

F-22A Raptor



No longer a fair fight

After a quarter century long development gestation, the awesome Lockheed Martin F-22A Raptor, the world's first fifth generation fighter, achieved initial operational capability (IOC) with the 27th Fighter Squadron (FS) of the 1st Tactical Fighter Wing (TFW) at Langley AFB in Virginia, in December.

The F-22's combination of stealth, supercruise, manoeuvrability, and integrated electronics means it not only indisputably rules the skies against all comers; it is likely to do so for decades to come.

Australian Aviation visited Langley and Washington DC the week before the IOC ceremony for an update on the F-22A program and the aircraft's introduction into service.

HISTORY & DEVELOPMENT

The F-22 was born out of the USAF's Advanced Tactical Fighter (ATF) competition, which had its origins in various USAF studies carried out in the late 1970s and early 1980s. Intelligence on the Soviet Union's emerging Su-27 and MiG-29 fighters was becoming available, and it soon became apparent that these promised to give the Soviets parity with their US F-15 and F-16 equivalents, so a new fighter had to be found.

The ATF program was officially initiated in 1981, with the USAF releasing a requirement

for a new air superiority aircraft which would take advantage of new technologies in fighter design including composite materials, light-weight alloys, advanced flight control systems, higher power propulsion systems and stealth technology.

Two contractor teams were selected in October 1986 for an initial 50 month demonstration and validation phase, with each team to deliver two concept demonstrators. The YF-22 was to be developed by Lockheed, General Dynamics and Boeing, while the rival YF-23 was born out of a Northrop and McDonnell Douglas teaming. Two competing engines were also developed for the flyoff; the Pratt & Whitney YF119 and General Electric's YF120, with both teams to fly both engines in their two demonstrator aircraft.

The resulting YF-22 and YF-23 demonstrators were both about 10 per cent larger than the F-15 they were designed to replace, with almost twice the internal fuel load, 50 per cent more wing area and 30 per cent greater combat weight.

The first YF-22, dubbed prototype air vehicle one (PAV-1) and equipped with YF120 engines, was officially rolled out in August 1990 at Lockheed's facility at Palmdale in California, and made its first flight on September 29. The second YF119 powered prototype made its first flight on October 30. Both aircraft were flown the short distance to Edwards AFB where they would be based for the demonstration and evaluation.

by Andrew McLaughlin

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“For air-to-air training, we train against both legacy aircraft and each other, but it's getting harder to get the legacy guys to come out to fight,” Major Corcoran told AA. “It's no fun for them anymore!”

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Title pic – The first operational F/A-22 Raptor overflies Fort Monroe in Hampton, Virginia, before arriving at its permanent home at nearby Langley AFB on May 12 2005. This was the first of 26 Raptors to be delivered to the 27th FS. (USAF)



The Raptor has four external hardpoints (two under each wing) for the carriage of auxiliary fuel tanks (pictured), JDAMs, air-to-air missiles, or a combination of all three. External stores are only used for ferry flights or once air dominance has been assured as they disrupt the aircraft's low observability. (USAF)

The YF-22/YF119 combination was declared the winner of the ATF evaluation in August 1991. The Lockheed/GD/Boeing team and Pratt & Whitney were awarded engineering and manufacturing development (EMD) contracts totalling US\$10.9bn, under which they would complete the aircraft's design, construct tooling and production facilities, and build and test nine airworthy and two ground test F-22s. This amount soon blew out to US\$18.6bn due to congressional budget cuts and schedule changes.

The first F-22, Raptor 4001, made a successful first flight at Marietta on September 7 1997, and following some minor structural modifications was delivered to Edwards AFB in February 1998. As more pre-production aircraft joined the test force at Edwards, the program began to experience several technical problems. These included manufacturing problems with titanium castings; delamination of composite longerons; structural weaknesses in the aft fuselage; anomalies in the braking, inertial reference and environmental control systems; fuel leaks; problems with engine low and high pressure turbine blades and combustors; and problems with excessive engine vibration.

A 1999 report showed the in-production F-22 was projected to cost at least three times as much as the US\$55m F-15 it was designed to replace, with the six FY00 development aircraft to be procured costing an astonishing

US\$300m (A\$406m) each. This meant the Pentagon's aircraft modernisation plan called for twice the historical percentage of procurement dollars to buy roughly half the number of aircraft.

