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Report to Congressional Committees

December 2010

DEFENSE ACQUISITIONS

Opportunities Exist to Improve DOD's Oversight of Power Source Investments

GAO-11-113

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GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-11-113, a report to congressional committees

Why GAO Did This Study

Virtually all Department of Defense (DOD) weapon systems and equipment rely on power sources, such as batteries. In response to a mandate in the National Defense Authorization Act for Fiscal Year 2010, GAO determined (1) DOD's approximate investment in power sources, (2) the extent to which DOD coordinates its power source investments, and (3) the extent to which DOD's policies facilitate the use of standard power sources. To address these objectives, GAO obtained and analyzed DOD investment data, met with DOD officials and industry representatives, and attended DOD conferences aimed at facilitating power source coordination.

What GAO Recommends

To increase oversight of power source investments, GAO recommends that DOD consider how to best aggregate departmentwide investment data. To improve interagency coordination of S&T projects, DOD should determine ways to strengthen agency participation in coordination mechanisms. To increase emphasis on standardization, DOD should develop a standardization plan and enforceable departmentwide policies and identify opportunities to retrofit existing systems with standard power sources when cost effective. DOD concurred with the first recommendation and partially concurred with the other four. It was unclear from DOD's response what actions it plans to take in response to GAO's recommendations.

View GAO-11-113 or key components. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

What GAO Found

GAO determined that DOD has invested at least $2.1 billion in power sources from fiscal year 2006 through fiscal year 2010. However, DOD lacks comprehensive, departmentwide data for its total investment in the power sources area. Availability of complete data varies across the three investment categories: science and technology (S&T), logistics support, and acquisition programs. While DOD appears to have adequate departmentwide data on S&T efforts, it does not have departmentwide data for all logistics support investments. DOD lacks sufficient data on its investments in power sources when they are developed or purchased for acquisition programs. The $2.1 billion amount includes investments in S&T and logistics support that GAO was able to identify, but not power source investments as part of acquisition programs because of the difficulty in obtaining investment data in that area. This lack of complete, departmentwide investment data hinders DOD's oversight and future planning in the power sources area, adversely affecting its ability to ensure basic accountability, anticipate future funding, and measure performance.

DOD's mechanisms for coordinating power source S&T—including interagency working groups, conferences, informal networks, and information technology resources—are generally effective. However, in some of these activities participation by pertinent member agencies is voluntary and could be more complete. Agencies may be missing opportunities to coordinate activities—such as avoiding initiation of similar research projects—and leverage resources because agency participation is voluntary and the level of participation by pertinent agencies varies. In addition, DOD's strategic planning process to facilitate the allocation of S&T funds for power source technologies could be improved. The S&T planning efforts can also be complicated by external factors, such as the additions Congress makes to DOD's budget.

Although DOD power source experts GAO staff spoke with agree that the department needs to increase its emphasis on power source standardization, DOD lacks departmentwide policies to help emphasize power source standardization. Existing policies have demonstrated limited effectiveness because of compliance problems and because they may only apply to specific power source applications. Although it is generally more economical to address standardization early in the acquisition process, according to DOD officials, power sources are generally not considered early in the process, potentially hindering standardization efforts. DOD has also not evaluated departmentwide opportunities for retrofitting deployed weapon systems and equipment with standard or other preferred power sources when cost effective.

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Chairman
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Ranking Member
Committee on Armed Services
United States Senate

The Honorable Ike Skelton
Chairman
The Honorable Howard P. McKeon
Ranking Member
Committee on Armed Services
House of Representatives

Virtually all Department of Defense (DOD) weapon systems and equipment rely on power sources such as batteries. We estimate that DOD invested at least $2.1 billion in power sources from fiscal year 2006 through fiscal year 2010 in three investment areas: science and technology (S&T) activities such as research, logistics support such as providing the warfighter with supplies, and acquisition programs such as those for weapon systems or equipment. This amount will likely rise because of growing warfighter energy and power demands as well as interest in smaller, lighter, and more capable power sources. Power sources are a mission-critical technology and may ultimately affect the warfighter if DOD is unable to meet demand. For example, severe shortages of some types of batteries during initial combat operations in Iraq threatened to significantly degrade the operational capabilities of the United States military.[1] During the shortages, caused in part by industrial base limitations and initial reliance on one supplier, the Marines reported

[1] The batteries that were in short supply are used by United States troops to communicate, acquire targets, and gain situational awareness on the battlefield. Specifically, these non-rechargeable batteries provide a portable power source for nearly 60 critical military communication and electronic systems, including two radio systems, a missile guidance system, and a transmission security device.

having less than a 2-day supply of certain mission-critical batteries rather than the required 30-day supply.[2]

The National Defense Authorization Act for Fiscal Year 2010 mandated that GAO determine DOD's power source investments and coordination efforts.[3] In this report, our specific objectives were to (1) determine, as completely as possible, DOD's total investment in power sources; (2) assess the extent to which DOD coordinates power source S&T investments departmentwide as well as with the Department of Energy (DOE); and (3) assess the extent to which DOD has policies that facilitate power source standardization. In consultation with congressional staff, we limited the scope of the term power sources to include tactical power sources used for soldier-carried equipment and vehicle applications as well as power sources for munitions (e.g., missiles) and satellites. Our scope excludes power sources used to support installations such as temporary or permanent military facilities. In terms of specific technologies, we focused on batteries, fuel cells, and capacitors. This was based on the predominance of batteries among tactically deployed power sources, the level of investment in fuel cells, and congressional interest in capacitors.

To determine DOD's total investment in power sources for S&T, logistics support, and acquisition programs, we interviewed officials within the Office of the Secretary of Defense (OSD) and across DOD component organizations to determine an appropriate methodology for collecting the most complete set of investment data possible. We analyzed DOD investment data extracted from DOD research and logistics support databases and also other data that we gathered from pertinent DOD components. We determined that the data were sufficiently reliable for the purposes of providing approximate or minimum investment amounts in S&T and logistics support in this report. To assess the extent to which DOD coordinates power source S&T investments, we interviewed officials across the military services, other pertinent DOD components, DOE, and the power source industry. In addition, we attended private sector and

[2] GAO, *Defense Logistics: Actions Needed to Improve the Availability of Critical Items during Current and Future Operations*, GAO-05-275 (Washington, D.C.: Apr. 8, 2005). Batteries have also presented logistical challenges in previous military conflicts. For example, the Army faced difficulties providing sufficient quantities of batteries during the Vietnam War and the Persian Gulf War.

[3] Pub. L. No. 111-84, § 243 (2009).

federal government conferences related to power sources, took part in training sessions related to DOD-wide information-sharing resources, and collected information from the membership of a power sources industry association. We also drew extensively on other GAO work related to interagency coordination.[4] In order to assess the extent to which DOD's policies facilitate power source standardization, we interviewed officials across the military services and other pertinent DOD components and reviewed existing policies and standardization efforts. A more detailed description of our scope and methodology is presented in appendix I.

We conducted this performance audit from December 2009 to December 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

DOD invests in power sources such as batteries, fuel cells, and capacitors to support the warfighting effort by powering weapon systems and equipment.[5] DOD's power source investment is expected to rise because of an increased reliance on advanced weapon systems and equipment and ongoing efforts to develop new technologies that are smaller, lighter, and more power dense.[6] Batteries are devices that convert chemical energy into electrical energy. The two main types of batteries are primary (non-rechargeable) and secondary (rechargeable). Primary batteries, which are discarded after their charge has been depleted, are the most common battery type for soldier-carried applications. A subclass of primary

