



F-35: Lightning Unleashed

By John A. Tirpak, Editorial Director

The Air Force's newest fighter is ready for action.

Parked on the flight line at Mountain Home AFB, Idaho, an operational test F-35A awaits a mission. It was one of six making a test deployment in February. This was followed up by a formal, graded deployment in June that saw near-perfect aircraft availability and weapon accuracy.

Fifteen years after the F-35 design was chosen to replace the F-16 and A-10, the first Lightning II squadron was declared operational on Aug. 2 and is now in the rotation of combat aircraft the Air Force can deploy around the world. The type will be USAF's most numerous fighter in a few years.

The announcement came from Air Combat Command chief Gen. Herbert J. "Hawk" Carlisle at a Pentagon press conference. The 388th Fighter Wing and its Reserve associate 419th Fighter Wing, both at Hill AFB, Utah, have met or surpassed the lengthy list of criteria to be considered "combat ready" with the F-35A, he said. The boxes checked off included having enough jets on hand (15 in the 3i configuration, versus the six to 12 airplanes required for initial operational capability), enough pilots trained and certified in the F-35's various missions, enough maintainers, adequate spare parts, and success at a practice deployment.

All those criteria were met with room to spare, and Carlisle said he was comfortable clearing the F-35A to take on real-world missions at any time. When that happens will be up to regional combatant commanders, he said: Their request for its capability will trigger the deployment. Carlisle was confident, though, that "sometime in the next 18 months" the F-35As will deploy to the European and Pacific theaters.

Program director Lt. Gen. Christopher C. Bogdan, in a press statement, said the announcement "sends a simple and powerful message to America's friends and foes alike: The F-35 can do its mission." He pointed out that the Air Force will operate the largest F-35 fleet in the world, with 1,763 planned, and it will form "the backbone of air combat superiority for decades and enable warfighters to see adversaries first and take decisive action."



USAF photo by J. M. Eddins Jr.

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Photo via Joint Strike Fighter Program

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Lockheed Martin photo

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USAF photo

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Lockheed Martin photo by Matt Short



USAF photo



JSF Program/OOD photo

The Marine Corps declared IOC with 10 F-35Bs a year ago, but has yet to deploy the jets overseas. The Navy's IOC is slated for 2018.

Hill is receiving an average of two F-35As a month. In a teleconference with reporters a few days before the declaration, 388th Maintenance Group Deputy Commander Lt. Col. Steven Anderson reported, "We are getting good aircraft off the line from Lockheed Martin," and depot modifications to bring jets up to the 3i configuration are proceeding smoothly and on or ahead of schedule.

The event that clinched the IOC declaration was a deployment of the 388th FW F-35s to Mountain Home AFB, Idaho, in June. During a two-week exercise to tax the unit's ability to operate away from home base, the F-35s defeated F-15s and F-16s in simulated dogfights and overcame threat-representative surface radars and defenses. The jets scored an impressive mission ready rate of more than 92 percent and flew "88 of 88" scheduled sorties, 388th commander Col. David B. Lyons told reporters. They also scored direct hits on 15 of 16 targets with inert bombs; the one miss was due to a problem on the bomb, not the jet. No sorties were lost due to software, and the Autonomic Logistics Information System, on which the F-35's computerized maintenance runs, worked as expected.

The jets at Hill won't reach the full-up Block 3F configuration standard until 2018. By 2019, the base will have its full complement of 72 F-35s, and the Air Force will be standing up new units at Burlington, Vt., and Eielson AFB, Alaska. After that, RAF Lakenheath, UK, will be next in line. (See "Building Homes for F-35s," March 2015, p. 22.)

Since the outset of the program, the Air Force has stuck to its goal of buying just over 1,700 F-35As.

The plan originally called for buying 110 a year, to expedite the retirement of the A-10 and F-16 so they wouldn't need a service life extension. Delays and budget cuts have kept USAF from buying more than 48 a year, however. At that rate, the full complement won't be delivered until the 2040s, by which time some of the earliest models will retire.

Carlisle said that while 80 a year would be "optimum," forecasted budgets will make that rate "very, very hard to get to." The current goal is to ramp up to 60 a year for USAF, but when that might happen Carlisle couldn't predict.

