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STATEMENT

BY

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BEFORE THE

HOUSE ARMED SERVICE COMMITTEE

TACTICAL AIR AND LAND FORCES SUBCOMMITTEE

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Introduction

Mr. Chairman, my testimony reviews the progress made in flight and ground testing over the past year and provides an update to my fiscal year (FY)14 Annual Report on the Joint Strike Fighter (JSF) program.

Test Progress and Demonstrated Capability 2014

In the past year, the program focused on completing F-35 Joint Strike Fighter (JSF) Block 2B development and flight testing in an effort to provide limited combat capability to the fielded early production aircraft and to support the Marine Corps plans for declaring Initial Operational Capability (IOC) later this year. The test centers sustained flight operations at nearly the planned pace through the end of December, despite stoppages and restrictions placed on the test fleet of aircraft.

However, in spite of this focused effort, the program was not able to accomplish its goal of completing Block 2B flight testing by the end of October 2014, as was planned. Slower than planned progress in mission systems, weapons integration, and F-35B flight sciences testing delayed the completion of the testing, which is yet to be completed, required for Block 2B fleet release. Fleet release will make Block 2B missions systems available for use by operational pilots in operational aircraft which are not monitored by a control room engineering team, as are flight test aircraft. Notwithstanding an additional delay in completing testing of Block 2B missions systems relative to the information provided in my Annual Report, the Program Office currently projects fleet release of Block 2B, which is a prerequisite for Marine Corps IOC, to occur in July 2015. Restrictions imposed on the test fleet as a result of the engine failure in June

2014 blocked the execution of some test points and slowed progress in mission systems and flight sciences testing from July through the end of the year. These restrictions have gradually been relaxed for test aircraft. Throughout the year, the program reduced the amount of growth in test points, or additional testing executed beyond that envisioned by the approved test plan, from that experienced in previous years (which had been observed as high as 124 percent over a 12-month period). However, the program still experienced an average growth of 86 percent in Block 2B mission systems testing throughout calendar year (CY) 14, which is higher than the planned rate of 43 percent. This meant that the program executed almost twice as many test points to accomplish the planned Block 2B mission systems task. These additional points were necessary to characterize performance, collect data valuable in creating fixes to deficiencies, and determine if fixes were successfully implemented. This growth in needed test points due to discoveries as testing unfolds is to be expected in a development program as complex as JSF. Late in 2014 and into 2015, the program also worked to reduce the amount of planned testing remaining to achieve the Block 2B fleet release. Testing was determined by the program as no longer applicable to the Block 2B fleet release, but either needed for Block 3F, or no longer required. As of the end January 2015, the program had redesignated 160 of the 350 remaining baseline test points as no longer required, and an additional 150 points as “highly desirable,” but to be completed only if the program is able to do so consistent with other priorities.

In the FY13 Annual Report, I estimated the program might not complete Block 2B testing until between May and November 2015, depending on the level of growth in testing, while assuming the program would continue test point productivity equal to that of the preceding 12 months, and that it would accomplish all of the testing planned at that time. The combination of the actions described above taken by the program to restrict the execution of additional testing, defer or delete planned test points, sustain slightly better productivity in terms of test points executed per flight, and maintain higher capacity for Block 2B mission systems testing than previously planned by delaying conversion of three aircraft to Block 3i, all have enabled the program to complete much of the testing now judged to be necessary for Block 2B fleet release by the end of February 2015. Nonetheless, in the middle of February, the program decided to generate an additional Block 2B software version, relative to its previous plan, that is scheduled to be delivered to flight test in March, to address deficiencies identified from flight testing. As a result, the program now plans to complete Block 2B flight testing in June, 2015, which is eight months later than expected in the program's prior Block 2B fleet release plans. The effect of flight testing of this additional software build on fleet release and the plans for the Marine Corps to declare IOC is not known to DOT&E. In my view, the program office should be commended for taking this action to correct deficiencies of operational significance revealed through ongoing testing.

