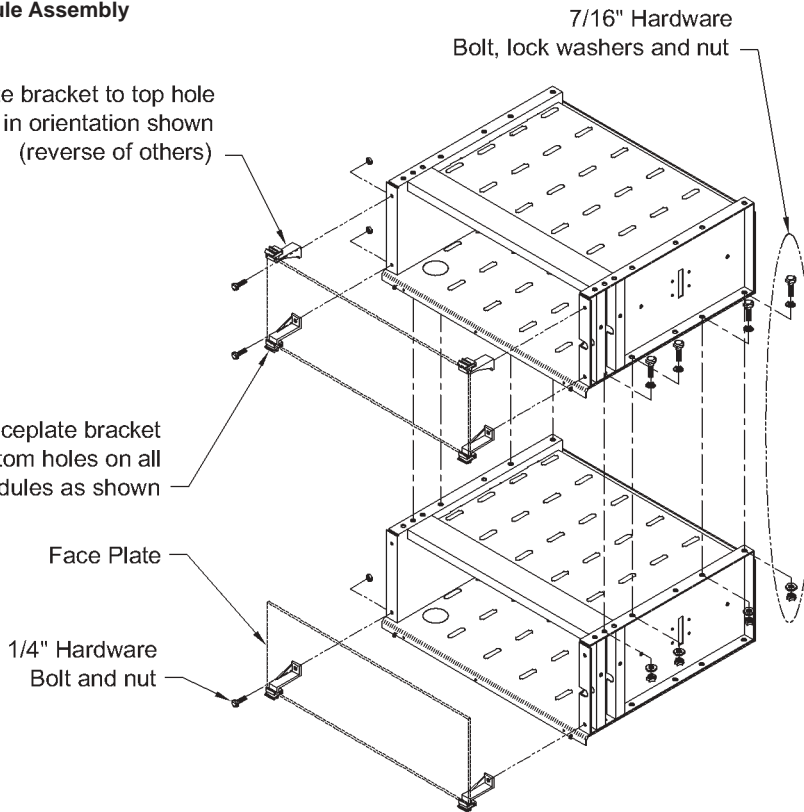
Attach faceplate bracket to top hole on top module in orientation shown (reverse of others)

