



July 2018

# FORCE STRUCTURE

## F-22 Organization and Utilization Changes Could Improve Aircraft Availability and Pilot Training

Accessible Version

## Why GAO Did This Study

The F-22 was designed and fielded as the Air Force's premier air-to-air fighter. The small fleet of 186 F-22s is central to the Air Force's ability to accomplish its air superiority mission in high threat areas. While the Air Force has focused on other missions over the last 15 years of conflict, it is now trying to refocus on overcoming advanced threats, even as it continues to support ongoing operations. Though the recent introduction of the F-35 gives the Air Force another advanced fighter, the F-35 is primarily designed for the air-to-ground missions and so is intended to complement but not replace the F-22.

Senate Report 114-255 included a provision for GAO to review a variety of issues related to Air Force F-22 fighter squadrons. This report examines the extent to which the Air Force's (1) organization of its F-22 fleet maximizes availability of aircraft and (2) utilization of its F-22 fleet affects pilot air superiority training. GAO reviewed Department of Defense (DOD) guidance, analyzed maintenance data and training information for the F-22, evaluated the use of F-22s during deployments, and interviewed agency officials. This is a public version of a classified report issued in April 2018. Information DOD deemed classified or sensitive has been omitted.

## What GAO Recommends

GAO recommends that the Air Force reassess its F-22 organizational structure to determine alternative approaches to organizing F-22 squadrons, and identify ways to increase F-22 pilot training opportunities for high-end air superiority missions. DOD concurred with GAO's recommendations.

View [GAO-18-190](#). For more information, contact John Pendleton at (202) 512-3489 or [pendletonj@gao.gov](mailto:pendletonj@gao.gov)

## FORCE STRUCTURE

### F-22 Organization and Utilization Changes Could Improve Aircraft Availability and Pilot Training

## What GAO Found

The Air Force's organization of its small F-22 fleet has not maximized the availability of these 186 aircraft. Availability is constrained by maintenance challenges and unit organization. For example, stealth is a central feature of the F-22 and, according to Air Force officials, maintaining the stealth coating on the outside of the aircraft is time consuming and significantly reduces the time F-22s are available for missions. Maintenance availability challenges are exacerbated by the Air Force's decision to organize the F-22 fleet into small units—18 or 21 primary mission aircraft per squadron and one or two squadrons per wing. Traditional fighter wings have three squadrons per wing with 24 aircraft in each squadron, which creates maintenance efficiencies because people, equipment, and parts can be shared, according to Air Force officials. Moreover, the Air Force organized F-22 squadrons to operate from a single location. However, it generally deploys only a part of a squadron, and the remaining part struggles to keep aircraft available for missions at home. Larger, traditional Air Force squadrons and deployable units provide a better balance of equipment and personnel, according to service officials. The Air Force has not reassessed the structure of its F-22 fleet since 2010. Without conducting a comprehensive assessment to identify and assess F-22 organization, the Air Force may be foregoing opportunities to improve the availability of its small yet critical F-22 fleet, and support combatant commander air superiority needs in high threat environments.

The Air Force's utilization of its F-22 fleet has limited pilot opportunities to train for air superiority missions in high threat environments. To complete the annual training requirements for air superiority missions, F-22 pilots must train almost the entire year. However, F-22 pilots are not meeting their minimum yearly training requirements for the air superiority missions, according to Air Force training reports and service officials. Moreover, the utilization of F-22s for exercises and operational missions that do not require the F-22's unique capabilities interrupt pilot training and lead to reduced proficiency. For example, F-22 units are often directed to participate in partnership building exercises. However, during these exercises, F-22 pilots may be restricted from flying the F-22 the way they would fly it in combat—due to security concerns about exposing the F-22's unique capabilities. These restrictions limit the value of the exercises and can result in pilots developing bad habits, according to Air Force officials. The Air Force also uses F-22s to support alert missions—a mission that requires certain bases to have jets ready at all times to respond to threats from civil or military aviation. The alert mission does not require the advanced capabilities of the F-22, but there are no other operational Air Force fighter squadrons currently based at the F-22 locations in Alaska and Hawaii, so the alert mission falls to the F-22 units. Pilots and aircraft assigned to the alert mission cannot be used for any other purposes, including training. This limits opportunities for pilots to enhance air superiority skills. Without examining and implementing options to improve F-22 pilot training opportunities, the Air Force may be foregoing opportunities to improve its capability to address the high-end air superiority challenges it expects to face.

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**Abbreviations**

CAS	Close Air Support
DOD	Department of Defense
LO	Low Observable
UTC	Unit Type Code

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July 19, 2018

The Honorable John McCain  
Chairman  
The Honorable Jack Reed  
Ranking Member  
Committee on Armed Services  
United States Senate

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

Widely regarded as the best air superiority fighter aircraft in the world, the F-22 is an integral part of the U.S. military's ability to defeat high-end adversaries.<sup>1</sup> Potential adversaries around the world are pursuing technologies and strategies that are reducing the Department of Defense's (DOD) relative advantage in a number of areas, according to the department, including air superiority—a primary mission for the Air Force. Air superiority is established when the air and missile threat is reduced to a degree that other operations can occur without significant interference.<sup>2</sup> As such, the Air Force considers it a precondition for success of combat operations, and therefore a mission it must address first. However, fourth generation fighters are increasingly unable to operate in highly contested environments where advanced air defense

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<sup>1</sup>For the purposes of this review, we use the term high-end adversaries to mean advanced adversaries most able to challenge the Department of Defense (DOD) capabilities. As such, when we use the term high-end training, we are referring to the training against the capabilities of the most advanced adversaries. We have also previously reported on growing challenges to DOD's ability to gain operational access. See, for example, GAO, *Defense Planning: DOD Needs Specific Measures and Milestones to Gauge Progress of Preparations for Operational Access Challenges*, [GAO-14-801](#) (Washington, D.C.: Sept. 10, 2014).

<sup>2</sup>DOD defines air superiority as follows: that degree of dominance in the air battle by one force that permits the conduct of its operations at a given time and place without prohibitive interference from air and missile threats. Joint Chiefs of Staff, Joint Pub. 3-01, *Countering Air and Missile Threats* (Apr. 21, 2017).

systems render them ineffective, according to the Air Force.<sup>3</sup> A linchpin in the Air Force's ability to establish air superiority in highly contested environments is its small fleet of F-22s. With a unique combination of advanced stealth and maneuvering capabilities, the F-22 is designed to achieve air superiority against the most advanced air and surface threats. The Air Force currently uses a variety of fourth generation fighters, and plans to use F-35s for the air superiority mission since F-22 units constitute only 6 of the Air Force's 55 combat coded fighter squadrons.

Over the past 15 years, U.S. air superiority has largely gone unchallenged, so it has not been a main focus during ongoing operations. Instead, the focus has been on attacking ground targets in support of ground operations. With little slowdown in the pace of operations, the Air Force finds itself in a position where it must balance ongoing operational demands with the growing need to be prepared for current and future threats to air superiority.

To meet its assigned air superiority responsibility, the Air Force needs to provide the combatant commanders with, at a minimum: 1) mission-capable aircraft, and 2) pilots who are trained to fly those aircraft in the expected threat environments. The Senate Armed Services Committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2017 questioned whether the Air Force's fleet of F-22s is optimized to deter, and if necessary, quickly defeat increasingly capable potential adversaries. The Senate report also included a provision for us to review a variety of issues related to Air Force F-22 fighter squadrons.<sup>4</sup> This report evaluates the extent to which the Air Force's (1) organization of its F-22 fleet maximizes aircraft availability, and (2) utilization of the F-22 fleet affects pilot air superiority training.

To address our objectives, we analyzed aircraft inventory data and maintenance data from the Integrated Maintenance Data System from 2012 through 2016. We used that date range so that we could observe any trends and because the force structure has been relatively stable

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<sup>3</sup>The Air Force's fourth generation fighter fleet includes F-16s, F-15Cs, and F-15Es, many of which were purchased in the 1970s, 1980s, and 1990s. The F-22 and F-35 are considered fifth generation fighter aircraft. Navy and Marine Corps aircraft also support the DOD's air superiority mission. A-10s are also a fourth generation aircraft, but for the purposes of our report we do not include them since they generally do not have an air-to-air role.

<sup>4</sup>S. Rep. No. 114-255, at 103-104 (2016).

since 2012. We performed data reliability procedures on the information by taking steps including comparing that information against related documentation and testimonial evidence, performing logic checks, and interviewing knowledgeable officials on controls over the reporting systems. We determined that the reliability of these data were sufficient for the purposes of describing general trends and making proximate comparisons. We also analyzed pilot training information, including yearly memorandums produced by the F-22 operational squadrons for years 2012 through 2016.<sup>5</sup> We also conducted on-site interviews with Air Force officials from Air Force Headquarters; Air Combat Command; Air National Guard; Air Force Reserve Command; the four locations with operational F-22 squadrons; the training unit; and the operational test and evaluation unit. We discussed how unit organization affects aircraft availability and the units' abilities to maintain their aircraft in both the short and long term, as well as how F-22 utilization affects pilot training for the air superiority mission. We also discussed issues regarding the need for aircraft that play the role of adversaries for F-22 training purposes, known as adversary air. To examine how operational utilization of the F-22 affects the fleet's ability to support air superiority, we reviewed mission assignments and deployment information for F-22 squadrons. We also interviewed officials from U.S. Central Command, U.S. European Command, U.S. Northern Command/North American Aerospace Defense Command, and U.S. Pacific Command, regarding F-22 requirements and utilization. Finally, we reviewed DOD and Air Force guidance as well as reports and other documentation relevant to our review, such as *Air Superiority 2030 Flight Plan* and various briefings.<sup>6</sup>

This report is a public version of a classified report that we issued on April 27, 2018.<sup>7</sup> The classified report included an appendix describing current and projected operational requirements for the F-22. DOD deemed the information in the appendix to be classified, which must be protected from loss, compromise, or inadvertent disclosure. Consequently, this public version excludes that appendix. Further, this public report omits certain

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<sup>5</sup>We reviewed or analyzed several different types of Air Force training and training-related reports, including Air Combat Command training health summary and other training briefings, unit readiness information, annual squadron training reports, as well as letters of qualification. We also reviewed previous GAO work on Air Force training.

