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Cover Photo: US Navy

Ryan FR-1 Fireball
Neither Fish Nor Fowl

Essentially a conventional World War Two fighter with a small jet engine stuffed in the back, the unfortunately-named Fireball was the US Navy's toe-in-the-water approach to putting jets on their aircraft carriers.

At the same time the Navy ordered the pure-jet McDonnell FD Phantom they hedged their bets by commissioning a fighter with both jet and piston engines. Ryan's was the best of the nine submissions. Pulling was a Wright Cyclone and pushing was a General Electric J31. The jet engine was mainly intended to boost performance at altitude rather than power the Fireball throughout its flight and used for take-off, for acceleration in combat and for landing.

Design work began in February 1943, and on 25 June 1944 the first XFR-1 (48232) flew at San Diego with Robert Kerlinger in the cockpit, but no jet engine in the fuselage.

The Fireball had a laminar-flow wing optimised for high-speed flight. This was the first carrier-based fighter designed from the outset to have such a wing. Two of the three XFR-1 prototypes were lost to wing failure.

Following early tests, the FR-1 required a substantial redesign of its tail surfaces, which initially looked quite jet-like but were soon replaced with larger, more conventional units.

The FR-1 was a very conservative method to introducing jet engines into the Navy. Only 17 of the 66 built were to see squadron service, which lasted just over two years. At least 33 accidents were recorded, of which 11 resulted in total write-offs.

With the FR-1 expected to be especially suited to intercepting kamikaze attacks, orders for 100 soon came, followed by 600 more in January 1945. In August, 643 of these were cancelled, as were improved FR-2 and FR-3 versions with different engine combinations. One example of the XFR-4 with a 3,400lb (15.1kN) thrust Westinghouse J34 jet was tested. The longer FR-4 had NACA-style intakes, replacing the FR-1's wing root intakes. For once a Westinghouse engine provided too much thrust and worked poorly in conjunction with the piston engine, although it was 100mph (160km/h) faster than the FR-1. A further development, the turboprop/jet XF2R-1 Dark Shark, remained a single prototype, flown in November 1946.

The escort carrier USS *Bairoko* embarked VF-41 with 16 FR-1s in March 1945, conducting trials until late April when manpower shortages forced the carrier into maintenance status. On 6 November, an FR-1 landed aboard USS *Wake Island* with a failing piston engine and the jet at full power, preceding the first official jet shipboard landing (by a British Vampire) by a month. Fireballs were also tested in Arctic conditions aboard USS *Midway* in March 1946. The type soon faded away into obscurity and only one example remains, at the Planes of Fame Museum at Chino, California.

Ryan FR-1 Fireball

Crew:	One
Length:	32ft 4in (9.86m)
Wingspan:	40ft 0in (12.19m)
Height:	13ft 8in (4.15m)
Empty weight:	7,689lb
Max T/O weight:	10,595lb (4,806kg)
Powerplants:	One Wright R-1820-72W Cyclone piston engine rated at 1,425hp (1,063kW) and one 1,600lb st (7.1kN) General Electric J31 turbojet
Max speed:	426mph (686km/h)
Service ceiling:	43,100ft (13,136m)
Range:	1,620 miles (2,607km)
Armament:	Four 0.50in machine-guns; provision for bombs or rockets



Below: ***The first two XFR-1 prototypes with new enlarged vertical tails installed. The aircraft in front has the tail fin as fitted on the production Fireballs. The plane on the background has an enlarged experimental tail fin.*** *Jim Winchester collection*

McDonnell FH-1

The First Phantom



A manufacturer with little experience built the Navy's first all-jet fighter. The Phantom was an unambitious but robust design that introduced jet aircraft to carrier decks and paved the way for greater things to come.

McDonnell Aircraft of St. Louis had only built one original design, the experimental XP-67 'Moonbat', before being awarded a contract for a carrier-based jet fighter in 1943. At one time McDonnell considered six small 300lb st (1.3kN) engines, but settled for a pair of Westinghouse XB-2Bs rated at 1,165lb st (5.2kN), later replaced by 1,600lb st (7.1kN) J30s.

Above: ***One of the two XFD-1 Phantoms seen flying near St. Louis in 1945. The pilot had no ejection seat and armament was less than most World War Two fighters.***

For some reason the design was ordered with the designation XFD-1, but D was normally allocated to Douglas in the navy's system. By the time production aircraft were being delivered in 1946, the more appropriate FH-1 nomenclature was being used, as was Phantom, the first of many names from the spirit world to be used by McDonnell.

For the first flight on 26 January 1945 one engine was replaced with ballast as a second was not yet available. Before the second XFD-1 flew the tailplane was modified. Development was hampered by a belly landing of the first aircraft and the loss of the second in a crash before the end of 1945.

Westinghouse engines were famously underpowered and unreliable, but the FH-1 seems to have been an adequate fighter for its day, although orders were cut from 100 to 60. Production FH-1s had a slightly longer fuselage, a square-tipped fin and more fuel capacity.

The Phantom was the first all-jet aircraft operated by the Navy. On 21 July 1946 Cdr Jim Davidson made the first jet take-off and launch from a carrier, the USS *Franklin D. Roosevelt*. It was also the first Navy aircraft to exceed 500mph (805km/h) in level flight).

In July 1947 VF-17A became the first operational shipboard jet squadron in the world, but did not go to sea until May 1948 on USS *Saipan* when the unit made 176 take-offs in a three-day trial period. No squadron ever made an operational cruise with the FH-1, however. The Phantoms were passed on to the Naval Reserves and the Marines. One USMC squadron, VMF-122, formed an aerobatic team called 'The Flying Leathernecks' under ace and future test pilot Marion Carl.

Of the 62 Phantoms built, at least 22 were lost in accidents. Five survive today.

The Navy was satisfied enough to quickly order a development of the same basic design and McDonnell duly completed the larger F2H Banshee in early 1947. It went on to see combat in Korea and was produced in night fighter and photoreconnaissance variants.

McDonnell FH-1

Crew:	One
Length:	37ft 3in (11.35m)
Wingspan:	40ft 9in (12.42m)
Height:	14ft 2in (4.32m)
Empty weight:	6,683lb (3,031kg)
Max T/O weight:	12,035lb (5,459kg)
Powerplants:	Two Westinghouse J30-WE-20 turbojets, rated at 1,600lb st (7.12kN) each
Max speed:	479mph (711km/h)
Service ceiling:	42,100ft (12,525m)
Range:	695 miles (1,118km)
Armament:	Four 0.50in machine-guns; provision for eight wing-mounted HVAR rockets

Vought F6U
The Pedestrian Pirate

Responding to a US Navy request for an aircraft powered by the Westinghouse J34 engine, Vought aircraft made its first tentative step into the jet era with the F6U Pirate. By the time it entered service it was obsolete.

Among several jet designs ordered in for the Navy in 1944, the Pirate was one of the first aircraft to use composite construction. The wing and tailfin were skinned with Metalite, a material composed of a sandwich of duralumin and balsa wood. Other parts were Fabrilite, a laminate of balsa and glass fibre. These materials proved hard to manufacture and prone to damage.

Ted Owens piloted the XFU-1 on its maiden flight on 2 October 1946 at Muroc, California. The flight ended with a dead-stick landing on the dry lake bed following an engine accessory drive failure.

The Pirate was powered by the unimpressive Westinghouse J34. In all there were five major modifications needed to correct poor handling, including an enlarged vertical tail and stabilising fins on the horizontal tailplane.

The F6U was essentially a piston-engined design powered by a jet. Like the FJ-1 Fury, the Pirate could be 'kneeled' to save carrier deck space, although it was never deployed aboard ship. After four years of testing, the Navy decided it wouldn't ever make a useful combat aircraft and never issued it to a fleet squadron.

The F6U has the distinction of being the first Navy jet equipped with an afterburner, the J34-30A version being fitted to the sixth and subsequent Pirates. Lengthening the fuselage to accommodate the afterburner caused more lateral stability problems. Even when the afterburner operated the F6U's performance was described as "sub-marginal."

The type was retired late 1950. A total of 65 Pirates were ordered, but in the end only 30 were built and these were used mostly for ground-based tasks such as crash barrier tests and battle damage repair practice. None of the production aircraft had more than 94 flying hours and some as few as six.

Plans for a swept-wing development did not progress and Vought moved on to the F7U Cutlass. Only one Pirate survives, at the National Museum of Naval Aviation, Pensacola, Florida.

Vought F6U-1

Crew:	One
Length:	37ft 8in (11.48m)
Wingspan:	32ft 10in (10.14m)
Height:	12ft 11in (3.97m)
Empty weight:	7,320lb (3,320kg)
Max T/O weight:	12,900lb (5,850kg)
Powerplant:	One 1916kg (4224lb) Westinghouse J34-WE-30 turbojet engine rated at 4,224lb st (18.79kN)
Max speed:	595mph (960km/h)
Service ceiling:	42,260ft (14,100m)
Range:	1,770 miles (1,880kg)
Armament:	Four 20mm cannon

Below: ***The third XFU-1, 33534, with the production vertical tail but before the addition of stabilising fins on the horizontal tailplane.***



McDonnell F2H Banshee

The Banjo

In many ways similar to the preceding FH Phantom, the Banshee was a much more mature and capable design, proving very valuable in the fighter/ground attack and reconnaissance roles in Korea.

Although sometimes hard to distinguish from each other, the Banshee was considerably larger and twice as heavy as the Phantom. Fixed armament was boosted from four machine-guns to four cannon, while cockpit pressurisation and an ejection seat were added. Otherwise, the basic configuration was the same with straight wings and wing root-mounted intakes, a bubble canopy and a conventional tail section.

The Banshee was ordered only 35 days after the first flight of the FD-1 (FH-1) Phantom. For a while before its first flight on 11 January 1947 at St. Louis, it was designated XF2D-1, the Navy again using the manufacturer designator assigned to Douglas. When Bob Edholm flew the first XF2H-1, 99858, it had considerable dihedral on the horizontal tail, but this was soon reduced then eliminated.

The F2H-2 added underwing two pylons each capable of carrying 1,000lb bombs. The F2H-2B had stronger wings and hard points able to carry weapons up to 3,000lb (1,361kg). These were Mk.7, Mk.8, Mk.12 or Mk.91 nuclear weapons. The Banshee's stability and good altitude performance made it ideal as a photoreconnaissance platform. The F2H-2P had its nose extended by 3ft (1.05m) to accommodate up to six reconnaissance cameras. One was converted from an F2H-2 and 89 production aircraft followed.

Fitted with a longer nose housing APS-19 AI radar, 14 F2H-2N night fighters were built. The cannon were relocated to the upper nose. The F3H-3 was a whole 8ft (2.4m) longer with 50% more fuel and pylons for up to eight bombs or rockets. Retrofits added AIM-9 Sidewinder capability and a refuelling probe to some aircraft. The latter replaced one cannon.