Attach faceplate bracket to bottom holes on all modules as shown

Face Plate

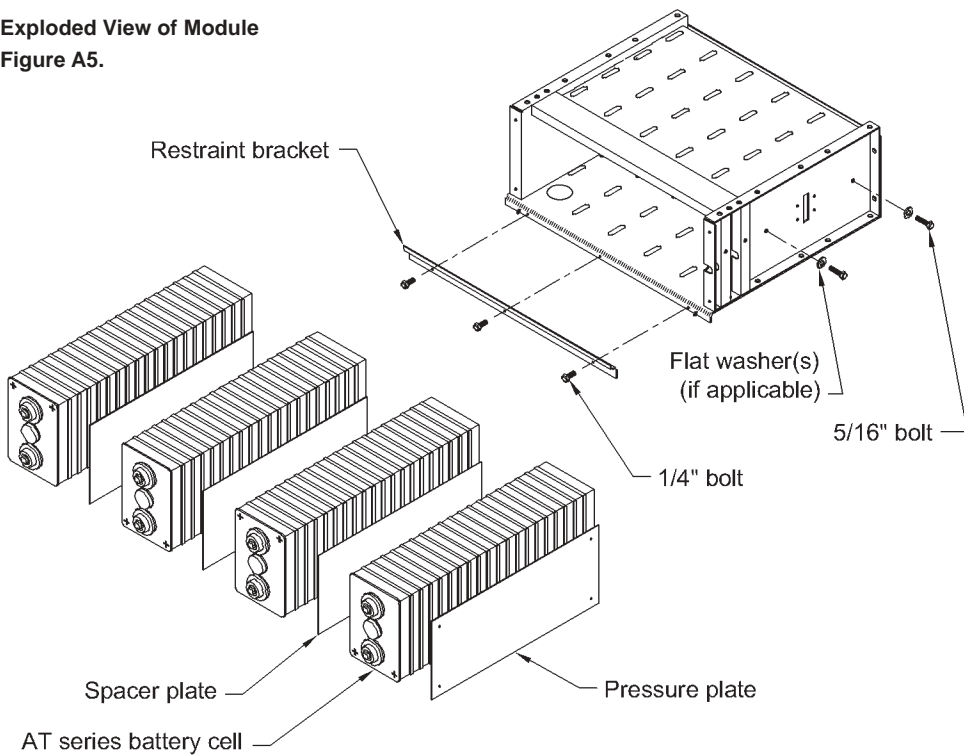
1/4" Hardware Bolt and nut

7/16" Hardware Bolt, lock washers and nut



Exploded View of Module

Figure A5.



APPENDIX B APPLYING NO-OX-ID GREASE

1. Remove any remaining factory-applied grease coating from the terminals with a dry cloth.
2. With a neutralizing solution consisting of one-pound baking soda 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. Brush the terminal with the brass bristle brush to a bright, shiny finish.
4. Remove the oxidation film from the connectors with the brass bristle brush, resulting in a bright, shiny finish.
5. Coat all electrical surfaces with pre-heated NO-OX-ID. (Use heat gun or hot plate-no open flames)
6. Re-flow excess NO-OX-ID with heat gun and wipe excess.

APPENDIX C CELL RATINGS



AT CELL RATINGS IN AMPERES AT 77F (25C) PER CELL

| FV/Cell | Cell Type | Cell Model | 1 hr | 2 hr | 3 hr | 4 hr | 5 hr | 6 hr | 7 hr | 8 hr |
|---------|-----------|------------|--------|-------|-------|-------|-------|-------|-------|-------|
| 1.75 | AT-350 | AT-07 | 186.3 | 122.2 | 92.5 | 74.9 | 63.1 | 54.6 | 48.1 | 43.1 |
| | AT-460 | AT-09 | 248.3 | 163.0 | 123.3 | 99.8 | 84.1 | 72.7 | 64.2 | 57.4 |
| | AT-580 | AT-11 | 310.4 | 203.7 | 154.1 | 124.8 | 105.1 | 90.9 | 80.2 | 71.8 |
| | AT-810 | AT-15 | 434.6 | 285.2 | 215.8 | 174.7 | 147.1 | 127.3 | 112.3 | 100.5 |
| | AT-1040 | AT-19 | 558.8 | 366.7 | 277.4 | 224.6 | 189.2 | 163.7 | 144.4 | 129.2 |
| | AT-1260 | AT-23 | 682.9 | 448.2 | 339.1 | 274.5 | 231.2 | 200.1 | 176.5 | 157.9 |
| | AT-1500 | AT-27 | 807.1 | 529.7 | 400.7 | 324.4 | 273.2 | 236.4 | 208.5 | 186.7 |
| | AT-2000 | AT-35 | 1044.1 | 687.5 | 523.4 | 425.9 | 360.3 | 312.9 | 276.8 | 248.3 |
| 1.80 | AT-350 | AT-07 | 172.7 | 114.7 | 87.5 | 71.3 | 60.4 | 52.5 | 46.5 | 41.8 |
| | AT-460 | AT-09 | 230.2 | 152.9 | 116.6 | 95.1 | 80.5 | 70.0 | 62.0 | 55.7 |
| | AT-580 | AT-11 | 287.8 | 191.1 | 145.8 | 118.8 | 100.7 | 87.5 | 77.5 | 69.6 |
| | AT-810 | AT-15 | 402.9 | 267.5 | 204.1 | 166.3 | 141.0 | 122.6 | 108.5 | 97.5 |
| | AT-1040 | AT-19 | 518.0 | 344.0 | 262.4 | 213.9 | 181.2 | 157.6 | 139.6 | 125.3 |
| | AT-1260 | AT-23 | 633.2 | 420.4 | 320.7 | 261.4 | 221.5 | 192.6 | 170.6 | 153.2 |
| | AT-1500 | AT-27 | 748.3 | 496.9 | 379.0 | 308.9 | 261.8 | 227.6 | 201.6 | 181.0 |
| | AT-2000 | AT-35 | 971.9 | 646.7 | 495.8 | 405.8 | 345.1 | 300.9 | 267.1 | 240.4 |
| 1.84 | AT-350 | AT-07 | 159.1 | 108.6 | 83.4 | 68.1 | 57.7 | 50.1 | 44.4 | 39.9 |
| | AT-460 | AT-09 | 212.2 | 144.9 | 111.2 | 90.7 | 76.9 | 66.9 | 59.2 | 53.2 |
| | AT-580 | AT-11 | 265.2 | 181.1 | 139.0 | 113.4 | 96.1 | 83.6 | 74.0 | 66.4 |
| | AT-810 | AT-15 | 371.3 | 253.5 | 194.5 | 158.8 | 134.6 | 117.0 | 103.6 | 93.0 |
| | AT-1040 | AT-19 | 477.4 | 325.9 | 250.1 | 204.2 | 173.1 | 150.4 | 133.2 | 119.6 |
| | AT-1260 | AT-23 | 583.5 | 398.4 | 305.7 | 249.6 | 211.5 | 183.9 | 162.8 | 146.2 |
| | AT-1500 | AT-27 | 689.6 | 470.8 | 361.3 | 294.9 | 250.0 | 217.3 | 192.4 | 172.8 |
| | AT-2000 | AT-35 | 896.5 | 612.1 | 471.9 | 387.0 | 329.3 | 287.2 | 255.0 | 229.5 |
| 1.86 | AT-350 | AT-07 | 150.6 | 104.4 | 80.5 | 65.8 | 55.8 | 48.6 | 43.0 | 38.6 |
| | AT-460 | AT-09 | 200.8 | 139.2 | 107.3 | 87.8 | 74.5 | 64.8 | 57.4 | 51.5 |
| | AT-580 | AT-11 | 251.0 | 174.0 | 134.1 | 109.7 | 93.1 | 80.9 | 71.7 | 64.4 |
| | AT-810 | AT-15 | 351.4 | 243.6 | 187.8 | 153.6 | 130.3 | 113.3 | 100.4 | 90.1 |
| | AT-1040 | AT-19 | 451.9 | 313.2 | 241.4 | 197.5 | 167.5 | 145.7 | 129.0 | 115.9 |
| | AT-1260 | AT-23 | 552.3 | 382.8 | 295.1 | 241.3 | 204.7 | 178.1 | 157.7 | 141.6 |
| | AT-1500 | AT-27 | 652.7 | 452.4 | 348.8 | 285.2 | 242.0 | 210.5 | 186.4 | 167.4 |
| | AT-2000 | AT-35 | 849.4 | 589.0 | 456.1 | 374.7 | 319.2 | 278.5 | 247.4 | 222.7 |

