



Owner's Manual

Iron Edison Nickel Iron Battery

(Revised 6/01/2017)



Congratulations on the purchase of your new Iron Edison Nickel Iron Battery

This manual was created by Iron Edison and contains vital information regarding proper care and maintenance of your new battery. The material in this manual ONLY applies to Iron Edison Industrial Series Nickel Iron batteries. Other nickel iron batteries may have different use and maintenance requirements.

Please read through this Owner's Manual carefully and completely before using your battery. It will help you achieve safe installation and use, optimum performance and long life from your new investment.

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

WARNING

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

THE ALKALINE 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.



Corrosive



Flammable



Explosive



Poison

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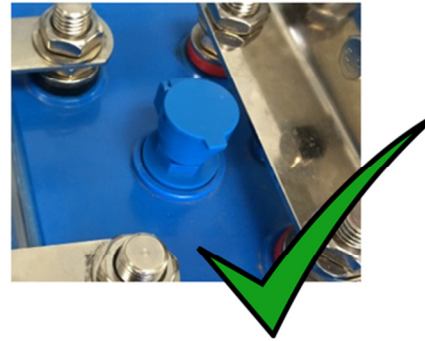
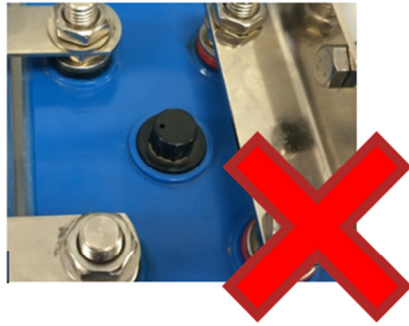
Batteries are dangerous, and should only be installed and maintained by qualified personnel.
FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN DEATH OR SERIOUS INJURY.

Precautions When Working With Nickel Iron Batteries:

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

1. Replace the BLACK SHIPPING CAPS with the BLUE VENT CAPS before using this battery.

YOU MUST USE THE BLUE VENT CAPS WHEN OPERATING YOUR NICKEL IRON BATTERY.



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 arcing and/or an explosion.

INSULATED TOOLS SHOULD BE USED ANY TIME YOU ARE WORKING AROUND BATTERIES.

3. Make sure the area around the battery is well ventilated.
4. Never smoke or allow a spark, flame or other ignition source near the battery.
5. Remove all metal items, like necklaces, rings, bracelets, and watches when working with batteries. Batteries produce a short circuit current high enough to weld metal to skin, causing a severe burn.
6. Have someone within range of your voice or close enough to come to your aid when you work near a battery.
7. Have plenty of fresh water and soap nearby in case battery electrolyte contacts skin, clothing, or eyes.
8. Wear complete eye / face protection, gloves, apron and mask. Avoid touching your eyes while working near batteries.
9. If battery electrolyte contacts skin or clothing, wash immediately with water. If electrolyte enters your eye, immediately flood it with running cold water for at least twenty minutes and get medical attention immediately.
10. Always remove the grounded terminal from the battery first, and connect it last. Make sure all chargers and loads are turned off so you don't cause a spark.
11. Always use identical size and chemistry batteries in the same battery bank.
12. Never install old or untested batteries. Check each battery's date code or label to ensure age and type.
13. Batteries are temperature sensitive. For optimum performance, they should be installed in a stable temperature environment.
14. Always recycle old batteries. Contact your local recycling center for proper disposal information.

Receiving Your Battery Shipment

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

Inspection on Receipt

It is very important that you carefully inspect your entire 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.

You should specifically look for any liquid stains on the crates; an indication that the crate may have been tipped over and electrolyte has been spilled. Also inspect the Tip N Tell on every crate as another indication that the crate may have been tipped over or mishandled.



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 delivery 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 before signing, you may sign for the shipment but must fully inspect the shipment and report any shipping damage to Iron Edison within 48 hours of receipt. After 48 hours of receiving your shipment, you have accepted full responsibility for the shipment in its current condition.

Batteries are dangerous, and should only be installed and maintained by qualified personnel.
FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN DEATH OR SERIOUS INJURY.

Prepare the Area

Always follow and comply with all national, state and local building codes, installation & owner's manuals and any other applicable installation requirements.

Iron Edison Nickel Iron Battery Warranty requires the battery be installed in an Iron Edison approved battery box or enclosure. Battery Box Design Requirements are in the Battery Boxes section of this manual. Nickel Iron batteries produce flammable hydrogen gas, and must not share airspace with other electrical equipment or potential ignition sources.

Iron Edison's Nickel Iron Battery Warranty requires the use of an Iron Edison battery rack or Iron Edison pre-approved installation solution.

The battery connections use metal busbars to create a single long battery bank, which needs to be on a completely level & solid surface. Make sure that the area you are going to place the battery bank is completely flat, and capable of supporting the battery's weight. An uneven or sagging surface will cause the busbars to exert pressure on the battery posts, which can damage the battery.

Iron Edison's Warranty does not cover damage due to improper installation.

Assemble the Battery Rack (sold separately)

Iron Edison recommends assembling the battery rack before uncrating the batteries. This will give you a place for the batteries and will minimize the number of times you need to move the batteries.

Rack assembly is easier with two people. Follow the included instructions for proper rack assembly.

[NOTE: 800Ah-1,000Ah battery racks include 4 horizontal rails per shelf to support the additional weight, and should be positioned to fully support the battery's feet.]

