Report No. DODIG-2021-134

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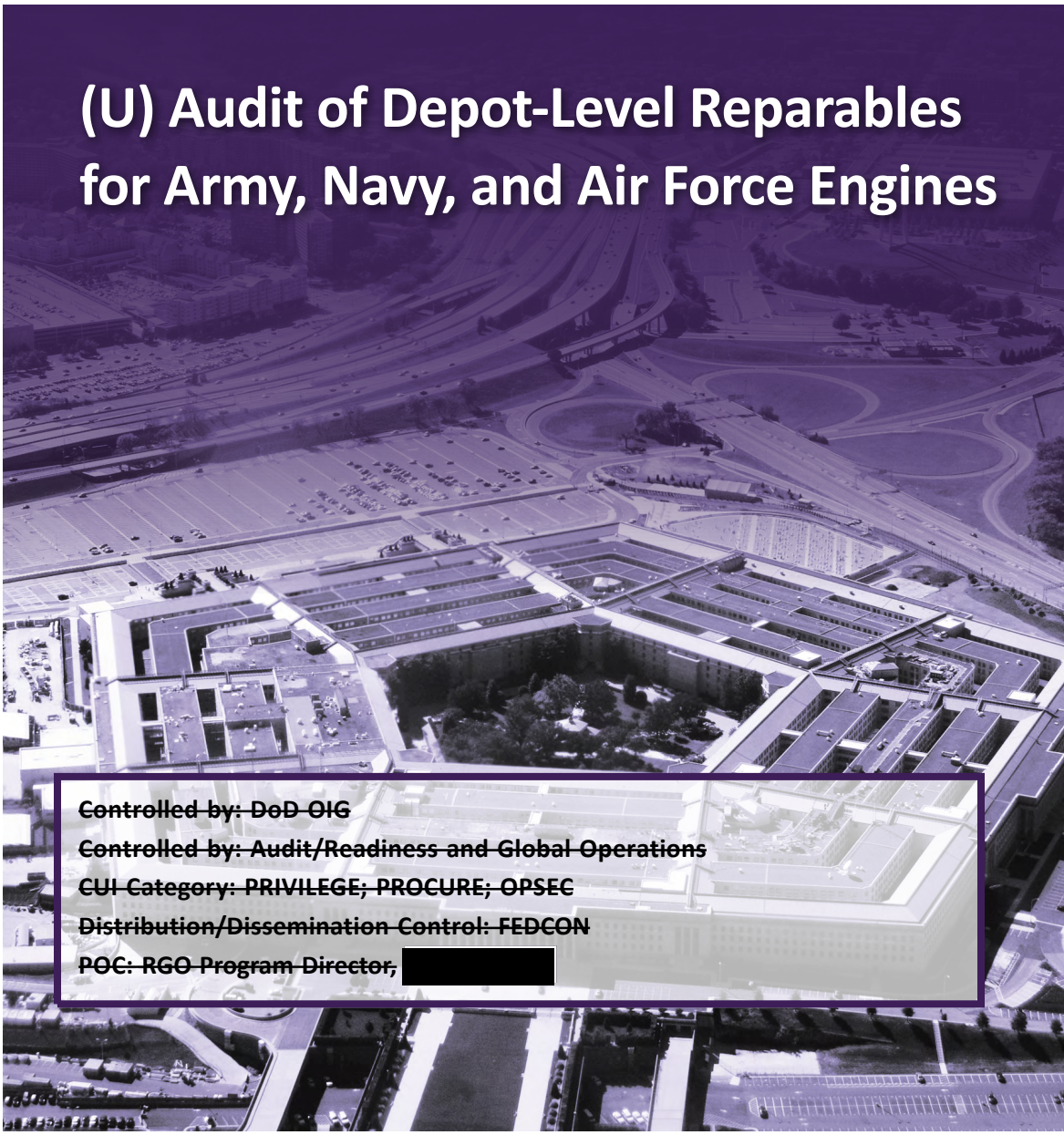
INSPECTOR GENERAL

U.S. Department of Defense

SEPTEMBER 30, 2021

(U) Audit of Depot-Level Reparables for Army, Navy, and Air Force Engines



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INTEGRITY ★ INDEPENDENCE ★ EXCELLENCE

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INSPECTOR GENERAL
INTEGRITY
EFFICIENCY
DEPARTMENT OF DEFENSE

(U) Results in Brief

(U) Audit of Depot-Level Reparables for Army, Navy, and Air Force Engines

September 30, 2021

(U) Objective

(U) The objective of this audit was to determine whether the Military Departments managed selected depot-level reparables (DLRs), specifically engines, to meet DoD requirements to maintain authorized stock levels and meet program readiness levels. A DLR is an item of supply that is designated for repair at a depot, or an item that is designated for repair below the depot level but cannot be repaired at that level.

(U) Background

(U) The DoD assigns different levels of maintenance to repair parts depending on the skill level, tooling, and facilities needed to execute the repairs. Depot-level repair is the most sophisticated level of maintenance. Depot-level repair consists of repairing a major end item, such as an aircraft or a ground vehicle, by performing repairs (when economical) and replacement of parts on the system.

(U) This audit focuses primarily on the depot, and its ability to repair sufficient numbers of engines or engine modules to maintain adequate quantities of these items to ensure that they are available for the weapon systems to meet operational readiness goals.

(U) Finding

(U) The Army, Navy, and Air Force did not consistently meet their stocking requirements for the nine engines in our sample.

- (U) The Army maintained sufficient quantities of the T-55, T700-GE-701D, Diesel (M88), and Diesel (M109) engines to meet the stocking requirements. The Army fell short of meeting its stocking requirement for the Diesel–Glow Plug (M113) engine in April 2021, but previously met the stocking requirement in January 2021 and was taking corrective actions related to a defect with a part that caused the shortage.
- (U) The Navy did not maintain sufficient quantities of the T700-GE-401C engine to meet the stocking requirements; however, the Navy was in the process of obtaining additional engines from General Electric and had engines installed on aircraft in long-term storage that were available to supplement stock, if needed.
- (U) The Air Force maintained sufficient quantities of the F108-100 engine but did not maintain enough supply of the F100-220 and F100-229 engines. However, the Air Force accepted the risk in engine stock to focus its limited resources on critical non-engine-related problems with the F-15 and F-16 aircraft.

(U) In addition, the three organic depots and one contractor depot that repaired the nine selected engines and engine modules did not consistently meet the Military Department's repair metrics for depot performance; however, the delay in repairing the nine selected engines and engine modules did not negatively impact readiness. Although the Military Departments did not consistently meet their stocking requirements and the depots did not consistently meet the repair metrics for depot performance, the engine impact to weapon system readiness was either insignificant or the Military Departments were taking action to correct the problems.

(U) Results in Brief

(U) Audit of Depot-Level Reparables for Army, Navy, and Air Force Engines

(U) Finding (cont'd)

(U) We are not making any recommendations because although supply levels for selected engines did not always meet required stock levels, and the depots did not always meet their production goals for the period reviewed, the Military Departments had processes in place to identify and correct potential problems. Despite the number of challenges identified in this report, the availability of engines and engine modules did not negatively impact readiness.
In addition, the Government Accountability Office made recommendations to the Military Departments addressing both the degraded state of DoD facilities and depot workforce challenges.

INSPECTOR GENERAL
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September 30, 2021

MEMORANDUM FOR AUDITOR GENERAL, DEPARTMENT OF THE NAVY
AUDITOR GENERAL, DEPARTMENT OF THE ARMY
ASSISTANT SECRETARY OF THE AIR FORCE
(FINANCIAL MANAGEMENT AND COMPTROLLER)

SUBJECT: (U) Audit of Depot-Level Reparables for Army, Navy, and Air Force Engines
(Report No. DODIG-2021-134)

(U) This final report provides the results of the DoD Office of Inspector General's audit. We considered management's comments on a discussion draft copy of this report when preparing this final report. We did not make any recommendations; therefore, no management comments are required.

(U) We appreciate the cooperation and assistance received during the audit. If you have any questions, please contact me at [redacted]

Richard B. Vasquez
Assistant Inspector General for Audit
Readiness and Global Operations

(U) Contents

(U) Introduction

(U) Objective

(U) The objective of this audit was to determine whether the Military Departments managed selected depot-level reparables (DLRs), specifically engines, to meet DoD requirements to maintain stock levels and meet program readiness levels. A DLR is an asset or piece of equipment within a system or end item that is designated for repair at the depot level. See Appendix A for our scope and methodology.

(U) Background

(U) The DoD performs maintenance in two different yet complementary ways that are differentiated largely by their relative capabilities, flexibility, agility, and capacity.

1. **(U) Depot-level maintenance** entails materiel maintenance requiring the major repair, overhaul, or complete rebuilding of weapon systems, end items, parts, assemblies, and subassemblies; manufacture of parts; technical assistance; and testing. Each Military Department manages and operates its own organic depot-level maintenance infrastructure (DoD personnel operating DoD facilities).
2. **(U) Field-level maintenance** comprises two sub-levels, shop-type work (intermediate), as well as on-equipment maintenance (organizational).
    a. **(U) Intermediate maintenance** consists of calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies; the emergency manufacture of non-available parts; and providing technical assistance to using organizations.
    b. **(U) Organizational maintenance** consists of inspecting, servicing, lubricating, and adjusting, as well as the replacing of parts, minor assemblies, and subassemblies. Of note is that organizational-level maintenance describes work performed in the field, on the flight line, or at the equipment site, and is accomplished not only by maintenance personnel, but also by equipment operators.