"How many we are going to buy ... [is] a decision that can be made later," he said.

The F-35 has been one of the longest development programs ever. Its genesis came in an early 1990s effort to develop a stealthy successor to the F-16; it was envisioned

/1/ The Boeing X-32 (left) and Lockheed Martin X-35 (right) vied to become the Joint Strike Fighter. The X-35 prevailed after a tough competition that saw many aeronautical and manufacturing firsts—hence the "X" designations. /2/ An F-35A at Edwards AFB, Calif., shown with all the ordnance the 3F version will be able to carry. /3/ The X-35A/B (Air Force/Marine) and C (Navy) prototypes under construction. /4/ The X-35A's first flight, on Oct. 24, 2000. /5/ Gen. T. Michael Moseley, then USAF Chief of Staff, unveils the first production-version F-35A on July 7, 2006, officially naming the fighter the Lightning II. /6/ A test of Pratt & Whitney's F135 engine, which powers the F-35 family of fighters.

as a cheap, lightweight aircraft called the Multirole Fighter. At the same time, the Navy and Marine Corps were pursuing stealthy replacements for the A-6 medium bomber (the A/F-X) and AV-8B jump jet (called the Advanced Short Takeoff/Vertical Landing—ASTOVL—project).

Defense leaders, grappling with deep post-Cold War budget cuts, ordered the services to merge their programs into a common effort. Called the Joint Advanced Strike Technology, or JAST, program, it was initially headed by Air Force Maj. Gen. George K. Muellner. His job was to somehow harmonize the needs of the three services, which wanted very different aircraft. He believed each service could get better than 80 percent of what it wanted, at an affordable price, and with the cost benefits of high commonality, so that they could use the same or greatly similar engines, simulators, parts, and logistics support.

An overriding goal was to keep the cost down. It was clear the services wouldn't be able to modernize their fighter fleets unless the 50-year upward trend in costs was reversed.

The JAST transitioned into the Joint Strike Fighter program, and it soon became clear this monster-size project would be the last fighter competition for the foreseeable future—a “must win” for any company that wanted to be a player in combat jets 30 years hence.

The magnitude of the program became evident in the first shakeout of competitors. Boeing, Lockheed Martin, and McDonnell Douglas were finalists. After McDonnell's JSF failed to make the cut, the company soon found itself merging with Boeing, and a major name in combat aircraft disappeared in 1997. Northrop Grumman and BAE Systems partnered with Lockheed in 2001.

Britain signed on as a JSF partner, contributing more than \$2 billion in cash for development in exchange for a say in requirements and an early place in line for production aircraft. It would later be joined by seven other partner countries, with varying levels of investment and technical inputs.

To meet congressional “fly before buy” mandates, the Pentagon ordered two prototypes each from Boeing and Lockheed Martin. They would have to demonstrate a low-cost approach using new design and manufacturing methods, stealth, vertical takeoff and landing, carrier suitability, and advanced sensors and avionics.

The goal of the program was to produce a conventional takeoff F-35A for the Air Force; a short takeoff and vertical landing F-35B model for the Marine Corps and British air services; and an F-35C with landing gear and larger

/1/ An Air Force jet making a flight test over Edwards in 2011. /2/ TSgt. Brandon Sullivan of the 33rd Aircraft Maintenance Squadron uses the Autonomic Logistics Information System—a maintenance planner/tracker and parts inventory system so ambitious Pentagon leaders considered making it a separate program. /3/ The F-35A line starts to ramp up at Lockheed Martin's Fort Worth, Texas, plant in 2012. The F-35 took over the mile-long space where F-16s were built. /4/ SSgt. Guin Duprey of the 31st Test and Evaluation Squadron works with an F-35 computerized maintenance trainer. /5/ Three F-35As of the 33rd Fighter Wing fly near Eglin AFB, Fla. /6/ Know your ABCs: F-35s of all three variants fly in formation at Edwards in late 2013.



Lockheed Martin photo by Darin Russell



Lockheed Martin photo by Fred Clingerman



USAF photo by Maj. Karen Roganov



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USAF photo by MSgt. John R. Nimmo Sr.



Lockheed Martin photo by Darin Russell

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Lockheed Martin photo by Darin Russell

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USAF photo by Samuel King Jr.