In March of last year, I recommended to the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) that the Block 2B Operational Utility Evaluation (OUE), which was planned to occur in mid-2015, should not be conducted. Instead, resources should be focused on conducting limited assessments of Block 2B capability and re-allocated to assure the completion of development and testing of Block 3i and Block 3F capabilities. In April, in coordination with the Service Acquisition Executives and the JSF Program Executive Officer, the USD(AT&L) agreed with my recommendation and approved substantially revising and down-scoping the content of the operational test period that had been allocated for the Block 2B OUE in the program's Test and Evaluation Master Plan. The JSF Operational Test Team, JSF Program Office, and the Services' operational test agencies began re-planning the Block 2B operational test period and activities. I made this recommendation after reviewing several factors: limited operational suitability, an inability to prepare pilots with adequate training and approved tactics on the planned schedule, and the deferral of fixes for operationally-relevant deficiencies to Block 3. It was also clear in March that aircraft availability for operational testing would be driven by the long timelines required to modify and retrofit the early production operational test aircraft to the full Block 2B configuration, which would not be complete until mid-2016. I assessed that delaying the Block 2B OUE until late 2016, as opposed to cancelling it, would have a significant negative effect on the program's ability to complete development of the full Block 3F combat capability in a timely manner.

Two key factors leading to my recommendation did not improve over the course of the year. First, in addition to late completion of Block 2B flight testing, the program's most recent aircraft depot modification plans would not make operational test and evaluation (OT&E) aircraft available in the full Block 2B configuration until January 2017, four months later than indicated in my annual report. This additional delay has occurred because the program has given priority to assuring the F-35B aircraft supporting the Marine Corps IOC have completed all needed modifications. Although five of the six F-35A OT&E aircraft assigned to the Edwards Air Force Base test squadron have been partially converted to the Block 2B configuration (i.e., full modification has not been completed) and are being flown with Block 2B software, the aircraft are still under operational limitations that restrict their utility. For example, these aircraft are currently restricted to maneuvers not exceeding 3 g's due to the limitation imposed on the fleet from the engine failure in June 2014. (Fully capable F-35A aircraft are to be able to maneuver at up to 9 g's.) The aircraft are also restricted from steep dives (greater than 50,000 feet per minute) due to fuel tank pressurization limitations. Additional restrictions include the prohibitions of: operating the weapon bay doors in flight, using the night vision camera display in the helmet, and night flying in instrument meteorological conditions. These limitations prevent the use of realistic combat tactics, which would have been necessary for conducting the OUE. Second, the mission data loads previously planned for release in mid-2015 will not complete the planned lab and flight testing until early 2016. The mission data loads enable the aircraft's sensors to search for, identify, and locate threat radio frequency emissions, a capability critical to the aircraft's combat effectiveness. The loads are being produced by a government laboratory, the U.S. Reprogramming Lab (USRL), which, it now is certain, is not adequately equipped for the task for Block 2B, Block 3F or beyond.

I need to emphasize problems caused by the deficiencies in the USRL, which I referred to in my annual report. Early in the program, a decision was made jointly by the contractor and the government to outfit the USRL facilities by simply replicating the planned mission systems development lab at Lockheed Martin, in Fort Worth, Texas. Apparently, between 2002 and 2008, the assumption was that the mission data file generation and mission data load testing capability needed by the USRL was essentially equivalent to, or perhaps a subset of, that needed for mission systems software integration. I reported my concerns to USD (AT&L) regarding significant shortfalls in the two laboratories' capabilities two years ago, and the program now recognizes significant shortfalls do indeed exist. In particular, the program now agrees that the USRL, as delivered by the contractor, has neither adequate hardware nor software for mission data load development and generation. For example, in addition to significant shortfalls in needed hardware, the software tools for generating mission data files were delivered with severe "bugs" that cannot be quickly remedied, which are preventing engineers from generating the mission data loads needed to quickly detect and accurately identify radiofrequency emissions. It is essential to act quickly to correct these shortfalls, as I have recently recommended to the USD (AT&L), to assure effective mission data loads for Block 3F, fully-combat-capable aircraft can be generated. My understanding is that the program believes funding constraints are an obstacle to making the necessary corrections. In my view, it would be a serious mistake to underfund and/or delay the needed corrections, as they are critical to the success of the F-35 in combat.