(U) This audit focuses primarily on the depot, and its ability to repair sufficient numbers of engines or engine modules to maintain adequate quantities of these items to ensure that they are available for the weapon systems to meet operational readiness goals. The DoD promotes depot maintenance partnerships between the DoD and commercial sectors to better support the warfighter, while balancing the national security need for the DoD to retain depot maintenance capabilities. Section 2466, title 10, United States Code, 2021, states that no more

(U) than 50 percent of Military Department funding for depot-level maintenance workload may be used to contract non-Federal personnel.[1] To this end, the Military Departments in some cases supplement their own organic depot maintenance and repair capabilities with contractor support.

(U) Depot-Level Reparables

A depot-level reparable is an asset or piece of equipment within a system or end item that is designated for repair at the depot level. A DLR consists of multiple subparts or assemblies composed of both reparable and consumable parts.

(U) The DoD designates different levels of maintenance to repair parts depending on the skill level, tooling, and facilities needed to execute the repairs. Depot-level repair is the most sophisticated level of maintenance. Depot-level repair consists of repairing a major end item, such as an aircraft or a ground vehicle, by performing repairs (when economical) on reparable parts and replacing consumable parts on the system. A depot-level reparable is an asset or piece of equipment within a system or end item that is designated for repair at the depot level. A DLR consists of multiple subparts or assemblies composed of both reparable and consumable parts. A reparable part is an item that, when broken, can be economically repaired, while a consumable part is any item that, upon installation, cannot be economically repaired. The Military Departments manage most reparable spare parts, and the Defense Logistics Agency manages most consumable spare parts.

(U) Military Department item managers are responsible for maintaining the right amount of inventory, including DLRs. Item managers perform materiel management functions such as worldwide item distribution and redistribution, materiel requirements determinations, budget estimates, cataloging, repair programs, and other related functions. Item managers within the Military Departments rely on guidance from the Office of the Under Secretary of Defense for Acquisition and Sustainment to execute these responsibilities. In addition, item managers have processes and procedures within their own organizations, which we discuss in the DoD-Level Guidance for DLR Stockage and Repair and the individual Military Department Command sections of this report.

[1] (U) Section 2466, title 10, United States Code, "Limitations on the performance of depot-level maintenance of materiel," effective March 17, 2021.

(U) DoD-Level Guidance for DLR Stockage and Repair

(U) The Office of the Under Secretary of Defense for Acquisition and Sustainment provides guidance and oversight related to establishing stock levels and ensuring readiness of programs by monitoring the performance of the DoD supply chain, which includes the management of DLRs.

(U) Specifically, DoD Manual 4140.01, volume 2, provides a framework for the DoD supply chain materiel management process.[2] This manual describes DoD requirements for planning for the amount of materiel (such as DLRs) needed, analyzing supply and demand to forecast future needs, item classification and coding to establish how materiel is managed, setting supply goals to meet weapon system objectives at the lowest cost, and using computations to achieve the optimal materiel stock position.

(U) The Military Departments have materiel, systems, and sustainment commands that provide organic and commercial repair and procurement of new engines and engine modules. The Military Departments used different processes to determine the stocking requirements for engines.[3] Army item managers determined stock levels on the wholesale inventory level for the Army using the Logistics Modernization Program database. The item managers conducted monthly reviews, which included validating the Logistics Modernization Program's recommendations for each supply action based on past and future requirements and usage factors, lead times, and coverage profiles (safety level stock). Navy officials annually updated the engine requirements, processes, and metrics that were used to calculate, approve, and validate engine readiness goals. The engine readiness goal is the number of engines needed to fill aircraft, the number of engines needed to support depot events, and the number of engines needed to support peacetime and wartime operations. Air Force officials reviewed the engine stocking requirements quarterly. To determine the stocking requirement Air Force officials used a complex process that included aircraft flying hours, current inventory of engines and aircraft, and the number of engines needed to undergo maintenance. It is through these processes, the Military Departments define and adjust their respective engine stocking requirements.

[2] (U) DoD Manual 4140.01, volume 2, "DoD Supply Chain Materiel Management Procedures: Demand and Supply Planning," November 9, 2018.

[3] (U) For this audit, we focused on whether the Military Departments had enough engines to meet their established stocking requirements. We did not review the process for determining the stocking requirements.

(U) Army Materiel Command and Subordinate Commands

(U) Army Materiel Command, headquartered at Redstone Arsenal, Alabama, oversees the Army's depot-level activities, including materiel readiness and the global supply chain. Army Materiel Command has ten subordinate commands including—Aviation and Missile Command, Tank-Automotive and Armaments Command, and Communications-Electronics Command. These entities operate six organic depots across the United States. The organic depots and examples of the platforms handled include the following.

- **(U) Anniston Army Depot, Alabama.** Tank-Automotive and Armaments Command operates the Anniston Army Depot, which maintains tracked and wheeled ground combat vehicles.
- **(U) Corpus Christi Army Depot, Texas.** Army Aviation and Missile Command operates the Corpus Christi Army Depot, which maintains rotary-wing components and aircraft.
- **(U) Letterkenny Army Depot, Pennsylvania.** Army Aviation and Missile Command operates the Letterkenny Army Depot, which maintains air defense and tactical missile ground support equipment.
- **(U) Red River Army Depot, Texas.** Tank-Automotive and Armaments Command operates the Red River Army Depot, which maintains tactical wheeled vehicles.
- **(U) Sierra Army Depot, California.** Tank-Automotive and Armaments Command operates the Sierra Army Depot, which maintains all petroleum and water distribution systems and is the largest facility dedicated to equipment retrograde, regeneration, reutilization, and redistribution.
- **(U) Tobyhanna Army Depot, Pennsylvania.** Communications-Electronics Command operates the Tobyhanna Army Depot, which maintains command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance systems.

(U) Army Materiel Command personnel rely on guidance in Army Regulation 710-1 to manage inventory in the supply chain, such as DLRs.[4] This regulation states that Army Materiel Command is responsible for DLR management from planning for DLR purchases through retrograde (turning in an unserviceable DLR for repair or replacement). Army Regulation 710-1 also states that the item manager will always try to repair a DLR or use a repaired DLR before buying a new DLR.

[4] (U) Army Regulation 710-1, "Centralized Inventory Management of the Army Supply System," November 28, 2016.

(U) Naval Systems Commands

(U) Naval Air Systems Command, headquartered at Patuxent River, Maryland, provides full life-cycle support of naval aircraft, weapons, and systems. This support includes acquisition, repair and modification, and engineering and logistics support. Naval Air Systems Command operates eight Fleet Readiness Centers that conduct maintenance, repair, and overhaul of Navy aircraft, engines, components, and support equipment. Listed below are the eight Fleet Readiness Centers.

- (U) Aviation Support Equipment at Solomons Island, Maryland
- (U) East at Marine Corps Air Station Cherry Point, North Carolina
- (U) Mid-Atlantic at Naval Air Station Oceana, Virginia
- (U) Northwest at Naval Air Station Whidbey Island, Washington
- (U) Southeast at Naval Air Station Jacksonville, Florida
- (U) Southwest at Naval Air Station North Island, California
- (U) West at Naval Air Station Lemoore, California
- (U) West Pacific at Naval Air Facility Atsugi, Japan

(U) Naval Operations Instruction 4400.9D provides the policy and responsibility for the management of DLRs.[5] This instruction states that DLRs are costly to procure; therefore, it is generally more economical to repair and restore DLRs than to procure replacements. The instruction also states that management of DLRs is essential for improving fleet readiness in the most effective manner. Naval Operations Instruction 13700.2B establishes policy, roles, and responsibilities for developing, validating, and updating engine and engine module requirements.[6] This instruction applies to inventory management of Navy and Marine Corps engines and engine modules.

(U) Air Force Materiel Command and Air Force Sustainment Center

(U) Air Force Materiel Command, headquartered at Wright-Patterson Air Force Base, Ohio, conducts research, development, test and evaluation, and provides acquisition management services and logistics support necessary to keep Air Force weapon systems ready for war. The Air Force Sustainment Center, part of the Air Force Materiel Command, headquartered at Tinker Air Force Base, Oklahoma, manages depot-level activities, the supply chain, and installation support.

[5] (U) Naval Operations Instruction 4400.9D, "Depot Level Repairable Item Management," September 18, 2017.

[6] (U) Naval Operations Instruction 13700.2B, "Engine, Engine Module, and Propulsion Sub-System Readiness," April 10, 2019.

(U) The Air Force Sustainment Center operates three Air Logistics Complexes that provide logistics, support, maintenance, and distribution. Listed below are the complexes and supported platforms.

- (U) Ogden Air Logistics Complex, Utah, provides logistics, support, maintenance, and distribution for fighter aircraft, transport aircraft, and other weapon systems.
- (U) Oklahoma City Air Logistics Complex, Oklahoma, handles depot maintenance for bomber and surveillance aircraft in addition to selected engines and major engine assemblies.
- (U) Warner Robins Air Logistics Complex, Georgia, provides depot maintenance, engineering support, and software development for fighter and transport aircraft.

(U) Air Force Instruction 21-101 states that organizational, intermediate, and depot maintenance capabilities for operational readiness are maintained to ensure effective and timely response to peacetime operations, mobilizations, national defense contingencies, and other emergencies.[7] Depot-level maintenance includes maintenance requiring overhaul, upgrading, or rebuilding of parts, assemblies, or subassemblies. The maintenance function ensures that assigned aircraft and equipment are safe, serviceable, and properly configured to meet mission needs.

