



MILITARY DEPOTS

DOD Can Benefit from Further Sharing of Best Practices and Lessons Learned

Accessible Version

January 2020

Why GAO Did This Study

DOD operates depots nationwide to maintain complex weapon systems and equipment through overhauls, upgrades, and rebuilding. These depots are crucial to sustaining military readiness by ensuring that the military services can regularly maintain critical weapon systems and return them to the warfighter for use in training and operations. For fiscal year 2018, DOD reported \$19 billion in total maintenance expenditures and about 84,000 personnel performing depot-level maintenance.

In June 2018, the Senate Armed Services Committee, in a report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2019, included a provision for GAO to review DOD's sharing and implementation of best practices and lessons learned among the depots.

GAO evaluated the extent to which DOD experiences benefits and has challenges with (1) sharing and (2) implementing best practices and lessons learned among the depots. GAO reviewed agency guidance; surveyed 17 depots; conducted site visits at five depots; and interviewed DOD, military service, and depot officials.

What GAO Recommends

GAO is making two recommendations to improve the depots' ability to share best practices and lessons learned by creating a comprehensive list of sharing venues, including points of contact, and re-establishing and maintaining materiel lessons learned organizations. DOD concurred with the recommendations.

View [GAO-20-116](#). For more information, contact Diana Maurer at (202) 512-9627 or maurerd@gao.gov

MILITARY DEPOTS

DOD Can Benefit from Further Sharing of Best Practices and Lessons Learned

What GAO Found

The Department of Defense (DOD) experiences benefits from sharing best practices and lessons learned among its depots, but communication and organization challenges exist. Best practices and lessons learned are shared among the depots through a variety of venues, including networking, working groups, and benchmarking trips to other depots. However, DOD has communication challenges, such as the lack of awareness of venues for sharing information. While Office of the Secretary of Defense officials reported posting a list of working groups, the list only contains three of the more than 60 working groups GAO identified. Without a centralized list of sharing venues and points of contact, it is unclear what groups exist and who to contact to participate, which may impede sharing of best practices and lessons learned. Further, while the Army stated it established lessons learned organizations for sharing maintenance best practices and lessons learned, it did not maintain them due to organizational restructuring and resource constraints. Establishing and maintaining effective organizations dedicated to sharing materiel best practices and lessons learned would encourage knowledge sharing among the Army depots.

Department of Defense's Benefits and Challenges with Sharing and Implementing Best Practices and Lessons Learned among the 17 Military Depots



Source: GAO analysis of Department of Defense information. | GAO-20-116

DOD is experiencing benefits and taking steps to mitigate challenges with implementing best practices and lessons learned among the depots. Depots reported that implementing some best practices and lessons learned has led to benefits, including time and cost savings. For example, Navy Fleet Readiness Center Southwest, California, implemented an intermittent fault detection system from Ogden Air Logistics Complex, Utah, on its F/A-18 aircraft generators. According to officials, the depot reduced repair time from 90 days to 30 days and quadrupled the generators' time between failures. Depots reported a variety of challenges to implementing lessons learned and best practices, including a lack of resources, lengthy approval processes, and acquisition and technology restrictions. DOD is taking steps to mitigate challenges to implementation, such as creating a new technology tool for viewing metrics on weapon systems' cost and availability which will allow senior leaders to steer resources to needed programs.

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Abbreviations

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|------|---------------------------------------|
| CJCS | Chairman of the Joint Chiefs of Staff |
| DOD | Department of Defense |

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January 30, 2020

Congressional Committees

The Department of Defense (DOD) operates depots nationwide to maintain complex weapon systems and equipment through overhauls, upgrades, and rebuilding.¹ These depots are crucial to sustaining military readiness by ensuring that the military services can regularly maintain critical weapon systems and return them to the warfighter for use in training and operations. For fiscal year 2018, DOD reported \$19 billion in total maintenance expenditures and about 84,000 personnel performing depot-level maintenance. However, our prior work shows that DOD is continually experiencing challenges at its depots, including deteriorating equipment and facility condition, filling critical personnel skills, and meeting service repair needs.² These challenges can lead to delays in the maintenance of weapon systems, which ultimately affects readiness by impeding the military services' ability to conduct training and to provide forces with sufficient equipment to perform operations around the world. According to DOD officials, these challenges could be better addressed within a culture of collaboration that shares best practices as well as leaders and processes that foster a culture of assessment and feedback.

To address these challenges and learn more about DOD's efforts to share best practices and lessons learned, the National Defense Authorization Act for Fiscal Year 2018 directed the Secretary of Defense to submit to the congressional defense committees a "comprehensive plan for the sharing of best practices for depot-level maintenance among

¹The term "depots" will refer to 17 installations reviewed in this report that perform depot-level maintenance, including the Army's depots, the Navy's shipyards and fleet readiness centers, the Marine Corps' production plants, and the Air Force's air logistics complexes. Depot maintenance includes inspection, repair, overhaul, or the modification or rebuild of end items, assemblies, subassemblies, and parts that, among other things, require extensive industrial facilities, specialized tools and equipment, or uniquely experienced and trained personnel that are not available in other maintenance activities. Depot maintenance is independent of any location or funding source and may be performed in the public or private sectors.

²See, for example, GAO, *Military Depots: Actions Needed to Improve Poor Conditions of Facilities and Equipment That Affect Maintenance Timeliness and Efficiency*, [GAO-19-242](#) (Washington, D.C.: Apr. 29, 2019) and *DOD Depot Workforce: Services Need to Assess the Effectiveness of Their Initiatives to Maintain Critical Skills*, [GAO-19-51](#) (Washington, D.C.: Dec. 14, 2018).

the military services.”³ In March 2018, DOD submitted a report to Congress describing a number of groups, committees, and activities related to a governance framework of joint collaboration.⁴ In June 2018, the Senate Armed Services Committee, in a report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2019, stated that it is not clear if DOD is effectively sharing and implementing best practices and lessons learned identified by its individual depots.⁵ As such, the Senate Armed Services Committee report included a provision for us to review DOD’s sharing and implementation of best practices and lessons learned among the depots. In this report, we examine the extent to which DOD experiences benefits and has challenges with (1) sharing and (2) implementing best practices and lessons learned among the depots. This report is the first in a series of reports examining depot maintenance requirements and timeliness for aviation, ground vehicles, and naval shipyards.

To address these objectives, we reviewed relevant laws and DOD and military service guidance that govern depot maintenance. We conducted a survey of 17 DOD depots performing depot-level maintenance to gain an understanding of how each depot shares with each other and implements best practices and lessons learned.⁶ The response rate for the survey was 100 percent. To gather detailed examples of DOD’s efforts to share and implement best practices and lessons learned, we visited a non-generalizable sample of five depots. To select our sample, we considered variation in geographic location, military service representation, and types of weapon systems maintained. At these sites, we conducted group discussions with depot officials and maintainers to gain insight into their roles in sharing and implementing best practices and lessons learned.

Additionally, we interviewed officials from the Office of the Secretary of Defense, military headquarters, military logistics or materiel components, and military lessons learned centers. We reviewed our prior reports related to challenges experienced at DOD depots and DOD’s report to

³Pub. L. No. 115-91 (2017).

⁴DOD, *Report to Congress on Sharing of Best Practices for Depot-Level Maintenance Among the Military Services* (March 2018).

⁵S. Rep. No. 115-262, at 147 (2018).

⁶To capture the full range of activities surrounding best practices and lessons learned, our unit of analysis for each survey was the depot as a whole. As such, our results will be reported by number of depots, rather than depot commanders or other metrics.

Congress on the sharing of best practices for depot-level maintenance among the military services. We obtained and analyzed documentation of sharing, such as working group charters and trip reports documenting results from visiting another depot, as well as benefits experienced from implementing a best practice or lessons learned, including time and cost savings. We assessed the documentary and testimonial evidence we collected against DOD and military service guidance, as well as the *Standards for Internal Control in the Federal Government* related to information and communication.⁷ A detailed discussion of our scope and methodology is in appendix I.

We conducted this performance audit from January 2019 to January 2020 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

