

White Paper

MetAir™ Ranger Portable
Power Systems: Meeting
Needs for Mission Critical and
Emergency Applications

July, 2012



The Need for Reliable Emergency Back-up Power Solutions is Clear and Growing.

According to [FEMA](#), major disaster declarations in the U.S. have grown 400% since 1950.¹ In 2011, there were 3,071 [reported power outages](#) across the U.S., affecting 41.8 million people² and leading to [costly service interruptions](#).³ More than 5 million people were affected by U.S. power outages exceeding eight hours in 2011 alone.⁴

Emergency communications rank as a top priority for contingency planning. For businesses and communities alike, a communications failure can be a disaster in itself. Communications are needed to report emergencies, to warn about dangers, to keep citizens informed about developments and coordinate response actions.⁵ The Center for Disease Control and Prevention (CDC) lists batteries and access to battery-powered radios as top priorities for emergency preparedness kits.⁶

Time is of the essence in emergency response situations, so reliable and immediately accessible back-up power is critical. The Department of Homeland Security's Office of Emergency Communications (OEC) developed the National Emergency Communications Plan (NECP) as the nation's first strategic plan for emergency communications guidance, setting goals for emergency response situations. By 2013, 75 percent of all Urban Areas Security Initiative (UASI) jurisdictions must be able to demonstrate response-level emergency communications within three hours of a significant event as outlined in national planning scenarios.⁷

MetAir™ Ranger Portable Power Systems (PPS) Fill this Critical Need

In addition to this pressing need for emergency communications equipment, widespread consumer use of portable, rechargeable electronic devices – smart phones, laptops, tablets, video cameras, games, and more - has created unprecedented growth in portable power demand. Prevalent technology available in today's lithium ion, nickel metal hydride, and lead acid rechargeable batteries lacks the capacity to address this vast need for on-demand portable power.

The MetAir™ Ranger Portable Power Systems (PPS) deliver outstanding performance improvements for multiple applications within the \$50B portable power market. The MetAir™ Ranger PPS is the newest high performance, low cost, long-lasting, disposable zinc-air battery system available - offering safe, lightweight, non-polluting back-up power for mission critical, emergency, and recreational applications.



Until now, traditional back-up or off-grid power solutions for emergency response, tactical military operations, or power outages included rechargeable batteries or diesel generators. These solutions are expensive, heavy,

¹ http://www.fema.gov/news/disaster_totals_annual.fema

² <http://powerquality.eaton.com/about-us/news-events/2012/pr070512.asp>

³ <http://www.asce.org/ascenews/featured.aspx?id=25769808638&blogid=25769815007>

⁴ <http://www.nmso-ups.eaton.com/Blackout-Tracker.asp>

⁵ <http://www.fema.gov/business/guide/section2b.shtm#header2>

⁶ <http://emergency.cdc.gov/preparedness/kit/disasters/>

⁷ http://www.dhs.gov/files/publications/gc_1281645820543.shtm

toxic, combustible, and require constant recharging with electricity or liquid fuel. Relying on combustible fuels, or solar- or wind-generated power in an “off-the-grid”, emergency power outage, or military situation can be dangerous, unpredictable, and inefficient.

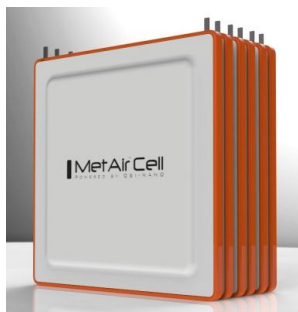
MetAir™ Ranger PPS is lightweight, safe, and reliable for emergency back-up power needs – day or night – when diesel generators, solar, or wind are not available for recharging batteries. The low-cost, replaceable plug and play MetAir™ Power Cartridge is designed for quick and easy replacement in emergency situations, offering convenience, security, and peace of mind.