The performance of Block 2B aircraft presently completing flight test will provide limited combat capability to operational units. Block 2B aircraft are limited to internal carriage of two short-range air-to-surface bombs of the same type and two medium-range air-to-air missiles; external weapons, mixed loads of weapons, gun employment, stand-off air-to-surface weapons, and more air-to-air missile capability are planned for Block 3F. Weapons integration testing has provided valuable information about system deficiencies that must be corrected in Block 3F in order to provide the F-35 autonomous targeting capability. Weapons delivery events in developmental testing to date have been characterized by significant involvement of the test control team to assist in target acquisition and identification and monitoring of sensor performance, such as radar search volume and target track stability. Fusion of own-ship and flight-member information continues to be problematic. Until these problems are resolved, it will be difficult for F-35 aircraft to operate either autonomously or with other aircraft systems to build situation awareness and simultaneously engage multiple air and surface targets, which is the requirement. Recent tests of multi-ship operations indicated debilitating clutter on the cockpit displays of the F-35 aircraft contributing to poor battlespace awareness and significantly detracting from target identification, location, and weapons employment. Mission systems performance problems combine with the problems I have identified with the mission data load generation and testing to increase pilot workload in discerning actual targets, prioritizing threats, and employing weapons. There are also several gaps of lesser operational significance between the Block 2B capabilities that have been planned for release to the fleet and the capability currently available in F-35 aircraft, such as lack of an infrared pointer and variable message format communications for close air support missions, lack of short-range radar target acquisition modes, and stable formation secure communication networks, all of which are useful in a variety of combat situations. Finally, though the Block 2B fleet release is planned to result in limited 5.5 g maneuver capability for the F-35B, and 7 g for the F-35A, current operating limitations are much more restrictive for F-35s that are not flight test aircraft. The restrictions on non-test aircraft (i.e. fielded, operational and training aircraft) due to the engine failure which occurred in June 2014 may be relaxed from the current 3 g limitation if the production aircraft are modified with pre-trenched stators or a "rub-in" flight procedure is completed. Additional restrictions due to a fuel siphon tank overpressure problem discovered last year may limit maneuverability by restricting g-load as a function of fuel weight as well. The details of the restrictions for fleet aircraft are still be determined by the Program Office and the operational impact is not known. There are also operating limitations associated with carriage of weapons, both air-to-air and air-to-surface, which persist until the weapons are expended; these limitations, which have been imposed in part based on results of the ongoing test program, affect self-defense and target attack capabilities. The fact that these problems exist notwithstanding the Program Office's best efforts is, in my view, not surprising given the decision early in the last decade to begin producing F-35 aircraft prior to testing.

To meet contract specification requirements, the program structures flight testing to provide data for the purpose of closing individual success criteria. As of January 21, there are 263 success criteria remaining to be closed that are aligned with the Block 2B fleet release, which is planned by the program to occur by July 2015. This number is only slightly less than the 288 success criteria that were closed in the last three years, since February 2012, and is an indication of the challenges that remain to successfully complete Block 2B fielding.

Because of the limited combat capability being provided in Block 2B, if the F-35 will be used in combat it will need the support of a command and control system that will direct target acquisition and control weapons employment for the limited weapons carriage available. If opposed, the F-35 Block 2B aircraft would need to avoid threat engagements and require augmentation by other friendly forces. In a Close Air Support (CAS) mission, for example, F-35B aircraft will need to operate under the direct control of a forward air controller, using voice communications to receive target information and clearance to attack. This is because of the combined effects of digital communications deficiencies, lack of infrared pointer capability, limited ability to detect infrared pointer indications by a controller, and inability to confirm coordinates loaded to GPS-aided weapons. If F-35 aircraft are employed at night for combat, pilots will have no night vision capability available due to the restriction on using the current night vision camera, which is planned to be subsequently upgraded after aircraft are retrofitted with Block 3i, using the Generation III helmet. In general, using Block 2B F-35 aircraft, pilots would operate much like early fourth generation aircraft using cockpit panel displays, with the distributed aperture system providing limited situational awareness of the horizon, and heads-up display symbology produced on the helmet. An F-35B, assuming, a 250-nautical mile ingress to a CAS area contact point would have approximately 20-30 minutes to organize with the controller and execute an attack using its two air-to-surface weapons. This would have to be above or outside of threat engagement zones. By comparison, an Air Force A-10 would have approximately one and one half hours of time in the CAS area under the same conditions, but would be able to autonomously acquire and identify targets, while using datalink to receive and/or pass target and situation awareness information. An A-10 would also be able to employ at least four air-to-surface weapons, including the ability to carry a mixed load of ordnance and employ its internal gun, which provides very useful flexibility in the CAS role. Although F-35 loiter time can be extended by air refueling, operational planners would have to provide sufficient tankers to make this happen. The F-35 fuel burn rate is very high compared to legacy strike fighters, at least 60 percent higher than the F-16C and 180 percent higher than the A-10. This creates a burden on the air refueling resources if used to increase F-35 loiter time.