The final variant was the F2H-4, with APG-37 radar and J34-WE-38 engines. Most -3s and -4s were retrofitted with an extension to the leading edge of the horizontal tailplane to counter a flutter problem. In general, the Banshee's tail section was regarded as weak, as was its landing gear.

The Banshee served in Korea from the summer of 1951, mainly in its -2 variant. Photo Banshees arrived on carriers from December, usually equipping four-plane detachments of VC-61. Marine squadron VMJ-1 also flew the F2H-2P from land bases in South Korea.

Although not much use for air combat against MiGs, the Banshee proved effective in

McDonnell F2H-3 Banshee

Crew:	One
Length:	48ft 2in (14.68m)
Wingspan:	49ft 9in (12.73m)
Height:	14ft 6in (4.42m)
Empty weight:	13,183lb (5,980kg)
Max T/O weight:	25,214lb (11,437kg)
Powerplants:	Two Westinghouse J34-WE-34 turbojets, rated at 3,250lb st (14.46kN) each
Max speed:	580mph (933km/h)
Service ceiling:	46,600ft (14,205m)
Range:	1,170 miles (1,883km)
Armament:	Four 20mm M-3 cannon; up to 2,000lb bombs; one Mk.7 nuclear weapon



Below: ***The F2H-2 added provision for 220 US gallon (833 litre) tip tanks and pylons for two 500lb bombs, not fitted on this example in use by the Naval Air Test Center at NAS Patuxent River, Maryland.*** *NHHC*

Above: ***An F2H-2 from USS* Kearsage *flying over North Korea in late 1952, with Wonsan airfield immediately below.*** *NHHC*

bombing and strafing missions. During the war, 14 fighter and two reconnaissance Banshees were lost to enemy action and operational causes, although this figure probably doesn't include aircraft destroyed in deck accidents aboard ships.

In all, 895 Banshees were built, of which at least 172 were written off in service. The Marines retired their last examples in 1959. The F2H-2P was retired in 1960

When the designation system was revised in late 1962, the FH2 became the F-2, with the F2H-3 becoming the F-2C and the F2H-4, the F-2D, although by this time few if any were still in the US inventory. Canada was the sole export customer, acquiring 39 surplus F2H-3s in 1955. These operated from Shearwater NAS and the carrier HMCS *Bonaventure* until retired in September 1962, becoming the Royal Canadian Navy's last fighter.

Below: ***An F2H-4 of VMF-214 'Black Sheep' in January 1956 wearing the gull grey and white scheme that began to replace the overall blue colours the previous year.*** *NHHC*



Grumman F9F Panther

The 'Iron Works' First Jet

Successor to the great Grumman 'cats' of World War Two, the F9F Panther was a simple but sturdy fighter-bomber which bore the brunt of US Naval Aviation's effort in the Korean War.

Grumman's G-75 design for a four-engined two-seat night-fighter received the designation XF9F-1 before it was cancelled in June 1946. Grumman convinced the Navy to transfer the contract to the unrelated G-79D design in December 1947, which was issued the designation XF9F-2. The new aircraft was a single-seat, single-engine jet with straight wings that folded near the root for carrier stowage. These went beyond the vertical to clear the hangar ceiling.

A large bubble canopy gave good all-around vision, and was often slid open for carrier take-offs and landings to allow easier escape in the event of a ditching. Panthers were fitted with Martin-Baker ejection seats, even before they reached service in the UK, but these were only effective above 1,000ft (305m) in the event of an engine failure.

Taking off from Bethpage on Long Island and landing at New York's Idlewild Airport, the first XF9F-2, 122475, flew on 21 November 1947 in the hands of Grumman test pilot Corwin H. 'Corky' Meyer.

From the 13th production aircraft Panthers featured fixed wingtip fuel tanks containing 120 US gal (445 litres) of fuel, an overall increase of 35%. The tanks also reduced drag. Underwing racks for four bombs or 5in rockets were added to the outer wing panels from 1950. The main armament was four 20mm cannon mounted in the nose, although one aircraft was tested with an experimental rotating turret containing four 0.50in machine-guns.

The XF9F-3 had an Allison J33-A-8 as a hedge against expected delivery problems with the J42. Water injection could be used to give an extra 750lb (3.34kN) thrust for take-off. Orders were placed for 47 F9F-2s and 54 F9F-3s, but

Below: ***An F9F-2B of VF-721 off USS Boxer flies near Kowon, North Korea in July 1951. The squadron was a reserve unit activated in called up to serve in the summer of 1950.***





the J42 proved satisfactory and most -3s were converted to -2s.

F9F-3 Panthers were delivered to the fleet from May 1949, initially to VF-51 at NAS San Diego. Pilots of VF-51 and VF-52 were the first to night qualify in jets aboard a carrier when they flew from USS *Boxer* in February 1950, but the lack of radar altimeters or adequate deck lighting made this a one-off at the time and the Panther remained a day-only fighter.

Due to their lower landing speeds, straight wings were preferred for most early carrier-based jets. As a result, aircraft like the Panther and Hawker Sea Hawk had poorer air combat

Left: ***The F9F-3 was powered by the Allison J33 engine as a back-up to the Pratt & Whitney J42. This is the XF9F-3, 122476, which is today preserved at Pensacola.*** *Jim Winchester collection*

Below: ***An F9F-2 of Marine squadron VMF-223 during carrier qualifications on USS*** **Franklin D. Roosevelt** ***in June 1951. The squadron served as a training unit during the Korean War.*** *NHHC*





performance than the swept-wing MiG-15s and F-86 Sabres.

Flying from the USS *Valley Forge*, Leonard Plog and Eldon Brown of VF-53 scored the Navy's first jet kills on 3 July 1950 when they each shot down a piston-engined Yak-9. Panther pilots were only officially credited with destroying four MiG-15s in Korea, although Royce Williams of VF-781 may have shot down as many as six in an epic 1953 dogfight that was unpublicised to avoid provoking further Soviet involvement in the war. Other notable F9F pilots included future astronauts John Glenn and Neil Armstrong and baseball star Ted Williams.

The F9F-2 alone flew nearly half of the Navy's attack sorties during the war. Navy Panther losses were 109 from all causes in Korea.

The Panther starred in the 1954 Korean War movie *The Bridges at Toko-Ri*, although the action on which it was based involved AD

Left: ***Where do we get such men? From New York City in the case of Lt (JG) George Elmies of VC-61 boarding his F9F-2P photo Panther on the USS* Princeton *off Korea in 1951.***





Right: ***The Panther was the first jet used by the Navy's Blue Angels demonstration team, flying the F9F-2 in 1949-50 and F9F-5 from 1951-1955.*** *NHHC*

Skyraiders and the original James Michener novel featured F2H Banshees. Panther squadron VF-192 'Golden Dragons' added 'World Famous' to its name after its appearance in the film,

The Panther became the first jet used by the Blue Angels flight demonstration team, joining the unit in July 1949. Uniquely in the team's history it was disbanded and its members assigned to operational service in Korea, forming the nucleus of VF-191, which deployed to aboard USS *Princeton* in November 1950. The 'Blues' flew the Panther again in 1952-55 when founding leader 'Butch' Voris reformed the team with F9F-5s.

The XF9F-4 with the Allison J33-A-16 remained a single prototype, 109 orders being converted to the F9F-5. This version was 2ft (61cm) longer with a taller fin and was powered by the Pratt & Whitney J48 engine, developed in conjunction with Rolls-Royce, which knew it as the Tay. First flown in May 1949, the -5 was the major production version, with 655 delivered. There were 36 examples of the camera-equipped F9F-5P delivered alongside the fighter variants.

Production amounted to 1,385 Panthers, and was completed in January 1953. After a fairly short career, Panthers were retired from frontline service in 1956, and from reserve squadrons two years later. A number were converted to F9F-2D and F9F-5D target drones with others modified as drone controllers and designated F9F-2KD and F9F-5KD.

Two-dozen F9F-2s were sold to Argentina, whose navy used them from land bases into the early 1970s when they were replaced by A-4Q Skyhawks.