(U) What We Reviewed

(U) We reviewed the Army, Navy, and Air Force procedures for stocking and repairing selected engines and engine modules.[8] Specifically, we reviewed engine stocking requirements for April 2021, and depot repair metrics for FY 2020 for the Army and Navy and FY 2021 for the Air Force. We reviewed the readiness requirements of the associated weapon system and whether stock levels and repair of engines and engine modules negatively impacted the readiness level of the weapon system. We selected engines based on the critical nature of those

We reviewed the Army, Navy, and Air Force procedures for stocking and repairing selected engines and engine modules. We selected engines based on the critical nature of those items to the availability of the weapon system.

[7] (U) Air Force Instruction 21-101, "Aircraft and Equipment Maintenance Management," January 16, 2020.

[8] (U) To meet demand not met by the depots, the Military Departments had processes in place to procure new engines and engine modules from commercial sources as another source of supply. In this report, we address the Military Departments' procurement of commercially repaired engines and engine modules, but not the procurement of new engines and engine modules.

(U) items to the availability of the weapon system. Specifically, we reviewed nine engines for 13 weapon systems.[9] Table 1 summarizes the engines in our review and the associated weapon system and repair depot.

(U) Table 1. Engines in Our Review and the Associated Weapon System and Repair Depot

(U) Military Department	Engine	Weapon Systems	Repair Depots
Army	T-55 Aircraft Turbine Engine	CH-47 Chinook aircraft	Corpus Christi Army Depot and Honeywell
Army	T700-GE-701D Engine	AH-64 Apache and UH-60 Black Hawk aircraft	Corpus Christi Army Depot and General Electric
Army	Diesel Engine	M88 Recovery Vehicle	Anniston Army Depot, L3 Harris, and Tecmotiv
Army	Diesel Engine	M109 Howitzer	Anniston Army Depot
Army	Diesel Engine–Glow Plug	M113 Armored Personnel Carrier	Anniston Army Depot
Navy	T700-GE-401C Engine	MH-60R/S Seahawk, AH-1Z Viper, and UH-1Y Venom aircraft	Corpus Christi Army Depot and General Electric
Air Force	F100-220 Engine	F-15 Eagle and F-16 Fighting Falcon aircraft	Oklahoma City Air Logistics Complex
Air Force	F100-229 Engine	F-15 Eagle and F-16 Fighting Falcon aircraft	Oklahoma City Air Logistics Complex
Air Force	F108-100 Engine	KC-135 Stratotanker aircraft	Oklahoma City Air Logistics Complex **(U)**

(U) Source: The DoD OIG.

(U) Review of Internal Controls

(U) DoD instruction 5010.40 requires DoD organizations to implement a comprehensive system of internal controls that provides reasonable assurance that programs are operating as intended and to evaluate the effectiveness of the controls.[10] We did not identify an internal control weakness related to the management of the selected engines and engine modules.

[9] (U) We reviewed the stocking requirement for nine engines. However, our review of the depot repair metrics included 7 of the 9 engines and 12 engine modules. The Navy repaired the T700-GE-401C engine and two of that engine's modules—the Power Turbine and the Cold Section modules. The Air Force repaired the F100-220 and the F100-229 by engine module only; each engine consisted of five engine modules repaired at the depot level—the Fan, Core, High Pressure Turbine, Low Pressure Turbine, and Gearbox.

[10] (U) DoD Instruction 5010.40, "Managers' Internal Control Program Procedures," May 30, 2013.

(U) Finding

(U) The Military Departments Did Not Always Meet Stocking Requirements for Selected Engines and Related Depot-Level Reparables

(U) The Army, Navy, and Air Force did not consistently meet their stocking requirements for the nine engines in our sample.

- (U) The Army maintained sufficient quantities of the T-55, T700-GE-701D, Diesel (M88), and Diesel (M109) engines to meet the stocking requirements. The Army fell short of meeting its stocking requirement for the Diesel–Glow Plug (M113) engine in April 2021, but previously met the stocking requirement in January 2021 and was taking corrective actions related to a defect with a part that caused the shortage.
- (U) The Navy did not maintain sufficient quantities of the T700-GE-401C engine to meet the stocking requirements; however, the Navy was in the process of obtaining additional engines from General Electric and had engines installed on aircrafts in long-term storage that were available to supplement stock, if needed.
- (U) The Air Force maintained sufficient quantities of the F108-100 engine but did not maintain enough supply of the F100-220 and F100-229 engines. However, the Air Force accepted the risk in engine stock to focus its limited resources on critical non-engine-related problems with the F-15 and F-16 aircraft.

(U) In addition, the three organic depots and one contractor depot that repaired the nine selected engines and engine modules did not consistently meet the Military Department's repair metrics for depot performance. The depots did not meet the repair metrics due to various issues, such as parts shortages, non-conforming parts, maintenance staff reductions due to coronavirus disease-19 (COVID-19), and funding constraints. However, depot performance for repairs of the selected engines and engine modules did not negatively affect readiness because the Military Departments were able to leverage other supply sources.

(U) Although the Military Departments did not consistently meet their stocking requirements and the depots did not consistently meet the repair metrics for depot performance, the engine impact to weapon system readiness was either insignificant or the Military Departments were taking action to correct the problems.

(U) The Army, Navy, and Air Force Did Not Consistently Meet Stocking Requirements for Some Engines

(U) The Army, Navy, and Air Force did not consistently meet their stocking requirements for some of the engines in our sample.[11] The Army maintained sufficient quantities of four selected engines, and the Air Force maintained sufficient quantities of one selected engine. However, the Army did not maintain sufficient quantities of one selected engine, the Navy did not maintain sufficient quantities of the one selected engine, and the Air Force did not maintain sufficient quantities of two selected engines.

(U) The Army Generally Met Stocking Requirements

(U) The Army maintained sufficient quantities of the T-55, T700-GE-701D, Diesel (M88), and Diesel (M109) engines to meet stocking requirements. The Army fell short of meeting its stocking requirement for the Diesel–Glow Plug (M113) engine in April 2021, but previously met the stocking requirement in January 2021 and was taking corrective actions related to a defect with a part that caused a shortage of two M113 engines.

The Army maintained sufficient quantities of the T-55, T700-GE-701D, Diesel (M88), and Diesel (M109) engines to meet stocking requirements. The Army fell short of meeting its stocking requirement for the Diesel–Glow Plug (M113) but was taking corrective actions related to a defect with a part that caused a shortage of two M113 engines.

(U) The Army used a combination of computer-generated recommendations and manual calculations to determine the stocking requirements for engines. Specifically, the item manager determined stock levels on the wholesale inventory level for the Army using the Logistics Modernization Program database.[12] The Logistics Modernization Program used historic customer demands and forecasted returns to generate a recommendation for the quantity of DLRs that the Army needed on hand at a given time. Item managers conducted monthly reviews, referred to as Material Requirements Planning (supply planning), which included validating the Logistics Modernization Program's recommendations for each supply action based on past and future requirements and usage factors, lead times, and coverage profiles (safety level stock). Item managers then made their own recommendation based on whether

[11] (U) Each Military Department used different terminology to describe its stocking requirements, so throughout the report we used the term stocking requirement to provide consistency.

[12] (U) According to DoD Manual 4140.01, Volume 2, "DoD Supply Chain Materiel Management Procedures: Demand and Supply Planning," November 9, 2018, the wholesale level refers to the highest level of DoD Component supply. At this level, requiring activities procure supplies, repair supplies, and maintain stocks to resupply retail levels of supply and to fill consumer demands not filled by retail levels (consumer levels) of supply. The Logistics Modernization Program is a commercial-off-the-shelf Enterprise Resource Planning solution that integrates components such as asset management, maintenance, and supply planning.

(U) the selected engine or other engine-related part was in a surplus or deficit stock position. This review involved the item manager manually adjusting the Logistics Modernization Program's recommendations based on the aforementioned stock position for the item.[13]

(U) We obtained information from the Army for the stock levels of the selected engines in January and April 2021. Engine stock levels fluctuate routinely based on various factors, including customer demands, induction for repair, and engines produced through repair or procurement. Table 2 describes each engine, the stocking requirement for that engine, and the available stock for that engine in April 2021.

(U) Table 2. Army Stocking Requirements and Available Stock for Selected Engines in April 2021

(U) Engine	T-55	T700-GE-701D	Diesel (M88)	Diesel (M109)	Diesel–Glow Plug (M113)
Managing Organization	AMCOM	AMCOM	TACOM	TACOM	TACOM
Weapon System	Chinook	Apache and Black Hawk	Recovery Vehicles	Howitzer, Full Tracked Self-Propelled 155MM	Armored Personnel Carrier
National Item Identification Number	01-458-5361	01-503-1701	01-414-6821	01-335-4579	01-412-2715
Unit Cost	$991,617	$871,237	$507,430	$84,539	$46,176
Stocking Requirements[1]	9	26	33	45	66
Available Stock[2]	50	95	63	52	64
Difference Between Available Stock and Stocking Requirements	41	69	30	7	(2)

(U)

(U) LEGEND

(U) AMCOM Aviation and Missile Command
(U) TACOM Tank-Automotive and Armaments Command

1 (U) The Army uses the term requirements objective instead of stocking requirement. The requirements objective establishes the target quantity for replenishing the item's level of stock through procurement or repair.

2 (U) Available stock is the sum of the Army's wholesale stock, retail stock, and tactical stock.

(U) Source: The DoD OIG.

[13] (U) In the Army's case, the stocking requirement we refer to is the requirements objective. The requirements objective establishes the target quantity for replenishing a national demand-based item's level of stock through procurement or repair. The stocking requirement represents the maximum authorized quantity of stock for an item and consists of the sum of stock represented by the economic order quantity, the safety level, the repair-cycle level, and authorized additive levels.