Of course, the F-35 is designed to do more missions than CAS, which is the primary mission for which the A-10 was designed. Also, F-35 development is not complete. If the capabilities stated in the Operational Requirements Document (ORD) are realized, Block 3F F-35 aircraft will have the ability to carry weapons externally, for an increased payload, as well as a gun. For example, a Block 3F F-35A aircraft could carry six GBU-12 laser-guided bombs (vice two in Block 2B) along with four air-to-air missiles (two AIM-120C and two AIM-9X). Fusion of information from on-board sensors and data from off-board aircraft (both F-35 aircraft in formation via the multi-function advanced data link (MADL) and other aircraft via Link 16) is planned to be much more capable and would provide better battlespace awareness than that being fielded with Block 2B and better than the capability of an A-10.

Block 3i was not planned to incorporate any new capability or fixes from the Block 2B development/fleet release. Though it eventually began in May 2014, Block 3i flight test progress began five months late as a result of hardware deficiencies, and has progressed more slowly than expected. As of the end of February, the program had completed only 25 percent of the baseline Block 3i test points and further testing was blocked as the test centers were awaiting the next iteration of Block 3i software. The first increment of Block 3i capability, designated 3iR1, is the initial release to Lot 6 aircraft and includes only Block 2A capability (no combat capability and inherently less capable than the final Block 2B fleet release). Subsequent increments of Block 3i software are planned to have additional capability. The second iteration of Block 3i software, 3iR4, included the capability to test the new Generation III Helmet-Mounted Display System (Gen III HMDS). The Edwards Air Force Base test center flew four test missions with 3iR4 on AF-3 in September 2014, accomplishing regression test points and some initial test points from the Gen III HMD test plan. This was the first testing of the new HMDS on F-35 test aircraft. The test team discovered deficiencies, particularly in the stability of the new display management computer – helmet (DMCH), and suspended further testing until software that fixes the deficiencies in the helmet system can be provided to the prime contractor and included in an updated load of mission systems software. The third increment of Block 3i software – version 3iR5 – will be used to provide production software for Lot 7 aircraft, the first lot to be delivered with the Gen III HMDS, which is planned to start delivery in July 2015. The program plans for the production software to have the equivalent capabilities as Block 2B and intends to deliver 3iR5 software to flight test in March, seven months later than in the baseline schedule approved in early 2013. It is not clear whether the delay in releasing 3iR5 software to flight test is due to problems in developing the software and testing it in the lab, or whether the program needs to continue development of the Block 2B software at the expense of continuing Block 3i and Block 3F development. Regardless of the reason, since Block 2B development and flight test was not completed as planned in October, the completion of Block 3i testing will be delayed if the equivalent capabilities from Block 2B development are to be realized in Block 3i. Assuming the program is able to restart Block 3i flight testing in March, plans adjusted in February – to allow

Block 2B flight testing to continue to June – show Block 3i testing completing between October and December 2015, which is eight to ten months later than the baseline master schedule completion date of February 2015. Additional time may be needed to address corrections to deficiencies identified in the Gen III HMDS and will add risk to the schedule.

The program needs to complete Block 2B development and flight test so it can transition fully to Block 3i, and focus on Block 3F in order to complete Block 3F development and test in late 2017. The program already acknowledges four to six months "pressure" on the end of Block 3F development and test, which is meant to provide "full warfighting capability." The test centers and contractor are completing detailed planning of Block 3F flight test. The test plan currently has approximately 7,000 test points. Plans completed after the 2012 rebaselining of the program showed the start of Block 3F flight testing in May 2014 and completion in February 2017, a span of 33 months. However, current program plans are to start Block 3F flight test in March 2015, simultaneous with the restart of Block 3i flight testing. If historical capacity to achieve test points remains consistent through the completion of Block 3F, and no additional testing is needed, Block 3F developmental testing would complete no earlier than October 2017, which represents at least eight months of schedule pressure.

