DEFENSE STANDARDIZATION PROGRAM

CASE STUDY

2002

ARMY BATTERY STANDARDIZATION

Rechargeable Batteries Power the Future Force

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This case study illustrates how the U.S. Army slashed operational support costs while improving performance of portable power for military vehicles and communications-electronics devices through standardization and improved technology.

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ARMY BATTERY STANDARDIZATION

Standardization Case Study

Rechargeable Batteries Power the Future Force

Background

During the 1970s and 1980s, Army systems were using more than 350 different types of 1.5-volt to 30-volt military batteries. The proliferation of battery types led to high expenditures for batteries and decreasing unit readiness and interoperability.

In 1995, as the Army received increasing pressure to reduce battery-related operational support costs, the Power Sources Center of Excellence (PSCOE) in the Communications–Electronics Command (CECOM) at Fort Monmouth, NJ, was established as a forum for portable power and power management issues. PSCOE membership includes technical and logistics representatives from the Army, Air Force, Navy, Marine Corps, and Defense Logistics Agency (DLA).

Problem

Several significant trends in the Army provided impetus to establish PSCOE:

- Increasing demand for portable power
- Rising battery expenditures
- Proliferation of battery types
- Decreasing military battery industrial base
- Decreasing unit readiness and interoperability.

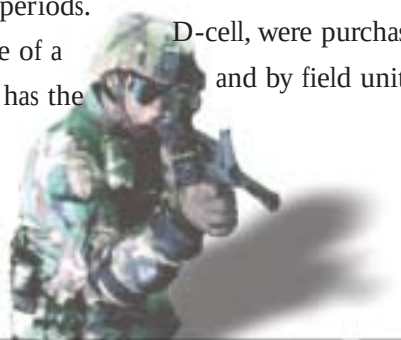
Increasing Demand for Portable Power

Portable power requirements of the digitized battlefield and its equipment are increasing the demand for more powerful batteries. The current inventory of U.S. military battery-dependent equipment contains more than 456 communications–electronics (C-E) devices such as radios, laser rangefinders, telegraph terminals, global positioning systems, night vision devices, meteorological systems, and early warning sensors. Their batteries must be extremely safe, lightweight, capable of operating in a wide range of temperatures and atmospheric conditions, capable of producing more power per unit volume, and operating after long storage periods. Land Warrior is one example of a power-intensive system that has the potential to double current Army battery requirements if disposable batteries are used.

Land Warrior is an Army program that increases the lethality, survivability, and command and control capabilities of individual soldiers in close combat. The Land Warrior program also depends heavily on electronic components that require significant portable power and that most likely will be provided by rechargeable batteries and fuel cells.

Rising Battery Expenditures

In 1996, the Army spent approximately $100 million on batteries, and expenditures for batteries were rising to historically high rates. Battery expenditures were distributed in approximately the percentages shown in Figure 1: 70 percent for C-E applications; 20 percent for vehicle applications; and 10 percent on aircraft and missile batteries. In addition, many other batteries, such as AA-, C-, and D-cell, were purchased through DLA and by field units using purchase



Initial fielding of Land Warrior is approximately 35,000 units.

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cards. Batteries for C-E applications consumed approximately 18–20 percent of a typical Army unit's annual operating budget.

Figure 1. Distribution of Battery Expenditures

Proliferation of Battery Types

A proliferation of battery types stemmed from the "one mission–one battery" philosophy. Rather than incorporate an existing battery type into a new system design, materiel developers often specified a unique battery for each system. This lack of standardization resulted in larger logistical footprints and increased operational support costs based on allocated space for the power source.

Decreasing Industrial Base

Several years ago, large battery manufacturers such as Eveready and Duracell walked away from the military battery business because of low-volume demand. Compared to commercial battery demand, the military-unique battery demand was small, which in turn created higher unit costs and uncertain contractual commitments. The result was a decreasing industrial base for military batteries.

In 1996, the Army Chief of Staff challenged the Army to reduce battery expenditures by 50 percent. To meet this challenge, PSCOE focused on the following:

- Improved primary and rechargeable batteries
- Battery standardization
- Power management (i.e., efficient generation, storage, regulation, conservation, and consumption of power)
- Alternative power sources (e.g., thermophotovoltaics, fuel cells, and solar power)
- Mobile electric power generators
- Forward-area charging (i.e., simplify and move battery charging capability as close as possible to the area of need).

Decreasing Unit Readiness and Interoperability

Unit readiness suffered from uncertain stock availability plus the requirement to stock, store, and issue increasing numbers of battery types. Battery size and weight are critically important, especially for dismounted soldiers. Sometimes squad leaders are required to carry as much as 20 pounds of batteries to accommodate various equipments' battery requirements. The proliferation of battery types also led to a lack of interchangeability of batteries within a single Army unit and when batteries were used in equipment in joint and combined operations.