To get the proper size for the rack's black rails, make 2 templates of your cell. Place the cell templates on the black rails to confirm that distance between the rails is correct. The batteries should fit snugly on the rail, but do not over tighten. Leave approximately 1mm between the battery and the front of the rail. With a single battery in place, tighten one side of the rails to the white supports. Slide the battery or template to the middle of the rail, and tighten to the center support. Do the same to the far end of the rack.



Battery Boxes

Iron Edison Nickel Iron batteries will produce hydrogen gas due to the electrolysis that occurs during charging. Hydrogen is a flammable & explosive gas that MUST be contained, diffused and vented outdoors for safe operation. Nickel Iron batteries must not share airspace with other electrical equipment or potential ignition sources.

Improperly ventilating your batteries will result in a hydrogen buildup and potential explosion. FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN DEATH OR SERIOUS INJURY. Iron Edison's Nickel Iron Battery Warranty requires proper containment & ventilation of your battery bank.

Battery Box Design Requirements:

- Contain, diffuse and ventilate the hydrogen generated by the battery bank per NEC 480.9(A).
- Locate the battery box in a dry area protected from the weather & elements.
- Provide spacing between the battery box exterior and other devices per local building codes.
- Provide at least 6" of clearance between the box interior and all sides / top of the batteries.
- Provide a vent outlet at the highest point of the battery box to vent the hydrogen. 3" PVC pipe can be used to vent the hydrogen outdoors.
- Install fan on vent outlet. Installing a continuous running inline fan with an ignition protected motor is **strongly recommended** to actively ventilate the battery box. This fan should be sized to provide a complete air change of the battery box every 10 minutes. [NOTE: Most bathroom and other exhaust fans DO NOT use brushless motors, making them a potential ignition source.]
- Provide a vent inlet near the bottom of the battery box for replacement air.
- Provide a battery cable entry opening near the bottom of the battery box. If the vent inlet is using outdoor replacement air, this battery cable opening should be sealed with expanding foam insulation or equivalent. Feed though battery posts are another battery box option to consider.



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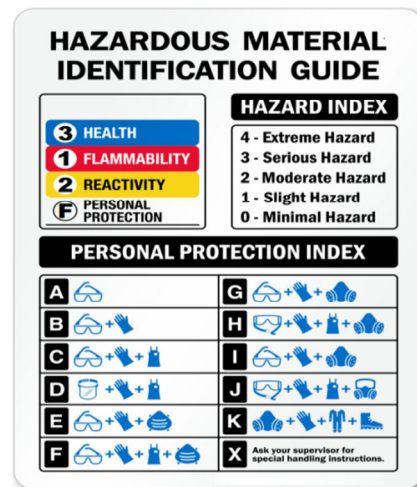
Unpack the Crates

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, gloves, apron and mask as you work with the battery. Remove any jewelry such as wedding rings, watches, necklaces or any other metal before working with your battery!

Batteries are dangerous, and should only be installed and maintained by qualified personnel.
FAILURE TO FOLLOW THESE INSTRUCTIONS CAN RESULT IN DEATH OR SERIOUS INJURY.



Your battery and accessories will arrive in wooden crates. The crates will contain batteries filled with electrolyte, busbars, busbar covers, and a safety kit.

Open the crate from the top. Carefully remove the batteries and place them on a flat surface or directly on the battery rack. Keep the workspace clear of animals or children.

Place the Batteries on the Rack

Use the white slip-over rack protection pieces before placing any batteries on the rack. This will prevent any of the soft black coating from scraping off the rack.

Place the batteries on the rack one at a time. Line the batteries in a row, positive to negative (The positive pole (+) of an Iron Edison battery is designated by a red ring around the terminal and the negative pole (-) is designated by a black ring around the terminal.) Load the back corners, then front corners. Then fill the back row before loading batteries onto the front row. With a 2-tier rack, add most of the cells on the bottom of the rack before loading batteries onto the top of the rack for stability.

Do not drop any of the batteries. You may want to enlist the help of another person while loading batteries onto the rack. Everyone should be wearing appropriate personal protective equipment.

Install Blue Vent Caps

Remove the BLACK shipping caps on each battery, and replace them with the provided BLUE vent caps.

**DO NOT CHARGE THE BATTERIES WITH THE BLACK SHIPPING CAPS INSTALLED.
INTERNAL PRESSURE WILL BUILD AND THE BATTERIES WILL EXPLODE!**

Battery Connections

Using an insulated wrench or socket, loosen and remove the top nut and washer from each post of the batteries. Leave the bottom nut on each battery post as it supports the plate assembly inside the battery. Collect all the nuts & washers in a bowl or container.

To connect the batteries in series, use the provided flat busbars to connect the positive post (+) of one battery to the negative post (-) of the next cell, creating a string of 10 batteries.

Use the L-shaped end of row busbars for the ends of each 10-battery row.

Replace the washer and nut on top of the busbar. **Using an insulated wrench or socket**, tighten the nut until it engages, but not tight. Pull the batteries apart to get the max distance between the batteries. This allows air to flow around the battery which helps with cooling during charging.



Align batteries before tightening any hardware. The batteries will rotate slightly as you tighten the hardware. Try to keep the batteries aligned before and during the tightening process.

Maximum electrical contact demands that all electrical connections must be tight and the contacting surfaces between the lugs and poles must be clean.