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USAF photo by Samuel King Jr.



Lockheed Martin photo by Darin Russell

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USAF photo by SSgt. Madelyn Brown

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Lockheed Martin

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USAF photo by SSgt. Marleah Robertson

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USAF photo by J. M. Eddins Jr.

wings suitable for operation from an aircraft carrier. The commonality of parts among the variants was estimated to be upward of 75 percent.

Boeing's airplane was designated the X-32, while Lockheed Martin's was the X-35. The "X" designations indicated these airplanes were more experimental than prototypes.

While the X-32 depended on a single intake, relying on "blockers" to shield the high-radar-return engine fan blades, Lockheed's X-35 featured two serpentine intakes that completely hid the fan blades. And although the rules specified a single-engine aircraft, Lockheed's STOVL version included a "lift fan," a vertically mounted propulsion unit connected to the engine via a shaft and gearbox. Lockheed's STOVL concept also featured a main engine exhaust that could rotate downward—an idea adapted from Russia's Yak-38 jet. Boeing's version used a two-dimensional nozzle similar to that on the F-22.

Both evaluation flight programs had their ups and downs. Boeing's airplane flew first, but Lockheed's jets, once flying, apparently scored more frequently. A telling achievement was when the STOVL-configured X-35B took off, flew supersonically, hovered, and landed vertically on the same sortie.

On Oct. 26, 2001, Undersecretary of Defense for Acquisition, Technology, and Logistics Edward C. "Pete" Aldridge Jr. presided over a Pentagon press conference to announce the JSF winner. "Both contractor teams met or exceeded" required performance and technology requirements, he said, turning the podium over to Air Force Secretary James G. Roche to announce that, in concert with the UK, the Defense Department had selected Lockheed Martin's X-35 as the winner. The choice was made based on "a best-value basis," Roche said, after evaluating the "strengths, weaknesses, and degrees of risk" of both offerors.

The new jet was awarded the wrong nomenclature. The next "number" in the fighter sequence was to have been F-24, following the F-22 and F-23. When asked what the new jet's nomenclature was, Aldridge flipped the question to then-program manager Marine Corps Lt. Gen. Michael A. Hough, who answered "F-35," presuming that the X-35 designation would convey. Traditionally, though, X designations have no bearing on operational designations; Hough was winging it, but the designation stuck.

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/1/ Test F-35As tank up from a KC-135R in 2014 while an Edwards F-16 flies chase. /2/ SSgt. Mark Freeman of the 33rd Aircraft Maintenance Squadron refuels an F-35A at Eglin in 2014. USAF recruited its best maintainers for the F-35, to train those that followed. /3/ An Eglin F-35A is prepped for a training sortie. There are no two-seat F-35s: A pilot's first flight is also his or her first solo. /4/ A 2015 test firing of an AIM-120C AMRAAM. Though optimized for ground attack, the F-35 must be a lethal air-to-air fighter, too. /5/ A trio of F-35As returns to the US after the type's first overseas deployment, to Britain in July 2016. /6/ An F-35B heads out on a night mission, its under-nose Electro-Optical Targeting System clearly visible. /7/ In May 2015, Lt. Col. Christine Mau, 33rd Operations Group deputy commander, gears up for her first F-35A flight. She was the first woman to fly the Lightning II. /8/ Four inert GBU-31 GPS guided bombs await loading during the February 2016 Mountain Home deployment.

The program is enormous. It aims to develop and build nearly 3,000 frontline combat aircraft for the US alone—and as many as half again that number for partners and export. There are three US services and eight nations as partners, with hundreds of suppliers and work performed globally. Regional depots are being built worldwide for both the aircraft and engine. It will use unprecedented technologies in manufacturing and a breathtaking amount of software—more than eight million lines of code in the aircraft itself and a like number for support systems and simulation—so delays and setbacks were to be expected.

Lockheed Martin had bet that advances in simulation and modeling would make it possible to drastically reduce the amount of flight testing required. If the aircraft's performance matched the computer predictions on two test points, for example, Lockheed reasoned that it didn't have to test all the points in between. The company believed a high level of "concurrency"—developing and testing aircraft at the same time the production line was running—could work on the F-35.

