

It has been 16 years since the Pentagon laid out a set of requirements—the blueprint—for the advanced stealthy strike fighter now known as the F-35 Lightning II. Ambitious plans called for the Air Force's F-35A to be operational by now, before Russia or China could field their own stealth fighters.

Plans, unfortunately, have changed. Serious program delays have pushed scheduled deliveries well to the right. Today, no one expects the fifth generation F-35A to enter operational service before 2017, if then.

How much of the F-35's postulated combat advantage will remain? By the time it reaches squadron service, will it still be a dominant fighter, relative to the rest of the world? In short, is the F-35A going to be worth the wait?

If the view of Lockheed Martin is any guide, the answer is emphatically yes. In a recent briefing for *Air Force Magazine*, the F-35's developer offered important new details about the fighter's stealthy design, employment concepts, modern air combat capabilities, and more.

Just a Quartet

The briefing, summarized here, offers what should be viewed as something close to a best-case scenario for the new fighter.

Lockheed Martin Vice President Stephen O'Bryan, the company's point man for F-35 affairs, declared that the fighter meets requirements. A former Navy F/A-18 Hornet pilot, O'Bryan said the combat capability of even the earliest baseline model will greatly exceed that of the most heavily upgraded fourth generation fighters and strike aircraft, such as the F-15, F-16, and F-18.

The fighter's capabilities will make it a three- or four-for-one asset, said the Lockheed briefers, meaning that it will be able to simultaneously perform the roles of several different aircraft types—from strike to electronic attack, from command and control to battlefield surveillance.

O'Bryan pointed out an important truth about air combat: Fourth generation strike aircraft assigned to hit targets guarded by modern anti-access, area-denial systems (A2/AD, in military parlance) require the support of "AWACS, electronic attack, sweep air-

Lt. Col. Peter Vitt pilots the F-35 designated AF-4 through an air-to-air refueling evaluation flight.

The F-35's Race Against Time

By John A. Tirpak, Executive Editor

While the US readies the F-35, Russia and China are developing their own stealth fighters.

Lockheed Martin photo by Darin Russell

planes, SEAD” (suppression of enemy air defenses) aircraft and cruise missiles. Such a package could run to dozens of aircraft.

The same mission, he claimed, can be achieved with just a quartet of F-35s. Each would be capable of operations that go well beyond air-to-ground missions. The four-ship would be a potent factor in any scenario calling for the employment of airpower, O’Bryan asserted.

In short, he concluded, the F-35 is “the efficient package” for future strike missions, offering high probability of success with “lower probability of loss.”

When it comes to maintainable stealth design, the F-35 represents the state of the art, O’Bryan said, superior even to the F-22 Raptor, USAF’s top-of-the-line air superiority aircraft.

The F-22 requires heavy doses of regular and expensive low observable materials maintenance. F-35 stealth surfaces, by contrast, are extremely resilient in all conditions, according to the Lockheed team.

“We’ve taken it to a different level,” O’Bryan said. The stealth of the production F-35—verified in radar cross section tests performed on classified

western test ranges—is better than that of any aircraft other than the F-22.

This, he went on, is true in part because the conductive materials needed to absorb and disperse incoming radar energy are baked directly into the aircraft’s multilayer composite skin and structure.

Moreover, the surface material smooths out over time, slightly reducing the F-35’s original radar signature, according to the Lockheed Martin official. Only serious structural damage will disturb the F-35’s low observability, O’Bryan said, and Lockheed Martin has devised an array of field repairs that can restore full stealthiness in just a few hours.

Dramatic Stealthiness

The F-35’s radar cross section, or RCS, has a “maintenance margin,” O’Bryan explained, meaning it’s “always better than the spec.” Minor scratches and even dents won’t affect the F-35’s stealth qualities enough to degrade its combat performance, in the estimation of the company. Field equipment will be able to assess RCS right on the flight line, using far less cumbersome gear than has previously been needed to make such calculations.

In designing the new fighter, Lockheed Martin engineers assumed they would guess wrong about some access doors; it would be necessary to put some in different places during the course of its lifetime.

Thus, said O’Bryan, the company left open several ways to make field modifications that can create a quick-release door in the aircraft’s skin. These doors won’t then need tape or caulk to restore stealthiness, the application of which is a time-consuming and expensive chore in other stealth aircraft.

The repair and upkeep of low observables has been one of the F-22’s “main maintenance drivers,” he said, “and that goes away with [the] F-35.”

The F-35A has a serpentine inlet making engine fan blades invisible from any point outside the fuselage. That factor eliminates one of the biggest RCS problems for stealth designs.

Moreover, the air intakes constitute a single piece of composite material devoid of seams, rivets, or fasteners. These types of parts are huge RCS reflectors and caused massive signatures on earlier-generation aircraft. Their absence dramatically aids the F-35’s stealthiness.

That’s not all. No antennas protrude from the aircraft’s surfaces. These elements are instead embedded in the leading and trailing edges of the wings. Their positioning there not only reduces the radar signature but also yields a far wider, deeper, and more precise picture of the battlespace.