In December 2002, the Raptor's designation was changed from F-22A to F/A-22A, for Fighter/Attack, to highlight the aircraft's evolving multi-role capability. However, following the Raptor being granted IOC in December 2005, the F-22A designation was re-instated in line with traditional USAF naming policy, with senior USAF chiefs admitting the F/A designation had probably been as much a marketing ploy aimed at Congress in order to get more aircraft approved as anything else.

"You can take this a bit to the extreme about the F/A, because (the Raptor) is equally capable as a Rivet Joint (RC-135V); it's equally capable as a Compass Call (EC-130); it's equally

capable as all these other aircraft when you look at the wide variety of things that it does," explained USAF Chief of Staff General Michael Moseley in a December interview. "But we had no desire to call it an RC or an EW or an F/A/EW/RC-22Something. So the simplicity of this is the Air Force has fighters with the nomenclature of F which should be in the lineage of the rest of the fighters."

Ironically, just after the designation change to F/A-22 and just as the program started to come good after years of development difficulties and delays, the DoD leadership decided to terminate procurement after FY2008 as a cost saving measure, thus reducing production to just 179.

Meanwhile, the 27th FS of the 1st TFW based at Langley AFB in Virginia, the USAF's oldest continuously operational fighter squadron, was selected in January 2000 to be the first operational Raptor unit. Assembly of the first operational aircraft, Raptor 4018, commenced in March 2001 and it was delivered to the 43rd FS at Tyndall AFB in Florida in September 2003 to begin pilot and maintenance crew training. The USAF's 422nd Test and Evaluation (T&E) Squadron, which also flies the F-15C, F-15E, F-16C and A-10, took delivery of its first of eight pre-production F-22s at Nellis AFB near Las Vegas in January 2003 for weapons testing and operational evaluation work.

"When the OT (T&E) guys first got the airplane, there were still a lot of problems with the avionics," Major Charles 'Corky' Corcoran from the 27th FS told *Australian Aviation*. "The stealth, engines, and FCS (flight control system) were all good, but there remained some challenges with the maintenance and integration of the avionics." Major

An Edwards based F-22 fires an AIM-9M Sidewinder during testing. (USAF)





The 27th FS flightline at Langley Air Force Base. The 94th and 71st FSs will follow the 27th in converting from the F-15C to the Raptor, with Langley expected to be home to some 72 F-22s by the end of 2007. (Andrew McLaughlin)

Corcoran came to the 27th after being one of eight USAF Air Combat Command pilots to be involved with some of the testing work on the F-22 at Edwards and Nellis AFBs since 2002 with contractors from Lockheed Martin, Boeing, Pratt & Whitney, Computer Sciences Corporation, Tybrin and JT3.

“Every flight got better and better, and we eventually got the software fixes we needed,” Major Corcoran said. “It was great to be a part of the team that found the solutions. But even when the avionics weren’t working right, nobody could see us, so we’d just roll in behind them and get them with guns! It was like playing a major league team against the little leaguers.”

In March 2005, the Pentagon’s Defense Acquisitions Board (DAB) gave the F-22 program approval to commence full rate production. Critics have panned the F-22, some estimating that the aircraft will end up costing more than US\$350m (A\$473m) each when research and development funding is extrapolated across the number of airframes acquired, and saying it was designed to fight an enemy which no longer exists.

Conversely, supporters of the program say this is a simplistic view in that, like it or not, the development money has already been spent, and much of the technology developed for the F-22 will find its way into the F-35 Joint Strike Fighter and other programs. Hawkish proponents add that, although the US no longer faces a threat from the USSR, many advanced Russian aircraft and anti-

aircraft weapons systems are finding their way into second and even third world military inventories, and that a China with rapid annual growth and regional tensions of its own looms as a potential future Cold War style adversary.

Current funding levels released in the wake of February’s Quadrennial Defense Review (QDR) allow for 183 F-22s to be acquired. The USAF puts the Raptor’s price tag at about US\$160m (A\$216m) per aircraft averaged over the production run, and Lockheed Martin estimates future unit recurring flyaway prices would drop to between US\$86 (A\$117m) and US\$100m (A\$135m) each if production were to be extended.

To date, the USAF has taken delivery of about 70 F-22s including training and T&E aircraft at Edwards, Nellis, Tyndall and Langley AFBs.

IOC ACHIEVED

The first of 26 F-22s to be delivered to the 27th FS, tail number 03-042, arrived at Langley on May 12 2005, and 16 more Raptors had followed by year’s end.

