Owner’s Manual

Iron Edison
Lithium Iron Phosphate Battery

(Revised 10/15/2018)
Congratulations on the purchase of your new Iron Edison Lithium Iron Battery
This guide, created by Iron Edison, contains vital information regarding proper care and maintenance of your new battery.

Please read through this Owner's Manual carefully and completely before using your battery. Doing so will help you achieve optimum performance and long life from your new investment.

For additional questions, feel free to contact Iron Edison at 720-432-6433.

**WARNING**

THIS BATTERY IS TO BE INSTALLED AND SERVICED ONLY BY QUALIFIED PERSONNEL EQUIPPED WITH APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND FOLLOWING SAFE ELECTRICAL WORK PRACTICES.

ALWAYS WEAR EYE PROTECTION, GLOVES, APRON AND MASK WHEN WORKING WITH BATTERIES, AND REMOVE ANY METAL / CONDUCTIVE JEWELRY.

REFER TO THE MATERIALS SAFETY DATA SHEET (MSDS) FOR ADDITIONAL INFORMATION INCLUDING: HAZARDS IDENTIFICATIONS, ELECTROLYTE FIRST AID MEASURES AND PRECAUTIONS FOR SAFE HANDLING AND USE.
Precautions When Working With Batteries:

1. Consider your access to emergency medical attention, and work safely.

2. Use caution to eliminate the risk of dropping a metal tool on the battery. It could spark or short circuit the battery or other electrical parts and could cause an explosion.

3. Insulated tools are strongly recommended anytime you are working around batteries.

4. Never smoke or allow a spark or flame near the batteries.

5. Remove all metal items, such as necklaces, rings, bracelets, and watches when working with batteries. Batteries can produce a short circuit current high enough to weld metal to skin, causing a severe burn.

6. Ensure that someone is within range of your voice or close enough to come to your aid when you are working near a battery.

7. Wear complete eye / face protection and gloves. Avoid touching your eyes while working near batteries.

8. If you need to disconnect the battery, always remove the negative terminal from the battery first. Make sure all accessories are turned off so you don’t cause a spark.

9. Never use or combine this battery with another battery.

10. Batteries are temperature sensitive. For optimum performance, they should be installed in a stable temperature environment.

11. Always recycle old batteries. Contact your local recycling center for proper disposal information.
Receiving Your Battery Shipment

Your battery will be shipped via freight carrier and will be delivered via semi-truck or large box truck. A call-ahead appointment and lift gate service are typical for most battery shipments. When the battery has shipped, you will receive an email from Iron Edison with the tracking information. If there is any reason a semi-truck will have a problem delivering to your location, Iron Edison can get you in touch with the freight carrier to make any special accommodations needed for your delivery.

Inspection upon Receipt

It is very important that you carefully inspect your entire battery shipment for loss or damage before signing the delivery receipt from the trucking company. By signing the delivery receipt without noting any damage or missing items, you are accepting complete responsibility for the shipment in its current condition.

Inspect the Tip ‘N Tell on every crate, as this is another indication that the crate may have been tipped over or mishandled during shipping.

Should you see any damage to the battery shipment, notice that anything is missing, or if the Tip ‘N Tell indicates the crate has been tipped or mishandled: make note of the issue on the delivery receipt (i.e. “damaged items”, “missing items”, etc.), sign the receipt, and give it to the truck driver. Then, contact Iron Edison to notify us of the damage or missing item(s).

If for some reason you are unable to thoroughly inspect your battery shipment, you may write "Concealed Damage" on the delivery receipt before signing it. Writing “Possible Concealed Damage” on the delivery receipt will greatly improve the chances of receiving reimbursement should you find something is damaged. You must inspect your shipment within 3 days of receipt. Alert Iron Edison immediately if you find damaged or missing items.
Prepare the Area

- The Iron Edison Lithium Iron Battery must be installed indoors on a dry, level surface capable of supporting the battery’s weight, and the installation must comply with all local building and electrical codes.
- The Iron Edison Lithium Iron Battery System must be installed in a location that will not be exposed to temperatures below 0°C/32°F or above 54°C/130°F.
- The Iron Edison Lithium Iron Battery should not be exposed to moisture, water, etc.
- Do not place the battery near flammable material or a heat source.
- Do not lean objects on the battery or place objects on top of the battery.
- Leave 6” of space between the battery and any other object.
- Refer to local building codes regarding any additional space requirements.

IMPORTANT: Failure to follow these requirements can damage the battery. Iron Edison’s Warranty DOES NOT cover damage due to improper installation. Please see warranty details at the end of this manual.

Unpack the Crate

Iron Edison Batteries are charged when shipped and present a shock hazard during installation. Take special care to NOT short the battery posts to each other or to any other metal!

You should be wearing complete eye / face protection and gloves as you work with the battery. Remove any jewelry such as wedding rings, watches, necklaces or any other metal before working with your battery!

Keep the workspace clear of animals and children.
Connecting the Battery

1. Before performing any work on the Iron Edison Lithium Iron Battery, ensure that the battery, inverter, charge controllers and all breakers on the power panel are turned to the “OFF” position.

![Image of an off/on switch](image)

2. Wear electrically insulated gloves, protective eyewear, and use electrically insulated tools while working on the battery.

