

Table 9. Comparison of Current AIM-120 Loadout with Enhanced Legacy Fighters

Type	Maximum # of AIM-120s	FTRs in Inventory	# OF AIM-120	notes
F-15C/E	8	468	3,744	2x External tanks
F-16C	4	1,017	4,068	2x External tanks
F-22	8	183	1,830	+ 2 AIM-9 ea, external carry, 2x External tanks
F-15SA	12*	120	1440	+ 4 additional AIM-9, *may allow 4 additional AIM-120 each, 2 x external tanks
F-16E	4	200	800	2x external tanks

Adapted from: Congressional Budget Office, *Alternatives for Modernizing U.S. Fighter Forces* (Washington DC: Government Printing Office, 2009), 46 and United States Air Force. *USAF Fact Sheets*. 2015

While the F-16E’s range improves to nearly match that of the F-15SA, the carriage capacity remains to fall short. Despite fewer numbers, F-15SAs produce an 80% increase in AIM-120s over the F-16E in an air to air configuration, and a 17% increase in the year 2035 total capacity when the 5th generation fighters employ internal carriage. Moreover, the range of the of the F-15SA’s APG-63 exceeds that of the F-16E, providing enhanced SA.⁸⁶

This difference becomes more profound in an air to ground role:

Table 10. Comparison of Enhanced Legacy Fighter Air to Ground Capacity

A/G LOADOUTS										
FTR type	FTRS avail	2k lb load out	# OF 2k lb	500 lb load out	# of 500 lb	SDB load out	# of SDB	AIM-120 load out	# of AIM-120s	Combat Radius (estimated)
F-15SA	120	5	600	13	1560	28	3360	8	960	1000
F-16E/F	200	2	400	6	1200	12	2400	2	400	700

Adapted from: Congressional Budget Office, *Alternatives for Modernizing U.S. Fighter Forces* (Washington DC: Government Printing Office, 2009)

As shown in Table 10, the F-15SA more than doubles the carriage capacity of the F-16E in every category. Despite the fewer numbers of aircraft, the F-15SA has the potential to improve the total fleet capacity for 500 lb weapons by 40% when compared to 5th generation fighters with internal carry. More importantly, it provides significantly more capacity for 2000 lb weapons beyond 600nm. For an Air Force that demands capacity over quantity, the F-15SA is the more capable choice. Finally, with Lockheed Martin fully committed to the production of F-35s, the company’s ability to produce F-16Es is likely limited.⁸⁷

Recommendations

In accordance with the CBO's Alternative 2, the USAF should purchase a platform such as the F-15SA in order to fill the fighter gap. Approximately 200 aircraft would minimize overall investment while providing significant impact in fighter weapons capacity, and should be considered a minimum procurement goal. While procurement in higher numbers, such as the 435 proposed by the CBO, will yield a larger increase in force capacity, it will certainly result in fewer F-35 purchases based on budget limitations. The deferment or reduction of F-35 procurement will, at some point, have a diminishing return in cost savings. The F-35 provides significant war fighting capability, and reductions should only occur as financial restraints demand. The exact number of F-35 and enhanced legacy fighters purchased will be determined by the actual costs of enhanced legacy fighter production once a contract has been negotiated, and is likely to change as production of each continues.

Though the F-16E may be the most affordable enhanced legacy fighter by strict dollar value, the limitations inherent in its design offer a marginal return on that investment. More specific estimates of the actual procurement and sustainment costs of the F-15SA are required, and study should also be done to examine alternative platforms that may provide similar capability enhancement at a lower cost. One potential aircraft is the USN's F/A-18E/F. This may reduce initial investment, as the aircraft is already in use by the USN, but would not mitigate the risk of maintenance or tactical vulnerabilities as a distinct airframe would.

Further investment and study is required to enhance the capabilities of our BVR missiles. Limited kinematics and reduced Pk in EA environments limits effectiveness. Gilbert recommended developing missiles that match AIM-120 kinematics in a smaller missile bodies in order to maximize internal carriage.⁸⁸ Perhaps an easier technological feat is to provide better

kinematics in a larger body. This may allow employment from external carriage utilizing standoff ranges beyond threat engagement envelopes. Such a development would increase the effectiveness of both enhanced legacy fighters and LO platforms.

