

# Future fighter: F-35 begins transition into US service

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**As the Lockheed Martin F-35 Lightning II Joint Strike Fighter begins to enter into US service in meaningful numbers, Gareth Jennings explores efforts being undertaken by the US Marine Corps, US Air Force, and US Navy to fully integrate the aircraft into their inventories and their plans for its future employment**

With the US Marine Corps (USMC) having declared initial operating capability (IOC) for the F-35B version of the Lockheed Martin Joint Strike Fighter (JSF) in 2015, the US Air Force (USAF) having done the same for the F-35A in 2016, and the US Navy (USN) set to follow suit with the F-35C in late 2018 or early 2019, the US military is at the beginning of the process to introduce what will be the country's premier combat aircraft for decades to come.



*The three variants of the Lockheed Martin Joint Strike Fighter (JSF): the conventional take-off and landing F-35A (right), the short-take-off/vertical landing F-35B (centre), and the carrier-variant F-35C (left). The aircraft is set to become the stalwart of US combat aviation for decades to come. (Lockheed Martin)*

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## **US Marine Corps**

As the first service to declare IOC, the USMC is at the forefront of not just the US effort to introduce the JSF into service, but also of the global effort. With a programme of record for 353 short take-off and vertical landing (STOVL) F-35Bs and 67 carrier variant (CV) F-35Cs to be spread across 16 and four squadrons respectively, plus an additional two training units, the corps is already well ahead on its path to fielding the F-35.



*Having declared IOC for its F-35Bs in 2015, the US Marine Corps is leading the rollout of the Joint Strike Fighter domestically and internationally. (IHS Markit/Patrick Allen)*

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As recently noted by the USMC's Deputy Commandant for Aviation, Lieutenant General Jon M Davis, following a slow start deliveries are now beginning to ramp up. "It's been a bit anaemic at the start in terms of putting planes on the ramp," he said earlier in the year, "[but] we are now well underway with the transition of both the B and the C into the Marine Corps".

To date the corps has stood up Marine Fighter Attack Squadron (VMFA) 121 'Green Knights', initially at Marine Corps Air Station (MCAS) Yuma in Arizona and now at MCAS Iwakuni in Japan, and VMFA 211 'Avengers' at MCAS Yuma as its first two operational F-35B units. The next three operational squadrons – VMFA 122 'Crusaders', VMFA 314 'Black Knights', and Marine Fighter Attack Squadron (All-Weather) VMFA(AW) 225 – will transition over from the Boeing F/A-18 Hornet in the coming months, with VMFA 314 being the first of the corps' four F-35C squadrons. The USMC will first transition over its Hornet units before doing the same with its Boeing/BAE Systems AV-8B Harrier IIs.



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Although only recently introduced into operational service the F-35 has already flown a series of 'real world' missions, such as these US Marine Corps F-35Bs conducting a joint patrol with Japanese F-2 fighters and US Air Force B-1B bombers in September 2017. (Japan Air Self-Defense Force)

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In addition to its current and near-term operational units, the USMC has one training unit in VMFAT 501 at MCAS Beaufort in South Carolina, as well as VMX-1 Test Squadron at Edwards Air Force Base (AFB) in California. This unit will move to MCAS Yuma, where it will co-locate with the USMC Operational Test and Evaluation (OT&E) unit and weapons school.

The transition of VMFA 121 from MCAS Yuma to the 1st Marine Aircraft Wing (MAW) at MCAS Iwakuni in January 2017 was a key milestone in the F-35B programme for the USMC, coming just six months after IOC for the type was declared in July 2015. Being the first operational unit (the squadron was actually stood up in November 2012), VMFA 121 has been heavily involved in developing the corps' tactical and austere capabilities for the jet.

In early April 2017, just four months into its inaugural overseas deployment, VMFA 121 trialled the use of 'hot' ground refuelling conducted from a USMC Lockheed Martin KC-130J Hercules from Marine Aerial Refueler Transport Squadron (VMGR) 152. As noted by the USMC at the time, this aviation-delivered ground refuelling (ADGR) trial was the first time that the F-35 had been fuelled with the engine running to enable the aircraft to be replenished in austere locations that are not equipped with the normal infrastructure. This "stepping stone" test, as the marines described it, was followed in September by the first 'hot loading' exercise of live missiles, again to develop the tactical capabilities of the aircraft.