(U) Table 2 shows that in April 2021 for four of the five selected engines—T-55, T700-GE-701D, Diesel (M88), and Diesel (M109)—the Army had more stock available than was required; therefore, the Army met its stocking requirements for those four engines. For example, the Army had 41 more T-55 engines and 30 more Diesel engines (M88) than it needed to meet its stocking requirement. As Table 2 shows, for April 2021, the Army had two fewer Diesel–Glow Plug (M113) engines than required. However, the Army began corrective actions to address a parts quality issue that caused the engine stock to fall below the requirement. Specifically there were problems with the parts supplier's tooling process for piston kits that resulted in non-conforming parts. The supplier agreed to replace the 1830 piston kits it supplied, had sent an initial shipment of conforming kits, and agreed to measure the remaining kits it produced for proper conformance. As previously stated, engine stock levels fluctuate routinely based on various factors, including customer demands, induction for repair, and engines produced through repair or procurement. According to January 2021 data, the Army had 72 more Diesel–Glow Plug (M113) engines than required.

(U) Although the Army met its stocking requirements in January 2021 and met the stocking requirement for four of the five engines in April 2021, the item managers stated that there were problems with acquiring specific repair parts for the engines. Some examples of the problems in acquiring certain repair parts included long lead times to procure, funding constraints, inaccurate forecasting, age of the weapon system, and sole-source manufacturers. However, some item managers we interviewed developed solutions to acquiring repair parts for engines. For example, an item manager for the M88 diesel engine stated that her work unit developed its own solutions for mitigating challenges with parts for that engine. These solutions included implementing an Integrated Product Team of DoD and commercial stakeholders for the M88 diesel engine to collaborate on solutions for better managing the engine's supply chain. The Integrated Product Team effort resulted in the item manager's work unit traveling to the Anniston Army Depot to work on an onsite reconciliation of the engine's bill of materials (a list of all materials needed to repair an engine during depot repair) for the M88 diesel engine. This effort resulted in the identification of some parts that officials incorrectly listed as components of the engine, and the coding of those items was subsequently corrected. The item manager stated that implementing Integrated Product Teams helped the Army more proactively address emerging challenges with engines and repair parts supplies. Because the Army item managers for the T-55, T700-GE-701D, Diesel (M88), and Diesel (M109) engines met their stocking requirements in April 2021 and the item manager for the Diesel–Glow Plug (M113) engine developed solutions for the problem with obtaining the necessary repair parts, we are not making a recommendation to the Army.

(U) The Navy Did Not Meet Stocking Requirements But Had Contingency Stocks of Additional Engines, If Needed

(U) The Navy did not maintain sufficient quantities of the T700-GE-401C engine to meet the stocking requirements; however, the Navy was in the process of obtaining additional engines from General Electric and had engines installed on aircrafts in long-term storage that were available to supplement stock.[14]

(U) The Navy's stocking requirement was the number of ready-for-issue engines needed to support peacetime (operational) activities and increased operating activities, such as wartime (surge) activities. To establish its peacetime (operational) stocking requirement for the selected engine, the Navy considered the engine demand, total number of storage locations required, and the transportation time to storage locations. To establish its wartime (surge) requirement, the Navy considered wartime usage rates and surge duration (timeframe). The Navy reassessed the stocking requirement annually.

(U) We obtained information from the Navy for the stock levels for the T700-GE-401C engine as of April 2021. Table 3 describes the engine, the stocking requirement, and the available stock in April 2021.

~~(CUI)~~ Table 3. Navy Compliance With Stocking Requirements for the Selected Engine for April 2021

~~(CUI)~~ Engine	T700-GE-401C
Managing Organization	Naval Air Systems Command
Weapon System	MH-60R, MH-60S, AH-1Z, and UH-1Y
National Item Identification Number	01-318-5538
Unit Cost	[redacted]
Stocking Requirement	[redacted]
Peacetime (Operational) Requirement	[redacted]
Wartime (Surge) Requirement	[redacted]
Available Stock*	[redacted]
Difference Between Available Stock and Stocking Requirement	[redacted] ~~(CUI)~~

*(U) Available stock is the Navy's number of ready-for-issue engines.

(U) Source: The DoD OIG.

[14] (U) Stocking requirement is the combination of peacetime (operational) requirement and wartime (surge) requirement. We are using the term stocking requirement throughout the report for consistency across the Military Departments.

~~(CUI)~~ Table 3 shows that the Navy had [redacted] fewer T700-GE-401C engines than it needed to meet its stocking requirement as of April 2021. Although, the Navy did not maintain the required number of spare engines the Navy was in the process of obtaining 21 engines through a contract with General Electric. According to Navy personnel, General Electric had quality issues that caused a delay in the production of T700-GE-401C engines. As of April 2021, General Electric had not provided 21 engines that were due between December 31, 2020 and April 30, 2021.

(U) In addition to the engines due from General Electric, the Navy maintained 58, T700-GE-401C engines in long-term storage. As of April 2021, these engines were in long-term storage at Davis-Monthan Air Force Base in Tucson, Arizona. According to Navy personnel, the Navy can uninstall and issue these engines in the event that stock levels become critically low. The Navy has not used the engines in long-term storage because the active aircraft already have engines installed; however, the engines in long-term storage are available to the Navy, if needed. Because the Navy had 58 engines available in long-term storage and 21 new engines were due from General Electric, we are not making a recommendation to the Navy.

(U) The Air Force Generally Did Not Meet Stocking Requirements

(U) The Air Force maintained sufficient quantities of the F108-100 engines but did not maintain sufficient quantities of the F100-220 and F100-229 engines to meet the stocking requirements. The Air Force Life Cycle Management Center, Propulsion Directorate accepted the risk of the F100-220 and F100-229 engines falling below the stocking requirement due to funding constraints. Additionally, the F-15 Program Office focused its limited resources on non-engine-related critical problems with the F-15 Eagle.

The Air Force Life Cycle Management Center, Propulsion Directorate accepted the risk of the F100-220 and F100-229 engines falling below the stocking requirement due to funding constraints. Additionally, the F-15 Program Office focused its limited resources on non-engine-related critical problems with the F-15 Eagle.

(U) The Air Force's stocking requirement was the number of engines needed to support training activities (target serviceable), and the number of engines needed to support wartime activities (war readiness engines). The target serviceable requirement also included the number of engines needed to support special demand and training; and periodic spikes in the production of engines and engine modules. The war readiness engine requirement was the number of serviceable

(U) engines required to support a weapon system during a war, from the start of the war until re-supply is established. The Air Force established the stocking requirement for each engine type and the program offices were responsible for tracking the stocking levels for their respective engine.

(U) We obtained information from the Air Force for the stock levels of the F100-220, F100-229, and F108-100 engines for March and April 2021. Engine stock levels fluctuated routinely based on various factors, including customer demands, number of engines inducted for repair, and number of engines repaired. See Table 4 below for Air Force compliance with stocking requirements for selected engines for April 2021.

~~(CUI)~~ Table 4. Air Force Compliance With Stocking Requirements for Selected Engines for April 2021

~~(CUI)~~ Engine	F100-220	F100-229	F108-100
Managing Organization	Oklahoma City Air Logistics Complex	Oklahoma City Air Logistics Complex	Oklahoma City Air Logistics Complex
Weapon System	F-15 Eagle and F-16 Fighting Falcon	F-15 Eagle and F-16 Fighting Falcon	KC-135 Stratotanker
Item Number	N/A-	N/A-	2840F108100AJG
Unit Cost	$3,500,000	$3,500,000	$3,840,610
Stocking Requirement	55	26	28
Target Serviceable (Training and Operations) Requirement	10	1	0
War Readiness Engines (Wartime) Requirement	[redacted]	[redacted]	[redacted]
Available Stock	6	8	32
Difference Between Available Stock and Stocking Requirements	[redacted]	[redacted]	[redacted] ~~(CUI)~~

(U) Source: The DoD OIG.

~~(CUI)~~ Table 4 shows that the Air Force had [redacted] fewer F100-220 engines and [redacted] fewer F100-229 engines than it needed to meet its stocking requirement. Although the Air Force did not have the required spare engines needed if a war occurred, this did not impact day-to-day operations for the aircraft. Air Force officials from the F-15 Program Office, the F100 Engine item managers, and depot operations officials stated that funding was the main reason that the Air Force did not meet its stocking requirement for the F100-220 and F100-229 engines. The Air Force

~~(CUI)~~ Life Cycle Management Center, Propulsion Directorate accepted the risk of the F100-220 and F100-229 engines falling below the stocking requirement and the F-15 Program Office focused its limited resources on more critical problems with the weapon systems. For example, some of the critical systems for the F-15 aircraft were flight controls, electrical, instruments, and fire controls for the F-15 aircraft. Additionally, the Air Force projected that it will continue to experience shortages with stocking levels for the F100-220 and F100-229 engines through at least April 2024.[15] To mitigate the shortage, the Air Force implemented several solutions, including approving waivers for extended use of engine modules and using alternative sources of repair.

~~(CUI)~~ The Air Force had [redacted] more F108-100 engines than it needed to meet its stocking requirement. The Air Force met the stocking requirement for the F108-100 engines but experienced problems with some parts such as the rotor assembly. Item managers stated that when they encountered problems with engine-related parts, they were able to resolve those problems before they affected aircraft readiness. For example, in September 2020, item managers discovered higher than usual condemnation rates and excessive procurement lead times on the rotor assembly for the F108-100 engine. In March 2021, the item manager resolved the problems that were caused by the one and two spool limiters for the rotor assembly. Because the Air Force had enough of the F108-100 engines and the Air Force Life Cycle Management Center, Propulsion Directorate accepted the risk for the F100-220 and F100-229 engines, we are not making a recommendation to the Air Force.