Conclusion

Given the potential value added to the USAF by an enhanced legacy fighter, the CBO's Alternative 2 would be the most suitable choice for closing the fighter gap. 5th generation fighters exhibit capabilities that are revolutionary and have the advantage in survivability and situational awareness due to their sensors. Enhanced legacy fighters such as the F-15SA have an advantage in range, persistence, weapons carriage, and cost. The potential for near-peer adversaries and maintenance or tactical vulnerabilities illustrate the need for both 5th generation and enhanced legacy fighters. When integrated with 5th generation platforms, enhanced legacy fighters are the best "capabilities bridge" between the aging legacy fighters and the future replacements to the F-22 and F-35. While the nature of air warfare is unclear beyond 2035, it is clear the fighter aircraft will continue to dominate the sky for the next 20 years.

Notes

¹ Congressional Budget Office, *Alternatives for Modernizing U.S. Fighter Forces* (Washington DC: Government Printing Office, 2009), VIII

² Congressional Budget Office, *Alternatives for Modernizing*, xv

³ Mark V. Arena et al., *Why Has the Cost of Fixed-Wing Aircraft Risen?* (Santa Monica CA: Rand Corporation, 2008) 72

⁴ Congressional Budget Office, *Balance and Affordability of the Fighter and Attack Aircraft Fleets of the Department of Defense*. (Washington DC: Government Printing Office, 1992) 11

⁵ Congressional Budget Office, *Options For Fighter and Attack Aircraft: Costs and Capabilities* (Washington DC: Government Printing Office, 1993), 14

⁶ Congressional Budget Office, *Balance and Affordability*, 6

⁷ Jeremiah Gertler, *Air Force F-22 Fighter Program*, (Washington DC: Congressional Research Service, 2013) 4

⁸ Congressional Budget Office, *Balance and Affordability*, 6

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- ⁹Jeremiah Gertler, *Air Force F-22 Fighter*, 2
- ¹⁰ Congressional Budget Office. *Balance and Affordability*, 4
- ¹¹ Ibid., 6
- ¹² Ibid., 6
- ¹³ Jeremiah Gertler *Air Force F-35 Joint Strike Fighter (JSF) Program*. (Washington DC: Congressional Research Service, 2014) 1
- ¹⁴ Government Office of Accountability. *F-35 Joint Strike Fighter; Assessment Needed to Address Affordability Challenges*. (Washington DC: Government Printing Office, 2015) 3,5
- ¹⁵ Congressional Budget Office, *Alternatives for Modernizing*, 7
- ¹⁶ Government Office of Accountability. *F-35 Joint Strike Fighter*, 3,5
- ¹⁷ Department of Defense. *Annual Aviation Inventory and Funding Plan, Fiscal Years (FY) 2014-2043*. (Washington DC: Government Printing Office, 2013) 9
- ¹⁸ Congressional Budget Office, *Alternatives for Modernizing*, XII
- ¹⁹ Ibid., XVIII
- ²⁰ United States Scientific Advisory Board, *Sustaining Air Force Aging Aircraft into the 21st Century* (Washington DC) 137
- ²¹ "Lockheed Martin F-22 and F-35: The 5th Generation Revolution in Military Aviation ." *PR Newswire*. February 21, 2006. <http://www.prnewswire.com/news-releases/lockheed-martin-f-22-and-f-35-the-5th-generation-revolution-in-military-aviation-55382552.html> (accessed October 4, 2015)
- ²² ibid
- ²³ Ian A. Maddock, "DARPA' Stealth Revolution, Now You See Them..." *DARPA, 50 Years of Bridging the Gap*, (2008)154 <http://www.darpa.mil/attachments/%282024%29%20Global%20Nav%20-%20About%20Us%20-%20History%20-%20Resources%20-%2050th%20-%20Stealth%20%28Approved%29.pdf>
- ²⁴ John Stillion "Trends in Air-To-Air Combat; Implications for Future Air Superiority" (Center for Strategic and Budgetary Assessments, (2015) 35
- ²⁵ Travis Tritten, "Report: F-35 Inferior to Older US, Foreign Fighters" *Stars and Stripes*, (2015) <http://www.stripes.com/report-f-35-inferior-to-older-us-foreign-fighters-1.362441>
- ²⁶ John Stillion "Trends in Air-To-Air Combat", 31
- ²⁷ Ibid, 31
- ²⁸ "AN/APG Active Electronically Scanned Array AESA" <http://www.globalsecurity.org/military/systems/aircraft/systems/an-apg-aesa.htm>
- ²⁹ Congressional Budget Office, *Alternatives for Modernizing*, 19: While the CBO attributes Synthetic Aperture Radar (SAR) mapping capability to AESA radars and 5th gen aircraft in their air to ground capabilities analysis, mechanically scanned radars also possess SAR mapping capability. This feature is employed by 4th generation fighters with air to ground capabilities.
- ³⁰ Northrop Grumman Capabilities, <http://www.northropgrumman.com/Capabilities>
- ³¹ Department of Defense. *Annual Aviation Inventory and Funding Plan*, 11
- ³² As quoted by Robbin F. Laird and Edward T. Timperlake, "The F-35 and the Future of Power Projection" *Joint Forces Quarterly*, issue 66, 3rd quarter (NDU Press2012) 87
- ³³ Ibid, pg 88
- ³⁴ Ibid, pg 88
- ³⁵ Brian M Flachsbar, *A Robust Methodology to Evaluate Aircraft Survivability Enhancement Due to Combined Signature Reduction and Onboard Electronic Attack*. Post Graduate Thesis, (Monterey CA, Naval Post Graduate School, 1997), 15
- ³⁶ Ibid., 3
- ³⁷ Serdar Cadirci, *RF Stealth (or Low Observable) and Counter-RF Stealth Technologies: Implications of Counter-RF Stealth Solutions for Turkish Air Force*. Post Graduate Thesis, (Monterey CA, Naval Post Graduate School, 2009), 93
- ³⁸ *Electronic Warfare Fundamentals Handbook*, (Electronic Warfare School Courseware, Nov 2000), 9-6
- ³⁹ Ibid, pg 12-4
- ⁴⁰ Ibid, pg 9-1
- ⁴¹ These numbers are notional due to unclassified approximation of radar and fighter parameters.
- ⁴² Brian M Flachsbar, *A Robust Methodology to*, 35
- ⁴³ Brian M Flachsbar, *A Robust Methodology to*, 24