Designed for “off-grid” backup power needs, when traditional sources of electrical power may be unavailable, the MetAir™ Ranger PPS is ideal for:

- Emergency preparedness and response
- Outdoor sports and recreation
- Tactical military applications
- Back-up power to run or charge consumer electronic devices



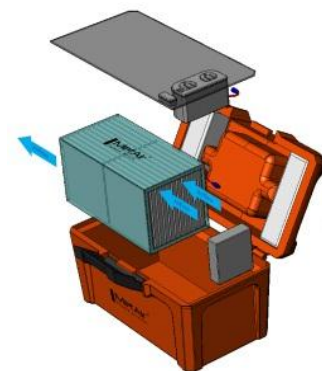
High Performance MetAir™ Cells and Power Cartridges Provide a Customizable Energy Source



Inside the MetAir™ Ranger PPS, primary (non-rechargeable) cells are assembled into a replaceable power cartridge. Multi-cell stacks of prismatic shaped zinc-air batteries comprise the “engine” powering the Ranger Portable Power System. These cells can be combined in various form factors and connected in series or parallel, depending on voltage, capacity, and current requirements. Once discharged (completely utilized), the MetAir™ Power Cartridge is replaceable and can be disposed of in the normal waste stream. **The MetAir™ Ranger provides 275 amp hours (Ah) of stored capacity and a total energy output of 3,300 watt hours or 3.3 kilowatt hours in a compact 28 pound portable system.**

Enter the MetAir™ Ranger Portable Power System (PPS)

The MetAir™ Ranger is essentially a lightweight “plug and play” box of portable energy using modular, replaceable power cartridges built using QuantumSphere’s (QSI) proprietary prismatic shape zinc-air battery cells. The MetAir™ Ranger PPS is a “primary” (non-rechargeable) power source, however, the power cartridge inside can be conveniently used and replaced much like replacing the ink toner cartridge in a printer.



The MetAir™ Ranger PPS is easily scalable and can be configured to provide emergency or back-up power for all types of off-grid uses, such as:

- Powering first responder radio equipment in disaster zones
- Powering or recharging portable electronics while camping or boating

- Emergency preparedness for municipal, home, school, or business power outages
- Tactical military applications, among others

The MetAir™ Ranger PPS has options for an integrated 150 watt 110 volt AC inverter, which provides two AC outlets and a USB charging port. The AC inverter converts 12 volts of DC output from the MetAir™ Power Cartridge into a convenient source of on-demand power. This system is a mini portable power plant capable of charging or powering emergency communications equipment and a myriad of portable, rechargeable consumer electronic devices such as laptops, amateur radios, cell phones, cameras, tablets, oscillating fans, and small refrigerators and TVs.



Independent tests⁸ have shown that the MetAir™ Ranger PPS surpasses the emergency preparedness industry's 72-hour benchmark, achieving an unprecedented 192 hours – EIGHT days – of instantly accessible portable power for emergency communications equipment, based on a duty cycle that simulates standard use in the field.

In keeping with the demand for the portability required in emergency and off-grid situations, one MetAir™ Ranger PPS is roughly half the weight of a single deep cycle lead acid battery, yet provides more than EIGHT times the equivalent energy per kilogram – an extremely high energy-to-weight ratio. In fact, the MetAir™ Ranger PPS delivers the highest energy density of any commercially available disposable battery, in various lightweight form factors, at the lowest cost per kilowatt hour (by weight and volume)⁹. Additionally, these high-power disposable batteries utilize recycled zinc from Electric Arc Furnace (EAF) dust, turning hazardous waste into clean portable power.

Key Safety and Performance Benefits

- **Reliable** – In an emergency or off-grid situation, nothing is more important than knowing you can count on your back-up power source. The MetAir™ Ranger PPS is available immediately, at a moment's notice. There is no delay in recharging from an alternative power source, as with solar cells, and no hazard and inconvenience of refuelling, as with diesel generators.
- **Long-Lasting Power** - The MetAir™ Ranger PPS received independent third party first responder validation that it surpasses the emergency preparedness industry's 72-hour

⁸ Validation tests by Tracy Lenocker (call sign WA6ERA), Mountain Division Chief, Office of Emergency Services, San Bernardino County Fire Department, incorporated both field testing and lab equipment running simulated duty cycle tests representing standard emergency communication uses.

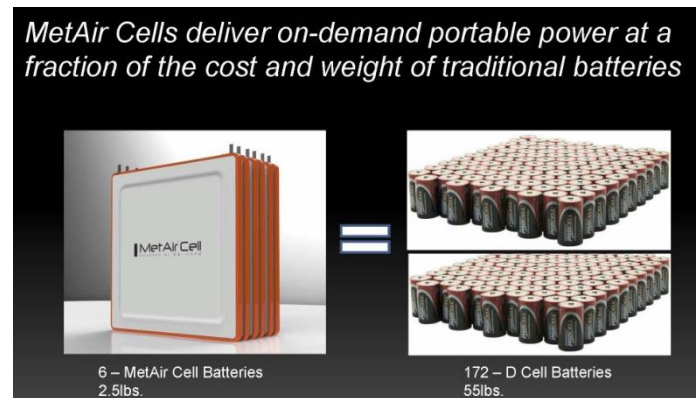
⁹ Energy densities of 268 Wh / Kg and costs per kilowatt hour of less than \$125

benchmark. The system achieved an unprecedented 192 hours – EIGHT days – of instantly accessible emergency power based on a standard use duty cycle.