<sup>6</sup>United States Air Force Enterprise Capability Collaboration Team, *Air Superiority 2030 Flight Plan* (May 2016).

<sup>7</sup>GAO, *Force Structure: Changes to F-22 Organization and Utilization Could Improve Aircraft Availability and Pilot Training*, GAO-18-120C (Washington, D.C.: Apr. 27, 2018).

information that DOD deemed to be sensitive related to (1) the inventory of F-22, F-35, F-15C, F-15E, F-16, and A-10 primary mission aircraft (aircraft authorized to perform combat), (2) maintenance data on aircraft availability and cannibalization rates, (3) maintenance challenges related to the F-22's low observable coating, (4) F-22 squadron organization into deployable units and related issues, (5) F-22 annual training sortie standards, (6) effects on pilot training of F-22 operational deployments, and (7) F-22 spare engine shortfalls. Although the information provided in this report is more limited, it addresses the same objectives and uses the same methodology as the classified report.

The performance audit upon which this report is based was conducted from July 2016 to April 2018 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. We worked with DOD from April 2018 to July 2018 to prepare this unclassified version of the report for public release. This public version was also prepared in accordance with these standards.

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## Background

DOD guidance states that the Air Force and other services are responsible for providing trained and ready forces to fulfill the current and future operational requirements of the combatant commands.<sup>8</sup> The Air Force is specifically responsible for gaining and maintaining air superiority. The Air Force Strategic Master Plan states that the Air Force must focus clearly on the capabilities that will allow freedom of maneuver and decisive action in highly contested spaces, including high-end air capabilities.<sup>9</sup> Fifth generation fighter capabilities and ready and trained Airmen who are properly equipped for their missions are central components of the Air Force's ability to provide air superiority in contested environments.

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<sup>8</sup>DOD Directive 5100.01, *Functions of the Department of Defense and Its Major Components* (Dec. 21, 2010).

<sup>9</sup>United States Air Force, *United States Air Force Strategic Master Plan* (May 2015).

The F-22 is the Air Force's fifth generation, air superiority fighter that incorporates a stealthy and highly maneuverable airframe, advanced integrated avionics, and engines capable of sustained supersonic flight.<sup>10</sup> The F-22 is optimized for air-to-air combat, able to carry up to eight air-to-air missiles, and equipped with a 20-millimeter cannon. After development began, the Air Force also added air-to-ground capabilities to the F-22. Air Force officials emphasized the synergistic benefits of the F-22 to the joint force. Specifically, the F-22's individual capabilities, like its stealth and sensors, help it to coordinate and improve the performance of other aircraft during operations, including fourth generation fighters. The Air Force views the F-22 and the F-35—its other fifth generation fighter—as complementary platforms with some overlapping capabilities. For example, the F-22 is focused on, and more capable in, air-to-air missions and the F-35 is focused on, and more capable in, air-to-ground missions. The Air Force announced in its fiscal year 2018 budget request that it now intends to retain the F-22 until 2060. It has also begun an effort to define and develop the next generation of air superiority capabilities that it plans to field in 2030 and beyond. Figure 1 shows a picture of an F-22.

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<sup>10</sup>According to the Air Force, the F-22's combination of sleek aerodynamic design, including its internal weapons bays, and powerful engines allow the F-22 to cruise at supersonic airspeeds (greater than 1.5 Mach) without using afterburner—a characteristic known as "supercruise". Supercruise greatly expands the F-22's operating envelope in both speed and range over current fighters, which must use fuel-consuming afterburners to operate at supersonic speeds.

**Figure 1: Air Force F-22**



Source: GAO. | GAO-18-190

The F-22 and the F-15C are the two operational fighters in the Air Force's Air Superiority Core Function.<sup>11</sup> The Air Force assigns two primary (air-to-air focused) missions and one secondary (air-to-ground focused) mission to the F-22. These missions are described in table 1. The Air Force

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<sup>11</sup> Air Force activities and budgets are managed primarily across 12 Core Functions—the broad capabilities the Air Force provides to the combatant commanders. The 12 core functions are: (1) Rapid Global Mobility, (2) Nuclear Deterrent Operations, (3) Education and Training, (4) Special Operations Forces, (5) Agile Combat Support, (6) Space Superiority, (7) Cyber Superiority, (8) Air Superiority, (9) Global Precision Attack, (10) Global Integrated Intelligence, Surveillance, and Reconnaissance, (11) Command and Control, and (12) Personnel Recovery. The Air Superiority Core Function also includes the EC-130H, an electronic warfare aircraft, the E-9A, and T-38 training aircraft.

requires its pilots to be proficient in their primary missions and familiar with their secondary missions.<sup>12</sup>

**Table 1: F-22 Primary and Secondary Missions**

Mission type	Mission	Description <sup>a</sup>
Primary mission	Offensive Counter-Air—Escort/Sweep	For the F-22, this mission is air-to-air focused, including defeating adversary fighters and escorting other fighters or bombers over hostile territory.
Primary mission	Defensive Counter-Air	This mission is focused on defending friendly airspace against air threats, such as fighters, bombers, and cruise missiles.
Secondary mission	Air Interdiction/Offensive Counter-Air—Attack Operations	This mission is focused on the air-to-ground role for the F-22 and includes defeating advanced surface-to-air missile threats and other ground targets that contribute to an adversary's air power.

Source: GAO Analysis of Air Force Information. | GAO-18-190

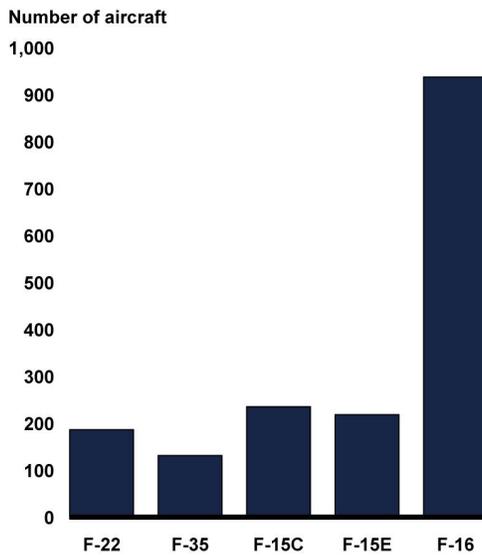
<sup>a</sup>The mission descriptions are summaries of the missions the F-22 conducts and are based on definitions in joint publications and F-22-specific details from the F-22 Ready Aircrew Program Tasking Memorandum and Air Force officials.

The size of the current F-22 fleet is smaller than the Air Force originally planned. The Air Force F-22 acquisition program began in 1991 with an intended development period of 12 years and a planned quantity of 648 aircraft. The Air Force had intended to station 40 percent of the operational fleet outside of the United States. However, schedule delays, cost increases, and changes to threats, missions, and requirements led DOD to reduce the number of F-22s it eventually purchased. The Air Force identified a requirement for 381 F-22s in 2002, but ended aircraft production in 2012 with approximately half of that number. As of May 2018, the Air Force had a total of 186 F-22s, as shown in figure 2. The total aircraft inventory includes primary mission aircraft in each

<sup>12</sup>The Air Force defines mission proficiency and familiarity in Ready Aircrew Program Tasking Memorandums as follows: Proficient: Aircrew have a thorough knowledge of mission area but occasionally may make an error of omission or commission. Aircrew are able to operate in a complex, fluid environment and are able to handle most contingencies and unusual circumstances. Proficient aircrew are prepared for mission tasking on the first sortie in theater. Familiar: Aircrew have a basic knowledge of mission area and may make errors of omission or commission. Aircrew are able to operate in a permissive environment and are able to handle some basic contingencies and unusual circumstances. Familiar aircrew may need additional training prior to first mission tasking.

community—those authorized to perform combat—as well as aircraft that are designated for other purposes.<sup>13</sup>

**Figure 2: Air Force Fighter Inventory as of May 2018**



Source: GAO analysis of Air Force information. | GAO-18-190

Notes: The Air Force plans to procure a total of 1,763 F-35s by 2038 according to Joint Strike Fighter Program Office data from October 2016.

Also, the figure does not include A-10s since they generally do not have an air-to-air role. The Air Force had 281 total A-10s, as of May 15, 2018.