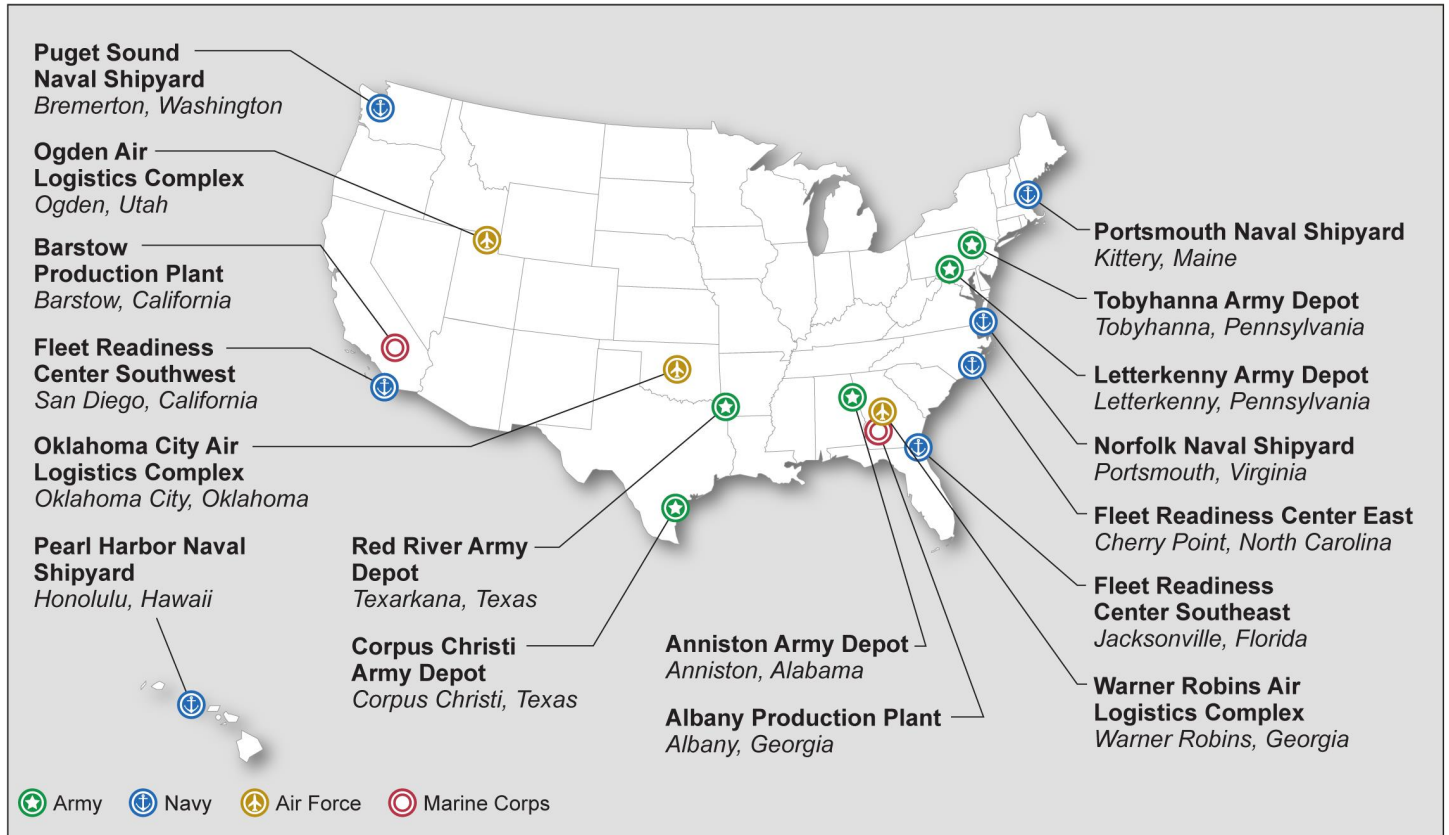
DOD's Depots

Depots are government-owned, government-operated industrial installations that maintain, overhaul, and repair a multitude of complex military weapon systems and equipment for the Department of Defense. Depots are essential to maintaining readiness for DOD and play a key role in sustaining weapon systems and equipment in meeting operational, contingency, and training requirements. There are 17 depots operated by the military services that perform depot-level maintenance on a wide range of vehicles and other military assets, including aircraft, engines, helicopters, combat vehicles, ships, and software. Five are Army depots, four are Naval shipyards, three are Navy fleet readiness centers, two are Marine Corps production plants, and three are Air Force air logistics complexes.⁸ Figure 1 below shows the location of these 17 depots across the United States.

⁷GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

⁸The Navy's fleet readiness centers are primarily focused on aviation-related repairs.

Figure 1: Department of Defense’s 17 Depots where Depot-Level Maintenance on Weapon Systems Is Performed



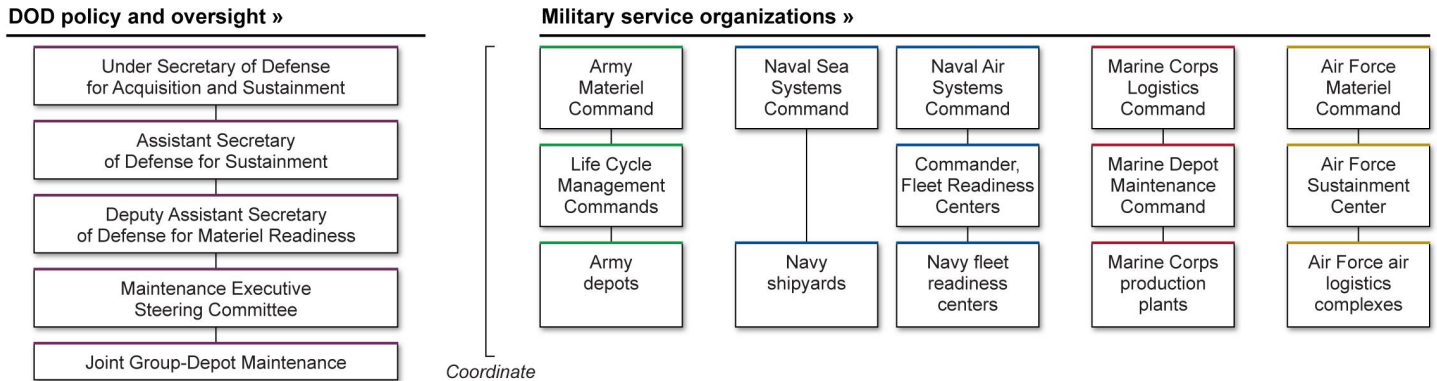
Source: GAO analysis of Department of Defense documents. | GAO-20-116

Note: Depots are government-owned, government-operated industrial installations that maintain, overhaul, and repair a multitude of complex military weapon systems and equipment.

Roles and Responsibilities

The depots are part of a larger, DOD-wide logistics enterprise that involves a number of different organizations (See fig. 2.).

Figure 2: DOD and Military Service Organizations Related to Depot Management



Source: GAO analysis of Department of Defense (DOD) and military service documentation. | GAO-20-116

Office of the Under Secretary of Defense for Acquisition and Sustainment. This office is responsible for, among other things, ensuring the defense industrial base, including depots, is robust, secure, resilient and innovative.

Office of the Assistant Secretary of Defense for Sustainment. This office serves as the principal assistant and advisor to the Under Secretary of Defense for Acquisition and Sustainment on material readiness. Among other responsibilities, the Assistant Secretary of Defense for Sustainment prescribes policies and procedures on maintenance, materiel readiness, and sustainment support.

Office of the Deputy Assistant Secretary of Defense for Materiel Readiness. This office establishes and maintains maintenance policies and programs to maintain the desired levels of weapon systems and military equipment readiness to accomplish the Department's missions. Further, according to DOD officials as well as DOD's March 2018 report to Congress on sharing best practices, the Office of the Deputy Assistant Secretary of Defense for Materiel Readiness has established a governance framework for materiel maintenance at DOD depots.⁹ There are a number of stakeholders involved in this framework, including the Maintenance Executive Steering Committee (Committee) and the Joint Group-Depot Maintenance.

Maintenance Executive Steering Committee. This Committee consists of senior maintenance and logistics representatives from the Office of the

⁹DOD, *Report to Congress on Sharing of Best Practices for Depot-Level Maintenance Among the Military Services* (March 2018).

Secretary of Defense, the Joint Staff, the Defense Logistics Agency, and the military services. According to DOD, this Committee advises the Deputy Assistant Secretary of Defense for Materiel Readiness on initiatives affecting efficiency, effectiveness, and affordability of maintenance management and operations. The Committee also serves as a forum for a coordinated review of maintenance policies, systems, programs and activities and helps optimize and steer DOD enterprise maintenance practices and strategy.

Joint Group–Depot Maintenance. As a standing committee of the Maintenance Executive Steering Committee, the mission of the Joint Group–Depot Maintenance is to promote and review depot maintenance functions at the enterprise level to achieve effective and affordable depot maintenance support for weapon systems and to execute responsibilities assigned in DOD maintenance of military materiel policy.¹⁰

Military service organizations. Each military service has its own logistics or materiel command component, which provides day-to-day management and oversight of the military services' depots.

DOD Guidance for Sharing Best Practices and Lessons Learned

The Chairman of the Joint Chiefs of Staff is responsible for formulating policies for gathering, developing, and disseminating joint lessons learned for the armed forces.¹¹ Chairman of the Joint Chiefs of Staff (CJCS) Instruction 3150.25G, *Joint Lessons Learned Program*, defines:

- best practice as “a validated method or procedure which has consistently shown results superior to those achieved with other means, and appears to be worthy of replication,” and
- lesson learned as “a resolved issue or best practice that improves operations or activities and results in an internalized change to capability, process, or procedure.”¹²

¹⁰DOD Directive 4151.18, *Maintenance of Military Materiel* (March 31, 2004) (Incorporating Change 1, Aug. 31, 2018). DOD materiel maintenance includes maintenance of weapon systems, hardware, equipment, software, or any combination.

¹¹10 U.S.C. § 153(a)(6)(E).

¹²CJCS Instruction 3150.25G, *Joint Lessons Learned Program* (Jan. 31, 2018).

The Joint Staff's Joint Lessons Learned Program collects, validates, and disseminates lessons learned to support sustainment and improvement of joint force readiness and effectiveness via refinements in doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy.¹³ Specific military service guidance on their respective lessons learned programs share the same purpose.¹⁴ Best practices and lessons learned are captured in the Joint Lessons Learned Information System—DOD's system of record for lessons learned—and are generally focused on sharing operational information from after-action reports and joint training exercises, rather than maintenance-related lessons learned. The DOD maintenance community, including the military service logistics or materiel command component and depots, do not typically coordinate with the military services' lessons learned centers or enter lessons learned into the Joint Lessons Learned Information System.

GAO's Prior Work on Depot Maintenance

Our prior work has identified multiple challenges that can affect depot performance, including having the right facilities and having personnel with the right skills, among other challenges (See fig. 3.).

Figure 3: Challenges Experienced at Department of Defense Depots That Can Affect Depot Performance



Source: GAO. | GAO-20-116

Note: Depots are government-owned, government-operated industrial installations that maintain, overhaul, and repair a multitude of complex military weapon systems and equipment.

¹³CJCS Manual 3150.25B, *Joint Lessons Learned Program* (Oct. 12, 2018).

¹⁴Army Regulation 11-33, *Army Lessons Learned Program* (June 14, 2017); Office of the Chief of Naval Operations (OPNAV) Instruction 3500.37D, *Navy Lessons Learned Program* (June 20, 2018); Marine Corps Order 3504.1, *Marine Corps Lessons Learned Program (MCLLP) and the Marine Corps Center for Lessons Learned (MCCLL)* (July 31, 2006); Air Force Instruction 90-1601, *Air Force Lessons Learned Program* (Dec. 18, 2013).

Specifically, in April 2019 we reported on the condition of facilities at DOD depots, such as the condition of these depots are poor and the age of equipment is generally past its useful life, and the military services do not consistently track the effect that these conditions have on depot performance. To address these challenges, we recommended that DOD improve its data collection on the effect of facilities and equipment condition on depot performance, among other things.¹⁵ DOD concurred, and stated, in general, that the Service Chiefs for the Army, Navy, Air Force, and Marine Corps will ensure that their respective material commands take actions to implement the recommendations for their respective service. Also, in December 2018 we reported on depot workforce challenges, such as hiring personnel in a timely manner and providing inexperienced personnel with the training necessary to become proficient in skilled operations. According to DOD officials, these workforce challenges contributed to delays in the maintenance of some weapon systems. To address these workforce challenges, we recommended that the military services assess the effectiveness of the actions they have taken to maintain critical skills in the depot workforce.¹⁶ DOD concurred, and stated that each of the four services will take action to assess the effectiveness of the hiring, training, and retention programs at their respective depots, shipyards, fleet readiness centers, and air logistics complexes. The Related GAO Products page at the end of this report provides a list of our depot-related reports and testimonies.

¹⁵[GAO-19-242](#).

¹⁶[GAO-19-51](#).

DOD Experiences Benefits from Sharing Best Practices and Lessons Learned among the Depots, but Communication and Organization Challenges Exist

DOD Experiences Benefits from Sharing Best Practices and Lessons Learned among the Depots through a Variety of Venues

DOD shares best practices and lessons learned among the depots through a variety of venues, including networking, working groups, and benchmarking.