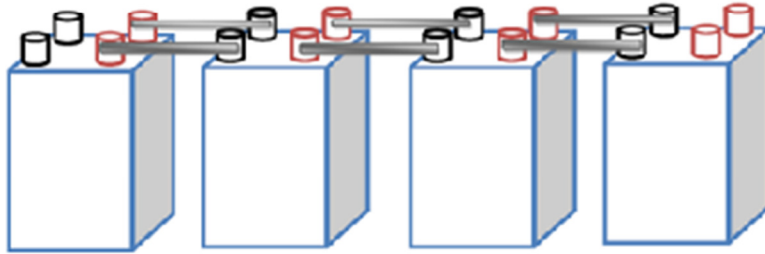
Torque all battery connections to 35 ft. pounds.

The positive to negative connection is a series connection, which will increase the battery voltage. Iron Edison battery banks are typically made of one series string of batteries.

With the cell-to-cell busbars attached, it is now time to make the row-to-row wire connections. Remove the nut, washer, and bolt from the L-shaped end-of-row busbars. Using 4/0 AWG battery cable, make the series connection(s) between rows (see diagram on previous page).

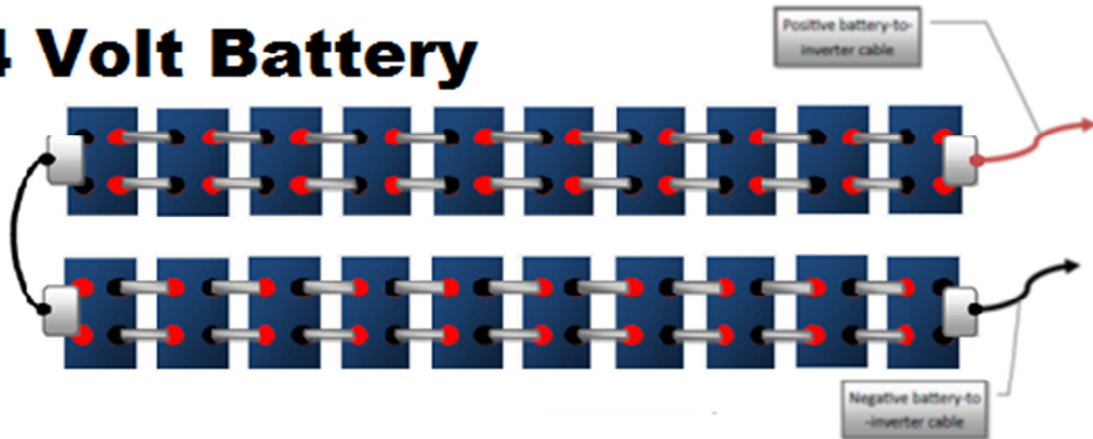
With a 24V and 48V battery on the standard rack, the positive and negative connection points will be on the same side of the battery.

Front View When connecting cells, use both terminals on each cell.

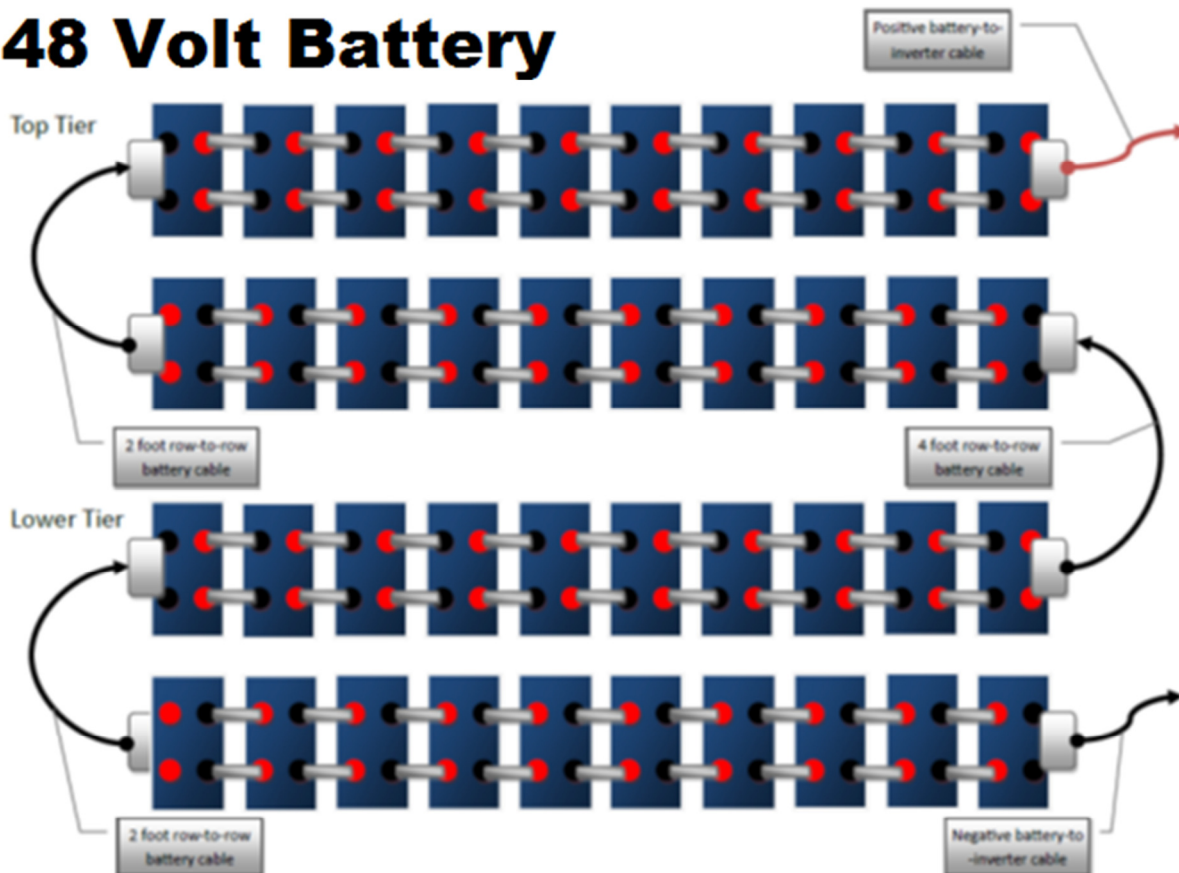


Top View When connecting cells, use both terminals on each cell.

