ENCELL technology

Installation and Operation Manual
Nickel Iron MG300 Battery

Effective: July 2015

Nickel Iron MG300 Battery

MG300

Effective Date: July 2015
Encell Technology, Inc.

NOTE:
Photographs contained in this manual are for illustrative purposes only. These photographs may not match your installation.

NOTE:
Operator is cautioned to review the drawings and illustrations contained in this manual before proceeding. If there are questions regarding the safe operation of this product, please contact Encell Technology or your nearest Encell representative.

NOTE:
Encell shall not be held liable for any damage or injury involving its enclosures, power supplies, generators, batteries, or other hardware if used or operated in any manner or subject to any condition not consistent with its intended purpose, or is installed or operated in an unapproved manner, or improperly maintained.

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Or visit the Contact Us page on the Encell Technology website.

TABLE OF CONTENTS

1.1 GENERAL SAFETY NOTES

Review the drawings and illustrations contained in this manual before proceeding. If there are any questions regarding the safe installation or operation of the system, contact Encell Technology or the nearest Encell representative. Save this document for future reference.

1.2 Chemical Hazards

Nickel Iron (NiFe) batteries contain dangerous voltages, currents and corrosive material. Battery installation, maintenance, service and replacement must be performed only by authorized personnel. The electrolyte in Nickel Iron batteries, consisting of a dilute caustic sodium hydroxide with a lithium hydroxide component, is harmful to the skin and eyes.

1.3 Safe Handling

- The servicing and connection of batteries shall be performed by, or under the direct supervision of, personnel knowledgeable of batteries and required safety precautions.
- Always wear protective clothing (insulated gloves, eye protection, etc.) when installing, maintaining, servicing, or replacing batteries. Wear shock and arc flash protection when required based on the system application. Remove all metallic objects from hands and neck.
- Prior to handling the batteries, touch a grounded metal object to dissipate any static charge that may have developed on your body.
- Never use uninsulated tools or other conductive materials when installing, maintaining, servicing, or replacing batteries. Use tools with insulated handles. Do not rest any tools on top of batteries.
- Use special caution when connecting or adjusting battery cabling. If an improperly connected or unconnected battery cable contacts an unintended surface, arcing, fire, or explosion can result.
- Adequate spacing between individual batteries is necessary for convection cooling. Encell-designed racking systems are configured to allow for proper cooling of the cells.
- Batteries produce explosive gases – especially during overcharge conditions. Keep all open flames and sparks away from batteries.
- Do not charge batteries in a sealed container.
- All battery compartments must have adequate ventilation to prevent accumulation of potentially dangerous gas. Ventilation should prevent trapped hydrogen gas pockets from exceeding a 1% concentration as per regulation 70E of the National Fire Protection Agency (NFPA).
- If any battery emission contacts the skin, neutralize with vinegar immediately and then wash thoroughly with water. Follow your company's approved chemical exposure procedures.
- Neutralize any spilled battery emission with plenty of water. If necessary, use sand to soak up the spill before diluting with water. Report a chemical spill using your company's spill reporting structure and seek medical attention if necessary.
- Batteries should be replaced by authorized personnel using batteries of identical type and rating. Never install old, untested batteries.
- Replace immediately any batteries that show signs of cracking, leaking, or swelling.

1.4 Recycling and Disposal Instructions

Spent or damaged batteries are considered environmentally unsafe. Always recycle used batteries or dispose of the batteries in accordance with all federal, state and local regulations.

2.1 RECEIVING THE BATTERY

The cells are not to be stored in the packaging; therefore, unpack the battery immediately upon receipt. The shipping container will be labeled indicating the top of the shipping container. Do not overturn the package to avoid damage to the cells or leaking of electrolyte.

2.2 Shipment Contents

The battery system will generally include battery system cells and an accessory pack. **Figure 2-1** (on the following page) shows a typical battery system cell. The cells will be delivered filled with electrolyte and in a discharged state. The cells are shipped with a vented white shipping cap equipped with a flame arrestor. The cells are ready for installation, conditioning and then application.