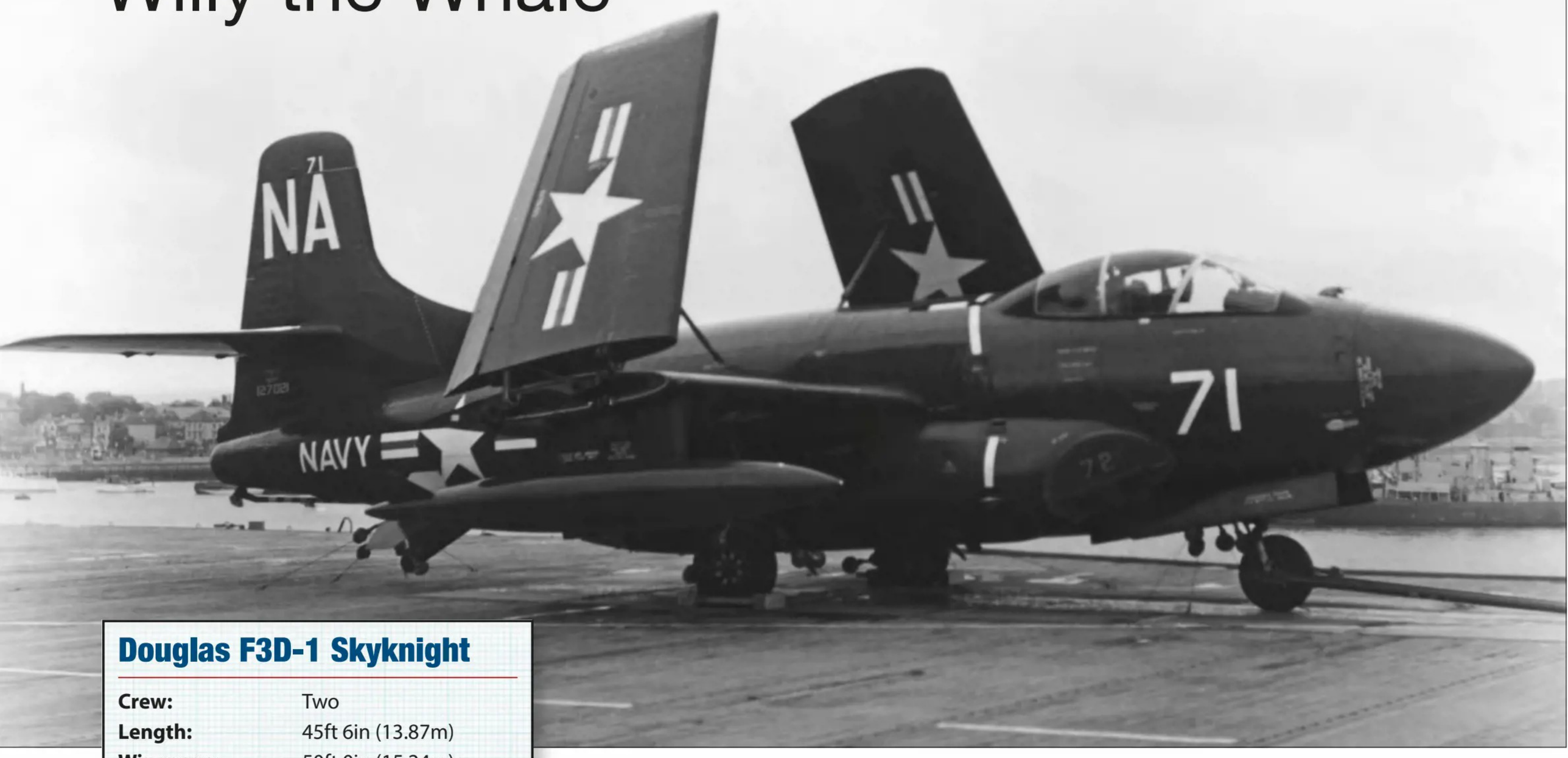
Grumman F9F-5 Panther

Crew:	One
Length:	38ft 10in (11.84m)
Wingspan:	37ft 11in (11.56m)
Height:	12ft 3in (3.73m)
Empty weight:	11,013lb (4,995kg)
Max T/O weight:	9,637kg (21,245lb)
Powerplant:	One Pratt & Whitney J48-P-6 turbojet rated at 6,250lb st (27.80kN)
Max speed:	604mph (972km/h)
Service ceiling:	42,800ft (13,045m)
Range:	1,300 miles (2,096km)
Armament:	Four 20mm cannon; up to 2,000lb (906kg) of ordnance on four underwing pylons

Left: ***Marine reconnaissance squadron VMJ-3 flew F9F-5P photo Panthers from MCAS Miami, Florida in 1954, moving to MCAS El Toro, California in the summer of 1955. That December it was redesignated VMCJ-3.*** *Jim Winchester collection*

Douglas F3D Skyknight

Willy the Whale



Douglas F3D-1 Skyknight

Crew:	Two
Length:	45ft 6in (13.87m)
Wingspan:	50ft 0in (15.24m)
Height:	16ft 0in (4.88m)
Empty weight:	14,890lb (6,754kg)
Max T/O weight:	22,362lb (12,411kg)
Powerplants:	Two Westinghouse J34-WE-24 turbojets rated at 3,400lb st (15.13kN) each
Max speed:	565mph (909 km/h)
Service ceiling:	34,000ft (10,363m)
Range:	1,297 miles (
Armament:	Four 20mm M2 cannon

Above: ***The F3D's appearance changed little from the prototype to the F3D-2, an example of which is seen here with VC-4 on a rare carrier deployment.***

The largely forgotten F3D Skyknight proved the most successful Navy or Marine fighter of Korea in terms of air-to-air victories and was the only tactical jet to serve in both Korea and Vietnam.

On 23 March 1946 Russ Thaw flew the XF3D-1 at El Segundo, California. The twin-engined night-fighter had been designed to a requirement for an aircraft able to intercept a target at 125 miles (201km) t 40,000ft (12,192m) and fly from carriers. Ed Heinemann of Douglas came up with a conservative design that edged out Grumman's four-jet XF9F-1.

Westinghouse built the engines and also the APQ-35 radar, most of the other avionics and the electrical generating system. For once, the company's engines worked reliably, but provided barely adequate thrust for the portly fighter. The complicated valve-driven radar provided endless trouble.

The pilot and radar operator sat side-by-side on conventional seats. Between them was an escape tunnel to use in an emergency.
A cartridge-operated windbreak door provided some assistance for bailing out. The wing was essentially that of the AD Skyraider. After 28 F3D-1s the F3D-2 (237 built) added spoilers for roll control.

VC-3 intreoduced the F3D-1 into service in early 1951. Only a couple of Mediterranean cruises and one Korean deployment were made. Most operations were land-based, one reason being that the angled jet pipes set fire to the wooden decks.

In September 1952 VMF(N)-513 began operations and soon shot down what was credited as a Yak-15 in what was the first night all-jet combat. In total, land-based Marine squadrons scored eight night kills and even flew some bombing missions.

The APQ-36 radar added to F3D-1Ms and F3D-2Ms provided continuous-wave guidance for the Sparrow I beam-riding missile. The latter version was designated MF-10B after 1962, although the only operational squadron, VMF(N)-542, retired it in 1959.

The Skyknight's long endurance (up to seven hours with external fuel) suited roles such as stand-off jamming and electronic intelligence (Elint). From 1956 remaining F3Ds were converted to these roles or as trainers for night-fighter pilots and radar operators. Elint Skyknights gathered the signatures of Chinese radars in 1957-58, and the interception of new types of radar signal in Cuba led to further investigation and the discovery of SAM sites, precipitating the 1962 Cuban Missile Crisis.

Sub-types included the F3D-2Q (later EF-10B), F3D-2T and -2T2 (TF-10B) trainers.

In Vietnam the EF-10B was assigned to USMC reconnaissance squadrons and performed sterling, if unsung, work jamming SAM radars and escorting interdiction missions over the Ho Chi Minh Trail. They were withdrawn in October 1969 and officially retired in May 1970.

North American AJ Savage

Two Turning, One Burning

In the eternal battle with the US Air Force, the Navy fielded a hybrid piston/jet bomber to carry out the strategic nuclear role and maintain the relevance of aircraft carriers. It proved too unwieldy to operate smoothly as part of an embarked air wing.

To prove the Navy had a role in the Atomic Age, in December 1945 the Navy requested a bomber that could carry a 10,000lb (4,536kg) bomb load from carrier decks. North American's proposal was chosen over others from Douglas Convair. The AJ Savage was a conventional-looking bomber with two wing-mounted radial engines and a a voluminous fuselage containing a J33 turbojet. The jet engine provided extra thrust for take-off and for the attack run. Its NACA-type intake was above the rear fuselage, concealed by a flap when not in use.

Bob Chilton flew the first XAJ-1 (121460) at Los Angeles on 3 July 1948. Two of the three prototypes were lost due to structural failure during testing. One NAA test pilot said that it was a dream to fly and when everything was working properly it handled like a fighter, unfortunately, he added, this was the case about five percent of the time.

Production AJ-1s (A-2As) flew from May 1949 and were first delivered to VC-5 in September. The squadron Made its first Savage cruise in April 1950. Despite the AJ's secondary conventional weapons capabilities, it was never embarked in carriers off Korea, but some were reportedly stationed in South Korea as a deterrent.

Ordered in 1951, the improved AJ-2 had a revised cockpit, level tailplanes and an enlarged canopy. The first of 30 photoreconnaissance AJ-2Ps flew in March 1952. These were fitted with K-38 camera in the nose and sideways-looking cameras in the bomb bay. Some AJs were operated as tankers. This capability was used to assist John Glenn's record-breaking July 1957 coast-to-coast flight in an F8U-1P Crusader.

An attempt to improve the performance resulted in the XA2J-1 Super Savage, the first of which flew on 4 January 1952 with Robert Baker at the controls. This had two Allison T40-A-6 turboprops, but problems with this engine led to the cancellation of the programme in mid-1953.

The size of the Savage made it impossible to deploy full squadrons as part of an air wing on the Essex- and Midway-class carriers, so they mainly operated as four-plane detachments. The manually-folding wings were spread most of the time, probably because the folding process took at least 16 minutes. By the time the roomier 'supercarriers' were in service the Savage had been replaced by the Douglas A3D Skywarrior. in the heavy attack squadrons.

Surviving Savages were redesignated A-2s in 1962, although it is unlikely any remained in Navy service after 1960. NASA used two AJ-2s to fly microgravity research parabolas in the early 1960s. Two others were operated as aerial firefighting tankers.

Total production was 145 AJs, of which at least 53 crashed or were written off after accident damage. Only a single AJ-2, a former engine testbed for Lycoming, remains today.

North American AJ-2 Savage

Crew:	Three
Length:	63ft 1in (19.23m)
Wingspan:	71ft 5in (21.77m)
Height:	21ft 0in (6.40m)
Empty weight:	27,558lb (12,500kg)
Max T/O weight:	30,776lb (13,959kg)
Powerplants:	Two Pratt & Whitney R-2800-48 radial piston engines, each rated at 2,400hp (1,790kW), and one Allison J33-A-10 turbojet rated at 4,600lb st (20.47kN) thrust
Max speed:	449mph (723km/h)
Service ceiling:	41,500ft (12,500m)
Range:	3,056 miles (4,918km)
Armament:	One Mk. III or Mk. IV nuclear weapon; up to 9,600lb (4,354kg) of conventional ordnance in internal bomb bay

Below: ***The weapons bay of an AJ-1 of VC-5 is loaded at the Naval Air Test Center, Patuxent River, Maryland. In this era VC (Composite) squadrons were tasked with introducing new technologies to the fleet.*** *NHHC*



Lockheed TO-1/TV-2 Shooting Star and T2V Seastar

Transition Trainers

The P-80, America's first operational jet, is primarily regarded as a USAF fighter and the T-33 its trainer equivalent, but large numbers of the Shooting Star family were operated by the US Navy and Marines under a wide variety of designations.

Three P-80Cs were transferred to the Navy in June 1945 and given the designation FO-1 (although this appears to have been unused). One was tail hook-equipped, and flown by legendary test pilot Lt Col Marion Carl made several catapult launches and arrested landings from the USS *Franklin D. Roosevelt* in November 1946, proving the feasibility of pure-jet carrier operations. In 1947 Lockheed offered a truly carrier-capable version as the FO-2, but the Navy chose to continue with their own jet designs.

Nevertheless, delays with fielding these types and a desire by young pilots to get into jets rather than be left behind by the Air Force saw the transfer of 50 F-80Cs from the USAF in 1949 under the designation TO-1. The same year the Navy acquired 26 two-seat TF-80Cs (T-33s).

Advanced Training Units (ATUs) were established to give jet training to pilots already experienced on piston aircraft and flew most TO-1s and TF-80Cs. The former also equipped frontline unit VMF-311, the second USMC jet squadron, and were issued to various bases and test units as hacks and to the Blue Angels.

In April 1952 the letter designator for Lockheed changed to V, and the TO-1s became TV-1s. TF-80Cs became TV-2s and the Navy and Marines eventually received 699 of them.

Some TV-2s were used to support missile trials as TV-2Ds and others as TV-2KD drones or drone control platforms.

Lockheed persisted with a carrier variant and in 1952 began work on the private-venture L-245, which first flew on 15 December 1953. The L-245 had a raised cockpit for better vision from the rear seat. The vertical tail was enlarged and leading-edge and trailing-edge flaps were fitted.