With VMFA 121 now operationally deploying the F-35B overseas for the first time, the USMC will conduct the first operational maritime deployments aboard its Wasp- and America-class amphibious assault ships this year. According to Gen Davis, the corps will embark six to eight F-35Bs on shipboard Marine Expeditionary Unit (MEU) task forces.

As announced by the then UK defence secretary, Michael Fallon, in December 2016, the inaugural maritime deployments will be followed soon after by an embarkation aboard the Royal Navy's (RN's) new HMS *Queen Elizabeth* aircraft carrier on its maiden operational deployment in 2021. Captain Jerry Kyd, *Queen Elizabeth's* first commanding officer, told *Jane's* ahead of Fallon's announcement that plans to bring the USMC aboard the carrier were already well under way, noting, "Discussions are ongoing about the Marine Corps embarking in the future, including looking at policy-level decisions, rules of engagement, weaponry coming on board, [and] how many aircraft." Gen Davis added to this, saying, "We have already worked through what our requirements are. It's a fantastic ship with a great capability. We want to make sure that we have adequate spare parts on board the ship to do surge operations if needs be."

From a UK perspective the USMC deployment aboard *Queen Elizabeth* will help 'de-risk' the ship for the RN by providing not only the know-how of flying this new aircraft type from the new carrier, but also by providing the F-35B numbers needed while the RN and Royal Air Force (RAF) continue to build up their own joint inventory. For the USMC the deployment will enhance the corps' interoperability with a fellow F-35B operator, which will include assessing UK-developed technology and systems such as the shipborne rolling vertical landing (SRVL) method of landing that includes the Bedford Array deck-lighting system as well as a ship-referenced velocity vector (SRVV) to help the pilot better judge his approach to the ship. Both of these innovations are said to be of interest to the USMC.

Although still a relatively new addition to the USMC's inventory, the F-35B has already been hailed by Gen Davis for its 'transformative' capabilities. Speaking in early 2017 the general noted how early simulated trials had shown unprecedented levels of mission success compared with legacy platforms, with the F-35B proving to be superior in just about every facet of capability when compared with older types still on operations.

"I have never seen capability like the F-35B," he said. "For years in training we have been getting our butts kicked, losing half of our aircraft and missing the targets as [those that did survive] manoeuvred to avoid fighters and surface-to-air missiles. Now we are getting all of our F-35Bs in and out of the target area and we are crushing the target. We are seeing kill ratios of 24:0 [in favour of the F-35B] and we are not losing any of our aircraft at all."

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## **US Air Force**

Having declared IOC for its conventional take-off and landing (CTOL)-variant F-35A in August 2016, the USAF is now just beginning to ramp up its aircraft numbers. To date the USAF has received approximately 120 F-35As, which are distributed across five bases in the contiguous United States (CONUS).



*A rare tri-service formation of Joint Strike Fighters, with a US Air Force F-35A in the lead, followed by a US Marine Corps F-35B and a US Navy F-35C. (US Air Force)*

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"What is interesting about that number is that it seems like a lot, but we are going to grow to 1,763 aircraft over the life of the programme. So in many ways, even though we have had the aircraft for a number of years already, we have only really just begun," a USAF spokesperson told *Jane's* in October 2017, adding, "The hallmark of the programme over the coming years will be the exponential growth of the number of F-35s and in the number of USAF bases in the US and overseas [such as at RAF Lakenheath in the United Kingdom in the early 2020s]."

Currently the USAF has F-35As located at Edwards AFB in California; Hill AFB in Utah; Eglin AFB in Florida; Luke AFB in Arizona; and Nellis AFB in Nevada. Hill AFB is the combat-ready unit with the 34th Fighter Squadron (FS). If a combatant commander required the F-35A, then this is the unit that would be deployed. As evidence of the 34th FS' capabilities, in April/May 2017 the unit

was deployed to the United Kingdom and across forward bases in Europe. “That training deployment was a huge milestone for that unit to demonstrate its combat readiness – and was also a significant signal from the USAF to show the world that it is ready with this stealth fighter and that we can take it any place that we need to,” the service representative said.