The accessory pack will generally include connector bars, tools and the watering system components. A sample accessory pack list is included as **Attachment 1**.

2.3 Shipment Inspection

Visual inspection of the shipment contents should be completed immediately upon receipt. An inventory of the cells and accessory package contents should be completed upon receipt. The customer should take note of any visual indications of electrolyte spill or leakage. Any evidence of spilling or leaking during shipment should be reported to the purchasing agent.

Note: The level of electrolyte in each cell may be different depending on storage time, temperature or other environmental factors. Varying electrolyte levels are not necessarily indications of leaks or spills. A leak or spill in electrolyte will appear either as a yellowish liquid or as dried electrolyte with crystal deposits.

Important:

- Do not use any cells that show signs of electrolyte leakage.
- Do not use any cell if the center watering cap is missing.
- Do not use any cells that show deposits of material on the terminals.

Warning:

Under no circumstances should the electrolyte level in the cells be topped up until ***after*** the cells have completed the first conditioning charge cycle. Topping up (adding deionized water or electrolyte) in the discharged state may cause an overspill during the first charge. Watering should occur during the rest after charge of the first conditioning cycle (see Section 5.0). Detailed watering instructions are included in Section 6.2 and in Attachment 3.

Figure 2-1: MG1 Cell Showing Minimum and Maximum Fill Lines

3.1 SYSTEM SITE PREPARATION

This section includes general discussions of site location, ventilation, and system layout.

3.2 Location

Install the battery in a dry, clean and secure room. Avoid direct sunlight and heat. The battery will give optimal performance and maximum service life if the ambient temperature lies between 10°C and 30°C. Encell recommends installing an atmospheric monitoring system to monitor site conditions. It is recommended the monitoring system be equipped with alarms for temperatures outside of optimal temperature ranges.

The site floor should be level and rated to uphold the weight of the battery system. With larger systems, adequate spacing between rows should be provided to allow access for routine maintenance.

3.3 Ventilation

During the latter part of charging, battery gases (a mixture of oxygen and hydrogen) are emitted. At normal application charging rates, the gas evolution is very small, but some ventilation is necessary. During overcharge, gassing evolution increases. Site ventilation should be equipped to prevent trapped hydrogen gas pockets from exceeding a 1% concentration as per US Regulation 70E of the National Fire Protection Agency (NFPA). Encell recommends installing an atmospheric monitoring system equipped with an alarm for hydrogen concentrations above these thresholds.

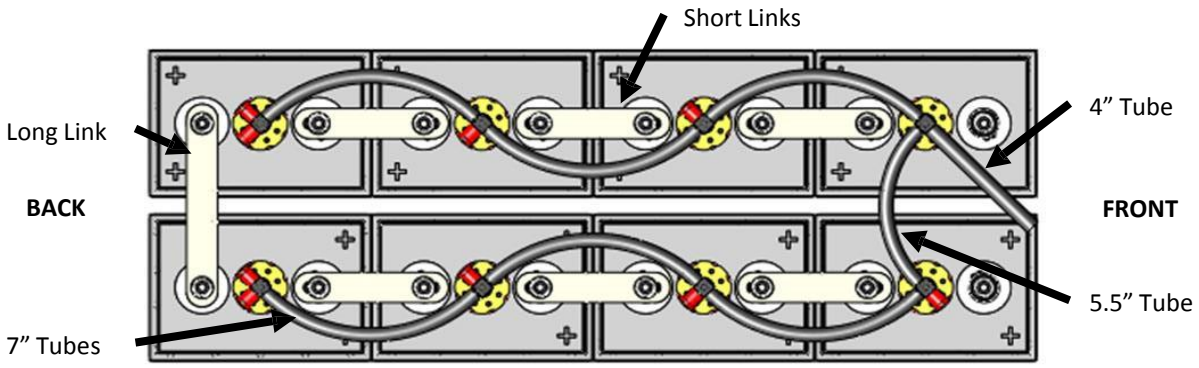
The customer is responsible for meeting applicable local, state and federal regulations.