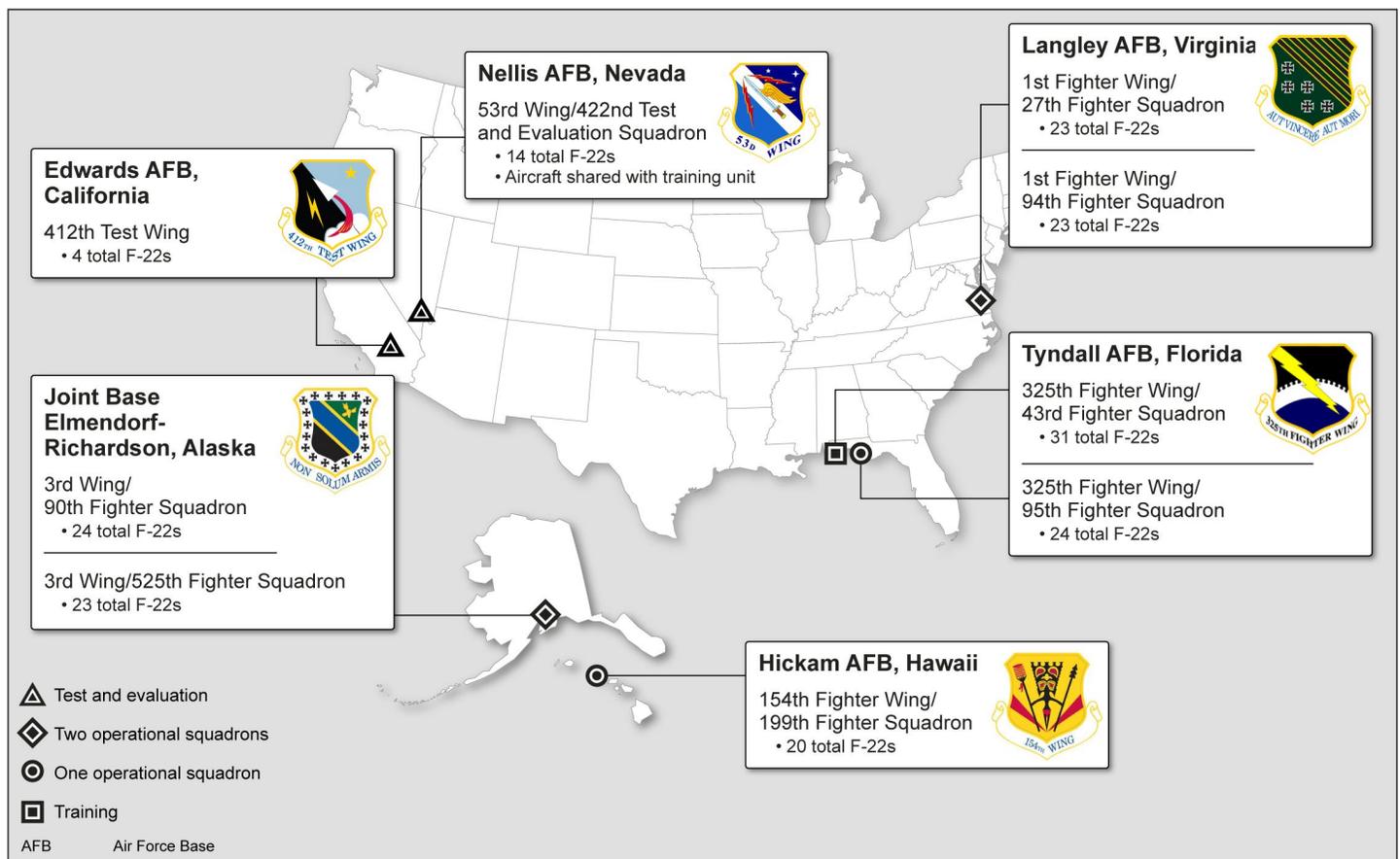
The operational portion of the F-22 fleet is organized into 6 operational squadrons at four locations. According to Air Force officials, the small number of F-22s provides a less than ideal fifth generation fighter capacity until F-35 numbers grow. However, in a June 2017 report to Congress, the Air Force stated that it would not make economic or operational sense to reopen the F-22 production line, and reported that it would cost approximately \$50 billion to procure an additional 194 F-22s.

<sup>13</sup>Many of the other aircraft are used as training aircraft or as developmental or operational test aircraft, but squadrons also have backup aircraft to use in place of their primary aircraft that are undergoing maintenance actions, and each fleet also has some aircraft that are designated as reserves to account for possible attrition. For the purposes of this review, we use the term “primary mission aircraft” to refer to aircraft in operational units authorized for performing the units’ missions. This does not include back-up or attrition reserve aircraft. The Air Force refers to these aircraft as Primary Aerospace Vehicle Authorized (PAA) for operational units or Primary Mission Aerospace Vehicle Inventory (PMAI). For further details, see Air Force Instruction 16-402, *Aerospace Vehicle Programming, Assignment, Distribution, Accounting, and Termination* (May 30, 2013).

The Air Force is continuing to fund programs to modernize the F-22 and make reliability improvements.<sup>14</sup>

Figure 3 shows the basing locations of the F-22 fleet, and the numbers of aircraft at each base.

**Figure 3: F-22 Force Structure and Posture (2018)**



Source: GAO analysis of Air Force information. | GAO-18-190

<sup>14</sup>GAO has previously reported on F-22 modernization and reliability programs. See, for example, GAO, *F-22 Modernization: Cost and Schedule Transparency Is Improved, Further Visibility into Reliability Efforts Is Needed*, GAO-14-425 (Washington, D.C.: May 15, 2014) and GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-17-333SP (Washington, D.C.: Mar. 30, 2017).

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## F-22 Unit Size and Organizational Structure Constrain Aircraft Availability and Have Not Been Reviewed by the Air Force since 2010

The size and structure of F-22 units diminishes the Air Force's ability to maximize the number of F-22s available for operations and have not been reviewed since 2010. The F-22 has sustainment issues due to the fleet's maintenance and supply challenges. These challenges have affected aircraft availability rates, which have remained below Air Force standards. The small size of F-22 squadrons and wings has contributed to low aircraft availability rates. Further, the Air Force practice of deploying a small portion of a squadron makes it difficult for F-22 squadrons, as currently organized, to make aircraft available for their missions at home station. The Air Force would also face difficulties generating aircraft to support DOD's concepts for using distributed operations in high threat environments with its current F-22 squadron organization. Although in 2016 it assessed its future air superiority capability needs, the Air Force has not comprehensively assessed whether the current F-22 organizational structure is optimized to support combatant commander needs.

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### Sustainment Issues Limit F-22 Aircraft Availability

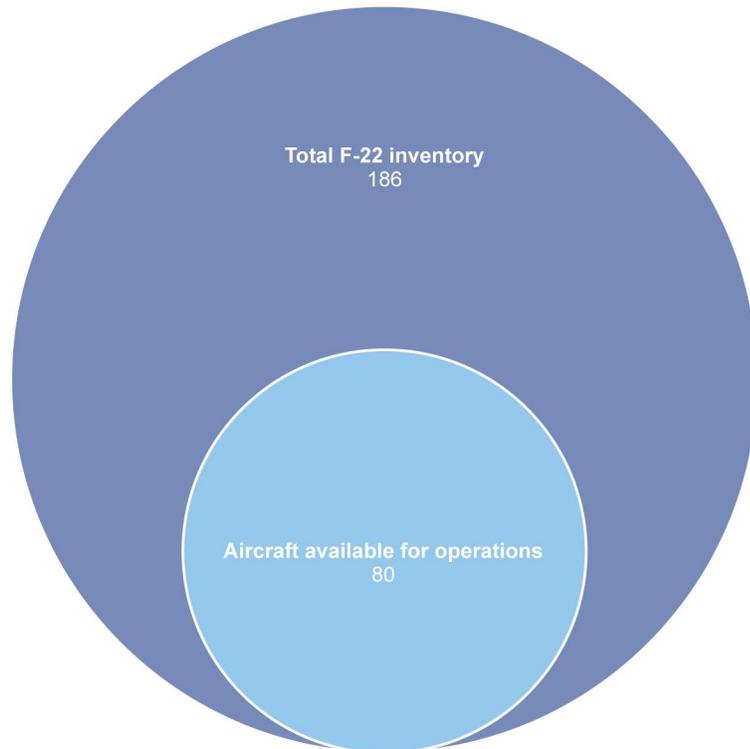
The F-22 has sustainment issues due to the fleet's maintenance and supply challenges that have affected aircraft availability rates. In fiscal year 2016, this resulted in the fleet having an average of 80 F-22s available for operations, as shown in figure 4.<sup>15</sup> According to the Air Force, from fiscal year 2012 through 2016, the F-22 fleet availability rate was below the Air Force's annual F-22 availability standard by 4 to 19 percent.<sup>16</sup>

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<sup>15</sup>According to the Air Force, the aircraft availability rate is the percentage of a fleet's total inventory that is available (i.e., mission capable). Air Force Logistics Management Agency, "Maintenance Metrics U.S. Air Force" (Mar. 20, 2009).

<sup>16</sup>The Aircraft Availability standard is based on Air Force evaluation of requirements, including operational and training requirements, and is not resource constrained, according to Air Force officials. The Air Force's aircraft availability standard for the F-22 was 66.7 percent for fiscal year 2012, rose to 72.6 percent in fiscal year 2015, and was 72 percent in fiscal years 2016 and 2017.

