

MITCHELL INSTITUTE
for Aerospace Studies



Accelerating 5th Generation Airpower

Bringing Capability and Capacity to the Merge

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A Collision Course

- 2022 National Security Strategy: “We stand now at the inflection point, where the choices we make and the priorities we pursue today will set us on a course that determines our competitive position long into the future”
 - Rapid military rise of an assertive China
 - Aggressive Russia
 - Nuclear weapons-ambitious Iran and North Korea
 - Non-state threats in the Middle East, Africa, and beyond
- The Air Force’s current fighter inventory is **geriatric** and **rapidly declining**
 - Between 1990 and 2023, AF fighter inventory dropped from 4,556 to 2,176
 - The bulk of the service’s fighter fleet consists of A-10Cs, F-15C/Ds, and F-16C/Ds designed in the 1960s and 1970s – now averaging 41, 38, and 32 years in age, respectively
 - “Newer” types, like the F-15E, average 30 years old
 - Air Force plan is to **retire 801 fighters over the FYDP, but only buy 345**

Why AF Fighters Matter

- AF fighters underpin key COCOM functions:
 - Air superiority
 - Strike for both land and maritime targets
 - Close air support
 - Deny adversary the electromagnetic spectrum
 - Intelligence, surveillance and reconnaissance (ISR)
 - JADC2 node
- Navy and Marine Corps have fighters, but...
 - They are not sized or organized to provide the volume and range of capabilities afforded by the AF
 - Their combat aircraft primarily purposed to meet service component objectives





A Vision Not Realized

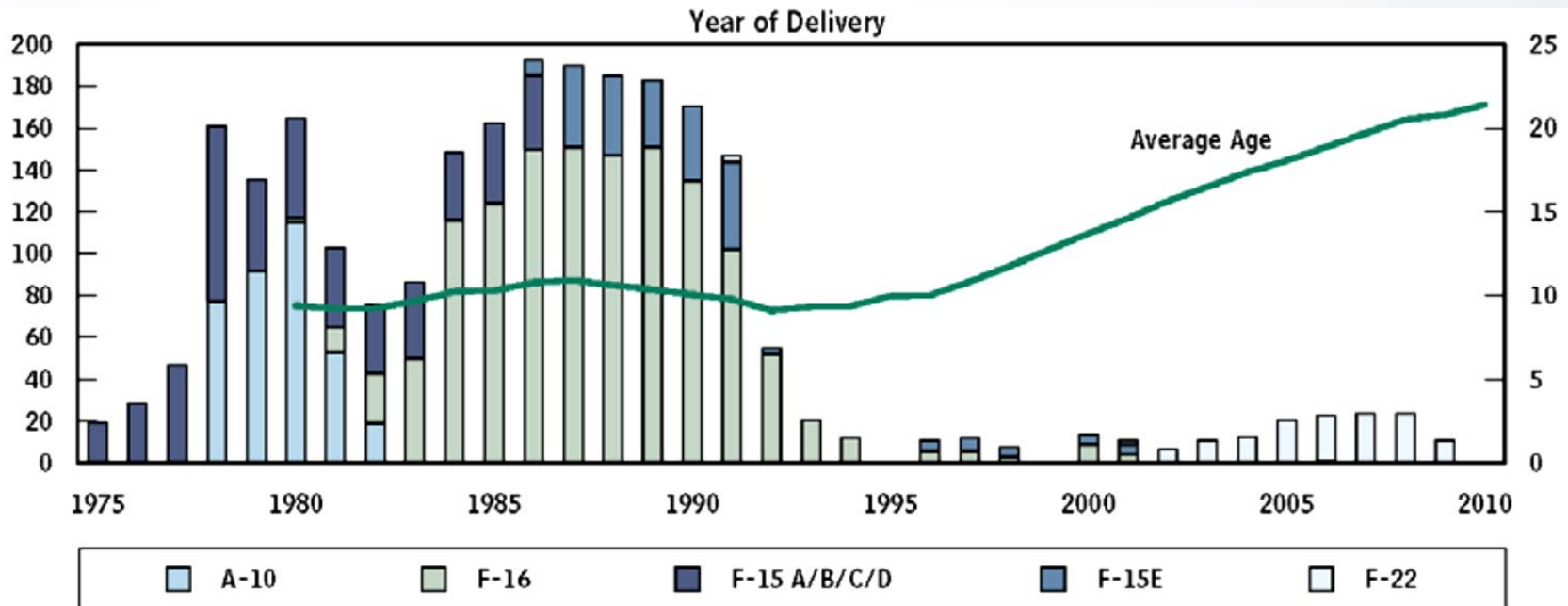
- Post-Cold War budget cuts drove the AF to reduce its fighter inventory by half
 - Between FY 92 and FY 94, AF retired seven fighter wing equivalents of 72 aircraft each
- Desert Storm revealed massive value of stealth
 - F-117s flew less than 2% of combat sorties but struck over 40% of the fixed targets
 - B-2s netted similar results during Operation Allied Force over Kosovo in 1999
- AF leaders bet on 5th gen fighters—the force could grow smaller if it was going to get better
 - The combination of stealth, sensors, processing power, connectivity, and superior flight performance
- 5th gen objectives not realized:
 - 187 F-22s procured, not 381...or 750 original req'mt
 - F-35 procurement rate well below planned levels