Networking. DOD shares best practices and lessons learned through informal networking, such as personal contacts and conferences. All 17 depots reported engaging in networking to share best practices and lessons learned and coordinating with their materiel commands, program managers and/or program offices, and academia. The majority of the depots also coordinated with industry, other depots, and/or a point of contact or group within the Office of the Secretary of Defense (see table 1 below).

Table 1: Department of Defense’s (DOD) 17 Depots’ Selected Responses on Coordination to Share Best Practices and Lessons Learned

| Does your depot coordinate with any of the following groups regarding best practices and lessons learned? | Yes |
|-------------------------------------------------------------------------------------------------------------------|-----|
| Your materiel command/systems command | 17 |
| The Program Manager and/or Program Executive Office for items serviced at your depot | 17 |
| Academia | 17 |
| Other depots within your service | 15 |
| Other depots outside of your service | 15 |
| Industry—i.e., commercial depots, original equipment manufacturers, industry sponsored conferences/working groups | 14 |
| An Office of the Secretary of Defense-level point of contact or group | 11 |

Source: GAO analysis of GAO survey of 17 DOD depots performing DOD-depot level maintenance. | GAO-20-116

Note: Depots are government-owned, government-operated industrial installations that maintain, overhaul, and repair a multitude of complex military weapon systems and equipment.

**Fleet Readiness Center Southwest
Learns and Implements Training Lab
Concept from Depot Maintenance**

Awards Winner, Portsmouth Naval Shipyard

It is DOD policy to enhance maintenance awareness and encourage maintenance excellence by providing appropriate recognition through an annual maintenance awards program. After Portsmouth Naval Shipyard won the Robert T. Mason Award for Depot Maintenance Excellence in 2016, Fleet Readiness Center Southwest officials visited the Portsmouth Naval Shipyard on a benchmarking trip. Benchmarking is when depot officials visit another depot to compare performance and find improvement ideas. During this trip, Fleet Readiness Center Southwest officials learned about Portsmouth Naval Shipyard's apprenticeship program. Upon their return, Fleet Readiness Center Southwest officials worked to establish their own apprenticeship program, which includes labs and courses to train artisans in sheet metals, paint, and electronics.

This success has been shared with Fleet Readiness Centers East and Southeast, which are both implementing similar systems. Successfully training new artisans is particularly important for depot performance, as our prior work has shown that this workforce is aging and the Department of Defense faces challenges in hiring and retaining workers with key skills. Officials cited examples of maintenance taking months or years longer than expected, in part due to shortages in skilled personnel.

Source: GAO analysis of Department of Defense (DOD) information and [GAO-19-51](#). | GAO-20-116

All 17 depots reported that the DOD Maintenance Symposium (Symposium), an annual department-wide conference addressing the maintenance of weapon systems and equipment, is the most regularly attended and most beneficial venue for networking. All 17 depots reported attending the Symposium regularly or occasionally, with depot officials stating in the survey and interviews that the Symposium provides opportunities to build relationships and network with peers in DOD and external contacts in industry. Depots reported in our survey that the Symposium was valuable because it offered opportunities to make contacts with equipment vendors and other services, as well as break-out sessions and informal discussions to exchange ideas. During the Symposium, a number of maintenance awards, including the Robert T. Mason Award for Depot Maintenance Excellence, are awarded to recognize maintenance excellence (see sidebar).¹⁷ Three depots reported that the recognition of the award-winning depots gives other depots the opportunity to reach out to the award-winning depots for relevant information.

Working Groups. DOD depots' leadership and staff use working groups and communities of practice as venues for the DOD maintenance community to collaborate and to share expertise on specific topics.¹⁸ When surveyed, 13 of 17 depots reported they share best practices and lessons learned in working groups, and they identified more than 60 such working groups.¹⁹ Our analysis of survey responses shows that depots value working groups because they improve depot support to the warfighter by allowing the depot to evaluate best practices, review new technology, exchange data, initiate relationships, and gain stakeholder support. In our interviews, depot officials affirmed the value of working

¹⁷The Robert T. Mason Award for Depot Maintenance Excellence is presented annually to one program from a depot-level maintenance activity. The competition is for programs having more than 400 DOD civilian and U.S. uniformed military employees engaged in depot-level maintenance operations.

¹⁸DOD defines a working group as an enduring or ad hoc organization within a headquarters consisting of a core functional group and other staff and component representatives whose purpose is to provide analysis on the specific function to users. DOD defines a community of practice as a group of people who share a common craft and/or professions and learn how to do it better through regular interaction. DOD Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Nov. 8, 2010) (as amended through Feb. 15, 2016); CJCS Instruction 3150.25G. For the purposes of this report, we use the term working groups to refer to working groups and communities of practice.

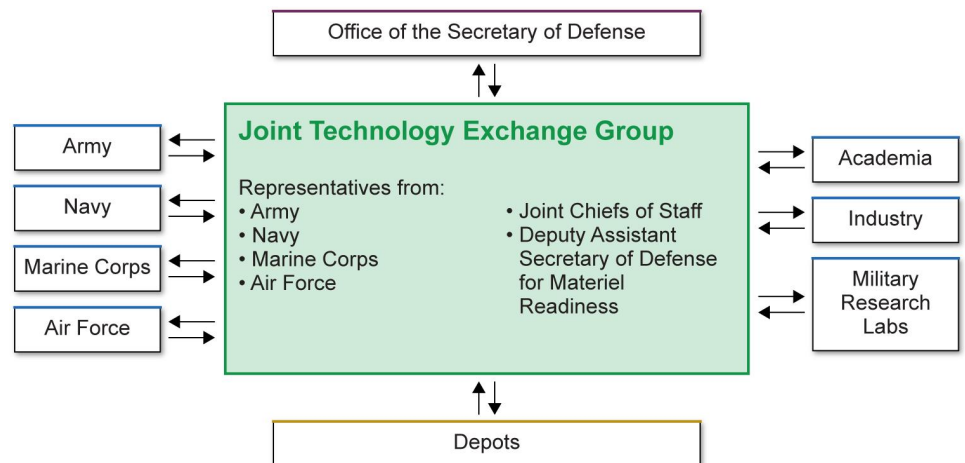
¹⁹See appendix II for a list of all working groups identified by the depots in our survey.

groups to promote collaboration and open discussions among peers focused on specific topics of common interest.

We found that the working groups fall into three topic areas: new technologies, specific weapon systems, and depot management. For example:

- **New technologies.** The Joint Technology Exchange Group was chartered to improve coordination in the introduction of new or improved technology, new processes, or new equipment into DOD depot maintenance activities. To do this, the Joint Technology Exchange Group facilitates a number of forums and working groups centered on specific technologies, which allow representatives from the depots to learn from other services, academia, and industry (See fig. 4.). One example of this is cold spray, a new technology that sprays high velocity metal particles to repair worn surfaces and damaged parts that are unreparable by traditional processes. Working groups facilitated by the Joint Technology Exchange Group have shared the usefulness of cold spray technology, and 12 depots from all service branches reported that they have begun adopting the technology. One depot estimates that its annual savings from using cold spray will be \$202,000 annually, as well as additional time savings.

Figure 4: Department of Defense’s Joint Technology Exchange Group Participants



Source: GAO analysis of Joint Technology Exchange Group participants. | GAO-20-116

Note: The Joint Technology Exchange Group was chartered to improve coordination in the introduction of new technology into Department of Defense depot maintenance activities.

- **Weapon systems.** According to Navy officials, depot officials and maintainers for the CH-53E/MH-53E heavy lift helicopter participate in the H-53 Fleet Support Team working group. Fleet Readiness Center East reported that its production team was able to implement lessons learned from this group for repairing misalignment in a piece of the helicopter’s tail. As a result, the safety of the helicopter was increased. See figure 5 for details on this heavy lift helicopter.

Figure 5: The CH-53E and MH-53E Heavy Lift Helicopters

cH



CH-53E
Marine Corps



MH-53E
Navy

Source: Defense Visual Information Distribution Service. | GAO-20-116

- **Depot management.** Depot commanders participate in the Industrial Base Commanders’ monthly teleconference to share best practices and lessons learned related, in part, to management of depot operations. Twelve of the 17 depots indicated that the Industrial Base Commanders’ monthly teleconference is beneficial. The depots reported that the Industrial Base Commanders’ monthly teleconference allows base commanders time to share and to work on specific depot maintenance problems and is particularly productive in the areas of personnel and policy.

Benchmarking. To benchmark, depot officials visit another depot to compare performance and find improvement ideas, particularly best practices and lessons learned related to weapon systems and depot

management.²⁰ Our analysis of site visit and survey data shows 10 of the 17 depots reported benchmarking trips. For example, in 2018 the Marine Corps Albany Production Plant sent a team of managers and technicians from their electronics and fabrications branches on a benchmarking trip to learn best practices from the team at Tobyhanna Army Depot. They visited six areas, where they observed processes and ideas that they could take back to their plant. In its trip report, the Marine Corps Albany Production Plant team highlighted a number of processes that increased efficiency in the electronics shop at Tobyhanna Army Depot, such as steps to eliminate unnecessary travel in sheet metal processes and updated electronics workstations.

According to our prior work, benchmarking is useful for reducing internal resistance to change—a barrier to sharing best practices and lessons learned cited by the depots—because knowing what others actually are accomplishing changes perceptions of what can be done and what should be attempted.²¹ One depot told us that it intentionally brings maintainers and depot officials together on benchmarking trips so that the maintainers can benefit firsthand from seeing the best practices and lessons learned.

DOD Has Communication Challenges That May Hinder Ability of the Depots to Share Best Practices and Lessons Learned

DOD has communication challenges, such as the lack of awareness of venues, that may hinder the ability of the 17 depots to share best practices and lessons learned. While many sharing venues exist, such as working groups, the depots' knowledge of them has gaps. According to our survey, 12 of the 17 depots reported being unaware of the existence of some venues where best practices and lessons learned can be shared. Additionally, 7 of the 17 depots reported not knowing who to contact to participate in some venues for sharing best practices and lessons learned. Moreover, in our interviews officials explained that staff turnover is also a challenge. Specifically, officials from one depot said that when

²⁰Benchmarking helps define specific reference points for setting goals for improving performance. It leads an organization to compare the performance of its processes and the way the processes are conducted with either (1) internal organizational pockets of excellence or (2) relevant peer organizations to obtain ideas for improvement. See GAO, *Managing for Results: Critical Actions for Managing Performance*, [GAO/T-GGD/AIMD-95-187](#) (Washington, D.C.: June 20, 1995).