Carrier Integration

Ship Integration and Suitability Testing for the F-35B and F-35C is underway. Following two previous periods of testing – one in October 2011 and one in August 2013 – the Marine Corps plans to conduct another test period on the USS *Wasp* in May 2015 to assess ship integration and suitability issues, using non-instrumented production F-35B aircraft and a non-deployable version of the Autonomic Logistics Information System (ALIS) standard operating unit (SOU) Version 1 installed on the vessel. Originally a part of the Block 2B OUE, this deployment has been re-scoped to support plans for the Marine Corps IOC later in 2015. The plans call for up to six production aircraft for the deployment, scheduled to take place in May 2015. These aircraft are not instrumented (as test aircraft are) and will allow the USS *Wasp* to operate its radars and communications systems in a representative manner since there is no concern with electromagnetic interference with flight test instrumentation. Nonetheless, the flight operations will not be representative of combat operations, unless the flight clearance and associated certifications enabling the deployment include clearances for weapons carriage and employment. These clearances are expected at fleet release, scheduled for July 2015, after the deployment. Maintenance will be mostly military, but with contractor logistics support in line with expected 2015 shore-based operations, such as having contractors perform propulsion data downloads after each flight. Maintenance operations will be conducted using some non-operationally representative support equipment, such as the Multifunction Analyzer Transmitter Receiver Interface Exerciser (MATRIX) laptop computer, a contractor-developed tool used for monitoring and troubleshooting electronic messages from the air vehicle during start up and shut down. The MATRIX is currently being used at field locations, but not part of production-representative maintenance concept of operations. Another example is the combined generator/air conditioning cart designed to support developmental flight testing, but used at fielded locations until production standard air and power carts are available. Maintenance activity will be limited to that required for basic flight operations, staging necessary support equipment for engine and lift fan removals only to check if space permits, and loading and downloading demonstrations of inert ordnance on the flight deck. These limitations are not representative of deployed combat operations.

For the F-35C, carrier-based ship suitability testing is divided into three phases. The first phase, DT-1, consisted of initial sea trials to examine the compatibility of F-35C with a CVN class ship and to assess initial carrier take-off and landing envelopes with steady deck conditions, a subset of the operational environment to be explored in future testing. DT-1 was conducted November 3 - 15, 2014; it was initially scheduled to begin in July. During DT-1, the test team completed 33 test flights (39.2 flight hours) and 124 arrested landings, of 124 attempts, including one night flight with two catapult launches and two arrested landings. No other aircraft deployed to the carrier, except transient aircraft needed for logistical support. All landings were flown without the aid of the Joint Precision Approach Landing System, which is planned for integration on the F-35C in Block 3F. No ALIS equipment was installed on the carrier. Instead, the test team created a network connection from the ship to the major contractor in Fort Worth to process necessary maintenance actions. The program expects to release a formal test report in March. The second and third phases, DT-2 and DT-3, consist of ship-borne operations with an expanded envelope, e.g., nighttime approaches, higher sea states than observed in DT-1 (if available), and asymmetrical external stores loading. DT-2 is currently planned for August 2015 and will expand the carrier operating envelope and include engine maintenance operations below deck, but likely with the same "reach back" ALIS architecture used for DT-1. The third set of sea trials is planned for CY16 and will be the first trials with ALIS on the ship.

Fielded Aircraft Availability

Aircraft monthly availability averaged 41 percent for the 12-month period ending November 2014 in the training and operational fleet, with a rapid increase in reported availability occurring between September and October. Prior to this increase, monthly availability rates remained relatively consistent in the 30 to 40 percent range for the two years ending September

2014. In October, availability achieved 50 percent for the first time in program history. The 11 percent jump in availability from 39 percent in September 2014 was also one of the largest month to month increases in program history. Availability reached 54 percent in November. The program established a goal of 60 percent availability by the end of 2014, but preliminary data indicate it did not meet this goal.

Aircraft availability rates by operating location for the 12-month period ending November 2014 are summarized in the table below. The first column indicates the average availability achieved for the whole period, while the maximum and minimum columns represent the range of monthly availabilities reported over the period. The number of aircraft assigned at the end of the reporting period is shown as an indicator of potential variance in the rates. Sites are arranged in order of when each site began operation of any variant of the F-35, and then arranged by variant for sites operating more than one variant.

