The Air Force says it wants a STOVL F-35. Is it right for today’s combat environment?

**Expeditionary Fighter**

By Rebecca Grant

Anyone who has ever watched the Marine Corps AV-8B Harrier “bow to the audience” at an air show grasps the potential of short takeoff and vertical landing (STOVL) technology. Combine that potential with the Air Force’s recent experiences at expeditionary airfields and it’s easy to see why the service wants a “jump jet” variant of the F-35 Joint Strike Fighter.

“The STOVL version of the aircraft will give us an opportunity to have a dedicated close air support aircraft in the future,” said Gen. John P. Jumper, Air Force Chief of Staff. In mid-December remarks, Jumper said he believed the service would procure “250 or so” STOVL F-35s in the 2010-20 period.

During the 50 years since the appearance of the first experimental aircraft, the Air Force has at times taken a serious look at jump jet technology. However, the F-35 decision marks the first time the service has announced plans to buy a STOVL-type aircraft and give it a major role—support of ground troops.

From a technology standpoint, short takeoff and vertical landing aircraft have come a long way. The JSF model offers a combination of...
power and performance never before seen in a jump jet. The question is whether the kinds of operational advantages provided by STOVL are essential for meeting 21st century Air Force missions.

Experiments with vertical/short takeoff and landing (V/STOL) technology began during the 1950s and 1960s. Test programs gave rise to a strange-looking zoo of aircraft, nearly all of which were plagued with flaws in power or control. Configurations ranged from the Navy XFY-1 “tail sitter” and USAF-funded Vertijet to tilt-wing turboprops.

Britain’s Hawker-Siddeley Kestrel was the first combat system to master deflected jet thrust and to place vertical lift technology into a fighter-style airframe. The first Kestrel flew in 1964. The US joined Britain and West Germany in acquiring a small test group of aircraft.

Kestrel later grew into the world’s first true V/STOL fighter—the Harrier—which began service with the RAF in 1969. Two years later, the US Marine Corps started buying its own Harriers.

**False Starts**

By then, though, USAF already had considered and abandoned the idea of acquiring STOVL aircraft. In 1958, an early requirements definition for what became the F-111 fighter-bomber included a V/STOL feature. However, technical problems led the Air Force to abandon the effort in the early 1960s. In 1963, Gen. Curtis E. LeMay, the Chief of Staff, launched Project Forecast, a major system and technology review, which advocated development of new materials and propulsion for VTOL—vertical takeoff and landing. Still, nothing really came of it.

The issue arose again with the advent of the Harrier, but airframe limitations and technology compromises robbed the aircraft of any appeal for Air Force leaders. USAF went ahead with the F-15, F-16, and A-10 fighters, all optimized for different roles.

Meanwhile, the RAF and US Marine Corps pressed ahead with Harrier acquisition. The RAF wanted the aircraft to provide support for the Army’s 1 Corps in Germany. They were to operate from hidden forward sites with aluminum planking runways or any available roadway. The US Marine Corps wanted the Harrier to operate off smaller ships with no need for catapult configurations. In 1972, the Royal Navy also began pursuing the Harrier, flying the first Sea Harrier variant in 1978, to fly off command cruisers fitted with “ski jumps.”

The gamble paid off for Britain in the 1982 South Atlantic war with Argentina over the Falkland Islands. Sea Harriers based on the Royal Navy carriers Hermes and Invincible fended off attacks on British ships by ground-based Argentine fighters and scored 20 air-to-air victories with no air losses. RAF Harriers also joined the fight, launching off naval platforms to attack ground targets. Only four Harriers—two Royal Navy and two RAF—were shot down by ground fire. (A third RAF aircraft was struck by ground fire but made it nearly back to its ship before it ran out of fuel.)

The next combat test—the 1991 Gulf War—did not provide a ringing endorsement of STOVL capabilities. Ashore and afloat, 84 Marine Corps Harriers joined the coalition air campaign against Iraq. They carried out about 3,400 sorties, divided almost evenly between air interdiction and close air support.

While pilot heroics abounded, the overall combat record was mixed. Five Harriers were lost, primarily on low-altitude ground-attack missions.

The Harriers were based close to Kuwait and flew short-duration ground-attack missions. For those reasons, they managed to turn in high sortie rates. However, critics pointed out that the force required an enormous transport and supply operation. A postwar article by the Los Angeles Times reported that support took 2,000 marines at King Abdel Aziz AB, Saudi Arabia.

The Harriers contributed little to strategic battlefield-shaping operations, and the lack of advanced targeting systems was apparent. USAF’s Gulf War Air Power Survey credited the AV-8 with just three precision guided missile strikes for the entire war.

**Afghan Air War**

Ten years later came the Afghanistan air war, which might have been a true test of the Marine Corps concept of bare-field basing. However, Harriers again played a minor role.

Harriers in small numbers joined in the air war in Afghanistan only after it was well under way. Two Harriers made a one-night deployment to Kandahar in November 2001, but the main contribution came from three groups of six Harriers embarked on three amphibious ships in the north Arabian Sea.