The 27th’s first training deployment took place on October 15 last year, when eight F-22s deployed to Hill AFB in Utah for a two week period. Cynics point out the Hill mission was designed as much to show the aircraft and its capabilities to the American taxpayer through the granting of unprecedented media access to the aircraft and its crews, as to demonstrate the aircraft’s deployability. “We are eager to take this airplane on the road and practice

our overall abilities with it,” the 27th’s squadron commander, Lieutenant Colonel Jim Hecker, said in a statement during the deployment. “It’s an important training opportunity for our Raptor team, but it’s also an event steeped in historic value.”

Nevertheless, the deployment successfully generated a combat effective sortie rate with regular JDAM bombing missions scoring 22 direct hits out of 24 bombs dropped, air combat sorties, and flights against simulated SAM batteries over the ranges near Hill and nearby Nellis AFBs. “Thousands of people have spent thousands of hours preparing this aircraft for mission-ready status,” LtCol Hecker said. “Our job now is to use this training opportunity to the fullest and continue on the path to bringing this air dominance vision to fruition.”

“In any other aircraft, if I was going to try and do what I did (at Hill), I’d be dead,” said Major Corcoran. “Pitting the Raptor against the simulated effectiveness of these next generation SAM systems is an important step in gaining confidence in the airplane’s capabilities.”

Following the squadron’s return from Hill, several smaller two day missions to Nellis were carried out. “Towards the end of ’05 we started making trips over to the Nellis range in Nevada with small four ship elements,” the 27th’s Director of Operations, Lieutenant Colonel Wade ‘Troll’ Tolliver, told *Australian Aviation*. “We’d fly straight from Langley to the Nellis range, fly the mission, then recover into Nellis. Then we’d do the same thing in reverse the



The F-22 has an intuitive cockpit layout which supplies Raptor pilots with an abundance of information. The biggest challenge for pilots is when to access the information and how to best use it. (USAF)

next day.” LtCol Tolliver has 13 years of experience flying F-16C Block 30, 40 and 50 fighters, and had a year on F-15Cs before converting to the F-22 in mid 2004.

The successful Hill deployment and subsequent Nellis missions combined with the continuing work performed by the Nellis based T&E unit culminated in the aircraft being granted IOC on December 15. This means the USAF now considers the aircraft as a part of its order of battle and that it can call upon at least 12 aircraft to be ready to deploy for combat. “If we go to war tomorrow, the Raptor will go with us,” the commander of the USAF’s Air Combat Command, General Ronald Keys, said during December’s IOC ceremony.

“I’m expecting we’ll achieve full operational capability (FOC) within 12 months, although our IOC allows us to be deployed tomorrow if something kicked off,” LtCol Tolliver added. “We’re definitely ready to go now if we were needed.”

In January the F-22A achieved another milestone when it completed its Follow-on Operational Test and

Evaluation (FOT&E) and was declared mission capable in the air-to-ground role. The capabilities evaluated during the FOT&E process included deployability, sortie generation and JDAM employment, and were conducted by the Nellis based 422nd Test and Evaluation Squadron.

Meanwhile, the F-22A is already showing availability and maintenance man hour rates comparable to the mature F-15C which it is replacing. Lockheed Martin projects that, once the Raptor fleet reaches ‘maturity’ at around 100,000 flying hours, it should require about one-third the maintenance hours per flight hour of its forebear. To date, the total Raptor fleet has flown about 11,000 hours. “It used to be that we had to care for stealth platforms like babies,” Lockheed Martin’s F-22 business development representative Danny Conroy, a former USAF F-4 and F-16 pilot, told AA. “Now we can park the F-22s outside alongside the F-15s and F-16s, and they don’t require any special handling at all. And the (APG-77 AESA) radar, because it has no moving parts, is designed to last as long as the airplane.”

The F-22 further demonstrated its combat readiness when the aircraft flew its first Operation Noble Eagle missions guarding US airspace against potential terror attacks on January 21 and 22 this year. “This is our first operational mission, the first mission where we’ve carried live ordnance,” LtCol Hecker said at the time. “Most of our pilots have done this before, but not with the Raptor. It’s a big step for us and a big step for the Raptor program.”

Although the F-22 is not expected to be deployed to Iraq or Afghanistan where air dominance has already been achieved, further missions and deployments are planned over the next few months culminating in the unit’s first visit to the Red Flag exercises at Nellis in October.

“At this stage, we’re planning to send our first detachment to Red Flag in October ’06 which should be just awesome,” LtCol Tolliver told AA. “However, towards the end of May or early June we’re planning on taking 12 jets to Elmendorf AFB in Alaska for a two month deployment called ‘Northern Edge’. Around the same

time, the rest of the unit will go to Hill AFB in Utah for a four week deployment before spending some time at Tyndall in Florida on the way back. While we're gone, our runways here at Langley will be upgraded."