[4] GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

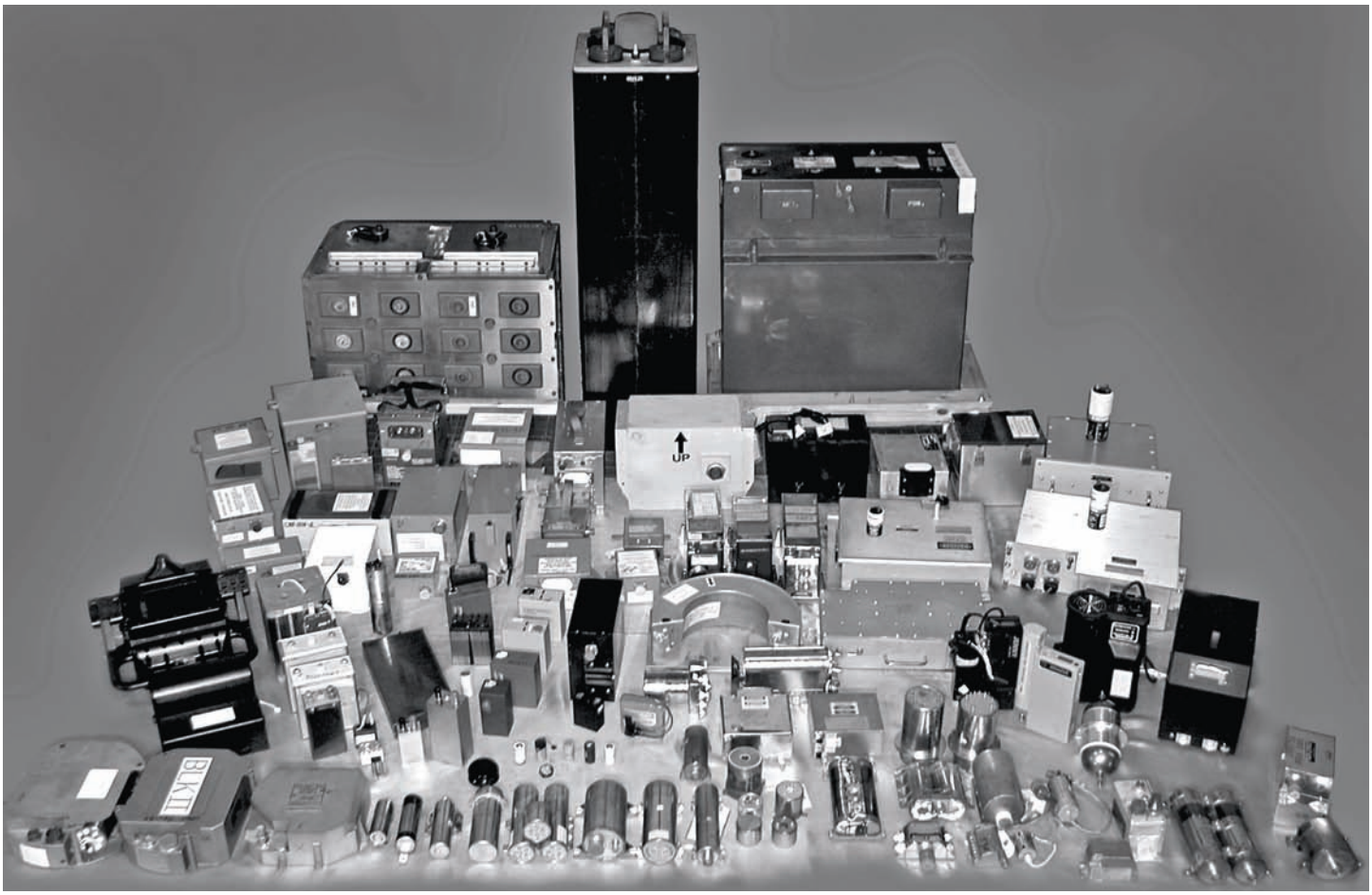
[5] The term power sources spans numerous technologies with a wide range of functions, including energy storage and power generation. Energy may be stored chemically, mechanically, or electrically within a power source. In general, power sources generate power by transforming energy stored within the power source device (in the case of batteries) or energy that is stored external to the power source (in the case of fuel cells). The power output may be pulsed, burst, or continuous depending on the specific application.

[6] In light of DOD-wide power source needs, the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 mandated that DOD submit a roadmap on this topic. This document has not yet been published. Pub. L. No. 110-417, § 218 (2008).

batteries called thermal batteries is used for short-term, high-power applications (e.g., missiles). While primary batteries typically self-discharge available energy when not in use, thermal batteries have a longer shelf life because they remain inert until activated. Secondary batteries, which can be reenergized after their charge has been depleted, are less commonly used by deployed units than primary batteries. However, the Army has undertaken educational campaigns to increase their use in light of some cost efficiencies and operational advantages—including overall weight reduction of soldiers' equipment.[7] Further, the military services are interested in transitioning from non-rechargeable batteries to secondary batteries because their use by deployed units may decrease the number of vehicle convoys needed to supply batteries in war zones. DOD is also interested in limiting the proliferation of battery types to reduce the number of different battery types the soldiers have to carry and limit soldier confusion over which battery is required to operate a device—thus simplifying operations and resupply. See figure 1 for a sample of DOD's power source inventory.

[7] DOD projects this total weight to increase as soldiers are equipped with additional electronic equipment.

Figure 1: Sample of the DOD Power Source Inventory



Source: Naval Surface Warfare Center, Crane (NSWC, Crane).

In general, fuel cells and capacitors are less mature technologies than batteries with respect to defense applications. Fuel cells are electrochemical devices that convert the chemical energy in a fuel, such as hydrogen, into electrical energy. Fuel cells look and function very similar to batteries. However, the available energy of a battery is stored within the battery—and its performance will decline as that energy is depleted—while a fuel cell continues to convert chemical energy to electricity as long as it has a supply of fuel. Capacitors are passive electrical components that store energy and may be used for a wide range of commercial and defense applications. Although most capacitors are used for small, primarily consumer-oriented electronic devices, they are increasingly being developed for high-power weaponry. DOD research organizations

have ongoing S&T efforts focused on maturing fuel cell and capacitor technologies so they can be deployed. Given the developmental nature of these technologies—as well as the predominance of batteries among tactically deployed power sources—this report principally discusses batteries.

DOD invests in power sources in three broad, interrelated investment categories: (1) S&T efforts related to developing and improving power source technologies, (2) purchasing power sources for logistics support as part of routine warfighter resupply, and (3) developing or purchasing power sources for integration into a weapon system or equipment as part of an acquisition program. Ideally, technologies developed as part of S&T efforts will ultimately be incorporated into new or existing weapon systems or equipment. These three investment categories are described below.

1. **S&T:** DOD research, development, test and evaluation investment is separated into seven discrete investment categories known as budget activities. The first three categories represent basic and applied research and technology development activities and are collectively known as S&T activities.[8] These can include activities such as developing or improving upon different chemical combinations that enhance energy storage or power output capabilities, developing lighter components, and identifying and incorporating novel material components. This research may be conducted by many different entities, including DOD research centers and other government laboratories, power sources manufacturers, and academic institutions. According to DOD officials, these projects may be funded through a variety of mechanisms, including a DOD component's base budget; small business programs, such as the Small Business Innovation Research (SBIR) program; and additions Congress makes to DOD's budget (i.e., congressional add-ons).[9]

[8] The latter categories include product development and support activities. The majority of the investment data we gathered from the research organizations were in the S&T category. An explanation of these activities can be found in app. II.

[9] The SBIR program is a competitive program designed to increase the participation of the nation's small, high-tech, innovative businesses in the federal government's research and development efforts.

2. **Logistics support:** This category includes the provision of logistical services, materiel, and transportation required to support the military in the continental United States and worldwide. Power sources are like any other materiel requirements of military units, such as food and clothing, in that they are a consumable commodity that must be reordered and resupplied according to military service needs. Power sources for logistics support are typically purchased through the Defense Logistics Agency (DLA), which is the primary supplying agent for DOD.

3. **Acquisition programs:** This category includes the selection of a military standard power source, the selection of a commercial-off-the-shelf (COTS) power source, or the design, development, and production of a program-unique power source as part of a DOD acquisition program. This process may be managed by the program office responsible for the weapon system or equipment acquisition, the contractor developing the system, or both. Since virtually all weapon systems and equipment include a power source, most acquisition programs have to undergo this process.

For the purpose of this report, we define coordination as any joint activity by two or more organizations that is intended to produce more public value than could be produced when the organizations act alone. As we have previously reported,[10] interagency coordination is important to avoid carrying out programs in a fragmented, uncoordinated way in areas where multiple agencies address a similar mission. Standardization, which is a form of coordination, includes efforts to expand the use of common or interchangeable parts by developing and agreeing on compatible standards. With respect to power sources, this may include developing standard shapes to facilitate the use of common, nonproprietary power sources in a range of weapon systems and equipment.

[10] GAO-06-15.

DOD Lacks Comprehensive, Departmentwide Data on Some Power Source Investments

DOD lacks comprehensive, departmentwide data for its total investment in the power sources area and no single DOD office aggregates these data across all investment categories. Further, availability of complete data varies across the three investment categories: S&T, logistics support, and acquisition programs. We determined that DOD invested at least $2.1 billion in power sources from fiscal year 2006 through fiscal year 2010. While DOD appears to have adequate departmentwide data on S&T efforts, it does not have departmentwide data for all logistics support investments. DOD has limited data on its investments in power sources when they are developed or purchased for acquisition programs. The $2.1 billion amount includes the investments in S&T and logistics support that we were able to identify but not power source investments as part of acquisition programs because of the difficulty in obtaining investment data in that area. In general, a lack of investment information can adversely affect DOD's ability to avoid unnecessary duplication; control costs; ensure basic accountability; anticipate future costs and claims on the budget; measure performance; maintain funds control; prevent and detect fraud, waste, and abuse; and address pressing management issues.[11]

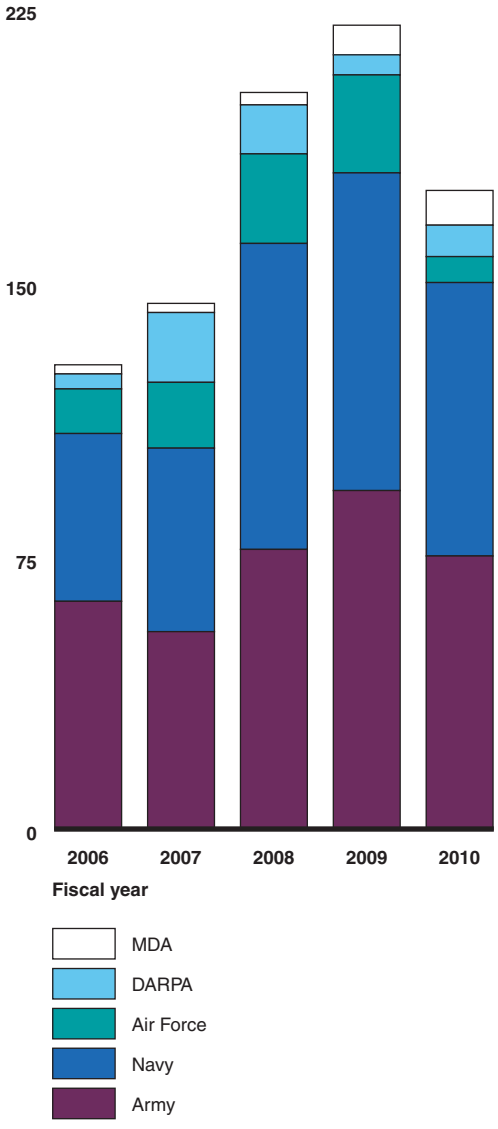
[11] GAO, *DOD's High-Risk Areas: Actions Needed to Reduce Vulnerabilities and Improve Business Outcomes*, GAO-09-460T (Washington, D.C.: Mar. 12, 2009).