**Figure 4: Fiscal Year 2016 Average Number of F-22s Available for Operations**



Source: GAO analysis of Air Force information. | GAO-18-190

First, the F-22 has some unique maintenance challenges, which have affected aircraft availability rates. The maintenance demands of the F-22's Low Observable (LO) coating, a critical component of its stealth characteristic, reduces aircraft availability. Without the LO maintenance issues, availability would have been significantly closer to meeting the annual availability standard, according to the Air Force officials. Fourth generation fighters do not have to contend with this maintenance issue.<sup>17</sup> The F-22's LO coating is actually a series of coatings that require diligent and time-consuming application and curing, which results in extended periods of time when the aircraft are not available, according to Air Force

<sup>17</sup>According to Headquarters Air Force officials, F-22 availability has generally lagged behind fourth generation fighters by 10 to 20 percent. However, aircraft comparison is complicated because each aircraft is at a different stage of its lifecycle. According to Air Force Air Combat Command officials, fourth generation fighters are currently underperforming due to an intense modification schedule, heavy maintenance requirements, and a lack of aircraft due to deployments. They stated that the Air Force has initiated efforts to improve aircraft availability for its fourth generation fighters.

officials. The F-22's LO coating is also beginning to reach the end of its service life, requiring maintenance actions that further reduce aircraft availability. The Air Force has begun to address these maintenance issues by using a more durable coating and standing up additional repair facilities.

Second, the F-22 faces a number of supply challenges that have contributed to reduced and unpredictable aircraft availability. Officials from all four operational locations expressed concerns over low supply levels and difficulties with obtaining needed parts. The F-22 fleet's small size and resulting low demand for parts contributes to this problem. Obtaining missing parts can be a time-consuming and costly process because some original manufacturers no longer make the parts or are completely out of business, according to Air Force officials. When this is the case, the Air Force may need to find the original aircraft and parts design plans, and obtain a new contractor to produce a small number of parts. Officials at one operational location said a simple wiring harness required a 30-week lead time.<sup>18</sup>

Appendix I contains additional information on F-22 maintenance and supply issues.

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### Small F-22 Squadrons and Wings Exacerbate Aircraft Availability Challenges

With 18 to 21 primary mission aircraft per F-22 squadron, and 1 or 2 F-22 squadrons per wing, the Air Force has been unable to gain the maintenance and supply efficiencies associated with its larger traditional squadrons and wings, and this has contributed to low aircraft availability rates. According to service officials, the Air Force has traditionally structured its fighter wings to have 3 squadrons with 24 primary mission aircraft per squadron to optimize maintenance efficiency and combat power. The Air Force is planning to organize its active duty F-35 fleet into traditional sized squadrons with 2 or 3 squadrons per wing. A RAND study also concluded that larger squadrons and multiple squadrons per wing create efficiencies.<sup>19</sup> Larger squadrons and wings create efficiencies

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<sup>18</sup>GAO has previously reported on challenges DOD faces with single sources of supply, including the lengthy parts redesign and requalification process. See GAO, *Defense Supply Chain: DOD Needs Complete Information on Single Sources of Supply to Proactively Manage the Risks*, [GAO-17-768](#) (Washington, D.C.: Sept. 28, 2017).

<sup>19</sup>RAND, *Assessment of Beddown Alternatives for the F-35* (Washington, D.C.: 2013).

because people, equipment, and parts can be shared, according to Air Force officials. Having a multi-squadron wing is also beneficial when one squadron deploys a portion of its aircraft, pilots, and maintenance personnel and leaves another portion of the squadron at the squadron's home station. In these cases, collocated squadron(s) can help backfill shortfalls for the portion of the squadron that remained at home station.

The Air Force recognizes that smaller F-22 operational squadrons and wings face sustainment challenges due to their size. Facing cuts in the total number of aircraft purchased, the Air Force decided in 2006 to organize its F-22s into 7 operational squadrons, each with 18 primary mission aircraft. However, in 2010, the Air Force found that this plan was unsustainable because operational squadrons were not able to produce adequate sorties. The Air Force then decided to eliminate 1 squadron and used some of the aircraft from that squadron to increase the number of primary mission aircraft to 21 in its 5 remaining active duty squadrons. The Air Force left its one F-22 National Guard squadron with only 18 primary mission aircraft. The Air Force's intent with this restructuring was to increase fleet sustainability while retaining enough squadrons for force projection needs.

F-22 aircraft availability metrics have fluctuated, but have generally been better for operational locations with more aircraft per squadron and more squadrons per wing. For example, table 2 shows that the operational locations in Alaska and Virginia—locations with 2 operational squadrons—have higher aircraft availability rates than the locations with only 1 operational squadron. Although Air Force maintenance data shows that the Florida operational squadron had a lower availability rate than the locations with 2 operational squadrons in fiscal years 2014, 2015, and 2016, Air Force officials noted that this squadron should be able to leverage the maintenance benefits of having the F-22 training squadron on base. However, a major maintenance backlog for the training squadron currently limits that benefit, according to the officials.<sup>20</sup>

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<sup>20</sup>The F-22s at the training squadron are some of the oldest F-22s in the fleet and are an older configuration than the operational jets. According to Air Force officials at Air Combat Command and at the unit level, F-22s used for training were not historically required to maintain the LO coatings on their aircraft. However, a change in that requirement resulted in a large maintenance backlog for these training aircraft.

**Table 2: Average F-22 Operational Unit Aircraft Availability (Fiscal Years 2014 through 2016)**

Base location	Description	Difference between fleet average aircraft availability and base availability
Langley Air Force Base, Virginia	2 squadrons	+11%
Joint Base Elmendorf-Richardson, Alaska	2 squadrons	+10%
Tyndall Air Force Base, Florida	1 squadron	-11%
Hickam Air Force Base, Hawaii	1 squadron	-14%

%=percent

Source: GAO analysis of Air Force information. | GAO-18-190

The F-22 units in Alaska and Virginia are also generally able to produce more sorties per month. Further, F-22 squadron officials in Hawaii stated that increasing their squadron—the smallest in the fleet—by 4 additional aircraft would allow the squadron to generate 32 percent more sorties. Air Force officials cautioned that there are many factors that influence maintenance metrics for the F-22, including the age of the aircraft, climate and leadership. However, they agreed that larger squadrons and wings increase maintenance performance.

### Partial Unit Deployments Hinder the F-22 Squadrons' Abilities to Maximize the Aircraft Available for Operations

Further, the Air Force practice of deploying a small portion of a squadron forward makes it difficult for F-22 squadrons as currently organized to make aircraft available for their missions at home station, according to officials from all four operational locations. The Air Force organizes its F-22 squadrons and other fighter squadrons based on a model where a squadron deploys to a single forward location, according to Air Force officials. In order to facilitate deployments, the Air Force has for approximately the last two decades organized squadrons into smaller deployable pieces called Unit Type Codes (UTCs). However, the UTCs are not the same size. For example, one of the F-22's UTCs is designed to have only 6 of a squadron's 21 aircraft but contains almost 50 percent of the squadron's equipment, approximately 40 percent of the squadron's maintenance personnel and 60 percent of its operational personnel.<sup>21</sup> This organizational approach therefore creates a disproportionate split among UTCs in terms of equipment and personnel, making it more

<sup>21</sup>The equipment number is based on the number of pallet positions of equipment, not number of items. In 2017, Air Force officials provided the information on UTC equipment in terms of how many pallet positions the equipment would take up on a cargo aircraft.

difficult for the underserved portions of the squadron to maintain readiness or generate sorties.

Furthermore, different UTCs will not only have unequal amounts of equipment and personnel, but will also tend to unevenly apportion their best aircraft, more experienced personnel, and critical parts, according to Air Force officials. The officials noted that during “split operations,” the portion of the squadron remaining at home struggles to keep aircraft available for missions. According to Air Force officials, traditional fighter squadrons have larger UTCs, which provides a better balance in equipment and personnel that lessens the strain of split operations.

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### Organizing for New Operational Concepts Poses Additional Aircraft Availability Challenges

With its current F-22 squadron organization, the Air Force would also face difficulties generating aircraft to support DOD’s concepts for using distributed operations in high threat environments.<sup>22</sup> According to DOD, potential adversaries are increasingly capable of challenging U.S. access to operational areas by, for example, developing cruise and ballistic missiles that are able to reach U.S. forward air bases. In its *Air Superiority 2030 Flight Plan*, the Air Force states that the ability to deploy and operate forces in non-permissive environments is essential to air superiority. One approach for doing this is to use distributed bases. Instead of operating from well-developed and vulnerable forward air bases, squadrons would break up into smaller units and operate independently from multiple locations, moving around so as to complicate enemy targeting. The Air Force is drafting an adaptive basing concept and implementation plan to help guide its efforts in this area.

Sustaining and maintaining multiple independent deployable units so that they have operational aircraft available for the combatant commander is not possible with the current F-22 squadron structure and would require significant investment, according to Air Force officials. F-22 squadrons have made a number of short exercise deployments, with small numbers of aircraft to provide forward presence and examine the units’ abilities to conduct distributed operations. These deployments showed that rapidly deploying small numbers of F-22s for short durations is possible. The

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<sup>22</sup>For a DOD concept that includes distributed operations, see Joint Chiefs of Staff, *Joint Operational Access Concept (JOAC)* (Washington, D.C.: Jan. 17, 2012).

deployments also identified a number of challenges the Air Force needs to address if it implements a distributed operations concept, including maintenance, logistics, spare parts, and tanker support challenges, according to after-action reports and service officials. Furthermore, according to the Commander of U.S. Pacific Command, distributed operations requires a dynamic logistics system that is more responsive, agile, and flexible than DOD is used to employing.<sup>23</sup> Air Force officials told us that the Air Force is early in the process of examining the implications of distributed operations and has not determined the extent to which F-22 squadron organization should be adjusted to support distributed operations.