F-35 Availability for 12-month period ending November 2014[1]				
Operational Site	Average	Max	Min	Aircraft Assigned
Whole Fleet	41%	54%	35%	93[2]
Eglin F-35A	42%	59%	35%	28
Eglin F-35B	41%	54%	26%	9
Eglin F-35C	54%	79%	24%	10
Yuma F-35B	35%	53%	24%	16
Edwards F-35A	44%	59%	19%	6
Nellis F-35A	33%	77%	19%	4
Luke F-35A[3]	48%	57%	23%	13
Beaufort F-35B[4]	26%	35%	4%	6

NOTES:
1. Data do not include flight test aircraft
2. Total includes 1 OT F-35B at Edwards that is not broken out in table
3. Luke F-35A data began in April 2014
4. Beaufort F-35B data began in July 2014

The program tracks aircraft availability by assigning non-available aircraft one of three categories of status: Not Mission Capable for Maintenance (NMC-M); Not Mission Capable for

Supply (NMC-S); and in depot. The program added the third category for tracking fleet status in January 2014 as the number of aircraft entering the depot for modifications, or receiving modifications or repair by a depot field team at the home station, began to increase. Prior to January 2014, these aircraft were assigned as Non-Possessed (NP) or Out Of Reporting (OOR) for depot-level actions under an NMC-M status. The program established new goals for all three of these unavailable statuses for 2014. The NMC-M goal is 15 percent, NMC-S is 10 percent, and depot status is 15 percent.

- The NMC-M rate averaged 25 percent for the 12-month period ending November 2014. The program showed an improving trend in NMC-M at the end of 2014. In September, NMC-M was 28 percent, but in October, it dropped (improved) to 24 percent, and in November, it further improved to 18 percent. A substantial amount of NMC-M down time continues to be the result of field maintenance organizations waiting for technical dispositions or guidance from the contractor on how to address a maintenance issue that has grounded an aircraft. These action requests (AR) are a result of incomplete or inadequate technical information in the field, in the form of Joint Technical Data (JTD). While JTD validation has progressed, the complexity of ARs is increasing, leading to longer times to receive final resolution. Reducing the rate of ARs or decreasing the response time to the ARs will improve (lower) NMC-M rates. NMC-M rates are also negatively influenced by long cure times for both Low Observable (LO) and non-LO materials. These items are the top two drivers for Elapsed Maintenance Time (EMT) on the aircraft by a wide margin. LO cure times account for sealants, coatings, and putties used to directly repair damage to the outer mold line, or to restore LO performance margins after maintenance that breaks the outer mold line. The latter can happen when a non-“quick-access” panel is removed to facilitate replacement of a failed component behind the panel, and an LO restoration is required after the panel is reattached. Non-LO cure time is accounted for by adhesives used to secure attaching hardware to the aircraft, such as nut plates and brackets, as well as internal sealants and gasket materials. The Program Office is addressing long cure times by introducing new materials with much shorter cure times.

- Over the 12-month period ending November 2014, the NMC-S rate displayed an improving trend, beginning at 26 percent in December 2013 and decreasing to rates in the high 10s to low 20s by mid-2014. In 2013, the Program Office predicted that better contracting performance and the maturing supply system would result in improved supply support resulting in lower NMC-S rates by late 2014. Although the trend is favorable, the rate of improvement is not yet fast enough to allow the program to achieve their goal of 10 percent NMC-S by the end of 2014. If the current trend continues, the program could reach this target around mid-2015.
- A large portion of the fleet began cycling through the depot for modifications made necessary by concurrent development, reducing overall fleet availability. The program began reporting the percentage of the fleet in depot status starting January 2014 at 13 percent, and since then it has risen to as high as18 percent as of July 2014. Current plans show over 10 percent of the operational aircraft inventory will be in depot status, either at a dedicated facility or being worked on

> by a depot field team at the home station, through at least mid-2015. All of the necessary depot-level modifications may not yet be identified, as testing and development are not complete. Although depot modifications reduce overall fleet availability, they potentially improve availability once the aircraft is out of depot by replacing low reliability components with improved versions, such as the 270 Volt Battery Charger and Control Unit. Any increased availability from reliability improvements will take time to manifest in the fleet-wide metrics, with significant improvement becoming evident only after the majority of aircraft have been modified.