²¹[GAO/T-GGD/AIMD-95-187](#).

the depot representative to a venue leaves, the institutional knowledge of the venue and its point of contact can be lost. They recounted having to resort to cold-calling other depots for information. Depots also reported that their staff did not attend best practices and lessons learned venues because they believed that those venues were for higher command levels. For example, one depot expressed confusion about the Industrial Base Commanders' meeting and reported that while the depot officials were aware of the meeting, they believed that it was for officials at a higher level, such as their Materiel Command.²²

Department of Defense Instruction 4151.18 states that DOD materiel maintenance programs should adopt business practices and quality management processes to continuously improve maintenance operations and maintenance production, achieve cost savings and avoidance, and realize process cycle time reduction.²³ Further, GAO's *Standards for Internal Control in the Federal Government* states that management should communicate quality information down and across reporting lines to enable personnel to perform key roles in achieving objectives.²⁴ However, the Office of the Secretary of Defense has not created, shared, or maintained a comprehensive and updated list of all depot-specific DOD sharing venues (i.e., working groups) that includes points of contact. Officials from the Office of the Secretary of Defense stated that the Joint Technology Exchange Group maintains a list on its website. However, the list is incomplete, only containing three of the over 60 working groups we identified in our analysis of our interview and survey data. Moreover, we found that not all depot officials were aware of the Joint Technology Exchange Group and so would not be familiar with the Joint Technology Exchange Group's website. Without a centralized list of venues and points of contact, it is unclear what groups exist and who to contact to participate, which may impede sharing of best practices and lessons learned.

²²The Industrial Base Commanders' meeting is a monthly teleconference for depot commanders to share best practices and lessons learned regarding depot management.

²³DOD Instruction 4151.18, *Maintenance of Military Materiel* (Mar. 31, 2004) (incorporating Change 1, Aug. 31, 2018).

²⁴[GAO-14-704G](#).

The Army Has Not Maintained Lessons Learned Organizations, Potentially Hindering the Ability of the Depots to Share Best Practices and Lessons Learned

Each military service has initiatives or organizations to encourage the sharing of best practice and lessons learned; however, the Army has not maintained its lessons learned organizations. The depots from the Navy, Marine Corps, and Air Force reported, in our survey and interviews, that their military services have initiatives and organizations that encourage knowledge sharing regarding best practices and lessons learned among the depots. For example:

- **Navy’s Fleet Readiness Center’s Naval Sustainment System.** The Naval Sustainment System is an initiative to increase maintenance capacity and readiness among the Navy’s fleet readiness centers by process reviews and benchmarking. The depots reported in our survey that it improves production by encouraging them to identify constraints and to share lessons learned. The Naval Sustainment System is also in the process of being adopted by the shipyards.
- **Navy’s “One Shipyard” Concept.** The “One Shipyard” concept is a Navy workforce initiative in which maintainers are exchanged among the shipyards to ensure that the shipyards will have the required number of workers and skill sets to meet current and planned maintenance requirements. A Navy depot stated that as a result of the communication required by this concept, they are better able to share best practices.
- **Marine Corps’ Marine Depot Maintenance Command.** Based on responses to our survey, Marine Corps officials stated that the Marine Corps depots have a single command structure. With this structure, all process improvement meetings are held with both depots in attendance, resulting in the sharing of best practices and lessons learned between the two depots.
- **Air Force’s Art of the Possible.** The Air Force Sustainment Center created this management program to focus attention on restrictions in workflow in the depots. Depots report that it creates a culture of collaboration and sharing of best practices and lessons learned because it focuses on process improvement and creates a culture in which it is acceptable to discuss problems with other depots.

To determine which depot will receive new workload, the Department of Defense (DOD) Instruction 4151.24, *Depot Source of Repair Determination Process* (Oct. 13, 2017) outlines a process under which workloads necessary to sustain core logistics capabilities are assigned to DOD depots that have the requisite competencies. Two Army depots reported that this process created competition for workload that hinders sharing for them. Depot officials stated that they fear that other depots will take workload from them if they share weapons system maintenance best practices. In one such instance, Marine Corps depot officials stated they visited an Army depot and observed a best practice for repairing 50-caliber machine gun receivers. However, when the Marine Corps depot reached out for technical details, the Army depot was not inclined to share, for a variety of reasons including competition for the same workload. Then, the Marine Corps depot asked Marine Corps Logistics Command to facilitate, and they resolved the issue by finding a Navy depot that had similar technology and was willing to share.



Senior Army officials concurred that competition between depots for jobs can be a barrier for sharing, particularly when it involves the preservation of specific depot workloads. However, depots in other services did not report competition for workload to be a barrier to sharing.

Source: GAO Analysis of DOD Information. Defense Visual Information Distribution Service (photos). | GAO-20-116

In contrast, the Army does not have similar initiatives or organizations. Army regulations direct the establishment and maintenance of two organizations for sharing depot best practices and lessons learned. First, Army Regulation 750-1 directs the Army Materiel Command to establish and maintain the Army Materiel Lessons Learned Analysis Program to identify potential systemic materiel sustainment issues and examine root and contributing causes.²⁵ Second, Army Regulation 11-33 directs Army Materiel Command to establish and maintain the Center for Army Acquisition and Materiel Lessons Learned to provide support in the collection, analysis, dissemination, and archiving capability of materiel lessons learned, with the objective of creating a knowledge sharing culture within the Army.²⁶ Moreover, the *Standards for Internal Control in the Federal Government* states that management should establish an organizational structure, assign responsibility, and delegate authority to achieve the entity's objectives.²⁷

The Army stated it established these organizations for sharing materiel best practices and lessons learned; however, Army Headquarters, Army Materiel Command, and Army depot officials stated that they were not aware of analysis or knowledge sharing of depot best practices and lessons learned that were performed by these organizations. Further, the Army did not maintain these organizations for sharing materiel best practices and lessons learned. First, officials from Army Futures Command confirmed that the Army Materiel Lessons Learned Analysis Program was transferred from Army Materiel Command to Army Futures Command in July 2018 and no longer focuses specifically on materiel lessons learned. Second, the officials confirmed that the Army ceased to maintain the Center for Army Acquisition and Materiel Lessons Learned in early 2017 due to direct funding limitations. In addition, some Army depots reported being unable to identify peers in other depots to share with, and they reported that competition hinders sharing (see sidebar). Senior Army officials concurred that there are cultural challenges, which result in the depots being less open to sharing and implementing best practices and lessons learned. Establishing and maintaining effective organizations dedicated to sharing materiel best practices and lessons learned would encourage knowledge sharing among the Army depots.

²⁵Army Regulation 750-1, *Army Materiel Maintenance Policy* (Aug. 3, 2017).

²⁶Army Regulation 11-33, *Army Lessons Learned Program* (June 14, 2017).

²⁷[GAO-14-704G](#).

DOD Is Experiencing Benefits and Taking Steps to Mitigate Challenges with Implementing Best Practices and Lessons Learned among the 17 Depots

DOD Is Implementing Some Best Practices and Lessons Learned That Has Led to Benefits

DOD is implementing some best practices and lessons learned among the 17 depots that have led to benefits, including cost and time savings. In response to our survey, 16 of the 17 depots reported benefits from successfully implementing best practices and lessons learned, such as sharing technology to reduce costs and improving maintenance processes to repair parts and systems. These implemented best practices and lessons learned can be defined as intra-service (within a military service), inter-service (between two or more military services), or DOD and external entities (between a military service and private industry).

Intra-service collaboration. Depots within each military service are collaborating to implement best practices and lessons learned to improve depot management processes and repairs related to weapon systems. For example, Red River Army Depot implemented a best practice learned from Anniston Army Depot to improve its depot management process in meeting its production schedule. The production schedule is a plan that identifies, among other things, working hours for maintainers, available storage, and parts supply. To facilitate the implementation of this best practice, Army Tank-Automotive and Armaments Command, which oversees these two depots, hosted a joint event for the purpose of Anniston's sharing how a small group of individuals at its depot is responsible for maintaining visibility of all end-item (i.e., components and parts ready for their intended use) production schedules. According to Army officials, Red River did not have an organization that performed a similar function, and during the joint event, depot officials from Red River saw this as a lesson learned that they could take back to their depot and implement. Additionally, Anniston shared how it conducts its risk assessments, or program reviews, and weekly execution meetings, among other processes, in meeting its production schedules. As a result,

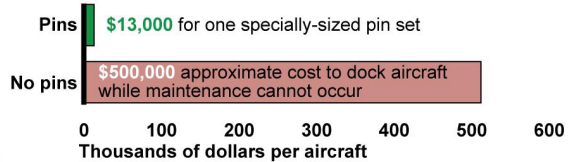
Army officials told us that Red River implemented the best practices they thought would be beneficial in helping them make progress in meeting their production schedules.

In another example, two Air Force depots that maintain the Navy's C-130 aircraft are working together to implement a best practice, which, according to program documentation, has led to cost and time savings (See fig. 6.).²⁸

Figure 6: Benefits of Using Specially-Sized Pins on Shelf Brackets for C-130 Aircraft at Ogden Air Logistics Complex, Utah



The Air Force reported that specially-sized pins allow the maintenance process to continue while the shelf bracket is removed and repaired.



In implementing this best practice, the Air Force reported the total annual benefit to the C-130 fleet at Ogden amounts to 288 days of aircraft availability and about \$9 million in cost avoidance.

C-130 aircraft

Empty holes where specially-sized pins are installed.