Those bets didn't pay off, and costs climbed as testing had to be added. Weight problems with the B model and arrestor hook issues on the C model forced redesigns.

Large-area use of composite materials also produced uneven results, leading to redesign of some major structures into smaller, more manageable pieces, adding weight in additional fasteners and structure. Dozens of similar deficiencies had to be corrected.

Original plans called for the Air Force F-35 to reach IOC in 2010, but the date was rolled back several times to work out the developmental kinks.

The program reached a crisis point in 2010. The program was billions over budget, and years of delay had accumulated. New management was brought in on both the government side and at Lockheed Martin. The F-35 was given a "re-baselining"—adding time and money to fix the problems, but only to a point. After that, new program manager Vice Adm. David J. Venlet said he would not ask for "more money or more time" on the F-35. Shortfalls would have to be managed within the program from then on.

Since 2012, the program office has kept its word. There have been additional hitches, but one by one they have been resolved. Problems that once seemed capable of derailing the project—an engine fire, issues with the F-35's unique and expensive helmet, and complaints that some of the aircraft's technology had been locked in prematurely—were addressed and are "no longer anything I lose sleep over," Bogdan said.

/1/ Photographers aboard a KC-130J tanker shoot a Marine Corps F-35B during the July 2016 visit to RIAT. /2/ An Eglin F-35 gets a "hot pit refuel," with the engine running, practicing a rapid wartime turnaround in May. /3/ MSgt. Jeffrey Taggart (center) supervises Amn. Juan Rivas and SSgt. Jeffrey Kalsbeek, both from the 388th Aircraft Maintenance Squadron, in an April weapons loading competition at Hill AFB, Utah. /4/ Two of the first all-up F-35As to be assigned to Hill. /5/ A Hill Lightning pulls into a climb. Under certain lighting, the stealthy metallic undercoating of the F-35's paint shines through. /6/ A Hill F-35 leads the two aircraft the type is to replace: an F-16 and an A-10.



Lockheed Martin photo by Jeff Flamer



USAF photo by Todd Cromar





USAF photo by SrA. Andrea Posey



Photo by Jim Haseltine



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USAF photo by R. Nial Bradshaw



USAF photo by Samuel King

The F-35, because its multiservice, multinational nature makes it the most expensive weapons program ever, has been subject to unrelenting criticism. But Bogdan has said the critics are out of date, especially on cost. Though a 53-year life cycle cost for all three variants—including buying the jets, maintaining and upgrading them, military construction, fuel, and five decades of inflation—at one

/1/ Hundreds attended the F-35's IOC ceremony at Hill on Aug. 5. /2/ The new Air Force Chief of Staff, Gen. David Goldfein, speaks at the ceremony at Hill. /3/ Maj. Gen. Jay Silveria, then commander of US Air Warfare Center, wears the F-35 helmet, tailor-made for each pilot. It has been described as a "workspace," displaying situational and targeting information in 360 degrees. Silveria was the first general officer to qualify in the F-35.

point pushed the program over the \$1 trillion mark, the cost has been steadily receding. That same program estimate is now under \$850 billion, and the program office promises that the per-jet F-35A price will be less than \$85 million by 2019. That's the same or a lower price than fourth generation jets like the European Typhoon or F/A-18.

The F-35 is now operating at many locations. Eglin AFB, Fla., is the basic training base for all F-35 pilots. Advanced F-35A training—for both USAF and foreign F-35A users—takes place at Luke AFB, Ariz. Nellis AFB, Nev., flies its F-35s for developing tactics, and flight test continues at Edwards AFB, Calif. Basic flight testing of the airframe is complete, and flight test of the final 3F software is nearly complete. Most testing now focuses on the carry and release of weapons and adjustments to software, and this effort will continue indefinitely.

The JSF partners do, indeed, see the F-35 as a platform that will be flying for most of this century and are already starting to develop the upgrades that will be a recurring feature of the program. For now, these are known as the "Block 4" changes and are expected to add new sensors, electronic warfare, and new weapons roughly every two years.

The new aircraft will give the Air Force an "unmatched advantage" in wars to come, officials said. "I have a message to our adversaries," Goldfein said. "It sucks to be you." ❖