A Gunslinger with Bad Eyesight?

Defense-update
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Serious issues reported by testers and pilots in the past 12 months raise questions about the prudence moving forward with procurement of hundreds of combat jets, whatever their cost will be, when the product in question is not ready for the mission.

Continued delays in the completion of the third and final developmental software block (Block 3f) of the F-35 is likely to push back the completion of the development phase of the new fighter, well into 2018 or even early 2019. But, according to the annual test and evaluation report published last week, the F-35 problems are worse than merely complex software. The scorecard the 5th generation fighter jet prepared by Michael J. Gilmore, the Director of Operational Test and Evaluation (DTO&E) at the Defense Department, uncovers scores of issues, some unveiled only recently; ussues that, according to Gilmore, cannot be resolved by the time the new fighter completes the System Development and Demonstration (SDD) phase and enters full rate production. According to the report, some of these issues could impede the combat effectiveness of hundreds of aircraft produced by that time.

Many of the findings concern availability and logistic aspects that are often used to criticize the trillion-dollar program. But the recent report raises some issues that cast doubt about the joint strike fighter's ability to carry out its primary mission – leading the 'first day' attacks against enemy fighters, ground based air defense and command and control centers.

The DOD chief tester warns that if the F-35s are sent to combat today, they will not be able to fulfill their mission independently as designed. “F-35 aircraft will need support to locate and avoid modern threat ground radars, acquire targets, and engage formations of enemy fighter aircraft, due to unresolved performance deficiencies and limited weapons carriage available” Gilmore wrote.

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The F-35C can carry weapons internally and externally. The wing is built with three hardpoints, two are designed to carry heavy weapons and the outer one is designed to catrry lighter, air/air missiles.

Summary

Many issues reported during the past 12 months raise questions about when the F-35 will achieve full combat capability, since the third software build – 3F is not likely to support all the deficiencies reported during the systems’ development and demonstration phase.

With 200 F-35 aircraft delivered, and more than 50 different software blocks and weapons to test, problems can be expected but it would be logical to expect reliability and readiness levels to increase. However, the in the past 12 months the mission capability level of the F-35 fleet actually dropped from a 2014 high and averaged 52 percent, below the modest goal of 60 percent, ten points below from the 62 percent all-time mark.

Since SDD will continue at least to the middle of 2018, and by then the program will have delivered hundreds of aircraft to the services in other than the 3F configuration, the depot modification program and its associated concurrency burden will be with the services for years to come.

Sensor fusion is one of the critical advantages offered by the sophisticated avionics and computing suite of the F-35. But sometimes this new and complex system confuses some of the tracks and displays multiple instances of objects, thus adding to the pilot workload. U.S. Marine Corps Photo by Lance Cpl. Dana Beesley

Missing Links in the Kill Chain

The DTO&E 2016 report lists the F-35 lack of accuracy in weapons delivery as an issue of concern. Such accuracy is derived by the aircraft fire-control capabilities to support the “find, fix, track, target, engage, assess” kill chain.

Issues were reported with all the air/air weapons currently used by the F-35 – AIM-120 AMRAAM, AIM-9X Sidewinder and AIM-132 ASRAAM. The later, to be used by the British F-35B, required changes to the fire control software to correct problems, but those changes may have caused other issues with the integration of the AIM-9X, used by all the remaining operators of the aircraft. On six tests of the AMRAAM missiles three were declared ‘partially successful’ or ‘unsuccessful’, five of the six required control room intervention to launch the

AMRAAM missile. Similar issues caused problems to the air/ground weapons – fixes designed to improve the use of Paveway IV for the Brits could cause issues with the GBU-31 laser guided bomb.

Other issues were related to sensor fusion, electronic warfare (EW) that continued to cause ambiguous threat displays, limiting the pilot ability to effectively respond to threats, to a level requiring offboard sources to provide accurate coordinates for precision attack. On some instances on board sensors could not accurately locate and identify 'enemy' radars and other electronic emitters.

