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OPERATIONAL TEST AND EVALUATION

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MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION, TECHNOLOGY AND LOGISTICS
SECRETARY OF THE AIR FORCE
CHIEF OF STAFF OF THE AIR FORCE

SUBJECT: Achieving Full Combat Capability with the Joint Strike Fighter (JSF) is at Substantial Risk

While the Air Force recently declared Initial Operational Capability (IOC) with "basic" Block 3i capabilities, most of the limitations and deficiencies for the F-35A with Block 3i discussed in my FY15 Annual Report and Congressional testimonies remain and will adversely affect mission effectiveness and suitability. In fact, the program is actually not on a path toward success, but instead on a path toward failing to deliver the full Block 3F capabilities for which the Department is paying almost $400 billion by the scheduled end of System Development and Demonstration (SDD) in 2018. If Initial Operational Test and Evaluation (IOT&E) were conducted today on the aircraft in the Block 3i configuration – with which the Air Force recently declared IOC –the system would likely be evaluated as not effective and not suitable across the required mission areas and against currently fielded threats. If used in combat, the F-35 in the Block 3i configuration, which is equivalent in capabilities to Block 2B, will need support to locate and avoid modern threats, acquire targets, and engage formations of enemy fighter aircraft due to outstanding performance deficiencies and limited weapons carriage available (i.e., two bombs and two air-to-air missiles). Unresolved Block 3i deficiencies in fusion, electronic warfare, and weapons employment continue to result in ambiguous threat displays, limited ability to effectively respond to threats, and, in some cases, a requirement for off-board sources to provide accurate coordinates for precision attack. Although the program recently addressed some of the Block 3i deficiencies, many significant deficiencies remain and more are being identified by operational test and fielded units, many of which must be corrected if the program is going to provide the expected "full warfighting capability" described in the Operational Requirements Document (ORD).

Although the F-35 program reached an interim milestone with the Air Force IOC declaration, it is not on track to deliver the full Block 3F capabilities by the planned end of SDD in 2018. In fact, it is running out of time and money to complete the planned flight testing and implement the required fixes and modifications. Flight test is making progress, but has fallen far behind the planned rate to complete SDD within the remaining time and funding. The final, most complex, required Block 3F capabilities are just now being added to the mission systems software builds and new problems requiring fixes and regression testing continue to be discovered at a substantial rate. Also, despite needing to continue developmental testing at full capacity for at least another year to complete the planned testing of the new capabilities and attempted fixes for the hundreds of remaining deficiencies, the program is already beginning to reduce the number of test personnel and defer required fixes to beyond SDD due to funding constraints. Also, progress toward meeting several key requirements to start IOT&E has stagnated because the required modifications for the operational test aircraft and essential upgrades to the U.S. Reprogramming Laboratory (USRL) for mission data are still not on contract, some of which will take at least two years to complete after the contracts are signed. Whether the F-35 will achieve operational effectiveness and suitability relative to its full set of approved requirements will not be known until the IOT&E of the F-35 system, including properly modified test aircraft equipped with Block 3F software, the full complement of weapons, and the Autonomic Logistics Information System, is conducted, beginning sometime in 2018, at the earliest.

This assessment of the capability of the F-35A in the Block 3i configuration, and challenges the program faces to complete SDD, is based on observations and data from developmental testing, limited operational test activities and fielded operations. The assessment of the Autonomic Logistics Information System (ALIS) is based on observations and data from deployment demonstrations with ALIS hardware in the Standard Operating Unit (SOU), Version 2 (V2) configuration supporting Block 2B and Block 3i aircraft, cybersecurity testing and program office projections for completing development of the remaining required capabilities for ALIS. Additionally, this assessment is fully consistent with the findings contained in the Air Force's own IOC Readiness Assessment (IRA) report.

System Overview

Block 3i is an interim set of capabilities, designed to run on newer "TR-2" processors in production F-35 aircraft beginning in Lots 6 and later, which is equivalent to the Block 2B set of capabilities fielded on earlier production lot aircraft. Block 3i also includes the newer Generation III (Gen III) Helmet Mounted Display System (HMDS), which began deliveries with Lot 7 aircraft. The Gen III HMDS was designed to address significant deficiencies in the Gen II HMDS fielded with earlier lot aircraft. F-35 aircraft in the Block 3i configuration can carry a combination of two AIM-120 air-to-air missiles and either two GBU-12 laser guided bombs or two GBU-31 (on the F-35A/C) or GBU-32 (on the F-35B) Joint Direct Attack Munitions (JDAM).