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- ⁴⁴ Ibid., 12
- ⁴⁵ Ibid., 12
- ⁴⁶ *Electronic Warfare Fundamentals Handbook*, 11-2
- ⁴⁷ Robbin F. Laird and Edward T. Timperlake, "The F-35 and the Future of Power Projection" *Joint Forces Quarterly*, issue 66, 3rd quarter (NDU Press 2012), 88
- ⁴⁸ *USAF Electronic Warfare Fundamentals*, 11-1
- ⁴⁹ Congressional Budget Office, *Alternatives for Modernizing*, 22
- ⁵⁰ John Stillion "Trends in Air-To-Air Combat", ii
- ⁵¹ Congressional Budget Office, *Alternatives for Modernizing*, adjusted
- ⁵² *USAF Fact Sheets*.
- ⁵³ Congressional Budget Office, *Alternatives for Modernizing*, 17
- ⁵⁴ Federation of American Scientists "Joint Direct Attack Munition (JDAM); GBU-29, GBU-30, GBU-31, GBU-32" <http://fas.org/man/dod-101/sys/smart/jdam.htm>
- ⁵⁵ Government Accountability Office. *F-35 Joint Strike Fighter; Current Outlook Is Improved, but Long-Term Affordability is a Major Concern*. (Washington DC: Government Printing Office, 2013.) 26
- ⁵⁶ United States Air Force Scientific Advisory Board, *Report on Sustaining*, 35
- ⁵⁷ Ronald E. Gilbert, *Strategic Implications of US Fighter Force Reductions: Air to Air Combat Modeling Using Lanchester Equations*. Graduate Research Paper, (Wright Patterson AFB: Air Force Institute of Technology, 2011), 45
- ⁵⁸ John P. Geiss, et al. *Blue Horizons II; Future Capabilities and Technologies for the Air Force in 2030*. Occasional Paper No 65 (Maxwell AFB: Center for Strategy and Technology, Air War College, 2009), 5-6
- ⁵⁹ Ibid, pg 8
- ⁶⁰ Ronald E. Gilbert, *Strategic Implications of US Fighter*, 50
- ⁶¹ Ibid., 51
- ⁶² Ibid., 29
- ⁶³ Ibid, 47
- ⁶⁴ John Stillion "Trends in Air-To-Air Combat", 42
- ⁶⁵ Maj. David L Peeler, *Counterinsurgency Aircraft Procurement Options; Processes, Methods, Alternatives, and Estimates*. Air Command and Staff College Wright Flyer Paper No 40 (Maxwell AFB AL: Air University, 2009) 2
- ⁶⁶ Raymond A Pyles, . *Aging Aircraft; USAF Workload and Materiel Consumption Life Cycle Patterns*. (Santa Monica CA: RAND Corporation, 2003) 188
- ⁶⁷ Jeremiah Gertler, *Air Force F-22 Fighter 2* (summary)
- ⁶⁸ Raymond A Pyles, . *Aging Aircraft; USAF Workload*, 188
- ⁶⁹ Mark A. Lorell, et al., *Do Joint Programs Save Money?* (Santa Monica Ca: RAND Corporation, 2013) 36
- ⁷⁰ Ibid, pg 37
- ⁷¹ John Stillion "Trends in Air-To-Air Combat", ii
- ⁷² Congressional Budget Office. *Balance and Affordability*, 6: The Multi Role Fighter program was considered unaffordable beyond \$25-35M per aircraft; current costs average \$63.9M in 1992 dollars.
- ⁷³ Government Accountability Office. *F-35 Joint Strike Fighter; Current Outlook Is Improved*, 2013, pg 23
- ⁷⁴ Department of Defense. *Annual Aviation Inventory and Funding*, 8
- ⁷⁵ Ibid., 30
- ⁷⁶ Congressional Budget Office, *Alternatives for Modernizing*, 30
- ⁷⁷ Ibid., 31
- ⁷⁸ Ibid., 30
- ⁷⁹ "Top Falcons: The UAE's F-16 Block 60/61 Fighters" *Defense Industry Daily* 2014 <http://www.defenseindustrydaily.com/the-uaes-f-16-block-60-desert-falcon-fleet-04538/>
- ⁸⁰ *All the World's Aircraft; 2014-2015* (United Kingdom, Jane's Information Group, 2015)
- ⁸¹ Government Accountability Office. *F-35 Joint Strike Fighter; Current Outlook Is Improved*, 26
- ⁸² Congressional Budget Office. *Balance and Affordability*, 25
- ⁸³ Ibid, pg 46
- ⁸⁴ William Stanley and Gary Liberson. *Measuring Effects of Payload and Radius Differences of Fighter Aircraft*. (Santa Monica CA: Rand Corporation, 1993), 53
- ⁸⁵ Ibid, pg 54