3. For batteries shipped through 2017, access the INVERTER connections by removing the bolts that attach the lid to the battery enclosure, and safely remove the metal lid (help from a friend may be required).

   Batteries shipped AFTER 2017 have the INVERTER connections on the outside of the battery enclosure; therefore removing the battery’s lid is not required or recommended.

4. If your Iron Edison Lithium Iron Battery consists of multiple battery enclosures, make the enclosure to enclosure connections first. There will be 4/0 battery cables AND communication cables connecting each enclosure.

5. Using a voltmeter, check that there is no voltage on the “INVERTER POSITIVE (+)” and “INVERTER NEGATIVE (-)” terminals by placing the positive voltmeter probe on the “INVERTER POS” terminal and the negative voltmeter probe on “INVERTER NEG” terminal. There should be no voltage present while the battery switch is in the “OFF” position.

![Image of a voltmeter](image)

   (Typical interior of an Iron Edison Lithium Iron Battery shipped through 2017.)

6. Land the battery cables on your inverter(s) / charger(s) / power distribution panel FIRST. Once these cables are securely connected, it is safe to connect them to the battery’s INVERTER terminals.
7. Land the positive inverter cable on the terminal labeled “INVERTER POSITIVE”.

8. Land the negative inverter cable on the terminal labeled “INVERTER NEGATIVE”.

9. **ENSURE CORRECT POLARITY OF POSITIVE AND NEGATIVE INVERTER CABLES.** Reversed polarity can cause instant, catastrophic and permanent damage to the battery and/or your balance of system when turned ON.
10. After confirming polarity, turn the battery switch to the “ON” position. The BMS will conduct a self-check. Assuming no issues are detected, the BMS will then turn the battery ON. You will hear a click as the on-board contactor closes.

![Battery Switch](image)

11. Using a voltmeter, verify that there is voltage at the INVERTER terminals with the battery in the “ON” position.

![Volts at Terminals](image)

(typical interior of an Iron Edison Lithium Iron Battery shipped though 2017)

12. Replace and secure the battery’s lid after turning the battery OFF (if applicable).

13. Continue commissioning your balance of system.
Charging the Battery

The bulk, absorb and float voltages for the Iron Edison Lithium Iron battery are noted below. Please see the Voltage Calibration section on the next page before programming your charger(s).

### Iron Edison Lithium Iron Battery – Recommended Charge Voltages

<table>
<thead>
<tr>
<th>Volts / cell</th>
<th>16 Cell 48 Volt*</th>
<th>15 Cell 48 Volt*</th>
<th>24 Volt</th>
<th>12 Volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk/Absorb Voltage</td>
<td>3.45 Volts</td>
<td>55.2 Volts</td>
<td>51.8 Volts</td>
<td>27.6 Volts</td>
</tr>
<tr>
<td>Absorb Time (PV)</td>
<td>&lt; 0.1 Hours</td>
<td>&lt; 0.1 Hours</td>
<td>&lt; 0.1 Hours</td>
<td>&lt; 0.1 Hours</td>
</tr>
<tr>
<td>Float Voltage</td>
<td>3.36 Volts</td>
<td>53.8 Volts</td>
<td>50.4 Volts</td>
<td>26.9 Volts</td>
</tr>
<tr>
<td>Float Time (PV)</td>
<td>Optional - All viable PV or renewable resource / &lt; 8 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Float Time (Gen)</td>
<td>Not recommended due to generator fuel costs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equalize Voltage</td>
<td>DO NOT EQUALIZE CHARGE an Iron Edison Lithium Iron Battery! Permanent damage and dangerous catastrophic failure could occur.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 400Ah & 800Ah batteries produced in 2018 or later have 15 cells, all others use 16 cells. Be sure to use the appropriate charge parameters for your battery.

### Charge Rate

- **Minimum recommended charge rate** = C/20 (battery’s Ah capacity / 20). The battery can be charged below the C/20 rate without damage, but for best performance this is not recommended.
- **Maximum charge / discharge rate** = (see chart below). Max charge / discharge rate is based on the battery’s internal fuse. Should this rate be exceeded and the fuse blown, contact Iron Edison to purchase a replacement fuse.
- For custom size and high capacity batteries, call Iron Edison Technical Support for charging requirements & parameters.

### Iron Edison Lithium Iron Battery – Charge & Discharge Rates

<table>
<thead>
<tr>
<th>Battery’s Capacity</th>
<th>Min. Recommended Charge Rate</th>
<th>Max. Charge / Discharge Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 Ah</td>
<td>9 amps</td>
<td>90 amps</td>
</tr>
<tr>
<td>360 Ah</td>
<td>18 amps</td>
<td>180 amps</td>
</tr>
<tr>
<td>400 Ah</td>
<td>20 amps</td>
<td>200 amps</td>
</tr>
<tr>
<td>540 Ah</td>
<td>27 amps</td>
<td>270 amps</td>
</tr>
<tr>
<td>700 Ah</td>
<td>35 amps</td>
<td>350 amps</td>
</tr>
<tr>
<td>800 Ah</td>
<td>40 amps</td>
<td>400 amps</td>
</tr>
<tr>
<td>1,400 Ah</td>
<td>70 amps</td>
<td>400 amps</td>
</tr>
<tr>
<td>2,100 Ah</td>
<td>105 amps</td>
<td>600 amps</td>
</tr>
<tr>
<td>2,800 Ah</td>
<td>140 amps</td>
<td>1,000 amps</td>
</tr>
</tbody>
</table>
Charging the Battery (continued)

Exceeding the Maximum Charge / Discharge Rate will cause the battery management system (BMS) to shut down the battery with a FAULT. Should this occur, decrease the charge or discharge rate. Cycling the battery’s ON/OFF switch will clear the FAULT and the battery will continue normal operation.