“Stealth technology had advanced such that the Air Force saw the benefits of fighter designs with 360-degree radar signature reduction that could nullify the entire radar-based air defense systems of adversaries. Confidence in the operational benefits of stealth, validated by the performance of the F-117s in Desert Storm, during January and February 1991, pushed the Air Force to pursue new fighters, in the form of the F-22 and F-35.”

- Gen Mike Loh, USAF (Ret.)

Procurement Holiday

- AF fighter procurement cratered in the post-Cold War era.
 - Highly concentrated buys in the 1980s of nearly 200 a/c per year carried the AF for decades
 - But...rapid acquisition followed by hard use and decisions to delay modernization created a **capacity freefall** that's accelerating

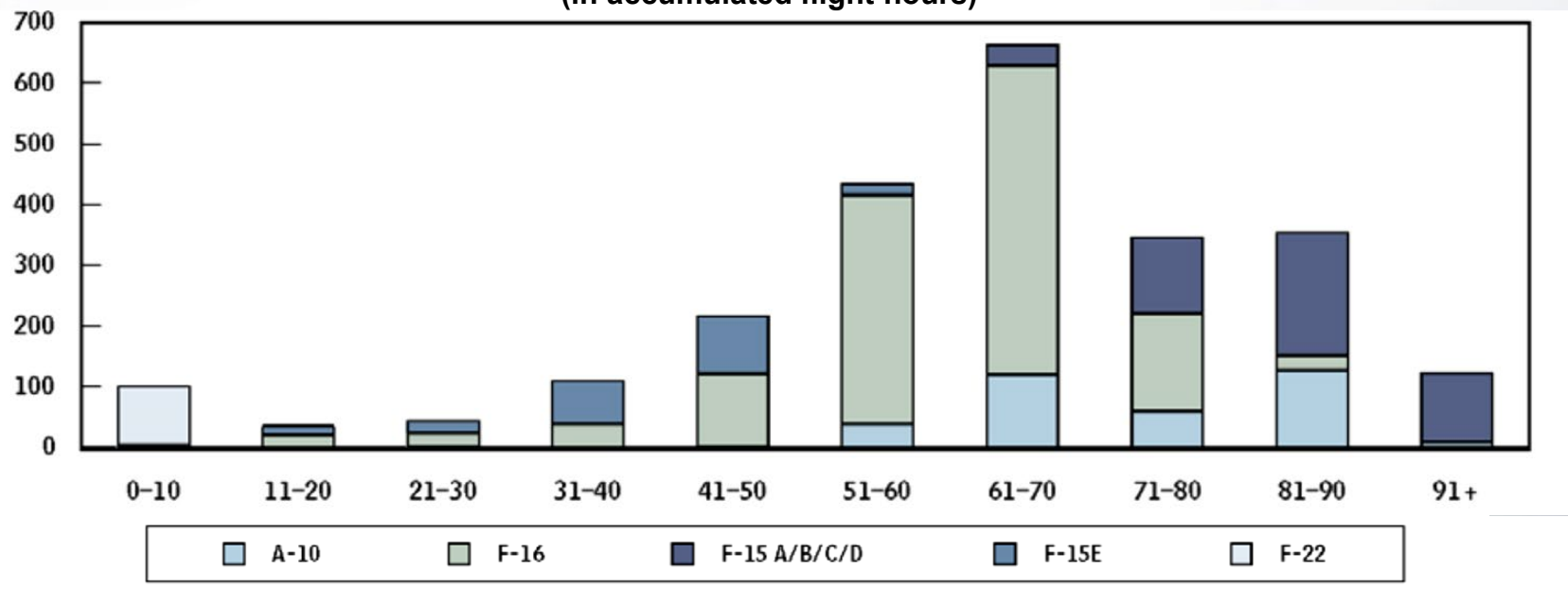