Below: ***The USN operated the P-80C Shooting Star as the TO-1 (later TV1). This example was assigned to the Naval Air Test Center at Patuxent River.*** *NHHC*

Lockheed TV-2

Crew:	Two
Length:	37ft 9in (11.51m)
Wingspan:	38ft 11in (11.86m)
Height:	11ft 4in (3.45m)
Empty weight:	8,084lb (3,667kg)
Max T/O weight:	11,965lb (5,427kg)
Powerplant:	One Allison J33-A-25 turbojet rated at 4,900lb st (21.79kN)
Max speed:	543mph (874km/h) at 25,000ft (7,620m)
Service ceiling:	47,500ft (14,478m)
Range:	1,025 miles (1,650km) with internal fuel
Armament:	(T-33A-1) two 0.50in Browning machine-guns

These, and a boundary layer control system lowered approach speeds for carrier landings.

It had a tail hook, a strengthened airframe and the more powerful J33-A-24 engine.

The Navy designated it the T2V-1 Seastar and deliveries of 149 examples began in 1956, with service from May 1957. The Seastar, redesignated T-1 in 1962, served mainly as a carrier landing trainer until replaced by the T-2 Buckeye.





Chance-Vought F7U Cutlass

'The Ensign Eliminator'

An extremely aerodynamically advanced and mechanically complicated aircraft for its day, the Cutlass has been called "the least safe US Navy fighter ever flown". Its development lasted longer than its service career.

Seeing that the lead in fighter development was falling to the USAF, the traditionally conservative US Navy ordered the radical swept-wing, twin-tailed Cutlass in 1946.

It has been said that the design owed much to Arado tailless aircraft proposals captured in Germany, but Vought had drawn up its initial V-346 configuration before that material became available. At first, the V-346 was to have three engines, but it was revised to accommodate two Westinghouse J34-WE-22 turbojets producing 3,700lb st (16.46kN) with afterburner.

With no horizontal tail, the Cutlass was controlled by what Vought called 'ailevators' on the wing, which combined the function of ailerons and elevators. Leading-edge slats helped with slow-speed handling, especially as there were no landing flaps.

On 29 September 1948, the first XF7U-1 flew at NAS Patuxent River, Maryland. Bob Baker was the test pilot and the flight was made using J34s-WE-34s without the Solar afterburners, which would not be ready for several months. The first XF7U-1 was wrecked in a bad landing, the second disappeared on a test flight, and the third caught fire during an air display.

Above: ***An F7U-3 just clears the fence at Vought's Dallas plant. This Cutlass, 128457 was the 31st Dash-3 built and the seventh production aircraft.*** *Jim Winchester collection*

The Cutlass failed its carrier suitability tests and the initial model was retrospectively designated an 'experimental' type. Only 36 Dash-1s were built and never entered the operational fleet. Two served for part of the 1951 season with the Blue Angels demonstration team, but were retired for want of spare parts.

A complete redesign produced the production F7U-3, which was really a new aircraft with a larger fuselage and wing, 3,000psi hydraulics and Westinghouse J46-WE-8 engines.


6
MARI

22


403
F7U-3
129676


US NAVAL TEST PILOT SCHOOL
RESCUE
DANGER
F-6A
139177



Grumman F9F-2 Panther, Bu. No. 127143 VMF-115, US Marine Corps Pohang, South Korea, 1953

Issued to Navy squadron VF-837, F9F-2 127143 sailed to Korean waters aboard USS* Antietam *as part of Carrier Air Group (CVG) 15. On 19 January 1952 it was hit in the starboard wing by 40mm anti-aircraft fire during a ground attack mission. Later that year it was transferred to Marine fighter squadron VMF-115. On 14 April 1953 the Panther was written off after a hard landing at K-3 near Pohang, South Korea due to battle damage.

North American FJ-2 Fury, Bu. No.131979 VMF-235, US Marine Corps USS Hancock*, July 1954*

FJ-2, 131979 ,was one of four 'Death Angels' Furies deployed aboard USS* Hancock *as part of Operation Steam, a July 1954 evaluation of steam catapults. FJ-2s were not regularly embarked on carriers and when he squadron deployed to Japan in November that year, its aircraft travelled as deck cargo aboard the former escort carrier USS* Corregidor*. The Fury was destroyed in a landing accident at Atsugi on 10 March 1955.



Chance Vought F7U-3 Cutlass, Bu. No. 129676 VF-83, US Navy NAS Oceana, Virginia, 1954.

First operated by VF-83, F7U-3 129676 was delivered to the Navy in 1954 when the squadron transitioned to the Cutlass from the F9F Panther. Despite its fighter role the unit was redesignated as an attack squadron (VA-83) on 1 July 1955. The squadron made the Navy's first overseas cruise with missile-equipped aircraft, aboard USS* Intrepid*. This Cutlass was next noted with VA-212 'Rampant Raiders' coded G-201 in 1956, and on 18 August that year was written off in unknown circumstances.

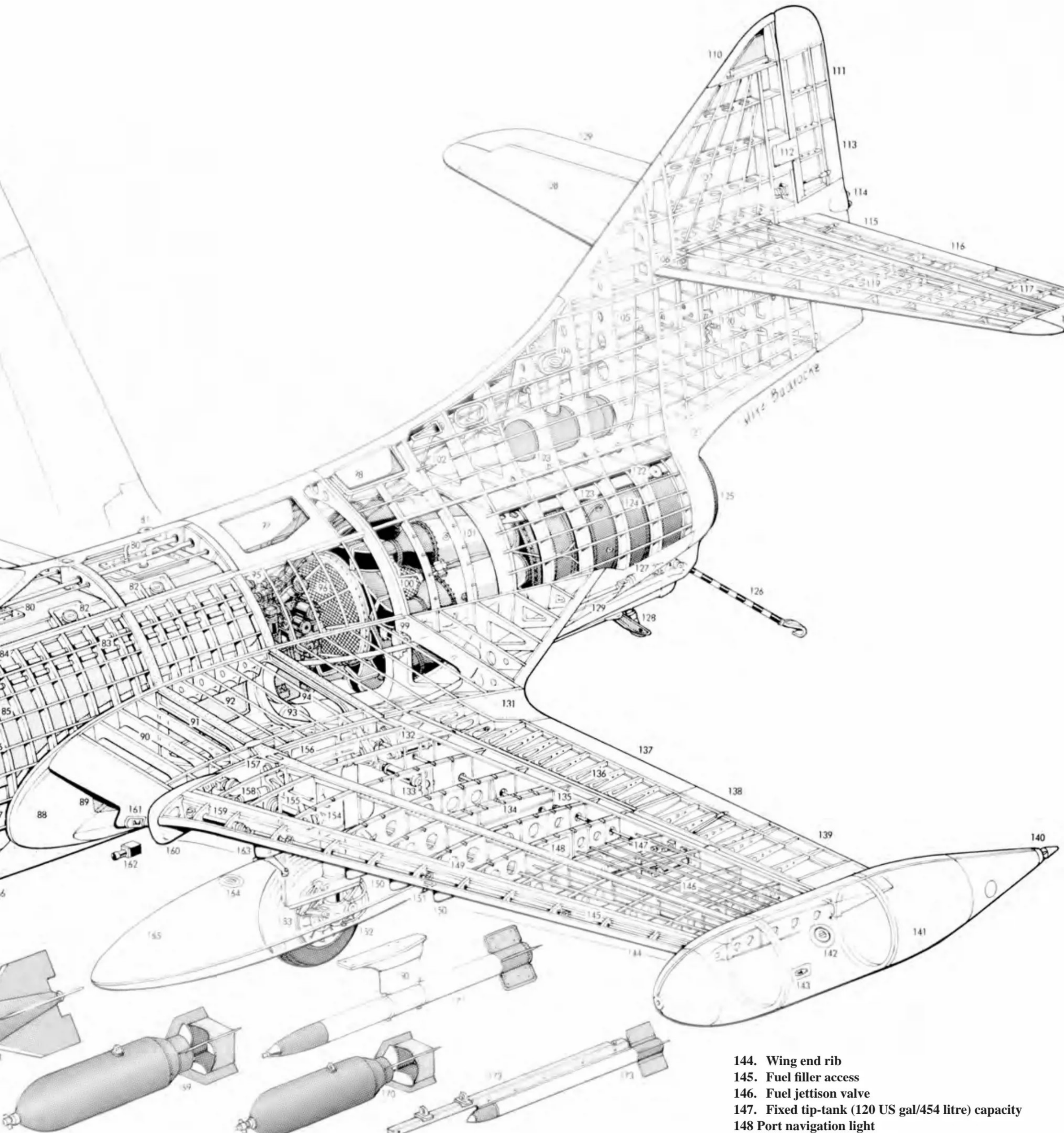
Douglas F-6A Skyray, Bu. No.139177 Naval Test Pilot School, US Navy NAS Patuxent River, Maryland, 1965-1969

Beginning with FASRON 8 in 1958, F4D-1 139177 served with numerous units in what would be a long career for an example of the type. These were VMF(AW)-115, VF-141, FASRON 7, VF-213, VMF(AW)-314, VMF(AW)-513, VMF(AW)-542, VMF-513, and VF-13 before it was put into storage at NAF Litchfield Park, Arizona in June 1963. It was reactivated in 1965 for the Naval Test Pilot School and served there until November 1969. After years of dereliction, it was restored for the Flying Leatherneck Aviation Museum at MCAS Miramar.