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### The Air Force Has Not Comprehensively Assessed F-22 Organizational Structure since 2010

While the Air Force reviews F-22 operations and sustainment needs as part of the annual programming and budgeting process within DOD, the Air Force has not comprehensively assessed whether the current F-22 organizational structure is the optimal structure to support combatant commander needs since 2010, according to Air Force officials. As previously discussed, the Air Force found in 2010 that operational squadrons were not able to produce adequate sorties and so eliminated 1 squadron and used some of the aircraft from that squadron to increase the number of primary mission aircraft in its 5 remaining active duty squadrons

DOD's Joint Publication 3-0, Joint Operations, states that risk management is the process to identify, assess, and control hazards arising from operational factors and make decisions that balance risk and cost with mission benefits. It assists organizations and individuals in making informed decisions to reduce or offset risk, thereby increasing operational effectiveness and the probability of mission success. Furthermore, *Standards for Internal Control in the Federal Government* states that management should periodically evaluate the organizational structure so that it meets the entity's objectives and has adapted to any new objectives for the entity.<sup>24</sup> Furthermore, management should

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<sup>23</sup>Prepared statement of Admiral Harry Harris, Commander, U.S. Pacific Command, for the Logistics Officer Association Symposium (Oct. 13, 2016).

<sup>24</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

periodically review policies, procedures, and related control activities for continued relevance and effectiveness in achieving the entity's objectives or addressing related risks.

However, the Air Force has not conducted a comprehensive assessment of the F-22 organizational structure since 2010, according to Air Force officials. As previously discussed, while the larger squadrons and wings created after the 2010 restructuring have generally had higher availability rates than smaller ones, fleet aircraft availability rates remain below the Air Force standard for what is needed. Further, the F-22's role has also evolved since 2010. For example, F-22s have begun participating in combat operations in Iraq and Syria. Additionally, potential adversaries are increasingly able to challenge U.S. air superiority, according to the Air Force. In 2016, the Air Force examined its future air superiority capability needs in its *Air Superiority 2030 Flight Plan*, but that review did not include an assessment of organizational structure, according to officials involved with the review. Such an assessment could consider a number of alternatives, such as consolidating the F-22 fleet into larger squadrons and/or wings to improve aircraft availability or revising the design of the deployable units in squadrons to better support current deployment practices and future operational concepts, as well as any risks associated with those alternatives. Without conducting a comprehensive assessment of the F-22 organizational structure that identifies and assesses alternative approaches to organizing F-22 squadrons, the Air Force may be forgoing opportunities to improve the availability of its small yet critical F-22 fleet to support current and future combatant commander high-end air superiority needs.

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## Air Force Utilization of F-22s Reduces Pilot High-End Air Superiority Training Opportunities

The Air Force's utilization of its F-22 fleet has limited its pilots' opportunities to train for their high-end air superiority missions, and contributed to F-22 pilots not meeting their training requirements. F-22 pilots need extensive training in order to be prepared to execute their high-end air superiority missions. However, Air Force utilization of F-22 units for exercises, the low supply of adversary air training capabilities, and the use of F-22s to meet combatant commander needs, including the alert mission, affects the ability of pilots to meet those requirements.

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## F-22 Pilots Are Not Meeting Minimum Training Requirements Necessary for Their Air Superiority Missions

F-22 pilots are not meeting their minimum yearly training requirements for the air superiority missions, according to Air Force training reports and service officials.<sup>25</sup> F-22 pilots need extensive training for F-22 units to fulfill their air superiority role. Air Force guidance notes that a key to maintaining air superiority is trained and ready Airmen that must possess a well-honed combat edge so that they are ready to prevail even against the most advanced opponents.<sup>26</sup> The Air Force strategy also notes that the training of Airmen must be relevant and responsive if they are to maintain superior agility in the future.<sup>27</sup> Through its Ready Aircrew Program, the Air Force establishes annual continuation training requirements for F-22 pilots. These requirements focus on the training needed to accomplish the core missions of F-22 units. They define the minimum required mix of annual sorties, simulator missions, and training events aircrews must accomplish to sustain combat mission readiness.<sup>28</sup> Air Force officials emphasized that the requirements outlined in the Ready Aircrew Program are minimums and noted that some pilots may need additional sorties to achieve proficiency.

In 2016, GAO reported that combat fighter squadrons were unable to meet annual training requirements across the full range of core

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<sup>25</sup>We reviewed or analyzed several different types of Air Force training and training-related reports, including Air Combat Command training health summary and other training briefings, unit readiness information, annual squadron training reports, as well as letters of qualification. We also reviewed previous GAO work on Air Force training.

<sup>26</sup>United States Air Force, *United States Air Force, Global Vigilance, Global Reach, Global Power for America* (August 2013).

<sup>27</sup>United States Air Force, *America's Air Force: A Call to the Future* (July 2014).

<sup>28</sup>The Air Force establishes Ready Aircrew Program requirements that are unique to each aircraft type. The memorandums contain different minimum requirements for pilots depending on their experience level and depending on whether they are Air Force active duty, Air National Guard, or Air Force Reserve pilots. The memorandums state that squadron commanders develop unit training programs and note that the squadron commanders have the authority and are expected to tailor their unit training plans when necessary.

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missions.<sup>29</sup> Further, an Air Force analysis conducted in 2016 determined that, based on current aircraft availability rates, pilots in an F-22 squadron with 21 primary mission aircraft need 270 days of home station training each year to meet their minimum annual continuation training requirements.<sup>30</sup> However, F-22 pilots are generally not meeting those minimums, according to the officials, and F-22 operational squadrons have reported numerous shortfalls. For example, one squadron identified training shortfalls in its primary missions for four consecutive years in its annual training reports. Another squadron identified training shortfalls in one of its primary missions, offensive counter-air, in three of the last four annual training reports.

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### F-22 Pilots Benefit from Exercises, but Exercise Quality and Quantity Can Detract from Training Needs

Although participation in exercises is an important component of F-22 pilot training, multiple exercises can interrupt pilot training cycles and restrictions in some exercises can detract from F-22 pilot training for the high threat environment. Exercises provide pilots an opportunity to train in a more realistic setting. At the same time, frequent participation in exercises can take time away from the home station training that is required to maintain combat mission readiness for high-end air superiority missions. Although high demand for exercise participation is causing stress across the Air Force,<sup>31</sup> the problem is particularly acute for F-22 pilots, according to a 2016 Air Force analysis. While F-22 pilots require 270 days at home each year, they are getting only 191 days on average, according to the analysis. Pilots from other fighter aircraft, such as the F-

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<sup>29</sup>GAO, *Air Force Training: Further Analysis and Planning Needed to Improve Effectiveness*, [GAO-16-864](#) (Washington D.C.: Sept. 19, 2016). [GAO-16-864](#) is a public version of the prior sensitive report issued in August 2016, which includes information on the completion of annual training requirements for active duty fighter squadrons, including the F-22. See GAO, *Air Force Training: Further Analysis and Planning Needed to Improve Effectiveness*, [GAO-16-635SU](#) (Washington, D.C.: Aug. 16, 2016).

<sup>30</sup>The number of days needed annually for home station training does not include weekends, federal holidays, family days, scheduled down days or days when on deployment orders. Therefore, F-22 pilots must train for almost the entire year to meet the annual training requirements for the high-end air superiority mission.

<sup>31</sup>Since 2001, there has been a 35 percent reduction in the number of fighter and bomber squadrons (from 94 to 61) and a 31 percent increase in exercise taskings, according to a May 2017 Air Force memorandum.

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16 and F-15E, are also experiencing home station training shortfalls, but not as great as those faced by F-22 pilots, according to the analysis.

Furthermore, F-22 units are often directed to participate in exercises as part of Air Force efforts to build relationships with partners. However, due to security concerns regarding exposing the F-22's unique capabilities, F-22 pilots may be restricted from flying the aircraft the way they would in combat, according to Air Force officials. As a result, the value of the training is reduced and these types of exercises can result in the F-22 pilots developing bad habits that must be corrected in future training, according to Air Force officials.

The Air Force recognizes that exercise demands on F-22 units and other fighter units make it difficult for pilots to complete their required training. Based on its analysis, the Air Force is planning to increase the time pilots have available to conduct home station training, including by establishing a goal of no more than 1 day on travel for every 5 days at home station. As a result, the Air Force will be reducing total exercise participation and thereby increasing the number of days F-22 pilots are at home station in fiscal year 2018 by 8 days. However, the Air Force projects that F-22 pilots in fiscal year 2018 will still fall 71 days short of the 270 days they need to meet their yearly training requirement, based on current aircraft availability rates. Without exploring further reductions in exercise events that do not contribute to high-end air superiority training, at current aircraft availability rates F-22 pilots may not be fully prepared to effectively support combatant commander needs against the most advanced threats.