24 Volt Battery



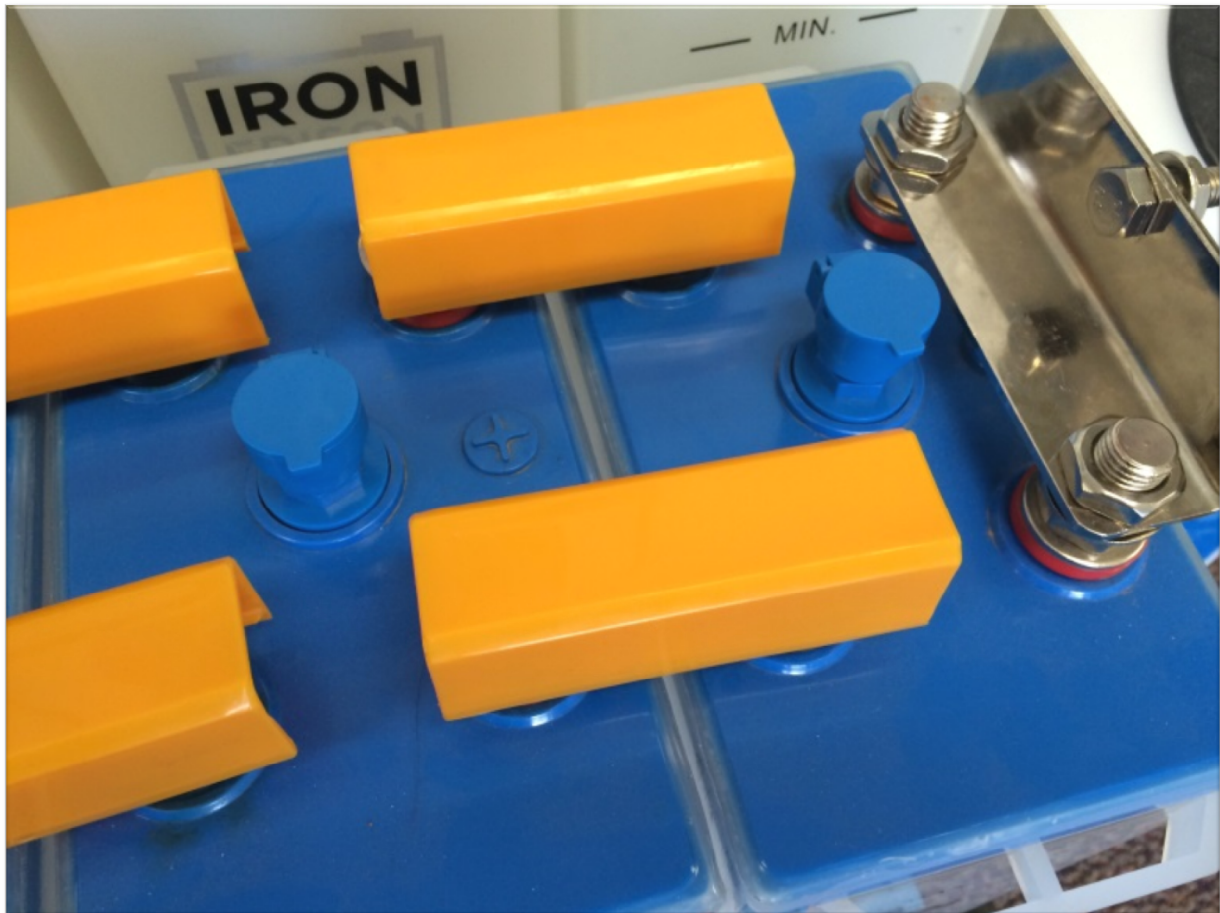
48 Volt Battery



Finally, coat all terminals & bus bars with the protective grease included with your battery. Put the container of grease in a cup of warm water to soften the grease. To make sure the grease adheres properly, all surfaces to be coated must be cleaned so as to be perfectly free of moisture or dirt, after which the grease may be applied with a plastic brush with no metal parts.

Install Yellow Busbar Covers

Install the included yellow busbar covers for optimal electrical safety.



Battery to Inverter Connection

Designate the positive battery cable by marking the cable with red electrical tape on both ends. Connect the battery to inverter cables in the following order:

1. Connect the positive battery cable to the inverter's circuit breaker (breaker should be open/off).
2. Connect the negative battery cable to the inverter's negative terminal.
3. Connect the positive battery cable to the battery's positive end-of-row busbar.
4. Connect the negative battery cable to the battery's negative end of row busbar.

Testing and Commissioning

Using a digital multimeter, test for correct voltage and polarity of your battery bank.

Follow your inverter and charger manuals for proper system commissioning and configuration.



Charging the Battery

Most chargers are designed to use default settings for a lead acid based battery, but also have a CUSTOM battery type allowing the configuration of custom charge voltages for other battery chemistries. You will likely need to use the custom battery type on your charger to properly configure it for your Nickel Iron battery bank.