Stealth, said O’Bryan, has to be “designed in from the beginning” and can’t be added as an afterthought or upgrade. That means radar, electronic warfare, data links, communications, and electronic attack “need to be controlled” and must be fused from the start to work in concert with the special shapes and materials of the airframe itself.

The F-35A fighter has an active electronically scanned array radar and unique antennas spaced around the aircraft so that it can direct radar energy precisely, with minimal “bleed” in unintended directions. That puts more power where it’s wanted and reduces emissions that can give away the F-35’s position.

In addition, it uses machine-to-machine communications with other F-35s. Emitters such as the radar and the electronic warfare system can flash on and off among all the F-35s in a flight.



USAF photo by MSgt. Jeremy T. Lock

An F-35 Lightning II (top), accompanied by an F-22 Raptor, powers over Fort Walton Beach, Fla. This was the first time the two fifth gen fighters had flown together.

A leading fighter, for example, can have a trailing F-35 illuminate his target with radar. The data in such an operation will be shared via a laser-powered Multifunction Advanced Data Link; the pilots don't even need to talk to each other.

Stealth also permits (and requires) internal fuel and weapons carriage. The Air Force F-35 variant, fully loaded for combat, can pull nine-G turns with a full load of fuel and missiles. This cannot be done by fighters lugging along external weapons and fuel tanks.

O'Bryan took skeptical note of other fighter makers' boastings that they have reduced by up to 75 percent the radar signatures of their fourth generation aircraft. He finds the claim perplexing; their original signatures are so massive, he says, that even a 75 percent reduction still leaves a huge radar return. These uprated fighters are visible within the maximum range of adversary air-to-air missiles, he said.

"You basically haven't really done anything, in terms of a practical tactical advantage against an enemy," said the Lockheed official.

Worse, the RCS reductions evaporate once nonstealthy ordnance, fuel tanks, and other stores are hung on the "clean" aircraft.

"Until you have a first-shot, first-look, first-kill" capability, said O'Bryan, "you're still at the same standoff [range], hoping that training and tactics are going to overcome a potential adversary."

China and Russia have recognized the fallacy of trying to make a silk stealth purse out of a nonstealthy sow's ear. That is why China is vigorously pursuing the J-20 and Russia the PAK-FA stealth fighter designs. If their programs pan out as expected, said O'Bryan, "fourth gen airplanes are really going to be at a serious disadvantage" against them.

In a modern A2/AD environment, no fourth generation fighter can survive, O'Bryan insisted, no matter how much support it receives from jammers. In such an environment, however, the F-35 can fly in relative safety, with more range than the F-16 and with the same combat payload.

When enemy defenses have been beaten down, and the need for stealthiness is not so strong, the F-35 will use



F-35 airframe AF-6 goes through the paces on a navigational accuracy/GPS test flight near Edwards AFB, Calif.

both internal and external stations. That would boost its carrying capacity to a full 18,000 pounds of ordnance—more than triple the F-16's max load of 5,200 pounds.

O'Bryan said the F-35 is an all-aspect stealth aircraft—that is to say, stealthy from any and all directions.

A Conspicuous Omission

Cost and performance trade-offs were made when it came to designing the F-35's exhaust system, O'Bryan said. Lockheed Martin chose not to employ a two-dimensional thrust-vectoring nozzle, as it had on the F-22 Raptor.

For one thing, the decision reduced cost. For another, it eliminated one of the larger practical challenges to maintaining the stealth characteristics of the F-35.

The classified "sawtooth" features that ring the nozzle help consolidate the exhaust into a so-called "spike"

signature, while other secret techniques have been employed to combat and minimize the engine heat signature.

"We had to deal with that, and we dealt with that," O'Bryan said, declining to offer details.

The F-35 meets or exceeds the services' infrared signature specifications. Many of the standard fighter engine features such as a big afterburner spray bar assembly and related piping are missing from the F-35. The F135 power plant, built by Pratt & Whitney, is truly a "stealth engine," he said.

Much speculation has swirled around the question of the F-35's electronic warfare and electronic attack capabilities. The Air Force has resolutely refused to discuss any specifics. Yet experts have pointed out that, in its most recent EW/EA roadmap, USAF has failed to mention any plans for a dedicated jamming aircraft. It is a conspicuous omission.

O'Bryan certainly couldn't go into the subject of the fighter's EW/EA suite in any detail, or the way it might coordinate with specialized aircraft such as the E-3 Airborne Warning and Control System, RC-135 Rivet Joint, E-8 JSTARS, or EA-18G Growler jammer aircraft.

He did say, however, that F-35 requirements call for it to go into battle with "no support whatever" from these systems.

"I don't know a pilot alive who wouldn't want whatever support he can get," O'Bryan acknowledged. "But the requirements that we were given to build the airplane didn't have any support functions built in. In other words, we had to find the target, ... penetrate the anti-access [defenses], ... ID the target, and ... destroy it by ourselves."