RATINGS IN KILOWATTS AT 77F (25C) PER CELL

| FV/Cell | Cell Type | Cell Model | 1 min | 5 min | 10 min | 15 min | 20 min | 30 min | 45 min | 1 hr |
|---------|-----------|------------|-------|-------|--------|--------|--------|--------|--------|-------|
| 1.67 | AT-350 | AT-07 | 0.802 | 0.758 | 0.699 | 0.641 | 0.586 | 0.498 | 0.412 | 0.357 |
| | AT-460 | AT-09 | 1.070 | 1.010 | 0.932 | 0.854 | 0.781 | 0.664 | 0.549 | 0.476 |
| | AT-580 | AT-11 | 1.337 | 1.263 | 1.166 | 1.068 | 0.977 | 0.83 | 0.687 | 0.596 |
| | AT-810 | AT-15 | 1.872 | 1.768 | 1.632 | 1.495 | 1.367 | 1.162 | 0.962 | 0.834 |
| | AT-1040 | AT-19 | 2.407 | 2.273 | 2.098 | 1.922 | 1.758 | 1.494 | 1.236 | 1.072 |
| | AT-1260* | AT-23 | - | - | - | - | - | - | - | - |
| | AT-1500 | AT-27 | 3.476 | 3.283 | 3.030 | 2.776 | 2.539 | 2.158 | 1.786 | 1.548 |
| | AT-2000* | AT-35 | - | - | - | - | - | - | - | - |