⁸⁶ *All the World's Aircraft*

⁸⁷ Jeremiah Gertler *Air Force F-35*, 21

⁸⁸ Ronald E. Gilbert, *Strategic Implications of US Fighter*, 67

Bibliography

All the World's Aircraft; 2014-2015 United Kingdom: Jane's Information Group, 2015

Arena, Mark v., Younossi, Obaid, Brancato, Kevin, Blickstein, Irv, Grammich, Clifford A. *Why Has the Cost of Fixed-Wing Aircraft Risen*. Report to the USAF; Santa Monica CA: RAND Corporation, 2008

Arthur, David, and Kevin Eveker. *Alternatives for Modernizing U.S. Fighter Forces*. Congressional Budget Office Report, Washington DC: Government Printing Office, May 2009

Cadirci, Serdar. *RF Stealth (or Low Observable) and Counter-RF Stealth Technologies: Implications of Counter-RF Stealth Solutions for Turkish Air Force*. Post Graduate Thesis, Monterey CA: Naval Post Graduate School, March 2009

Department of Defense. *Annual Aviation Inventory and Funding Plan, Fiscal Years (FY) 2014-2043*. Report to Congress, Washington DC: May 2013

"Electronic Warfare Fundamentals" Nellis AFB: USAFD Electronic Warfare Curriculum, Nov 2000

Flachsbart, Brian M. *A Robust Methodology to Evaluate Aircraft Survivability Enhancement Due to Combined Signature Reduction and Onboard Electronic Attack*. Post Graduate Thesis, Monterey CA: Naval Post Graduate School, June 1997

Federation of American Scientists "Joint Direct Attack Munition (JDAM); GBU-29, GBU-30, GBU-31, GBU-32" <http://fas.org/man/dod-101/sys/smart/jdam.htm>

Geiss, Col John P II, PhD, Col Christopher J. Kinnan, Col (Retired) Ted Hailes, Col Harry A. Foster, Col