The bulk & absorb voltage for the Iron Edison Industrial Series Nickel Iron battery is 1.65 volts per cell. You must achieve this voltage in the bulk cycle, and hold it through the absorb cycle to properly charge the battery.

The absorb cycle should be time based, not using an End Amps setting on your charger.

The float voltage for the Iron Edison Industrial Series Nickel Iron battery is 1.45 volts per cell.

Equalization charging is not needed or recommended.

It is normal to see and hear Iron Edison Nickel Iron batteries bubbling while charging.

Charge Rate

- Maximum charge rate = $C/2$ (battery's Ah capacity / 2)
- Optimum charge rate = $C/4$ (battery's Ah capacity / 4)
- Minimum charge rate = $C/20$ (battery's Ah capacity / 20)

Iron Edison Industrial Series Nickel Iron Battery – Recommended Charge Rate

Battery's Ah Capacity	Min Charge Rate $C/20$ (amps)	Optimal Charge Rate $C/4$ (amps)	Max Charge Rate $C/2$ (amps)
100	5	25	50
200	10	50	100
300	15	75	150
400	20	100	200
500	25	125	250
600	30	150	300
700	35	175	350
800	40	200	400
900	45	225	450
1000	50	250	500

If necessary, and if full capacity is not required, a battery may be taken off charge at any time and used. In an emergency, when time for a normal charge is not available, charging may be done at higher rates than normal, providing there is no frothing and the battery temperature does not rise above 115 ° F.

Low Rate Charging (Trickle Charging)

The Iron Edison Industrial Series Nickel Iron battery should never be charged at less than the minimum charge rate. Low rate charging does no damage the battery, but best results are obtained from charging at normal rates.

Tips on Battery Charging

Most solar charge controllers will charge a Nickel Iron battery bank with no problems, however many inverter/chargers are limited by two factors:

- 1) The inverter's built-in charger is limited to a lower than required output voltage (charger's voltage)
- 2) The inverter's DC input range is lower than the required charge voltage (high battery cut out)

Should your inverter have these limitations and it is impacting your system's performance, the recommended solution is to change the number of batteries in your battery bank. By bypassing 1 - 2 batteries in your battery bank, the battery bank's voltage will be reduced to within your inverter's capabilities.

Customers with limited solar resource in the winter may find themselves frequently charging their battery via their inverter/charger and a generator instead of solar. Bypassing 1-2 batteries in your battery bank during the winter months will allow the inverter and a generator to properly charge the battery bank. Once solar charging becomes viable again, these bypassed batteries are returned for normal operation.

Simply moving the end of row bus bar 1 - 2 batteries inward will accomplish this without physically removing the batteries.



Normal Operation



2 Batteries Bypassed

Nickel Iron batteries won't be damaged by overcharging or over discharging. If you are living off-grid and cycling the battery every day, Iron Edison recommends charging from your solar array for 5-7 hours. Set the absorb timer to 5 hours, and then adjust higher to charge later into the day. Be sure to keep a close eye on electrolyte levels when using this charge regimen.

When charging from a generator, many customers like to limit generator runtimes to conserve fuel. Set the inverter's charger to a 2 hour absorb time to keep generator runtimes relatively short. This shorter absorb charge cycle won't bring the battery to a 100% state of charge, but should adequately charge the battery to sustain the loads until PV charging is viable again. This absorb time can be adjusted as needed to suit the needs of the application; balancing between fuel consumption and obtaining a 100% SoC.

Additionally, float charging can be skipped when generator charging to conserve fuel.

Iron Edison Industrial Series Nickel Iron Battery – Recommended Charge Configuration

		48 Volt Nominal Configuration					
		Volts / cell		40 Cells	39 Cells	38 Cells	
Bulk / Absorb Voltage	1.65 Volts	66.0	Volts	64.4	Volts	62.7	Volts
Absorb Time (PV)		5.0	Hours	5.0	Hours	5.0	Hours
Absorb Time (Gen)		2.0	Hours	2.0	Hours	2.0	Hours
Float Voltage	1.45 Volts	58.0	Volts	56.6	Volts	55.1	Volts
Float Time (PV)		All viable PV resource					
Float Time (Gen)		Not recommended					
Equalize Voltage		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	
Equalize Time		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	

Resting Battery Voltage

100% State of Charge	1.40 Volts	56.0	Volts	54.6	Volts	53.2	Volts
50% State of Charge	1.25 Volts	50.0	Volts	48.8	Volts	47.5	Volts
20% State of Charge	1.15 Volts	46.0	Volts	44.9	Volts	43.7	Volts

		24 Volt Nominal Configuration					
		Volts / cell		20 Cells	19 Cells	18 Cells	
Bulk / Absorb Voltage	1.65 Volts	33.0	Volts	31.4	Volts	29.7	Volts
Absorb Time (PV)		5.0	Hours	5.0	Hours	5.0	Hours
Absorb Time (Gen)		2.0	Hours	2.0	Hours	2.0	Hours
Float Voltage	1.45 Volts	29.0	Volts	27.6	Volts	26.1	Volts
Float Time (PV)		All viable PV resource					
Float Time (Gen)		Not recommended					
Equalize Voltage		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	
Equalize Time		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	

Resting Battery Voltage

100% State of Charge	1.40 Volts	28.0	Volts	26.6	Volts	25.2	Volts
50% State of Charge	1.25 Volts	25.0	Volts	23.8	Volts	22.5	Volts
20% State of Charge	1.15 Volts	23.0	Volts	21.9	Volts	20.7	Volts