*Contact C&D for rates

ATL CELL RATINGS IN AMPERES AT 77F (25C) PER CELL

| FV/Cell | Cell Type | Cell Model | 1 hr | 2 hr | 3 hr | 4 hr | 5 hr | 6 hr | 7 hr | 8 hr |
|----------|-----------|------------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1.75 | ATL-295 | ATL-07 | 157.5 | 103.5 | 78.4 | 63.5 | 53.6 | 46.4 | 40.9 | 36.6 |
| | ATL-390 | ATL-09 | 210.0 | 138.0 | 104.5 | 84.7 | 71.4 | 61.8 | 54.6 | 48.9 |
| | ATL-490 | ATL-11 | 262.5 | 172.5 | 130.7 | 105.9 | 89.3 | 77.3 | 68.2 | 61.1 |
| | ATL-685 | ATL-15 | 367.5 | 241.5 | 182.9 | 148.2 | 125.0 | 108.2 | 95.5 | 85.5 |
| | ATL-880 | ATL-19 | 472.5 | 310.5 | 235.2 | 190.6 | 160.7 | 139.1 | 122.8 | 109.9 |
| | ATL-1075 | ATL-23 | 577.5 | 379.5 | 287.5 | 232.9 | 196.4 | 170.0 | 150.0 | 134.3 |
| | ATL-1270 | ATL-27 | 682.5 | 448.5 | 339.7 | 275.3 | 232.1 | 200.9 | 177.3 | 158.8 |
| ATL-1700 | ATL-35 | 892.5 | 586.5 | 444.3 | 360.0 | 303.5 | 262.8 | 231.9 | 207.6 | |
| 1.80 | ATL-295 | ATL-07 | 146.1 | 96.9 | 73.8 | 60.0 | 50.8 | 44.1 | 39.0 | 35.0 |
| | ATL-390 | ATL-09 | 194.9 | 129.2 | 98.4 | 80.0 | 67.7 | 58.8 | 52.0 | 46.7 |
| | ATL-490 | ATL-11 | 243.6 | 161.5 | 123.0 | 100.1 | 84.6 | 73.5 | 65.0 | 58.3 |
| | ATL-685 | ATL-15 | 341.0 | 226.2 | 172.2 | 140.1 | 118.5 | 102.9 | 91.0 | 81.7 |
| | ATL-880 | ATL-19 | 438.4 | 290.8 | 221.4 | 180.1 | 152.4 | 132.3 | 117.0 | 105.0 |
| | ATL-1075 | ATL-23 | 535.9 | 355.4 | 270.6 | 220.1 | 186.2 | 161.7 | 143.1 | 128.4 |
| | ATL-1270 | ATL-27 | 633.3 | 420.0 | 319.7 | 260.1 | 220.1 | 191.1 | 169.1 | 151.7 |
| ATL-1700 | ATL-35 | 828.2 | 549.3 | 418.1 | 340.2 | 287.8 | 249.9 | 221.1 | 198.4 | |
| 1.84 | ATL-295 | ATL-07 | 133.7 | 90.7 | 69.5 | 56.7 | 48.1 | 41.8 | 37.0 | 33.3 |
| | ATL-390 | ATL-09 | 178.2 | 120.9 | 92.7 | 75.6 | 64.1 | 55.8 | 49.4 | 44.3 |
| | ATL-490 | ATL-11 | 222.8 | 151.2 | 115.9 | 94.6 | 80.2 | 69.7 | 61.7 | 55.4 |
| | ATL-685 | ATL-15 | 311.9 | 211.6 | 162.2 | 132.4 | 112.2 | 97.6 | 86.4 | 77.6 |
| | ATL-880 | ATL-19 | 401.0 | 272.1 | 208.5 | 170.2 | 144.3 | 125.4 | 111.1 | 99.8 |
| | ATL-1075 | ATL-23 | 490.1 | 332.6 | 254.9 | 208.0 | 176.3 | 153.3 | 135.8 | 121.9 |
| | ATL-1270 | ATL-27 | 579.2 | 393.0 | 301.2 | 245.9 | 208.4 | 181.2 | 160.5 | 144.1 |
| ATL-1700 | ATL-35 | 757.4 | 514.0 | 393.9 | 321.5 | 272.5 | 237.0 | 209.8 | 188.4 | |
| 1.86 | ATL-295 | ATL-07 | 125.8 | 87.0 | 67.1 | 54.9 | 46.6 | 40.6 | 36.0 | 32.3 |
| | ATL-390 | ATL-09 | 167.8 | 116.1 | 89.5 | 73.2 | 62.2 | 54.1 | 47.9 | 43.1 |
| | ATL-490 | ATL-11 | 209.7 | 145.1 | 111.9 | 91.6 | 77.7 | 67.6 | 59.9 | 53.8 |
| | ATL-685 | ATL-15 | 293.6 | 203.1 | 156.6 | 128.2 | 108.8 | 94.7 | 83.9 | 75.4 |
| | ATL-880 | ATL-19 | 377.5 | 261.1 | 201.4 | 164.8 | 139.9 | 121.7 | 107.9 | 96.9 |
| | ATL-1075 | ATL-23 | 636.3 | 403.1 | 300.6 | 241.1 | 201.7 | 173.6 | 152.5 | 136.1 |
| | ATL-1270 | ATL-27 | 545.3 | 377.2 | 290.9 | 238.0 | 202.1 | 175.8 | 155.8 | 140.0 |
| ATL-1700 | ATL-35 | 713.0 | 493.2 | 380.4 | 311.3 | 264.2 | 230.0 | 203.8 | 183.0 | |