ALIS version 2.0.1 software supports both Block 2B and Block 3i aircraft. The next iteration of capability, ALIS version 2.0.2, was planned for release prior to Air Force IOC, but is continuing to fall behind schedule due to problems integrating the propulsion system and data. As a result, ALIS 2.0.2 was divided into incremental releases to provide an update without integration of propulsion data, now expected in October 2016 at the earliest, followed by another release that integrates propulsion data in late 2016. Although the Air Force had previously stated ALIS version 2.0.2 should be fielded prior to the IOC declaration, the delays in development and testing of that version of ALIS prevented that from occurring. As a result, the Air Force, along with all other F-35 operators, must continue to use time-consuming work-arounds to mitigate the limitations and deficiencies in ALIS 2.0.1. The delays in developing and testing ALIS 2.0.2 are also adding more schedule risk to completing ALIS 3.0, the currently planned version of ALIS meant to provide full capability, by the end of SDD.

Full F-35 combat capability, compliant with the ORD, is planned to be delivered in Block 3F, which is still in development as it undergoes flight testing, and ALIS version 3.0, which is incomplete and has not yet begun testing due to the delays with ALIS 2.0.2. Despite the continued delays with F-35 development and testing, the production rate of the F-35 continues to ramp up, requiring the Services to accept and field production aircraft in the Block 3i configuration at a steadily increasing rate, most of which will require significant and costly modifications. As of the end of July, the Air Force had accepted 48 aircraft in the Block 3i configuration, which are in addition to the 44 aircraft delivered in the earlier Block 2B configuration. The Air Force will accept another 35 aircraft in the Block 3i configuration before the program plans to start delivering aircraft in the Block 3F configuration in Lot 10, starting in January 2018.

Assessment of Block 3i Capabilities

Because Block 3i is an interim capability based on Block 2B, it has numerous inherent limitations that will reduce operational effectiveness and require workarounds if the F-35A in the Block 3i configuration is used in combat. These limitations, which were also a factor during the Air Force IRA, affect the following mission areas discussed below.

Close Air Support (CAS). The F-35A in the Block 3i configuration has numerous limitations which make it less effective overall at CAS than most currently-fielded fighter aircraft like the F-15E, F-16, F-18 and A-10 in a permissive or low-threat environment, which is where CAS is normally conducted. The following observations are consistent with the Air Force IRA report:

- The limited weapons load of two bombs (along with two missiles for self-defense) constrains the effectiveness of the Block 3i F-35A for many CAS missions. Compared to a legacy fighter with multiple weapons on racks, and multiple weapons types per aircraft, the limited Block 3i load means that only a limited number and type of targets can be effectively attacked.

- No gun capability. 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 "danger 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, along with a version of Block 3F software that supports weapons delivery accuracy (WDA) testing with the gun. For these reasons, gun WDA testing, with the required modifications and software, has slipped to the fall of 2016, at the soonest.

- Limited capability to engage moving targets. Even though the Block 3i F-35A does not have a functioning gun, it can carry the GBU-12 laser guided bomb which can be used against moving targets. However, Block 3i does not have an automated targeting function with lead-laser guidance (i.e., automatically computing and positioning the laser spot proportionately in front of the moving target to increase the likelihood of hitting the target) to engage moving targets with the GBU-12, like most legacy aircraft that currently fly CAS missions. Lead-laser guidance is currently not planned for Block 3F. Instead, F-35 pilots can only use basic rules-of-thumb when attempting to engage moving targets with the GBU-12, resulting in very limited effectiveness. Also, limitations with cockpit controls and displays have caused the pilots to primarily use two-ship "buddy lasing" for

GBU-12 employment, which isn't always possible during extended CAS engagements when one of the aircraft has to leave to refuel on a tanker.

- Voice communications are sometimes required to validate digital communications. Problems with Variable Message Format (VMF) and Link-16 data link messaging – including dropped/hidden information or incorrect formats – sometimes require pilots to use work-arounds by validating or "reading back" information over the radio that prevent them from conducting digital (only) CAS, a capability that is common in most legacy CAS aircraft.

- Limited night vision capability. Although Lot 7 and later aircraft are fielded with the Gen III HMDS, which has shown improvement to the deficiencies with the earlier Gen II HMDS, limitations with night vision capability remain. Pilots using the Gen III helmet for night operations report that visual acuity is still less than that of the night vision goggles used in legacy aircraft, which makes identification of targets and detecting markers more difficult, if not impossible. Also, "green glow" – a condition where light leakage around the edge of the display during low-light conditions makes reading the projected information difficult – is improved over the Gen II HMDS, but is still a concern during low ambient illumination conditions. Finally, accuracy testing of the gun with the HMDS has not yet been completed, although the testing is planned for late CY16. Hence, the aiming accuracy of the combined HMDS and windscreen are still unproven for both air-to-air and air-to-ground gun employment.