-
- David Blanks. *Blue Horizons II; Future Capabilities and Technologies for the Air Force in 2030*. Occasional Paper No 65, Maxwell AFB: Center for Strategy and Technology, Air War College, July 2009
- Gertler, Jeremiah. *Air Force F-22 Fighter Program*. Congressional Research Service Report for Congress, Washington DC: Government Printing Office, July 2013
- Gertler, Jeremiah. *Air Force F-35 Joint Strike Fighter (JSF) Program*. Congressional Research Service Report for Congress, Washington DC: Government Printing Office, April 2014
- Gilbert, Ronald E. *Strategic Implications of US Fighter Force Reductions: Air to Air Combat Modelling Using Lanchester Equations*. Graduate Research Paper, Maxwell AFB AL: Air University Air Force Institute of Technology, June 2011
- Global Security.org "AN/APG Active Electronically Scanned Array AESA"
<http://www.globalsecurity.org/military/systems/aircraft/systems/an-apg-aesa.htm>
- Government Office of Accountability, *F-35 Joint Strike Fighter; Assessment Needed to Address Affordability Challenges*. Government Office of Accountability Report to Congressional Committees, Washington DC: Government Printing Office, April 2015
- Government Accountability Office, *F-35 Joint Strike Fighter; Current Outlook Is Improved, but Long-Term Affordability is a Major Concern* Government Office of Accountability Report to Congressional Committees, Washington DC: Government Printing Office, 2013
- Laird, Robbin F. and Timperlake, Edward T. "The F-35 and the Future of Power Projection." *Joint Forces Quarterly*, Issue 66, 3rd Quarter (2012): [85-93]
- Lorell, Mark A., Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An, Robert A. Guffey. *Do Joint Programs Save Money?* Santa Monica Ca: RAND Corporation 2013
- "Lockheed Martin F-22 and F-35: The 5th Generation Revolution in Military Aviation ." *PR Newswire*. February 21, 2006. <http://www.prnewswire.com/news-releases/lockheed-martin-f-22-and-f-35-the-5th-generation-revolution-in-military-aviation-55382552.html>
- Maddock, Ian A. "DARPA' Stealth Revolution, Now You See Them...." *DARPA, 50 Years of Bridging the Gap*, 2008 <http://www.darpa.mil/attachments/%282024%29%20Global%20Nav%20-%20About%20Us%20-%20History%20-%20Resources%20-%2050th%20-%20Stealth%20%28Approved%29.pdf>
- Northrop Grumman "AN/APG-77 AESA Radar"
<http://www.northropgrumman.com/Capabilities/ANAPG77AESARadar/Pages/default.aspx>
- Northrop Grumman "AN/APG-81 AESA Radar"
<http://www.northropgrumman.com/Capabilities/ANAPG81AESARadar/Pages/default.aspx>

Pierrot, Lane. *Balance and Affordability of the Fighter and Attack Aircraft Fleets of the Department of Defense*. Congressional Budget Office Report, Washington DC: Government Printing Office, April 1992

Pierrot, Lane. *Options For Fighter and Attack Aircraft: Costs and Capabilities* Congressional. Budget Office Report, Washington DC: Government Printing Office, May 1993

Peeler, Major David L. Jr. *Counterinsurgency Aircraft Procurement Options; Processes, Methods, Alternatives, and Estimates*. Wright Flyer Paper No 40, Maxwell AFB: Air University Press, August 2009

Pyles, Raymond A. *Aging Aircraft; USAF Workload and Materiel Consumption Life Cycle Patterns*. Project Air Force Report, Santa Monica CA: RAND Corporation, 2003

Stanley, William and Liberson, Gary. *Measuring Effects of Payload and Radius Differences of Fighter Aircraft*. Santa Monica CA: Rand Corporation, 1993

Stillion, John. *Trends in Air-To-Air Combat; Implications for Future Air Superiority*. Center for Strategic and Budgetary Assessments, 2015

Sustaining Ar Force Aging Aircraft into the 21st Century. Report, USAF Scientific Advisory Board, August 2014

“Top Falcons: The UAE’s F-16 Block 60/61 Fighters” *Defense Industry Daily* January 2014

<http://www.defenseindustrydaily.com/the-uaes-f-16-block-60-desert-falcon-fleet-04538/>

Tritten, Travis. “Report: F-35 Inferior to Older US, Foreign Fighters” *Stars and Stripes*, August 2015

<http://www.stripes.com/report-f-35-inferior-to-older-us-foreign-fighters-1.362441>