(U) Depots Did Not Consistently Meet Metrics for Repairing Selected Engines, but Processes Existed to Mitigate Delays

(U) All three organic depots and one of the four contractor depots that repaired the nine selected engines and engine modules did not consistently meet the Military Department's repair metrics for depot performance. The Military Departments established and tracked metrics to measure depot performance and to ensure that the depots had access to sufficient quantities of engines and repair parts.

Although the depots did not consistently meet the metrics for depot performance, the Army, Navy, and Air Force were able to leverage other supply sources, including awarding contracts for depot repair capabilities for the nine selected engines and engine modules; and procuring new engines.

[15] (U) The Air Force forecasts engine outlook 6, 12, and 36 months in the future.

(U) Although the depots did not consistently meet the metrics for depot performance, the Army, Navy, and Air Force were able to leverage other supply sources, including awarding contracts for depot repair capabilities for the nine selected engines and engine modules; and procuring new engines. The three organic depots responsible for repairing the selected engines and engine modules had processes in place to forecast and assess their ability to perform the anticipated workload for the engines and engine modules.

(U) Depots Did Not Always Repair Army Engines by the Agreed-Upon Dates

(U) Two organic depots and four contractor depots repair the five selected Army engines. The Army's organic depots, Anniston and Corpus Christi Army Depots, did not meet the agreed-upon metrics for repairing the five selected engines. For the FY 2020 repair program, the Anniston Army Depot ranged from 2 to 6 months late in repairing the selected engines and the Corpus Christi Army Depot ranged from 5 to 13 months late in repairing the selected engines. The Army used the performance-to-promise metric to measure the depot's performance in repairing engines. The performance-to-promise metric means that the depot had to repair a certain number of engines by a certain date to meet the metric.

(U) The Army Materiel Command had two subordinate commands that oversaw repair of the selected aircraft and ground vehicle engines—Tank-Automotive and Armaments Command and Aviation and Missile Command.

1. (U) The Tank-Automotive and Armaments Command oversaw the Anniston Army Depot, which repaired the engines for the M88, M109, and M113 ground vehicles; and oversaw two contractors, L3 Harris and Tecmotiv, which repaired engines for the M88.
2. (U) The Aviation and Missile Command oversaw the Corpus Christi Army Depot and two contractors, General Electric and Honeywell, which repaired the engines (T700-GE-701D and T-55) for the Apache, Black Hawk, and Chinook aircraft.

(U) These subordinate commands forecasted the aircraft and vehicle priorities for their respective depots based on unit readiness. Unit rotations, unit activations, and geographic operating environment are some of the factors affecting a unit's needs.

(U) Before accepting the repair work from the command, the Anniston and Corpus Christi Army depots used a tool called 7D (seven dimensions) to address the adequacy of the scope of work, availability of skilled labor, asset availability,

(U) funding, and other topics. To meet demand not met by the respective Army depots, the Tank-Automotive and Armaments Command and Aviation and Missile Command has contractors, including General Electric, Honeywell, L3 Harris, and Tecmotiv, that repair engines and these contractors have all met their performance metrics.

(U) Anniston Army Depot

(U) The Anniston Army Depot did not meet the performance-to-promise metric for the three selected engines—Diesel (M88), Diesel (M109), and Diesel–Glow Plug (M113). The Anniston Army Depot established a repair program each fiscal year in which depot officials used the 7D tool to determine the performance-to-promise metric for each engine. For its FY 2020 repair program, the Anniston Army Depot agreed to repair 142 engines for the M88 by January 2021, 228 engines for the M109 by April 2021, and 500 engines for the M113 by December 2020. Table 5 shows the quantity of engines that the Anniston Army Depot promised to repair, the date promised, and the actual or expected completion dates for repairing the selected engines, as of April 2021.

(U) Table 5. Anniston Army Depot Actual or Expected Performance-to-Promise for the FY 2020 Repair Program

(U) Engine	Diesel (M88)	Diesel (M109)	Diesel–Glow Plug (M113)
Weapon System	M88	M109	M113
Quantity Promised	142	228	500
Promise Date	January 2021	April 2021	December 2020
Quantity Provided by Promise Date	124	133	405
Completion Date (Actual or Expected)	March 2021	September 2021	June 2021
Difference Between Promise and Completion Dates	18 engines completed 2 months late	95 engines completed 5 months late	95 engines completed 6 months late **(U)**

(U) Source: The DoD OIG.

(U) As Table 5 shows, the Anniston Army Depot did not meet the FY 2020 metric for the M88 engine. The depot promised to provide 142 M88 engines by January 2021; however, it did not provide 18 of the 142 M88 engines until February and March 2021, 2 months after the promise date. M88 item management staff stated that this 2-month delay occurred because the FY 2019 repair program did not finish on schedule because the depot could not repair the engine cylinders and there were long lead times to get new cylinders. In addition to the delayed

(U) start of the FY 2020 program, the depot's engine test stands were down for a few days at the start of the FY 2020 program, which caused repair delays until depot personnel repaired the test stands.

(U) The Anniston Army Depot did not meet its FY 2020 metric for the M109 engine. The depot promised to provide 228 M109 engines by April 2021; however, it did not provide 95 of the 228 M109 engines by the promise date. The depot did not meet the metric because the depot could not repair and reuse as many exhaust manifolds and piston heads as anticipated. Because of the supply problem, the TACOM item management personnel put the repair program on hold until the depot received new parts from the contractor. According to Anniston Army Depot officials, the depot's supplier could not provide the new cylinder heads and pistons needed for repairs in a timely manner due to the COVID-19 pandemic. The depot expected to receive the parts in May 2021 and complete the remaining 95 engines by September 2021, 5 months after the promise date.

(U) The Anniston Army Depot did not meet its FY 2020 metric for the M113 engine. The depot promised to provide 500 M113 engines by December 2020; however, it did not provide 95 of the 500 M113 engines by the promise date. The depot did not meet the metric due to nonconforming material from multiple suppliers. The depot had to prove nonconformance, obtain new parts, and conduct more tests. According to M113 item management staff, as of April 2021 the supplier still had to test all of the piston kits produced before shipment and the depot also had to test the piston kits upon receipt to ensure that the parts conformed to specification. The depot expected to complete the remaining engines by June 2021, 6 months after the promise date. As of July 2021, Tank-Automotive and Armaments Command staff did not reply to multiple requests to determine whether the June 2021 estimate was achieved.

(U) Even though the Anniston Army Depot did not meet the promise dates, Tank-Automotive and Armaments Command item management personnel stated that they were satisfied with the depot's performance. Item management personnel indicated that depot repair delays were not causing engine supply problems that would prevent the weapon system from meeting readiness requirements, because in the event of a surge in demand, Army personnel can employ overtime, hire temporary employees, or award contracts to the commercial sector for engine repair work, as the Army did for the M88.

(U) Corpus Christi Army Depot

(U) The Corpus Christi Army Depot did not meet the performance-to-promise metric for the two selected engines—T-55 and T700-GE-701D. The Corpus Christi Army Depot established a repair program each fiscal year in which officials used

(U) the 7D tool to determine the performance-to-promise metric for each engine. For its FY 2020 repair program, the Corpus Christi Army Depot agreed to repair 49 T-55 engines for the Chinook by February 2021 and 215 T700-GE-701D engines for the Apache and Black Hawk by March 2021. Table 6 shows the quantity that the Corpus Christi Army Depot promised to repair, the date promised, and the expected completion dates for repairing the selected engines, as of April 2021.

(U) Table 6. Corpus Christi Army Depot Expected Performance to Promise for the FY 2020 Repair Program

(U) Engine	T700-GE-701D	T-55
Weapon System	AH-64 Apache and UH-60 Black Hawk Aircraft	CH-47 Chinook aircraft
Quantity Promised	215	49
Promise Date	March 2021	February 2021
Quantity Provided by Promise Date	126	2
Completion Date (Expected)	August 2021	March 2022
Difference Between Promise and Completion Dates	89 engines completed 5 months late	47 engines completed 13 months late (U)

(U) Source: The DoD OIG.

(U) As Table 6 shows, the Corpus Christi Army Depot did not meet the FY 2020 metric for the T700-GE-701D or T-55 engine. The depot promised to provide 215 T700-GE-701D engines by March 2021; however, it did not provide 89 by the promise date. For example, the depot had to repair some rotors that did not conform to specifications, which delayed completion of three engines. As of April 2021, the depot expected to complete the remaining 89 T700-GE-701D engines by August 2021, 5 months after the promise date.

(U) The Corpus Christi Army Depot promised to provide 49 T-55 engines by February 2021; however, it did not provide 47 by the promise date. For the T-55 engine, according to depot personnel, the sole-source manufacturer was delinquent on its delivery schedule of turbine blade sets, compressor blades, and other engine-related parts that delayed repair operations. The depot expected to complete the remaining T-55 engines by March 2022, 13 months after the promise date. According to Corpus Christi Army Depot personnel, the depot did not meet its promise date for the T700-GE-701D and T-55 engine mainly because of the COVID-19 pandemic, which negatively affected the depot's suppliers.

(U) In addition to the supply issues discussed above, the Corpus Christi Army Depot also experienced tool, equipment, facility, and process problems that delayed the FY 2020 repair programs. According to depot personnel, problems similar to the following can be expected to occur until completion of the new engine facility in FY 2025.