DOD Has a High Level of Data on Power Source S&T Investments

We determined that from fiscal year 2006 through fiscal year 2010 DOD invested approximately $868 million in the development of power source technologies through many individual power source S&T projects. However, this amount is approximate as it may not include all power source S&T project funding.[12] Figure 2 depicts DOD's approximate investment in power sources S&T by DOD component. In the period from fiscal year 2006 through fiscal year 2010, the Army was the largest investor with a total investment of about $361 million and the Navy was the second largest investor with a total investment of about $342 million. During that same time period, the Air Force invested about $90 million, the Defense Advanced Research Projects Agency (DARPA) invested about $51 million, and the Missile Defense Agency (MDA) invested about $26 million.

[12] Creating an exhaustive list of all power source S&T projects was not possible because of the lack of centralized DOD management of data on these projects. We had to rely on data gathered by each research organization identified by DOD, and the potential exists that some pertinent organizations were not identified. Additionally, since some organizations involved in this area are funded by other DOD customers, it is difficult to accurately track the precise amounts of funding for specific projects.

Figure 2: Approximate Investment in Power Source S&T by DOD Component from Fiscal Year 2006 through Fiscal Year 2010



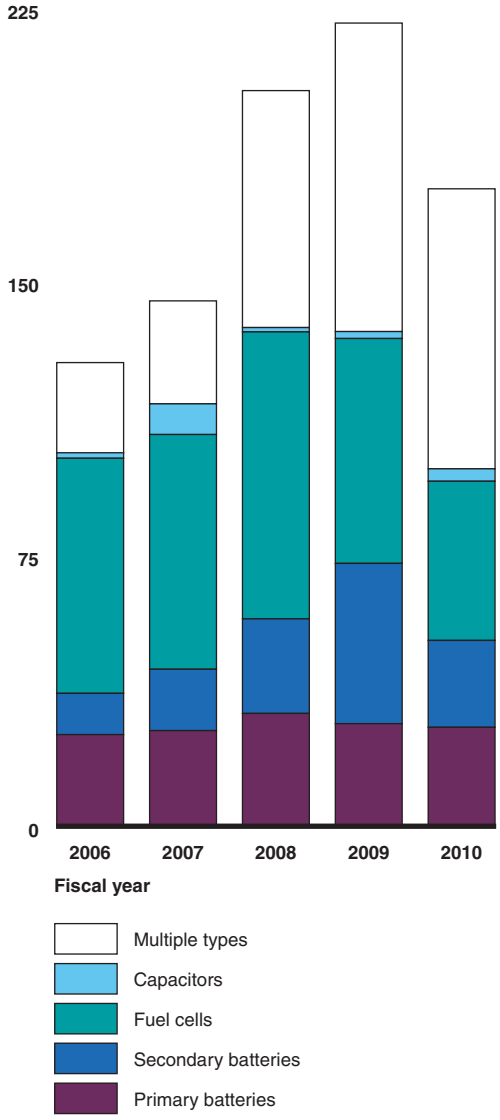
Source: GAO analysis of data from the Army, Navy, Air Force, DARPA, and MDA.

DOD's investment is largely concentrated within two power source technology areas: batteries and fuel cells. There is also significant investment in projects that involve more than one type of technology, which we refer to in figure 3 as multiple types. We found that the total

investment for capacitor-related research was small relative to the other areas. This may be because capacitors for high-power defense applications are an emerging and still immature technology.[13] Officials informed us that DOD-wide interest in capacitors has increased along with an interest in high-power weaponry. As shown in figure 3, the largest investment—about 36 percent of the total for fiscal year 2006 through fiscal year 2010—was in fuel cells.

[13] Capacitors have been used for consumer-oriented electronic devices and other commercial applications for a long time, but the types required for these DOD applications are still an immature technology.

Figure 3: Approximate Investment in Power Source S&T by Type from Fiscal Year 2006 through Fiscal Year 2010



Source: GAO analysis of of data from the Army, Navy, Air Force, DARPA, and MDA.

We identified a suite of DOD-wide information technology resources that includes a database used for tracking DOD-wide S&T activities.[14] This database does not categorize projects in such a way that one could readily and reliably extract all activities for a certain research area (such as batteries). Despite these limitations, we were able to obtain suitable data from each research organization, which enabled us to present an approximate investment figure.

DOD Has Data on Some Logistics Support Investments, but Not All Investments Are Tracked

We found that DOD invested at least $1.2 billion in power sources for logistics support from fiscal year 2006 through fiscal year 2010. Though DLA supplies the nation's military services with critical resources needed to accomplish their worldwide missions, there are additional methods outside of DLA's procurement processes by which the military services may purchase power sources.[15] For example, a service might purchase a power source outside of DLA's procurement processes if that service is the only consumer of the power source item. However, we found no DOD effort to aggregate and analyze these investments, even though DLA and military service logistics databases track investments using a standard governmentwide federal supply coding system that could be used for this purpose.

We collected data from DLA and military service databases for investments in power sources for logistics support from fiscal year 2006 through fiscal year 2010. We determined that military service purchases through DLA likely account for the majority of logistics support investments captured by DOD databases.[16] However, while the $1.2 billion investment amount we compiled includes data from these databases, DOD officials informed us that not all of these databases track power source purchases made as part of contractor-performed maintenance for weapon

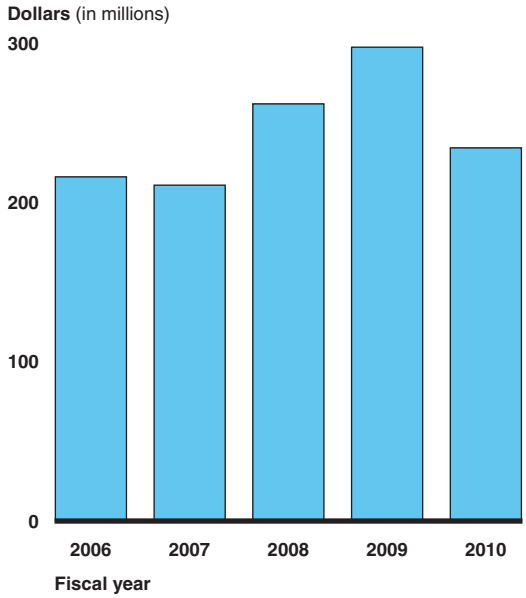
[14] The Defense Technical Information Center maintains a database called the Research and Engineering Database. The purpose of the database is to make information on S&T projects available to researchers and engineers across DOD.

[15] The military services purchase power sources from the DLA inventory according to their needs. The prices at which DLA sells power sources to the military services are marked up from what DLA originally paid to account for the cost of managing supply and distribution of these items.

[16] We obtained logistics support investment data from the military services. The data came from multiple databases and acquisition program sources. We did not include the services' data in the total amount because we lacked sufficient information about the reliability of these data. However, the amounts were very small compared to the DLA total.

systems and equipment—known as contract logistic support. As we have previously reported, DOD has extensively relied on contractors for activities such as logistics support.[17] Thus, the minimum investment amount we generated does not include what is likely a substantial amount of power source investments for logistics support. Figure 4 depicts DOD's minimum investment in power sources for logistics support.

Figure 4: Minimum DOD Investments through DLA in Power Sources for Logistics Support



Source: GAO analysis of DLA data.

DOD Lacks Sufficient Data on Its Total Investment in Power Sources for Acquisition Programs

Though virtually all DOD weapon systems and equipment rely on a power source, DOD has little data on its total investment in power sources for acquisition programs. DOD officials told us that neither the department nor individual DOD components have information showing the total amount invested in power sources for acquisition programs, although this information may be retained by individual program offices. We asked some program offices if they could provide basic cost information on the

[17] GAO, *Defense Management: DOD Needs to Reexamine Its Extensive Reliance on Contractors and Continue to Improve Management and Oversight*, GAO-08-572T (Washington, D.C.: Mar. 11, 2008).

principal power sources used by their programs. Some program offices provided this information, but others did not. Some offices that could not provide this information provided an explanation; for example, one program office told us that the cost for the power source was built into the overall cost for the system and thus was not broken out as a specific expense. Other program offices simply provided no cost data and no explanation.

We also asked a number of senior DOD officials—including officials from OSD and from the services at the assistant or deputy assistant secretary level[18]—whether they could provide data on total investment in power sources for acquisition programs at the departmentwide or service levels, but none were able to do so. Officials from the Office of the Director of Operational Energy Plans and Programs, an office within OSD that serves as the principal advisor to the Secretary of Defense and others regarding operational energy, concurred.[19] They stated that since these costs are not aggregated, DOD would have to require each acquisition program office to identify power source investments and then consolidate them. They stated that this would be a labor-intensive data collection effort given the large number of DOD acquisition programs.[20]

In order to gain an understanding of how some acquisition programs determined which power sources would be used by their programs, we asked several Army, Navy, and Air Force acquisition program offices to provide us with information on this process.[21] Although these offices provided responses with varying levels of detail, we determined that there

[18] Each service has an assistant or deputy assistant secretary who has responsibility for energy and power issues.