Eglin AFB and Luke AFB are pilot training bases for USAF and international F-35A customers, as well as for USN F-35C pilots, while Edwards AFB is where developmental testing is carried out by four USAF aircraft. The final location where USAF F-35As can currently be found is Nellis AFB, which is home to the 'Red Flag' exercises. As noted by the USAF official, the F-35A recently racked up kill ratios of more than 20 to 1 during this event. “Red Flag’ has demonstrated not only how good the F-35 is, but how it can make the legacy fourth-generation aircraft better; the F-35 can fly into the airspace to neutralise ground threats primarily, paving the way for the F-15s, -16s, and -18s to then come in to strike their targets,” he said.

While the F-35 can perform the air-to-air mission, it will primarily be used as a strike fighter that will complement the legacy air superiority fighters. “While some day it will eventually come true that the F-35 will replace these fighters, we’ve got to find a way as an air force for the F-35, the [Lockheed Martin] F-22, the [Lockheed Martin] F-16, the [Boeing] F-15, to all fight together,” the representative said, adding, “The reality is that we are going to have all of these aircraft for a considerable time, so we have to figure out how they complement each other and ... we have the right fighter structure in place to maintain the combat lethality that we need.”



*The US Air Force is developing the means by which its future fifth-generation partnership of the F-35 and F-22 (pictured) can seamlessly serve alongside its legacy fourth-generation platforms. (IHS Markit/Patrick Allen)*

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Although the F-35A is still in the early stages of its operational life – the initial operational test and evaluation (IOT&E) phase of the programme has yet to even begin – the message being delivered by the USAF is that it is pleased with what it has seen of the aircraft to date and has high hopes for the capabilities it is expected to deliver in the future. “The F-35 programme for the air force is really

in a good place at the moment,” the service told *Jane's* , adding, “It is an operational aircraft; it is combat-ready; and it continues to [roll out] towards a full warfighting capability.”

Explaining further, the USAF emphasised, “The F-35 is an absolute game-changer. Its ability to penetrate heavily defended enemy airspace is unmatched; there is just nothing like it in the world. Other capabilities include its ability to gather, process, and disseminate information. It provides combat commanders with more and faster situational awareness than they have ever had before while deploying a wide and varied mix of weapons from the one aircraft. The F-35 is better than anything that we have – and better than anything there will be in the world for a number of years.”

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## **US Navy**

The USN is set to receive 273 CV F-35Cs over the life of the programme. For the service the urgency to introduce the F-35 into service has not been as acute as it has been for the USMC and USAF, given that it is still receiving Boeing F/A-18E/F Super Hornet and EA-18G Growlers fresh from the factory. As such, it will be the last of the three services to declare IOC when it does so toward the end of this year.



*An F-35C undergoing a catapult launch from the carrier USS George Washington in August 2016. Sea trials to date have reportedly gone well, with the US Navy saying that the aircraft has “earned her sea legs”. (US Navy)*

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Despite the lack of urgency, and contrary to anecdotal reports that of all the US service arms the USN is the least keen to receive the F-35, the service is keenly anticipating the arrival of its future primary combat aircraft. As one senior navy official, speaking under the Chatham House Rule, put it, “The US Navy has never had a fifth-generation stealthy multirole fighter before – and there is much to be excited about.”

In terms of its F-35C stand-up to date, the USN has so far equipped Strike Fighter Squadron (VFA) 101 'Grim Reapers' and VFA 125 'Rough Raiders' as the East and West Coast Fleet Replacement Squadrons respectively. The first operational fleet unit will be VFA 147 'Argonauts', which will transition from the F/A-18E this month.

The service is now anticipating the Block 3F (full combat) software release early this year, with the next phase of operational testing to begin on the Nimitz-class aircraft carrier USS *Abraham Lincoln* shortly thereafter. IOC is expected between August this year and February 2019, with the first deployment scheduled for the carrier USS *Carl Vinson* in 2020/21. Once their future air components are fully stood up, each carrier will be equipped with two F-35C squadrons to complement the two F/A-18E/F squadrons and one EA-18G unit that will also be embarked.

As the USN official recently explained, "It's not just about the aircraft, but how that aircraft fits into the wider Carrier Strike Group [CSG] concept. The F-35 is not being planned as a replacement for the F/A-18E/F [and EA-18G] on the carrier flight deck, but rather as a complementary platform with the capability of the former matching the capacity of the latter through to about 2035. The F-35 will bring a niche capability to strike and suppress heavily defended enemy air defences and to win in any fight against current fourth- and future fifth-generation enemy fighter aircraft."