Air Force fighter buys according to the CBO

Burning Up Legacy Fighters

- The Reagan-era inventory wore out due to non-stop combat deployments.
 - Inventory reductions, like CAF REDUX, only exacerbated the problem—fewer aircraft shouldered higher demand.

Percentage of Service Life Expended as of 2008
(in accumulated flight hours)

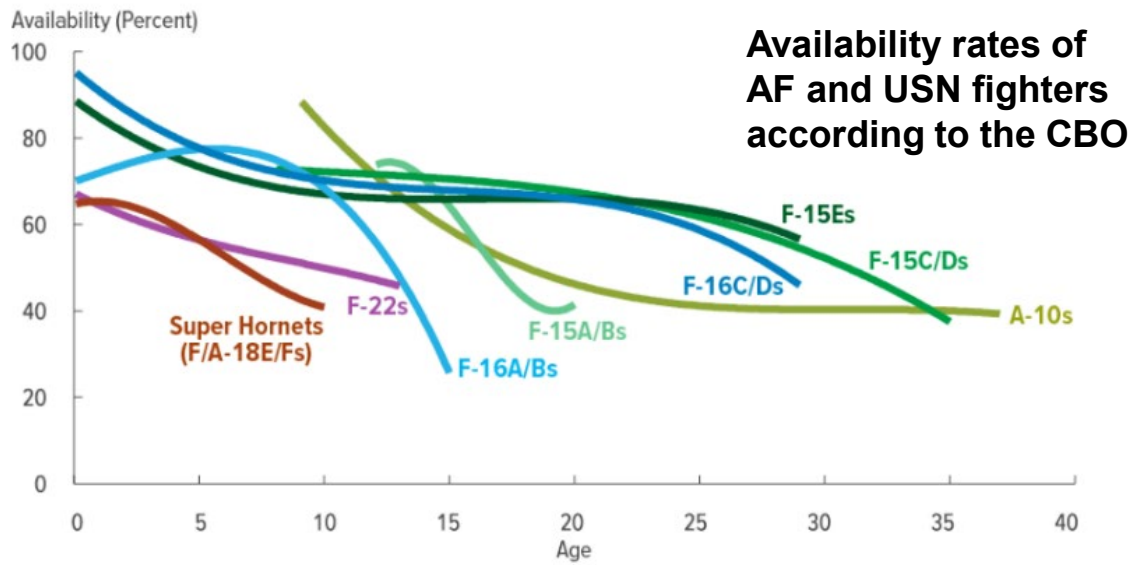


Air Force fighters rapidly burned through available lifespan according to the CBO

High Demand, Low Density Takes a Toll

Burning Up Legacy Fighters

- As *fighters age*, their *availability drops* and their *relevancy declines*...a major factor impacting COCOM options
- Sustaining old aircraft is also displacing the ability to buy new ones:
 - 80 percent of the AF inventory is *flying beyond design service life*



