

White Paper

# Reducing the Battery Burden on the Dismounted Soldier

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For the dismounted soldier, loss of power to critical equipment such as radios is not an acceptable option. However, the burden of carrying numerous spare batteries contributes significant additional weight. This white paper explores current thinking in power provision solutions that mitigate risk and reduce soldier burden.

## Primary batteries - Impacting the burden on the dismounted soldier

The weight of batteries carried by modern combat infantry is striking. This is largely driven by the widespread use of primary batteries. According to a 2011 article, a typical Canadian soldier may carry a set of fifteen AA batteries and two CR123 batteries upon exiting a forward operating base. If a mission is expected to last more than three hours, a further set of batteries will be carried. Once the expected mission time exceeds 24 hours, a soldier will carry a third set of AA and CR123 batteries – a total of 51 batteries.

Another 2011 article reported that the average weight of batteries carried by US Army combat personnel in Afghanistan could amount to 4.5kg (10lb) – with some soldiers carrying 11.7-13.2kg (26-29lb) depending on their battlefield role. British soldiers are also expected to carry a considerable burden in order to power their electronic equipment. In 2012 it was reported that British infantrymen could carry 12.3kg (27.1lb) in batteries for a 36-hour patrol.

When one considers that a modern soldier will carry equipment weighing 30-50kg (66-110lb), of which as much as 25% can be batteries, the need to reduce this burden becomes even more pressing. Excess weight reduces a soldier’s mobility and considerably increases the risk of musculoskeletal injuries.



Figure 1: Radio with rechargeable battery

## Battery failure at a critical moment is not an option

Long aware of this problem, armed forces have been exploring a variety of ways in which to reduce the weight of a soldier’s battery burden. Reducing the power consumption of equipment can help to reduce the number of spare batteries that need to be carried. It is important to maximise the use of low power components in the design of dismounted systems, and to ensure that software runs efficiently on the hardware being employed. However, there are limits to the extent to which power demand can be reduced.

Studies have shown that non-rechargeable batteries are often discarded before they have been fully discharged, at a considerable logistic and environmental cost. A study by the US Army Communications – Electronics Research, Development, and Engineering Center (CERDEC) found that 50% of discarded batteries had more than 50% of their charge remaining. The reason for this is simple, a soldier cannot afford for a piece of equipment to fail at a critical moment. In order to ensure that a device will function for as long as possible, primary batteries are invariably changed for fresh cells, even if some charge remains.

**“A modern soldier will carry equipment weighing upwards of 30kg, reducing a soldier’s mobility and considerably increasing the risk of musculoskeletal injuries”**

Increasing the useful life of equipment is therefore only one part of the process of reducing the overall power burden. Setting aside the challenge to logisticians of supplying non-rechargeable batteries into theatres of battle, primary cells also present other operational disadvantages to soldiers. Providing a suitable housing with access to remove and replace primary cells often adds unwanted size to a radio. This will also present an opening for the ingress of dust and water when changing batteries.

**“A rechargeable battery that is small and light, while being rugged, is an ideal starting point”**

## **Rechargeable batteries – A more efficient and cost effective solution**

The main option for powering soldier equipment is to use rechargeable (secondary) cells on each of the high power consumption modules. Secondary cells may not be suitable for all equipment, for example low power equipment may not justify their use so some mix of primary and secondary cells may be required. However, the main burden of batteries is driven by high power modules and significant savings can be made here.

The use of secondary batteries entails a need for battery chargers, spare batteries and processes to manage the re-charge cycle. These have been very successfully dealt with on existing in-service modules. The deployment of common (multi-battery) chargers, power scavenging from numerous sources, improvements in the number of charge cycles and regular increases in secondary battery power densities have made a compelling case for the use of rechargeable batteries on all major soldier equipment.

The use of a rechargeable battery that is small and light, whilst still being rugged, is an ideal starting point. The addition of a useful life in excess of 24 hours and the option to scavenge power from almost any USB-equipped power source creates a compelling alternative to carrying pockets full of AA batteries. Potential power sources for replenishment of batteries include laptops, solar panels, or vehicle cigarette-lighter sockets.

The adoption of a centralised rechargeable system offers further benefits where a soldier has multiple electronic devices to power. Many developed nations are experimenting with centralised units that supply power to each of the dismounted soldier's individual electronic devices. By centralising power in this way, it can be easier to achieve a higher overall power density for a given weight, thus reducing the overall soldier power burden further.

Moreover, such centralised power units open up the future possibility of using innovative technologies, such as fuel cells, to power equipment and/or re-charge distributed batteries where they are retained on critical modules such as radios. The biggest challenge faced by those developing centralised power solutions comes in the need to package the power connectivity around the user in an acceptable manner. This currently entails the use of an array of cables and diverse connectors. However, evolving standards and technology solutions are addressing these issues in a manner which will allow connection to both new and legacy modules from a central power source.

The transition to central power sources, with suitable back-up batteries located on critical equipment, does offer major advantages. In particular the simplification of battery logistic demand.

Centralised power offers the best approach to minimising total weight burden through use of high power-density main batteries. It provides an approach well suited to “topping up” from external sources (fuel cells, vehicles, solar arrays, etc.). It offers major Whole Life Cost (WLC) savings to the user community including reducing the number of bespoke battery charging solutions required. It will provide the path to a suite of equipment with common connectors which can be readily swapped between locations and users.

However, these systems are still evolving and are not yet in use. Moreover, it can be anticipated that future armies will deploy mixed fleets of central and ‘local’ power systems across their user communities to suit specific user needs. There is therefore a need for an immediate and enduring ‘local’ solution which also supports the transition to central power systems as these emerge.

## The way ahead

Soldier equipment which demands a significant amount of power, such as radios, must be designed to provide the means to allow the best management of that power demand and provide migration paths to function with future central power systems.

The use of an optimised, low profile, rechargeable power source meets the immediate and enduring need for a local power solution with significant weight and through-life cost benefits over primary batteries.

The ability to replace this battery (in the future) with a central power ‘interface module’ including a local back-up battery provides the future-proofing to ensure equipment bought now can still be used with future soldier systems.

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