

F-35B: A Less-Than-Capable Platform  
EWS Contemporary Issue Paper  
Submitted by Captain E.A. Peterson  
To  
Major D.R. Everly, CG 8  
19 February 2008

# Report Documentation Page

*Form Approved*  
*OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>19 FEB 2008</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2008 to 00-00-2008</b>	
4. TITLE AND SUBTITLE <b>F-35B: A Less-Than-Capable Platform</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>United States Marine Corps, Command and Staff College, Marine Corps Combat Dev, Marine Corps University, 2076 South Street, Quantico, VA, 22134-5068</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
				10. SPONSOR/MONITOR'S ACRONYM(S)	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
				12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>	
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>13</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

**How many different things do you want to be bad at?**  
**--LtCol Mark O'Connor, USMC (Ret.)<sup>1</sup>**

Nicknamed "Lightning II," the F-35 is a family of conventional take-off and landing, aircraft carrier-capable, and short take-off/vertical landing (STOVL) aircraft.<sup>2</sup> Arguably the most controversial of this family is the F-35B STOVL variant, which is destined to replace the USMC's aging F/A-18 and AV-8B fleets. While the mantra "newer is better" is typically the rule, the STOVL variant is an exception. The F-35B will prove to be a less-than-capable platform due to its limited ordnance payload, single engine, and single aircrew design.

### **Limited Ordnance Payload**

Perhaps the most apparent shortcoming of the F-35B is its decreased ordnance payload capability compared to the aircraft it will replace. According to Jane's Online, the F-35B will have a total of eleven weapons stations: six external and five internal.<sup>3</sup> The number of stations is equal to that of the F/A-18E/F Super Hornet while exceeding the F/A-18A-D Hornet and AV-8B Harrier by two and four, respectively. These numbers are misleading, however, as the F-35B has significant limitations on

---

<sup>1</sup> Mark O'Connor, interview with author, 4 January 2008.

<sup>2</sup> Christopher Bolkcom, *F-35 Joint Strike Fighter (JSF) Program: Background, Status, and Issues*, Congressional Research Service (CRS) Report RL30563, July 2007, 1.

<sup>3</sup> Jane's Online, *F-35*, <<http://www.janesonline.com/f-35>> (30 November 2007).

the types and weight of ordnance with which it can be loaded. For example, today's Hornets are capable of carrying up to 13,700 pounds of ordnance.<sup>4</sup> When specific to an air-to-air mission, this loadout can include up to twelve medium and/or short-range missiles, or up to four Mk-84 (2,000-pound class) bombs for air-to-surface missions, or any load combining the above. The F-35B, however, will be limited to only two internally carried medium-range missiles and two externally carried short-range missiles, and/or no more than two Mk-83 (1,000-pound class) internally carried bombs (up to 24 externally carried 250-pound small diameter bombs may also be carried, but these are still in development).<sup>5</sup> The limitation to carry only two one-thousand pound bombs is comparable to the limitation currently realized within the Harrier community. Twice as many F-35B's will be required to achieve the same weapons effectiveness as just one of today's multi-role aircraft due to these substantial ordnance inadequacies.

While additional ordnance can be attached to its external wing stations, it will come at a significant cost to stealth capability. Though it was not designed to embody the same degree of stealth as that of the USAF's B-2 Spirit or F-117 Nighthawk, the F-35B is intended to be of "low observability to

---

<sup>4</sup> Federation of American Scientists, *F/A-18*, <<http://www.fas.org/man/dod-101/sys/ac/f-18.htm>> (14 December 2007).

<sup>5</sup> Jane's Online.

radar and sensors," producing significantly smaller radar returns than those of today's fighter and attack aircraft.<sup>6</sup> This stealth capability will be negated, though, if ordnance is attached to the external stations. The F-35B will be limited to its minimal internal payload in order to maximize its stealth potential.