[19] This position was established by the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, Pub. L. No. 110-417, § 902 (2008). Operational energy is the energy required for moving and sustaining DOD's forces and weapons platforms for military operations.

[20] DOD is currently managing about 100 Acquisition Category (ACAT) I programs, which are programs at or above a funding threshold of more than $365 million in fiscal year 2000 constant dollars or, for procurement, of more than $2.190 billion in fiscal year 2000 constant dollars. GAO, *Defense Acquisition: Observations on Weapon Program Performance and Acquisition Reforms*, GAO-10-706T (Washington, D.C.: May 19, 2010).

[21] We spoke to officials in 12 program offices for major acquisition programs designated ACAT I. We also attempted to identify smaller acquisition programs for the purpose of assessing how some programs acquired power sources. However, we were unable to identify active programs below the ACAT I level.

are several methods by which a program office may acquire power sources. For example:

- **Selection of existing military standard power sources:** The program office for the V-22 Osprey, a tilt rotor aircraft developed by the Navy in the 1980s, followed a mandatory Navy specification for rotary aircraft that required the use of government-furnished batteries made to DOD military standards. According to the program office, the V-22 program tested two military standard batteries already used in two other aircraft and determined that they met the power source requirements of the V-22. As such, the program selected these two batteries for use by the V-22. Because the V-22 selected preexisting batteries, the program incurred no development costs; the combined unit costs provided were $3,688.

- **Selection of COTS power sources:** Officials from the Navy's P-8A Multi-mission Maritime Aircraft told us the program uses a COTS battery as the principal power source for its electronics systems.[22] The P-8A is derived from a Boeing 737 commercial aircraft and has roles in antisubmarine and antisurface warfare as well as intelligence, surveillance, and reconnaissance. The program office assessed the suitability of the power source used by the Boeing 737 and found that this COTS solution met their requirements and selected it for use by the program. Because the P-8A selected a preexisting COTS battery, the program incurred no development costs associated with program-unique power sources. The unit cost provided was $11,500.

- **Development of program-unique power sources:** Officials in the Joint Air-to-Surface Standoff Missile program office told us that they determined that the program required the design, development, and production of a program-unique thermal battery because of the missile's strict design parameters in terms of internal space available for the power source. The program developed a new battery, but the program office was only able to provide limited cost information because the costs involved were included in the overall cost of the missile. The unit cost provided was $3,775.

[22] Although some programs may select a COTS power source, they are not suitable for all defense applications, especially those that are highly specialized (e.g., missiles) or for programs that require reliability and survivability in adverse environmental conditions.

S&T Coordination Mechanisms Are Generally Effective, Though Opportunities Exist to Improve Strategic Planning

DOD coordination mechanisms for power source S&T activities are generally effective in facilitating coordination across pertinent DOD components and with DOE, but opportunities exist for improvement. We also found that DOD's strategic planning process for appropriately directing S&T investment for power source technologies could be improved. DOD also generally has deficiencies in strategic planning for critical technologies, processes for technology transition, and tools that support transition. Further, S&T planning efforts can be complicated by external factors. For example, congressional additions to DOD's budget account for just over half of the total S&T funding we identified for power sources. Since this process can be informal and lack transparency, outcomes in this area may be unpredictable and difficult to incorporate into strategic plans.

S&T Coordination Mechanisms Are Generally Effective

DOD uses various mechanisms to facilitate the coordination of power source S&T activities across pertinent DOD components, DOE, and in some cases industry. According to DOD power source researchers, the principal means for coordinating is the Chemical Working Group of the Interagency Advanced Power Group (IAPG). The Chemical Working Group is part of the long-standing IAPG interagency working group and brings together researchers from relevant DOD components, DOE, and other federal stakeholders to exchange information about power source projects and avoid unnecessary duplication of effort. In addition, the Defense Technical Information Center—an organization responsible for providing information services to DOD—has a number of information technology resources related to S&T that were developed to facilitate information sharing between stakeholders across the DOD research and engineering community. Table 1 lists the principal ways DOD coordinates S&T projects.

Table 1: Principal DOD Coordination Mechanisms for Investments in Power Source S&T Projects

Select coordination mechanisms	Description
Interagency groups	Interagency groups provide a forum in which researchers, acquisition personnel, and other pertinent stakeholders can share information and leverage resources. Key groups related to power sources include the Chemical Working Group of the IAPG and the Power Sources Technology Working Group of the Joint Defense Manufacturing Technology Panel.
Conferences	There are several major conferences in the power sources area that provide a forum for information sharing and professional development in the power sources community, which includes DOD, DOE, and other agencies. One such conference is the Power Sources Conference, which has been held 44 times and brings together government, academic, and commercial researchers to discuss research projects.
Information technology resources	The Defense Technical Information Center provides a suite of databases and Web 2.0 services to facilitate information sharing and professional development. One example is the Research and Engineering Database that compiles ongoing research and development projects throughout DOD.

Source: GAO analysis.

As an example of the efficacy of these mechanisms, no power source projects presented at the 2010 annual Chemical Working Group meeting were identified as involving duplicative research within DOD or between DOD and DOE, though the meetings have been effective in identifying instances of project duplication in the past. Additionally, both DOD and DOE participate in several other coordinating groups together to leverage common efforts, and in July 2010 DOD and DOE signed a memorandum of understanding developing a framework for cooperation and partnership on energy issues. Both organizations agreed to collaborate on S&T projects at research institutions sponsored by either agency, to synchronize S&T to expand complementary efforts, and to develop joint initiatives for major energy S&T programs of mutual interest.

Though we found these mechanisms to be generally effective, agencies may miss opportunities to fully coordinate because attendance at these interagency groups and conferences is voluntary and the level of agency participation varies. Further, conversations with officials from DOD component organizations suggest that there may be limited awareness within the DOD power sources community of the coordination services available through the Defense Technical Information Center. In areas where multiple agencies address a similar mission, interagency coordination is important to collectively meet common goals and avoid carrying out programs in a fragmented, uncoordinated way. As we have

previously reported,[23] this lack of coordination can waste scarce funds, confuse and frustrate program customers, and limit the overall effectiveness of the federal effort. Agency officials informed us that the community of power source experts from the federal government, industry, and academia is small and well-connected by interpersonal relationships. Although it is not possible to accurately estimate the impact of these often informal relationships, officials believed that such relationships facilitate information sharing, which is beneficial to DOD-wide power source S&T.

S&T Strategic Planning Could Be Improved

We found that though DOD has generally effective S&T coordination mechanisms, its strategic planning process to facilitate the allocation of S&T funds for power source technologies could be improved. Most DOD components generate strategic plans to guide S&T investments, though we found no current Air Force plan. We found that existing military service-level S&T strategic plans are not specific and typically do not discuss investments in power sources in depth, if at all. There have also been several technology roadmaps developed or initiated specifically for the power sources area.[24] However, we have been told by DOD researchers that these roadmaps may quickly become irrelevant without frequent updating because necessary investment levels and the maturity of the pertinent technologies may evolve over time. Further, unless roadmapping efforts are coordinated, DOD cannot be assured that they will be complementary and fully assist agencies in addressing shared technological challenges. Additionally, though DOD has established the Energy and Power Community of Interest to focus on power source issues as part of its broader Reliance 21 program,[25] representatives of this group told us that it is a relatively new organization and is still finalizing organizational planning. They said that the community of interest will develop strategic planning documents specific to power sources that will enable DOD to better plan in this area.

[23] GAO-06-15.

[24] One such example is the October 2009 *Power Sources Technology Roadmap* sponsored by the Power Sources Technical Working Group of the DOD Joint Defense Manufacturing Technology Panel.

[25] The Reliance 21 program was established to perform integrated strategic planning for DOD S&T and encourage transparency across components.

We have previously reported that DOD lacked a single executive-level OSD official who is accountable for operational energy matters and recommended that one be designated.[26] We also noted that DOD lacked a comprehensive strategic plan for operational energy. As a result, in October 2009 DOD established the Director of Operational Energy Plans and Programs. According to officials from this office, they will, among other things, coordinate departmentwide policy, planning, and program activities related to operational energy demand and relevant technologies. Further, officials told us that this office will also include power source technologies in its purview. The Director was recently confirmed, and the office is currently working to gather the personnel required to support its efforts. The Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 requires the office to submit an Annual DOD Energy Management Report on departmentwide operational energy.[27]

We have previously reported that DOD generally faces problems with deficiencies in strategic planning for critical technologies, processes for technology development and transition, and tools that support transition.[28] Similarly, some DOD officials told us about challenges in transitioning a new power source technology from the laboratory to an acquisition program. We identified some efforts that support power source technology transition within the services. However, DOD researchers said that the overall problem still occurs in this area and that promising technologies may be forgotten or overlooked if they are not transitioned into an acquisition program. In addition, DOD's lack of oversight and comprehensive data on power source investments for acquisition programs may further complicate technology transition efforts.

External Factors Can Pose Planning Challenges

S&T planning efforts can be complicated by external factors. We found that DOD investments in power source S&T come from several sources, including base budget funds, small business programs (such as the SBIR program), and congressional add-ons—that is, additions Congress makes to DOD's budget. From the data we collected, we determined that

[26] GAO, *Defense Management: Overarching Organizational Framework Needed to Guide and Oversee Energy Reduction Efforts for Military Operations*, GAO-08-426 (Washington, D.C.: Mar. 13, 2008).