Low availability rates, in part due to inadequate reliability, are preventing the fleet of fielded operational F-35 aircraft (all variants) from achieving planned, Service-funded flying hour goals. Original Service plans were based on F-35 squadrons ramping up to a steady state, fixed number of flight hours per tail per month, allowing for the projection of total fleet flight hours. In November 2013, a new "modelled achievable" flight hour projection was created because low availability was preventing the realization of bed-down plan flight hours. The revised model used selected actual fleet maintenance and supply data, and also made assumptions about the evolution over time of the many factors affecting availability to predict the number of flight hours the fleet could generate in the future. By October 30, 2014, the fleet had flown approximately 72 percent of the modelled achievable hours because availability had not increased in accordance with assumptions. In November 2014, the Program Office made another "modelled achievable" flight hour projection. This new projection used actual flight hours achieved at the beginning of November 2014 and made assumptions about future availability rates similar to the assumptions incorporated in the November 2013 projection to predict future fleet flight hours, but also used updated fleet supply and maintenance data. The fleet flight hours achieved since then, through the end of February, appear to be tracking to this new model, but are well below the original bed-down plan, as can be seen in the table below.

F-35 Fleet Planned vs. Achieved Flight Hours as of February 26, 2015			
Variant	Original Bed Down Plan Cumulative Flight Hours		
	Estimated Planned	Achieved	% Planned
F-35A	16,000	8,934	56%
F-35B	10,000	7,588	76%
F-35C	3,000	1,419	47%
Total	29,000	17,941	62%

F-35 Reliability

Aircraft reliability is assessed using a variety of metrics, each characterizing a unique aspect of overall weapon system reliability.

- Mean Flight Hours Between Critical Failures (MFHBCF). This metric includes all failures that render the aircraft not safe to fly, and any equipment failures that would prevent the completion of a defined F-35 mission. It includes failures discovered in the air and on the ground.
- Mean Flight Hours Between Removal (MFHBR). This metric gives an indication of the degree of necessary logistical support and is frequently used in determining associated costs. It includes any removal of an item from the aircraft for replacement with a new item from the supply chain. Not all removals are failures, and some failures can be fixed on aircraft without a removal. For example, some removed items are later determined to have not failed when tested at the repair site. Other components can be removed due to excessive signs of wear before a failure, such as worn tires.

- Mean Flight Hours Between Maintenance Events, unscheduled (MFHBME). This metric is useful primarily for evaluating maintenance workload. It includes all failures, whether inherent or induced by maintenance actions, that lead to maintenance and all unscheduled inspections and servicing actions.
- Mean Flight Hours Between Failure, Design Controllable (MFHBF_DC). This metric includes failures of components due to design flaws under the purview of the contractor, such as the inability to withstand loads encountered in normal operation.

The F-35 program developed reliability growth projections for each variant throughout the development period as a function of accumulated flight hours. These projections are shown as growth curves and were established to compare observed reliability with target numbers to meet the threshold requirement at maturity, defined by 75,000 flight hours for the F-35A and F-35B, and by 50,000 flight hours for the F-35C; and 200,000 cumulative fleet flight hours. In November 2013, the program discontinued reporting against these curves for all ORD reliability metrics, and retained only the curve for MFHBF_DC, which is the only reliability metric included in the JSF Contract Specification (JCS). The growth curves for the other metrics have been re-constructed analytically and are used below for comparison to achieved values. As of the end of November 2014 the F-35, including both operational and flight test aircraft, had accumulated approximately 22,000 flight hours, or slightly more than 11 percent of the total 200,000 hour maturity mark defined in the ORD. By variant, the F-35A had achieved around 11,000 flight hours, or nearly 15 percent of the total 75,000 hours for its variant specific maturity. The F-35B accumulated approximately 8,300 hours, or slightly more than 11 percent of its 75,000 hours to maturity. The F-35C achieved just over 2,700 hours, or over 5 percent of its 50,000 hours to maturity.

The most recent reported and projected interim goal of MFHBCF, with associated flight hours, are shown in the table below. Threshold at maturity, and the values reported in the prior five months are shown for comparison.