The battery should not be charged less than the Minimum Charge Rate. Low rate charging does not damage the battery, but best results are obtained from charging at normal rates.

There is no Minimum Discharge Rate for the Iron Edison Lithium Iron Battery.

If necessary, and if full capacity is not required, the battery may be taken off charge at any point in the charge cycle with no long term impact on the battery.

Voltage Calibration

It is common for chargers to not accurately measure the battery’s voltage, and to see voltage drop in battery cables between the battery and balance of system. With most other battery chemistries a discrepancy of a couple tenths of a volt is not an issue; however this can be an issue with your Lithium Iron battery. Voltage discrepancies between the battery and charger(s) can result in the battery not being properly charged, or potentially overcharged resulting in a FAULT.

For batteries shipped through 2017, Iron Edison recommends measuring the battery’s voltage at the battery’s terminals using a high quality voltmeter, and comparing this measurement with your charger’s battery voltage measurement. Using a high quality voltmeter with fresh batteries is critical for this process.

For batteries shipped after 2017, using the battery’s voltmeter is adequate.

Any discrepancy found between the battery’s true voltage and your charger’s voltage measurement needs to be factored into your charger’s programming. Some chargers have a voltage calibration feature to address this issue; otherwise you will need to adjust the charge voltage set points from the previous page to compensate for any discrepancy found.

This calibration should be done during initial commissioning while the battery is at rest, and again while charging at your system’s highest charge rate to fine-tune the calibration.

Example: If your charger measures the battery voltage 0.5 VDC higher than the battery’s true voltage, the battery will never reach its required bulk / absorb voltage. Therefore the bulk / absorb voltage setting on your charger should be increased 0.5 VDC to compensate for this discrepancy, so the battery will reach the required bulk / absorb voltage. If the charger measures the battery voltage 0.5 VDC lower than the battery’s true voltage, the battery could be overcharged causing the battery to shutdown with a FAULT. Decreasing your charger’s bulk / absorb setting by 0.5 VDC in this case will prevent this.

Initial Use

It is recommended to fully charge your battery before its initial use. Iron Edison Lithium Iron batteries are typically shipped at a 50% (+/-) state of charge. After sitting at rest between manufacturing and
commissioning, the battery’s State of Charge meter (batteries shipped through 2017) will have drifted and need to be calibrated. Each time the battery is fully charged, this SoC meter will auto calibrate to 100%.

**Battery Controls (Batteries shipped through 2017)**

On the front of the Iron Edison Lithium Iron Battery you will find an ON/OFF switch, state of charge meter and a green LED:

**ON/OFF Switch** – Master switch for the battery and battery management system. Turning the switch ON activates the BMS, and assuming there are no fault conditions will turn the battery on. Turning the switch OFF shuts down both the battery and BMS.

**State of Charge Meter** – Indicates the battery’s estimated state of charge by measuring current flow in and out of the battery. (NOTE: This method of measuring SoC will drift over time, therefore the BMS will auto calibrate the SoC meter each time the battery is charged to 100% SoC based on voltage. It is recommended to fully charge your battery on a regular basis to ensure the most accurate SoC measurements.)

  - **FAULT** – Indicates that an issue is present that has caused the BMS to initiate a self-protect shutdown. Specific FAULT conditions are covered on page 12
  - **WARNING** – Indicates that a measurement is nearing the operational threshold, but is still within its operational limits. Specific WARNING conditions are covered on page 12.
  - **LOAD POWER** – This indicator is not utilized.
  - **CONTACTOR** – This indicator is not utilized.
  - **SOURCE PWR** – Indicates the BMS is on.

**Green LED** – Indicates there is voltage present on the battery’s INVERTER connections. This voltage source can be the battery OR the inverter / charger connected to the battery. Most inverters and charge controllers have capacitors that slowly discharge after the device is turned off. Therefore this LED may take several minutes to turn off after turning the battery OFF. (NOTE: You should assume any other conductors or connections inside the battery’s enclosure are energized at all times!)
**Battery Controls (Batteries shipped after 2017)**

On the front of the Iron Edison Lithium Iron Battery, you will find an ON/OFF switch, battery voltmeter and several indicator LEDs:

**ON/OFF Switch** – Master switch for the battery and battery management system. Turning the switch ON activates the BMS, and assuming there are no fault conditions will turn the battery on. Turning the switch OFF shuts down both the battery and BMS.

**Battery Voltmeter** – Indicates the battery’s voltage, which is used to estimate the battery’s state of charge when the battery is at rest. **NOTE:** The battery’s voltage will be artificially high when charging, and can be artificially low when under load. When the battery’s state of charge drops to a critical level, the Battery Voltmeter will turn red and start flashing.