3.4 Cell Layout, Spacing and Constraints

The cell layout will be site specific according to each customer application or system size. However, in general, the cells should be configured in the following manner for longevity and peak performance:

- The MG300 cells should be placed in rows with the small sides of the cell abutted against one another. The cells should be abutted end to end and secured against one another to avoid overturn. Spacing between rows of the cells should be a minimum of 0.5 inches. (See **Figure 3-1** for a layout example.)
- Please ensure adequate spacing between modules, rows, and/or shelves is provided for long term cell maintenance; e.g., watering and voltage monitoring.
- For peak long term performance, cell constraints are recommended but not mandatory. Constraint of the cells will extend cycle life of the battery system. If the racking system does not provide constraints, a simple solid fixture (4 inches wide by 8.5 inches tall) installed at the end of each row can be held in place with ratchet straps. A fixture that is heat conductive (such as a steel plate) is recommended.

Figure 3-1: Cell Layout Example



4.1 SYSTEM INSTALLATION

This section will provide general information on building the battery system. The general order of activities is listed as follows.

- Design the battery layout according to system application.
- After carefully removing the cells from the shipping container, assemble the cells according to the system layout. Confirm cell polarity is in appropriate orientation.
- Cells should be configured so that they are abutted end to end (narrow sides together).
- Apply contact NO-OX-ID grease to terminal threads and top contact surface. Connect the individual cells using the short connector links, flat washer, split lock washer, and M8 screw.
    - *If the system includes more than one string, string-to-string connections with the long links will be made at the end of set up.*
    - *Applicable company, local, state and federal safety regulations must be followed.*
- Install the short link covers.
- Remove the white shipping caps. Install the watering valves in each cell. Use the red water valve wrench to tighten each valve in place.
- Attaching tubing provided in the accessory pack. If you do not have precut tubing, use tubing cutters to cut tubing to length for fitting between the cells. If you have precut tubing, fit the cell to cell connection tubing into the ports on the vent valves between the cells. Plug all remaining ports with the red caps.
- Attach the filling port to the end cell for deionized water filling.
- If the system will include voltage monitoring (recommended), install the voltage monitoring leads and set up voltage monitoring system.
- Make final row to row connections using long link connectors and link covers.
- Torque all of the connections to 160 to 200 in-lbs.
- Install the watering system manifold to the individual modules (if applicable).
- Confirm that connector bars and all connection wires meet the rating for the maximum current to be employed in the system application.
- Connect battery system to the power supply.

Important:

- Under no circumstances should the cells be topped up before the cells are in over-charge (gassing at the end of charge) during the first conditioning cycle (Section 5.0). Topping up (adding) deionized water or electrolyte in this discharged state may cause an overspill during the first charge. See watering instructions in Section 6.0 for more detailed information.

Each site application will be different. Always comply with the site- or project-specific assembly drawings, circuit diagrams and other separate instructions.

5.1 CONDITIONING

After completing system set up, the cells should undergo a series of conditioning cycles prior to beginning application. Conditioning is necessary because of the manner in which the cells were prepared specially for shipment. Conditioning reinitiates the cells for optimum performance.

Conditioning regimes are customer-, site-, and application-specific. Please contact your Encell purchasing agent or on-site Encell representative to develop the appropriate conditioning regime for your system.

A typical recommended conditioning regime for Encell NiFe batteries is as follows:

Where "C" is the capacity in Ampere-hours (Ah) of the system,

- Charge at C/2 for 3 hours
- Rest 2 hours
- Discharge at C/10 to 1.1V average per cell
- Rest 2 hours
- Repeat for a total of 3-5 cycles.

For example, if you have a 40 cell, 300Ah system

- *Charge at 150A (300/2) for 3 hours*
- *Rest 2 hours*
- *Discharge at 30A (300/10) down to a battery voltage of 44V (1.1V * 40).*
- *Rest 2 hours*

If the system components cannot complete the charge/discharge rates as recommended above, please contact the purchasing agent for alternative conditioning regimes per the customer system capabilities.

6.1 SYSTEM MAINTENANCE

This section discusses system maintenance activities including general maintenance and cell watering.