An F-35B test pilot live fires an AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) above the Point Mugu Sea Test Range, California. This weapons test was one in a series of tests performed with the F35's latest 3F software in 2016. Photo: Lockheed Martin by Darin Russell.

A known limitation of the F-35 that results from its stealth advantage is the limited space in the internal weapons bay. However, apart from the limited number of weapons is the fact that the two guided munitions carried in this weapons bay cannot be launched from a distance; at present the F-35 in the Marine Corps Blocks 2b and US Air Force 3i are limited to carrying direct attack weapons (laser guided or GPS guided weapons). Lack of a stand-off weapon means the F-35 must get very close to its target to carry out the attack, thus risking detection. "Lack of a standoff weapon choice would force the F-35 Block 3i to fly much closer to engage ground targets and, depending on the threat level of enemy air defenses and acceptable mission risk, it may be limited to engaging ground targets that are defended by only short-range air defenses, or by none at all." Gilmore warned.

One of the standoff weapons the U.S. Navy considered for the F-35C was the Joint Stand-Off Weapon (JSOW-C1). However, due to integration problems uncovered during testing recently it may not be ready for the planned initial operational deployment (IOC) next year.

The F-35 Lightning II Pax River Integrated Test Force from Air Test and Evaluation Squadron (VX) 23 conducted the first weapons separation test of an AGM-154 Joint Standoff Weapon (JSOW) from an F-35C Lightning II carrier variant March 23. 2016. Testing of the weapon revealed issues with mission planning and pilot-vehicle interface that limit the weapon's usability. Photo: U.S. Navy, by Dane Wiedmann.

A formation of F-35B flys over USS America. Seven F-35Bs are on board the USS America beginning Oct. 28 until mid-November, 2016. Photo: Lockheed Martin

Apart of the unique stealth capability, sensor fusion is hailed as a unique force multiplier for the F-35, providing its pilots the capability to dominate the battlespace and engage targets before the enemy can realize they are at risk. However, recent tests indicated that, although highly sophisticated and advantageous this fusion shield may not be as solid as planned. In some instances, rather than reducing pilot workload fusion sometime added clutter. Testers reported air tracks that split erroneously or a single target displaying multiple false tracks, when the different sensors do not add up, and cause erroneous fusion solution. As a workaround pilots are trained to turn off some of the sensors, to try and cancel multiple tracks. “This method is unacceptable for combat and violates the basic principle of fusing contributions from multiple sensors into an accurate track and clear display to gain situational awareness and to identify and engage enemy targets.” Gilmore commented in his report.

Managing electronic tracks from ground targets is particularly tricky. Sometime, multiple false tracks are displayed when only one threat emitter is operating. On the other hand, tracks that ‘time out’ and drop from the display cannot be recalled. Such absence can cause pilots to lose tactical battlefield awareness on enemy air defense radars that turn on only intermittently, as is typical of missile engagement radars.

The issues of fusion errors are not limited to a specific aircraft. Since F-35s share data over the Multifunction Advanced Data Link (MADL) network, fusion error issues exacerbate to entire formations as aircraft share erroneous tracks over the network.

Another highly praised capability is employing the APG-81 phased array radar and other electronic warfare on board to jam enemy emitters. However, testing has shown that the aircraft Electronic warfare (EW) capabilities, including electronic attack (EA), are inconsistent and, in some cases, not effective against required threats. Understandably the details of these deficiencies are classified, but they could limit the F-35 capacity to conduct Suppression/Destruction of Enemy Air Defenses (SEAD/DEAD) and other missions against fielded threats.

Although these issues are likely to be resolved in future software upgrades, problems could get worse if the F-35 is sent to combat now, where it could face new and unfamiliar threats. Theoretically, the U.S. Reprogramming Laboratory (USRL), responsible to produce the Mission Data Loads for the aircraft, will provide the updates for the fleet. However, recent inspections realized the lab is way behind in delivering the first operational MDL for the Block 3f. According to the current schedule Block 3f MDLs will not be optimized to ensure the F-35 will be capable of detecting, locating, and identifying modern fielded threats until 2020. Even worse, lacking the manpower and tools to assess new threats, when tasked with an urgent requirement to deliver updates the lab processed the updates in months, rather than days required for the task. A possible solution could come from some foreign users are turning to their own labs to develop MDL to suite their needs, but these would require further validation to be used with the US aircraft.