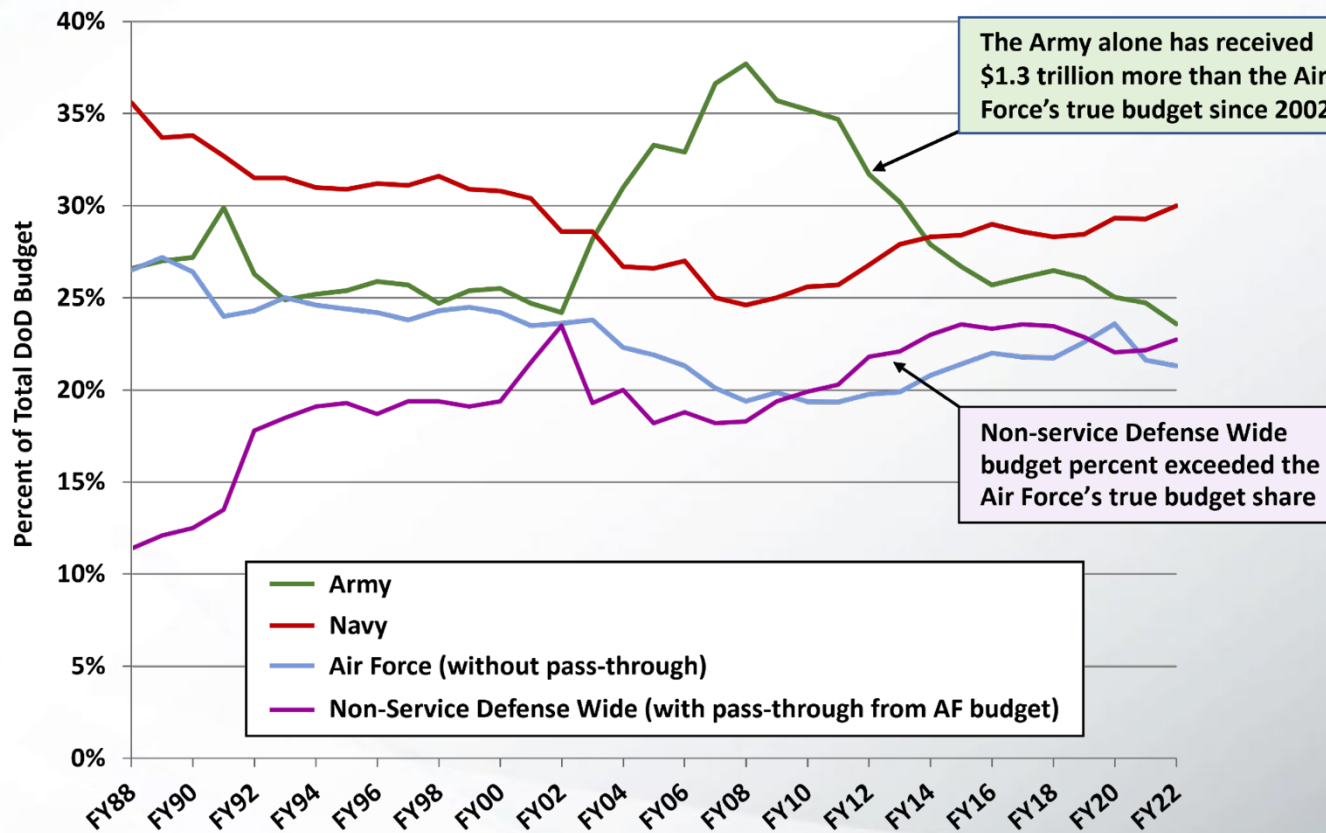
In FY22, AF spent:

\$22.87 billion on procurement—**only \$5.96 billion for new aircraft**

\$63.22 billion on O&M—
\$12.30 billion on weapons systems sustainment

Resource Shortfall

- The Air Force fighter modernization challenge ultimately comes down to resources...or a lack thereof
- USAF has been funded less than the Army and Navy 31 years in a row



The AF's Portion the Defense Budget has Lagged Other Services for Decades

No Bucks, No Buck Rogers

- AF capacity has dropped across three decades, despite increasing demand
 - 4th gen vs. 5th gen ratio remains too low given threat-based demand
 - 1,900 fighter pilot shortfall further impedes force generation