6.2 General Maintenance

General maintenance of the system should be performed in a discharged state. Cells in a charged state have the potential for igniting resident hydrogen gases if a spark occurs.

- Always keep the battery, its container and installation equipment clean and dry.
- Check the nuts on the battery terminals at least every six months to ensure they are seated firmly.
- Clean watering valves annually. Replace defective watering valves.
- At regular intervals, smear all bright metal parts on the cells, such as battery terminals and cell connectors, with diluted, acid-free petroleum jelly. This does not include the cell cases. Take care that the diluted petroleum jelly is not applied to plastic parts of the battery. Do not use solvent based cleaning agents.
- Do not use or store NiFe batteries in the same room as lead acid batteries. Take suitable precautions, such as ventilation or hermetic isolation of the rooms, to keep the charging gases from lead acid batteries away from NiFe batteries.
- Do not use tools for lead acid batteries with NiFe batteries.

6.3 Cell Watering

Cell maintenance will be required during system operation. Cells should be filled with ***deionized water*** only. Any other water (tap water, spring water, etc.) will damage the cell.

During cycles with overcharge, water loss will increase, and watering may be needed every cycle (for example, during conditioning and equalization). Cell watering maintenance requirements during application will be dependent on site-specific application regimes. Detailed watering instructions are included as **Attachment 3**.

7.0 SYSTEM MONITORING

Voltage monitoring of the battery system is recommended to evaluate and track cell performance in long term battery system applications. Individual cell monitoring is best. If individual monitoring is not an option, reduced monitoring of cells in groups of up to 20 cells is acceptable.

A monitoring system with remote access is highly recommended. This type of system would allow the manufacturer access to data to assist with system evaluation.

8.1 RECOMMENDED APPLICATIONS

System applications will be site- and application-specific. As examples, two standard application regimes for Encell NiFe batteries are included here.

8.2 Standard 80% Input Application Regime

Where “C” is the capacity in Ampere-hours (Ah) of the system,

- Charge at C/4 for 3.4 hours
- Rest 4 hours
- Discharge at C/4 to 1.1V average per cell
- Rest 4 hours
- Repeat
- Equalization cycle to be performed once per quarter (see Section 9.0)

For example, if you have a 40 cell, 300Ah system

- *Charge at 75A (300/4) for 3.4 hours*
- *Rest 4 hours*
- *Discharge at 75A (300/4) down to a battery voltage of 44V (1.1V * 40).*
- *Rest 4 hours*

8.3 Standard 50% Input Application Regime

This application may be used during certain times of the year when the charging rates may be limited.

Where “C” is the capacity in Ampere-hours (Ah) of the system,

- Charge at C/4 to 15% SOC (100 minutes is fully discharge)
- Charge at C/4 for 2 hours
- Rest 4 hours
- Discharge at C/4 for 2 hours or 1.1V average epv (whichever is sooner)
- Rest 4 hours
- Repeat
- Equalization cycle to be performed monthly (see Section 9.0)

These are just two application regimes that may be employed. Please discuss your site specific needs with your Encell purchasing agent to develop the site application regime applicable to your site.

9.1 SYSTEM EQUALIZATION

During application, the cells should periodically undergo a series of equalization cycles. Equalization is necessary for optimum long term performance. The optimal equalization regime recommended is as follows:

Where “C” is the capacity in Ampere-hours (Ah) of the system,

- Charge at C/2 for 3 hours
- Rest 2 hours
- Discharge at C/10 to 1.1V average per cell
- Rest 2 hours
- Complete 3 to 5 cycles.

If the system components cannot complete the charge/discharge rates as recommended above, please contact the purchasing agent for alternative equalization regime per the customer system capabilities.

10.1 STORAGE

Rooms where batteries are stored must be clean, dry, cool and well ventilated. The ambient temperature should be 50°F (10°C) to 86°F (30°C). Do not store cells in the packaging or expose to direct sunlight or UV-radiation.