During this time, the 27th will also assist its sister squadron at Langley, the 94th FS, to transition to the F-22. The 94th is due to take delivery of its first F-22 in March and ceased flying its F-15Cs during December, with several of the unit's pilots and maintainers currently converting to the Raptor at Tyndall.

"The 27th is providing a huge amount of corporate knowledge to the 94th," LtCol Tolliver explained. "Their focus is now on the Raptor, and their CO (commander) and one other have already been checked out on the aircraft. The 94th's pilots will fly with the 27th as a 'super squadron' until their unit has about six aircraft somewhere in the July '06 timeframe, and their path to IOC will take about 12 months. The 94th certainly won't go through the pains of startup on their own."

"We are in a good situation because they (the 27th) have built a good concept of operations, and we have the ability to take what they have learned to the next level," added the 94th's squadron commander, LtCol Dirk Smith. "We will be able to enjoy the benefits of the work that the 27th has done. From the operator perspective, we see it as a way to better equip the force. It's more than just getting a new airplane; it's about the people who make it happen."

The third and final element of the 1st TFW, the 71st FS, will follow the 94th in converting from the F-15C to the F-22 from early next year, after which units at Elmendorf AFB in Alaska, Hickham AFB in Hawaii, and possibly Holloman AFB in New Mexico are expected to follow suit. There are no firm plans to replace F-15C units permanently based overseas in the UK or Japan with Raptors, although regular deployments to these areas by US based F-22 units can be expected.

FLYING THE F-22

With an hour in a simulator the author couldn't possibly equate to what it's like to really fly the world's best fighter, especially as the simulator was no doubt 'detuned' for visitors not cleared to know what the F-22 can really do.



A 1999 report showed the in-production F-22 was projected to cost at least three times as much as the US\$55m (A\$74m) F-15 it was designed to replace. (USAF)

However, the ease at which even this writer adapted was remarkable. Everything in the Raptor's cockpit just falls to hand, and everything can be controlled by numerous toggles and switches on either the right mounted side stick or left mounted throttles. Pilots no longer need to scan the aircraft's entire instrument panel to find out what is happening; it's all there on one screen with one flick of your right forefinger or your left thumb.

"The cockpit has been designed to be intuitive, so a fighter pilot knows where to look instinctively," LtCol Tolliver explained. "The F-22 has a mix of the best things from other fighters, although it's probably slightly easier for an F-16 guy to transition over because of the side stick, frameless canopy and DFCS (digital flight control system).

A 27th FS Raptor being readied for flight. (Andrew McLaughlin)



"The biggest challenge in flying the Raptor is information management," LtCol Tolliver continued. "All the data is at your disposal – you just need to know when to access the information and how to use it. For conversion, because there's no two-seater, you do eight-to-nine simulator flights before your first flight. And before you do your first flight, we suit you up and take you out to the jet and do all your ground checks in a dummy run as if you were going to fly. Your first flight won't just be a jaunt around the airfield; it's a full mission where you explore the AHC (advanced handling characteristics), and then perform four-to-five practice landings when you return to base.

"We've been very careful about who and how we brought pilots into the 27th," LtCol Tolliver said. "We took some young guys who had just over 500 hours on the F-15 and the F-16. We picked a lot of young guys because we don't want to get caught up in old theories."

After about 10 minutes instruction, the author was able to not only fly and manoeuvre the aircraft, but also to bomb two simulated SA-10 SAM sites with a brace of 120kg GPS guided small diameter bombs, shoot down a number of Su-27s with AIM-120C AMRAAMs, do some supersonic aerobatics over the Nellis test ranges, and then fly an approach and land the aircraft safely at Nellis AFB.

"Any kid who's good at playing video games can fly the Raptor," Captain Brad



"It's pretty much leaps and bounds ahead of any fighter out there. It brings situational awareness through its sensor suite, tasking and fusing far greater than any other fighter." (Andrew McLaughlin)

'Bruiser' Spears, one of the 27th's newer pilots said the day before the author's sim ride. Captain Spears had just converted to the F-22 after flying F-16C Block 30 fighters and Block 50CJ 'Wild Weasels' which specialise in suppression of enemy air defences (SEAD) missions. "It's so much like a video game, it's easy."