An F-35C drops a GBU-31 Joint Direct Attack Munition (JDAM) bomb over China Lake Weapon Impact Range, California. This weapons test was one in a series of tests in 2016, performed with the F35's latest 3F software. Lockheed Martin photo by Chad Bellay.

A Gunslinger with Bad Eyesight

Other shortfalls encountered with the F-35 last year concerned the fire control and gunsight. During aerial firing of the gun pilots realized issues with gun aiming and accuracy. In particular the aiming reticule shown on helmet mounted display was unstable in marking aimpoints and tracking the targets, both air-to-ground and air-to-air starfing. Again, due to late discovery of this issue fixes will not be available soon.

An F-35A drops a small diameter bomb during weapons tests. This weapons test was one in a series of tests performed with the F35's latest 3F software. Over the 31 calendar day "surge" period, the team accomplished 30 weapon releases (live fires and separations). Photo: Lockheed Martin by Chad Bellay

The Armor Piercing Explosive (APEX) ammunition used for the weapon proved suitable and effective against air and ground targets, including soft targets, vehicles and personnel in the open, but required a modification of the fuse to improve its efficiency against armored targets.

CAS With Workarounds

Much of the scrutiny of the F-35 program was on its ability to support ground forces through Close Air Support missions. As a modern and more capable successor to F-16, F-15, F/A-18, A-10 and AV-8B, the F-35 should be ready to conduct CAS. Such mission is most critical for the US Marine Corps, requiring a near term replacement for AV-8B. The replacement of the Air Forces' A-10C by the F-35A remains in debate, at least for the next few years.

However, test and evaluation have indicated that the F-35, at least in the Block 2b and Block 3i configurations are not yet ready for serious CAS, equivalent to the capabilities of the fourth-generation aircraft it is intended to replace. The F-35A in the Block 3i configuration has numerous limitations that make it less effective overall in the CAS mission role, in a permissive or low-threat environment, which is where CAS is normally conducted.

https://www.youtube.com/watch?v=5gm2HSzKfac

When tested in the air-to ground gun strafing the symbology, displayed in the helmet, was unusable and potentially unsafe to complete the planned testing. The air-to-air mode proved more stable but testers reported the pipper symbology (on the helmet display) was unstable while tracking a target aircraft. However, the funnel version of the air-to-air gunsight appeared to be more stable in early testing. Fixing these deficiencies may require changes to the mission systems software that controls symbology to the helmet, or the radar software.

The aircraft is currently certified to carry weapons internally, thus being limited to a loadout of two bombs and two air/air missiles. Furthermore, an aircraft-mounted gun is a key weapon for some CAS scenarios when a bomb cannot be used due to collateral damage concerns or when the enemy is “dangerously close” to friendly troops. The gun can also be an effective weapon for attacking moving targets. However, even though an internal gun is installed in the Block 3i F-35A, it cannot be used until significant modifications to both the gun system and aircraft are completed, and a version of Block 3f software is tested and delivered to fielded aircraft.

Another issue is the capability of the F-35 to engage moving targets. Without a functioning gun, and lacking certain fire-control capabilities, limiting the laser guided bomb carried by the aircraft to use automated targeting functions with lead-laser guidance, like most legacy aircraft can. As a stop-gap, F-35 pilots use basic rules-of-thumb when attempting to engage moving targets with the GBU-12, resulting in limited effectiveness.

Other methods would use two-ship “buddy lasing” for GBU-12 employment, which consumes more assets and is not always possible during extended CAS engagements. The Air Force is considering integrating the GBU-49, a fielded weapon that has similar size, weight and interfaces as the GBU-12, or a similar weapon that does not require lead-laser guidance, in Block 3f. Otherwise, the program plans to develop and field lead-laser guidance in Block 4.2, which would be delivered in 2022, at the earliest.