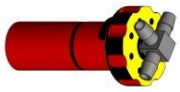
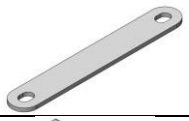
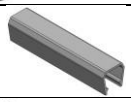
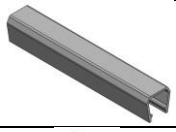
10.2 Filled Charged/Discharged Cells

- Filled cells can be stored no longer than 12 months from the time of delivery.
- Filled cells stored at temperatures above 86ºF (30°C) will lose capacity.
- If electrolyte has been lost during transport, refill the cell to the “MIN” mark with electrolyte before attempting to store it.

10.3 Empty Discharged Cells

To store cells and batteries for long periods of time without damage, make sure they are deeply discharged, drained, well-sealed, and kept in appropriate storage facilities. For long term storage of empty cells, please contact your purchasing agent for more detailed instructions.

ATTACHMENT 1: Sample MG1, 360 Cell Accessory Pack List

Part Drawing (not to scale)	Part Number	Part Description	Quantity	Purpose
	150001	Valve, Watering, 2.5"lg, 1.8"Shut ht, Flame Arrestor, Red	360	Cell watering
	152001	Cap, Manifold, Red, EPDM	95	Seal open Tee ports on Watering Valve (5-Extra)
	153003	Tubing, .25"ID, .44"OD, EDPM, Black (102mm/4.0")	45	Cell to cell watering connection
	153012	Tubing, .25"ID, .44"OD, EDPM, Black (140mm/5.5")	45	Cell to cell watering connection
	153013	Tubing, .25"ID, .44"OD, EDPM, Black (178mm/7.0")	270	Cell to cell watering connection
	180002	Manifold, Watering, 40 MG1 Cells	9	Quick connection and manifold for watering battery to battery
	151002	Water Valve Wrench	1	Installing or removing Watering Valve
	140008	Link, Connection, .875"x 4.32"x .13"thk, M8 hole, Ni-Plated Cu	270	Cell to cell connection (short)
	140009	Link, Connection, .875"x 5.88"x .13"thk, M8 hole, Ni-Plated Cu	63	Battery to battery connection (long)
	141002	Link, Cover, .75"x 4.6"x .075"thk, PP, Black	270	Covers cell to cell connection (short)
	141003	Link, Cover, .75"x 6.2"x .075"thk, PP, Black	63	Covers cell to cell connection (long)
	141005	Link, Cover, Cable .75"x 2.0"x .075"thk, PP, Black	55	Covers cable connection (1-Extra)
	100027	Washer, Flat, M8, 8.4mm ID, 16mm OD, 1.4mm - 1.8 mm thk, 304 SS	725	Terminal connections (5-Extra)
	100031	Washer, Split Lock, M8, 304 SS, DIN 127	725	Terminal connections (5-Extra)
	100026	Screw, Socket Head Cap, M8 x 1.25 x 16, 304 SS	725	Terminal connections (5-Extra) **Recommended Torque: 160-200 in-lbs** (6mm Hex Wrench)
	520003	Grease, Dielectric, NO-OX-ID "A Special", # 10210 - 8 oz tin with brush	1	Apply thin coating to cell and battery terminal connections for corrosion protection.

ATTACHMENT 2: Site-Specific Assembly Instructions

When applicable, site-specific assembly and installation instructions will be included in this section.

Each site application will be different. Always comply with the site- or project-specific assembly drawings, circuit diagrams and other separate instructions.

ATTACHMENT 3: Battery Watering Instructions

WARNING

WEAR EYE PROTECTION AND PROTECTIVE CLOTHING WHEN WORKING WITH BATTERIES.

ELECTROLYTE IS HIGHLY CORROSIVE. IF ELECTROLYTE SPLASHES INTO THE EYES OR ONTO THE SKIN, RINSE WITH PLENTY OF CLEAR WATER AND SEEK IMMEDIATE MEDICAL ADVICE.

FOLLOW THE SAFETY DATA SHEET (SDS) FOR ADDITIONAL INFORMATION INCLUDING HAZARDS IDENTIFICATIONS, ELECTROLYTE FIRST AID MEASURES AND PRECAUTIONS FOR SAFE HANDLING AND USE.