[27] Pub. L. No. 110-417, § 331 (2008).

[28] GAO, *Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes*, GAO-06-883 (Washington, D.C.: Sept. 14, 2006).

congressional add-ons account for approximately 55 percent of the DOD total investment we identified in power source S&T from fiscal year 2006 through fiscal year 2010. While these add-ons provide funding for S&T, officials at DOD research organizations told us that these add-ons may pose a challenge to strategic planning for two reasons. First, research organizations may lack complete discretion over how to apply the funds—while they may be able to accept or decline an add-on, these add-ons do not give them full control over the project. Second, since this process can be informal and lack transparency, outcomes in this area may be unpredictable and difficult to incorporate into strategic plans.

DOD's Power Source Standardization Efforts Are Not Departmentwide and Lack Robust Enforcement

Though DOD officials agree that the department needs to increase its emphasis on power source standardization, it lacks a departmentwide policy to emphasize or compel early consideration of standard power sources. Absent emphasis on early standardization, profit incentives can often lead companies to develop unique, proprietary power sources. The Army has a policy to encourage standardization, but the other services lack comparable policies. Although it is generally more economical to address standardization early in the acquisition process and prior to the deployment of weapon systems or equipment to the field, opportunities may exist to increase standardization by retrofitting weapon systems or equipment for which a proprietary power source has already been developed. This was recently done successfully with the TALON bomb disposal robot. DOD's lack of emphasis on power source standardization limits opportunities to obtain potential benefits, including reduced item unit costs and a smaller logistical footprint.

Efforts to Standardize Lack Sufficient Emphasis and Oversight

It is important to emphasize standardization early in a program before certain system decisions are made. Without early consideration of the available standard power source, the design parameters of a system may become more constrained as other parts are developed and integrated. As a result, remaining space may not be sufficient to fit the shape of appropriate standard power sources. Although in some cases developing a program-unique power source is necessary because of legitimate constraints, such as necessary limitations on the space available for a power source, officials told us that companies may develop program-unique power sources unnecessarily. Not requiring power source standardization can result in unnecessary proliferation that may ultimately have downstream implications in terms of resupplying the warfighter. DOD officials we spoke with agree that the department needs to increase its emphasis on power source standardization. However, DOD lacks a

departmentwide policy to help emphasize power source standardization and compel early consideration of standard power sources. We found that without policies requiring standardization, programs may choose to develop or select nonstandard power sources when an existing military standard or other preferred item could have been used, potentially hindering standardization efforts.

DOD and industry officials told us that power sources are often not considered by program offices, or are thought of by acquisition officials as a peripheral concern because of the low costs relative to overall program costs. Additionally, according to the Defense Standardization Program, DOD's performance-based acquisition policies give contractors primary responsibility for recommending the use of standard components to meet performance requirements. DOD officials and power source company representatives have told us that program managers may choose not to exercise oversight of these contractor decisions. Further, during these discussions, we were told that companies have a profit motive to develop proprietary power sources as part of the acquisition of a weapon system or equipment because they would prefer to be sole-source suppliers. Thus, they may not consider standard options that would provide more optimal solutions for DOD customers.

According to DOD officials, an instance of a contractor choosing a proprietary power source over an existing battery occurred with the batteries for two radio systems used by the Army and the Marine Corps—the AN/PRC-148 Multiband Inter/Intra Team Radio and the AN/PRC-152 Falcon radio. Though the radios are functionally similar, they each use a program-unique proprietary battery instead of an existing battery or a battery common to both radios. Further, although the batteries are very similar in design and each will fit in the other device, a superficial design characteristic on one battery prohibits the battery from powering the other manufacturer's radio. In addition, the charger interfaces are not compatible, so the batteries cannot be charged using a single charger without modification, such as through an adapter. As a result, the service users of the two radios must manage inventories for two types of batteries and chargers, and the soldiers in the field have to ensure that they take the correct battery for their radio since the other battery will not be compatible. Also, the military services are unable to competitively procure the batteries because each is a proprietary device and the services must rely on the sole-source supplier of each battery—potentially increasing the risk of item shortages or delays.

Though DOD officials we spoke with in the power sources area agree that the department needs to increase emphasis on power source standardization early in programs, existing organizational efforts lack authority and resources to implement any policies. For example, DOD's Defense Standardization Program established the Joint Standardization Board for Power Source Systems to focus specifically on power source standardization.[29] According to the board's charter, it serves as a standing technical group for power source standardization efforts.[30] Its specific role is to participate in the development of an overarching DOD standardization strategy for power sources and to promote commonality of component parts or interfaces by facilitating a coordinated approach with joint programs. However, the Chairman of the Joint Standardization Board for Power Source Systems told us that though the board is part of the Defense Standardization Program, it does not have the funding it needs to function and thus has had little impact. He added that other joint standardization boards have significant user funding because particular acquisition program managers, or sponsors, have a vested interest in the results of their work.

Officials from this board also noted that while emphasizing standardization early in acquisition programs will undoubtedly yield future benefits, DOD lacks a comprehensive plan for creating an appropriate level of emphasis on power source standardization and that DOD also lacks a policy for ensuring the achievement of standardization goals. Accordingly, these officials recommended in a Defense Standardization Program publication that DOD establish a plan (in conjunction with power source experts from throughout the federal government, industry, and academia) to create an appropriate level of DOD-wide emphasis on standardization. Further, they recommended that DOD create a policy that addresses the use of nonstandard power sources and that might articulate

[29] The Defense Standardization Program is a program established by DOD and is responsible for promoting standardization throughout DOD. Department of Defense, Office of the Under Secretary of Defense for Acquisitions, Technology and Logistics, *Defense Standardization Program (DSP): Policies and Procedures*, DOD 4120.24-M (March 2000).

[30] The Joint Standardization Board for Power Source Systems is one of nine chartered joint standardization boards under the Defense Standardization Program that are focused on different technology areas. Each board is responsible for advancing interoperability, logistical readiness, and cost efficiency within its technology focus area. These boards also provide standardization advocacy, guidance, and executive-level support, ensuring high-level oversight and advocacy of strategic standardization initiatives. OSD Memorandum for Joint Battery Technical Working Group, Subject: Joint Standardization Board for Power Source Systems (June 8, 2006).

a process of senior-level review to determine if requests to use nonstandard power sources are justified.

Army Policy Encourages Standardization, but Other Services Lack Comparable Policies

The most significant DOD power source standardization policy we found related to acquisition programs is section 8.8 of Army Regulation (AR) 70-1.[31] Two main objectives of this policy are to decrease the number and types of batteries the Army uses and limit the development of unique batteries except where necessary. The regulation prioritizes use of military or commercial standard rechargeable batteries in acquisition programs, with a particular emphasis on using rechargeable batteries. Program managers are supposed to coordinate system battery requirements with Army power source subject matter experts, who we were told are currently in the Army Power Division.[32] For programs where military or commercial standard rechargeable battery types are not practical, program offices can choose from a list of military-preferred batteries. The regulation requires that program managers obtain an Army acquisition executive approval—which we were told is the responsibility of the Assistant Secretary of the Army for Acquisition, Logistics and Technology—if a program manager intends to use batteries other than those articulated in the regulation. This approval is based on a favorable technical evaluation by Army Power Division officials.

Army Power Division officials stated that there are several difficulties associated with ensuring that acquisition programs consistently follow the regulation. They said that section 8.8 of AR 70-1 can only succeed if there is an effective mechanism for ensuring that acquisition programs comply with it, and they identified challenges that may compromise effective implementation of the regulation. First, Army Power Division officials told us that program managers might not be aware of the requirements. They said that they do not know how many Army acquisition programs comply with section 8.8 of AR 70-1 since they are only aware of the programs to which they provide consulting services as part of the regulation. They could not tell us if any programs did not comply with the regulation and

[31] Army Regulation 70-1, *Research, Development, Acquisition: Army Acquisition Policy*, para. 8-8 (December 2003).

[32] These experts formerly made up the Power Sources Center of Excellence, but now this responsibility has been transferred to the Army Power Division of the Army Communication-Electronics Research, Development, and Engineering Center.

therefore did not request a technical evaluation before developing a program-unique battery.

Second, they said that program managers may not comply with AR 70-1 because they do not understand the potential downstream logistical issues that can occur when battery decisions are not made early in the acquisition process. Army Power Division officials said they prefer to get involved with an acquisition program early in the process so they can help identify the best battery solution before system decisions restrict potential choices. They said that to do so they have to earn the respect and trust of program managers so that these programs will seek technical consultation early in the process. They added that the Army Power Division proactively tries to establish and maintain good relationships with the different Army program offices that might have battery needs.

Third, the Army Power Division receives approximately half of its funding via customer reimbursement, meaning that it receives funding from program offices when it provides consultative services. These variables put the Army Power Division in a difficult position when current and potential acquisition program customers of their technical services request a favorable technical evaluation to support use of a program-unique battery. Army Power Division officials told us that their evaluation may be influenced by their desire to avoid compromising existing relationships with program offices. They added that an unfavorable evaluation may lead the program manager to forgo consultation with the Army Power Division in the future, meaning the Army Power Division would lose a customer and associated funding. Further, these officials told us that if a program were to request an evaluation of a nonstandard battery late in the weapon system or equipment development process (such as right before the start of production), the Army Power Division might suggest approval of the battery to the Army acquisition executive to avoid delaying production.