- Lack of marking capability – a key capability for both Forward Air Controller-Airborne (FAC-A) and CAS missions. Legacy CAS platforms can mark targets with rockets, flares, and/or infrared (IR) pointers, none of which are currently available on the F-35. The F-35 has a laser designator as part of its Electro-Optical Targeting System (EOTS), but the laser is used for targeting from ownship when using the GBU-12 laser guided bomb or to "buddy-guide" a weapon from another aircraft. This limitation is not planned to be fixed during SDD.

- Reduced on-station time and greater reliance on tanker aircraft. Although this limitation is not unique to the Block 3i configuration, the F-35has high fuel burn rates and slow air refueling rates that extend air refueling times and decrease overall on-station time which may impact mission effectiveness.

- The Air Force IRA had similar observations on CAS limitations and concluded that the Block 3i F-35A does not yet demonstrate equivalent CAS capabilities to those of 4^{th} generation aircraft.

Other mission areas. In addition to the Block 3i limitations listed above that affect the CAS mission area, the following inherent Block 3i limitations will also affect the capability of the F-35A in other mission areas:

- Poor geolocation capability against certain types of emitters and threat laydowns.

- No standoff weapon. With only direct attack bombs, the F-35 in the Block 3i configuration will be forced 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 short-range air defenses or none at all.

- The limited weapons loadout of the Block 3i F-35 makes effective prosecution of many expected types of targets in a typical theater a challenge.

- Pilots report that inadequacies in Pilot Vehicle Interfaces (PVI) and deficiencies in the Tactical Situation Display (TSD) continue to degrade battlespace awareness and increase pilot workload. Workarounds to these deficiencies are time-consuming and detract from the efficiency and effectiveness of mission execution.

Block 3i has significant deficiencies that must still be addressed. In addition to the limitations listed above, Block 3i also has hundreds of other deficiencies, the most significant of which must be fixed in Block 3F to realize the full warfighting capability required of the F-35. These deficiencies include, but are not limited to the following:

- Avionics sensor fusion performance is still unacceptable.

  - Air tracks often split or multiple tracks are created when all sensors contribute to the fusion solution. The workaround during early developmental testing was to turn off some of the sensors to ensure multiple tracks did not form, which 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 tracks.

  - Similarly, multiple ground tracks often are displayed when only one emitter threat is operating. In addition, tracks that "time out" and drop from the display cannot be recalled, causing pilots to lose tactical battlefield awareness.

  - Sharing tracks over the Multi-Aircraft Data Link (MADL) between aircraft in the F-35 formation multiplies the problems described above.

  - The Air Force IRA report also identified deficiencies with fusion in Block 3i.

- Electronic Warfare (EW) capabilities, including electronic attack (EA), are inconsistent and, in some cases, not effective against required threats.

  - Although the details of the deficiencies are classified, effective EW capabilities are vital to enable the F-35 to conduct Suppression/Destruction of Enemy Air Defenses (SEAD/DEAD) and other missions against fielded threats.

  - The Air Force IRA report also identified significant EW deficiencies in Block 3i.

- Datalinks do not work properly. Messages sent across the MADL are often dropped or pass inaccurate off-board inter-flight fusion tracks based on false or split air tracks and inaccurate ground target identification and positions.

- Mission data development, optimization, and operationally-representative testing are inadequate.

  - As DOT&E has highlighted on numerous occasions, the F-35 relies on mission data loads in order to be effective in detecting, identifying, geo-locating, and – if necessary – responding to threats. These data loads are a compilation of mission data files that drive sensor search parameters and provide the data required to identify and correlate sensor detections of threat emissions, as well as files that drive automatic or pilot-directed responses to threat engagements. The mission data files (MDF) are developed by the USRL, which is tasked to provide them to the Services, tailored for various geographic regions and multiple aircraft configurations (i.e., Block 2B, Block 3i, and Block 3F).

  - Significant deficiencies in the USRL preclude efficient development and testing of the mission data files, but the program has yet to take adequate action to address many of these deficiencies. Key hardware upgrades needed to develop and verify Block 3F mission data files for detecting and identifying emissions from current threat systems are still not on contract, despite the requirement being identified and funding provided in 2012. It will take at least two years after ordering the equipment, so the required equipment will not be in the lab in time to support MDF development for IOT&E. Also, the software tools used for developing, modifying and testing the files continue to be plagued by significant usability shortfalls and a lack of adequate technical data.

  - Consistent with these observations, the Air Force IRA report emphasized the need for adequate resourcing for upgrades and sustainment of the USRL and operationally-representative testing of mission data files.