Speaking at the standing-up ceremony of VFA 125 at Naval Air Station (NAS) Lemoore, California, in early 2017, the commander of US naval aviation, Vice Admiral Mike Shoemaker, noted the reasoning behind the service's decision to field mixed carrier air wings (CAWs) of Lightning IIs and Super Hornets. "Without question the F-35 is required to win the future high-end fight, but it will be effectively complemented by the fourth-generation capabilities and capacity of our Super Hornets – as well as the rest of our future air wing – to include carrier-based unmanned platforms," he said, adding, "Much has been said about the value of fourth- and fifth-generation aircraft, and I'd like to share why our carrier air wings need both capabilities. There are mission sets each platform could accomplish, but some – like maritime intelligence, surveillance, and reconnaissance or close air support in the relatively permissive environment we see today in Iraq and Syria – don't require fifth-generation aircraft. Across the force we carefully manage aircraft utilisation, and I would rather not expend precious fifth-generation fatigue life doing missions that can be performed by other, third- or fourth-generation platforms. This is why CNO [the chief of naval operations] said we will supplement Lightning II with a healthy cadre of Super Hornets. This 'high-low' mix is essential to sustainable, cost-effective, combat lethality now and in the future."

To this end the USN has taken the F-35C to sea for trials four times already and, notwithstanding a tail hook redesign and an issue of excessive head movement for the pilot during catapult launches, the trials have proven successful.

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One aspect of the F-35C's carrier performance that has pleased the navy has been the aircraft's automatic landing technology, or delta flight path (DFP) mode, as it is officially known. According to the official, "The delta flight path advanced landing capability is something that we are quickly finding is revolutionising our ability to land on the aircraft carrier more accurately. As naval aviators we tend to target the number two or three wire on the flight deck, and with DFP we are able to do this at a phenomenally consistent rate."

He went on to explain that, "When VFA 101 was doing trials they had zero bolters [ie no aircraft having to abort their landing]. The DFP is coming online at the same time as the Magic Carpet [system] that has been developed for the Super Hornet; it uses the exact same technology. The

two systems will revolutionise carrier operations, reducing the time steaming into the wind and the number of tanker aircraft that are needed.”

Integrating the F-35C into the USN is going to fall on the Naval Air Warfare Development Command (NAWDC) at NAS Fallon as it works to develop the tactics, techniques, and procedures to bring the aircraft into the CSG.

“How the aircraft fits into the multitude of missions, such as air interdiction, SEAD/DEAD [suppression/destruction of enemy air defences] and all the others that we do, will follow on with the NAWDC. The F-35C will work closely with our F/A-18E and F [Super Hornets], as well as our EA-18Gs [Growlers], which it will complement. We will become a navy with both fourth- and fifth-generation fighters, utilising the capability of the F-35 matched with the capacity of the Super Hornet,” the service official said, adding, “It’s not about the individual aircraft, but how the aircraft fits into the carrier strike group of an aircraft carrier, surface combatants, and submarines. NAWDC will be the key as to how the F-35 will fit into the carrier strike group concept.”



*The F-35C’s delta flight path (DFP) approach mode allows the pilot to target the number two or three wire on the flight deck “at a phenomenally consistent rate”, the navy has said, making for safer operations. (US Navy)*

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In terms of its place within the CSG, the F-35C will bring information superiority. As the navy official noted, “I can take those fused, active, and passive tracks and how they would be passed between all of the different CSG assets in the network – [Grumman] E-2Ds airborne early warning



platforms]; Super Hornets; Growlers; and ships – [and] all will now have situational awareness in areas that were once denied to these platforms. This is all because of the sensors on the F-35, which will be able to provide unprecedented target detection, combat identification, and location in both the air-to-air and air-to-surface modes.”

This improved situational awareness provides for decision superiority among airborne and sea-based assets because the information gathered by the F-35 can be disseminated across the CSG, to include air, surface, and subsurface assets. The F-35C is at the centre of the USN's new 'Kill Web' concept that allows the service to network multiple platforms and weapons to engage airborne and surface targets with weapons not necessarily carried by the target-designating platform. The multispectral fusion of data from the F-35C's radar, electronic support measures, electro-optical distributed aperture system, and infrared search-and-track system brings an unprecedented situational awareness capability to the strike group.

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