Solution

Solutions to some problems involve improved battery technology and standardization. By dramatically decreasing the number of commercial and military primary (nonrechargeable) battery types in new equipment, while encouraging the use of preferred military rechargeable batteries and chargers, PSCOE was able to significantly reduce operational support costs and shrink the logistical footprint. The result was reduced weight, enhanced operational performance, and increased interoperability and availability.

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> Packing [for deployment to Kosovo] was noticeably easier because the BB series [rechargeable] batteries are not hazardous material and no special paperwork or packing was required.
>
> *3rd Battalion, 504th Parachute Infantry Regiment, Fort Bragg*

Constraints

PSCOE is addressing other constraints as it continues to solve the numerous problems associated with battery proliferation:

- Solutions must meet the demanding power requirements (e.g., reduced weight, longer operating times, reduced cost) of increasingly powerful and sophisticated military devices and equipment.
- Solutions must include the capability to operate under extreme field conditions, temperature ranges, and physical abuse.
- Soldiers must be convinced that battery-related changes improve current operating procedures and do not interfere with the mission.

A key factor is battery technology. Recent advances, such as improved rechargeable batteries, have been instrumental in success. Previously, rechargeable batteries were hampered by weight, higher initial cost, limited operating time, and the time and effort to recharge batteries. The improved rechargeable batteries minimize these constraints, require less storage space, and provide for easier transport and disposal.

Approach

PSCOE's approach incorporated policy changes, new technology, reduced proliferation, and education. PSCOE took steps to

- reduce types of batteries and encourage preferred batteries,
- develop a battery standardization policy,
- improve battery safety and reduce environmental impact, and
- increase education and market standardization.

Reduce Types of Batteries and Encourage Preferred Batteries

PSCOE developed a preferred list of commercial and military primary and rechargeable batteries by grouping all batteries into voltage categories and selected as standard batteries those with the greatest number of systems applications. The preferred list considered battery shape, size, and connector type. The Army developed an equivalent rechargeable battery for most preferred primary batteries and a single universal charger to service all rechargeable C-E batteries.

Develop a Battery Standardization Policy

PSCOE developed a standardization policy to reduce the number of battery types the Army must manage and support, while improving battery safety and performance and reducing cost. PSCOE worked with Army executives to craft the following specific policy directives:

- When developing new systems that require portable power, Army program managers must select power sources from the PSCOE list of preferred commercial and military batteries or obtain a waiver from the Army Acquisition Executive. (In all new programs that require portable power, program managers select independently, or work with PSCOE to select, power sources from the approved standard list. No waivers have been issued since the policy was instituted in 1996.)
- All units (except units that use fewer than 12 batteries a year) must use rechargeable C-E batteries for garrison duty, training, and support and stability operations when the commander deems it appropriate, except in wartime operations.

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> I have been asked why this [use of rechargeable batteries] seems to work for us and not for other units, and all I can say is that maybe we want it to work.
>
> *3rd Battalion, 504th Parachute Infantry Regiment, Fort Bragg*

- All program executive offices, deputies for systems acquisition, and program managers must field new equipment using military or commercial standard batteries with an initial issue quantity of the rechargeable battery and its charger.

Improve Battery Safety and Reduce Environmental Impact

As battery technology improves, PSCOE will introduce new standard primary and rechargeable batteries with safer chemistry and fewer adverse environmental impacts. Lithium-manganese dioxide (Li/MnO^2) batteries are replacing older lithium-sulfur dioxide (Li/SO^2) primary batteries, and newer lithium ion (Li-Ion) batteries are replacing rechargeable nickel metal hydride (NiMH) batteries where possible.

Increase Education and Market Standardization

To implement battery standardization in the field and promote the benefits of rechargeable batteries, PSCOE conducts an education and marketing program that includes the following:

- Demonstrations and operational field use promote conversions to rechargeable battery power. The 3rd Battalion, 504th Parachute Infantry Regiment from Fort Bragg, NC successfully used rechargeable batteries during its 6-month peacekeeping deployment to Kosovo in 1999. The unit endorsed using rechargeable batteries, which significantly reduced costs and increased logistical advantages.
- PSCOE visits battery maintenance shops to promote rechargeable batteries. The maintenance facilities that use rechargeable batteries provide feedback on battery use and any operational issues.
- PSCOE publishes information through websites, online databases, newsletters, and magazine articles to educate Army units on the advantages of rechargeable batteries and standardization.
- CECOM, in conjunction with the Combined Arms Support Command and Forces Command, conducted a study that proved that rechargeable batteries work in combat and that field charging does not burden manpower or cost.