F9F-5 Panther



1. Nose cap
2. Cannon ports (4)
3. Barrel sleeves
4. Cannon forward support mounting
5. Radio compass antenna bracket
6. Nose upper compartment
7. Detachable nose cone
8. Electronics
9. Forward bulkhead
10. Battery
11. Electrical leads
12. Starboard M3 cannon ammunition boxes (190 rpg)
13. Port M3 cannon ammunition boxes (190 rpg)
14. Port canon shell slide tracks
15. Groundcrew nose-removal hand-hold
16. Nose lower compartment
17. Port cannon breeches
18. Nosewheel retraction mechanism
19. Nosewheel doors
20. Nosewheel leg
21. Steering cylinder
22. Rearward-retracting nosewheel
23. Axle fork
24. Hub tie-down lug
25. Torque links
26. Nosewheel door actuating rod
27. Nosewheel well
28. Cockpit floor support beams
29. Detachable nose join
30. Rudder pedal assembly
31. Cockpit frontal armour
32. Control column
33. Instrument panel
34. Starboard side console
35. Windscreen frame
36. Instrument panel shroud
37. AFCS Mk 6 Mod O gun/weapons site
38. Bullet-resistant windscreen
39. Rearward-sliding one-piece canopy
40. Pilot's ejection seat
41. Headrest
42. Seat guide rails
43. Engine control quadrant
44. Entry hand-hold
45. Port side console
46. Seat support frame
47. Lower bulkhead
48. Airbrake actuating ram
49. Hydraulics cylinder
50. Airbrake attachment/pivot
51. Ventral split airbrake (extended)
52. Ventral split airbrake (retracted)
53. Retractable entry step
54. Catapult-launch forward ventral hook
55. Access panels
56. Electronics/radio bay
57. Cockpit angled
58. Canopy external release/lock
59. Canopy slide mechanism
60. Suppressed antenna
61. Aileron control linkage
62. Wing front spar
63. Wing front spar
64. Fuel pipes
65. Fixed tip-tank (120 US gal/454 litre) capacity
66. Emergency ram-air (fuel jettison) valve
67. Wing fold (carrier stowage) arc
68. Wing fold position
69. Fuel jettison valve
70. Starbord aileron
71. Flap section
72. Carrier crane hoist
73. Dorsal electrics/fuel lines
74. Fuselage fuel filler points
75. Fuselage aft fuel tank
76. Fuselage main frame
77. Fuselage forward fuel tank
78. Intake lip
79. Intake duct
80. Ventral blade antenna
81. Wing fence
82. Intake trunk
83. Front spar attachment
84. Trunk frames
85. Rear spar attachment
86. Engine accessories
87. Engine intake fuselage frame
88. Fuselage frame
89. Dorsal identification/formation light
90. Spring-loaded plenum chamber blower doors
91. Detachable aft fuselage construction break
92. Pratt & Whitney J48-P-8 turbojet
93. Engine plenum chamber
94. Ram pressure emergency release doors
95. Finroot fairing frames
96. Control access
97. Water injection tank (25 US gal/94.6 litre capacity)
98. Filler point
99. Fin structure
100. Fairling leading edge
101. Starboard tailplane
102. Starboard elevator
103. Fin upper structure
104. Tip antenna housing
105. Rudder assembly
106. Centre hinge
107. Rudder tab
108. Tail position lights (2)
109. Tailplane attachment points
110. Tailplane spar
111. Rib structure
112. Tab control linkage
113. Port elevator
114. Elevator tab
115. Balance



116. Rudder lower section
117. Fin support structure
118. Control linkage
119. Fairing
120. Jet exhaust
121. Arrestor hook (extended)
122. Tail bumper (extended)
123. Bumper actuating mechanism
124. Fuselage aft frames
125. Jet pipe
126. Support colour
127. Wingroot aft fairing
128. Support collar
129. Fuselage/wing attachment
130. Wing-fold mechanism
131. Fold mechanism
132. Mainwheel door
133. Inboard (No.4) underwing pylon
134. Undercarriage retraction mechanism
135. Mainwheel leg support beam
136. Inboard wing solid ribs
137. Access panel
138. Wing rear spar
139. Inboard trailing-edge fixed section
140. Flap actuating mechanism
141. Port flap outer section
142. Aileron tab (port wing only)
143. Port aileron
144. Wing end rib
145. Fuel filler access
146. Fuel jettison valve
147. Fixed tip-tank (120 US gal/454 litre) capacity
148 Port navigation light
149. Emergency ram-air((fuel jettison) valve
150. Tank forward attachment
151. Wing outer structure
152. Wing front spar
153. Leading-edge variable-camber flap
154. Underwing pitot head
155. Underwing rocket launcher pylons
156. Mainwheel leg door
157. Axle assembly
158. Mainwheel leg
159. Port main wheel
160. Torque links
161. Inboard underwing pylon (see 133) for either
162. One 1,000lb (454kg) bomb or naplalm, or
163. 150 US gal (567 litre) drop tank
164. Three 5in (12.7cm) HVAR high-velocity aerial rockets



Above: ***Modifying the Cutlass to create the F7U-3P photoreconnaissance version did nothing for its looks. Only 11 of this variant were produced.***

The nose landing gear was made extensible to provide the correct angle of attack for catapult launches off small carriers. Unfortunately, the long strut was prone to collapse, which sometimes fired the ejection seat.

In 1954, before the F7U-3 entered service, the Navy initiated several schemes to get the aircraft and personnel up to speed: a Fleet Introduction Program (FIP) at Patuxent River and Project Cutlass and Project Checkout on the West Coast. These showed up numerous deficiencies and delayed deliveries into 1955. VF-124 was formed at Miramar and suffered several accidents while working up for its first deployment. VF-81 accepted the F7U-3 in May 1955, making one deployment before becoming VA-66, one of several squadrons to be redesignated when the aircraft proved unsuitable as a day fighter.

Standard F7U-3 armament was four 20mm cannon mounted above the intakes. The F7U-3M was a dedicated missile carrier with four pylons for Sparrow I AAMs; 98 were built. Firing either missiles or guns tended to flame-out the engines. A belly pack was developed to carry a battery of 2.75in rockets, but the unit weighed 1,500lb (680kg) and blocked engine access doors so was infrequently used, as was a fuel pod of the same shape. Engine thrust was not increased and carrier operations were marginal. It was impossible to make a deck landing with four missiles aboard. The Cutlass could carry a variety of bombs, and made the first recorded supersonic weapons drop (in a dive). It had a secondary nuclear strike role with Mk.7 and Mk.8 bombs.

The A2U-1 was a multi-role attack variant cancelled in November 1954. Only 12 examples of the F7U-3P photoreconnaissance variant with an extended camera nose were built. These were mainly used by units involved in testing parachutes at high speed.

The Cutlass is usually remembered for its poor safety record, with over a quarter of the 320 F7Us built being lost or involved in serious accidents. The low power gave rise to the nickname 'Gutless' and the accident rate, especially to inexperienced pilots, to 'Ensign Eliminator' and 'Widowmaker'.

Below: ***A F7U-3M carrying Sparrow I missiles underwing and equipped with a belly pack believed to be an experimental unit containing a pair of 5in rockets.***

When the hydraulics failed, which they often did, a manual control system kicked in, but only after 11 seconds, during which the Cutlass went where it had last been pointed. Use of the afterburners drained the central transfer tank so fast that it was possible to flame-out the engines just after take-off even though the wing tanks were full.

The short endurance meant it could not be fitted into the normal launch/recovery cycle and it was so heavy it required a tow tractor for any deck movement. Most Cutlass cruises were notable for the amount of time the aircraft spent ashore. Several Air Wings craned them off as soon as they reached a foreign port.

On the positive side, the Cutlass was strongly built and could outmanoeuvre other Navy fighters of the day. Its twin-tail design would be adopted by many future combat aircraft. Only five complete examples surive today.

Chance-Vought F7U-3 Cutlass

Crew:	One
Length:	44ft 3in (13.13m)
Wingspan:	39ft 8in (11.70m)
Height:	14ft 4in (4.36m)
Empty weight:	18,260lb (8,285kg)
Max T/O weight:	31,640lb (14,350kg)
Powerplants:	Two Westinghouse J46-WE-8A afterburning turbojets rated at 4,600lb st (20.5kN) each
Max speed:	680mph (1,095km/h)
Service ceiling:	44,000ft (13,411m)
Range:	695 miles (1,120km)
Armament:	Four 20mm cannon, four AAM-N-2 Sparrow I air-to-air missiles



Douglas F4D Skyray

The Ford

The Skyray was the first Navy fighter capable of routinely flying faster than sound. Its superior climb performance saw it operate as a land-based interceptor in defence of NORAD airspace.

In 1946, Douglas lost a design competition for a carrier-based interceptor capable of 600mph (966 km/h) at 40,000ft (12,190m) to Vought's F7U Cutlass. A new competition was opened in 1947. In Germany, Alexander Lippisch had pioneered studies into tailless delta-winged aircraft and this material became available. On 17 June 1947, Douglas Aircraft's proposal, based on Lippisch ideas was accepted by Bureau of Aeronautics to go forward to a preliminary design phase led by Douglas engineers E. H. Heinemann and C. S. Kennedy.

McDonnell actually won this round with the F3H Demon, even though it was soon recognised as the inferior design. In those days of multiple contractors and less scrutiny of contract awards, it was sometimes thought that awarding contracts in turn would keep manufacturers honest and competitive. Ordering

Below: ***VF-102 'Diamondbacks' flew the Skyray from USS* Forrestal *on cruises in 1958-59 and 1961 before exchanging them for Phantoms in December that year.*** *Jim Winchester collection*

Douglas F4D-1 Skyray

Crew:	One
Length:	45ft 3in (13.79m)
Wingspan:	33ft 6in (10.21m)
Height:	13ft 0in (3.96m)
Empty weight:	16,024lb (7,268kg)
Max T/O weight:	27,116lb (12,300kg)
Powerplant:	One Pratt & Whitney J57-P-8 turbojet rated at 10,200lb st (45kN) dry, and 16,000lb st (71kN) with afterburning
Max speed:	722mph, (1,161km/h)
Service ceiling:	55,000ft (17,000m)
Range:	700 miles (1,130km)
Armament:	Four 20mm Colt Mk 12 cannon; two 12-shot 2.75in rocket pods or AIM-9 Sidewinder AAMs on underwing pylons





Above: ***The Skyray was one of the last Navy jets to appear in overall Midnight Blue, but by the time it entered service, the Gull Gray and Insignia White scheme was the standard.***

multiple types allowed the Navy to hedge its bets, even though in this case both types were to be powered by the same poor engine.

The J-40 engine turned out to be a disaster. Despite the seemingly leisurely pace of prototype construction, the J-40 was not ready and the XF4D-1 first flew with the Allison J35 on 21 January 1951 at Edwards Air Force Base, California. Douglas test pilot Larry Peyton encountered a number of control difficulties, mainly due to the trimming system, and reportedly refused to fly the aircraft again. Russ Thaw and Bob Rahn did much of the early test flying.

In an XF4D-1 Lt Cdr Jim Verdin set a new world's air speed record of 752.944 mph over a 3km course above the Salton Sea in California on 3 October 1953. This was the first time that the record had been captured by a carrier-based aircraft. On 16 October of that year, Bob Rahn used the same aircraft to set a 100km closed course speed record of 728.11mph over Muroc Dry Lake, California.

The J40 was abandoned in 1955. Heinemann's team had been clever enough to make the structure of the F4D compatible with larger engine sizes. Nonetheless, it is estimated that 80% of the aircraft needed a redesign to accommodate the Pratt & Whitney J57-P-2 engine. With this, the first production F4D-1 exceeded the speed of sound in level flight during its first flight on 5 June 1954, but needed modifications to the intakes and exhaust area to cure engine stalls and buffeting problems.

In 1957, the Skyray was co-winner of aviation's prestigious Collier Trophy along with the USAF's F-100 Super Sabre. On 23 May 1958, Marine Corps test pilot Major Edward N. LeFaivre made a Skyray climb faster than any aircraft had ever climbed before. The ultimate record was a climb to a height of 15,000 meters (49,213 feet) and was accomplished in just 2 minutes 36.05 seconds.