- **5-Year Shelf Life Ensures Readiness** – A sealed MetAir™ Power Cartridge offers an unprecedented shelf life and performance warranty of up to 5 years before initial use. Alkaline and lead acid batteries suffer from low rate self-discharge that decrease shelf life dramatically. When lead acid batteries are stored fully charged, they suffer from a permanent capacity loss over time and must be maintained (re-charged) every three months to ensure a full state of charge and operational readiness.

Lead acid batteries experience a 40% permanent capacity loss over a 12 month period when stored at room temperature.¹⁰ The peace of mind and security of knowing your battery back-up power system has a long shelf life and will be ready and available when needed is a primary reason to utilize MetAir™ Ranger PPS.

- **No Charging Required** - Traditional back-up power solutions for emergency response, tactical military operations, or power outages must be constantly recharged using electricity or liquid fuel. Relying on combustible fuels, or solar- or wind-generated power in an off-grid situation can be dangerous, unpredictable, and inefficient. During critical times, fuel may not be available for diesel generators, and the sun and wind may not be available to charge lead acid batteries with solar panels. The MetAir™ Ranger PPS is maintenance free and requires no external energy sources to stay charged.



- **Portable, Lightweight** – At less than 28 pounds, the MetAir™ Ranger PPS is fully-equipped as a self-contained “plug and play” power source for emergency communications and portable electronic devices. It offers the highest energy/weight ratio of any commercially available primary/disposable or rechargeable battery.
- **Low Cost per Kilowatt Hour** – MetAir™ Power Cartridges yield energy densities of 268 Wh / Kg and costs per kilowatt hour of less than \$120. MetAir™ Ranger PPS delivers on-demand portable power at a fraction of the cost and weight of traditional portable batteries.

¹⁰ Power-Sonic Corporation

- Safe and Non-combustible** – Lead-acid batteries contain sulphuric acid, a highly corrosive and poisonous liquid that can cause severe chemical burns. MetAir™ cells contain zinc, a non-combustible, non-toxic material. When a lead-acid battery is charged, hydrogen and oxygen gases are formed, which can cause it to explode.¹¹ Lithium-ion batteries can rupture, ignite, or explode when exposed to high temperature or air. In the event of a fire, the device may emit dense irritating smoke.¹² Lithium batteries have been implicated in at least two fatal cargo plane crashes since 2006.¹³ MetAir™ cells contain no liquid fuels and are approved for transport via air, land, and sea by the U.S. Department of Transportation.



- Waste-to-Clean-Portable Power** – The primary fuel source material in the anode of the MetAir™ cells is zinc metal powder derived from recycled Electric Arc Furnace (EAF) dust. EAF is produced as a by product from steel mills and is classified as a hazardous material. EAF contains roughly twenty percent zinc which is recycled, refined, and treated for use in batteries and other applications. The resulting high purity zinc powder is safe, non-toxic, non-combustible, and environmentally friendly - delivering clean portable power in the MetAir™ Cells. And because these zinc-air batteries contain no added mercury, cadmium, lead or lithium, the replaceable MetAir™ Power Cartridges are considered safe for disposal in the normal waste stream with no special hazardous waste handling required.

- High Energy-to-Weight Ratio** – The MetAir™ Ranger PPS is about the size of a single deep cycle (heavy duty) lead acid marine battery, yet it weighs roughly half as much and provides more than EIGHT times the equivalent energy density per kilogram.
- Versatile** - The MetAir™ Ranger PPS can be configured to provide emergency or back-up power for all types of off-grid or portable electronic uses including outdoor sports and recreation, and military, among other applications. Power outlets include 110 VAC and an USB charging port.

¹¹ http://www.ehow.com/info_8139940_dangers-lead-acid-batteries.html

¹² Electrochem Commercial Power (9 September 2006). "Safety and handling guidelines for Electrochem Lithium Batteries"(PDF). <http://marine.rutgers.edu>. Rutgers University. Retrieved 21 May 2009.