Outcomes

Through standardization of primary and rechargeable batteries, the Army achieved the following results:

- Reduced number of military-unique battery types
- Reduced battery purchases
- Reduced disposal costs
- Improved safety
- Increased battery interchangeability
- Reduced logistics support footprint
- Improved industrial base
- Improved contracting and pricing
- Improved stock availability
- Increased commercial content
- Increased unit readiness
- Reduced operational support costs.

Reduced Number of Military-Unique Battery Types

By November 2001, the Army had reduced the number of 1.5-volt to 30-volt military-unique battery types used in new systems from more than 350 during the 1980s to 35 types. The goal is to standardize on 25 military-unique batteries. To support legacy equipment (often found in the National Guard and Army Reserves), more than 300 low-demand battery

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types will remain in the logistics system inventory until the legacy equipment is disposed of or redesigned. In these cases, conversion to a preferred battery can be uneconomical. The cost of redesigning systems outweighs the benefits. The demand for these batteries is too low and the expected remaining life of the legacy equipment is too short to justify the cost of developing replacement batteries and disposing of the existing stocks.

Reduced Battery Purchases

The Army now spends $75 million a year on battery purchases for all applications, a 25 percent reduction from its 1996 baseline. The decrease is significant in light of increases in fielded Army systems, training, and the number of worldwide conflicts involving the U.S. Army. The growing use of rechargeable batteries accounts for a significant portion of the savings.

Reduced Disposal Costs

Rechargeable batteries last longer and are disposed less frequently. The result is lower disposal cost. For example, with the SINCGARS AN/PRC-119 Manpack Radio, the Army can save $417 in disposal costs or 88 percent per radio over a 3-year period on batteries alone.

Improved Safety

The Army is moving away from older Li/SO^2 to the newer, safer Li/MnO^2 chemistry. Lithium-sulfur dioxide batteries use pressurized cylindrical cans that are hazardous when punctured or abused. The high-energy-density Li/MnO^2 cell is not pressurized. Hazardous gasses venting from older cells are a serious safety issue. Replacing older cells in most electro-optical-type devices, such as night vision goggles, with new chemistry cells avoids the possibility of a battery venting noxious gas in the face of a soldier because of a short circuit or overheating. The Army will continue to take advantage of new battery technology by replacing older preferred batteries with newer and safer chemistries.

Increased Battery Interchangeability

Through standardization of primary and rechargeable batteries, the Army achieved a higher level of battery interchangeability within military units and across joint and combined operations. Several foreign nations have adopted the DoD battery system and are buying U.S. Army batteries. For example, the Australian army purchases U.S. Army batteries for operational use in East Timor.

Reduced Logistics Support Footprint

Using rechargeable batteries reduces the number of batteries that must be purchased, shipped, and stored. The 3rd Battalion, 504th Parachute Infantry Regiment from Fort Bragg estimated the cost savings attributed to using rechargeable batteries for its 6-month peacekeeping mission in Kosovo to be $665,790. The 2nd Battalion, 502nd Infantry Regiment, 101st Airborne Division (Air Assault) from Fort Campbell, KY, conducted a feasibility study for the best battery purchase plan and determined that rechargeable batteries yielded cost and flexibility advantages.

Improved Industrial Base

Standardization enables the Army to offer manufacturers greater production volumes. With higher volumes, a single battery now may appear on multiple contracts (typically split between two manufacturers on a 60/40 basis), and a single contract may cover multiple battery types. The Army's goal is to contract with at least two manufacturers for each primary battery type to help ensure uninterrupted supply availability.

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When our projected annual battery needs budget dropped from $180,000 to $37,000, the argument against recharging becomes even more absurd.

3rd Battalion, 504th Parachute Infantry Regiment, Fort Bragg

Improved Contracting and Pricing

The Army transitioned to 5-year, flexible contracts. The manufacturer bids a 5-year production with firm prices established for each performance period. Contracts contain specific testing and quality requirements. Rechargeable batteries are warranted by the manufacturer for 4 years. As sales of commercial rechargeable cells and batteries rise, the Army can take advantage of the higher volume to lower unit costs. The result is lower, more stable costs, with some battery prices reduced by 30 percent.

Improved Stock Availability

The improved supplier base, contracting, and pricing have resulted in improved stock availability. Recently the Army attained a 90 percent battery stock availability, an improvement from the 85 percent baseline availability during the 1990s. Flexible contracting and close coordination with manufacturers made the improvement possible and increased the likelihood of continuous deliveries.

Increased Commercial Content

The Army also has integrated commercial components into its military-unique batteries. All rechargeable NiMH and Li-Ion batteries use commercial battery cells of the type found in laptops and cell phones. As sales of commercial rechargeable cells and batteries rise, the Army can take advantage of the higher volume and lower unit cost.