A third shortfall regarding the F-35B's ordnance capabilities is its lack of an internal cannon. While both the F-35A and F-35C are designed to include a gun, the F-35B is not. During early assessments, it was determined that the STOVL variant was grossly overweight. Removal of the gun was one of the "fixes." Engineers decided on a removable GAU-12 25mm gun pod that can be externally attached or removed as necessary (the AV-8B uses a similar system). It is unclear if this weapon will be used for both air-to-air and air-to-surface missions, or designed specifically for the latter. What is certain, however, is the lack of a gun in the air-to-air environment places the F-35B at a significant disadvantage in a "within visual range" fight.

### **Single Engine**

The F-35B's performance, dependability, and capability will suffer due to its single engine design. In the STOVL variant,

---

<sup>6</sup> Bolkcom, 4.

the engine will not only provide thrust for forward movement, but will also swivel to produce direct lift. The engine will also power a forward lift fan which will provide the additional lift required for the aircraft to hover. Though the engine has received promising reviews from contractors and developers for its ease of maintenance and reliability, few care to acknowledge the engine's shortcomings, particularly regarding vertical landings.<sup>7</sup> In total, the F-35B is capable of producing 39,800 pounds of thrust.<sup>8</sup> Subtracting the empty weight of the aircraft (approximately 30,000 pounds), plus fuel (to include any fuel for safety/divert considerations: minimum 2,000 pounds), results in 7,800 pounds of thrust remaining.<sup>9</sup> Though this margin may appear comfortable, the excess thrust delta rapidly diminishes when one considers divert distances, the weight of a gun pod and other ordnance, or any aircraft component upgrades that may come along. For the expeditionary-type vertical landings that the F-35B is intended to conduct, its capability is severely limited because it must rely on the power of only one engine.

A second point of contention regarding the F-35B's single-engine design concerns the safety of both the airplane

---

<sup>7</sup> Global Security, *F-135*, <<http://www.globalsecurity.org/military/systems/aircraft/systems/f135.htm>> (14 December 2007).

<sup>8</sup> Global Security, *F-135*.

<sup>9</sup> Carlo Kopp, "ANALYSIS: Lockheed-Martin F-35 Joint Strike Fighter," 15 July, 2002, <<http://www.sci.fi/~fta/aviat-6b.htm>> (14 December 2007).

and its crew. Jet aircraft do not glide well; they require thrust to enable their wings to provide lift (or allow them to hover). Without thrust, the airplane will fly only as far as its crash site. The majority of today's tactical aircraft were designed around two engines (the F-16 and AV-8B being exceptions). Having more than one source of thrust provides a considerable amount of redundancy in running aircraft systems and ensuring a safe recovery of the aircraft. Given the USMC's vision for using the F-35B as an expeditionary platform, it is safe to assume that it will be required to execute vertical landings at Forward Operating Bases or aboard ships. What if the aircraft sustains battle damage to its forward lift fan? Suppose a mechanical failure prevents the jet exhaust nozzle from swiveling to its downward position? The pilot in either scenario will be left with only two choices: divert to an airfield where a conventional landing can be made (if enough fuel remains) or eject from the aircraft. Both of these scenarios refer to events just prior to landing. What if the pilot is hundreds of miles from his destination when his engine encounters a catastrophic failure? In a single-engine aircraft, his options are extremely limited. A second powerplant would provide more than enough thrust and lift to allow the pilot to fly his aircraft to his destination and recover safely with only one operational motor.

A third argument against the F-35B's single engine design is its lack of any significant increase in aircraft capability. Today's fighter aircraft are capable of flying in the Mach 1.7+ realm. When compared specifically to the F/A-18A-D, the multi-role platform the F-35B is ultimately intended to replace, the Lightning II is *slower* than the Hornet.<sup>10</sup> Although capable of reaching supersonic speeds, its less-than-impressive top speed of Mach 1.5 is a step backward in terms of defending against adversary aircraft and missiles.<sup>11</sup> The addition of a second engine would likely have resulted in a top speed close to or beyond Mach 2.0. For any aircraft with a limited air-to-air ordnance loadout, the capability to launch its weapons then turn and run away safely is essential. Unfortunately, the F-35B's "launch and leave" potential is capped due to its single engine design.