¹³ <http://www.fastcompany.com/1836973/postal-service-usps-bans-lithium-batteries-ipad-kindle-iphone-smartphone-laptop>

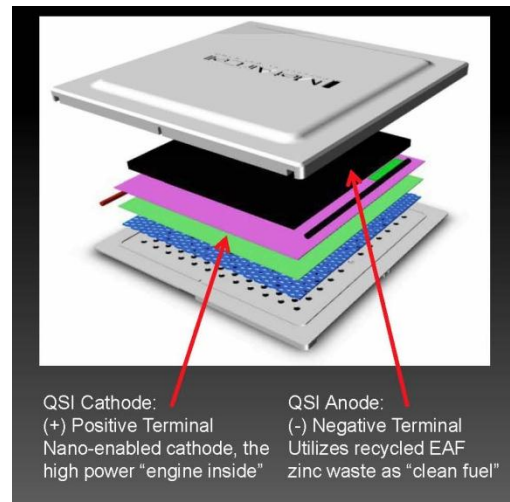
“Under the Hood:” About Zinc-Air Batteries

Based on low cost, reliable, century-old zinc-air battery chemistry, the unique MetAir™ Ranger PPS technology offers high energy densities that are extremely safe and relatively inexpensive to produce. QSI has several patents issued and applications pending covering key aspects of this technology.

Unlike other common battery chemistries, such as lithium-ion, nickel metal hydride and lead acid, zinc-air batteries are electro-chemical batteries powered by exposing zinc metal to oxygen from the air to generate an electrical current. The user literally pulls a tab to break the seal, thereby activating airflow into the battery and generating an electrical current. Once activated, the oxygen from the air slowly turns the zinc into zinc-oxide. Then, when the activated battery has been fully utilized, it is safe for disposal in the normal waste stream. This technology is similar to the hundreds of millions of small zinc-air button cell batteries consumed annually around the world in hearing aids and other small electronic devices.

How It Works

Batteries of all types have two main components; anodes and cathodes along with other key ingredients such as an active catalyst and electrolyte to connect and activate them. For zinc-air battery operation, the fuel for the cathode is simply oxygen from the air we breathe and the fuel for the anode is zinc metal powder. Inside the battery, a mass of zinc particles form a porous anode, which is saturated with an electrolyte to make it electrically conductive. Oxygen causes a reaction that forms hydroxyl ions, which in turn forms zincate, thereby releasing electrons to travel to the cathode. QSI’s patented nanotechnology production processes create the high surface area advanced catalysts that facilitate this electrochemical reaction with greater efficiencies, resulting in higher energy densities within the zinc-air battery.



Unlike a conventional battery that contains both cathode and anode material, oxygen from the atmosphere is one of the battery reactants and is not packaged within the battery. So a cell can contain more zinc fuel in the anode to provide more capacity, or run time, than a conventional battery. As a result, the MetAir™ Ranger PPS has higher energy capacity-to-volume (and weight) ratio than any other commercially available battery.

Portable Power Provided by the MetAir™ Ranger PPS Serves a Variety of Mission Critical and Emergency Applications

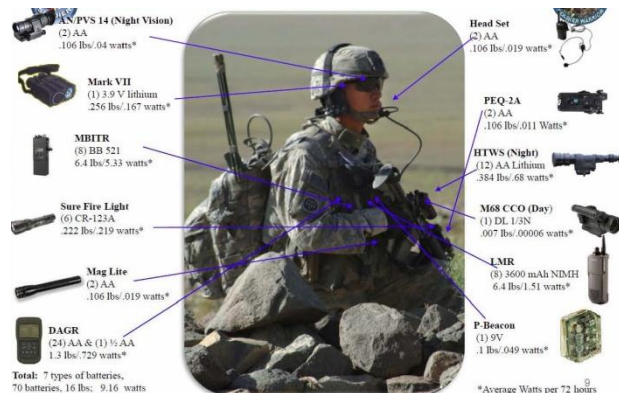
First Responder Need and Validation

According to the Public Safety and Homeland Security Bureau, disaster preparedness and recovery planning is designed to reduce the disruption of essential services when an emergency situation occurs. Emergency communications planning is a key component of any disaster plan.¹⁴ In an emergency, phones, gas, water, and electrical services may be unavailable for an extended period. Experts suggest being prepared for at least 72 hours or three full days should a disaster occur. As a result, emergency responders, utilities and crisis management professionals need reliable tools to ensure ongoing communication capabilities for at least 72 hours following an event. The MetAir™ Ranger PPS has been validated to exceed that threshold, delivering up to 192 hours of clean, quiet, safe, reliable, off-grid / back-up power, day or night.