Source: GAO analysis of Air Force data; Defense Visual Information Distribution Service (photos). | GAO-20-116

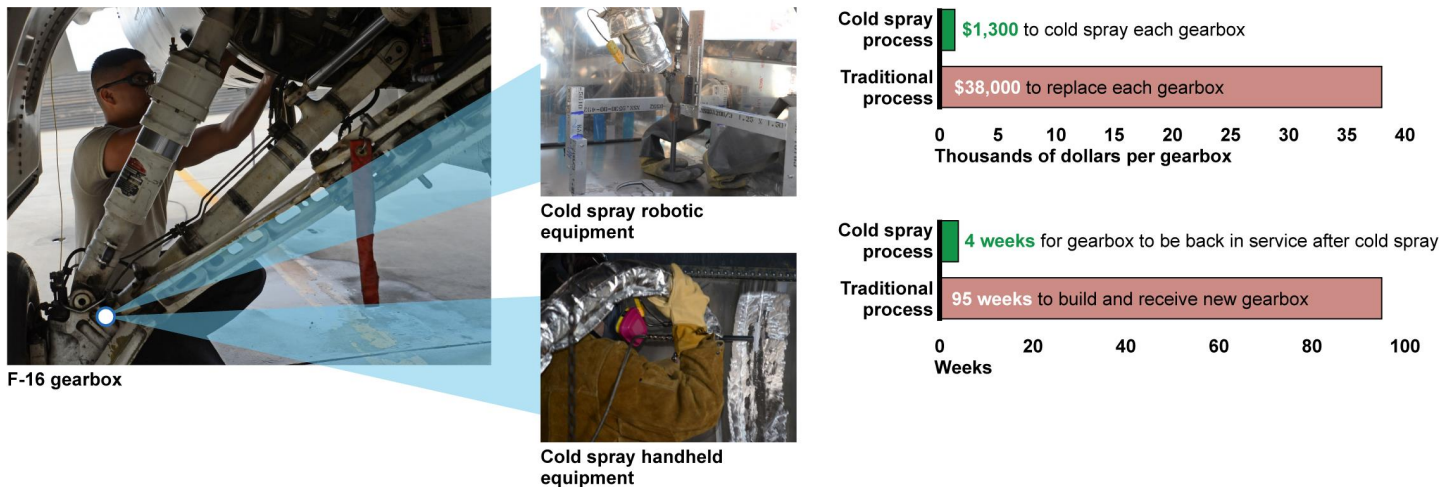
Specifically, the Navy's C-130 aircraft, which, according to Ogden officials, is maintained at Ogden Air Logistics Complex and Warner Robins Air Logistics Complex, contains a shelf bracket, which holds the pieces of the aircraft together. The aircraft becomes structurally vulnerable and unfit for operations and training if the shelf bracket is removed. The process of blasting, inspecting, plating, and reinstalling the shelf bracket takes an average of 63 days. During this time, some maintenance activities cannot occur until the shelf bracket is reinstalled. To address this issue, engineers at Ogden told us they created a series of specially-sized pins to lock the Navy's C-130 aircraft in place to help maintain the structural integrity of the airframe while other areas of the aircraft are being repaired. As a result of this best practice, maintainers have eliminated 16 days in the maintenance process for the C-130. Also,

²⁸The C-130 Hercules is a transport aircraft operated by the Navy, Marine Corps, and Air Force and maintained by the Air Force.

depot officials told us for a one-time cost of \$13,000 for one set of specially-sized pins, eliminating 16 days in the maintenance process in turn generates a cost avoidance of \$32,000 per day (the cost to dock the aircraft) or more than \$500,000 per aircraft. In implementing this best practice, the total annual benefit to the C-130 fleet at Ogden amounts to 288 days of aircraft availability and about \$9 million in cost avoidance. Officials at Ogden told us they have implemented this new process and are discussing this best practice with maintainers at Warner Robins for implementation at their depot as well.

Further, Air Force depots are partnering to further implement another best practice, cold spray technology, which allows depots to repair damaged parts instead of replacing them. Replacing these damaged parts can be expensive or difficult if they are low in supply. Also, limited parts and long lead times can cause delays in the supply system, and existing repair processes have a long turnaround time. Cold spray technology has not been fully implemented; however, even with its limited implementation, cold spray technology has yielded cost and time benefits (See fig. 7.).

Figure 7: Benefits of Cold Spray Technology for the F-16 Gearbox



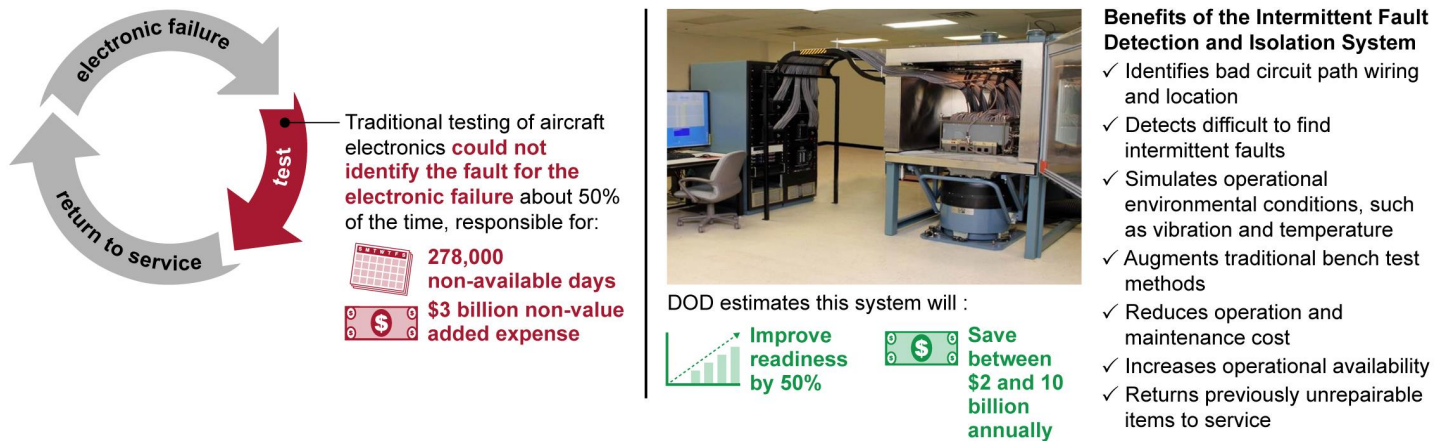
Source: GAO analysis of Air Force data; Defense Visual Information Distribution Service (photos). | GAO-20-116

According to Air Force officials, Ogden has been collaborating with the Oklahoma City Air Logistics Complex to cold spray its F-16 gearboxes until Ogden can obtain adequate workload to sustain the cold spray technology. According to Ogden officials and program documentation, cold spraying each gearbox costs about \$1,300 whereas replacing each gearbox costs about \$38,000; at 13 units per year, this amounts to almost \$500,000 in annual cost avoidances. Additionally, it would take 95 weeks

to build and receive a new gearbox unit; however, with the cold spray repair the unit is back in service in 4 weeks. Ogden officials are currently working to include cold spraying gearboxes for the F-15, C-5 and E-3 weapon systems to its workload.²⁹

Inter-service collaboration. Depots from two or more military services are collaborating to implement best practices and lessons learned which has led to benefits. For example, the Navy’s Fleet Readiness Center Southwest implemented a best practice learned from Ogden Air Logistic Complex to improve testing of electrical circuits. Specifically, according to depot officials, a maintainer at Ogden created a method—Intermittent Fault Detection and Isolation System—which tests systems and software to detect, isolate, and repair intermittent problems due to open circuits, short circuits, and poor wiring by replicating the environment of the aircraft in flight (See fig. 8.). According to Ogden officials and program documentation, by implementing this best practice, they have recovered out-of-service assets and generated about \$62 million in cost savings. For example, after testing its F-16 chassis, Ogden officials recovered 138 out-of-service assets—amounting to \$42 million of flight hardware returning to service.

Figure 8: Benefits of the Intermittent Fault Detection and Isolation System



Source: GAO analysis of Department of Defense (DOD) and military service documentation; DOD (photos). | GAO-20-116

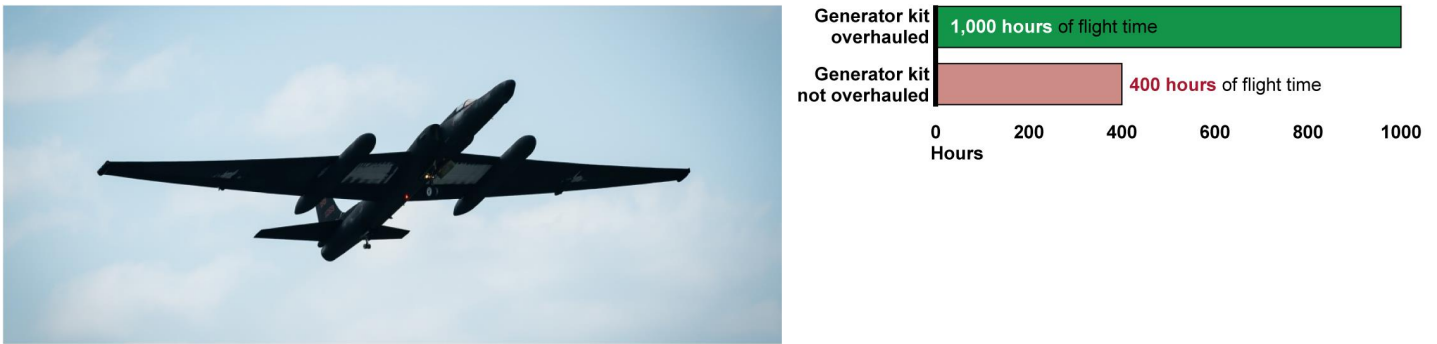
Moreover, officials at Fleet Readiness Center Southwest visited Ogden during a benchmarking trip to discuss the process of implementing the Intermittent Fault Detection and Isolation System to test their systems.

²⁹The F-16 Fighting Falcon, F-15 Eagle, C-5 Galaxy, and E-3 Sentry are aircraft operated and maintained by the Air Force. The F-16 and F-15 are tactical fighter aircraft; the C-5 is a transport aircraft; and the E-3 is a warning and control system aircraft.

According to officials from the Office of the Secretary of Defense, the intermittent faults due to aircraft electrical systems amounted to more than \$300 million in operating and support costs in fiscal year 2014. The Fleet Readiness Center Southwest used the Intermittent Fault Detection and Isolation System to test its F/A-18 aircraft generators, which provide electrical power to the aircraft. As a result of testing these generators using the Intermittent Fault Detection and Isolation System, the mean time between failures for the generators has increased, according to officials, from 104 flight hours to over 400 flight hours, and the Navy anticipates a reduction of about 30 to 90 days of repair time.³⁰

DOD and external entities. Depots are also partnering with private industry to implement best practices and lessons learned, which has led to time-savings benefits (See fig. 9.).

Figure 9: Benefits of Overhauling Generator Kit for U-2 Aircraft



U-2 aircraft

Source: GAO analysis of Air Force data; Defense Visual Information Distribution Service (photo). | GAO-20-116

For example, according to program officials, the Air Force, Navy, original equipment manufacturer, and contractor collaborated to implement a best practice for the U-2 aircraft. Specifically, in 2018, generators for the Air Force’s U-2 aircraft had decreased their mean time between failures from 1,000 hours to 400 hours. To sustain the fleet, the Air Force was cannibalizing—removing parts from one aircraft to another—generators from aircraft in depot maintenance to those preparing for deployment. The U-2 program office identified the Navy’s F/A-18 A/B generator as similar to the U-2 generator and learned valuable information on the repair and overhaul process, root cause analysis of failure of critical parts, and the Navy’s recommendation for procuring and building overhaul generator

³⁰The mean time between failures predicts, in hours, the average amount of time the part will operate before a failure occurs.

kits. In order to implement the Navy’s processes, the Air Force program office, working with the original equipment manufacturer and contactor, incorporated the Navy’s best practices in overhauling its generator kit concept. As a result, the Air Force is no longer cannibalizing these generators and the mean time between failures has returned to about 1,000 hours of flight time.