**ENERGIZED LED** – Indicates there is voltage present on the battery’s INVERTER connections. This voltage source can be the battery OR the inverter / charger connected to the battery. Most inverters and charge controllers have capacitors that slowly discharge after the device is turned off. Therefore this LED may take several minutes to turn off after turning the battery OFF. **(NOTE: You should assume all other conductors or connections inside the battery’s enclosure are energized at all times!)*

**HIGH LED** – Indicates that the battery has initiated a self-protect shutdown due to a high cell voltage fault. This is typically caused by the battery being overcharged, and will clear itself once the battery management system has corrected the high cell voltage issue. Reduce the charge voltage and/or the charge current to prevent future occurrences.

**LOW LED** – Indicates that the battery has initiated a self-protect shutdown due to a low cell voltage fault. This is typically caused by the battery being over discharged, and should clear itself once the battery voltage has naturally recovered from a high load. Contact Iron Edison Technical Support for assistance if the issue doesn’t clear itself in a reasonable period of time.

**FAULT LED** – Indicates that an issue is present that has caused the BMS to initiate a self-protect shutdown, and requires human intervention to clear the fault. See pg. 13 for specific FAULT conditions.
**Battery Controls (Batteries shipped after 2017 - continued)**

**USB Port or Ethernet Port** – Newer Lithium Iron batteries will have a USB port or Ethernet port on the side of the battery enclosure. This port is used for diagnostic & troubleshooting purposes ONLY, and should only be utilized under the direction of Iron Edison Technical Support.

**Circuit Breaker(s)** – These provide overcurrent protection for the battery management system’s low voltage power supply. These circuit breakers DO NOT provide overcurrent protection for the battery. The BMS and a high amperage internal fuse provides overcurrent protection for the battery.

**Emergency Bypass** – In the event that the battery reaches a state of extreme discharge causing the battery’s BMS to enter an unrecoverable Low Voltage Fault, the Emergency Bypass will bypass the BMS for 20 minutes, allowing the battery to turn ON & start a charge cycle. This feature should ONLY be used in the situation of an extreme discharge, and when a charging source is available to IMMEDIATELY start charging the battery.

DO NOT use the Emergency Bypass to extend battery use beyond the battery’s Low Voltage Fault. This will discharge the battery beyond its critically discharged level and significantly shorten the battery’s life expectancy.
Battery Management System

The Iron Edison Lithium Iron Battery includes an onboard digital battery management system (BMS). The BMS monitors the battery’s cell voltage, current, resistance, and temperature. If any of these measurements deviate outside of their safe operating ranges, the BMS will actively work to correct the deviation. If the deviation cannot be corrected automatically, the BMS will initiate a self-protect shutdown by opening an onboard contactor, disconnecting the battery from the charger and loads.

**WARNING LED** – Indicates that one of the BMS’ sensors has detected a measurement nearing a critical level, but isn’t severe enough to initiate the self-protect shutdown. The warning LED will clear itself if the BMS’ active correction system can do so.

**FAULT LED** – Indicates that an issue has been detected that could potentially damage the battery, and the BMS has initiated a self-protect shutdown by opening the on board contactor. The issue that caused the FAULT will need to be resolved before the battery can reset. Cycling the ON/OFF switch on the front of the battery will manually reset the battery.

Common causes of a WARNING or FAULT include:

**High Voltage Limit** – The battery has likely been overcharged causing one or more cells’ voltage to reach a high voltage limit and initiate a high voltage limit / self-protect shutdown. As the cell’s voltage climbs above the recommended charge voltage, the WARNING light will indicate a potential issue. If the cell’s voltage continues to climb past the safety threshold, a High Voltage Limit will occur. The battery will disconnect and use its cell balancing capability to discharge the overcharged cell(s) to within safe operating parameters. Once all the cells’ voltages have discharged to the safe operating range, the battery will automatically reconnect and resume normal operation. The charging source should be adjusted to prevent future overcharging situations; otherwise no human intervention is required to clear this High Voltage Limit.

**Low Voltage Limit** – The battery has been over discharged causing the battery’s voltage to reach a low voltage limit and initiate a low voltage limit / self-protect shutdown. As the battery’s voltage drops below the recommended max discharge level, the WARNING light will indicate a potential issue. If the battery’s voltage continues to drop a FAULT will occur, causing the battery to disconnect. After a period of rest, the battery’s voltage will likely recover enough to continue operating once the FAULT is cleared by cycling the ON/OFF switch. This fault should NOT be cleared until a charging source is available to immediately start charging the battery. If this fault cannot be cleared by cycling the ON/OFF switch, contact Iron Edison Support for recovery options. It is strongly recommended to utilize any low battery cut-off (LBCO) features available on your inverter to initiate a shutdown well before reaching the battery’s Low Voltage Limit.