- (U) Power outages that required technicians to use paper manuals instead of the digital version. Using the digital version of manuals is faster because technicians can search for key terms and steps in the process rather than having to physically flip pages and scan until they find the correct place in the manual. These power outages also affected operation of the engine test cells and caused equipment to malfunction. The test cells are important to the repair process because depot personnel use them to determine whether an engine meets performance requirements, such as exhaust parameters and vibrations points, that are necessary to be within certain parameters for storage, shipment, or use.
- (U) Severe weather according to depot personnel, a hurricane, and a winter storm cost the depot about 2 weeks of repair operations during FY 2020.
- (U) Broken equipment such as the test cell computer system and a coordinated measurement machine.

(U) In addition to the power outages, severe weather, and broken equipment, Corpus Christi Army Depot personnel cited delayed arrival of engine parts and equipment downtime as a major risk for future productivity.

(U) Even though the Corpus Christi Army Depot did not meet the promise dates, Aviation and Missile Command item management personnel indicated that depot repair delays had not caused engine supply problems that hindered the readiness of he weapon systems.

(U) Contractor Depots That Repaired Selected Army Engines

(U) Unlike the Army's organic depots, the contractor depots that repaired the T-55, T700-GE-701D, and M88 engines met the repair metrics. According to Army data and item management personnel for the T-55, T700-GE-701D, and M88 engines, Army contractors met the negotiated repair turnaround time for the aircraft engines (Honeywell for the T-55 engine and General Electric for the T700-GE-701D engine), and Army contractors were not subject to a negotiated repair turnaround time for the ground vehicle engine (L3 Harris and Tecmotiv for the M88 engine). According to Aviation and Missile Command item management personnel, Honeywell repaired the T-55 engines within the negotiated 120-day timeframe, and General Electric repaired the T700-GE-701D within the negotiated

(U) 150-day timeframe. According to Tank-Automotive and Armaments Command item management personnel, contractors repaired only one of the three selected engines, the M88 engine. Item management personnel stated that the Army did not track a negotiated repair turnaround time for the two contractors, Tecmotiv and L3 Harris. The Army required only that the contractor provide the repaired M88 engines within the contract period.

(U) Depots Did Not Repair Navy Engines and Engine Modules Within the Agreed-Upon Timeframe

(U) The Corpus Christi Army Depot repaired the T700-GE-401C engine modules and General Electric repaired the T700-GE-401C engine and engine modules for the Navy. The Corpus Christi Army Depot and General Electric did not meet the agreed-upon metrics for repairing the T700-GE-401C engine and engine modules. The Corpus Christi Army Depot ranged from 50 to 190 days late in repairing T700-GE-401C engines modules, and General Electric ranged from 9 to 79 days late in repairing the T700-GE-401C engine and engine modules. The Navy had organic and commercial processes to complete the repair of the selected engine and related engine modules. The Navy used the depot turnaround time metric to measure performance at both its organic and commercial depots. The turnaround time is the depot agreed-upon time to repair engines and engine modules to ensure the readiness of the related weapon systems.

The Navy used the depot turnaround time metric to measure performance at both its organic and commercial depots. The turnaround time is the depot agreed-upon time to repair engines and engine modules to ensure the readiness of the related weapon systems.

(U) The repair process began when the organizational unit sent spare engines to an intermediate-level repair facility for their initial induction and processing. Once the spare engines were at an intermediate-level repair facility, the facility determined whether to send the spare engines to a depot for repair, or to repair the engines on site.

(U) The intermediate-level repair facility that received spare engines used a metric called the beyond capability of maintenance percentage to determine whether a spare engine should remain at its repair facility or be transported to a depot maintenance facility. The beyond capability of maintenance metric was based on the repair capability of the intermediate-level repair facility.

(U) For the spare engines that met the beyond capability of maintenance metric, the Navy's intermediate-level repair facility sent T700-GE-401C spare engines and engine modules to either the Corpus Christi Army Depot or General Electric Engine Services. According to the program executive office, General Electric

(U) conducted 60 percent of the repairs, and the Corpus Christi Army Depot conducted 40 percent of the repairs. The Corpus Christi Army Depot repaired the Power Turbine Module and the Cold Section Module, but not the whole engine. General Electric repaired the engine in its entirety, or just the Power Turbine and Cold Section modules.

(U) The Navy used the depot turnaround time to measure performance of its organic and commercial depots. Table 7 provides a comparison of the repair turnaround times at the Corpus Christi Army Depot and General Electric for FY 2020.

(U) Table 7. The Navy's Depot Repair Turnaround Time for the T700-GE-401C Engine

(U) Engine	T700-GE-401C				
Managing Organization	Naval Air Systems Command				
Weapon Systems	MH-60R, MH-60S, AH-1Z, and UH-1Y				
Depot Site	Corpus Christi Army Depot		General Electric		
Module Name	401CL Power Turbine	401CX Cold Section	401C Engine	401CL Power Turbine	401CX Cold Section
Negotiated Repair Turnaround Time (TAT) (in Days)	90	90	120	90	90
Average TAT (in Days)	140	280	129	169	138
Difference Between Negotiated and Average	(50)	(190)	(9)	(79)	(48)

(U)

(U) Source: The DoD OIG.

(U) As Table 7 shows, the Corpus Christi Army Depot and General Electric did not meet the FY 2020 metric for the T700-GE-401C engine modules. The Army and the Navy agreed that the Corpus Christi Army Depot would repair the T700-GE-401C engine modules within 90 days; however, the Corpus Christi Army Depot ranged from 50 to 190 days late. Corpus Christi Army Depot personnel stated that they did not meet the turnaround time mainly due to the COVID-19 pandemic that resulted in missed repair shifts due to cleaning protocols and delays in receiving parts from suppliers. Also, as stated previously in this report, the depot also experienced a hurricane, a winter storm, multiple power and network outages, and equipment failures.

(U) The Navy and General Electric agreed that General Electric would repair the T700-GE-401C engine within 120 days and repair the engine modules within 90 days. However, on average, General Electric was 9 days late repairing the T700-GE-401C engine and ranged from 48 to 79 days late in repairing the engine modules. According to General Electric personnel, General Electric did not meet the turnaround time due to staff reductions as a result of the COVID-19 pandemic and an increase in staff turnover of trained personnel. The Navy met with General Electric to discuss the delays, but because the delays were mostly COVID-19 related, the Navy did not take any actions against the contractor.

(U) Even though the Corpus Christi Army Depot and General Electric did not meet the agreed-upon metrics, Navy personnel stated that they did not foresee any current or long-term negative impact to readiness for the T700-GE-401C engine.

(U) Air Force Depot Did Not Always Repair Engines and Engine Modules Within the Agreed-Upon Timeframe

(U) The Oklahoma City Air Logistic Complex did not always meet the agreed-upon metrics for repairing the selected engines and engine modules. From January 2021 through March 2021, the Oklahoma City Air Logistic Complex ranged from 11 to 87 days late in repairing the selected engine and engine modules. The Air Force used the depot turnaround time metric to measure performance, which helped determine whether it had enough engines to ensure the readiness of the related weapon systems. Additionally, the Air Force tracked the quantity of engines and engine modules and identified challenges in procurement and repair.

(U) The Oklahoma City Air Logistics Complex repaired bomber, tanker, fighter, and special mission aircraft engines in the Air Force. The Air Force had two approaches for repairing selected engines at the Oklahoma City Air Logistic Complex. For the F108-100 engines, the Air Force sent the entire engine to a depot for repair, whereas for the F100-220 and F100-229 engines, the Air Force divided the engine into modules and sent the modules to the depot for repair. Despite the differing methods, both depot teams had similar processes in place to forecast and assess their ability to perform the anticipated workload of the selected engines and engine modules. To measure their performance, the depots used turnaround time metrics.

The Air Force had two approaches for repairing selected engines at the Oklahoma City Air Logistic Complex. For the F108-100 engines, the Air Force sent the entire engine to a depot for repair, whereas for the F100-220 and F100-229 engines, the Air Force divided the engine into modules and sent the modules to the depot for repair.

(U) Tables 8 and 9 provide the repair turnaround times at Oklahoma City Air Logistics Complex from January 2021 through March 2021 for the F100-220 and F100-229 engine modules.

(U) Table 8. F100-220 Depot Repair Turnaround Time

(U) Engine	F100-220				
Weapon System	F-15 and F-16				
Module Name	220 Fan	220 Core	220 High Pressure Turbine	220 Low Pressure Turbine	220 Gearbox
Standard Repair Turnaround Time (TAT) (in Days)	60	90	90	90	60
TAT Range (in Days)	71-81	115-125	22-32	63-73	35-45
Difference Between Standard and TAT Range	(11-21)	(25-35)	58-68	17-27	15-25 (U)

(U) Source: The DoD OIG.

(U) Table 9. F100-229 Depot Repair Turnaround Time

(U) Engine	F100-229				
Weapon System	F-15 and F-16				
Module Name	229 Fan	229 Core	229 High Pressure Turbine	229 Low Pressure Turbine	229 Gearbox
Standard Repair Turnaround Time (TAT) (in Days)	60	90	90	90	60
TAT Range (in Days)	52-60	150-160	42-50	75-80	45-50
Difference Between Standard and TAT Range	0-8	(60-70)	40-48	10-15	10-15 (U)

(U) Source: The DoD OIG.

(U) Table 8 and Table 9 show that the Air Force exceeded depot turnaround times for some modules for the F100-220 and F100-229 engines. The F100-220 and F100-229 item manager stated that the organic repair and buy programs for depots were underfunded, which caused temporary shortage of some engine-related parts. Therefore, the depot did not have the available funding to complete the desired number of repairs in agreed upon timeframes. However, as of May 2021, the Air Force officials projected that the depot would meet the F100-220 and F100-229 engine module production goals for FY 2021.