Unlike legacy aircraft, Block 2B aircraft will need to make substantial use of voice communications to receive targeting information and clearance to conduct an attack during Close Air Support (CAS) missions due to the combined effects of digital data communications deficiencies, lack of infrared pointer capability, limited ability to detect infrared pointer indications from a controller (which may be improved in the Generation III Helmet Mounted Display System (Gen III HDMS), and inability to confirm coordinates loaded to GPS-aided weapons. Each of these shortfalls limit effectiveness and increase the risk of fratricide in combat.

An F-35B loaded with four GBU-12 laser guided bombs seen on the deck of USS America. Photo: Lockheed Martin

Searching for (Targeting) Solutions

Among the serious issues limiting the Block 2B (F-35B) effectiveness in CAS are lack of night vision capability and the need to rely on voice communications too often.

F-35 pilots have encountered problems with the Variable Message Format (VMF) and Link-16 datalink messaging used in the F-35, that randomly dropped information, or used incorrect formatting. Since such error could mean hitting the wrong target or put friendly forces at risk, pilots are required to validate target coordinates phonetically over the radio, rather than using digital CAS – a capability that is common in most legacy CAS aircraft.

Another problem is limited night vision capability. This issue affects mostly the first production batches using second generation (GEN II) helmet mounted displays. From the production Lot 7 aircraft were fielded with the Gen III HMDS, which perform better but pilots report that even this improved version is still less than that of the night vision goggles used in

legacy aircraft. The effect makes identification of targets and detecting markers more difficult, if not impossible. They noticed a “green glow” – a condition where light leakage around the edge of the display during low-light conditions makes reading the projected information difficult, particularly during low ambient illumination conditions.

The most significant safety concern of this condition pertains to nighttime carrier operations. Another limitation of Block 2B aircraft (the fielded marine corps variants) is the fact that when they are employed at night in combat, pilots are restricted from using the current limited night vision camera in the Generation II helmet. For this task pilots flying Block 2B aircraft would operate much like early fourth generation aircraft, using cockpit panel displays, with the Distributed Aperture System (DAS) providing limited situational awareness of the horizon, and heads-up display symbology projected on the helmet.

The F-35 pilot uses an advanced helmet mounted display (HMD) system that integrates an image intensifier camera for night flying. Some of the aircraft flown by the US Marine Corps use the second generation sensor that supports limited nigh flight capabilities. Photo: U.S. Navy, by Lt. j.g. Maideline Sanchez

Other issues affecting all F-35 blocks are related to the Electro-Optical Targeting System (EOTS). Generally, pilots assess the EOTS on the F-35 as inferior to those currently on legacy systems.

While EOTS provides visual and thermal imaging and target designation capabilities, of the target, its imaging quality falls behind those provided by current targeting pods in its ability to enable pilots to discern target features and identify targets at tactically useful ranges, along with maintaining target identification and laser designation throughout the attack.

Environmental effects, such as high humidity, often forced pilots to fly closer to the target than desired, in order to discern target features and then engage for weapon employment, much closer than needed with legacy systems, potentially alerting the enemy, exposing the F-35 to threats around the target area or requiring delays to regain adequate spacing to set up an attack. The EOTS is built as an integral part of the aircraft and, due design limitations, there are no significant improvements to EOTS planned for Block 3f. Theoretically, F-35 will be able to use conventional targeting pods such as the Litening and Sniper, but this will compromise their stealth performance.

Lack of target marking capability, traditionally used by the pilot and forward air controller to mark a target using an infrared laser beam is another limitation associated with EOTS. Although the F-35 has a laser designator and rangefinders integrated into the EOTS, this laser is used for the designation of target for laser guided weapons and is not suitable for target marking.

An F-35A Lightning II from the 61st Fighter Squadron deploys a GBU-12 500-pound laser-guided bomb. In April 2016 three F-35s successfully delivered six inert GBU-12s during the practice sortie. Photo: U.S. Air Force photo by Airman 1st Class Ridge Shan

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