**High Charge / Discharge Current** – If the battery is charged or discharged at a rate greater than the battery’s Max Charge / Discharge Rate, a FAULT will occur causing the battery to initiate a self-protect shutdown. Appropriate adjustments should be made to the charge or discharge rate, and then clear the FAULT by cycling the battery’s ON/OFF switch to resume normal operation.
**High / Low Temperature** – If the battery’s temperature nears the high or low limit (0°C/32°F to 54°C/130°F), the WARNING light will illuminate to indicate a potential issue. If the temperature issue continues to worsen, the battery will initiate a self-protect shutdown. This WARNING will clear itself and resume normal operation once the temperature has returned to normal operating range.

**Fuse**

The Iron Edison Lithium Iron Battery has a high amperage internal fuse as a final layer of protection against overload or short circuit. In the rare event this fuse is blown, please contact Iron Edison to purchase a replacement.

**Maintenance**

Under normal operation, the Iron Edison Lithium Iron battery requires no maintenance. Periodic dusting or vacuuming of the battery’s exterior is suggested, using only non-conductive cleaning tools.

**Storing the Battery**

If the battery is to be stored for any length of time, make sure the battery is in a dry place. Turn the battery’s ON/OFF switch to OFF to prevent over discharging the battery. If left in the “ON” position, the BMS will completely discharge the battery, significantly diminishing the battery’s life expectancy.

The battery can be stored for extended periods at any state of charge.

The battery can be stored short term (3 month max) at temperatures from -20°C/-4°F to 54°C/130°F. Storing the battery longer than 3 months should be within normal operating temperatures (> 0°C/32°F).

When returned to service, it is recommended to fully charge the battery before use.
## State of Charge Graph

**Iron Edison Lithium Iron Battery**

<table>
<thead>
<tr>
<th>Charging</th>
<th>BULK</th>
<th>48 Volt Battery</th>
<th>24 Volt Battery</th>
<th>12 Volt Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.45</td>
<td>55.2 / 16 Cells</td>
<td>27.6 / 8 Cells</td>
<td>13.8 / 4 Cells</td>
</tr>
<tr>
<td></td>
<td>3.36</td>
<td>53.8 / 15 Cells</td>
<td>26.3</td>
<td>13.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SoC</th>
<th>Resting Voltage</th>
<th>48 Volt Battery</th>
<th>24 Volt Battery</th>
<th>12 Volt Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>3.36</td>
<td>53.8 / 16 Cells</td>
<td>26.9</td>
<td>13.4</td>
</tr>
<tr>
<td>90%</td>
<td>3.25</td>
<td>52.0 / 16 Cells</td>
<td>26.0</td>
<td>13.0</td>
</tr>
<tr>
<td>80%</td>
<td>3.24</td>
<td>51.8 / 16 Cells</td>
<td>25.9</td>
<td>13.0</td>
</tr>
<tr>
<td>70%</td>
<td>3.23</td>
<td>51.7 / 16 Cells</td>
<td>25.8</td>
<td>12.9</td>
</tr>
<tr>
<td>60%</td>
<td>3.22</td>
<td>51.5 / 16 Cells</td>
<td>25.8</td>
<td>12.9</td>
</tr>
<tr>
<td>50%</td>
<td>3.21</td>
<td>51.4 / 16 Cells</td>
<td>25.7</td>
<td>12.8</td>
</tr>
<tr>
<td>40%</td>
<td>3.20</td>
<td>51.2 / 16 Cells</td>
<td>25.6</td>
<td>12.8</td>
</tr>
<tr>
<td>30%</td>
<td>3.19</td>
<td>51.0 / 16 Cells</td>
<td>25.5</td>
<td>12.8</td>
</tr>
<tr>
<td>20%</td>
<td>3.17</td>
<td>50.7 / 16 Cells</td>
<td>25.4</td>
<td>12.7</td>
</tr>
<tr>
<td>10%</td>
<td>3.14</td>
<td>50.2 / 16 Cells</td>
<td>25.1</td>
<td>12.6</td>
</tr>
<tr>
<td>0%</td>
<td>3.10</td>
<td>49.6 / 16 Cells</td>
<td>24.8</td>
<td>12.4</td>
</tr>
</tbody>
</table>

* due to variances in manufacturing, state of charge percentages above may vary.

(Revised 10-10-2018)
Iron Edison Battery Company

Lithium Iron Phosphate Battery

LIMITED WARRANTY

Iron Edison Battery Company warrants only to the original purchaser that any battery product which becomes unserviceable (not merely discharged) due to defect in material and/or workmanship within the free replacement period stated below will be replaced without charge. Any battery product which becomes unserviceable (not merely discharged) due to defect in material and/or workmanship within the pro-rated period stated below will receive a credit or refund as stated below. This warranty starts from the date delivered, applies to the original purchaser of the battery and is non-transferable. Purchaser is responsible for all shipping and testing costs for returned batteries, including any additional duties & taxes. If the battery is deemed to be defective under the terms stated below, replacement product of materials shall be shipped free of charge and testing costs shall be refunded. Iron Edison shall make all reasonable efforts to accomplish testing in a timely and efficient manner.

Lithium Iron Phosphate Batteries cannot be discharged more than 80% of nominal capacity, or below 3.15 volts per cell. Battery shall not be charged or discharged at a rate greater than C/2 (50% of the battery’s amperage rating). Charge controllers, inverters & generators must be configured using Iron Edison provided settings to be compliant with these requirements. This warranty does not include use in electric vehicle drive train, or other motive applications.