- Block 3F mission systems software required multiple corrections to deficiencies before weapons delivery accuracy testing could begin. However, despite DOT&E asking the program office for information on the extent to which these deficiencies exist in Block 3i, this information is apparently still unknown.

The Air Force identified seven “Must Fix” deficiencies from Block 2B for the program to fix in Block 3i to meet their IOC requirements. The program was able to adequately address four of these seven deficiencies. Two of the remaining three showed improvement, but were not fully resolved, and one remains unresolved. The status of these seven deficiencies is summarized in the table below.

Deficiency	Status
Inability to Positively Confirm the Next-to-Shoot Designated Coordinates and Elevation	Resolved.
Radar Azimuth Field of Regard Not Properly Displayed to Pilot	Partially Resolved.
No Pilot Indication of Fusion Tactical Situation Model (TSM) Failure	Improvements in stability of the TSM and indications have reduced the effect of this problem; the AF considers this deficiency satisfactorily addressed.
No Pilot Indication of Integrated Core Processor (ICP) Failure or Degradation	Improvements in stability of the ICPs and indications have reduced the effect of this problem; the AF considers this deficiency satisfactorily addressed.
Weapon Quality Track Indications to Pilot	Not Fully Resolved.
No Pilot Indication of Radar Failure	The AF assessed the correction to this deficiency as MARGINAL (not fully resolved) due to limited use of the final Block 3i software version (3iR6.21), but expects the improvement in stability to negate the need for pilot indications of radar failure.
Mission Debrief Time is Excessive due to Long Download Time of Post Flight Data	Not Resolved; although the newer "Generation III" ground data receptacle has shown improved (shorter) decrypting capability, problems with certification have delayed fielding. The program is considering whether a redesign will be needed.

The program was also able to improve stability of the mission systems software to support the Air Force's plan to declare IOC. The program office reported improvements in Mean Flight Hours Between Instability Events (MFHBSE) for both start-up and in-flight of Block 2B and Block 3i. These data, depicted in the table below, show that stability has improved with the last build of Block 3i software to the level seen in the most recent build of Block 2B software.

Software Version	Flight Hours	Mean Flight Hours Between Instability Events*
3FR5.03 (a build for developmental flight testing)	72.6	9.1
Early 3F software in flight testing	136.8	5.07
3iR6.21 (AF IOC build)	128.3	25.66
Early 3i software in flight testing	181.3	6.97
Last Block 2B software load	28.5	28.5

*Note: Does not include subsequent failures of the same system and associated system failures

The operational effect of mission systems instabilities on the F-35 is still not well understood. One of the objectives of the Air Force IRA was to examine the frequency and mission effect of these instability events as well. The Air Force defined and scored instability *events* during the IRA in the same way as the program office and the contractor for comparison purposes and observed similar trends. An instability event is generally the initial failure, or the primary system failure, and does not account for subsequent failures of the same system or failures of subsystems. In addition, the Air Force collected data on instability *occurrences*, which includes a broader set of instabilities. An instability occurrence accounts for all failures of systems and associated subsystem failures, even though each of these subsequent failures could have affected the mission capability of the aircraft. The Air Force collected data on instability occurrences with F-35A aircraft flying the most current Block 3i software and counted 25 occurrences in 34.1 flight hours, resulting in a mean flight hours between instability occurrences of 1.4 hours. During IOT&E, all relevant stability events and occurrences, on the ground or in the air, including repeat events (unless attributed to a hardware failure) will be counted, to better characterize the impact on mission effectiveness and suitability.

Testing of Block 3i Capability

Block 3i began with re-hosting the immature Block 2B software and capabilities into new avionics processors (referred to as Technical Refresh-2 or TR-2). Because of the extreme overlap of development and production, combined with delays in software development, the program was forced to create a Block 3i capability to support delivery of Lot 6 and later aircraft, as they were being delivered with the new processors before the planned Block 3F software was ready. Although the program originally intended that Block 3i would not inherit technical problems from earlier blocks, this occurred, which has resulted in severe, ongoing problems with Blocks 3i and 3F, including avionics stability, fusion, and other unresolved deficiencies.

When Block 3i developmental flight testing began in May 2014, six months later than planned in the program’s integrated master schedule (IMS), the combination of re-hosted immature software and new processors resulted in avionics stability problems that were significantly worse than Block 2B. Continued delays in completing Block 2B software development and testing in support of the Marine Corps IOC, which was a priority over Block 3i for the program and the test centers, combined with the severe stability problems with the early versions of Block 3i software, caused several pauses in early Block 3i flight testing. Block 3i flight testing resumed again in March 2015 and completed, for the first time, in October 2015, eight months later than planned in the IMS. Despite the continued problems with avionics stability, sensor fusion, and other inherited issues from Block 2B, the program terminated Block 3i developmental flight testing in October 2015, and released Block 3i software to the fielded units. This decision was made, despite the unresolved Block 3i deficiencies, in an attempt to meet the program's unrealistic schedule for completing development and flight testing of Block 3F mission systems.