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### Adversary Air Demands for F-22s Detract from the Ability of Pilots to Meet Training Requirements

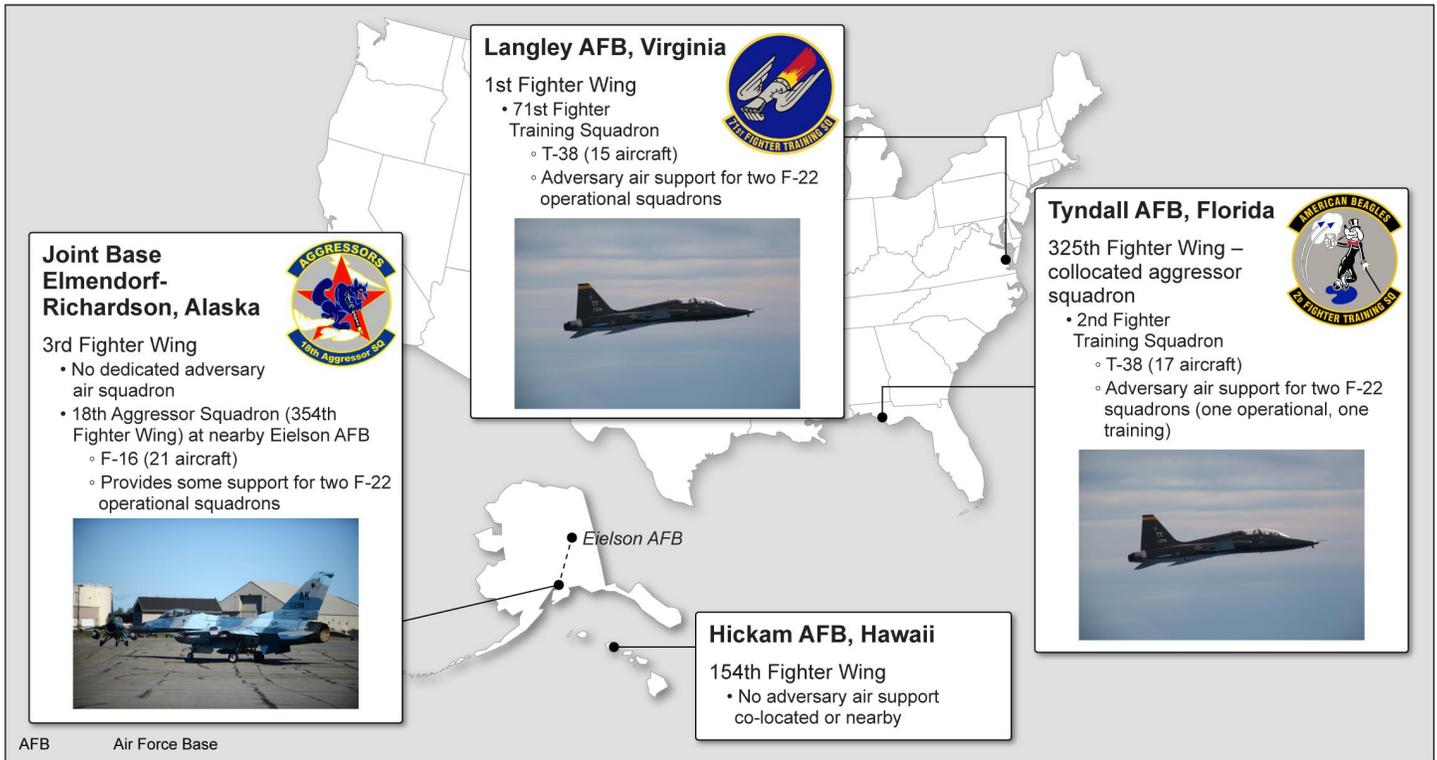
F-22 pilot training requires flying against aircraft playing the role of adversaries, but high demand and low supply of adversary air resources have resulted in training shortfalls. Due to the F-22's unique air superiority role and high-end capabilities, the Air Force expects F-22 pilots to face and defeat numerically superior adversaries. This results in an annual demand of between 145 and 171 adversary air sorties for every operational F-22 pilot.<sup>32</sup> The adversary air demand for fourth generation fighters is much lower. For example, continuation training for the Air

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<sup>32</sup>There is a range of requirements because the Air Force sets a lower sortie requirement for experienced pilots as compared to inexperienced pilots.

Force’s other air superiority fighter—the F-15C—results in an annual demand of between 45 and 73 adversary air sorties. To support F-22 training requirements, the Air Force has provided two of the four operational locations (Virginia and Florida) with a squadron of T-38s to provide dedicated adversary air support for use in training. In Alaska, an adversary air squadron is located at a nearby base that is able to provide some support for F-22 training, according to officials. The F-22s in Hawaii have no adversary air support on base or nearby. Figure 5 shows F-22 operational locations and their adversary air support.

**Figure 5: Adversary Air Units That Support F-22 Home Station Training (2018)**



Source: GAO analysis of Air Force information; Defense Video Imagery Distribution System (photos). | GAO-18-190

All F-22 operational locations report that insufficient adversary air caused pilots to have shortfalls in their training. For example, the operational F-22 squadron in Florida, which shares an adversary air squadron with a collocated F-22 training unit, reported that F-22 pilot training deficiencies in fiscal year 2016 were caused in part by limited adversary air support. Specifically, adversary air shortfalls negatively impacted the training of 83 percent of the squadron’s pilots for the offensive counter-air mission and

54 percent of the pilots for the defensive counter-air mission. Operational squadrons at other locations reported similar negative effects on training caused in part by the limited adversary air.

Moreover, the limited supply of dedicated adversary aircraft means that often F-22 pilots must fly their aircraft in an adversary aircraft role to support the training of the squadron's other F-22 pilots. For example, according to a 2017 Air Force memo, 55 percent of all sorties generated by F-22s based in Hawaii were dedicated to adversary air. The F-22 squadron in Hawaii reported that this practice negatively affected the combat readiness of all of the squadron's pilots. The Air Force categorizes adversary air sorties as useful only for maintaining basic flying proficiency. Officials from the Virginia unit explained that F-22 pilots flying adversary air do not fly like they would during combat missions and so these sorties are wasteful, having no or negative training value. An official representing the Hawaii unit indicated that the high percentage of sorties dedicated to adversary air leads to wasteful training and declines in readiness against potential threats.<sup>33</sup> Air Force officials expect competing demands for limited adversary air to grow as the Air Force stands up more F-35 squadrons.

The Air Force recognizes and is attempting to mitigate adversary air shortfalls.<sup>34</sup> For example, the Air Force has hired contractors to address Air Force adversary air shortfalls at exercises, as we previously reported.<sup>35</sup> In addition, the Air Force has outlined a plan to provide

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<sup>33</sup>F-22s are also over three times more expensive to fly for adversary air than the next most expensive aircraft, the F-16. According to cost data provided by Air Force officials, the cost of one operational flying hour in fiscal year 2016 for the F-22 was \$61,726 versus \$19,168 for an F-16 and \$8,946 for a T-38.

<sup>34</sup>The Air Force also notes that the service will focus more efforts on virtual training, including the use of simulators. In 2012, for active duty pilots, the Air Force reduced the required number of flight sorties and increased the number of simulator sorties. However, Air Force Ready Aircrew Program requirements show that the use of simulators is allowed to meet a small proportion of training sorties, but live sorties are required to train primary skillsets. Although the Air Force is currently able to supplement real flying hours and mitigate training shortfalls through the use of simulators, officials told us that using simulators is not always possible or effective. For example, from 2014 to 2016 an Alaska-based squadron noted that a combination of simulator closures and insufficient contractor support negatively affected the ability of all the squadron's pilots to train using simulators. Further, officials from one operational location said there are clear advantages of having pilots fly as adversaries because they are better able to adapt and provide new and challenging problems for the pilot being trained.

<sup>35</sup>[GAO-16-864](#).

additional adversary air support for its fighter units, including contract adversary air support for the F-22 training squadron in Florida and the operational squadrons at two of the four operational locations (Virginia and Hawaii) in the 2019 timeframe. However, the Air Force must first complete additional analysis and finalize funding before additional adversary support is provided to these locations, according to an August 2017 Air Force briefing on the plan.<sup>36</sup> Until the Air Force explores additional alternatives for increasing external adversary air training support at all of the operational locations, F-22 pilots will likely continue to face training shortfalls and use limited sorties on flying adversary air themselves. Furthermore, this may result in the F-22 squadrons not being fully prepared to execute the high-end air superiority missions.

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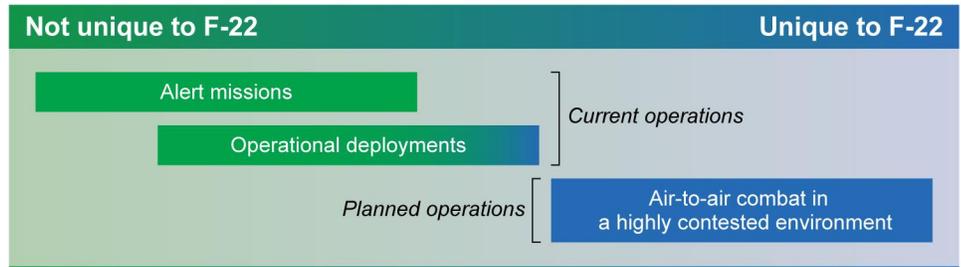
### Current Operations Reduce F-22 Pilot High-End Air Superiority Training Opportunities

The Air Force is providing F-22s in support of current combatant commander needs, including alert missions and operational deployments, but the alert mission and these operational deployments take time away from air superiority training. Although these missions are important, they take no or limited advantage of the unique capabilities provided by the F-22, as figure 6 illustrates. Classified details regarding the current and projected operational requirements for the F-22 are included in the classified version of this report.

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<sup>36</sup>The Air Force briefing identifies the Commander of Air Combat Command's priorities for providing additional adversary air support. They are as follows: (1) Nellis Air Force Base in support of combat readiness, (2) training units to support pilot production, and (3) fifth generation fighters to support combat readiness. The briefing also outlines a number of proposals for addressing adversary air shortfalls that reach out through 2030 and beyond, but notes the need for conducting further evaluations and securing funding.