While Army officials acknowledge compliance issues, the Program Manager-Mobile Electric Power has recently established the position Product Director for Batteries to help facilitate central coordination to reduce battery proliferation in the Army based on a perceived lack of central coordination in the Army on battery issues.[33] This position has just been established and thus has not yet had much impact, but the Product

[33] This position is in the office of the Program Manager-Mobile Electric Power, which has traditionally dealt with attempting to create DOD-wide standards for military generators.

Director for Batteries told us that pending approval he intends to eventually take over and update section 8.8 of AR 70-1—including enforcement and approving or denying of waiver applications—as well as any other Army battery standardization efforts. He told us that because he is a program manager he will have more authority than the Army Power Division to promulgate and enforce policies applicable to increasing the emphasis on standardization.[34]

Aside from the Army efforts, we found limited power source standardization efforts in the other military services. In general, they are limited to specific applications, such as aircraft, and are not applicable to the whole service or are not departmentwide. The Navy has several platform-specific efforts within the Naval Air Systems Command to develop military performance specifications for multiple battery types to limit proliferation of aircraft battery types. The Marine Corps Systems Command has developed an interactive computer-adaptive tool to help acquisition personnel in selecting appropriate, existing batteries for their programs. Also, the Marine Corps Systems Command has a topic paper on electrical connectors—including connectors for batteries—that is intended to reduce proliferation of the connectors that connect the battery to weapon systems or equipment. However, use of these tools is voluntary. We did not find any Air Force-wide processes for encouraging the use of existing standard or other preferred power sources.

DOD Has Not Evaluated Departmentwide Opportunities to Standardize Power Sources in Deployed Weapon Systems and Equipment

Although it is generally more economical to address standardization early in the acquisition process and prior to the deployment of weapon systems or equipment to the field, opportunities may exist to increase standardization by retrofitting weapon systems or equipment for which a proprietary power source has already been developed. However, DOD has not undertaken a departmentwide assessment to identify other weapon systems or equipment that use a nonstandard power source but that could be retrofitted with a more efficient and lower-cost standard power source with a relatively small investment. Such efforts may provide significant

[34] Before his position was established, the Product Director for Batteries discussed the possibility of establishing such a position with relevant organizations throughout the Army. Officials in these organizations thought that the idea of a having battery director was warranted to facilitate improving management in this area. Though a charter is still forthcoming, the mission of his office will be to facilitate central coordination in this area.

cost savings and operational benefits.[35] For example, Army and Navy research organizations replaced the expensive proprietary batteries used by TALON bomb disposal robots with military standard batteries that are already in the DLA inventory. Army officials noted that their standardization effort for the TALON robot generated a cost savings of about $7,000 per unit of the system. A Navy effort to retrofit TALON robots with military standard batteries extended the robot's battery life by 23 percent. Because of the success of the standardization effort in terms of cost and operational advantages, the Marine Corps and the Army replaced proprietary battery packs with the retrofitted military standard batteries for deployed units of the system.

Standardization May Provide Benefits to Both DOD and the Industrial Base

DOD's lack of emphasis on power source standardization limits opportunities to obtain potential benefits, including reduced item unit costs and a smaller logistical footprint. According to a Defense Standardization Program case study of an effort by the Army to standardize batteries, standardization may enable DOD components to offer manufacturers greater production volumes and avoid reliance on sole-source suppliers for mission-critical items, which may result in a healthier industrial base and improved operational readiness.[36] In general, the military battery industrial base in the United States is characterized by small and midsized companies that operate in an environment with lower sales volume compared to the commercial battery industry. One study of the industry characterized the United States military battery industry as struggling for survival with some companies relying solely on government sales for income.[37] Further, DOD demand is irregular because of fluctuations based on periods of increased or decreased military activity. For example, a surge in demand for some non-rechargeable batteries related to the initiation of combat operations in Iraq exceeded the amount that the industrial base could produce—which threatened to reduce military capability.[38] Though representatives from a major DOD battery supplier told us that they would prefer to develop and be the sole-source supplier of proprietary power sources, they noted that absent this option

[35] In some cases, retrofitting may be achieved through the use of an adapter cable that enables a system to use a standard battery.

[36] Defense Standardization Program, *Army Battery Standardization: Rechargeable Batteries Power the Future Force* (2002).

[37] Department of Defense, *Battery Manufacturing Gap Study* (July 2004).

[38] GAO-05-275.

they would prefer a scenario where companies could compete to produce standard power sources in order to stabilize their production volumes and revenue. Actions that could contribute to the health of the industrial base—such as providing for greater production volumes through increased standardization—could be beneficial to DOD in ensuring the continued availability of military battery producers and mitigating future potential production and supply shortfalls.

Conclusions

The goal of any acquisition program is to provide the warfighter with the best possible weapon system or equipment. However, in light of increasing dependence on power sources, supporting the warfighter's power needs with more power, longer life, and less weight—as well as ease and sufficiency of supply—is also crucial. The proliferation of unique battery types could become more pronounced and ultimately affect the warfighter as military power demands increase. The current manner in which DOD manages its power source investments and translates them into products that meet warfighter needs is less than optimal. Specifically, DOD is not able to efficiently and effectively plan future investments if it lacks strategic investment knowledge of its total power source investment in S&T, logistics support, and acquisition programs. Further, while DOD mechanisms for coordinating S&T power source projects appear effective, their success depends on voluntary participation by all pertinent agencies. DOD agencies not fully participating in coordination mechanisms limit opportunities to leverage common efforts. Though DOD has some standardization efforts, decisions on what power sources will be put into new equipment and ultimately the hands of the warfighter and the supply system are often not made by DOD program managers and hence these programs may unnecessarily use proprietary power sources. Improving management and coordination of the power sources area could help DOD achieve optimal return on its investment. Without sufficient, departmentwide investment data; more effectively coordinated investments; and increased power source standardization, optimal DOD outcomes in this area cannot be expected.

Recommendations for Executive Action

To increase oversight of power source investments and to allow for enhanced strategic planning, we recommend that the Secretary of Defense consider how to best aggregate departmentwide investment data (from S&T, logistics support, and acquisition programs) in the power sources area and develop a mechanism to aggregate power source investment data across these investment categories at a level sufficient to guide decisions and policy.

To ensure a high level of interagency participation and coordination in the power sources S&T area, we recommend that the Secretary of Defense determine methods to strengthen pertinent member agency participation in interagency coordination mechanisms.

To increase DOD-wide emphasis on power source standardization both during design of weapon systems and equipment as well as for deployed systems, we recommend that the Secretary of Defense identify and direct the appropriate office(s) to take the following actions:

- Develop a plan to optimize use of standard power sources for weapon system or equipment types that are more amenable to such standardization.
- Develop a DOD-wide policy—based on the above standardization plan—similar to section 8.8 of Army AR 70-1 that requires senior acquisition executive approval before allowing acquisition programs to use a power source that is not standard or preferred. As part of this new policy, consider requiring an independent review of the appropriateness of using the nonstandard or nonpreferred power source.
- Identify opportunities to cost effectively retrofit deployed weapon systems and equipment that use a proprietary power source with an existing military standard or other preferred power source.

Agency Comments and Our Evaluation

In written comments on a draft of this report, DOD concurred with one of our five recommendations and partially concurred with four. The department stated that it had already taken or plans to take specific actions in response to our recommendations, but it is unclear from DOD's response what these actions entail.

DOD concurred with our recommendation that the Secretary of Defense consider how to best aggregate departmentwide investment data (from S&T, logistics support, and acquisition programs) in the power sources area and develop a mechanism to aggregate power source investment data across these investment categories at a level sufficient to guide decisions and policy. We believe that aggregating these data is important to inform decision making and investment in the power sources area.

DOD partially concurred with our recommendation that the Secretary of Defense determine methods to strengthen pertinent member agency participation in interagency coordination mechanisms. DOD commented

that existing coordination mechanisms are generally effective and have been improving since the office of the Director, Operational Energy Plans and Programs (DOEPP) was established. DOD added that the DOEPP office will continue to seek ways to strengthen interagency coordination. However, DOD did not provide specific information on how it believes coordination mechanisms have improved or what additional methods might be used to strengthen coordination. Our review identified voluntary attendance and varying participation in interagency groups that if enhanced could further improve coordination.

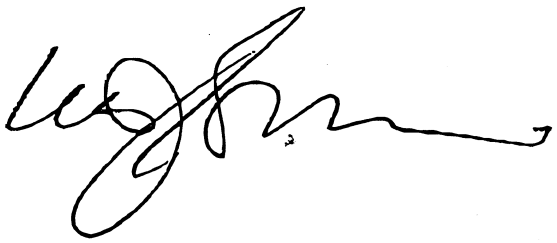
DOD also partially concurred with three recommendations related to power source standardization, namely, that the Secretary of Defense (1) identify and direct appropriate office(s) to develop a plan to optimize use of standard power sources for weapon systems or equipment types more amenable to standardization; (2) develop a DOD-wide policy similar to section 8.8 of Army AR 70-1 that requires senior acquisition executive approval before allowing acquisition programs to use a power source that is not standard or preferred; and (3) identify opportunities to cost effectively retrofit deployed weapons systems and equipment that use a proprietary power source with an existing military standard or other preferred power source. DOD indicated that ongoing activities led by the DOEPP office are adequately addressing all these needs and no expansion of effort is necessary. However, DOD did not provide any details related to specific, ongoing DOEPP activities addressing these needs, and we found no evidence of any such DOD or DOEPP actions while conducting our review. While DOD established the DOEPP office in October 2009, it has only had a Director since June 2010. In late August 2010, DOEPP office officials informed us that they were still writing position descriptions and working to gather the personnel required to support their efforts, but gave no indication that any substantive work had been undertaken. Our review revealed there is no DOD-wide plan or policy to emphasize power source standardization, even though DOD officials told us that DOD needs further emphasis in this area. Without a departmentwide plan to emphasize or compel early consideration of standard power sources, the use of unique, proprietary power sources will likely continue and DOD will not be able to obtain the full benefits of standardization, such as reduced item unit costs and a smaller logistical footprint.