The program created Block 3F by adding the final required capabilities and weapons to the problematic Block 3i software. However, when the program attempted developmental testing of Block 3F mission systems, the Block 3F software had become so unstable, and there were so many deficiencies that productive flight testing could not be accomplished. As previously stated, the Air Force insisted on fixes for seven (five identified in 2014 and two more in 2015) of the most severe deficiencies inherited from Block 2B, called the "Must Fix" deficiencies, as a prerequisite to use the final Block 3i capability in the Air Force IOC aircraft. Consequently, in February 2016, the program decided to return to Block 3i development and testing in another attempt to address key unresolved software deficiencies, including the avionics instabilities troubling both Block 3i and Block 3F. A new version of mission systems software, Block 3iR6.21, was quickly developed and tested which showed improvement to several "Must Fix" deficiencies identified by the Air Force and in-flight stability, so it was released to the fielded aircraft in late May 2016. Data collected on start-up and inflight stability of Block 3iR6.21 show that both have improved over earlier versions of Block 3i, and are approximately equivalent to final version of Block 2B software. The Air Force collected data during the IRA as well, which also show improvement in stability over the previous version of Block 3i.

The Air Force IOC decision was informed by a schedule-driven and limited series of events, referred to as an IRA, which was completed prior to their pre-determined IOC declaration window of August through December 2016. The Air Force conducted the assessment with six Block 3i-configured aircraft at Nellis Air Force Base (AFB), Nevada, using four different versions of Block 3i mission systems software and various data collection capabilities (i.e., two of the aircraft were "orange-wired" with flight test instrumentation for recording detailed data messages; the other four aircraft had the less-capable Quick Reaction Instrumentation Package (QRIP)), which is designed to work on production aircraft with limited "orange wire" modifications. The Air Force IRA report highlighted a lack of documentation for configuring the instrumentation and accessing the collected data, which limited their ability to analyze the results.

The IRA team at Nellis AFB flew a total of 18 mission scenarios (72 aircraft sorties) covering the mission sets of CAS, Air Interdiction (AI), and SEAD/DEAD. The missions were flown over the western test ranges from March 1 through April 29, 2016. Additionally, the assessment included observations from an Air Force-led deployment to Mountain Home AFB, Idaho with six F-35A aircraft from Edwards, supported by an ALIS SOU V2 with software 2.0.1. Although the Air Force has determined that the F-35A with Block 3i mission systems software provides "basic" capabilities for IOC, many significant limitations and deficiencies remain. In fact, the detailed results of the IRA, as reported by the Air Force, are consistent with the assessments in the DOT&E Annual Report, with the exception of recent corrections to some of the deficiencies which were identified by the Air Force to be fixed before IOC, and restoration of the in-flight stability of mission systems back to levels comparable to Block 2B.

Autonomic Logistics Information System

The program has delivered a more deployable version of the ALIS SOU, known as version 2 (or SOU V2). As has been shown during deployment demonstrations by both the Air Force and the Marine Corps, although the modular set of hardware is easier to deploy and set up than the bulky, original version of the SOU, deploying to support combat operations with the F-35 in the Block 3i configuration still requires multiple days before flight operations can commence. The time consuming activities include:

- Aircraft data from home station must be transferred to the deployed ALIS SOU and checked for accuracy to ensure the files will support the fielded operations. If the aircraft data are "new" to the SOU – i.e., have not been loaded on the SOU previously – each aircraft have to be inducted into the SOU, a process that takes approximately 24 hours for each aircraft and can only be done serially (one at a time).

- Network security protocols may have to be lowered (i.e., be less secure) to allow maintenance personnel to access the local base network structure with the ALIS hardware components to transfer and validate aircraft data to the deployed ALIS SOU V2.

- Setting up the large logistics footprint for fielded operations. The ALIS hardware must be housed in a Special Access Program Facility (SAPF), which may consist of one or multiple Deployable Debrief Facilities (DDF).