DOD Has Not Been Able to Implement Some Best Practices and Lessons Learned among the 17 Depots, but Is Taking Steps to Mitigate Challenges

DOD has not been able to implement some best practices and lessons learned among the 17 depots, but DOD is taking steps to mitigate challenges to implementation. In its March 2018 *Report to Congress on Sharing of Best Practices for Depot-Level Maintenance Among the Military Services*, DOD noted some of the challenges in implementing best practices such as differing military service priorities, strategies, and resourcing of technologies and infrastructure.³¹ In responding to our survey, 15 of the 17 depots reported challenges in implementing best practices and lessons learned, including insufficient resources, restrictions related to information technology, approval process, and acquisition and contracting policies, among others (See table 2.).

Table 2: Challenges Affecting the Implementation of Best Practices and Lessons Learned at Department of Defense (DOD) Depots

| Implementation challenges | Army depots | Navy fleet readiness centers | Navy shipyards | Air Force air logistics centers |
|------------------------------------------------|-------------|------------------------------|----------------|---------------------------------|
| Insufficient resources | yes | yes | yes | yes |
| Restrictions related to information technology | yes | yes | yes | yes |
| Approval process | yes | yes | yes | yes |
| Acquisition and contracting policies | yes | yes | | yes |

Source: GAO analysis of GAO survey of 17 DOD depots performing DOD depot-level maintenance. | GAO-20-116

³¹The *National Defense Authorization Act for Fiscal Year 2018*, Pub. L. No. 115–91 (2017) directed the Secretary of Defense to submit to the congressional defense committees a “comprehensive plan for the sharing of best practices for depot-level maintenance among the military services.” In March 2018, the Secretary submitted the report, *Sharing of Best Practices for Depot-Level Maintenance Among the Military Services*.

Note: Individual depot survey responses were aggregated to represent the military service as a whole. In responding to the survey, Marine Corps depots at Albany, Georgia, and Barstow, California, reported that best practices that are beneficial to its production plants and can easily be implemented at low cost and with limited to no impact on production. However, officials from the Marine Corps Logistics Command, which provides day-to-day management and oversight of the Marine Corp depots at Albany and Barstow, stated that they also experience these four challenges when implementing best practices and lessons learned at their depots.

Insufficient resources. Ten of the 17 depots reported insufficient resources as a challenge to implementation for various reasons. First, depots reported not having adequate time, staff, or funding to attend knowledge sharing activities or to analyze data from best practices and lessons learned. According to depot officials, not being able to attend knowledge sharing activities has made networking more difficult because these activities allowed them to discuss best practices and lessons learned with colleagues from other depots and industry. Second, in addition to not having adequate funding, depots also reported identifying sources of funding as a challenge to implementing best practices and lessons learned for specific weapon systems. For example, according to officials from one depot, they have been unable to identify a funding source to implement the laser de-painting system for the F-16, which would allow the aircraft to stay in service longer and would produce less hazardous materials than the current blasting process to remove paint from the aircraft. Third, depots reported insufficient equipment to implement a best practice. For example, one depot reported not having enough hand-held tablets, which contain electronic technical data and best practices from private industry to assist maintainers working on a weapon system. Another depot reported that it has not implemented the tablets and are relying on paper documentation to maintain its weapon systems. According to depot officials, the lack of tablets has had direct effects at the depot, such as delays in standing-up new capability and maintainers waiting on available tablets to perform their work.

To mitigate challenges with insufficient resources, DOD, military service, and depot officials have taken a variety of steps. For example, officials from the Office of the Secretary of Defense held an event through the Joint Technology Exchange Group to discuss available funding sources for new and emerging technologies, such as the funding sources for the cold spray technology. According to officials at a Navy depot, depots can petition the Office of Naval Research for federal laboratory designation. With this designation, depots can partner with private industry to evaluate technology in any area that is consistent with the federal laboratory's mission and may receive funds from private industry for technology research and development. Specific to the tablets, depot officials told us that the materiel command has taken responsibility for managing the funding of these assets and the depots will receive a technical upgrade

every 4 years. Moreover, in February 2019 the Office of the Secretary of Defense launched the Enterprise Sustainment Dashboard (Dashboard), a web-based tool that will provide access to an online central repository of sustainment data for the military services and will allow senior leaders to steer resources to needed programs. The Dashboard will allow users to analyze metrics such as materiel availability (condition of a weapon system to perform an assigned mission), operational availability (availability of active inventory to conduct military service operations), and cost per day availability (maintenance cost per day for a population of weapon systems by type, model, and series). The Dashboard will also consolidate inventory, availability, and cost data systems from each of the military services. This Dashboard is in its early phase and the implementation plan includes milestones extending into fiscal year 2020.

Restrictions related to information technology. Ten of the 17 depots reported restrictions related to information technology as a challenge to implementation of best practices. Specifically, depots reported having outdated and incompatible software systems and a lack of a consolidated database for departments and product lines, which may hinder their ability to connect computer systems to automate a repair process. Additionally, depots stated that it may take years to obtain authority and approval to operate information technology systems, making data collection, sharing, and implementation of best practices difficult. For example, one depot reported a technology tool was not user friendly and had a rigid infrastructure, making it difficult for maintainers to use to analyze metrics to improve depot maintenance. Specifically, depot officials told us that this technology tool performs its functions as designed but is limited in its scope of meeting depot requirements, such as identifying bottlenecks in the maintenance process. In another example, one depot reported cybersecurity concerns with commercial off-the-shelf products, which may not be compatible with the depot's information technology system.

To mitigate challenges related to information technology, depots reported using information systems, such as SharePoint, as a primary source for collecting, storing, organizing, sharing, and accessing information via a web browser. For example, Navy officials told us that there are SharePoint sites for different departments within their organization, including portals dedicated to training, aircraft, and business processes and procedures, which capture best practices and lessons learned from subject matter experts. In another example, an Air Force depot reported that its SharePoint portal includes a section focused on practical problem solving methods for some of its continuous process improvement projects, such as balancing weight on an aircraft and issues related to the

wings of the C-130T. Further, depot officials told us they conducted an analysis to mitigate concerns about a technology tool, mentioned above, that was not user friendly and had a rigid infrastructure. Based on this analysis, depot officials found a modeling and simulation tool that would help resolve challenges in several key areas, including projecting workload and personnel required to perform depot maintenance and determining the depot's capability for the volume of work that can be inducted into the depot, among other areas. The modeling and simulation tool has not been implemented yet because it was recently funded in September 2019.

Moreover, in 2018, we reported on steps that DOD is taking to improve its information technology systems.³² Specifically, the Secretary of Defense asked the Defense Business Board to provide actionable recommendations that DOD could adopt to transform its six core business processes, including acquisition and procurement, logistics and supply, and real property management, and their supporting information technology systems. We recommended, in part, that DOD identify timeframes and deliverables for identifying and adopting optimal information technology solutions. DOD concurred with this recommendation and is taking steps to improve its information technology systems, such as issuing its initial plan for business operations reform in April 2019, collecting federal and private industry benchmarks, and reviewing information technology costs.

Approval process. Eight of the 17 depots reported that the approval process and guidance for implementing best practices is challenging. Specifically, depots reported that the layers of leadership approval prevent timely implementation of best practices and, at times, can cause enthusiasm for a project's implementation to wane. Depot officials also told us that implementing new ideas for maintaining or repairing weapon systems is challenging because they have to get multiple approvals from their chain of command as well as the program manager for a specific weapon system, thus making implementation more difficult and less timely. For example, depot officials told us that implementing best practices at the depot from one weapon system to another requires retesting of the practice and approval from each program manager. Additionally, in response to the survey, a depot reported that many of the essential, time-sensitive engineering decisions for one of its new weapon

³²GAO, *Defense Management: DOD Needs to Address Inefficiencies and Implement Reform across Its Defense Agencies and DOD Field Activities*, [GAO-18-592](#) (Washington, D.C.: Sept. 6, 2018).

system reside at another location, which has caused delays in making timely decisions. In another example, depot officials told us that they had to get approval from individual program managers to implement the cold spray technology and the Intermittent Fault Detection Isolation System.

To mitigate challenges in the approval process, such as these, depot officials told us it is beneficial when technological development that affect the DOD-wide logistics enterprise or an entire military service occurred at a higher organizational level, making it easier for new ideas to be implemented at the lower levels. For example, one depot reported on the Navy's approach of implementing a best practice across its platforms to eliminate corrosive plating on its weapon systems. Navy officials told us that these decisions are made at the headquarters level and implemented across the depots. Moreover, one depot reported allowing decision authority for specific weapon systems to reside within the depot, rather than at another location, to help the depot make timely decisions on implementing new ideas. Finally, the Office of the Assistant Secretary of Defense is providing specific guidance in implementing best practices and lessons learned, such as the memorandum issued in April 2019 on the Intermittent Fault Detection and Isolation System directing the military services to adopt this best practice.³³

Acquisition and contracting policies. Five of the 17 depots reported acquisition and contracting policies as a challenge to implementation. Specifically, depots reported that current acquisition and contracting policies are complex and time consuming, which causes government to lag behind industry in implementing best practices. For example, officials from one depot told us that even when two depots need the same item to repair a weapon system, each depot was encouraged to pursue a separate contract. Depot officials described this as an inefficient and burdensome process, which sometimes resulted in an inferior item. Similarly, officials from another depot told us that they started an initiative to make equipment and software more similar across their service's depots; however, they were unable to implement this initiative for similar reasons. Further, officials from one depot told us that the procurement of a weapon system does not always include access to all data necessary to

³³Deputy Assistant Secretary of Defense for Materiel Readiness Memorandum, *Addressing Electronics Intermittence Across DOD's Sustainment Enterprise* (April 11, 2019).

maintain the system.³⁴ According to depot officials, this limits their ability to implement a best practice or lesson learned from a similar weapon system because the contractor retains ownership of the intellectual property needed to repair or optimize the system.