O'Bryan said the power of the F-35's EW/EA systems can be inferred from the fact that the Marine Corps "is going to replace its EA-6B [a dedicated jamming aircraft] with the baseline F-35B" with no additional pods or internal systems.

Asked about the Air Force's plans, O'Bryan answered with several rhetorical questions: "Are they investing in a big jammer fleet? Are they buying [EA-18G] Growlers?" Then he said, "There's a capability here."

O'Bryan went on to say that the electronic warfare capability on the F-35A



Aircraft AF-6 and AF-7 overfly the California desert during a formation maturity flight. The Lightning II can interrogate a target to its rear, an ability unique to the F-35.

“is as good as, or better than, [that of the] fourth generation airplanes specifically built for that purpose.” The F-35’s “sensitivity” and processing power—a great deal of it automated—coupled with the sensor fusion of internal and offboard systems, give the pilot unprecedented situational awareness as well as the ability to detect, locate, and target specific systems that need to be disrupted.

When it comes to electronic combat, the F-35A will make possible a new operational concept, O’Bryan said. The goal is not to simply suppress enemy air defenses. The goal will be to destroy them.

“I don’t want to destroy a double-digit SAM for a few hours,” he said. “What we’d like to do is put a 2,000-pound bomb on the whole complex and never have to deal with that ... SAM for the rest of the conflict.”

At present, that is difficult to do. Adversaries, O’Bryan pointed out, recognize that the basic American AGM-88 High-Speed Anti-Radiation Missile has a light warhead able to do little more than damage an air defense array. Thus, they have adapted to the threat by deploying spare arrays with their mobile systems.

The hope is that the introduction of the new F-35 will put a stop to that practice.

The effect of the F-35’s stealth, EW/EA capabilities, and powers of automatic target recognition and location in all weather will offer conventional “deterrence” on an unprecedented scale, O’Bryan said.

The fighter’s version 3.0 automatic target recognition software won’t be able to distinguish one kind of battle tank from another. However it will be able to pluck out the mobile surface-to-air missile system from a forest of other kinds of vehicles.

Multiple fighters detecting and characterizing a site’s electronic emissions, coupled with a detailed synthetic aperture radar image, will lead a strike group to specific aimpoints. It goes without saying that all of this can be achieved while the fighters themselves remain undetected.

The F-35’s electronic attack capabilities, said O’Bryan, allow the fighter to penetrate into “places that other airplanes can’t go” and therefore “hold strategic targets at risk.” These capabilities are unique to the F-35, he asserted.

Countermeasures, Not Turning

As F-35s criss-cross enemy airspace, they also will automatically collect vast amounts of data about the disposition of enemy forces. They will, much like the JSTARS, collect ground moving target imagery and pass the data through electronic links to the entire force. This means the F-35 will be able to silently and stealthily transmit information and instructions to dispersed forces, in the air and on the ground.

Because it was designed to maneuver to the edge of its envelope with a full internal combat load, the F-35 will be able to run rings around most other fighters, but it probably won’t have to—and probably shouldn’t.

“If you value a loss/exchange ratio of better than one-to-one, you need to stay away from each other,” said O’Bryan, meaning that the fighter pilot who hopes to survive needs to keep his distance from the enemy.

He noted that, in a close-turning dogfight with modern missiles, even a 1960s-era fighter such as the F-4 can get into a “mutual kill scenario” at close range with a fourth generation fighter. That’s why the F-35 was provided with the ability to fuse sensor information from many sources, triangulating with other F-35s to locate, identify, and fire on enemy aircraft before they are able to shoot back.

The F-35’s systems will even allow it to shoot at a target “almost when that airplane is behind you,” thanks to its 360-degree sensors.

According to O’Bryan, the F-35 also can interrogate a target to its rear, an ability possessed by no other fighter.

If you survive a modern dogfight, O’Bryan claimed, “it’s based on the countermeasures you have, not on your ability to turn.”

If the situation demands a turning dogfight, however, the F-35 evidently will be able to hold its own with any fighter. That is a reflection on the fighter’s agility. What’s more, a potential future upgrade foresees the F-35 increasing its air-to-air missile loadout from its current four AIM-120 AMRAAMs to six of those weapons.

The F-35, while not technically a “supercruising” aircraft, can maintain Mach 1.2 for a dash of 150 miles without using fuel-gulping afterburners.

“Mach 1.2 is a good speed for you, according to the pilots,” O’Bryan said.

The high speed also allows the F-35 to impart more energy to a weapon such as a bomb or missile, meaning the aircraft will be able to “throw” such munitions farther than they could go on their own energy alone.

There is a major extension of the fighter’s range if speed is kept around Mach .9, O’Bryan went on, but he asserted that F-35 transonic performance is exceptional and goes “through the [Mach 1] number fairly easily.” The transonic area is “where you really operate.”

In combat configuration, the F-35’s range exceeds that of fourth generation fighters by 25 percent. These are Air Force figures, O’Bryan noted. “We’re comparing [the F-35] to [the] ‘best of’ fourth gen” fighters. The F-35 “compares favorably in any area of the envelope,” he asserted. ■