The battery owner will read warning labels on the battery and exercise due care in working on or around it. The battery is intended to be used by persons with training or experience with batteries. This warranty replaces all previous warranties, and may be updated in the future.

WARRANTY EXCLUSIONS

Iron Edison’s exclusive liability for breach of any warranty on the battery shall be to repair or replace the battery or repay the pro-rated portion of the actual purchase price paid for the defective product within the warranty period in accordance with the terms of this limited warranty. In no event shall Iron Edison Battery Company or any of its affiliates be liable in contract, tort or otherwise for any loss, claim or damages of any other kind, whether direct, incidental, consequential, exemplary, special, punitive, remote or otherwise, including any lost profits, lost revenue or incentives, loss of equipment, cost of purchased power, cost of substitute product, facilities or services, claims of customers of owner, or removal, shipping, transportation or installation expenses.

The battery must be used in the application for which it was designed, and placed into service within 180 days of delivery. Warranty does not cover abuse or neglect, corroded hardware, improper maintenance, improper installation, cosmetic shortcomings which do not impact use or performance, breakage, force majeure (ie: fire, flood, earthquake, storm damage, overvoltage, lightning strikes, etc.), damage in transportation, exposure to fire, water, snow, moisture or liquid ingress, exposure to excessive heat (above 45C) or extreme cold (below -20C), charging at low temperatures (below 0C), the addition of any chemical or solution, damage from other electrical equipment or if the manufacturing codes have been destroyed or tampered with. Any changes made to the battery’s hardware or software without prior approval shall immediately void this warranty. This warranty excludes any changes in appearance of the product that do not impact its performance, replacement of fuses, and replacement or resetting of circuit breakers.

(Revised 7/26/2017)
WARRANTY PERIOD:

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>Free Replacement (months)</th>
<th>Pro-rated (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium Iron Phosphate</td>
<td>1-24</td>
<td>25-120</td>
</tr>
</tbody>
</table>

HOW TO RECEIVE WARRANTY SERVICE:

To resolve problems covered by this warranty for renewable energy applications, contact Iron Edison Battery Company to confirm the defect. You will need to provide proof of purchase along with the serial number for the battery. Iron Edison Customer Service will diagnose the issue with the customer, including the completion of a specific reconditioning procedure to determine if parts, service or replacement is needed. If deemed necessary by Iron Edison Battery Company, customer must ship the defective product in approved shipping box / container to Iron Edison Battery Company for testing before a warranty replacement / refund will be offered. Customer is responsible for all shipping and testing costs for returned batteries. Replacement materials or product will only be shipped following a complete examination of returned equipment.

At the sole discretion of Iron Edison, if a single cell or a group of cells within the battery qualifies for warranty replacement, only these cells shall be replaced, if possible, and that all serviceable parts and functioning cells will be incorporated in a returned battery.

During the free replacement period, the battery will be repaired or replaced with a similar battery or one of equal value.

During the pro-ration period, the Performance Replacement Refund will be calculated using the formula below:

If the customer requires an Advanced Exchange on the suspected defective product(s), the customer must deposit into escrow funds equal to the replacement and shipping cost of the product(s) being replaced. Replacement product(s) will then be shipped to the customer as soon as possible. The customer will then return the suspected defective product(s) to Iron Edison for testing and evaluation. If the product(s) is deemed defective by Iron Edison and is within the free replacement period, the funds in escrow will be refunded to the customer. If the product(s) is deemed defective by Iron Edison and is within the pro-ration period, the Performance Replacement Refund formula below will be used to calculate the escrow refunded to the customer. If the product(s) is not deemed defective by Iron Edison, Iron Edison will retain the funds in escrow as payment for the advanced exchange product(s) shipped to the customer, and the original product(s) shipped to Iron Edison may be returned to the customer. The customer is responsible for ALL return shipping costs.

Performance Replacement Refund:

Current Discounted Retail Price \times \% \text{Warranty Remaining} \times \left[0.7 \times \left(\frac{\text{Tested Ah Capacity}}{\text{New Ah Capacity}}\right)\right]

The Performance Replacement Refund may be in form of a cash payment, or a credit toward repair / replacement of the battery. If a cash payment is made for the warranty claim, the customer may retain ownership of the defective battery with no further warranty coverage. Customer will be responsible for any return shipment costs. If repairs are made to the battery, the original warranty will continue from the initial purchase date.

In no event will Iron Edison Battery Company’s total liability exceed the sum paid by the owner for the product giving rise to the claim hereunder. Iron Edison Battery Company reserves the right to add or delete batteries from those listed above as they become available or are obsolete.

LIMITATION ON IMPLIED WARRANTIES:

Iron Edison Battery Company makes no express warranties with respect to its batteries other than the limited warranties stated above.