		12 Volt Nominal Configuration					
		Volts / cell		10 Cells	9 Cells	8 Cells	
Bulk / Absorb Voltage	1.65 Volts	16.5	Volts	14.9	Volts	13.2	Volts
Absorb Time (PV)		5.0	Hours	5.0	Hours	5.0	Hours
Absorb Time (Gen)		2.0	Hours	2.0	Hours	2.0	Hours
Float Voltage	1.45 Volts	14.5	Volts	13.1	Volts	11.6	Volts
Float Time (PV)		All viable PV resource					
Float Time (Gen)		Not recommended					
Equalize Voltage		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	
Equalize Time		<i>(not used)</i>		<i>(not used)</i>		<i>(not used)</i>	

Resting Battery Voltage

100% State of Charge	1.40 Volts	14.0	Volts	12.6	Volts	11.2	Volts
50% State of Charge	1.25 Volts	12.5	Volts	11.3	Volts	10.0	Volts
20% State of Charge	1.15 Volts	11.5	Volts	10.4	Volts	9.2	Volts

Watering

Due to the electrolysis that occurs during charging, the electrolyte level in Iron Edison Nickel Iron batteries will decrease over time and will need to be replenished. The electrolyte levels of each battery should be monitored at least monthly to ensure the fluid does not drop below the MIN fill line. Only water is lost during the charge process, not the chemical composition of the electrolyte. Therefore **ONLY USE DISTILLED WATER** to water your batteries.

Iron Edison also offers a water deionizer that will produce adequately filtered water (<10 PPM TDS) for use in Iron Edison Nickel Iron batteries.



Electrolyte levels will fluctuate with the battery's state of charge, therefore **batteries should ONLY be watered after a complete charge cycle has completed**. This is when the electrolyte levels will be at their highest and will prevent a potential overflow situation due to over watering. Over time dark deposits may obscure actual water levels, so make sure you are accurately measuring the electrolyte level.

How frequently you water your batteries will depend on the charge current and duration. Most customers water their batteries every 1-4 months.

Detailed Watering Instructions

USE APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT ANYTIME YOU'RE WORKING AROUND YOUR BATTERY BANK!



Corrosive



Flammable



Explosive



Poison

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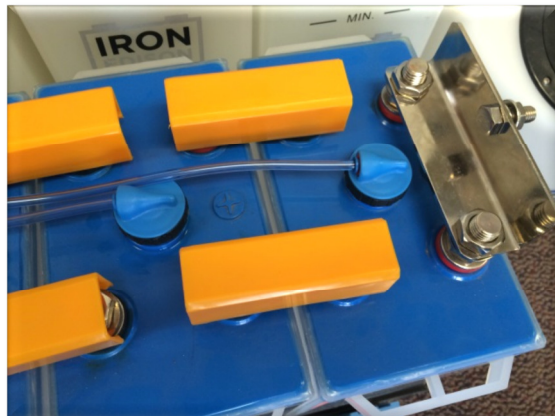
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F	X Ask your supervisor for special handling instructions.

Water your batteries when they are at rest – not charging or discharging.

Iron Edison offers several battery watering options, including a watering cart & gun, deionizer, and a single point watering system. Using a funnel and jugs of distilled water is perfectly acceptable too.



1. Visually check the electrolyte levels of each battery at or near 100% state of charge, when the electrolyte is at its highest level. If any batteries are at or near the MIN fill line, you should water your batteries.
2. Remove all blue vent caps and place them in distilled water to soak and be cleaned.
3. Fill each battery up to the MAX fill line with **DISTILLED WATER ONLY** (<10 PPM TDS).
4. Inspect each vent cap to ensure they are clean and unobstructed, then reinstall on the battery.

Specific Gravity

Specific gravity readings are of no value in determining the state of charge or discharge of an Iron Edison Nickel Iron battery, because the specific gravity of the alkaline electrolyte does not change to any appreciable extent during charge or discharge. Such small changes are entirely due to extreme low or high temperatures, or to electrolyte concentration variances caused by either evaporation or electrolysis in operating the battery.

Cleaning

The batteries, trays, and battery compartment must be kept dry, and care must be taken that dirt and other foreign substances do not collect at the bottom or between the batteries.

Periodically remove any electrolyte encrustation from the top of batteries, taking care not to let the material fall between or into the batteries. Soak battery vent caps in distilled water, inspect and remove any electrolyte encrustation while performing routine battery watering.

If excessive dust and debris collects on the battery, a thorough cleaning is necessary. The battery bank should be disassembled and removed from the battery compartment to do this. Before reassembling, make sure that all poles, connectors and jumper lugs are clean. Also, batteries, trays, and compartments must be dry before replacing battery.

Protective Coating on Exposed Metal Parts

Occasionally, after being cleaned, the terminals and busbars should be recoated with an alkaline-proof, silicone based dielectric grease. Put the container of grease in a cup of warm water to soften the grease. To make sure the grease adheres properly, all surfaces to be coated must be cleaned so as to be perfectly free of moisture or dirt, after which the grease may be applied with a plastic brush with no metal parts.

Storing the Battery

If the battery is to be stored for any length of time, make sure the battery is in a dry place and the electrolyte is filled to the proper height. **NEVER** remove the electrolyte and let the battery stand unfilled. Ensure no dirt or debris can enter the battery and contaminate the electrolyte. A Nickel Iron battery can be stored at any state of charge with no problems.

When recommissioning the battery, verify that the electrolyte is filled to at least the MIN fill line, and then fully charge the battery.