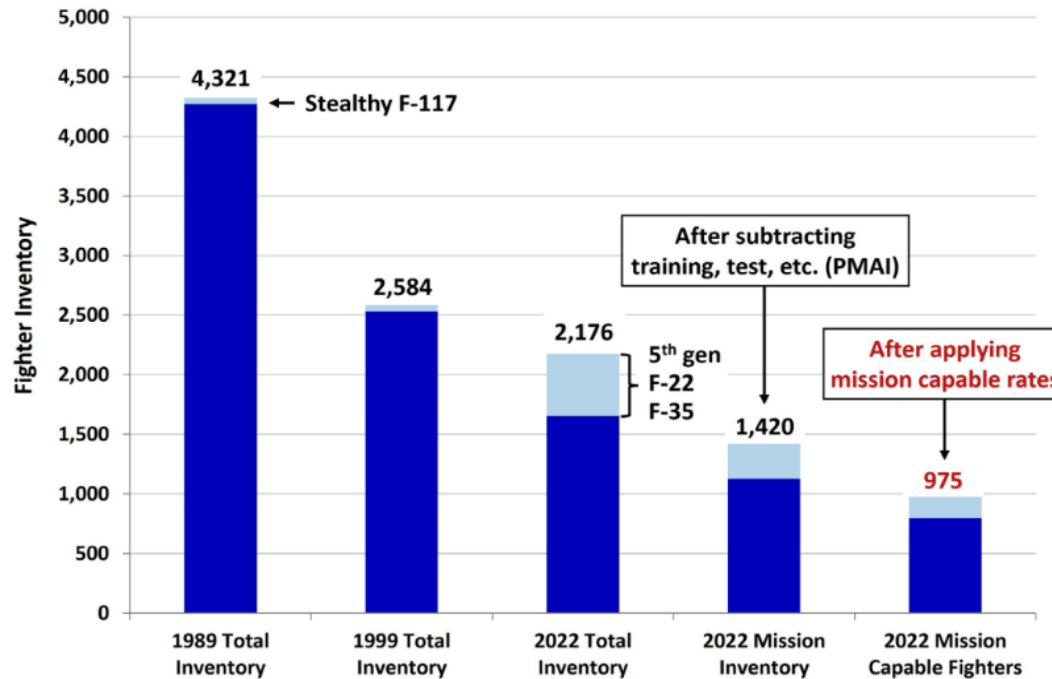


Figure 2: Decline of the Air Force's Fighter Inventory

Credit: Mitchell Institute. Inventory data provided by the U.S. Air Force and mission capable rates from a [U.S. Air Force database](#) current as of October 19, 2021. Lockheed Martin provided the mission capable rate for F-35As. Also see John A. Tirpak, "Fighter Mission Capable Rates Fell in 2021," *Air Force Magazine*, November 22, 2021.

"The stark reality is the United States Air Force is too small to do all that the nation expects of it."

-Hon Heather Wilson, 2017



All In On F-35?

- When F-22 cancelled in 2009, DOD doubled-down on F-35
 - SECDEF Gates planned on the AF procuring 80 F-35s per year
 - Target buy of 1,763 F-35As effectively replaces the majority of the Air Force's 4th generation fighter aircraft inventory
- The promised aircraft have yet to materialize
 - AF only had 272 F-35As by 2020, not 750 planned
 - No more than 60 F-35As per year procured: FY 2023 was 44, and FY 2024 request is 48

“You can’t skip three decades worth of Air Force modernization and then try and compress everything into a few years. It doesn’t work. That said, here we are and so we must do our best.”

-Gen T. Michael Moseley, USAF (Ret)



4+1 AF Fighter Plan

- In 2020, Air Force recognized it needed a new fighter modernization plan
 - NGAD/F-22 for most stressing air superiority
 - F-35 for 5th gen mass against peer threats
 - F-15E/EX for homeland defense, high payload, etc.
 - F-16 for affordable mass against lower end threats and homeland security
 - A-10 sunset by end of decade
- Air Force insistent F-35s procured must be TR-3/Block 4 capable
- Seeking to sustain 60 fighter squadrons (up from 48 today)
- CCA would be developed for additive mass

“Extensive analysis unambiguously shows that the current fighter fleet will not succeed. We must change now to provide the capability, capacity, and affordability required to meet the peer threat.”

-Gen Mark Kelly, Commander, Air Combat Command

It's Time To Realize This Plan, Fast

What is TR-3?