Increased Unit Readiness

Increased use of longer-lasting primary and rechargeable batteries has resulted in higher unit readiness. Because of standardization and the longer life cycle of rechargeable batteries, units can reduce the number and weight of batteries they requisition, manage, and carry. For example, the BB-390 NiMH battery life is two to three times longer (depending on application) than the nickel cadmium (Ni-Cad) equivalent. The BB-2590 Li-Ion version will last even longer and weigh a pound lighter. Another benefit of rechargeable batteries is increased energy independence—units can continue to operate using rechargeable batteries even if logistics pipelines that provide battery replacements are severed or delayed.

Reduced Operational Support Costs

Standardization and technology advances, which are resulting in reduced battery purchases, reduced disposal costs, increased battery interchangeability, a smaller logistics support footprint, and improved pricing, are contributing to the overall reduction in operational support costs for portable power.

Investments and Payoffs

A 1996 CECOM study, validated by the Army Audit Agency, concluded that the average Army battalion could reduce its battery expenditures by 66 percent during a 3-year period by using rechargeable batteries for training. The study showed that a switch from primary to rechargeable batteries by five selected battalions would amount to average savings of $300,000 in the first year and $1.9 million in 3 years. According to PSCOE, savings from using rechargeable batteries may approach $8 million to $15 million annually if the Army maximizes their use in the field as soon as possible.

In FY97, PSCOE received $10.7 million in Army funds to apply to the

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reduction of battery-related operational support costs. PSCOE promised to demonstrate a return on investment of $33 million over the following 7 years. On the basis of quarterly sales measurements, the Army saved more than $43 million during the first 4 years alone; of that, more than $30 million was related to rechargeable C-E battery and charger use.

Current Status

The Army's digital battlefield will continue to drive power demands upward, especially when the Land Warrior system is introduced. Batteries will remain the critical energy source for portable electronic equipment for many years to come.

PSCOE estimates that the Army has already achieved a 30 percent conversion rate from primary to rechargeable batteries. The largest hurdle facing further conversion is the upfront cost associated with procuring rechargeable batteries and chargers. Because individual units have difficulty making this investment, PSCOE recommends that the Army, rather than individual operational units, provide the initial investment. It will cost approximately $48 million to outfit remaining active Army, National Guard, and Army Reserve units with rechargeable batteries.

PSCOE also advocates a change in Army doctrine that would allow rechargeable battery use in combat, not just for use in training and garrison duty. PSCOE continues to inform and educate soldiers of the potential savings and operational benefits of rechargeable batteries. Several Army units deployed to peacekeeping missions in Kosovo, Bosnia, and Afghanistan have used rechargeable batteries successfully, demonstrating that charging batteries in the field is not a significant issue.

PSCOE is working closely with the International Elecrotechnical Commission, a nongovernment standards organization, to develop a draft standard for lead acid and nickel-cadmium batteries for use in commercial and military aircraft. Efforts also focus

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on developing a lithium ion battery standard for aircraft applications.

PSCOE is committed to finding the most power-efficient solutions for the least weight and cost. Its commitment includes investigating and developing promising new technologies such as fuel cells, thermophotovoltaics, micro-turbines, ultra-capacitors, and hybrid systems, as well as advances in power management techniques to reduce battery use and improve operating efficiency.

Lessons Learned

The following is a summary of the lessons learned in this case that might have application in other areas:

- Standardization initiatives may start with a wake-up call provided by operational, logistical, or cost issues, which grab the attention of leaders.
- Standardization and item reduction are one set of solutions that can improve interoperability, logistics readiness, and life-cycle cost.
- The *one mission–one item* philosophy often proves costly with profound implications for interoperability, logistics readiness, and life-cycle cost.
- Standardization can help create and maintain a healthy industrial base, hold down unit costs, and increase product availability.
- Standardization can yield many secondary benefits such as improved safety, reduced environmental impact, increased contract leverage, better power performance, and lower life-cycle cost.
- Successful standardization efforts may require seed money to yield early and effective results.
- Effective and creative standardization policy is a critical component for deploying standardization solutions into practice.
- Customer involvement from start to finish is essential in finding solutions that satisfy requirements.
- Education and marketing are a necessary part of the standardization strategy to ensure that all stakeholders understand the underlying reasons and benefits.
- Advocacy by operational leaders is key to convincing soldiers to adopt change.
- Clear guidance and authority to execute standardization can set the stage for success.
- When the objective is clear and strongly supported by leadership, standardization can be straightforward and uncomplicated.

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This unit [equipped with rechargeable batteries] can sustain peacekeeping operations virtually indefinitely at a significantly reduced cost and significantly reduced battery logistic dependency. And, it is my assessment that this unit can [also] fight using this technology with the same cost [savings] and [improved] logistic freedom.

3rd Battalion
504th Parachute Infantry Regiment
Fort Bragg

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