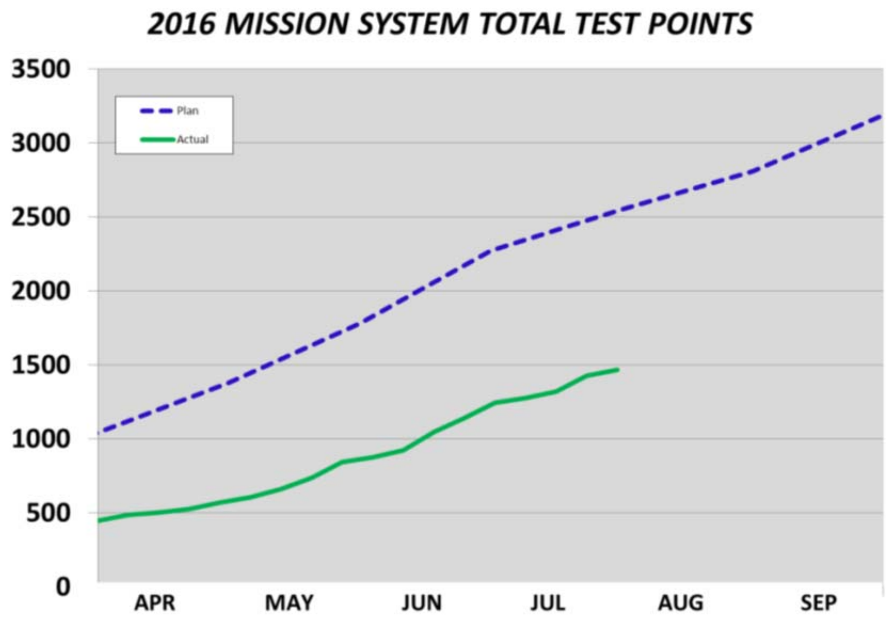
Deploying with ALIS SOU V2 and software version 2.0.1 will also require additional contractor support than what is planned for later software versions. Lockheed-Martin administrators are needed to set up and check out the SOU V2 at the deployed location. They are also needed to transfer aircraft data files from home station to the deployed SOU. Pratt and Whitney field service representatives are also needed to download engine data from the aircraft during the post-flight maintenance process.

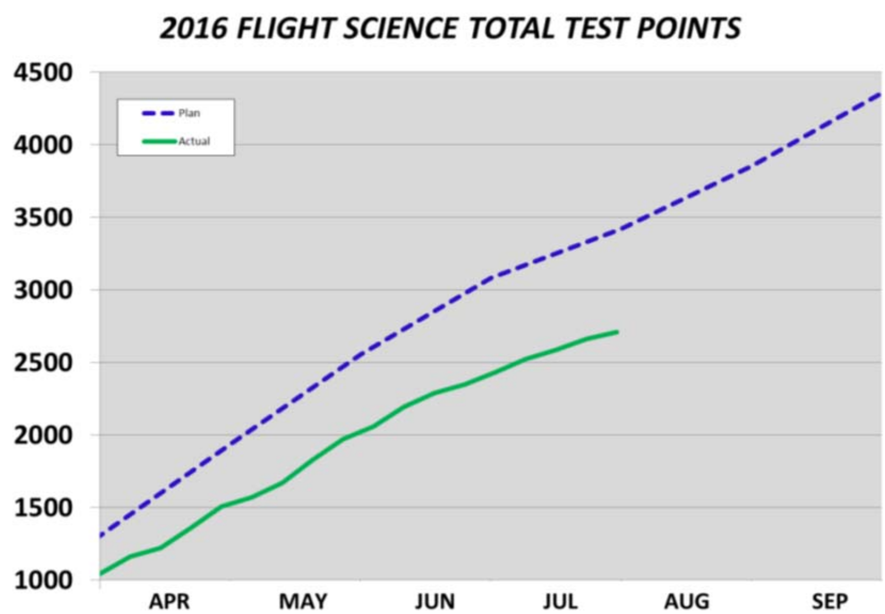
Post-mission debriefings are delayed by the current version of the ground data receptacle (GDR), which is used to decrypt and transfer data from the portable memory device (PMD). The PMD records data – including video of the cockpit displays – during flight, to the Off-board Mission Support (OMS) stations where pilots can review, play back, and debrief flight events. During the Mountain Home AFB deployment, the GDR decrypting time averaged 1.1 minutes for each minute of video and the missions averaged 55 minutes of video time. Hence, the post-mission debriefs were delayed by approximately an hour due to waiting for the video to become available which limited debrief time and delayed analyses and reporting of mission results. Although the program has developed a new GDR (version III) which has displayed faster decrypting times, certification problems have delayed fielding and the program is considering the need for another redesign.

Challenges Remaining to Complete Development

It appears as though the program is running out of time and out of money to deliver the required full F-35 combat capability in Block 3F before the completion of SDD. Observations that support this hypothesis are as follows:

- The program is behind in flight testing of Block 3F mission systems and flight sciences testing, and is still not catching up due to a combination of factors (e.g., aggressive schedule, new discoveries, regression testing, and normal attrition for reasons like ground aborts, weather and airspace), as indicated in the program office test point completion progress charts for 2016 shown below:





How the program will be able to accomplish the balance of required test points remaining in the time and budget allotted, given historic rates and ongoing personnel reductions, is unclear.