According to Tracy Lenocker (call sign WA6ERA), Mountain Division Chief, Office of Emergency Services, San Bernardino County Fire Department, “In our field tests, the MetAir™ Ranger portable zinc-air power system far exceeded our performance expectations. For mission critical applications using amateur and commercial radios we need to have at least 72 hours of battery run-time. Recent testing during actual events and simulated duty cycle tests showed that the MetAir™ Ranger battery life exceeded the 72-hour requirement by 120 hours, that’s 192 hours or EIGHT days of constant, hassle-free portable energy. With a long shelf life that guarantees readiness in emergency situations, this reliable back-up power source helps alleviate worries associated with the need for constant re-charging of traditional secondary rechargeable batteries.”

Tactical Military Operations

MetAir™ Cells can be assembled into a custom lightweight wearable battery pack and can help reduce soldier worn battery weight by up to 30%, reducing the logistical burden while providing enhanced power access, safety, mobility, and reliability during 72+ hour tactical operations.



Outdoor Sports and Recreation

Outdoor sports and recreational enthusiasts can use MetAir™ Ranger PPS for off-grid power during camping trips, or endurance sporting events, such as off-road rallies that span several days in remote areas. Each application will benefit from the convenience of constant, reliable, safe, lightweight, on-demand, portable electric power. Additionally, the MetAir™ Ranger PPS has multiple uses in the marine industry for recreational boaters. For small craft with electric motors, the MetAir™ Ranger PPS can be a reserve battery in the event the lead acid battery becomes fully discharged and the craft still needs power to return to shore. Another application is powering ancillary lights, radios, navigation devices, and desalination systems on powerboats or sailboats when power is not available from the engine, generator, or main battery bank.

¹⁴ <http://transition.fcc.gov/pshs/emergency-information/guidelines/first-responders.html>

Marine Emergency Need and Validation

QuantumSphere recently supported the four crew members of Arctic Row with two MetAir™ Ranger PPS on their historical and unprecedented 1,100-mile expedition across the Arctic Ocean. The custom-designed portable zinc-air battery systems provided emergency back-up and charging power for the rowboat's electrical system and rechargeable electronic devices during their epic journey from Canada to Russia.

Only 495 ocean rowers have successfully crossed an ocean and no one has ever completed a crossing of the frigid Arctic Ocean by rowboat, according to the Ocean Rowing Society. The team is comprised of four members who took on two rowing positions at a time, trading off every two hours for 24 hours a day for the month-long adventure.¹⁵

The boat's instruments were previously solely powered by lithium batteries recharged by a solar panel and wind-turbine system. Contemplating the unpredictable nature of weather extremes, the team reconsidered their approach. In mission-critical and other life threatening applications, one cannot trust that the sun and wind will be present when needed most, and reliable, on-demand back-up power sources are an absolute necessity for survival.

After learning about QuantumSphere's zinc-air battery technology, the team relied on the new MetAir™ Ranger PPS for back-up power to recharge portable electronic devices and the lithium battery connected to a radio, GPS navigation system, and the onboard desalination water system. In field tests, the MetAir Ranger™ PPS achieved an unprecedented 192 hours – eight days – of instantly accessible back-up power for emergency communications equipment, while offering the highest energy density of any commercially available primary disposable battery at the lowest cost per kilowatt hour.

“Given the size and weight constraints of our boat, the MetAir™ Ranger provides us with a very efficient and reliable back-up power source in case solar and wind power are not available or we encounter an emergency situation”, said Arctic Row Team Member, Neal Mueller. “We selected MetAir™ Ranger because of its compact size, high power, light weight, and portability.”

The revolutionary technology contained in the Met Air™ Ranger PPS fills a vital need for reliable, safe and convenient portable power. Its proven reliability, immediate accessibility, and longevity position it uniquely for multiple applications within the \$50B portable power market. For more information and order inquiries, visit www.qsinano.com.

¹⁵ <http://www.latimes.com/news/nation/nationnow/la-na-nn-arctic-row-20120704.0.1854635.story>