To mitigate challenges related to acquisition and contracting policies, depot officials told us that military services are purchasing enough new technology for all their depots rather than have each depot purchase technology individually. For example, according to Navy officials, they purchased the equipment to implement cold spray technology across all four shipyards, which makes implementing the best practice or lesson learned more timely. Additionally, officials from one depot told us that they use public-private partnerships to bridge gaps for systems that lack access to the necessary data rights to conduct maintenance on the systems.³⁵ Our February 2019 report identified additional steps DOD is taking to mitigate challenges related to intellectual property, especially software sustainment.³⁶ First, our prior work found that DOD is in the early stages of addressing a statutory provision for DOD to (1) develop policy on the acquisition or licensing of intellectual property; and (2) establish a cadre of intellectual property experts to help support the acquisition workforce on intellectual property matters.³⁷ Second, in our prior work, we reported that DOD officials we spoke with emphasized that there are situations in which the data rights needed may not be known until years into sustainment and that it would be useful if data rights could have a pre-negotiated price and be an option as part of the initial contract. Such an option would give the government the right, but not the obligation, to

³⁴GAO has reported in the past that DOD needs access to technical data—recorded information used to produce, support, maintain, or operate a system—which can enable the government to complete maintenance work in-house, as well as to competitively award contracts for the acquisition and sustainment of a weapon system. See GAO, *Defense Acquisition: DOD Should Clarify Requirements for Assessing and Documenting Technical-Data Needs*, [GAO-11-469](#) (Washington, D.C.: May 11, 2011).

³⁵DOD defines a public-private partnership as a cooperative arrangement between a government-owned and government-operated activity and one or more private-sector entities to perform defense-related work, use DOD facilities and equipment, or both. DOD Instruction 4151.21, *Public-Private Partnerships for Product Support* (Nov. 21, 2016) (incorporating Change 4, July 31, 2019).

³⁶GAO, *Weapon System Sustainment: DOD Needs to Better Capture and Report Software Sustainment Costs*, [GAO-19-173](#) (Washington, D.C.: Feb. 25, 2019).

³⁷*National Defense Authorization Act for Fiscal Year 2018*, Pub. L. No. 115-91, § 802 (Dec. 12, 2017) (codified at 10 U.S.C. § 2322).

purchase the data rights at the pre-negotiated price if needed in the future.

Conclusions

The sharing and implementation of best practices and lessons among the 17 depots is crucial to sustaining military readiness by ensuring that the military services can regularly maintain critical weapon systems and return them to the warfighter for use in training and operations. Successful collaboration of maintenance best practices and lessons learned across military services, private industry, and academia is increasingly essential as DOD operates, and thus needs to maintain, weapon systems. DOD shares best practices and lessons learned among the depots through a variety of venues, including networking, working groups, and benchmarking. However, DOD has communication challenges, including a lack of awareness of many sharing venues, which may hinder the ability of the depots to share best practices and lessons learned. The Office of the Secretary of Defense has not created, shared, or maintained a comprehensive and updated list of all depot-specific DOD sharing venues (i.e., working groups) that includes points of contact. Without a centralized list and points of contact, it is unclear what groups exist and who to contact to participate, which may impede sharing of best practices and lessons learned. Further, while the Army stated it established lessons learned organizations for sharing materiel best practices and lessons learned, it did not maintain them due to organizational restructuring and resource constraints. Establishing and maintaining effective organizations dedicated to sharing materiel best practices and lessons learned would encourage knowledge sharing among the Army depots.

Recommendations

We are making two recommendations, including one to the Under Secretary of Defense for Acquisition and Sustainment and one to the Secretary of the Army. Specifically, the Secretary of Defense should direct that:

The Under Secretary of Defense for Acquisition and Sustainment should ensure that the Deputy Assistant Secretary of Defense for Materiel Readiness create, share, and maintain a comprehensive and up-to-date

list of all DOD sharing venues (i.e., working groups), including points of contact, related to depot maintenance. (Recommendation 1)

The Secretary of the Army should ensure that Army Materiel Command reestablish and maintain organizations dedicated to sharing materiel best practices and lessons learned, as required by Army regulations. (Recommendation 2)

Agency Comments and Our Evaluation

We provided a draft of this report to DOD for review and comment. In written comments on a draft of this report, DOD concurred with the recommendations. DOD's comments are reprinted in their entirety in appendix III. DOD also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretaries of the Army, Navy, and Air Force, and the Commandant of the Marine Corps. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff has any questions about this report, please contact Diana Maurer at (202) 512-9627 or maurerd@gao.gov. Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff that made key contributions to this report are listed in appendix IV.



Diana Maurer
Director,
Defense Capabilities and Management

List of Committees

The Honorable James M. Inhofe
Chairman

The Honorable Jack Reed
Ranking Member

Committee on Armed Services
United States Senate

The Honorable Richard C. Shelby
Chairman

The Honorable Dick Durbin
Ranking Member

Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Adam Smith
Chairman

The Honorable Mac Thornberry
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Pete Visclosky
Chairman

The Honorable Ken Calvert
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Scope and Methodology

To conduct the work for our reporting objectives, we reviewed relevant laws and the Department of Defense (DOD) and military service guidance that govern depot maintenance and the sharing of best practices and lessons learned. We included in our scope DOD depots performing major depot-level maintenance.¹ We conducted a survey of DOD's 17 depots performing depot-level maintenance to gain an understanding of how each depot shares with each other and implements best practices and lessons learned.² The response rate for the survey was 100 percent. These depots included:

- Anniston Army Depot, Anniston, Alabama
- Corpus Christi Army Depot, Corpus Christi, Texas
- Letterkenny Army Depot, Letterkenny, Pennsylvania
- Red River Army Depot, Texarkana, Texas
- Tobyhanna Army Depot, Tobyhanna, Pennsylvania
- Norfolk Naval Shipyard, Portsmouth, Virginia
- Pearl Harbor Naval Shipyard, Honolulu, Hawaii
- Portsmouth Naval Shipyard, Kittery, Maine
- Puget Sound Naval Shipyard, Bremerton, Washington
- Fleet Readiness Center East, Cherry Point, North Carolina
- Fleet Readiness Center Southeast, Jacksonville, Florida
- Fleet Readiness Center Southwest, San Diego, California

¹The term "depots" will refer to 17 installations reviewed in this report performing major depot-level maintenance, including the Army's depots, the Navy's shipyards and fleet readiness centers, the Marine Corps' production plants, and the Air Force's air logistics complexes.

²To capture the full range of activities surrounding best practices and lessons learned, our unit of analysis for each survey was the depot as a whole. As such, our results will be reported by number of depots, rather than depot commanders or other metrics.

- Albany Production Plant, Albany, Georgia
- Barstow Production Plant, Barstow, California
- Ogden Air Logistics Complex, Ogden, Utah
- Oklahoma City Air Logistics Complex, Oklahoma City, Oklahoma
- Warner Robins Air Logistics Complex, Warner Robins, Georgia

We analyzed survey responses to gain an understanding, for example, of which depot officials are coordinating with others to share best practices and lessons learned, which sharing venues are attended, and the extent to which this information sharing is beneficial. To ensure that the survey questions were clear, comprehensible, and technically correct, we conducted expert reviews of our draft survey with four subject matter experts with knowledge and experience in auditing DOD depots. We also conducted two pre-tests of our draft survey with the depot commanders of Anniston Army Depot and Warner Robins Air Logistics Complex, respectively.³ During each pre-test, conducted by teleconference, we read the instructions and each survey question aloud and asked the depot commanders to tell us how they interpreted the question. We then discussed the instructions and questions with each depot commander to identify any problems and potential solutions by determining whether (1) the instructions and questions were clear and unambiguous, (2) the terms we used were accurate, (3) the survey was unbiased, and (4) the survey did not place an undue burden on the depot officials completing it. We noted any potential problems and modified the survey based on feedback from the subject matter experts and depot commanders, as appropriate. We sent a fillable survey and a cover email to 17 depots on May 29, 2019, and asked them to complete the survey and email it back to us by June 14, 2019. We closed the survey on July 3, 2019. Data were auto-extracted from the Adobe PDF form into an Excel spreadsheet. Our examination of the survey results included both a quantitative data analyses on closed-ended questions and a review of open-ended responses to identify common themes.

Additionally, to gather detailed examples of DOD's efforts to share best practices and lessons learned, we visited a non-generalizable sample of 5 depots (Anniston Army Depot, Anniston, Alabama; Norfolk Naval

³As the expert review and pre-test we conducted generally indicated that our questions were clear and comprehensible, and as the universe for this survey was only 17 depots, we determined that we had taken reasonable and sufficient steps to ensure the reliability of the survey instrument.

Shipyard, Portsmouth, Virginia; Fleet Readiness Center Southwest, San Diego, California; Marine Corps Albany Production Plant, Albany, Georgia; and Ogden Air Logistics Complex, Ogden, Utah). To select our sample, we considered variation in geographic location, military service representation, and types of weapon systems maintained. At these sites, we conducted group discussions with individuals across the depot to gain insight into their roles in sharing best practices and lessons learned. Qualitative data analyses were conducted by our staff who have subject matter expertise to identify themes and select examples of best practices or lessons learned shared through collaboration with another depot. We then obtained and analyzed documentation of sharing, such as working group charters and trip reports documenting results from visiting another depot; as well as benefits experienced from implementing a best practice or lessons learned, including time and cost savings.

We interviewed officials from the Office of the Under Secretary of Defense (Acquisition and Sustainment) (Deputy Assistant Secretary of Defense for Materiel Readiness), Joint Chiefs of Staff (Joint Lessons Learned Division), and the military service headquarters (Headquarters, Department of Army G4; Deputy Assistant Secretary of the Navy for Expeditionary Programs and Logistics Management; Headquarters Marine Corps, Installations & Logistics; and Air Force Acquisition, Logistics & Product Support. We also interviewed officials from the military service logistics or materiel components (Army Materiel Command; Naval Sea Systems Command; Naval Air Systems Command (Commander, Fleet Readiness Center); Marine Corps Logistics Command; and the Air Force Materiel Command) as well as the military lessons learned centers (Center for Army Lessons Learned, Naval Warfare Development Command, Marine Corps Center for Lessons Learned, and the Air Force LeMay Center for Lessons Learned).

Finally, we reviewed our prior reports related to challenges experienced at DOD depots and DOD's report to Congress on the sharing of best practices for depot-level maintenance among the military services.⁴ We assessed the documentary and testimonial evidence we collected against DOD and military service guidance on lessons learned and materiel maintenance and GAO's *Standards for Internal Control in the Federal*

⁴DOD, *Report to Congress on Sharing of Best Practices for Depot-Level Maintenance Among the Military Services* (March 2018).

*Government.*⁵ Specifically, the information and communication component of internal control—the actions management uses to internally communicate the necessary quality information to achieve the entity’s objectives—was significant to this audit.

We conducted this performance audit from January 2019 through January 2020 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.

⁵GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

Appendix II: Depot Working Groups and Communities of Practice

During the course of our work examining the extent to which the Department of Defense (DOD) experiences benefits and has challenges with (1) sharing and (2) implementing best practices and lessons learned among the depots, we collected information from the depots on the working groups and communities of practice in which they participate. The list below is compiled from analysis of our survey data, in which we surveyed all 17 of DOD's depots, as well as the interviews we conducted during our site visits to a non-generalizable sample of five depots. Note that this is not a list of all the possible working groups and communities of practice which exist among the depots, simply those which the depots shared with us.