F-35 Reliability: MFHBCF (hours)										
ORD Threshold			Values as of November 29, 2014			Prior Observed MFHBCF (3 Mos. Rolling Windows)				
Variant	MFHBCF	Flight Hours	Observed MFHBCF (3 Mos. Rolling Window)	Cumulative Flight Hours	Interim Goal to Meet ORD Threshold MFHBCF	JUN 2014	JUL 2014	AUG 2014	SEP 2014	OCT 2014
F-35A	20	75,000	10.8	10,979	15.4	6.6	6.3	8.2	8.4	10.4
F-35B	12	75,000	6.2	8,329	8.8	8.7	7.3	7.5	6.3	6.3
F-35C	14	50,000	7.3	2,727	9.6	6.5	8.4	8.3	6.0	7.0

Similar tables showing the current reported and projected interim goals, plus the reported values for the prior five months for comparison, for MFHBR, MFHBME and MFHBF_DC for all three variants are provided in the tables below. MFHBF_DC is a contract specification and its Joint Contract Specification (JCS) requirement value is shown in lieu of an ORD threshold.

F-35 Reliability: MFHBR (hours)										
ORD Threshold			Values as of November 29, 2014			Prior Observed MFHBR (3 Mos. Rolling Windows)				
Variant	MFHBR	Flight Hours	Observed MFHBR (3 Mos. Rolling Window)	Cumulative Flight Hours	Interim Goal to Meet ORD Threshold MFHBR	JUN 2014	JUL 2014	AUG 2014	SEP 2014	OCT 2014
F-35A	6.5	75,000	4.3	10,979	5.0	3.9	3.1	3.1	2.9	4.0
F-35B	6.0	75,000	2.8	8,329	4.4	3.1	2.8	2.5	2.4	2.6
F-35C	6.0	50,000	3.3	2,727	4.1	2.9	2.7	2.3	2.3	2.7

F-35 Reliability: MFHBME (hours)										
ORD Threshold			Values as of November 29, 2014			Prior Observed MFHBME (3 Mos. Rolling Windows)				
Variant	MFHBME	Flight Hours	Observed MFHBME (3 Mos. Rolling Window)	Cumulative Flight Hours	Interim Goal to Meet ORD Threshold MFHBME	JUN 2014	JUL 2014	AUG 2014	SEP 2014	OCT 2014
F-35A	2.0	75,000	1.09	10,979	1.5	0.92	0.82	0.85	0.83	1.03
F-35B	1.5	75,000	1.02	8,329	1.1	1.16	1.05	0.96	0.89	0.98
F-35C	1.5	50,000	1.09	2,727	1.0	0.88	0.93	0.84	0.81	0.93

F-35 Reliability: MFHBF_DC (hours)										
Contract Specification Requirement			Values as of November 29, 2014			Prior Observed MFHBF_DC (3 Mos. Rolling Windows)				
Variant	MFHBF_ DC	Flight Hours	Observed MFHBF_DC (3 Mos. Rolling Window)	Cumulative Flight Hours	Interim Goal to Meet Contract Specification MFHBF_DC	JUN 2014	JUL 2014	AUG 2014	SEP 2014	OCT 2014
F-35A	6.0	75,000	4.9	10,979	4.3	4.8	4.0	4.0	3.9	4.7
F-35B	4.0	75,000	4.2	8,329	2.8	4.6	3.7	3.5	3.4	3.8
F-35C	4.0	50,000	4.5	2,727	2.5	3.4	3.3	3.6	3.3	4.2

The trends in the reliability metrics we track are unclear. The most recent data we have obtained generally indicate, with the exception of Mean Flight Hours Between Critical Failure for the F-35B, a three-month upward trend from September 2014 through November 2014. However, when combined with data from the previous three months, the data show both declines and increases, indicating we cannot yet conclude with confidence that reliability is significantly improving. Comparing observed values to interim goals to meet ORD or contract specification requirements at maturity, only for mean flight hours between design controllable failure did all three variants exceed the interim goal. Amongst the rest of the metrics, only the F-35C was ahead of an interim goal, and that was for mean flight hour between maintenance events.

DOT&E will continue to update reliability growth analyses as additional reliability data become available.