APPLICATION OF STATE LAW:

This Limited Warranty shall be governed by the laws of the State of Colorado without giving effect to any conflict of laws principles that may provide the application of the law of another jurisdiction. Any claim or dispute in connection with this Limited Warranty shall be resolved between both parties in writing if a mutual agreement is made. If the a mutual agreement is not made, any legal action would be filed and governed by jurisdiction of the state courts located within Jefferson County, Colorado and the federal courts in Colorado for the purpose of litigating all such claims or disputes, which courts shall have exclusive jurisdiction of such claims or disputes.
MATERIAL SAFETY DATA SHEET
LITHIUM IRON PHOSPHATE BATTERY

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Lithium Iron Phosphate Battery
MANUFACTURER: Iron Edison Battery Company
ADDRESS: Denver, CO
CHEMTEL / EMERGENCY PHONE: 888-533-7762
Iron Edison Battery Company: 720-432-6433
PRODUCT USE: Stationary Energy Storage
PREPARED BY: Iron Edison Battery Company
MSDS CREATION DATE: July 1st, 2017
REVISION: B

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Weight %</th>
<th>CAS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare Earth Y</td>
<td>40.5%</td>
<td>7440-65-5</td>
</tr>
<tr>
<td>Li2CO3</td>
<td>16%</td>
<td>554-13-2</td>
</tr>
<tr>
<td>Mn</td>
<td>4.4%</td>
<td>7439-96-5</td>
</tr>
<tr>
<td>Ca</td>
<td>0.3%</td>
<td>7440-70-2</td>
</tr>
<tr>
<td>Graphite</td>
<td>5%</td>
<td>7782-42-5</td>
</tr>
<tr>
<td>Na</td>
<td>1.5%</td>
<td>7440-23-5</td>
</tr>
<tr>
<td>C</td>
<td>3.1%</td>
<td>7440-44-0</td>
</tr>
<tr>
<td>Fe</td>
<td>3.4%</td>
<td>7439-89-6</td>
</tr>
<tr>
<td>PE</td>
<td>3.3%</td>
<td>9002-88-4</td>
</tr>
<tr>
<td>Cu</td>
<td>10%</td>
<td>7440-50-8</td>
</tr>
<tr>
<td>Al</td>
<td>6%</td>
<td>7429-90-5</td>
</tr>
<tr>
<td>K</td>
<td>1.7%</td>
<td>7440-09-7</td>
</tr>
<tr>
<td>F</td>
<td>3.3%</td>
<td>7782-41-4</td>
</tr>
<tr>
<td>Sr</td>
<td>1.5%</td>
<td>7440-24-6</td>
</tr>
</tbody>
</table>

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Not dangerous with normal use. The battery should not be disassembled or incinerated. Exposure to the ingredients contained within or their combustion products could be harmful.

PHYSICAL: The Lithium-Iron rechargeable batteries described in this Material Safety Data Sheet are sealed units which are not hazardous when used according to the recommendations of the manufacturer.

Under normal conditions of use, the solid electrode materials and liquid electrolyte they contain are non-reactive provided the battery integrity is maintained and seals remain intact. There is Risk of fire only in cases of abuse (mechanical, thermal, electrical), which leads to the activation of the safety valve and/or the rupture of the battery container. Electrolyte leakage, electrode materials reaction with moisture/water or battery vent/fire may follow, depending upon the circumstances. In case of excessive internal pressure and/or temperature the batteries are fitted with a safety vent for protection and/or rupture of the cell case.

ROUTES OF ENTRY: Eyes, skin, mucous membranes.

POTENTIAL HEALTH EFFECTS
EYES: Contact between the battery and eye will not cause any harm. Eye contact with the contents of a ruptured battery can cause severe irritation to the eye.

SKIN: Contact between the battery and skin will not cause any harm. Skin contact with positive and negative terminals of high voltages may cause burns to the skin. Skin contact with a ruptured battery can cause skin irritation.

INGESTION: Swallowing of material from a sealed battery is not an expected route of exposure. Swallowing mists from a ruptured battery may cause respiratory irritation, chemical burns of the mouth and gastrointestinal tract irritation.

INHALATION: Inhalation of material from a sealed battery is not an expected route of exposure. Vapors or mists from a ruptured battery may cause respiratory irritation.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Not Available
SECTION 4: FIRST AID MEASURES

GENERAL: In case of battery rupture, fume or fire, evacuate personnel from contaminated area and provide maximum ventilation to clean out fumes/gases. Meantime, spray th

EYES: Wash affected eye with lukewarm water for at least 30 minutes. Rinse with saline solution if possible. Immediate hospital treatment. Consult eye specialist.

SKIN: Remove all contaminated clothing and flush affected areas with plenty of Water and soap for at least 30 minutes do not apply greases or ointments. If irritation or pain persists, seek medical attention.

INGESTION: Dilute by giving plenty of water and get immediate medical attention. Assure that the victim does not aspirate vomited material by use of positional drainage. Assure that mucus does not obstruct the airway. Do not give anything by mouth to an unconscious person.

SECTION 5: FIRE-FIGHTING MEASURES

FIRE AND FUME HAZARD: Except LFP series batteries, LCP and LMP batteries can leak and/or spout vaporized or decomposed and combustible electrolyte fumes in case of exposure above 150°C (302°F) resulting from inappropriate use, abuse, or from the environment. Possible formation of hydrogen fluoride (HF) and phosphorous oxides during fire. LiPF 6 salt contained in the electrolyte releases hydrogen fluoride (HF) in contact with water.