By not identifying specific actions the department has taken or plans to take to implement our recommendations, we believe that DOD may not have appropriately considered our recommendations, and as a result we are concerned that in the coming months it will not seek ways to fully implement these recommendations.

DOD's written comments are reprinted in appendix III.

We are sending copies of this report to the Secretary of Defense; the Deputy Secretary of Defense; the Under Secretary of Defense for Acquisition, Technology and Logistics; the Secretaries of the Army, Navy, and Air Force; the Commandant of the Marine Corps; the Director, Office of Management and Budget; and other interested parties. The report also is available at no charge on the GAO Web site at http://www.gao.gov.

Should you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or sullivanm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix IV.



Michael J. Sullivan
Director
Acquisition and Sourcing Management

Appendix I: Scope and Methodology

For the purposes of this report, we limited "power sources" to tactical power sources used for soldier-portable and vehicle applications (e.g., motorized land vehicles, aircraft, and ships) as well as munitions and satellite power sources. We excluded power sources for operational or strategic applications, including power sources used to support installations such as temporary or permanent military facilities, because of the size and complexity of the tactical power sources portfolio and its significance to the efforts of the warfighter. We focused on batteries, fuel cells, and capacitors based on (1) language in the congressional mandate, (2) predominance of batteries among tactically deployed power sources, and (3) the recommendations of Department of Defense (DOD) experts.[1]

To determine DOD's total investment in power sources, we met with officials from the Office of the Secretary of Defense (OSD) and across DOD component organizations to determine an appropriate methodology for collecting as complete a set of investment data as possible. We divided investment into three categories generally based on the three main defense technology life cycle areas: (1) science and technology (S&T); (2) logistics support, or the provision of logistics, materiel, and transportation according to military needs; and (3) power sources for DOD weapon systems or equipment acquisition programs. Based on a review of the budget and on discussions with OSD officials, we found that there was no central repository for DOD investments in power source S&T. DOD officials told us that one would have to request the data from each pertinent S&T organization. As a result, we developed a data collection instrument asking each research organization to provide data on all power source projects within our scope. Specifically, we requested project-level information, including the project name, purpose, budget activity, and funding history from fiscal year 2006 through fiscal year 2010. We also requested data on projected future funding, but not all organizations were able to provide this information. The Office of Naval Research (ONR) compiled the data for the Navy since ONR manages all Department of the Navy S&T funds, including those for the Marine Corps. The Army Deputy Director for Technology from the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology's Research and Technology Division compiled the data from the Army research organizations. The Air Force Research Laboratory compiled data for Air

[1] We conducted an analysis of the total weight of power sources carried by soldiers during a typical mission based on initial information that the combined weight of these power sources is overly burdensome. We found that the total weight of power sources carried by soldiers is not as significant as has been suggested by some sources.

Force power source S&T projects. We assessed the reliability of these S&T data by (1) performing electronic testing of required data elements and (2) obtaining responses from agency officials knowledgeable about the data. We determined that the data were sufficiently reliable for the purposes of presenting an approximate total of S&T investments in this report. This investment amount is approximate because creating an exhaustive list of all power source S&T projects was not possible because of the lack of centralized DOD management of this area and the fact that we had to rely on data gathered by each research organization. Additionally, since some organizations involved in this area are funded by other DOD customers, it is difficult to accurately track the precise amounts of funding for specific projects.

We also interviewed officials from each service and its component research organizations about S&T efforts in the power sources area. For the Army, we met with the Army Deputy Director for Technology from the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology, Research and Technology Division; officials from the Army Research, Development, and Engineering Command; officials from the Army Research Laboratory; officials from the Army Communications-Electronics Research, Development and Engineering Center's Army Power Division; and the Program Manager-Mobile Electric Power Product Director for Batteries. The Assistant Secretary of the Army for Installations and Environment, and the Army Tank Automotive Research, Development and Engineering Center both provided written responses to our questions. For the Navy, we spoke with officials from ONR; Navy Surface Warfare Center Crane Division; the Naval Undersea Warfare Center Newport Division; the Naval Air Systems Command's Power and Energy Division; and the Marine Corps Systems Command. The Assistant Secretary of the Navy for Energy, Installations, and Environment provided written responses to our questions. For the Air Force, we spoke with officials from the Air Force Research Laboratory, and we obtained written responses from the Deputy Assistant Secretary of the Air Force for Energy, Environment, Safety and Occupational Health and the Air Force Materiel Command. We also obtained written responses from the Defense Advanced Research Projects Agency (DARPA). We also spoke with officials from U.S. Special Operations Command and obtained data on their power sources S&T investments.

To assess the involvement of the defense power sources industry in DOD investments in power source S&T, we met with representatives of Saft America Inc. (Saft), Advanced Thermal Batteries, and EaglePicher Technologies, LLC (EaglePicher). According to the companies, Saft and

EaglePicher are two large DOD battery suppliers. We also attended an annual power sources technology conference as well as two meetings of the National Defense Industrial Association (NDIA) Military Power Sources Committee and spoke with representatives from additional companies, including Alion Science and Technology, Dow Kokam, and Yardney Technical Products. We also gathered information through interviews with and written responses from the membership of the NDIA Military Power Sources Committee in order to gain additional perspective from the industry. We also met with members of the South Carolina Research Authority's Defense Advanced Battery Manufacturing Coalition.

To determine DOD's investments in power sources as part of a DOD weapon systems or equipment acquisition programs, we initially searched DOD budget requests to locate power source investment data related to acquisition programs. This method demonstrated that power sources are typically not broken out as specific cost elements of budget request line items related to acquisition programs. We were told by cognizant DOD officials that this information was not available in an aggregated format. Though we judged that the scope of DOD's existing acquisition programs, which includes around 100 major defense acquisition programs and smaller programs, was too large for us to obtain information from every program, we decided to obtain information from selected programs. We did not assess the reliability of acquisition program data because we determined that it would not be feasible for DOD to generate these data to enable us to determine the investment in this area for this report. We selected weapon systems and equipment from each of the military services to provide a cross section of weapon system and equipment types (e.g., aircraft, satellites, ships, vehicles, and portable electronics). As part of this effort, we spoke with program office officials and obtained data from the following programs:

- Army: Patriot/MEADS missile and Joint Light Tactical Vehicle.
- Navy: Joint Program Executive Office for the Joint Tactical Radio System, DDG 1000 destroyer, AGM-88E Advanced Anti-Radiation Guided Missile, P-8A Poseidon, Joint Multi-mission Submersible, Mine-Resistant Ambush Protected vehicle, and the V-22 Osprey program offices.
- Air Force: Joint Air-to-Surface Standoff Missile, Navstar Global Positioning System (GPS) GPS III, and Advanced Extremely High Frequency satellites program offices.

To determine DOD's investments in logistics support, we requested Defense Logistics Agency (DLA) data on sales of power sources to the

military from fiscal year 2006 through fiscal year 2010. Though these data do not include power sources that DLA might have procured as part of its inventory management processes, they do include all power sources that the military services bought from DLA during this period. To obtain data on military service power source procurements that occur outside of DLA, we obtained data from the Air Force Materiel Command, the Naval Supply Systems Command, and the Army Materiel Command. We assessed the reliability of logistics support data by (1) performing electronic testing of required data elements and (2) obtaining responses from agency officials knowledgeable about the data. We determined that the data were sufficiently reliable for the purposes of presenting a minimum investment in this area in this report. Our investment total for logistics support represents a minimum amount because, as DOD officials informed us, the data we obtained from DLA and military service logistics databases do not capture power source purchases made as part of contract logistics support—a type of contracting activity on which DOD has relied extensively.

To assess the degree to which DOD coordinates power source investments, we spoke with cognizant officials from each of the military services, research organizations across DOD, and DLA—including DLA's Battery Network group. For information on coordination of S&T investments, we spoke with the Army Deputy Director for Technology from the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology, Research and Technology Division; officials from the Army Research, Development, and Engineering Command; officials from the Army Research Laboratory; officials from the Army Communications-Electronics Research, Development and Engineering Center's Army Power Division; and the Program Manager-Mobile Electric Power's Product Director for Batteries. The Assistant Secretary of the Army for Installations and Environment and the Army Tank Automotive Research, Development and Engineering Center both provided written responses to our questions. For the Navy, we spoke with officials from the ONR, the Naval Surface Warfare Center Crane Division, the Naval Undersea Warfare Center Newport Division, the Naval Air Systems Command's Power and Energy Division, and the Marine Corps Systems Command. We also received written responses to our questions from the Assistant Secretary of the Navy for Energy, Installations, and Environment. For the Air Force, we spoke with officials from the Air Force Research Laboratory, and we obtained written responses from the Deputy Assistant Secretary of the Air Force for Energy, Environment, Safety and Occupational Health. In addition, we obtained written responses from DARPA. We also spoke to officials from the DOD ManTech

office and officials involved with the DOD Reliance 21 program and the Energy and Power Community of Interest. We also took part in a training session related to DOD-wide information-sharing resources.