**APPENDIX D
CELL CONDUCTANCE**

| Cell Type | Typical Resistance (ohms) | Typical Conductance (KMhos) | Maximum Short Circuit Current (amperes) |
|------------------|----------------------------------|------------------------------------|--|
| AT-350 | 0.000816 | 2.4 | 2,500 |
| AT-460 | 0.000612 | 2.9 | 3,400 |
| AT-580 | 0.000490 | 3.3 | 4,200 |
| AT-810 | 0.000350 | 4.4 | 5,900 |
| AT-1040 | 0.000272 | 5.8 | 7,600 |
| AT-1260 | 0.000223 | 6.4 | 9,200 |
| AT-1500 | 0.000188 | 6.6 | 10,900 |
| AT-2000 | 0.000138 | 7.5 | 14,266 |
| ATL-295 | 0.000943 | 2.3 | 2,100 |
| ATL-390 | 0.000708 | 2.8 | 2,800 |
| ATL-490 | 0.000566 | 3.2 | 3,500 |
| ATL-685 | 0.000404 | 4.3 | 4,900 |
| ATL-880 | 0.000314 | 5.6 | 6,400 |
| ATL-1075 | 0.000257 | 6.2 | 7,800 |
| ATL-1270 | 0.000218 | 6.4 | 9,200 |
| ATL-1700 | 0.000167 | 7.3 | 12,300 |

APPENDIX E
MATERIAL SAFETY DATA SHEETS →

MATERIAL SAFETY DATA SHEET

| SECTION I: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION | |
|---|--|
| PRODUCT IDENTITY: Sealed, Lead-Calcium Battery CDID: AT SERIES, msEndur | MANUFACTURER NAME: C & D Technologies, Inc. ADDRESS: 1400 Union Meeting Road P. O. Box 3053 Blue Bell, PA 19422-0858 TELEPHONE: (215) 619-2700 |
| EMERGENCY: (610) 828-9309 24 HOUR EMERGENCY TELEPHONE: (CHEM TEL) 1-800-255-3924 | |