EXTINGUISHING MEDIA: Type D extinguishers , Co2, Dry chemical or Foam extinguishers

FIRE FIGHTING PROCEDURE: Put on fully protective gear, including self-contained breathing apparatus, goggles, fireproofing jacket and gloves.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Exposing battery cell to excessive heat, fire or over voltage condition may cause a leak, fire, hazardous vapors and hazardous decomposition products. Damaged or opened cells or batteries can result in rapid heating and the release of flammable vapors.

SPECIAL HAZARDS: Following cell overheating due to external source or due to improper use, electrolyte leakage or battery container rupture may occur and release inner component/material in the environment.

EYE CONTACT: The electrolyte solution contained in the battery is irritant to ocular tissues.

SKIN CONTACT: The electrolyte solution contained in the battery causes skin irritation.

INGESTION: The ingestion of electrolyte solution causes tissue damage to throat and gastro/respiratory tract.

INHALATION: Contents of a leaking or ruptured battery can cause respiratory tract, mucus, membrane irritation and edema.

SPECIAL PROTECTION: Use self-contained breathing apparatus to avoid breathing irritant fumes. Wear protective clothing and equipment to prevent body contact with electrolyte solution.

SECTION 6: ACCIDENTAL RELEASE MEASURES

The material contained within the batteries would only be expelled under abusive conditions. Soak under water or spray with copious amounts of water, place in approved container (after cooling if necessary) and dispose in accordance with local regulations.

SPILL CLEANUP METHOD: The material contained within the batteries is only expelled under abusive conditions. Use a shovel and cover battery with sand or vermiculite, place in an approved container and dispose in accordance with section 13.

SECTION 7: HANDLING AND STORAGE

The batteries should not be opened, destroyed nor incinerate since they may leak or rupture and release in the environment the ingredients they contain.

HANDLING: Do not crush, pierce, short (+) and (-) battery terminals with conductive (i.e. metal) goods. Do not directly heat or solder. Do not throw into fire. Do not mix batteries of different types and brands. Do not mix new and used batteries. Keep batteries in non-conductive (i.e. plastic) trays.

STORAGE: Store in a cool (preferably below 30°C/86°F) and ventilated area away from moisture, sources of heat, direct sunlight, open flames, food and drink. Insulate positive and negative terminals to avoid short circuit. Elevated temperatures can result in reduced battery life.
SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

VENTILATION: Not necessary under normal use.

RESPIRATORY PROTECTION: Not necessary under normal use. In case of battery rupture, use self-contained full-face respiratory equipment.

HAND PROTECTION: Not necessary under normal use. Use Viton rubber gloves if handling a leaking battery.

EYE PROTECTION: Not necessary under normal use. Wear safety goggles or glasses with side shields if handling a leaking or ruptured battery.

SKIN PROTECTION: Not necessary under normal use. Use rubber apron and protective clothing in case of handling of a ruptured battery.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: No metal or conductive materials should be worn during battery maintenance.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

DIMENSIONS: See specifications

WEIGHT: See specifications

APPEARANCE: Metal enclosure (typically blue) containing lithium iron phosphate cells and battery management system

TEMPERATURE RANGE: 0°C - 45°C

SPECIFIC INSTANT POWER: 1 up to 1000 W/Kg during 1 second

MECHANICAL RESISTANCE: According to mechanical tests in IEC60623 standard.

SECTION 10: STABILITY AND REACTIVITY

CONDITIONS TO AVOID: Avoid exposing battery to high temperatures (above 85°C/185°F). Do not incinerate, deform, mutilate, crush, pierce, short circuit or disassemble. Prolonged exposure to humid conditions.

HAZARDOUS DECOMPOSITION PRODUCTS: Corrosive/Irritant Hydrogen fluoride (HF) is produced in case of reaction of lithium hexafluorophosphate (LiPF₆) with water. Combustible vapors and formation of Hydrogen fluoride (HF) and phosphorous oxides during fire.

SECTION 11: TOXICOLOGICAL INFORMATION

Lithium Iron batteries do not contain toxic materials.

Irritation: Risk of irritation only occurs if battery cells are mechanically, thermally or electrically abused and the enclosure is compromised.

NEUROLOGICAL EFFECTS: Not applicable.

SENSITIZATION: Not applicable.

TERATOLGENICITY: Not applicable.

REPRODUCTIVE TOXICITY: Not applicable.

MUTAGENICITY (Genetic Effects): Not applicable.

TOXICOLOGICALLY SYNERGISTIC MATERIALS: Not available

SECTION 12: ECOLOGICAL INFORMATION

When properly used or disposed, Lithium Iron batteries can be recycled and do not present environmental hazard during their life time.
MATERIAL SAFETY DATA SHEET
LITHIUM IRON PHOSPHATE BATTERY

SECTION 13: DISPOSAL CONSIDERATIONS

INCINERATION: Never incinerate Lithium Iron batteries.

LANDFILL: Never dispose Lithium Iron batteries in the landfill.

RECYCLING: Lithium Iron batteries can be fully recycled. Iron Edison recommends proper recycling of these batteries whenever possible.

SECTION 14: TRANSPORT INFORMATION

SHIPPING NAME: Lithium Ion Batteries
HAZARD CLASS: 9
UN NUMBER: 3480
PACKING GROUP: II