Electrolyte Replacement

A Nickel Iron battery's electrical capacity will degraate approximately 1% per year under normal use. This is due to a carbonate buildup in the electrolyte. Due to this degradation, it is recommended to replace the battery's electrolyte every 10 years +/- to recover this capacity loss. When your battery has reached this age, or if the degraded capacity has become a performance issue, please contact Iron Edison for instructions on replacing your electrolyte.

State of Charge Graph

Iron Edison Nickel Iron Battery Bank



SoC %* V / cell			48 Volt Nominal			24 Volt Nominal			12 Volt Nominal		
			40 Cells	39 Cells	38 Cells	20 Cells	19 Cells	18 Cells	10 Cells	9 Cells	8 Cells
Charging	BULK	1.65	66.0	64.4	62.7	33.0	31.4	29.7	16.5	14.9	13.2
		1.62	64.8	63.1	61.5	32.4	30.8	29.1	16.2	14.6	13.0
		1.59	63.5	61.9	60.3	31.8	30.2	28.6	15.9	14.3	12.7
		1.56	62.3	60.7	59.1	31.1	29.6	28.0	15.6	14.0	12.5
		1.53	61.0	59.5	58.0	30.5	29.0	27.5	15.3	13.7	12.2
		1.49	59.8	58.3	56.8	29.9	28.4	26.9	14.9	13.4	12.0
	FLOAT	1.45	58.0	56.6	55.1	29.0	27.6	26.1	14.5	13.1	11.6
		1.42	56.8	55.3	53.9	28.4	27.0	25.5	14.2	12.8	11.4
Resting Voltage	100%	1.40	56.0	54.6	53.2	28.0	26.6	25.2	14.0	12.6	11.2
	90%	1.37	54.8	53.4	52.0	27.4	26.0	24.6	13.7	12.3	11.0
	80%	1.34	53.5	52.2	50.8	26.8	25.4	24.1	13.4	12.0	10.7
	70%	1.31	52.3	50.9	49.6	26.1	24.8	23.5	13.1	11.8	10.5
	60%	1.28	51.0	49.7	48.5	25.5	24.2	23.0	12.8	11.5	10.2
	50%	1.24	49.8	48.5	47.3	24.9	23.6	22.4	12.4	11.2	10.0
	40%	1.21	48.5	47.3	46.1	24.3	23.0	21.8	12.1	10.9	9.7
	30%	1.18	47.3	46.1	44.9	23.6	22.4	21.3	11.8	10.6	9.5
	20%	1.15	46.0	44.9	43.7	23.0	21.9	20.7	11.5	10.4	9.2
	10%	1.12	44.8	43.6	42.5	22.4	21.3	20.1	11.2	10.1	9.0
	LBCO	1.09	43.5	42.4	41.3	21.8	20.7	19.6	10.9	9.8	8.7

* Due to variances in manufacturing, state of charge percentages above may vary slightly





Iron Edison Battery Company

Nickel Iron 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.

Nickel Iron Batteries cannot be discharged more than 80% of nominal capacity, or below 1.0 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. Rated battery capacity is based on operation at STC. Efficiency and capacity can change with temperature.

Nickel Iron batteries must be installed in an Iron Edison provided or Iron Edison approved racking system and battery box. Nickel Iron batteries may only be used in fixed, stationary installations. This warranty does not apply to mobile applications, including but not limited to vehicles, boats and recreational vehicles.

When adding distilled water to the battery, the owner may use any method, tool, or system, as long as they maintain the fluid at the recommended level and do not over or under water the battery. Electrolyte levels must be maintained above the "MIN" fill line at all times. The owner must change the electrolyte every 8-10 years, and/or prior to filing any performance claim.

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 90C) or extreme cold (below -30C), the addition of any chemical or solution (other than distilled water, KOH or LiOH electrolyte), 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.

WARRANTY PERIOD:

Battery Type	Free Replacement (months)	Pro-rated (months)
Nickel Iron	1-24	25-120

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 X % Warranty Remaining X [1- (70% of new Ah rating ÷ Tested battery Ah capacity)]

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

NICKEL IRON BATTERY



SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Nickel Iron 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: April 3, 2017
REVISION: B

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT:	EINECS No.:	CAS No.:	Symbol	RISK (R No.):
Nickelous oxide-	028-008-X	1313-99-1	NC	Not Classified
Cadmium Hydroxide	048-001-00-5	21041-95-2	NC	Not Classified
Cobalt Hydroxide	244-166-4	21041-93-0	NC	Not Classified

METALS:	%	PLASTICS	%	OTHER	%
Iron (FE)	25-37	Polyamide (PA/PP)	2.5-3.5	Potassium K/Na/Li	1.8-2.9
Nickel (Ni)	20-28	Rubber EPDM	<0.05	Water (H2O)	4-9
Cadmium (CD)	10-15	Polythylene	0.2-0.4	OH-	8-14
Cobalt	0.4-1.0	PVC	0.2-0.7		

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Corrosive. The electrolyte of batteries causes eye and skin burns. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns.

ROUTES OF ENTRY: Eyes, skin, mucous membranes.

POTENTIAL HEALTH EFFECTS

EYES: Causes eye burns. May cause chemical conjunctivitis and corneal damage

SKIN: Causes skin burns. May cause deep, penetrating ulcers of the skin. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.

INGESTION: May cause severe and permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the digestive tract. Causes severe pain, nausea, vomiting, diarrhea, and shock. May cause corrosion and permanent tissue destruction of the esophagus and digestive tract. May cause systemic effects.

INHALATION: Irritation may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. Causes chemical burns to the respiratory tract.

CHRONIC HEALTH HAZARDS: Prolonged or repeated skin contact may cause dermatitis. Effects may be delayed.