| SECTION II: COMPOSITION / INFORMATION ON INGREDIENTS | | | | |
|---|-----------|-----------|-----------|-------------|
| NOTE: The C&D "Liberty Series" batteries are sealed, recombinant design. Under normal use and handling the customer has no contact with the internal components of the battery or the chemical hazards. Under normal use and handling these batteries do not emit regulated or hazardous substances. | | | | |
| HAZARDOUS COMPONENT | CAS# | OSHA PEL | ACGIH TLV | % BY WEIGHT |
| *Lead, Lead compounds | 7439-92-1 | 0.05mg/m3 | 0.05mg/m3 | 72-73% |
| *Sulfuric Acid | 7664-93-9 | 1.0mg/ m3 | 1.0mg/ m3 | 7 - 8 % |
| Tin | 7440-31-5 | 2.0mg/m3 | 2.0mg/m3 | < .1% |
| Aluminum | 7429-90-5 | 15.0mg/m3 | 10.0mg/m3 | < .01% |
| *Copper | 7440-50-8 | 1.0mg/m3 | 1.0mg/m3 | < .01% |
| NON-HAZARDOUS INGREDIENTS | | | | |
| Water | 7732-18-5 | N/A | N/A | 15 - 17% |
| Calcium | 7440-70-2 | N/A | N/A | .01% |
| Inert Components | N/A | N/A | N/A | 3 - 6% |
| SECTION 313 (40 CFR 372) LISTED TOXIC CHEMICALS ARE PRECEDED BY AN *. | | | | |

| SECTION III: HAZARDS IDENTIFICATION |
|---|
| APPEARANCE AND ODOR: Colorless, Oily Fluid, Vapors are Colorless; Acrid odor when hot or charging. |
| RATING CODES: 0=Insignificant, 1=Slight 2=Moderate 3=High 4=Extreme |
| HMIS RATING: Health: 2 Flammability: 0 Reactivity: 1 Other: 0 |
| NFPA RATING: Health: 2 Flammability: 0 Reactivity: 1 Other: CORR |
| ROUTES OF ENTRY: Inhalation X Skin X Ingestion X |
| TARGET ORGANS: Skin, Eyes, Upper Respiratory Tract |
| HEALTH HAZARDS (ACUTE AND CHRONIC): |
| ACUTE: Tissue destruction on contact. May cause 2nd and 3rd degree burns or blindness with prolonged contact. Ingestion will cause corrosive burns on contact. May be fatal if swallowed. |
| CHRONIC: Inhalation of mists may cause upper respiratory irritation. |
| SIGNS AND SYMPTOMS: Irritation and burning of exposed tissues. |
| MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Respiratory disorders may be aggravated by prolonged inhalation of mists. |
| <i>California Proposition 65 Warning – Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Batteries also contain other chemicals known to the State of California to cause cancer. Wash hands after handling.</i> |

SECTION IV: FIRST AID MEASURES

EMERGENCY AND FIRST AID PROCEDURES:

SKIN / EYES

Flush with water for 15 minutes
Remove contaminated clothing
If irritation continues, seek medical attention.

INGESTION

Do not induce vomiting
Drink large quantities of milk or water
Give CPR if breathing has stopped
Seek medical attention immediately

SECTION V: FIREFIGHTING MEASURES

FIRE AND EXPLOSIVE PROPERTIES: Flash Point: N/A

Oxygen Index: >32

Flammable Limits (as H₂ gas):

LEL: 4%

UEL: 74%

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen gas may be present when used in a battery. Hydrogen gas and acid mist is generated upon overcharge or in fire. Ventilate area.

EXTINGUISHING MEDIA: Class ABC or CO₂. Caution should be taken not to use CO₂ directly on the battery cell as the thermal shock may cause cracking of the battery case and release of battery electrolyte.

SPECIAL FIREFIGHTING PROCEDURES: Ventilate the area well. SCBA and acid protective clothing are recommended.

SECTION VI: ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF BATTERY IS BROKEN: Neutralize any spilled electrolyte or exposed battery parts with soda ash or sodium bicarbonate until fizzing stops. pH should be neutral at 6-8. Collect residue and place in a suitable container. Residue may be hazardous waste. When neutralized, the spill is non-hazardous. Keep untrained individuals away from the spilled material. Place the broken battery in a heavy gauge plastic bag or other non-metallic container. Provide adequate ventilation, hydrogen gas may be given off during neutralization.

SECTION VII: HANDLING AND STORAGE

Store in a cool, dry area away from combustibles. Do not store in sealed, unventilated areas. Avoid overheating and overcharging. Do not use organic solvents or other than recommended chemical cleaners on the batteries.