"It's seat of the pants," added LtCol Tolliver. "The aircraft is very easy, in fact, amazingly easy to fly, it just makes it easy for you. Pilots like its speed and manoeuvrability, it moves like an F-16 with its digital FCS."

The four full-colour cockpit displays are incredibly logical and legible, with the main display giving the pilot a 'god's eye view' of the battlespace for hundreds of thousands of cubic kilometres. The picture is provided by sensor feeds taken not just from the F-22's radar, but also via datalink from accompanying aircraft, from the electronic warfare system, and probably from other classified sensors.

"It's pretty much leaps and bounds ahead of any fighter out there," Captain Spears added. "It brings situational awareness through its sensor suite, tasking and fusing far greater than any other fighter."

The screen's image not only shows friendly and enemy aircraft, ground based threats, and their relation to your position, but it also draws a 'bubble' around each threat which indicates the range at which they can 'see' you with their own sensors. As long as you don't cross that bubble and you have the right weapons on board, you can engage them at will. During the author's 'flight' three Su-27s were well within AMRAAM

range while the F-22 remained well outside their detection range, and it could approach an S-300 SAM site to well within SDB (small diameter bomb) range...they just wouldn't have known the jet was there.

"The most impressive part of the airplane is the stealth," Major Corcoran explained. "It separates the airplane from anything else out there, and allows you to pick and choose who you engage. Its speed allows you to get around them faster, and its 'active' stealth through its sensors lets you know if you can be seen and allow you to stay outside an enemy's 'bubble'. You can't really compare with that level of situational awareness. It's no longer a fair fight!

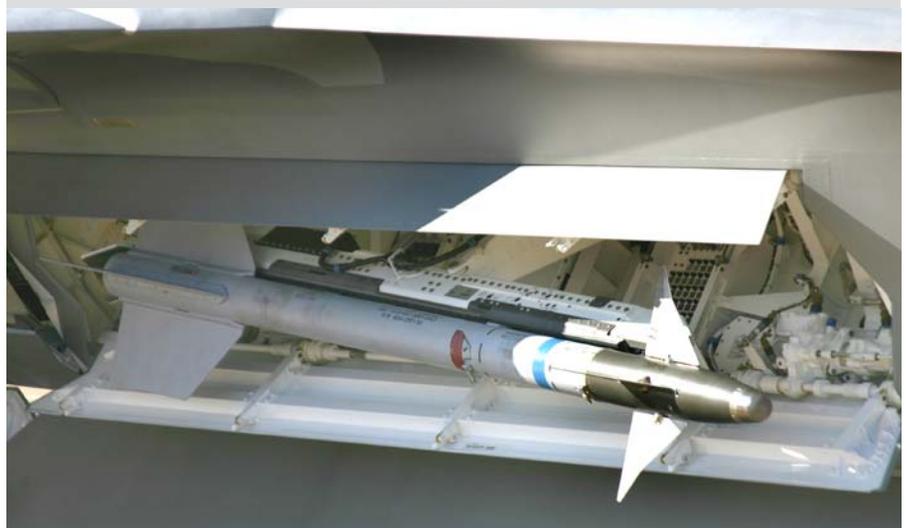
"The hardest thing for guys transitioning to the F-22 is to take advantage of the stealth," Major Corcoran continued. "You tend to do some defensive manoeuvring you don't really need to do. It's a matter of seeing is believing. You still have habits you need to break. In air-to-air in legacy aircraft (F-15, F-16), if we see the other guy we assume he sees us. In the Raptor, it's different."

"It's a lot bigger than the F-16, twice the size in fact, and you can feel its size," Captain Spears noted. "But it reacts as quick and manoeuvres through a greater envelope than the F-16. It's about as fast as an F-16 down low, but at altitude it just keeps going which is very impressive. When you're at 50,000ft and accelerating and you're just clicking the Mach numbers over, that's just awesome."

In the simulator, and again although the aircraft's best supercruise and top speeds are classified, the author saw Mach 1.6 and accelerating at about 45,000ft without using the afterburners. In fact, in all the combat scenarios presented, the author used the burners just once during a max rate climbing turn after dropping the SDBs.

"That saves us a lot of gas and opens up a whole host of things when you start talking about dropping bombs," instructor pilot LtCol David Krumm from Tyndall's 43rd FS said in a recent interview. "You can imagine if you are 60,000ft doing Mach 1.9 and these bombs are flying out of your airplane,

The starboard intake weapons bay of a Langley based F-22 showing an AIM-9M training round on its retractable rail. The latest generation AIM-9X is expected to be introduced onto the Raptor from mid 2007. (Andrew McLaughlin)



the swath of hell you can produce going through a country saying 'I'll take that target, and that target?'"