Below: ***F4D-1s of Marine squadron VMF-314. The 'Black Knights' operated their Skyrays from land bases in the US and Japan.***

'Fords' entered service with VC-3 and Skyrays would equip16 Navy and eight Marine squadrons, albeit most of them briefly. VF-74 'Be-Devilers' and VF-141 'Iron Angels' were the first squadrons to take the F4D-1 operationally aboard a carrier. Notably, VF(AW)-3, the 'Blue Nemesis' flew from NAS North Island, California (and, during 1961 tensions over Cuba, fromKey West, Florida) with the unique distinction of being the only Navy squadron ever assigned to the Air Force-dominated North American Air Defense Command. VF(AW)-3 was judged the best in NORAD for two years running.VMF-115 at El Toro was the first Marine squadron to receive the Skyray in April 1956.

Some pilots praised the F4D for its flying qualities and performance. Others regarded its handling as "bizarre". A particular quirk was its loss of directional stability as the landing gear came up. With experience, pilots learned to anticipate and compensate for this yawing effect with rudder.

A total of 419 production F4D-1s were built, the last example being delivered in December 1958. At least 230 others were cancelled.

The final Skyray cruise was by VF-13 on USS *Shangri-La* in 1962. Renamed the F-6A in October that year, the Skyray continued in service with a handful of Marine, Reserve and utility units as late as 1965. The Naval Test Pilots' School at Pax River operated three Skyrays from 1961 until late 1969.





McDonnell F3H Demon
Lead Sled

Designed as a shipboard interceptor, the early F3H Demon had a performance described as 'farcical', but introduced air-to-air missiles to the fleet and later versions served relatively successfully as general-purpose fighters.

Stemming from a 1948 request for a fleet-defence all-weather interceptor, McDonnell's Model 58 offering was more conventional in appearance than the competing Douglas F4D and Vought F7U. It was the company's first swept-wing design and its only single-engined jet except the XF-85 Goblin.

First flown by Bob Edholm on 7 August 1951, the first XF3H-1 prototype, 125444, proved to have poor stability, bad forward visibility and a low roll rate. These faults were corrected by revising the nose shape and moving the ailerons to a mid-span position. The biggest problem was the low power of the Westinghouse J40 engine, with only 10,500lb st (46.7kN) in afterburner, barely enough for such a large airframe.

The poor reliability and performance of the J40 engine meant that most of the 58 F3H-1s built never flew. Many were barged directly from the factory to shore bases for use as ground trainers. The early Demon's J40 engines were known to cut out when flying through rain. The cause was shrinking of the compressor case, cured by trimming the compressor blades - and reducing the thrust. The engine now gave so little power that it was easy to get into a position in slow-speed flight that it was impossible to recover from.

The engine problems were not McDonnell's fault and development was allowed to continue. Built in parallel, the F3H-2N all-weather fighter and -2M missile carrier had a larger wing and the J40 was replaced by the Allison J71, which fitted inside the Demon's fuselage but still gave limited power. A modified afterburner system gave thrust in the range needed to make safe carrier landings, although the accident rate was horrendous by modern standards. Of the remaining F3H-1s,

Above: ***Son on a test flight in April 1954, an early F3H-2N Demon shows the type's unusual semi-circular engine air intakes***

29 were re-engined to become F3H-2Ns. New-build -2Ns flew from April 1955 and in July of that year the last J40-powered Demon was grounded.

Introduced in 1956, the F3H-2M was the first USN jet armed with radar-guided missiles, using the beam-riding Sparrow I. This was not very effective, but the improved Sparrow III worked well with the subsequent F3H-2, and many -2Ms were retrofitted to this standard.

Demons could also carry AIM-9 Sidewinder missiles and a variety of air-to-ground ordnance, although this was rarely seen. Aerial refuelling probes were added in service.

The first operational squadron was VF-14 'Tophatters', which took delivery of its first Demon in April 1956. Up to 1964, a total of 23 Navy fighter squadrons flew versions of the F3H Demon. The Marines wisely wanted nothing to do with it



McDonnell F3H-2

Crew:	One
Length:	58ft 11in (17.96m)
Wingspan:	35ft 4in (10.77m)
Height:	14ft 7in (5.13m)
Empty weight:	21,287lb (9,656kg)
Max T/O weight:	39,000lb (17,690kg)
Powerplant:	One Allison J71-A-2E turbojet rated at 8,700lb st (38.7kN) dry and 14,400lb (64.1kN) in afterburner
Max speed:	693mph (1,116km/h)
Service ceiling:	46,250ft (14,097m)
Range:	1,370 miles (2,205m)
Armament:	Four (often reduced to two) 20mm cannon; up to four Sparrow III missiles

Demons made more deployments than Skyrays or Cutlasses. but by the time the later versions were in service the Demon had gained a reputation that was hard to shake off.

The Demon line closed in April 1960, having rolled out 519 production aircraft and two prototypes. Of this total, 153 were written off in service. After 1962, surviving F3H-2s were redesignated F-3Bs, F3H-2Ms became MF-3Bs and F3H-2Ns; F-3Cs.

Above: ***A pair of F3H-2N Demons of VF-141 'Iron Angels' circa 1961. The squadron deployed to the Western Pacific on USS* Lexington *late that year.*** *NHHC*

McDonnell offered twin-engined J65 and J79 variants as the F3H-G and F3H-H, respectively. The latter was refined into what became the Phantom II, somewhat redeeming the company's reputation. VF-161 was the last squadron to fly the Demon, retiring the type in September 1964 and replacing it with the Phantom II.

Only three examples of the Demon are preserved today, at Pensacola, on USS *Intrepid* in New York and at the Pima Air & Space Museum in Tucson, Arizona.

Below: ***A Sparrow III-armed F3H-2 of VF-41 'Black Aces' aboard USS* Independence *in the 1960-61 timeframe. It crashed in the Med in April 1964 after running out of fuel.*** *Jim Winchester collection*





Grumman F9F-6/7/8 Cougar

Swept-Wing Day Fighter

The Panther's low performance in comparison with the MiG-15 and USAF F-86 was corrected by adding swept wings to make the Cougar, which became the fleet's mainstay fighter. Although soon superseded by more sophisticated fighters, one version lasted long enough to see combat in Vietnam.

Although a swept-wing version of the F9F Panther had been considered as early 1946, the Panther's uncompetitiveness as a fighter in Korea led to the quick modification of the design. Two F9F-5 airframes were converted to produce XF9F-6 prototypes, the first of which Corky Meyer flew on 20 September 1951. With almost all parts except the nose changed it was considered different enough to be renamed Cougar. The new wing had 40% more area and was swept back 35 degrees with a thicker airfoil section and no tip tanks. The swept tailplane had powered elevators. The engine was the Pratt & Whitney J48-P-6, which was upgraded to the P-8 from the 31st of the 646 F9F-6s built.

In only five months the Cougar was delivered to the Naval Air Test Center and entered service with VF-32 'Swordsmen' in November 1952. Despite this rapid development it was not deployed on a carrier before the Korean War ended. It was soon the most numerous carrier-based jet, but can be seen as a placeholder before the introduction of dedicated attack aircraft such as the A4D Skyhawk.

The F9F-8, which first of 662 of which flew in December 1953, was lengthened again (although the span was reduced) and had a refuelling probe and the ability to carry four AIM-9 Sidewinder missiles. Fitted with the LABS, the F9F-8B had provision to deliver a nuclear bomb or ASM-N-7 Bullpup missile. After September 1962 the F9F-8 was redesignated the F-9J and the F9F-8B, the AF-9J.

Above: ***The swept wing is very evident in this view of F9F-7 130761. This particular Cougar only served from 1953 until late 1956 when it was put into storage.***

There were two major photoreconnaissance variants. The F9F-6P had a lengthened camera nose and no cannon. There were 60 of this model and 110 F9F-8Ps with an even longer nose with 14 camera positions. Both versions could be fitted with a fixed refuelling probe on the tip of the nose. The F9F-7 was supplied with the Allison J33-A-16A, which proved unreliable and 50 of the 198 built were delivered with the J48, as in the F9F-6. Most of the rest were refitted with the J48.



Above: ***An Cougar of VA-76 'Spirits' catches a wire aboard USS* Forrestal *in 1956-57. The squadron operated the F9F-8 fighter and F9F-8 attack version.*** *Jim Winchester collection*

F9F-7s were used for trials of the 'flex deck', a rubberised landing surface that would stop aircraft quickly without the need for heavy and complicated landing gear. Of course, many land airfields would also need sto be equipped uch mats, making the flex deck concept somewhat inflexible.

Some F9F-6s were converted to F9F-6K (QF-9F) drones and F9F-6D (DF-9F) drone directors, used to support missile programmes such as the submarine-launched Regulus.

The Cougar replaced the Panther with the Blue Angels team, the F9F-6 serving for the 1953 and 1954 seasons and the F9F-8 from 1954 to 1958. Cougars were retired from Pacific Fleet squadrons in 1958 and from the Atlantic Fleet the following year.

Although there was no two-seat version of the Panther, 401 examples of the Cougar were built as the F9F-8T, which was used as an advanced jet trainer by the US Navy's Training Command until the last was retired by VT-4 in February 1974, by which time the designation had changed to TF-9J. One TF-9J remained in use with the Blue Angels until December 1969.Argentina's navy also received two dual-control Cougars.

Grumman F9F-8 Cougar

Crew:	One
Length:	38ft 10in (11.84m)
Wingspan:	34ft 6in (10.55m)
Height:	12ft 3in (3.73m)
Empty weight:	12,474lb (5,658kg)
Max T/O weight:	24,783lb (11,232kg)
Powerplant:	One Pratt & Whitney J48-P-8A turbojet rated at 7,250lb st (11.2kN)
Max speed:	647mph (1,041km/h)
Service ceiling:	42,200ft (12,802m)
Range:	1,308 miles (2,106km)
Armament:	Four 20mm M3 cannon; six weapons pylons capable of carrying two 1,000lb and four 500lb bombs or 5in or 2.75in rockets or four AIM-9 Sidewinder AAMs



The two-seaters had only a pair of cannon, but four pylons could carry ordnance. From 1965 some two-seat Cougars were used as fast forward air control platforms by the Marines in Vietnam, using rockets for target marking. They were replaced in the Headquarters and Maintenance (H&MS) squadrons by TA-4F Skyhawks before the war ended.

Left: ***The two-seat F9F-8T (TF-9J) Cougar mainly served as an advanced trainer. This example, 142438, ended its career in 1971 with VT-25.***



North American FJ Fury

Seagoing Sabres

The North American Fury series began with the straight-wing progenitor of the F-86 Sabre and ended with a very different and more capable aircraft.

North American Aviation (NAA) had previously only made fighter aircraft for the Army, selling only trainers and some B-25 (PBJ) bombers to the Navy, when it offered its NA-134 jet design in response to a 1944 Bureau of Aeronautics (BuAer) request.