1. 448th Supply Chain Management Wing
2. Air Force Metrology and Calibration Working Group
3. Air Force Sustainment Center Logistics Directorate's Strategic Planning Division
4. Aircraft Cyber Threat Working Group
5. Aircraft Maintenance Group Summit
6. Aircraft Storage Strikeboard
7. AIRSpeed Office
8. Army Safety and Occupational Health Information Management System Working Group
9. Army Safety and Occupational Health Management System Working Group
10. Carrier Team One
11. Cold Spray Action Team
12. Commander, Fleet Readiness Centers Advanced Technology & Innovation Integrated Project Team

13. Commercial Technologies for Maintenance Activities Working Group – Additive Manufacturing
14. Commodities, Electronics, Missiles, & Propulsion Maintenance Groups
15. Coordinate Measuring Machine Community of Practice
16. Corporate Electrical Community of Practice
17. Corrosion Control Working Groups
18. Cyber Resiliency Office for Weapon Systems Working Groups
19. Depot Maintenance Activation Working Group
20. Depot Maintenance Enterprise Action Group
21. Diminishing Manufacturing Sources and Material Shortages Knowledge Sharing Portal
22. DOD Digital Manufacturing Users Group
23. DOD Unmanned Systems & Robotics Summit
24. DOD Voluntary Protection Programs
25. Engineeringpalooza
26. Enterprise IT Systems Strikeboard
27. F-35 Joint Risk Working Group
28. H-53 Fleet Support Team
29. Heavy Metal Working Group
30. Industrial Base Commander’s Meetings
31. Integrated Quality Teams
32. Investment Working Group
33. Joint Additive Manufacturing Steering Group
34. Joint Additive Manufacturing Working Group and Community of Practice
35. Joint Intermittence Team
36. Joint Requirements Working Group
37. Joint Robotics Working Group
38. Joint Technology Exchange Group
39. Metrics Community of Practice

40. Modernization Working Group
41. National Center for Defense Manufacturing and Machining
42. Naval Surface Warfare Center, Carderock Division Human Augmentation
43. Naval Undersea Warfare Center Division, Keyport Human Performance/Augmented Reality/Virtual Reality
44. Navy Forum for Small Business Innovation Research/Small Business Technology Transfer Transition
45. Non-Destructive Inspection Forum
46. Non-Destructive Testing Working Group
47. Norfolk Naval Shipyard Technology and Innovation Community of Practice
48. Organic Industrial Base Commander's Summit
49. Project Management Executive Steering Committee
50. Public-Private Partnership Community of Practice
51. Quality Performance System Community of Practice
52. Quality Work Environment Working Group
53. Residential Economic Development Inc.
54. RepTech Working Group
55. Shipyard departmental level Communities of Practice: C200, C1200, C1200N, C600, C400, etc.
56. Shipyard-only Community of Practice
57. Software Engineering Institute Agile Collaboration Group
58. Software Maintenance Group Summit
59. Sub Team One
60. Tri-Air Logistics Complex Summits
61. Weapon-system Specific Enterprise Cross-talks: C-130 Enterprise Crosstalk, A-10 Enterprise Crosstalk, etc.

Appendix III: Comments from the Department of Defense

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of Defense



SUSTAINMENT

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

JAN 15 2020

Ms. Diana Maurer
Director, Defense Capabilities Management
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Ms. Maurer,

This is the Department of Defense (DoD) response to the GAO Draft Report GAO-20-116, "MILITARY DEPOTS: DOD Can Benefit From Further Sharing of Best Practices and Lessons Learned," dated December 4, 2019 (GAO Code 103257).

Attached is DoD's proposed response to the subject report. My point of contact is Colonel Curtis Hafer, who can be reached at curtis.r.hafer.mil@mail.mil or (703) 697-3047.

Sincerely,

A handwritten signature in black ink, appearing to read "Steven J. Morani".

Steven J. Morani
Deputy Assistant Secretary of Defense
(Materiel Readiness)

GAO DRAFT REPORT DATED DECEMBER 4, 2019
GAO-20-116 (GAO CODE 103257)

**“MILITARY DEPOTS: DOD Can Benefit from Further Sharing of Best
Practices and Lessons Learned”**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION**

RECOMMENDATION 1: The GAO recommends that the Under Secretary of Defense for Acquisition and Sustainment should ensure that the Deputy Assistant Secretary of Defense for Materiel Readiness create, share, and maintain a comprehensive and up-to-date list of all DoD sharing venues (i.e., working groups) related to depot maintenance with their points of contact.

DoD RESPONSE: Concur. The Under Secretary of Defense for Acquisition and Sustainment should ensure that the Deputy Assistant Secretary of Defense for Materiel Readiness create, share, and maintain a comprehensive and up-to-date list of all DoD sharing venues related to depot maintenance with their points of contact.

RECOMMENDATION 2: The GAO recommends that the Secretary of the Army should ensure that Army Materiel Command re-establish and maintain organizations dedicated to sharing materiel best practices and lessons learned, as required by Army regulations.

DoD RESPONSE: Concur. The Secretary of the Army will ensure that Army Materiel Command will re-establish and maintain organizations dedicated to sharing best practices and lessons learned, as required by Army regulations.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Diana Maurer, 202-512-9627 or maurerd@gao.gov

Staff Acknowledgments

In addition to the contact listed above, Jodie Sandel (Assistant Director), Laura Czohara (Analyst-in-Charge), Clarine Allen, Felicia Lopez, Amie Lesser, Christina Murphy, Clarice Ransom, Andrew Stavisky, and Courtney Tepera made key contributions to this report.

Appendix V: Accessible Data

Data Tables

Accessible Data for Figure 6: Benefits of Using Specially-Sized Pins on Shelf Brackets for C-130 Aircraft at Ogden Air Logistics Complex, Utah

| Category | Cost per aircraft |
|----------|----------------------------------------------------------------------------|
| Pins | \$13,000 for one specially-sized pin set |
| No pins | \$500,000 approximate cost to dock aircraft while maintenance cannot occur |

Accessible Data for Figure 7: Benefits of Cold Spray Technology for the F-16 Gearbox

| Category | Cost per gearbox |
|---------------------|-------------------------------------|
| Cold spray process | \$1,300 to cold spray each gear box |
| Traditional process | \$38,000 to replace each gear box |

| Category | Time per gearbox |
|---------------------|------------------------------------------------------------|
| Cold spray process | 4 weeks for gearbox to be back in service after cold spray |
| Traditional process | 95 weeks to build and receive new gearbox |

Accessible Data for Figure 9: Benefits of Overhauling Generator Kit for U-2 Aircraft

| Category | Hours of flight time |
|------------------------------|----------------------------|
| Generator kit overhauled | 1,000 hours of flight time |
| Generator kit not overhauled | 400 hours of flight time |

Agency Comment Letter

Accessible Text for Appendix III Comments from the Department of Defense

Page 1

JAN 15 2020

Ms. Diana Maurer

Director, Defense Capabilities Management

U.S. Government Accountability Office

441 G Street, NW

Washington DC 20548

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Sincerely,

Steven J. Morani

Deputy Assistant Secretary of Defense (Materiel Readiness)

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GAO DRAFT REPORT DATED DECEMBER 4, 2019

GAO-20-116 (GAO CODE 103257)

“MILITARY DEPOTS: DOD Can Benefit from Further Sharing of Best Practices and Lessons Learned”

DEPARTMENT OF DEFENSE COMMENTS

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DoD RESPONSE: Concur. The Secretary of the Army will ensure that Army Materiel Command will re-establish and maintain organizations dedicated to sharing best practices and lessons learned, as required by Army regulations.

Related GAO Products

Navy Maintenance: Persistent and Substantial Ship and Submarine Maintenance Delays Hinder Efforts to Rebuild Readiness. [GAO-20-257T](#). Washington, D.C.: December 4, 2019.

Naval Shipyards: Key Actions Remain to Improve Infrastructure to Better Support Navy Operations. [GAO-20-64](#). Washington, D.C.: November 25, 2019.

F-35 Aircraft Sustainment: DOD Faces Challenges in Sustaining a Growing Fleet. [GAO-20-234T](#). Washington, D.C.: November 13, 2019.

Depot Maintenance: DOD Should Adopt a Metric That Provides Quality Information on Funded Unfinished Work. [GAO-19-452](#). Washington, D.C.: July 26, 2019.

Military Depots: Actions Needed to Improve Poor Conditions of Facilities and Equipment That Affect Maintenance Timeliness and Efficiency. [GAO-19-242](#). Washington, D.C.: April 29, 2019.

Weapon System Sustainment: DOD Needs to Better Capture and Report Software Sustainment Costs. [GAO-19-173](#). Washington, D.C.: February 25, 2019.

Army Modernization: Steps Needed to Ensure Army Futures Command Fully Applies Leading Practices. [GAO-19-132](#). Washington, D.C.: January 23, 2019.

DOD Depot Workforce: Services Need to Assess the Effectiveness of Their Initiatives to Maintain Critical Skills. [GAO-19-51](#). Washington, D.C.: December 14, 2018.

Navy and Marine Corps: Rebuilding Ship, Submarine, and Aviation Readiness Will Require Time and Sustained Management Attention. [GAO-19-225T](#). Washington, D.C.: December 12, 2018.

Navy Readiness: Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet. [GAO-19-229](#). Washington, D.C.: November 19, 2018.

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Military Readiness: Analysis of Maintenance Delays Needed to Improve Availability of Patriot Equipment for Training. [GAO-18-447](#). Washington, D.C.: June 20, 2018.

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Depot Maintenance: Improvements to DOD's Biennial Core Report Could Better Inform Oversight and Funding Decisions. [GAO-17-81](#). Washington, D.C.: November 28, 2016.

Naval Shipyards: Actions Needed to Improve Poor Conditions that Affect Operations. [GAO-17-548](#). Washington, D.C.: September 12, 2017.

Army Working Capital Fund: Army Industrial Operations Could Improve Budgeting and Management of Carryover. [GAO-16-543](#). Washington, D.C.: June 23, 2016.

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Navy Working Capital Fund: Budgeting for Carryover at Fleet Readiness Centers Could Be Improved. [GAO-15-462](#). Washington, D.C.: June 30, 2015.

Sequestration: Documenting and Assessing Lessons Learned Would Assist DOD in Planning for Future Budget Uncertainty. [GAO-15-470](#). Washington, D.C.: May 27, 2015.

Operational Contract Support: Actions Needed to Enhance the Collection, Integration, and Sharing of Lessons Learned. [GAO-15-243](#). Washington, D.C.: March 16, 2015.

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