"We can go against threats that F-16s and F-15s wouldn't even think about trying to attack," said LtCol Hecker. "In boxing, if you fought a man you couldn't see, he'd hit you all day."

"It's unfair to compare the F-22 with the F-15 and F-16," observed LtCol Tolliver. "This jet in a tactical scenario just can't be compared, and I know I'm in the most survivable aircraft out there." In fact, the F-22's superiority over its forebears means there are no longer any really testing 'sparring partners' to train against. "For air-to-air training, we train against both legacy aircraft and each other, but it's getting harder to get the legacy guys to come out to fight," Major Corcoran told AA. "It's no fun for them anymore!"

"They just bring their mission tapes with them and we watch them together, and we say 'sorry guys'," offered LtCol Tolliver, only half joking. "The F-15 pilots, they are the world's best pilots," explained LtCol Krumm. "When you take them flying against anyone else in the world, they are going to wipe the floor with them. It's a startling moment for them to come down here and get waylaid."

"We want to kick the door down so the airspace is clear for any (aircraft) you want to go in," LtCol Krumm said. "Someone could come in flying a Cessna 172 with a pistol if you wanted after we're done." He added that F-117s and B-2s "want to sneak in, drop their bombs, and sneak out again. They have absolutely no wish for a fight. They don't have air-to-air missiles, they cannot manoeuvre that well or anything else. Our airplane is entirely offensive. Not only am I stealthy, but I'll also hunt you down and kill you if you get in my way."

"Even with its limited capability, it's a magnificent weapon," LtCol Tolliver remarked. "But we're not going to see the best out of the F-22 until we get the younger guys who have grown up in the information age coming on to the jet. The airplane will really grow into the younger generation."

Perhaps the final word on the aircraft's capability should go to the USAF's ACC commander. "Lamentably, we have never been privileged to hold a weapon like this in our hands," said General Keys at the F-22's IOC cer-



This photo shows in detail the F-22A's stealthy engine exhausts, weapons bays, radar absorbent leading edge treatments and generally smooth lines. (USAF)

emony. "After reviewing our test results, seeing our operational deployment performance, and talking to the pilots that will go to war with it, I am confident that the F-22A joins the combat force at a far more mature and capable level than any of our previous great aircraft."

PROGRAM FUTURE

In the meantime, follow-on capabilities for the F-22A have been frozen in favour of drawing out the production run for an additional two years to 2010 in order to have a smoother transition between F-22 and F-35 JSF production for the Lockheed Martin workforce at Fort Worth. The QDR will "Restructure the F-22A program and extend production through Fiscal Year 2010 with a multi-year acquisition contract, to ensure the Department does not have a gap in fifth generation stealth capabilities."

While savings from this proposal will result in an additional four aircraft being added to the production run, planned spiral upgrades to the F-22 which were to give it a synthetic aperture radar and ground moving target indication (SAR/GMTI) capability, data-links, and the ability to deploy the SDB in Block 20 and Block 30 increments are on hold for now. "At the end of the day, the F-22 just winds up being more expensive," the US's Heritage Foundation defense analyst James Carafano said in a recent interview. "It just pushed all the hard things to the outer years, and it really didn't even address that."

"It becomes more important to improve the capability if there are only 180 aircraft," Larry Lawson, Lockheed Martin's F-22 program general manager said in a separate interview in December. "No one else can go in there," he said, referring to an integrated air defence system with advanced fighters such as that currently being fielded by China.

USAF Chief of Staff General Michael Moseley says 183 Raptors will be enough to field seven "full-up, combat coded" operational squadrons, although curiously, current squadron fielding levels of 24 aircraft per squadron plus a training and T&E requirement of about 60 aircraft suggests a minimum of 228 F-22s is required to meet the General's target.

"There was a time when we defended the world with 50,000 P-51s," ACC's General Keys said recently. "Now there may come a time when we defend this globe with 126 Raptors. If you have 183 of them, you have about 126 that are combat capable (at any one time). That just means they won't be the force they would have been."

Ironically, the QDR move may also prove to be the F-22's saviour, in that it also pushes any decisions on the final number of Raptors to be built into the next presidential administration. While the Bush Administration has consistently blocked the USAF's efforts to procure the 381 F-22s it says it needs, some observers have said that the extension offers a chance for the USAF to make the aircraft's case with a new administration. □