Hedging its bets, the Navy ordered the NAA prototype at the same time as the Vought F6U Pirate and McDonnell FD Phantom. Although swept-wing aircraft were clearly the future for high combat speeds, the Navy required good handling at low speeds and all three designs had straight wings. NAA's XFJ-1 also had wingtip tanks and wing-mounted speed brakes. Power came from a single General Electric J35-GE-2 turbojet rated at 3,820lb st (17.0kN). Armament was six 0.50in machine-guns with no provision for external stores. The FJ-1's nose wheel leg could 'kneel' to maximise parking space aboard ship, but unusually for a carrier jet, the wings were non-folding.

The XFJ-1's first flight took place on 11 September 1946 when Wally Lien flew 39053 from Mines Field, Los Angeles to Muroc Army Airfield in the Californian desert.

The only operational unit was VF-5A, which later that year became VF-51. Although carrier trials had been successful, VF-5A quickly wrecked most of its aircraft when embarked aboard USS *Princeton*. Deliveries were completed in March 1948. Only 33 FJ-1s were built and 15 of these were written off after accidents. In 1949 the remaining FJs were issued to Naval Reserve squadrons for jet familiarisation and conversion training.

In early 1945, NAA began work on a fighter based around the NA-34 to meet a USAAF requirement. The original NA-140 design had straight wings, but the availability of German aerodynamic research led to the XP-86 Sabre which flew in October 1947.

Experience in Korea saw the Navy urgently request a carrier-capable Sabre. First flown by Bob Hoover on 27 December 1951, the FJ-2 was essentially an F-86E Sabre with a strengthened nose undercarriage, folding wings, a tail hook and catapult bridle attachments. With a weak

Above: ***VF-5A was the first and only FJ-1 squadron, based at NAS North Island, California until it exchanged its Furies for F9F-2 Panthers in 1949.*** *Jim Winchester collection*

nose gear and poor low-speed handling, it proved unsuitable for carrier operations, and apart from some used by test units, most of the 200 FJ-2s were delivered from Columbus

North American FJ-3 Fury

Crew:	One
Length:	37ft 11in (11.46m)
Wingspan:	37ft 7in (11.31m)
Height:	13ft 8in (4.2m)
Empty weight:	12,205lb (5,536kg)
Max T/O weight:	21,024lb (9,536kg)
Powerplant:	One Wright J65-W4 turbojet rated at 7,700lb st (34.0kN)
Max speed:	681mph (1,096km/h)
Service ceiling:	49,000ft (14,935m)
Range:	1,784 miles (2,871km)
Armament:	Four 20mm Colt Mk.12 cannon; two AIM-9 Sidewinder AAMs

Right: ***The third XFJ-2 Fury prototype 133756, first flew in December 1951. The early FJ-2s were essentially F-86E Sabres, but were 1,000lb (454kg) heavier.***



Ohio to Marine Corps squadrons from 1954 and phased out all together by 1958.

A reasonably minor redesign resulted in the FJ-3, which had a enlarged nose intake for the Wright J65, a license-built version of the British Armstrong Siddeley Sapphire. Early examples had leading-edge slats, but these were replaced by a fixed leading-edge extension. Gun armament was beefed up to four 20mm cannon. The first mirror-assisted carrier landing was carried out with an FJ-3 on USS *Bennington* on 22 August 1955

FJ-3 production amounted to 538 aircraft, all built at Columbus, and delivered from September 1954 to August 1956. By the following year, 21 squadrons were equipped with FJ-3s. The last 194 aircraft were delivered as FJ-3Ms with the ability to carry AIM-9B Sidewinders. A number were modified to control KDU-1 Regulus missiles and Grumman F9F-6K Cougar target drones as the FJ-3D.

The FJ-4 was even further redesigned, with a shorter and deeper fuselage and a wider undercarriage. The wing now had high-lift flaps, a controllable drooping leading edge, and mid-span control surfaces. Fixed refuelling probes were fitted to many FJ-4s. Production began in August 1954 and of the 374 FJ-4s built, 222 were FJ-4B fighter-attack versions with six underwing pylons. These could use the ASM-N-7 (AGM-12) Bullpup missile, the first mass produced guided air-to-ground weapon. FJ-4Bs also had the LABS (Low Altitude

Below: ***An FJ-3 of VF-53 'Blue Knights' aboard USS* Kearsage *during its first post-modernisation cruise in 1957-58.*** *SDASM*



Above: ***A high-altitude break over San Diego from a division of FJ-4s of VF-121 'Pacemakers'. NAS North Island can be seen below.*** *NHHC*

Right: ***The FJ-4B was capable of launching the ASM-N-7 Bullpup, with a maximum load of five missiles and a guidance pod, as carried by this VX-4 example.***

Bombing System) to allow loft bombing with early tactical nuclear weapons such as the Mk.7 and Mk.12 bombs.

Furies flew patrols during the 1958 Lebanon crisis and operated over Indochina in 1962, but never saw combat action nor were exported. The remaining Furies were redesignated F-1s in 1962. The FJ-3 became the F-1C, the FJ-3D the DF-1C; the FJ-3M the MF-1C; the FJ-3D2 the DF-1D; the FJ-4 the F-1E; and the FJ-4B the AF-1E. The last frontline squadron, VA-216, phased out its AF-1Es in late 1962, leaving only a few Reserve and utility units.



Grumman XF10F Jaguar

Bad Kitty

In 40 years of fighter development from the FF biplane to the F-14 Tomcat, the only Grumman fighters not accepted by the US Navy were the XF5F-1 Skyrocket and the XF10F-1 Jaguar.

The XF10F began as a redesigned F9F Panther in 1948, but evolved into a tubby aircraft sporting the first power-operated variable geometry or 'swing' wing to be used on any warplane. This, and its associated system of flaps and spoilers proved far too complicated, but most of the trouble came from the tiny tailplane, and the Jaguar proved almost impossible to keep in balanced flight.

'Corky' Meyer flew the second XF10F airframe at Edwards AFB, California on 19 May 1952. The aircraft was grounded for long periods while modifications were made to cure its handling problems. Unlike the variable geometry wings on later fighters where only the outer panel moved, the whole wing on the XF10F 'translated', with a complex arrangement of moving panels to fill the gaps. At full sweep the wings were only 35 degrees and the performance gains were largely negated by the extra weight of the wing sweep mechanism. The tailplane was operated by a novel arrangement where the pilot controlled a small delta wing airfoil at the tip of the tail bullet. This in turn moved the main elevator. Unfortunately a lag in the response between stick and surface usually resulted in a pilot-induced oscillation (PIO) and the Jaguar was virtually uncontrollable much of the time. At maximum wing sweep the directional control was marginal, not helped by the ineffective rudder. The spoiler system was so complicated it was disconnected, leaving only tiny ailerons, which gave a very poor roll response.

The Jaguar was another of those naval aircraft crippled by the Westinghouse J40 engine, which underwent its own development problems and never received the intended afterburner.

The XF10F-1 only made 32 flights, all of them eventful, before the programme was terminated in April 1953.

Perhaps uniquely in the annals of naval aviation the cancellation effort was led by the Navy's project officer, usually the person most loyal to any project, whatever its faults. The flying Jaguar was used to test carrier deck crash barriers and the static test airframe became a target for tank guns.

Grumman XF10F-1 Jaguar

Crew:	One
Length:	54ft 0in (16.46m)
Wingspan:	Unswept 50ft 7in (15.48m), swept 36ft 8in (11.19m)
Height:	16ft 3in (4.95m)
Empty weight:	20,425lb (9,265kg)
Max T/O weight:	35,450lb (16,094kg)
Powerplants:	One Westinghouse XJ40-W-8 turbojet rated at 6,800lb st (30.2kN)
Max speed:	710mph (1,142km/h)
Service ceiling:	n/a
Range:	1,670 miles (2,690 km)
Armament:	None

Below: ***Seen here during land-based carrier landing trials, the Jaguar never went to sea. Only one example was ever flown, by one pilot, the legendary 'Corky' Meyer.***



Douglas A-3 Skywarrior

The Whale

The A-3 was the first all-jet bomber designed for shipboard use and the heaviest aircraft to regularly operate from carriers. It gave the Navy a strategic bombing capability before submarine-launched missiles took over.

The Douglas Skywarrior was the first all-jet bomber designed for aircraft carrier use and was conceived in a 1947 US Navy specification for an aircraft able to carry a 10,000lb (4,536kg) payload over 2,000 nautical miles (3,704km) and returning safely to its carrier. Although the specification allowed for a weight of up to 100,000lb, (45,360kg), Douglas' design team kept the weight as low as possible as they forecast (correctly) that the *United States*-class supercarriers would be cancelled. North American withdrew from the competition, believing that the specified weight was impossible to achieve. Ed Heinemann at Douglas worked tirelessly to eliminate unnecessary weight. With the design pared down to 68,000 lb (30644 kg), Douglas was awarded the prototype contract in March 1949, and the XA3D-1 Skywarrior prototype flew on 28 October 1952 with George R. Jansen in the pilot's seat.

The A3D's fuselage was designed around a large bomb bay that could be accessed in flight for arming nuclear weapons. Otherwise, the crew was in the nose compartment and the only defensive armament was a remotely-operated turret with a pair of 20mm cannon.

The swept, shoulder-mounted wing necessitated that the undercarriage retracted into the fuselage. Pod-mounted engines were

Above: ***The third Skywarror built, and the first to have the J57 engines installed was YA3D-1, 130352, is seen on the dry lakebed at Edwards AFB in 1954.***

a fortunate choice, as this allowed alternative powerplants to be used when the original Westinghouse XJ40-WE-3 engines which provided only 7,000lb (32.5kN) thrust proved inadequate to meet the required performance. The much better Pratt & Whitney J57 was installed on third aircraft and the production A3D-1, which entered service with heavy attack squadron VAH-1 'Smokin' Tigers' at NAS Jacksonville, Florida in April 1956.

In August 1959, a Skywarrior was launched from USS *Independence* at a weight of 84,000lb (38,102kg), a record for a carrier launch. This was still below the original specification of 1947.

Operations from *Essex*-class carriers, even once refitted with angled decks, were marginal for the heavy Skywarrior. The elimination of ejection seats from the design to save weight led to the grim nickname 'All Three Dead' from the original A3D designation, which changed to A-3 in 1962. As many as 108 Skywarriors were destroyed in accidents and combat over the type's long career. Twenty 'Whales' were lost in Vietnam, one shot down by Chinese MiGs.