MATERIAL SAFETY DATA SHEET

NICKEL IRON BATTERY



SECTION 4: FIRST AID MEASURES

GENERAL: In case of electrolyte solution spill (cell leakage) precautions must be taken to avoid any contact of human tissues.

EYES: Rinse immediately with plenty of water during at least 15-30 min. Immediate hospital treatment. Consult eye specialist.

SKIN: Rinse immediately with plenty of water: Medical treatment.

INGESTION: If the injured is fully conscious: plenty of drink, preferably milk. Do not induce vomiting. Immediate Hospital treatment.

INHALATION: Fresh air. Rinse mouth and nose with water: Medical treatment.

SECTION 5: FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA:

Suitable: Class D-Dry chemical, sand, CO₂.

Not to be used: Water.

SPECIAL FIRE FIGHTING PROCEDURES: Cells can be overheated by an external source or by internal shorting and release alkaline electrolyte mist or liquid. In fire situations fumes containing Cadmium may evolve. Electrolyte reacts with zinc, aluminum, tin and other active materials releasing flammable hydrogen gas. In case of PVC sleeved products, the combustion releases chloride gas. Pls note that the rechargeable Ni-Cd batteries have no electrolyte inside, so there are no exposure hazards.

SPECIAL PROTECTIVE EQUIPMENT: Use self-contained breathing apparatus and full fire-fighting protective engineering plastic container.

HMS HAZARD CLASSIFICATION

HEALTH: 3

FLAMMABILITY: 1

REACTIVITY: 2

PROTECTION: F

SECTION 6: ACCIDENTAL RELEASE MEASURES

ACCIDENTAL RELEASE MEASURES: The rechargeable Ni-Iron battery without electrolyte is safe and cannot spill.

PRECAUTIONS TO PROTECT ENVIRONMENT: Cells with electrolyte may generate short-circuits, causing release of alkaline electrolyte mist or liquid. Electrolyte reacts with zinc, aluminum, tin and other active materials releasing flammable hydrogen gas

SPILL CLEANUP METHOD: In such a case, use self-contained breathing apparatus and protective clothing.

SECTION 7: HANDLING AND STORAGE

USAGE PRECAUTIONS: In normal usable conditions, no safety rule is specified to handle the cells.

HANDLING AND STORAGE: It is recommended to store in the following specifications in order to ensure longer usage: +5 to +25°C in a 65 +/- 5% relative humidity.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

VENTILATION : NiFe batteries will produce Hydrogen gas under normal operation, which should be contained, diffused and vented per NEC 480.9 (A)

RESPIRATORY PROTECTION: Assuming adequate ventilation, none required under normal operation

EYE PROTECTION: Eye protection must be used during battery maintenance, None required during normal operation.

SKIN PROTECTION: Skin protection must be used during battery maintenance, None required during normal operation.

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

MATERIAL SAFETY DATA SHEET

NICKEL IRON BATTERY



SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Nickel plated steel prismatic cell with electrolyte in translucent container.

DIMENSIONS See specifications

WEIGHT: See specifications

APPEARANCE: White translucent container with blue top

TEMPERATURE RANGE: Risk of electrolyte leakage over 100°C

SPECIFIC ENERGY: 35 to 45 Wh/Kg

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:

Ni-Fe batteries are stable in storage.

In case of storage in humidity, some rust may appear on the product.

In case of storage in a charged state, batteries with electrolyte progressively loose their energy, generating eventually a progressive temperature increase according to the thermal insulation efficiency of the packing.

In case of exposure to temperature over 100°C, a risk of release of alkaline electrolyte mist or liquid is created.

At higher temperature (160°C) the plastics used can melt or decompose (Polyamide gasket, rubber valve, PVC container).

HAZARDOUS DECOMPOSITION PRODUCTS:

Electrolyte solution is corrosive to all human tissues and will react violently with many organic chemicals. Electrolyte solution reacts with zinc, aluminum, tin and other material releasing flammable hydrogen gas.

MATERIAL SAFETY DATA SHEET

NICKEL IRON BATTERY



SECTION 11: TOXICOLOGICAL INFORMATION

Name N° EEC
N° CAS
Symbole effects Dust exposure limits Carcinogenicity
Cadmium Hydroxyde
048-001-00-5
21041-95-2
Cd(OH)₂ LD50. Not available
VME :50 µg/m³
VLE : 50 µg/m³ (for CdO)
Occupational
Nickelous oxide
028-008-x*
1313-99-1
NiO LD50/oral/rat:
1600 mg/Kg
VME : 1000 µg/m³
VLE : /
Occupational
Hydroxyde de cobalt
-
21041-93-0
Co(OH)₂ LD50. Not available
VME : 100 µg/m³
VLE : /
alkaline
Hydroxydes
019-002-00-8
1310-58-3
KOH
NaOH
LiOH
LD50/oral/rat:
365mg/Kg
KOH VME: 2mg/m³
NaOH VME:2mg/m³
LiOH VME : 25µg/m³

SECTION 12: ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: The storage battery is TCLP toxic. If not recycled, must be disposed of in accordance with all state and local regulations.

SECTION 13: DISPOSAL CONSIDERATIONS

INCINERATION: Never incinerate Nickel Iron batteries.

LANDFILL: Never dispose Nickel Iron batteries in the landfill.

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

SECTION 14: TRANSPORT INFORMATION

SHIPPING NAME:	Nickel Iron Battery
HAZARD CLASS:	8
UN NUMBER:	2795
PACKING GROUP:	II