The AV-8Bs lacked laser targeting pods and could fly combat missions only when other aircraft did the “lasing” for them.

In October 2002, a six-airplane detachment of Harriers from Marine Attack Squadron (VMA)-513 set up shop at Bagram, near Kabul, where A-10s had been operating since March
of that year. They have helped meet the need to provide on-call air support from a local base. At Bagram, however, poor runway stability and thin air at 5,000-foot altitude caused the Corps to nix vertical takeoffs. The main benefit to the Harrier deployment was that basing at Bagram improved on-station times. The addition of Litening pods has made Harrier pilots valuable players in operations, but the benefits of the aircraft do not stem primarily from its STOVL capability. “I think the reason the AV-8s were used at all in Afghanistan was a tendency by the US military to give everybody their turn, whether you needed them or not,” Anthony H. Cordesman, an analyst with the Center for Strategic and International Studies, told the Los Angeles Times.

In Operation Iraqi Freedom in 2003, sea basing was the preferred mode for Harrier operations. Sixty of the 76 Harriers in the theater were embarked on amphibious ships. USS Bataan and USS Bonhomme Richard each became a “Harrier carrier.” Other AV-8Bs were with the Air Force in Kuwait. According to the Marine Corps, the Harriers logged some 3,000 flight hours and 2,000 short-duration sorties. Many Harriers made some use of a forward arming and refueling point at An Numaniyah, 60 miles south of Baghdad, after coalition forces took the area. However, as one Harrier squadron commander pointed out, it was a major task keeping such aircraft supplied with jet fuel at that site.

“The Harrier wasn’t used to its full potential out there,” said Marine Corps Lt. Col. Paul K. Rupp, commanding officer of VMA-211, in remarks to the Marine Corps Times. “It takes a lot of support and logistics, ... so we chose to use other platforms.”

**Big Questions**

The Harrier’s mixed combat record has raised major questions about whether the US military services actually need a new jump jet. Still, the Marine Corps has stuck with the basic operational concepts that led it to buy the Harrier and keep improving it over the years.

Its desire for STOVL F-35s stems from a perceived need to have Marine Air-Ground Task Force (MAGTF)-owned aircraft based close to marines engaged in combat, whether it is on a beach, in a city, or far inland. Marines also want to keep these STOVL aircraft under Marine control, if at all possible.

The new jump jet incorporates technology far superior to that of the Harrier. By any measure, the performance of the X-35B STOVL demonstrator was strong enough to silence criticism of the safety and technical performance of a STOVL aircraft. Pairing a lift fan with the main engine generated nearly 40,000 pounds of thrust—an immense improvement over the Kestrel’s 15,200 pounds or the first Harrier’s 21,000 pounds. (Today’s Harrier II has 23,400 pounds.)

The JSF jump jet also produces much less exhaust, which adds to the safety of flight deck operations at sea.

These promising improvements sparked new ideas about how to exploit STOVL. In 2002, Edward C. Aldridge, then undersecretary of defense for acquisition, went so far as to speculate that the STOVL JSF could supplant the Navy’s planned F-35 carrier variant and lead to new aircraft carrier configurations. “Maybe the future carrier doesn’t have a wire,” Aldridge told Inside
Is STOVL Needed?

The classic Cold War case for vertical or short takeoff clearly no longer applies. It was based on runway vulnerability to massive nuclear or conventional attack. STOVL aircraft could land on roads or other hard surfaces serving as impromptu forward arming and refueling points. In a desperate fight to slow down the lead echelons of a Warsaw Pact assault, every tactical aircraft could make a difference. Dispersal would ensure that a preemptive strike would not strip NATO of tactical airpower.

Nor is mission flexibility as important to the Air Force as it is to the RAF. Britain’s interest in STOVL JSF depends on sea basing, since the aircraft will be both a land- and sea-based fighter and will influence the design of future British aircraft carriers.

Different Case

The Air Force case today is different. As Jumper has explained, STOVL JSF could be part of an overall long-term close air support strategy. “Our requirement is somewhat different than [that of] the Marine Corps,” he said. “We do not plan to deploy into austere, nonprepared locations. What we want to be able to do is take advantage of the many short airfields that are out there in expeditionary operations.”

The Chief of Staff, in remarks to reporters last December, added that evolving Army concepts of operations—which envision a “discontinuous battlefield”—would make it necessary to “keep corridors of access available” and provide deep fire support.

The Air Force’s case rests on three primary needs: to make use of expeditionary airfields, to generate large numbers of combat sorties, and to conduct persistent operations in the battlespace.

USAF’s recent experience employing its airpower from expeditionary airfields, particularly Bagram Air Base in Afghanistan, taught many lessons.

Soon after coalition forces seized the field from Taliban forces in 2001, Bagram was described by a visiting aviator as “the scariest place on the planet.” It was filled with bearded special operations forces troops, unexploded ordnance, and two hangars full of abandoned former Soviet equipment.