The following provides the recommended watering instructions for the cells. Cells should be filled with **ONLY** deionized (DI) water using the instructions below for best performance. Using other liquids will cause permanent damage to the cells. **FAILURE TO FOLLOW THIS PROCEDURE WILL VOID THE MANUFACTURER'S WARRANTY.**

GENERAL INFORMATION

During shipment and storage, the electrolyte level within each cell may become variable. Upon receipt, the electrolyte level may appear to be below the minimum fill line (see Figure A3-1). Do NOT add deionized water to the cells in this discharged state, as this will cause the electrolyte overflow during the first charge cycle.

Following system installation, the first cycle should be an initial charge and discharge of the battery system to condition the system. During the first cycle, the cells should be filled will deionized water during the rest immediately following the first charge cycle using the automatic watering system and following the directions below.

Electrolyte levels of the cells should be monitored periodically. There are two fill lines identified on the labels on each cell showing minimum and maximum fill levels (Figure A3-1).

- The minimum fill line indicates the electrolyte level, at the end of discharge cycle, which would trigger a watering after the subsequent charge cycle.
- The maximum fill line indicates where the automatic stop valve will stop the flow of DI water when using the automatic watering system. Note: Only use automatic watering system after a charge cycle.

Frequency of filling cells will be dependent on the charge current and amount of charge input of the battery application. Increased current and charge input will increase the frequency of filling cells. During conditioning/maintenance cycling, electrolyte levels will require more frequent monitoring/filling.

Figure A3-1: Cell Showing Minimum and Maximum Fill Lines

Maximum Fill Line

Electrolyte Level

Minimum Fill Line

DETAILED CELL WATERING INSTRUCTIONS

1. Electrolyte levels of all cells should be monitored for the need for filling at the end of a discharge cycle on a periodic basis.
2. If the electrolyte level at the end of a discharge cycle is below the minimum fill line on any cell in the battery system, the cells require watering. DO NOT WATER USING AUTOMATIC WATERING SYSTEM DURING DISCHARGE OR IN REST AFTER A DISCHARGE CYCLE.
3. IMPORTANT: Watering of the cells using the watering system with automatic stop valves should **ONLY** occur at the end of a charge cycle or during the rest immediately following a charge cycle. In high voltage systems, the rest after charge cycle is recommended. The end of a charge cycle represents the highest level the electrolyte will rise during a cycle. Thus, watering during this time using the automatic stop valve will protect against overflow of electrolyte during charge. Filling cells during any other time using the automatic stop valves may cause electrolyte overflow during charge.

4. The watering valves are equipped with an automatic stop valve which will stop the flow of DI water when the cells have reached the maximum fill line.
5. The water pump is equipped with a visual indicator for water flow. The indicator has three red balls that will move during flow and will stop when flow is ceased.

6. If visual monitoring during a discharge cycle triggers a watering event due to electrolyte levels being below the minimum fill line, use the automatic watering system during the rest after the subsequent charge cycle to fill all the cells in the system with DI water.
    a. Connect the water pump to a source of DI water.
    b. Connect the water pump to the ¼" Barb Male Coupler with Dust Protector that connects to the watering manifold system.
    c. Pump DI water through the system until the cells are full.
    d. Stop the flow of DI water when the visual indicators have stopped movement. Continuing flow will add unnecessary pressure to the system.

GENERAL MAINTENANCE

- If electrolyte rises and leaks from the valve(s) during charge and not during a watering event, the cell(s) have been overfilled during a previous cycle.
- If the electrolyte level rises above the maximum fill line during watering and electrolyte exits through the valve vents, the watering valve requires maintenance. Use the valve wrench to remove the valve. Rinse the valve with DI water and test for restored functionality of the automatic stop valve. If functionality cannot be confirmed, replace the valve.
- If DI water leaks from the top of the valve from the port of the tube fitting tee while filling cells, the O-ring on the tube fitting tee (Part Number 154002) needs replacing.
- If a cell is not receiving water during a watering event, the valve may be closed shut and requires replacing. Use the valve wrench to remove the valve and replace the valve with a new valve.