- Several remaining required Block 3F capabilities continue to have deficiencies or are still not ready for flight test. Recent program estimates show that many of these Block 3F capabilities are behind the delivery plan to flight test or carry schedule risk, including:

  - Radar Warning Receiver (RWR) functions
  - Ground Moving Target Tracking (GMTT) with the radar
  - Infrared Search and Track (IRST)
  - Variable Message Format (VMF) communications are still not fully operational
  - Basic Link 16 transmit/receive capability for specific messages
  - Health Reporting capability within Prognostic Health Management
  - Joint Precision Approach and Landing System (JPALS) for the F-35C
  - Radio frequency countermeasures capability
  - P5 Combat Training System
  - EOTS Forward Looking Infrared capability
  - Internal gun for the F-35A and gun pods for the F-35B and F-35C
  - Synthetic Aperture Radar, Automatic Target Classification
  - MADL capability to share imagery
  - Enhanced Geo-location
  - Small Diameter Bomb-I (SDB-I) integration

  How the program will be able to address the schedule risk and delivery these critical Block 3F capabilities is not known.

- Contractor staffing at the test centers has already started to draw down at a critical time when flight testing must continue at a high rate. The test centers experience approximately a 20 percent turnover of personnel annually, but recent turnovers are not being backfilled. In addition, actual layoffs have started, including maintenance personnel, engineers, analysts, and other personnel supporting flight sciences, mission systems and weapons testing. The steady loss of personnel is accelerating as other key personnel are looking for jobs and voluntarily leaving before they are eventually laid off.

How the program will be able to complete the volume of work remaining at the integrated test centers while the staffing begins to ramp down is not known.

- Discovery of deficiencies with Block 3i continues from both operational test and fielded units. For example, the Air Force recently identified a Category 1 HIGH deficiency (the most severe category possible) for failures and degradations of the Stores Management System (SMS) which controls the inventory and status of weapons on the aircraft, and the Fuselage Remote Interface Unit (FRIU), which is the electronic interface between the aircraft and weapons. These failures and degradations would severely impact mission effectiveness in combat and must be fixed, although the program may not have the time, budget, or a plan to address such new deficiencies, which are to be expected with so much flight testing remaining.

- Recent flight testing of the AIM-9X air-to-air missile, which is mounted externally on the outermost wing stations and is planned to be fielded on all variants, produced load exceedances during F-35C landings and up-and-away maneuvers that caused buffet. The program conducted a review of the margins of safety of the wing substructure and determined that flight limitations for AIM-9X carriage or a redesign of the supporting wing structure may be needed. The path ahead for AIM-9X carriage on the F-35C in Block 3F is not known.

- All variants of the F-35 gun are at risk of not having a functioning and accurate gun system in time for IOT&E, which would also affect fielded aircraft. Significant deficiencies discovered during initial testing of the F-35A's internal gun in 2015 require multiple modifications to the aircraft and gun system before weapons delivery accuracy testing of the F-35A gun system can begin for the first time later this year. Until then, it is unknown if the F-35 gun system, aimed by the Gen III HMDS, will meet accuracy requirements for air-to-air and air-to-ground gun employment. In addition, flight sciences testing of the F-35A recently revealed that the small doors that open when the gun shoots induce a yaw (i.e. sideslip), resulting in gun aiming errors that exceed accuracy specifications. As a result, additional software changes to the flight control laws, very late in the flight test program, may be needed to cancel out the yaw when the gun doors are open. These control law changes, if required, and the resulting regression testing, would delay the start of gun accuracy flight testing on mission systems test aircraft, currently planned for this fall, due to the time required for development, regression testing and integration into a late or unplanned version of Block 3F software. The program may not have adequate funding or time remaining to implement and test the required F-35A gun fixes prior to the planned start of IOT&E. The most recent program office schedule estimates that gun modifications will not be completed on the IOT&E aircraft until 2020. Of note, the F-35B and F-35C gun pods are farther behind in testing, so new discoveries requiring late fixes and additional modifications are likely. Therefore, the program's ability to deliver gun capability with Block 3F is at risk.