**Figure 6: Relative Unique Role of the F-22 in Addressing Current and Planned Operations**



Source: GAO analysis of Air Force information. | GAO-18-190

The Air Force Provides F-22s to Combatant Commanders through Established Processes

DOD has an established risk-informed process to distribute the service’s operational forces to the combatant commanders. Air Force officials told us that combatant commanders can request a general fighter capability or a very specific capability that only an F-22 can provide. Air Force officials also said the Air Force does not set aside F-22 units for only the most advanced threat missions, and it does not set aside any other fighter units for unique missions. The Air Force provides F-22 units to the combatant commands when those units address the combatant commander’s capability requirement and are available, according to service officials.

Use of F-22s for Alert Missions Diminishes Pilots’ Ability to Train for High-End Air Superiority Missions

F-22 support for ongoing air sovereignty alert missions further reduces F-22 pilots’ abilities to train for the high-end air superiority mission. The alert mission supports homeland defense, DOD’s top priority.<sup>37</sup> This mission requires certain air bases have fully fueled, fully armed jets ready at all times to respond to threats from civil or military aviation.<sup>38</sup> Two F-22

<sup>37</sup>Department of Defense, *Quadrennial Defense Review 2014* (Washington, D.C.: Mar. 4, 2014).

<sup>38</sup>For more information on air sovereignty alert mission see GAO, *Homeland Defense: Actions Needed to Improve Management of Air Sovereignty Alert Operations to Protect U.S. Airspace*, [GAO-09-184](#) (Washington, D.C.: Jan. 27, 2009), and GAO, *Homeland Defense: Continued Actions Needed to Improve Management of Air Sovereignty Alert Operations*, [GAO-12-311](#) (Washington, D.C.: Jan. 31, 2012).

operational locations have full time alert mission responsibilities (Alaska and Hawaii) and one location (Virginia) performs alert missions on an as-needed basis. According to Air Force officials, the alert mission does not require the high-end capabilities provided by the F-22 and currently F-15C and F-16 squadrons are filling alert mission requirements in other parts of the United States. F-35s could also conduct this mission if they were assigned it, according to Air Force officials. The Air Force plans to start fielding 2 F-35 squadrons in Alaska beginning in 2020. However, there are currently no plans to use F-35s for the alert mission, according to U.S. Northern Command. With no other operational Air Force fighter squadrons currently based in Hawaii and Alaska, the alert mission falls to the F-22 units.

Dedicating F-22s to the alert mission reduces the ability of F-22 pilots to train for their primary missions. Operational squadrons in Alaska and Hawaii have F-22 pilots sitting alert in order to address the 24-hour per day alert commitment. During this time they are not able to train for their high-end air superiority missions. Further, the squadrons must dedicate a number of mission-capable aircraft to this mission, which is more challenging for squadrons with a smaller number of aircraft. Squadron officials from one location estimated that they could generate hundreds of additional training sorties on an annual basis if they could use the aircraft that are currently dedicated to the alert mission.

#### Operational Deployments Diminish F-22 Pilots' Ability to Train for High-End Air Superiority Missions

The Air Force also deploys F-22s outside of the United States to address combatant commander requirements and these deployments also reduce the time available for F-22 pilots to conduct home station training for their high-end air superiority missions. Since 2007, the Air Force has deployed F-22s to a number of combatant commands to address a variety of needs, including providing assurance to friends and allies and deterring potential adversaries. F-22s deployed to U.S. Central Command have also been supporting ongoing operations against ISIS in Iraq and Syria.

F-22 pilots can gain valuable experience from deployments but their ability to train for the high-end air superiority mission can suffer. For example, F-22 involvement in current combat operations against ISIS provides pilots with experience deploying for combat, integrating with coalition forces, and conducting air-to-ground attack operations,

according to Air Force officials. Although its high-end capabilities provide some benefits in current operations against ISIS,<sup>39</sup> F-22s have primarily been used for close air support (CAS) missions in operations against ISIS, according to Air Force officials. However, CAS is not a primary or secondary mission for the F-22. As such, F-22 pilot air superiority skills degrade while on deployment because they are conducting CAS missions and not able to train for their air superiority missions, according to Air Force officials.

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## Conclusions

The F-22's current availability and pilot training challenges will likely become more significant as fourth generation fighters become less survivable and the Air Force's reliance on its small fleet of F-22s to execute the air superiority mission grows. Limitations on F-22 availability are due in part to maintenance challenges inherent to the F-22, including maintaining its LO coating. It is also due in part to Air Force decisions to organize the F-22 fleet into small wings and squadrons, resulting in lost efficiencies that come with larger organizations. Further, F-22 squadrons, designed to operate from one location, face challenges generating available aircraft when they are split, as current Air Force practices and future concepts require. The Air Force also requires well-trained pilots in order to take full advantage of the F-22's high-end capabilities. However, F-22 pilots' ability to train for its air superiority missions and meet associated training requirements is constrained by factors including adversary air limitations and participation in exercises with limited training value. Operational use of the F-22 for missions that have no or limited need for the F-22's unique capabilities, such as the alert mission, further limit the ability of pilots to prepare for the high-end air superiority challenges the nation increasingly faces.

One option for addressing these challenges would be to purchase more F-22s. However, the Air Force's determination that it does not make economic or operational sense to restart F-22 production means that the Air Force has to find other ways to improve its F-22 fleet's ability to

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<sup>39</sup>The Combined Forces Air Component Commander for U.S. Central Command noted in a May 24, 2017, DOD press briefing that the F-22 is important for supporting ground troops and air domain awareness and deconfliction in the fight against ISIS. He noted that the F-22's capability to fuse information and understand where friendly forces are and what Syrian and Russian forces are doing is unmatched. See Department of Defense, *Department of Defense Press Briefing by General Harrigian* (May 24, 2017).

address high-end air superiority challenges. Air Force efforts to improve F-22 capabilities and maintainability and wider efforts to address high exercise demand and adversary air shortfalls are examples of positive steps the service is taking. The Air Force has also shown a prior willingness to consolidate its F-22 fleet. Further, the Air Force outlined its commitment to addressing high-end air superiority challenges in its Air Superiority 2030 Flight Plan. This effort, along with the planned fielding of a large number of F-35s provides the Air Force with the opportunity to more comprehensively review and, if necessary, transform how it should best organize, posture, train, and utilize its fifth generation assets, including the F-22. However, unless the Air Force takes steps to assess and make necessary adjustments to the current organization and use of its F-22s, F-22 units are likely to continue to experience aircraft availability and pilot training rates that are below what they could be. As a result, the Air Force may be incurring increased risks in future operations in high threat areas.

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## Recommendations for Executive Action

We are making the following two recommendations to the Air Force:

The Secretary of the Air Force should conduct a comprehensive assessment of the F-22 organizational structure that identifies and assesses alternative approaches to organizing F-22 squadrons. The assessment could at a minimum assess the following two alternatives: consolidating the fleet into larger squadrons and/or wings in order to improve aircraft availability, and revising the design of the deployable units in squadrons to better support current deployment practices and future operational concepts. (Recommendation 1)

The Secretary of the Air Force should identify and assess actions to increase F-22 pilot training opportunities for the high-end air superiority missions. This effort could consider alternatives such as: reducing exercise events that do not contribute to F-22 pilot high-end air superiority training, increasing external adversary air support so all F-22 pilots can use their available limited sorties to conduct high-end air superiority training rather than having a significant portion of the F-22 pilots providing training support, and finding alternatives to using F-22 units for alert missions, and other missions that do not require the jet's unique capabilities or prepare F-22 pilots for their primary missions. (Recommendation 2)

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## Agency Comments and Our Evaluation

We provided a draft of the classified version of the report to DOD for review and comment. That draft contained the same recommendations as this unclassified version. In written comments (reproduced in appendix II), DOD concurred with our recommendations and noted planned actions to address each recommendation. DOD also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the Senate Armed Services Committee and the House Armed Services Committee and the Secretary of Defense; the Chairman of the Joint Chiefs of Staff; and the Secretary of the Air Force, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staffs have any questions about this report, please contact me at (202) 512-3489 or [pendletonj@gao.gov](mailto:pendletonj@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.



John H. Pendleton  
Director, Defense Capabilities and Management

# Appendix I: F-22 Maintenance and Supply Challenges Limit Aircraft Availability

Maintenance demands of the F-22's unique Low Observable (LO) coating, along with supply challenges exacerbated by the fleet's small size, limit the number of aircraft available for missions. In part because of these challenges, the Air Force had an average of 80 F-22s available for operations during fiscal year 2016.

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## Maintenance of the F-22's Unique Low Observable Coating Reduces Aircraft Availability

Maintenance demands of the F-22's unique LO coating, a critical component that gives the F-22 its stealth characteristics, reduces aircraft availability. Without the LO maintenance issues, availability would have been significantly closer to meeting the annual availability standard, according to Air Force officials. Fourth generation fighters, lacking a full LO coating, do not have to contend with this maintenance issue.<sup>1</sup> The LO coating is actually a series of coatings that require diligent and time-consuming application and curing, resulting in extended periods of time during which aircraft are not available, according to Air Force officials. Further, the LO coating for each F-22 requires regular and thorough inspection to ensure that any damaged or degraded areas are identified and repaired. If damage to the LO coating exceeds a threshold, the F-22

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<sup>1</sup>According to Headquarters Air Force officials, F-22 availability generally lagged behind fourth generation fighters by 10 to 20 percent. However, aircraft comparison is complicated because each aircraft is at a different stage of its lifecycle. According to Air Force Air Combat Command officials, fourth generation fighters are currently underperforming due to an intense modification schedule, heavy maintenance requirements, and a lack of aircraft due to deployments. They reported that the Air Force has initiated efforts to improve aircraft availability for its fourth generation fighters.

is considered not capable of conducting its mission.<sup>2</sup> An Air Force report summarizing fiscal year 2016 maintenance issues reported that LO maintenance was the primary reason F-22s were not considered mission capable due to maintenance.