(U) The Air Force chose to focus its limited funding on more critical systems for the F-15 and F-16 aircraft rather than the engines, because the F100-220 and F100-229 engines were not factors that affected aircraft mission capability rates for the F-15 and F-16 aircraft. For example, the F-15 Program Office focused on flight controls, electrical, instruments, and fire controls.

(U) Table 10 provides the repair turnaround times at Oklahoma City Air Logistics Complex for March 2021 for the F108-100 engine.

(U) Table 10. F108-100 Depot Repair Turnaround Time

(U) Engine	F108-100
Weapon System	KC-135
Standard Repair Turnaround Time (TAT) (in Days)	40
Average TAT (in Days)	127
Difference Between Standard and Average TAT	(87) (U)

(U) Source: The DoD OIG.

~~(CUI)~~ Table 10 shows that the Air Force exceeded depot turnaround times for the F108-100 engine. However, as of April 2021, the Air Force had [redacted] more of the F108-100 engines than required. As a result, repair delays did not affect the supply of engines. Additionally, in May 2021 delays in engine repair did not negatively impact the readiness level for the KC-135 aircraft and the data we obtained on mission capability (measurement of readiness) confirmed these statements. We discuss the readiness of the weapon systems in the following section of this report.

(U) Engines Did Not Impact the Readiness Goals for Weapon Systems Negatively or Significantly

(U) Although the Military Departments did not consistently meet their stocking requirements and the depots did not meet the repair metrics for depot performance, the engine impact to weapon readiness was either insignificant or the Military Departments were taking action to correct the problems.

(U) The Selected Army Engines Did Not Significantly Affect Readiness Goals for Their Associated Weapon Systems

Army program officials stated that the selected engines were in a healthy supply position for the M88, T-55, and T700-GE-701D engines or that they were actively managing supply related risks in the case of the M109 and M113 engines to maintain adequate supply.

(U) The five engines for all six weapon systems either had no impact or minimal impact on readiness in April 2021. The impact ranged from 0 percent for the T700-GE-701D engine for the Apache and Black Hawk to an impact of 1.3 percent for the M88 Recovery Vehicle engine. The respective Army program officials stated that the selected engines were in a healthy supply position for the M88, T-55, and T700-GE-701D engines or that they were actively managing supply related risks in the case of the M109 and M113 engines to maintain adequate supply. Table 11 shows the readiness goals and actual readiness levels for the weapon system and percent contribution of engines towards the actual readiness rates as of April 2021.[16]

~~(CUI)~~ Table 11. Army Selected Engines Affect on Weapon Systems Readiness during April 2021

~~(CUI)~~ Command	Engine	Weapon System	Fully Mission Capable Rates		
			Goal (percent)	Actual (percent)*	Engine Impact (percent)
AMCOM	T-55	Chinook	75	[redacted]	0.6
AMCOM	T700-GE-701D	Apache	75	[redacted]	0
AMCOM	T700-GE-701D	Black Hawk	75	[redacted]	0
TACOM	M88	M88A2 Recovery Vehicle	90	[redacted]	1.3
TACOM	M109	M109A6 Howitzer	90	[redacted]	0.7
TACOM	M113	M113 Personnel Carrier	90	[redacted]	1.2

~~(CUI)~~

*(U) For April 2021.

(U) LEGEND

(U) AMCOM Aviation and Missile Command
(U) TACOM Tank-Automotive and Armaments Command`

(U) Source: The DoD OIG.

[16] (U) Army Regulation 700-138, "Army Logistics Readiness and Sustainability," February 26, 2004, provides readiness goals of 90 percent fully mission-capable ground vehicles and 75 percent fully mission-capable aircraft. The term fully mission-capable refers to equipment that is on hand and able to perform its combat missions.

(U) In December 2020, Army Aviation and Missile Command item management personnel stated that the Army would ensure that sufficient T-55 engines remained available long term after having increased contractor output for the T-55 engine to 10 engines per month and procuring additional spare engines. For the T700-GE-701D, the Army had endured long lead times for Corpus Christi Army Depot part support, forecasting problems, and budget cuts for FY 2021. However, a T700-GE-701D item management official stated that Army Materiel Command guidance encourages item managers to maintain a minimum of three months of stock on hand, based on average monthly demands, as funding allows, to minimize the impact of supply availability on readiness.

(U) In December 2020, Tank-Automotive and Armaments Command item management personnel noted some areas that could have future readiness impacts. M109 item management personnel stated that the engine was more than 30 years old and had not been procured in 25 years. Therefore, as the engine continues to age, the Army expects more unrepairable parts, and that replacement parts could be difficult to procure. However, the next variant of the M109 will use another engine and plans were underway to phase out the variant that uses the engine we reviewed for the audit. Personnel stated that the M113 program had a parts quality issue with nonconforming piston kits that caused delays in filling orders for engines. However, the staff resolved the parts quality issue with the supplier in April 2021 and did not note any potential future concerns. Because the Army routinely monitored and took actions as demonstrated in the examples above, coupled with the fact that the selected engines were not the major drivers for the readiness shortfalls of the weapon systems, we are not making a recommendation to the Army.

(U) The Selected Navy Engine Did Not Significantly Affect Readiness Rates for the Associated Weapon Systems

(U) The engine for four weapon systems had minimal impact on the mission capable rates in February (for the MH-60R Seahawk and the MH-60S Seahawk) or March 2021 (for the AH-1Z Viper and UH-1Y Venom). The impact ranged from 2.7 percent for the AH-1Z Viper to an impact of 7.1 percent for the MH-60R Seahawk. Several factors, including the T700-GE-401C engine, contributed to the non-mission capable rate for the MH-60R Seahawk, MH-60S Seahawk, AH-1Z Viper,

(U) and UH-1Y Venom. Table 12 shows the readiness goals and actual readiness levels for the weapon systems as well as the amount of the non-mission capable rate that the Navy determined was attributable to the engine.

~~(CUI)~~ Table 12. Navy Weapon Systems Impacted By the T700-GE-401C Engine

~~(CUI)~~ Weapon System	Mission Capable Rates		Non-Mission Capable Rates	
	Goal (percent)	Actual (percent)	Engine Impact (percent)	Other Impact (percent)
MH-60R Seahawk	75	[redacted]	7.1	[redacted]
MH-60S Seahawk	75	[redacted]	5.9	[redacted]
AH-1Z Viper	85	[redacted]	2.7	[redacted]
UH-1Y Venom	85	[redacted]	3.9	[redacted] ~~(CUI)~~

(U) Note: The Naval Air Systems Command is responsible for the T700-GE-401C engine. The mission capable rate is the percentage of total time when the aircraft can fly and perform at least one mission. Conversely, the non-mission capable rate is the percentage of total time when the aircraft cannot fly or perform at least one mission. The Navy used the mission capable rate to assess the health and readiness of an aircraft fleet.

(U) Source: The DoD OIG.

The One-List was used to ensure that sustainment teams focused resources on the degraders that had a significant negative impact on weapon system readiness. The Navy compiles the One-List using supply data, maintenance data, and historical trend data.

(U) As of April 2021, the Navy did not identify the T700-GE-401C as a top degrader for the AH-1Z Viper and UH-1Y Venom; however, the engine was a high-ranked item on the MH-60R Seahawk and the MH-60S Seahawk degrader list. The degrader list, also known as the One-List, provides one single degrader list for each weapon system. The One-List was used to ensure that sustainment teams focused resources on the degraders that had a significant negative impact on weapon system readiness. The Navy compiles the One-List using supply data, maintenance data, and historical trend data. The Navy assigned a cross-functional team to a specific degrader on the One List. The team was responsible for identifying root causes and developing corrective actions to resolve the problems associated with the degrader.

(U) Although, the engine negatively impacted readiness for the MH-60R Seahawk and MH-60S Seahawk, there were other DLRs that were ranked higher on the degrader list and the Navy had a process in place to develop corrective actions to mitigate the problems associated with the engine. In addition, the Navy considered the engine impact for the AH-1Z Viper and UH-1Y Venom as insignificant. Although

(U) the Navy did not meet the mission capable goal for the weapons, the engine impact was either insignificant or the Navy was taking action to correct the problem; therefore, we are not making a recommendation to the Navy.

(U) The Selected Air Force Engines Did Not Significantly Affect Readiness Goals for the Weapon Systems

~~(CUI)~~ The three engines for all three weapon systems either had no or minimal impact on readiness in April 2021. The impact ranged from [redacted] percent for the KC-135 Stratotakner to [redacted] percent for F-16 Fighting Falcon. Several factors, including the engine and other impacts, contributed to the non-mission capable rate for the F-15 Eagle and F-16 Fighting Falcon. Although, the KC-135 Stratotanker did not meet its mission capable goal the engine was not a contributing factor. Table 13 shows aircraft mission capable rates and engine impact on overall mission capable rates for each related aircraft.

~~(CUI)~~ Table 13. Air Force Weapon Systems Impacted By the Engines

~~(CUI)~~ Engine	Weapon System	Mission Capable Readiness		Non-Mission Capable	
		Goal (percent)	Actual (percent)	Engine impact (percent)	Other impact (percent)
F100-220	F-15C/D Eagle	75	[redacted]	[redacted]	[redacted]
	F-16 Fighting Falcon	77	[redacted]	[redacted]	[redacted]
F100-229	F-15E Eagle	73	[redacted]	[redacted]	[redacted]
	F-16 Fighting Falcon	77	[redacted]	[redacted]	[redacted]
F108-100	KC-135 Stratotanker	96	[redacted]	[redacted]	[redacted] ~~(CUI)~~

(U) Note: The Air Force Sustainment Center is responsible for these three Air Force engines. Similar to the Navy, the Air Force used the mission capable rate to assess the health and readiness of an aircraft fleet.