- ALIS development and testing continue to fall further behind the planned schedule. As mentioned previously, the program had planned to field ALIS 2.0.2 to support the Air Force IOC declaration, but progress in development prevented that from happening. More recently, the program cancelled a logistics test and evaluation (LT&E) of the ALIS software build 2.0.2 that was planned for August and is now planning to combine it with another test event and move planned testing at the developmental test center at Edwards AFB, California to the operational test unit at Nellis AFB, Nevada. This move to test a new software version of ALIS for the first time at an operational unit is high risk, as problems will inevitably be discovered and will likely affect flight operations at the unit. Also, the program had developed an ALIS test venue – referred to as the Operationally Representative Environment (ORE) – but apparently has elected not to use it to conduct the LT&E of this next version of ALIS software. The rationale for pushing an untested version of ALIS to the field without a complete LT&E, in light of the severe problems discovered with the previous version of ALIS 2.0.2, is not known, other than possibly time or funding constraints. Also, the final required delivery of ALIS capabilities, version 3.0, continues to slip due to the ongoing problems with ALIS 2.0.2.

- Prognostics Health Management (PHM) functions, which support required capabilities for reliability and maintainability, are mostly being deferred or are immature. The program planned to include 128 PHM algorithms in ALIS by the end of SDD. To date, no PHM algorithms have been fielded with any of the ALIS software builds. The program now plans to include only 16 algorithms – 8 in ALIS 2.0.2 and 8 in ALIS 3.0 – before the end of SDD. To work around the lack of PHM capability, the Services have accepted aircraft with additional inspection requirements (referred to as Production Aircraft Inspection Requirements, or PAIRs), along with the added maintenance burden these inspections bring.

- Program office plans and support for preparing for an adequate IOT&E have stagnated, as indicated by the following---

  - To date, the program has no executable plan to provide aircraft for IOT&E in the proper Block 3F configuration which is representative of the full-rate production aircraft, as required by the F-35 Lightning II Test and Evaluation Master Plan (TEMP), Fourth Revision, and as mandated by Title 10. Due to the lengthy program delays and discoveries during developmental testing, extensive modifications are required to bring the OT aircraft, which were wired during assembly to accommodate flight test instrumentation and produced in Lots 3 through 5, into the production-representative configuration required. Over 155 modifications are currently required for the 23 IOT&E aircraft, some of which are not on contract yet.

  - Despite program office assurances, an accredited simulator environment is not on track to be delivered in time to start IOT&E in 2018.

  - The OT aircraft require an instrumentation pod (the Data Acquisition Recording and Telemetry or DART pod) to be mounted on one of the weapons stations. The DART pod must be tested and cleared for a flight envelope that permits weapons to be simulated from that station – including the weapons bay doors opening and closing within the envelope cleared for the actual weapon – during operational testing. Currently the program does not have a plan for ensuring the DART pod gets cleared to the same envelope as the weapons.

- IOT&E will require integration of Air-to-Air Range Infrastructure (AARI) and associated range threat emitters with the fusion processing within the F-35. Within the aircraft, the Embedded Training (ET) function supports live/virtual/constructive training using a mixture of real and virtual entities (e.g., missiles, ground systems, and aircraft). To avoid intermingling data from real and virtual entities, as it may cause performance issues within the F-35, Lockheed Martin developed a separate model, referred to as the Fusion Simulation Model (FSM), to emulate fusion functionality for virtual entities within ET. However, the current FSM implementation has significant deficiencies that make the model so inaccurate that some required capabilities will likely not be usable for IOT&E. Although a properly functioning FSM is required for IOT&E, the program recently informed the JSF Operational Test Team that it currently has no funding or plans to correct the FSM deficiencies within SDD and prior to IOT&E.

Recommendations

The F-35 program appears to be focused on starting to close out SDD within the current schedule and budget at a critical time for the program when flight testing must continue at a high rate and required fixes must be implemented. Therefore, the program should immediately be provided the resources in FY17 required to adequately complete development, testing, required fixes, and fielding of the full Block 3F capabilities. Specifically, the program should be provided adequate resources to complete the following actions:

1. Continue addressing the deficiencies in fusion that currently affect tactical situational awareness, as presented on the cockpit displays to the pilot;

2. Ensure adequate funding is available to properly complete Block 3F development, including a plan for correcting and verifying deficiencies which will be discovered during IOT&E, prior to Block 4;

3. Fund and complete the contracting actions to complete all necessary modifications for all the IOT&E aircraft prior to the start of IOT&E, as required in the approved TEMP;

4. Ensure funding is available and contracting actions are completed as soon as possible for the necessary upgrades to the USRL, which are several years late to need;

5. Complete full development and testing of ALIS 3.0;

6. Ensure the planning, resourcing, and execution of adequate testing to assure the required DART pod envelope and data collection capability are provided in time for entry into IOT&E;

7. Plan, resource and execute a supportable test schedule to adequately integrate and characterize the JSF gun systems on all three variants prior to certification for entry into the OT pilot spin-up phase prior to formal IOT&E;

8. Address the current and emerging critical deficiencies in mission systems, ALIS, and mission planning that have been identified by the combatant commands and operational test teams.

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cc:
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