- Technology Refresh-3 (TR-3) is the hardware portion of the modernization
 - A new integrated core processor (ICP) that is **25 times more powerful** than its predecessor and provides
 - A significant memory boost
- Experienced development delays, but now is installed on aircraft coming off the production line





What is Block 4?

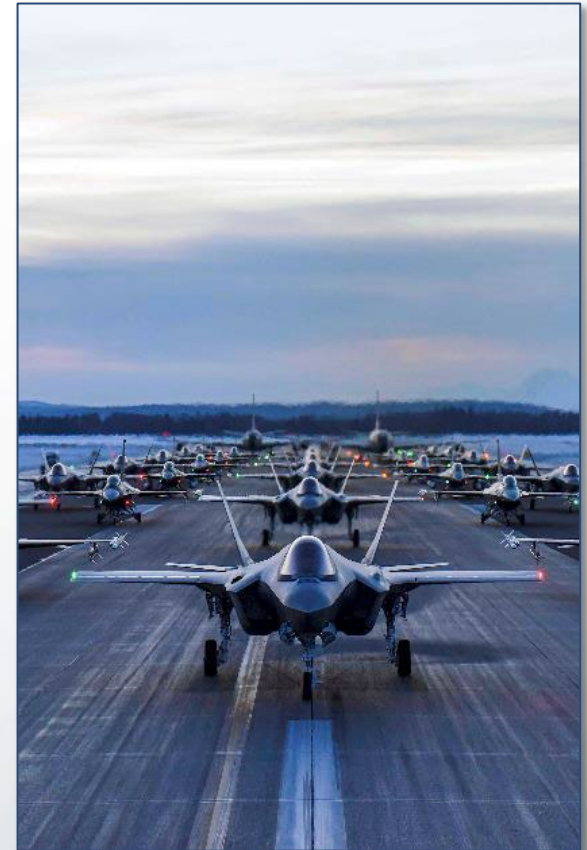
- Block 4 upgrades are generally focused on new software, with a limited number of hardware additions
 - F-35 relies on software for 90 percent of its avionics requirements
 - There is no goal line for all these deliverables, but instead a ***rolling set of capability insertions*** that will happen over the next few years
 - Provides the F-35 fleet with a common configuration among all three variants

*“The Block 4 capabilities are what we really need for the pacing challenge—
for China and their advanced systems. So, we need to get that done”*

-Hon Frank Kendall, Secretary of the Air Force

TR-3/Block 4 Deliverables

- **Advanced Radar**
- **Improved Passive Sensing**
- **Improved Target Tracking**
- **Improved Panoramic Cockpit Display**
- **Expanded Weapon Carriage**
- **Improved Processing Power**



Between TR-3 & Block 4, There Are Approximately 75 Specific Upgrades



TR-3/ Block 4 Deliverables

- **Improved Passive Sensing.** Extensive hardware upgrade to passively collect threat radar emissions and cooperatively correlate their identities, locations, and threat range capabilities that are then graphically displayed in real time to the pilot.
 - Passive sensing does not reveal the aircraft's location like an active sensor.
 - Sensitivity of new receivers will dramatically improve the functionality of the aircraft's mission system computer and empower it to build a more accurate, timely battlespace picture.
 - Upgrades also include six distributed aperture system (DAS) infrared external perimeter cameras to help visually acquire surface or airborne targets or provide inbound threat warning.
 - Bottom line: all of this builds a more accurate, timely picture of the battlespace for the pilot.



TR-3/ Block 4 Deliverables

- **Advanced Radar.** Block 4 includes a new active electronically scanned array (AESA) fire control radar called the AN/APG-85 that multiplies the capabilities of the legacy AN/APG-81 it will replace by a factor of two.
 - Achieve a first shot targeting solution sooner and further out.
 - Enhanced synthetic aperture radar for ground mapping operations.
 - Increase the F-35's utility for standoff electronic attack.
 - Better targeting of surface or airborne radars at further ranges.
 - Significantly more effective supporting strike packages and improving the strikes against high-value surface-to-air (SAM) missile sites.

"Most of what we need the F-35 to do rests on the Block 4 electronic warfare capabilities."