Maintaining the integrity of the LO coating complicates other F-22 maintenance actions because the LO coating must be removed and then restored. According to Air Force officials, removing and replacing a part on an F-22 and a fourth generation fighter, like an F-15C, could take a similar amount of time. However, the F-22 would require additional time at the beginning and end of the maintenance action to gain access to the part through the LO coating and then restore the integrity of the coating, significantly increasing the time aircraft would be unavailable due to maintenance. The Air Force is taking steps to reduce the impact of LO maintenance by, for example, creating panels that can be removed without requiring a full recoating procedure and by developing a more durable coating. Additionally, Air Force officials told us that the LO coating for its other fifth generation fighter—the F-35—uses different materials and processes and should be easier to maintain than the F-22's LO.

The F-22's LO coating is also beginning to reach the end of its service life, requiring maintenance actions that further reduce aircraft availability. According to Air Force officials, the LO coating has an 8-to-10 year life span, but environmental factors such as high temperatures, humidity, and salinity can reduce that span by 2 to 3 years. Further, the Air Force does not house its F-22s in climate-controlled hangars at 3 of the 4 operational locations (Florida, Hawaii, and Virginia), thus exposing them to these LO-degrading environmental factors. The Air Force has taken action to address maintenance challenges by using a more durable coating and standing up additional repair facilities. The Air Force also plans to use more durable materials to make long-term corrective repairs beginning in calendar year 2019, but this will constitute a costly long-term effort, according to the Air Force.

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<sup>2</sup>For further details on this process, see Air Force Instruction 21-101, *Combat Air Forces Supplement, CAF: Aircraft and Equipment Maintenance Management (F-22)—Addendum A* (Oct. 9, 2012).

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## The F-22's Small Fleet Size Exacerbates Spare Part Supply Challenges

As a result of the F-22 fleet's small size and resulting low demand for parts, the F-22 faces a number of supply challenges that have contributed to reduced and unpredictable aircraft availability. Officials from all four operational locations identified low supply levels and difficulty obtaining needed parts as a concern. Obtaining parts can be a time-consuming and costly process because some original manufacturers no longer make the parts or are completely out of business, according to Air Force officials. When this is the case, the Air Force may need to find the original aircraft and parts design plans, and obtain a new contractor to produce a small number of parts. Officials at one operational location said a simple wiring harness required a 30-week lead time. Air Force maintenance statistics for fiscal year 2016 show that 14 percent of the F-22 fleet was not mission capable, and therefore not available, due to supply issues. According to Air Force officials, the F-22 fleet's small size and resulting low demand for parts makes this problem more acute.

F-22 squadrons face an unenviable choice when necessary parts are not available, according to Air Force officials: they can make the aircraft unavailable until the spare part arrives and can be installed or they can take the part from another aircraft that may be broken for a different reason. The second option, called cannibalization, is an inefficient way to conduct maintenance because it doubles the work. A good part needs to be removed from one aircraft and put into another. Once the replacement part arrives, it needs to be installed on the cannibalized aircraft. There is also a chance that the cannibalized part could get damaged in the process or just not work. Further, cannibalization could result in additional LO repairs on the donor aircraft. An Air Force report summarizing fiscal year 2016 maintenance issues reported that F-22 cannibalization rates have grown by 6 percent between fiscal years 2012 and 2016.

The F-22's small fleet size also exacerbates supply challenges it is facing with its engines, potentially falling below minimum spare part requirements for multiple calendar years. Further, an increase in flying hours in 2014 resulted in engines requiring overhauls sooner than previously anticipated. It is taking time for the engine maintenance contractor to build up enough capacity to deal with this increased

demand.<sup>3</sup> The officials said that the F-22's small fleet size contributed to this problem because, as was the case with other parts issues, low early demand meant that many of the vendors that built parts for those engines no longer build the parts or are not in business. Additionally, it takes time to find vendors and skilled people to build those parts again. The Air Force is implementing a mitigation plan that includes increasing production, overflying the standard engine maintenance interval, and borrowing engines from aircraft in long-term maintenance. According to Air Force officials, this kind of engine issue is not unique to the F-22. They noted that there was a time when B-1s, another small fleet, had a major engine shortfall that resulted in aircraft parked without engines in them. An Air Force forecast shows that mitigation efforts will avoid that problem, barring unanticipated increases in demand or maintenance problems.

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<sup>3</sup>Pratt & Whitney is the contractor that built the F-22's engines and maintains them.

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# Appendix II: Comments from the Department of Defense

Appendix II: Comments from the Department  
of Defense



ACQUISITION

THE OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE  
3600 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3600

DEC 08 2017

Mr. John Pendleton  
Director, Defense Capabilities and Management  
U.S. Government Accountability Office  
441 G Street, N.W.  
Washington, DC 20548

Dear Mr. Pendleton:

This is the Department of Defense response to the Government Accountability Office (GAO) Draft Report, GAO-18-120C, "FORCE STRUCTURE: Changes to F-22 Organization and Utilization Could Improve Aircraft Availability and Pilot Training," dated October 18, 2017. Detailed comments on the report recommendations are enclosed.

Sincerely,

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

James A. MacStravic  
Acting Assistant Secretary of Defense  
for Acquisition

Enclosure:  
As stated

GAO DRAFT REPORT DATED October 18, 2017  
GAO-18-120C (GAO CODE 100994)

“FORCE STRUCTURE: CHANGES TO F-22 ORGANIZATION AND UTILIZATION  
COULD IMPROVE AIRCRAFT AVAILABILITY AND PILOT TRAINING”

DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS

**RECOMMENDATION 1:** The Secretary of the Air Force should conduct a comprehensive assessment of the F-22 organizational structure that identifies and assesses alternative approaches to organizing F-22 squadrons. The assessment could at a minimum assess the following two alternatives: consolidating the fleet into larger squadrons and/or wings in order to improve aircraft availability; and, revising the design of the deployable units in squadrons to better support current deployment practices and future operational concepts.

**DOD RESPONSE:** Concur. The Department agrees it is a national military priority to ensure our small fleet of F-22s are optimally postured to provide air superiority in high threat environments. The Air Force will conduct an assessment to determine if changes to F-22 home station organizational structure and/or deployment practices would better meet global combatant commander requirements.

**RECOMMENDATION 2:** The Secretary of the Air Force should identify and assess actions to increase F-22 pilot training opportunities for the high-end air superiority missions. This effort could consider alternatives such as: reducing exercise events that do not contribute to F-22 pilot high-end air superiority training; increasing external adversary air support so all F-22 pilots can use their available limited sorties to conduct high end air superiority training rather than having a significant portion of the F-22 pilots providing training support; and, finding alternatives to using F-22 units for alert missions, and other missions that do not require the jet’s unique capabilities or prepare F-22 pilots for their primary missions.

**DOD RESPONSE:** Concur. The Department agrees it is a national military priority to ensure highly trained F-22 pilots are postured to secure air superiority against near-peer competitors. To that end, the Air Force is continuously looking for opportunities to optimize its operational training, and will include this GAO recommendation in its established staff process to identify, assess, and implement such actions. Additionally, the Air Force will pursue alternatives to using F-22s for homeland alert or other missions that detract from preparation for their primary missions. Of note, there are several ongoing initiatives within the Air Force that already align with this GAO recommendation. Prominent examples include: 1) modernization of the Total Force Operational Training Infrastructure to provide more realistic Live, Virtual, and Constructive training opportunities for F-22 pilots at the lowest possible cost to tax payers, and 2) the growth of dedicated contract Adversary Air (ADAIR) to ensure F-22 pilots are spending available sorties training Blue Force tactics instead of serving as Red Force training aids. These efforts have been in the works for years with phased fielding of ADAIR forces scheduled in Fiscal Year 2019. Details on the Air Force’s ADAIR plan were provided to Congress via UNCLASSIFIED report on June 20, 2017.

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# Appendix III: GAO Contact and Staff Acknowledgments

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## GAO Contact

John H. Pendleton, (202) 512-3489 or [pendletonj@gao.gov](mailto:pendletonj@gao.gov)

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## Staff Acknowledgments

In addition to the contact name above, Michael Ferren, Assistant Director; Vincent Buquicchio; Nicolaas Cornelisse, Analyst-in-Charge; Patricia Donahue; Amie Lesser; Tamiya Lunsford; Matthew Jacobs; Travis Masters; Richard Powelson; Walter Vance; and Nicole Volchko made key contributions to this report.

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# Appendix IV: Accessible Data

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## Data Table

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Accessible Data for Figure 2: Air Force Fighter Inventory as of May 2018

Aircraft	Number of aircraft
F-22	186
F-35	131
F-15C	235
F-15E	218
F-16	937

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## Agency Comment Letter

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Accessible Text for Appendix II Comments from the Department of Defense

Page 1

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Director, Defense Capabilities and Management

U.S. Government Accountability Office

441 G Street, N.W.

Washington, DC 20548

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James A. MacStravic

Acting Assistant Secretary of Defense for Acquisition

Enclosure:

As stated

Page 2

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