SECTION VIII: EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS: General room ventilation is sufficient during normal use and handling. Do not install these batteries in a sealed, unventilated area.

PERSONAL PROTECTIVE EQUIPMENT (IN THE EVENT OF BATTERY BREAKAGE):

Eye Protection = chemical goggles or safety glasses with sideshields and a full-face shield.

Protective Gloves = rubber or neoprene

Respiratory Protection = NIOSH approved acid mist respirator, if OSHA PEL is exceeded or respiratory irritation occurs.

Other Protective Equipment = acid resistant apron or clothes.

WORK PRACTICES: Do not wear metallic jewelry when working with batteries. Use non-conductive tools only. Discharge static electricity prior to working on a battery. Maintain an eyewash, fire extinguisher and emergency communication device in the work area.

SECTION IX: PHYSICAL AND CHEMICAL PROPERTIES

ACID:

Vapor Density: (air=1): >1

Evaporation Rate (water=1): N/A

Melting Point: N/A

Boiling Point: N/A

Vapor Pressure: N/A

Solubility in water: N/A

Specific Gravity (contained in battery): 1.310+/-0.010

SECTION X: STABILITY AND REACTIVITY

STABILITY: This battery and contents are stable.

CONDITIONS TO AVOID: Overheating, overcharging which result in acid mist / hydrogen generation.

INCOMPATIBILITY (MATERIALS TO AVOID): Strong alkaline materials, conductive metals, organic solvents, sparks or open flame.

HAZARDOUS DECOMPOSITION OR BYPRODUCTS: Hydrogen gas may be generated in an overcharged condition, in fire or at very high temperatures. In fire may emit CO, CO₂ and Sulfur Oxides.

HAZARDOUS POLYMERIZATION WILL NOT OCCUR.

SECTION XI: TOXICOLOGICAL INFORMATION - SULFURIC ACID

The "Liberty Series" batteries are sealed, recombinant design. Under normal use and handling the customer has no contact with the internal components of the battery or the chemical hazards. Under normal use and handling these batteries do not emit regulated or hazardous substances.

| | | | |
|---------------|-----------------------------------|------------------------|-------------------------|
| LD 50: | Administration Route: Oral | Dose: 2140mg/kg | Test Animal: Rat |
|---------------|-----------------------------------|------------------------|-------------------------|

| | | | |
|--------------|---|-----------------------|-------------------------|
| LDLo: | Administration Route: Unreported | Dose: 135mg/kg | Test Animal: Man |
|--------------|---|-----------------------|-------------------------|

| | | | |
|--------------|---|-----------------------|-------------------------|
| LC50: | Administration Route: Inhalation | Dose: 510mg/m3 | Test Animal: Rat |
|--------------|---|-----------------------|-------------------------|

CARCINOGENICITY: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mists containing sulfuric acid" as a category 1 carcinogen (inhalation), a substance that is carcinogenic to humans. "The National Toxicology Program (NTP) has designated strong inorganic sulfuric acid mists as a known human carcinogen." This classification does not apply to the liquid forms of sulfuric acid contained within the battery. Misuse of the product, such as overcharging, may result in the generation of sulfuric acid mist at high levels.

SECTION XII: ECOLOGICAL INFORMATION

Lead and its compounds can pose a threat if released to the environment. See waste disposal method in Section X III.

SECTION XIII: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: This battery is recyclable. It is illegal to dispose of lead-acid batteries by any means other than recycling. C&D provides an environmentally responsible nation wide lead acid battery collection and recycling program. Contact your local C&D sales representative for more information.

HAZARDOUS WASTE CODES: D002, D008

SECTION XIV: TRANSPORTATION INFORMATION

FOR DOMESTIC, CANADIAN, AND EXPORT SHIPMENTS:

UN OR NA IDENTIFICATION: **UN-2794**

PROPER DOT SHIPPING NAME: Batteries, Wet, Filled with Acid, Electric Storage

| | | |
|-----------------|--------------------|------------------|
| HAZARD CLASS: 8 | PACKING GROUP: III | LABEL: Corrosive |
|-----------------|--------------------|------------------|

SECTION XV: REGULATORY INFORMATION

See 29 CFR 1910.268(b)(2)

SECTION XVI: OTHER INFORMATION

The information herein is given in good faith, but no warranty, expressed or implied, is made.