-Gen Mark Kelly, Commander Air Combat Command

Between TR-3 & Block 4, There Are Approximately 75 Specific Upgrades



TR-3/ Block 4 Deliverables

- **Improved Target Tracking.** Target identification and tracking is a critical element for many tactical operations, like searching for mobile targets, identifying friend from foe in the air or on the ground, and even surveilling key enemy combatants for high-value targeting missions.
 - Block 4 provides a significantly upgraded replacement for the F-35's combined infrared imager and laser designator called the electro-optical targeting system (EOTS).
 - Used for automatic or manual tracking of designated surface or air targets, improvements include new super higher-definition day-or-night video, increased optical zoom magnification, and improved stability/reliability features that are displayed on the pilot's panoramic cockpit display.
 - The system can also provide fast and accurate real-time targeting data and 4K video for friendly forces on the ground.
 - Laser designator can precisely guide munitions from any aircraft in the strike package.
 - Can also detect threats relevant to ground forces and share very high-fidelity video to support ground maneuver.



TR-3/ Block 4 Deliverables

- **Improved Panoramic Cockpit Display.** F-35 pilot is presented with more real-time information than any other pilot of any other aircraft ever in the history of combat aviation.
 - How the information is presented makes the difference between decision advantage, versus drowning the pilot in too much data.
 - A new higher-fidelity touch-sensitive screen allows the pilot to better maneuver through compartments of information and configure presentation based on needs and preferences.
 - These features enable the pilot to more easily interpret critical movements in high-density environments, leading to increased situational airspace awareness during day or night operations.
 - Additional improvements include a more capable mission recording capability that captures PCD and systems video for post-mission pilot, maintenance, and intelligence debriefs.



TR-3/ Block 4 Deliverables

- **Expanded Weapon Compatibility.** Block 4 allows the aircraft to carry a more diverse load of weapons inside the F-35's two carriage bays—upwards of 16 new types.
 - Gaining internal carriage capacity preserves stealth and adds more firepower.
 - Adds dual-rail missile racks for each of the weapon bays. This permits the carriage of one additional missile similar in size to an AIM-120 AMRAAM in each bay.
 - Also allows for internal carriage of the AIM-9X Block II by allowing the aircraft's sensors to feed data to the missile while it is still in the bay.
 - New integration will enable the employment of the GBU-53/B Small Diameter Bomb Block II (SDB II) Stormbreaker— a network-enabled glide bomb capable for all-weather environments with options for guidance via laser, GPS coordinates, or millimeter wave target discrimination radar.
 - Block 4 also enables the use of the AGM-154C-1 Joint Standoff Weapon (JSOW). Its precision guidance can be directed through GPS coordinates and imaging from its infrared seeker head.
 - Integration of the B-61 Mod 12 nuclear gravity bomb—making the F-35 a dual-capable aircraft for both conventional and nuclear strike rolls.



TR-3/ Block 4 Deliverables

- **Improved Processing Power.** The key to unlocking the F-35's capability enhancements comes down to improved processing power. The integrated core processor delivers 25 times more computational speed and memory.
 - Enhanced mission data file (MDF) is the primary database the aircraft uses to make sense of the battlespace. AI and rapid fusion allows the F-35 to harness real-time sensor data and cross reference it with known enemy system attributes
 - Upon landing, the aircraft's MDF can be retrieved for review to check the health of the jet, conduct pilot debrief, and assess signals exploitation for future use.
 - Mission System's Communication, Navigation, Identification Processor (CNIP) increases processing capabilities to support concurrent multi-netting operations. That comes down to the F-35 being able to talk seamlessly to a broader range of actors. This specifically addresses challenges involved with real-time 5th to 4th generation aircraft data sharing.