To assess the effectiveness of some of DOD's coordinating mechanisms, we attended the 44th Power Sources Conference where industry, academic, and DOD power source researchers and other experts discussed ongoing power source S&T efforts. We attended the annual meeting of the Chemical Working Group of the Interagency Advanced Power Group as well as a meeting of the Power Sources Technology Working Group. In addition, we spoke with members of the Lithium Battery Technical/Safety Group. To assess DOD coordination with the Department of Energy (DOE), we spoke with representatives of the Joint DOD/DOE Munitions Technology Development Program and the DOE Office of Vehicle Technologies. We also drew extensively on other GAO work related to interagency coordination.

To assess the extent to which DOD's policies facilitate the use of standard power sources, we met with cognizant officials from each of the military services, including officials from the Army Communications-Electronics Research, Development and Engineering Center and the Program Manager-Mobile Electric Power's Product Director for Batteries. We received written responses to questions from an official from the Defense Standardization Program's Joint Standardization Board for Power Source Systems. We also received written responses from the Assistant Secretary of the Navy for Energy, Installations, and Environment; the Assistant Secretary of the Army for Installations and Environment; and the Deputy Assistant Secretary of the Air Force for Energy, Environment, Safety and Occupational Health. We also reviewed applicable standardization policies and regulations.

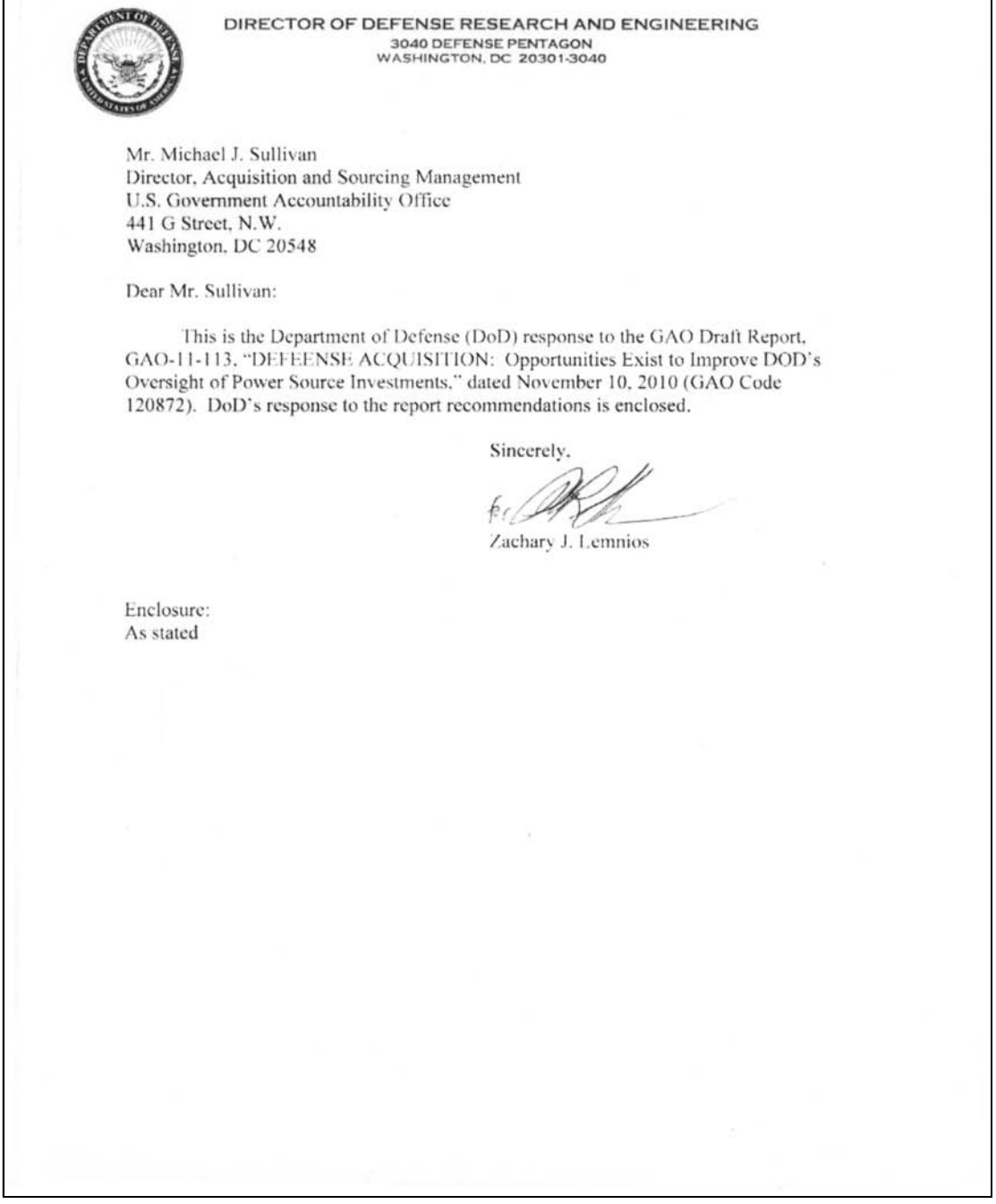
We conducted this performance audit from December 2009 to December 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: DOD Research, Development, Test and Evaluation (RDT&E) Budget Activities

Budget activity		Description of activity
1	Basic Research	Systematic study directed toward greater knowledge or understanding of fundamental aspects of phenomena without specific applications toward processes or products in mind.
2	Applied Research	Systematic study to understand the means to meet a recognized and specific need.
3	Advanced Technology Development	Development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments, tests in a simulated environment, or both.
4	Advanced Component Development and Prototypes	Efforts necessary to evaluate integrated technologies, representative modes or prototype systems in a high-fidelity and realistic operating environment.
5	System Development and Demonstration	Conducting engineering and manufacturing development tasks aimed at meeting validated requirements prior to full-rate production.
6	RDT&E Management Support	RDT&E efforts and funds to sustain, modernize, or both, the installations or operations required for general RDT&E.
7	Operational Systems Development	Development efforts to upgrade systems that have been fielded or have received approval for full-rate production and anticipate production funding in the current or subsequent fiscal year.

Source: GAO analysis of DOD Financial Management Regulation DOD 7000-14R, Volume 2B, Chapter 5, July 2008.

Appendix III: Comments from the Department of Defense



DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
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WASHINGTON, DC 20301-3040

Mr. Michael J. Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Sullivan:

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-11-113, "DEFEENSE ACQUISITION: Opportunities Exist to Improve DOD's Oversight of Power Source Investments," dated November 10, 2010 (GAO Code 120872). DoD's response to the report recommendations is enclosed.

Sincerely,

for

Zachary J. Lemnios

Enclosure:
As stated

Draft Report Dated November 10, 2010
GAO-11-113 (GAO CODE 120872)

"DEFENSE ACQUISITIONS: Opportunities Exist to Improve DOD's Oversight of Power Source Investments"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense consider how to best aggregate department wide investment data (from S&T, logistics support, and acquisition programs) in the power sources area and develop a mechanism to aggregate power source investment data across these investment categories at a level sufficient to guide decisions and policy. (See page 31/GAO Draft Report.)

DoD RESPONSE: Concur. The Director of Operational Energy Plans and Programs (DOEPP) has initiated efforts to aggregate power source investment data more effectively.

RECOMMENDATION 2: The GAO recommends that the Secretary of Defense determine methods to strengthen pertinent member agency participation in interagency coordination mechanisms. (See page 31/GAO Draft Report.)

DoD RESPONSE: Partially concur. Existing coordination methods are generally effective, and have been improving with the stand-up of the DOEPP office. Under DOEPP leadership, the Department will continue to seek ways of strengthening interagency coordination.

RECOMMENDATION 3: The GAO recommends that the Secretary of Defense identify and direct the appropriate office(s) to develop a plan to optimize use of standard power sources for weapon system or equipment types that are more amenable to such standardization. (See page 31/GAO Draft Report.)

DoD RESPONSE: Partially concur. On-going activities led by DOEPP are adequately addressing this need, and no expansion of effort is required.

RECOMMENDATION 4: The GAO recommends that the Secretary of Defense develop a DOD-wide policy-based on the above standardization plan-similar to section 8.8 of Army AR 70-1 that requires senior acquisition executive approval before allowing acquisition programs to use a power source that is not standard or preferred. As part of this new policy, consider requiring an independent review of the appropriateness of using the nonstandard or nonpreferred power source. (See page 31/GAO Draft Report.)

DoD RESPONSE: Partially concur. On-going activities led by DOEPP are adequately addressing this need, and no expansion of effort is required. Also, within the standardization efforts, there is a need to preserve some flexibility for forward-deployed commanders to adjust as conditions on the ground may require.

RECOMMENDATION 5: The GAO recommends that the Secretary of Defense identify opportunities to cost effectively retrofit deployed weapons systems and equipment that use a proprietary power source with an existing military standard or other preferred power source. (See page 32/GAO Draft Report.)

DoD RESPONSE: Partially concur. On-going activities led by DOEPP are adequately addressing this need, and no expansion of effort is required.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Michael J. Sullivan, (202) 512-4841 or sullivanm@gao.gov

Staff Acknowledgments

In addition to the contact named above, Art Gallegos, Assistant Director; John Oppenheim, Assistant Director; Frederick K. Childers; John Dell'Osso; Rosa Johnson; John Krump; C. James Madar; Bill Solis; Don Springman; Bob Swierczek; and Mark Viehman made key contributions to this report.

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