APPENDIX F HANDLING AND REPLACEMENT OF INDIVIDUAL CELLS

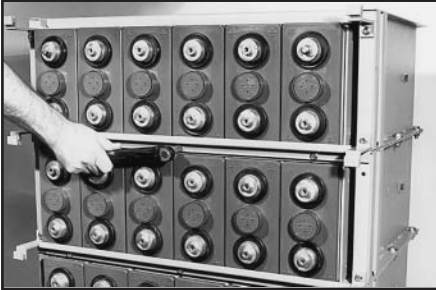


Figure F1.
Removal of cell retaining bar

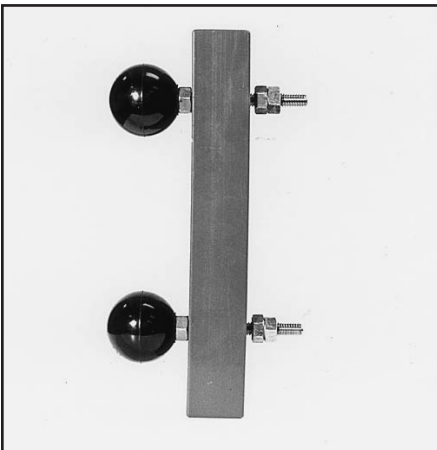


Figure F2.
Cell puller, C&D part number RE03197



Figure F3.
Removing a cell from the module

A key design feature of the msEndur battery is the provision for servicing individual cells. With a minimum amount of handling and downtime, individual cells can be changed in the field. In addition, disassembly and re-assembly of the stack modules may accommodate installation of a new battery if necessitated by a hard-to-access location.

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: Back out the cell pressure plate bolts several turns but do not remove bolts.
6. Remove cell retaining bar, shown in Figure F1.
7. Attach the “cell puller tool”, part number RE03197. This tool, shown in Figure F2, is available from your local C&D TECHNOLOGIES Representative.
8. Prepare for cell removal by moving a platform lift or equivalent lifting apparatus in proximity to the bottom of the stack module from which the cell is to be removed. Make sure all exposed metal on the platform is insulated. Verify the capacity of the lifting apparatus is sufficient to safely lift the cell. **IMPORTANT:** Before removing the cell, note the orientation of the cell in the module, i.e., positive terminal up or down.
9. Pull the cell straight out onto the platform, shown in Figure F3.
10. Follow Steps 2, 3 and 4 in reverse order to physically install the replacement cell or reinstall a new disassembled battery. Make sure the metal plates that separate adjacent cells are properly positioned on each side of the cell being installed. Do not perform the electrical connections at this time. Verify the cell pressure plate is in the proper orientation and that the cell is in the proper orientation.
11. Note: There is also a connection drawing supplied with each battery that will aid in cell orientation and installation. When all cells for a given module have been installed, tighten the cell pressure plate bolts evenly until the heads are seated. Reinstall the cell-retaining bar.
12. Perform terminal and connector preparation
13. Perform polarity check
14. Reinstall connections
15. Note: msEndur cells should never be lifted by the terminals. Do not use the cell puller tool as a lifting device.

APPENDIX G 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 No.: |
| | Other: |
| System OEM: | Installation by: |

BATTERY & CHARGER SYSTEM INFORMATION

USER INSPECTION

C&D INSPECTION

| | |
|---------------------------------------|---|
| C&D Order No. | 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 <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Application | |
| Bus Voltage, Portable Meter | |
| Bus Voltage, Equipment, Final | |
| Charger Size, Type, Serial No. & Mfg. | |
| | |
| | |
| Ambient Room Temperature | |
| Last Discharge | |
| Peak Load Current Amp. or KW | |
| Typical Load Current/KW | |
| Cell Arrangement | |

COMMENTS AND RECOMMENDATIONS

APPENDIX H 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.

C&D TECHNOLOGIES, INC.

STANDBY POWER DIVISION

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