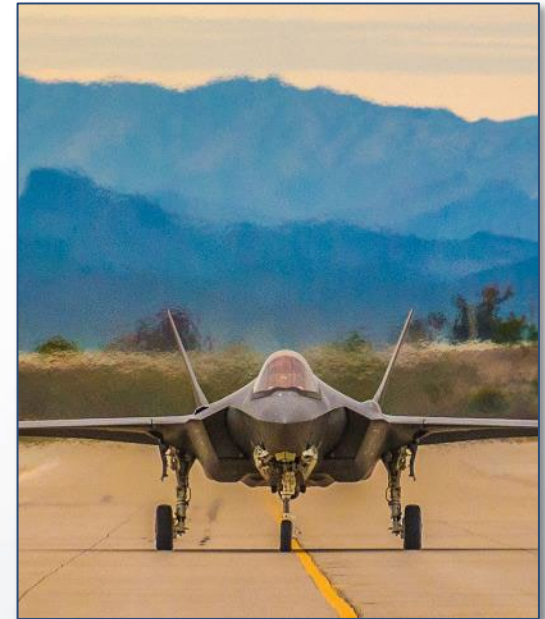
Recommendations 1/2

- 1. Buy More Fighters***
- 2. Ensure TR-3 and Block 4 Efforts Remain on Schedule***
- 3. Develop and Implement a Force Sizing Construct***
- 4. Harness Cost-Per Effect Assessment to Build the Future Fighter Force***
- 5. Ensure Testing and Evaluation Does Not Impede Necessary Results***



Recommendations 2/2

6. *Monitor and Steward Aerospace Industrial Base Health*
7. *Abandon the “Divest to Invest” Mindset: Additive Investment is Required*
8. *Steward Human Capital as Part of the Fighter Equation*
9. *Respect and Empower the Total Force*
10. *Scale production to include increased Allied buys—aircraft and weapons*





Recommendations

- ***Harness Cost-Per Effect Assessment to Build the Future Fighter Force.*** The best way to develop the most effective, efficient military capabilities demands using “cost-per-effect” analysis to evaluate what it costs to execute various missions using the mix of systems required. Currently, systems are evaluated and bought on a cost-per-unit basis absent operational context.
- ***Ensure Testing and Evaluation Does Not Impede Necessary Results.*** While it is imperative that aircraft function reliably and meet necessary performance targets, it is also true that “perfect” is the enemy of “good enough” when it comes to setting the threshold for testing requirements. The Air Force should also consider ways to add more test and evaluation capacity through boosting the number of assigned aircraft, technicians, and harnessing live, virtual, and constructive solutions where appropriate.



Recommendations

- ***Monitor and Steward Aerospace Industrial Base Health.*** The aerospace defense industrial base is currently struggling to meet peacetime objectives. Meeting wartime demand surges would prove impossible unless elasticity can be cultivated within the enterprise.
- ***Abandon the “Divest to Invest” Mindset: Additive Investment is Required.*** The nation has asked the Air Force to do too much with too little for too long. Additive funding is required in the Air Force budget to meet demand and make up for decades of inadequate Air Force combat aircraft buys that have failed to recapitalize its inventory.
- ***Steward Human Capital as Part of the Fighter Equation.*** The F-35 will only deliver optimal results if properly crewed. The Air Force currently faces a fighter pilot shortfall of 1,900 individuals. Similar shortfalls exist within the maintenance community.



Recommendations

- ***Respect and Empower the Total Force.*** The Air Force is presently sized such that there is no operational reserve—a role is traditionally filled by the Air National Guard and Air Force Reserve. The entire Total Force is required to meet everyday strategy demands. Air Force modernization must be resourced to meet the demands of the Total Force, for the Total Force is what is required to meet the National Defense Strategy.
- ***Factor-in the Allied Component.*** It is time, from an industrial policy perspective, to assess whether the Department of Defense and Congress should invest in additive production capacity. This is particularly relevant for the F-35, with the line presently scaled for the annual production of 156 aircraft. With many countries operating, purchasing, or planning to purchase the aircraft in the coming years, it may be time to grow that cap.

Bottom Line

Failing these steps, the fighter force *will collapse*

- Look what happened at Kadena AFB in the fall of 2022: fighters in the heart of the threat environment retired without direct backfill
- The threat cannot be ignored—adversaries have spoken
- ***F-35 is a key solution: 5th gen capability and mass capacity***

US Air Force begins withdrawal of F-15 fighters from Japan

NEWS AVIATION By Colton Jones | Dec 1, 2022
Modified date: Dec 1, 2022



*"If it's always about 'program next,'
you'll never have a program at all."
General John Corley, USAF (Ret.)*



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