### **Single Aircrew**

A third reason why the F-35B will prove to be less than capable is that it has room for only one aircrew: the pilot. This will become a factor when it comes to learning to fly the

---

<sup>10</sup> Federation of American Scientists, *F/A-18*, <<http://www.fas.org/man/dod-101/sys/ac/f-18.htm>> (14 December 2007).

<sup>11</sup> Global Security, *F-35 Joint Strike Fighter Lightning II*, <<http://www.globalsecurity.org/military/systems/aircraft/f35-specs.htm>> (14 December 2007).

aircraft, employing the aircraft effectively in combat, and carrying out specific tactical missions.

A potential hurdle in developing combat effective F-35B pilots will be teaching them how to fly the airplane. Currently, there are no plans to field a two-seat training variant. Most AV-8B pilots will agree that hovering and vertical landings are the most difficult maneuvers to perform in their aircraft. The pilots were taught how to safely execute these maneuvers with an experienced instructor sitting behind them in a two-seat TAV-8B. Having an instructor able to regain control of the aircraft has prevented countless mishaps and taught many junior Harrier pilots valuable, yet costless lessons. What about the use of high-definition simulators? According to Quantum3D, the company responsible for the simulator's image generation system, "The F-35 simulator enables pilots to fly the aircraft in highly realistic simulator flight and air combat scenarios."<sup>12</sup> Unfortunately, however realistic it may appear, a computer simulation will never truly replicate the experience of flight; learning to fly an airplane requires getting airborne. The lack of pilot training in a two-seat STOVL variant will likely result in preventable losses of both aircraft and lives.

---

<sup>12</sup> Quantum3D, *Lockheed Martin Selects Quantum3D Independence for F-35 Joint Strike Fighter Advanced Concepts Simulator*, <[http://www.quantum3d.com/press/2003/07-28-03\\_lm\\_f-35.htm](http://www.quantum3d.com/press/2003/07-28-03_lm_f-35.htm)> (15 December 2007).

The F-35B is designed to incorporate today's latest technologies, making it a flying battlefield information hub. With the abundance of systems, though, comes the risk of overwhelming the pilot who must simultaneously fly his aircraft. Task saturation is the result of trying to do too much at once, and often leads to "close calls" and/or aircraft mishaps.<sup>13</sup> The number of built-in systems necessitates a second person to assist with the effective employment of all of the F-35B's capabilities. Most importantly, a second person would free-up a substantial amount of the pilot's attention, allowing him to ensure that the aircraft's flight parameters stay within tolerances. However, because the USMC requires that the F-35B be a STOVL aircraft, the lift fan has priority over a second aircrew position. Though the drawbacks of having only one aircrew may never truly be appraised, it is reasonable to assume that the majority of shortcomings would be alleviated with the addition of a second seat in part of the F-35B fleet.

A third complaint of the single-seat F-35B is its potential to satisfy the intended mission requirements in contrast with the aircraft it is meant to replace. The F-35B will not be as effective in the Forward Air Controller (Airborne) (FAC(A)) or

---

<sup>13</sup> Department of the Navy, *Technical Manual Safety Investigation Vol. III Safety Investigation Workbook*, 31 July 1987. <<http://safetycenter.navy.mil/aviation/aeromedical/downloads/references/00-80t-116-3.pdf>> (15 December 2007).

Tactical Air Controller (Airborne) (TAC(A)) roles as a two-seat platform. Both missions require a substantial amount of situational awareness and interactivity with other aircraft and procedural and terminal controllers. In the F/A-18D/F, for example, much of this work is done by the Weapons and Sensors Operator (WSO) while the pilot maneuvers the airplane for proper positioning and timing. Once the two-seat Hornet is replaced by the F-35B the total workload for these missions will fall on its one crewmember. The counter-argument that the Lightning II will be able to execute these missions is that single-seat F/A-18 and AV-8Bs pilots are currently training and qualifying as FAC(A)-capable. This, however, has resulted in a dispute throughout the USMC tactical aviation community over the necessity for and overall effectiveness of a single-seat platform conducting FAC(A)/TAC(A) missions. Given a high-threat scenario, mission requirements, and the multitude of aircraft systems the pilot will be tasked with managing, the F-35B will not be as effective a FAC(A)/TAC(A) platform as a two-seat aircraft.