Improving bare bases, however, is a necessity for efficient, long-term combat operations. By the time A-10s arrived at Bagram, efforts were already under way to change the place from an austere site to an expeditionary base. The arrival of an Army headquarters and XVIII Airborne Corps coincided with improved living conditions at Bagram.

US and coalition forces were also committed to improve the Bagram facility as part of an access agreement. The agreement was that, whenever an expeditionary force occupied a building, it would repair it as well as one additional building. The Harrier pilots and maintainers who arrived in October 2002 were pleasantly surprised with what had already been accomplished.

It’s one thing to provide hot chow and plumbing. It’s quite another to pour the acres of concrete needed to greatly improve an airfield. The Bagram case suggests that, at some airfields, improvements will be needed. Otherwise, an expeditionary force will encounter problems that cannot be solved even with an aircraft that needs only 1,000 feet of takeoff roll. Airfields with crumbling ramp space, or that lack power, fuel, water, and ordnance, have no combat utility.

Global USAF deployments for relief operations and peacekeeping, as well as combat, have already proved that airfield quality is a major variable in expeditionary operations. Operating from short runways that are in poor condition is a potential con-
stirnt on airlift as well as fighter basing.

Three Variables

A second point often cited in favor of STOVL is sortie generation. The Marine Corps saw that as a major Harrier plus in Operations Desert Storm and Iraqi Freedom. The metric for sortie generation is a complex one, however. High sortie generation depends on three variables: basing in proximity to the fight, sortie duration, and aircraft reliability. Capitalizing on those factors does not necessarily require STOVL capabilities, say experts.

In Desert Storm, for example, F-16s no less than Harriers made use of forward bases for quick-turn rearming and refueling. In Iraqi Freedom, A-10s quickly deployed forward to capture Tallil Air Base in Iraq. The most important metric was the flow of aircraft into land component sectors or to the CAS stacks over Baghdad. The Harriers enjoyed no particular edge over conventional aircraft.

Stability operations in Iraq and Afghanistan have seen persistence eclipse sortie generation as a metric. Ground controllers treasure advanced targeting pods and like to keep aircraft on station long enough to build their situation awareness. Attacks on insurgent leadership targets often require time to execute—either to get updated reconnaissance data, strike permission, or to conform with rules of engagement.

New demands for persistence contrast with the concept of using STOVL aircraft to generate high sorties in strikes and restrikes on massed enemy forces or fixed targets. While the STOVL JSF endurance trade-off is far less than that for the Harrier, opting for STOVL still shortens the fighter’s legs. That means a cut in persistence.

A third benefit attributed to STOVL is its possible future flexibility. In theory, this is the one aircraft that could make landing on carrier decks, amphibious ships, or austere airfields a common occurrence. Air Force, Marine Corps, and Navy pilots could all be part of the blended squadron deployed and employed anywhere and everywhere—at least as long as their maintainers were not too far out of reach. Marine Corps Lt. Gen. Michael A. Hough, the deputy commander for aviation, proposed an even more radical role for Air Force jump jets. “Why can’t you put them on carriers?” Hough asked at an October 2004 conference. “It hasn’t been done before in America, but it can be done.”

Configuring a STOVL JSF for Air Force use faces problems.

Until 2002, plans called for all three JSF variants to have a common weapons bay, but that proved unworkable. Now, DOD wants to shift back to equip the STOVL variant with a smaller bay, designed to hold two 1,000-pound Joint Direct Attack Munitions (JDAM) and two AIM-120 Advanced Medium-Range Air-to-Air Missiles.

Moving to a smaller weapons bay is not necessarily a black mark on the STOVL JSF. Experience in Afghanistan and in Iraq has shown that 500-pound laser guided bombs, un guided 500-pound Mk 82s with airburst, and the new 500-pound JDAM are the preferred weapons. Smaller bombs with variable fuse settings reduce collateral damage and can be easier to employ in CAS situations, with friendly troops in close proximity.

For the future, the advance of technology is leading to weapons with smaller bodies, notably the 250-pound Small Diameter Bomb. If properly configured, even the smaller STOVL weapons bay will be able to carry up to six Small Diameter Bombs, plus air-to-air missiles, making it a flexible asset for air component tasking.

Incorporating a gun will be another matter. Jumper called the gun a “necessity” and said, “We’re going to want the gun on the plane.” Rear Adm. Steven L. Enewold, the JSF program executive officer, told Defense Daily, “It looks possible but not easy. It would add weight and drag to the airplane, we think.”

The promise of STOVL first came into view a half-century ago. It now appears that JSF can actually deliver on that promise with superior combat performance. Advanced technology puts the STOVL JSF into a competitive league.

Yet to be seen is how changes in the operating environment itself will affect the actual utility of STOVL, at least for the Air Force. The payoff that would flow from even a sophisticated STOVL aircraft is just one variable among many—and probably won’t be the decisive one.

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