(U) Source: The DoD OIG.

(U) According to Air Force personnel, the F100-220 and F-100-229 engines affected unit readiness and sustainment but did not affect the overall aircraft mission capable rate in April 2021. Although the KC-135 Stratotanker did not meet its mission capable goal, the F108-100 engine was not a contributing factor. Therefore, according to the respective program offices there are no major readiness issues related to selected engines.

(U) Conclusion

Military Departments reported that the overall impact on weapon system mission capable rates, due to engine and engine module availability, was not a significant factor or actions were taken to mitigate the impact.

(U) Although supply levels for selected engines did not always meet required stock levels, and the depots did not always meet their production goals for the period reviewed, the Military Departments reported that the overall impact on weapon system mission capable rates, due to engine and engine module availability, was not a significant factor or actions were taken to mitigate the impact. The Military Department used several strategies to ensure weapon system readiness. These readiness strategies included:

- (U) stocking materiel, including engines, engine modules, and other engine related parts to support peacetime and wartime contingency operations; and
- (U) operating or contracting with a number of industrial maintenance and repair facilities capable of repairing and returning to stock engines, engine modules, and other engine-related parts.

(U) Although engine-related problems account for at least some of the non-mission capable readiness rates, the Services' representatives contend they had sufficient stock, repair facilities, or other contingency plans in place to address these issues to an acceptable risk level.

(U) In 2018 and 2019, the Government Accountability Office made recommendations to the Military Departments addressing both the degraded state of DoD facilities and depot workforce challenges; therefore, we are not making recommendations that duplicate the Government Accountability Office's recommendations. In addition, the Military Departments had processes in place to identify and address potential problems so that there are sufficient engines and engine modules available to meet the needs of each Military Department despite the number of challenges identified in this report. Examples of processes to address engine problems included accounting for engines in long-term storage, executing surge capabilities at the depots, and taking action to resolve excessive procurement lead times.

(U) Appendix A

(U) Scope and Methodology

(U) We conducted this performance audit from July 2020 through September 2021 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 objective. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

(U) Audit Universe and Sample

(U) We selected nine engines and engine modules due to the critical nature of those items to the availability of the weapon system.

(U) To determine the Army's sample, we consulted with Army Materiel Command officials and examined two lists of Army readiness drivers, which included 35 items for Tank-Automotive and Armaments Command and 62 items for Aviation and Missile Command. We then selected three engines for Tank-Automotive and Armaments Command and two engines for Aviation and Missile Command. We selected the M88, M109, M113, T-55, and T700-GE-701D engines due to the critical nature of the engines to the readiness of their associated weapon systems and the estimated high dollar value of each engine.

(U) To determine the Navy's sample, we examined the Department of the Navy FY 2021 Budget Estimates, dated February 2020, which included the costs associated with depot-level maintenance for the Navy. The three main maintenance types related to aircraft were Basic Aircraft, Engine, and Other maintenance. We analyzed the Navy's budget for depot-level maintenance to determine which engines had the greatest budget for FY 2021. We selected the T700-GE-401C engine and engine modules because they were ranked within the top 10 for the FY 2021 budget.

(U) To determine the Air Force's sample, we examined the Air Force's Mission Impaired Capability Awaiting Parts List. This list included the top 99 parts that negatively impacted readiness for the Air Force. We selected the F-100-220, F-100-229, and F-108-100 engines because those engines were on the Air Force's Mission Impaired Capability Awaiting Parts List.

(U) Methodology

(U) To accomplish the audit objective, we reviewed the Military Departments stocking requirement for the selected engines. Although the Military Departments use different metrics to measure the required stock levels, we used generic terms to describe the target number of spare engines that the Military Departments tried to achieve. When the Military Departments did not achieve that target number, we analyzed the part that the depots may have played in that overall stock position and the potential impact that the shortage had on the readiness posture of the weapon system.

(U) To determine how well the repair depots performed their mission, we analyzed the depot's ability to repair engines and engine modules in accordance with the Military Departments' performance metrics. The Army used the performance-to-promise metric to measure the depot's performance in repairing engines. The performance-to-promise metric means that the depot had to repair a certain number of engines by a certain date to meet the metric. The Navy and Air Force used the depot turnaround time metric to measure performance at the depots. The turnaround time is the depot agreed-upon time to repair engines and engine modules to ensure the readiness of the related weapon systems.

(U) To determine the overall impact that both the engine stock levels and the depot level repairs of engines had on weapon system readiness, we surveyed the Services readiness metrics and analyzed the primary reasons that the weapon systems did not meet their mission capable goal. If the weapon systems did not meet their mission capable goal due to engine or engine modules, then we determined the engine or engine module to have a negative impact on readiness. If the weapon systems did not meet their mission capable goal for reasons other than engine or engine-module, we did not attribute the engine or engine modules to be the primary cause for the weapon system not meeting is mission capable goal.

(U) Criteria Reviewed

(U) We reviewed the following applicable DoD, Army, Navy, and Air Force criteria to understand the regulations that govern the management of engines and engine modules.

- (U) DoD Manual 4140.01, Volume 2, "DoD Supply Chain Materiel Management Procedures: Demand and Supply Planning," November 9, 2018
- (U) Army Regulation 710-1, "Centralized Inventory Management of the Army Supply System," November 28, 2016
- (U) Naval Operations Instruction 4400.9D, "Depot Level Repairable Item Management," September 18, 2017

- (U) Naval Operations Instruction 13700.2B, "Engine, Engine Module, and Propulsion Sub-System Readiness," April 10, 2019
- (U) Air Force Instruction 21-101, "Aircraft and Equipment Maintenance Management," January 16, 2020

(U) Interviews Performed and Sites Visited

(U) We interviewed personnel from the following Military Departments and Defense agencies:

- (U) Army
  - (U) Army Logistics, G-4, Washington D.C.
  - (U) Army Materiel Command, Redstone Arsenal, Alabama
  - (U) Army Aviation and Missile Command, Redstone Arsenal, Alabama
  - (U) Army Tank-automotive and Armaments Command, Detroit Arsenal, Michigan
  - (U) Anniston Army Depot, Anniston, Alabama
  - (U) Corpus Christi Army Depot, Corpus Christi, Texas
- (U) Navy
  - (U) Naval Supply Systems Command, Mechanicsburg, Pennsylvania
  - (U) Naval Air Systems Command, Patuxent River, Maryland
  - (U) PMA 299 Program Office, Patuxent River, Maryland
  - (U) PMA 231 Program Office, Patuxent River, Maryland
- (U) Air Force
  - (U) Air Force Material Command, A-4, Wright-Patterson Air Force Base, Ohio
  - (U) Air Force Life Cycle Management Command, Wright-Patterson Air Force Base, Ohio
  - (U) Air Logistics Complex, Tinker Air Force Base, Oklahoma
  - (U) 448th Supply Chain Management Wing, Tinker Air Force Base, Oklahoma
  - (U) 546th Propulsion Maintenance Squadron, Tinker Air Force Base, Oklahoma
  - (U) 548th Propulsion Maintenance Squadron, Tinker Air Force Base, Oklahoma
- (U) Defense Logistics Agency
  - (U) Defense Distribution Anniston, Alabama
  - (U) Defense Distribution Corpus Christi, Texas

(U) We also visited Anniston Army Depot, Anniston, Alabama, and Corpus Christi Army Depot, Corpus Christi, Texas.

(U) Internal Control Assessment and Compliance

(U) We reviewed internal controls and compliance with laws and regulations necessary to satisfy the audit objective. In particular, we reviewed the Military Departments' processes and controls governing the management of the selected engines and engine modules. However, because our review was limited to these internal control components and underlying principles, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit.

(U) Use of Computer-Processed Data

(U) We did not use computer-processed data to perform this audit.

(U) Prior Coverage

(U) No prior coverage has been conducted on the management of engines and engine modules during the last 5 years.

(U) Appendix B

(U) Engines Reviewed

(U) Military Department and Command	Engine and National Item Identification Number	Weapon Systems	Depot-Level Repair Facility
Army AMCOM	T55 aircraft turbine engine 014585361	CH-47 Chinook	1. Corpus Christi Army Depot 2. Honeywell
Army AMCOM	T700-GE-701D 015031701	AH-64 Apache and UH-60 Black Hawk	1. Corpus Christi Army Depot 2. General Electric
Army TACOM	Diesel Engine 013354579	Howitzer (M109)	Anniston Army Depot
Army TACOM	Diesel Engine 014146821	Recovery Vehicle (M88)	Anniston Army Depot
Army TACOM	Diesel Engine 014122715	Armored Personnel Carrier (M113)	Anniston Army Depot
NAVAIR	T700-GE-401C	MH-60R, MH-60S, AH-1Z, and UH-1Y	1. Corpus Christi Army Depot 2. General Electric
Air Force AFMC	F100-220	F-15 Eagle and F 16 Fighting Falcon	Oklahoma City Air Logistics Complex
Air Force AFMC	F100-229	F-15 Eagle and F 16 Fighting Falcon	Oklahoma City Air Logistics Complex
Air Force AFMC	F108-100	KC-135	Oklahoma City Air Logistics Complex **(U)**

(U) LEGEND

(U) AFMC Air Force Materiel Command
(U) AMCOM Aviation and Missile Command
(U) NAVAIR Naval Air Systems Command
(U) TACOM Tank-Automotive and Armaments Command

(U) Acronyms and Abbreviations

(U) COVID-19 Coronavirus Disease–2019

(U) DLR Depot Level Reparable

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