### **Conclusion**

Although intended to be an improvement to the aircraft it is meant to replace, the F-35B will be a less-than-capable platform. Its ordnance limitations will require more aircraft to be employed in order to achieve the same results as one of

today's multi-role airplanes. A greater potential exists to lose more aircraft due to combat damage or mechanical failure as a result of its single engine design. Because there is only room for one aircrew, mission effectiveness may be severely degraded. Perhaps the only thing the USMC stands to gain by fielding the F-35B is an aircraft capable of achieving supersonic speeds and hovering in the same flight.

1858 words

## Bibliography

- Bolkcom, Christopher. *F-35 Joint Strike Fighter (JSF) Program: Background, Status, and Issues*. Congressional Research Service (CRS) Report RL30563, July 2007.
- Department of the Navy. *Technical Manual Safety Investigation Vol. III Safety Investigation Workbook*. 31 July 1987.  
<<http://safetycenter.navy.mil/aviation/aeromedical/download/s/references/00-80t-116-3.pdf>> (15 December 2007).
- Duvall, Stephanie and Jennifer Whitlow. "F135 Team Delivers F135 STOVL Propulsion System to Lockheed Martin." 28 November 2007. <[http://www.pw.utc.com/vgn-ext-templating/v/index.jsp?vnextoid=2e35288d1c83c010VgnVCM1000000881000aRCRD&prid=731ec855ec186110VgnVCM100000c45a529f\\_\\_\\_\\_](http://www.pw.utc.com/vgn-ext-templating/v/index.jsp?vnextoid=2e35288d1c83c010VgnVCM1000000881000aRCRD&prid=731ec855ec186110VgnVCM100000c45a529f____)> (14 December 2007).
- Federation of American Scientists. *AV-8B*.  
<<http://www.fas.org/man/dod-101/sys/ac/av-8b.htm>> (14 December 2007).
- Federation of American Scientists. *F/A-18*.  
<<http://www.fas.org/man/dod-101/sys/ac/f-18.htm>> (14 December 2007).
- Federation of American Scientists. *F-35*.  
<<http://www.fas.org/man/dod-101/sys/ac/f-35.htm>> (14 December 2007).
- Global Security. *F-135*.  
<<http://www.globalsecurity.org/military/systems/aircraft/systems/f135.htm>> (14 December 2007).
- Global Security. *F-35 Joint Strike Fighter Lightning II*.  
<<http://www.globalsecurity.org/military/systems/aircraft/f35-design.htm>> (14 December 2007).
- Global Security. *F-35 Joint Strike Fighter Lightning II*.  
<<http://www.globalsecurity.org/military/systems/aircraft/f35-specs.htm>> (14 December 2007).
- Global Security. *F-35B Joint Strike Fighter*.  
<<http://www.globalsecurity.org/military/systems/aircraft/f35b.htm>> (14 December 2007).

Janes Online. *F-35*. 21 December, 2006.

<<http://www.janesonline.com/f-35>> (30 November 2007).

Kopp, Carlo. "ANALYSIS: Lockheed-Martin F-35 Joint Strike Fighter." 15 July, 2002. <<http://www.sci.fi/~fta/aviat-6b.htm>> (14 December 2007).

O'Connor, Mark. Interview with author, 4 January 2008.

Quantum3D. "Lockheed Martin selects quantum3D Independence for F-35 Joint Strike Fighter Advanced Concepts Simulator." <[http://www.quantum3d.com/press/2003/07-28-03\\_lm\\_f-35.htm](http://www.quantum3d.com/press/2003/07-28-03_lm_f-35.htm)> (15 December 2007).