Informally known as the 'Whale', the Skywarrior, saw some action as a bomber in Vietnam, but was mainly used as a tanker and/or an electronic warfare platform. The tail guns were soon replaced by electronic jammers. Other variants served as transports or photographic reconnaissance aircraft. The A3D-2Q, nicknamed the 'Queer Whale' and later designated EA-3B, was designed for electronic reconnaissance or 'ferreting' of enemy radar emissions. Of the 283 Skywarriors, 26 were built as A3D-2Qs (later EA-3Bs) and served with the Navy's electronic intelligence or VQ squadrons. Other variants included 30 A3D-2P (RA-3B) photoreconnaissance aircraft, 12 A3D-2T (TA-3B) trainers and many conversions to KA-3B tankers and EKA-3B reconnaissance/tankers.

In Southeast Aisa,, RA-3B photo platforms were used to detect enemy vehicles through the jungle canopy with their infra-red cameras. The EA-3Bs were the last Skywarriors in regular service, seeing use in Operation Desert Storm with VQ-2. The last active aircraft were retired at Rota, Spain in October 1991. Their role was replaced by the ES-3A Shadow aboard carriers and EP-3 Orions from land bases. Several flew on with Raytheon on avionics development work into the 2000s.

Douglas A-3B Skywarrior

Crew:	Three
Length:	76ft 4in (23.27m)
Wingspan:	72ft 6in (22.1m)
Height:	22ft 10in (6.95m)
Empty weight:	39,409lb (17,876kg)
Max T/O weight:	84,000lb (38,102kg)
Powerplants:	Two Pratt & Whitney J57-10 turbojets each rated at 12,400lb st (57.5kN) thrust with water injection
Max speed:	618mph (995km/h)
Service ceiling:	41,000ft (12,000m)
Range:	2,900 miles (4,667km)
Armament:	Twin 20mm cannon in tail barbette; up to 8,560lb (3,892kg) of conventional or nuclear ordnance

Below: ***An A3D-2 (A-3B) on a test flight. The remotely-operated 20mm cannon in the tail was largely eliminated by the time the Skywarrior saw combat.***

Right: ***The A-3 saw use in the bombing role in the early years of the Vietnam War. Note the bomb symbols on this VAH-4 A-3B flying from USS* Ticonderoga *in 1965-65.*** *US Navy*

Bottom right: ***An EA-3B Skywarrior electronic warfare aircraft lands aboard the USS* Kitty Hawk *in 1987. Note the windows for the pressurised crew cabin and the ventral sensor 'canoe'.*** *US Navy*




ZB
142650
96
142650
USS TICONDEROGA
NAVY
VAH-4
896
8796


016
NAV

Convair F2Y Sea Dart
Supersonic Seaplane

The Sea Dart was the only flying-boat to go faster than sound, if only just. Before the bugs were sorted out, development of the supercarrier allowed true high-performance aircraft to go to sea.

In the late 1940s the US Navy found they could not exploit the new swept-wing technology and thus supersonic flight with the aircraft able to use the small carriers of the day. A high-performance seaplane fighter was the Navy's solution and Convair was awarded a contract for two XF2Y-1s in January 1951.

Convair was a pioneer of delta wings, and unsurprisingly, the XF2Y-1 Sea Dart emerged in this configuration. It had a V-shaped hull and intakes mounted as high as possible.

Delays in the intended Westinghouse J46s saw their substitution by the 3400lb st (15.12kN) J34, another of Westinghouse's inadequate engines. The J34s were eventually replaced by XJ46s, which each only gave 680lb (3.03 kN) more thrust and far less than promised.

E. D. 'Sam' Shannon made the official first flight from San Diego Harbor on 9 April 1953, although the XF2Y-1 had made 'hops' out of the water during taxying trials before that.

The Sea Dart took off on a pair of retractable hydro-skis, one on each side of the hull. These moved between three positions during the take-off run. Problems with vibration during water operations saw a variety of multiple and single ski and skid arrangements tested. No totally satisfactory solution was found. The dive brakes in the lower rear fuselage doubled as water brakes and as a water rudder when floating.

Like Convair's original F-102 Delta Dagger, the XF2Y-1 had too much drag to be supersonic in level flight. Test pilot Charles E. Richbourg got the first pre-production YF2Y-1 up to Mach 1.01 in a shallow dive in August 1954. On 4 November, Richbourg pushed it too far during a demonstration and the Sea Dart broke up over San Diego Bay.

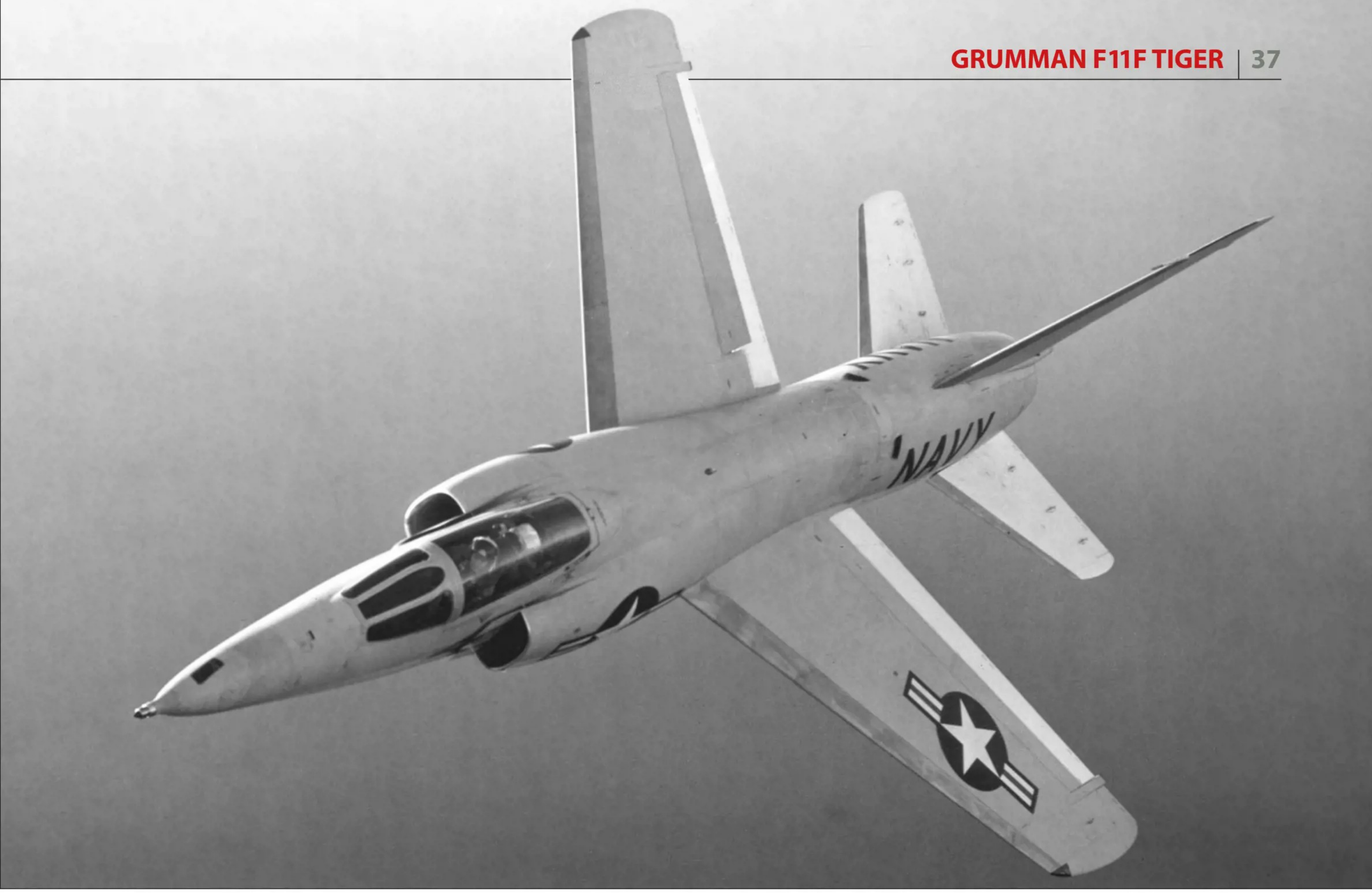
The XF2Y-1 was modified with afterburners and declared an experimental type before the whole thing was abandoned in 1957. Somehow, this aircraft, the single Sea Dart in the inventory in 1962 was redesignated YF-7A, although it had not flown for several years.

Convair XF2Y-1

Crew:	One
Length:	52ft 7in (16.03m)
Wingspan:	33ft 8in (10.26m)
Height:	16ft 2in (4,93m)
Empty weight:	12,625lb (5,727kg)
Max T/O weight:	21,500lb (kg)
Powerplants:	Two Westinghouse J34 turbojets rated at 3,400lb st (15.12kN) each
Max speed:	825mph (1,325km/h)
Service ceiling:	54,800ft (9,752kg) (estimated)
Range:	512 miles (824km) (estimated)
Armament:	Four 20mm cannon and a pack of unguided 2.75in rockets (proposed)

Below: ***The Convair Sea Dart had poor water handling characteristics and was not very impressive in the air, either.***





Grumman F11F Tiger

Long-nosed, short-lived

Grumman's Tiger was the first supersonic jet in US Navy service, it served in the fleet for only three years, making six carrier deployments. Its career was extended in Training Command and with the Blue Angels.

The Tiger was ordered in April 1953 as a 'negotiated procurement', where Grumman offered the design and the Navy bought it, then decided what to do with it. Grumman began design of its G.98 as an attempt to make the F9F-8 Cougar supersonic, but it soon morphed into something altogether new. Originally designated XF9F-9, it had nothing in common with the Panther or Cougar except very broadly the same configuration of the latter. It was a slender fighter with an area-ruled fuselage and very thin wings wings swept back to 35 degrees. These folded at the tips, but downwards. There were no ailerons, but large spoilers were used for roll control.

It was powered by an afterburning version of the British Armstrong Siddeley Sapphire engine built by Wright as the J65. In the hands of 'Corky' Mayer, the prototype (138604) flew on 30 July 1954, with a non-afterburning J65-W-7 engine. By this time 42 initial F9F-9s had already been ordered

The second prototype flew on 2 October 1954, but the first crashed on the 20th.

The designation changed to F11F and the name Tiger was applied in April 1955. The F11F-1 joined the fleet in March 1956 with deliveries to VA-156. Although the aerodynamics were refined, the engine was not really reliable or powerful enough, and the thin wing offered no room for fuel, which was stored everywhere else, including the vertical fin and the intake sides. Unsurprisingly, the range was inadequate.

The initial version with a refuelling probe on the centreline was replaced by the 'long-

Above: ***The 'wasp-waisted' area-ruled fuselage which helped the Tiger go supersonic is apparent in this view of an early F11F-1.***

nose' Tiger, which had a rudimentary air-to-air ranging radar (although some sources say it was never fitted), and a retractable refuelling probe. Both variants had the F11F-1 designation, with 157 of the later version produced, the last being delivered in December 1958.

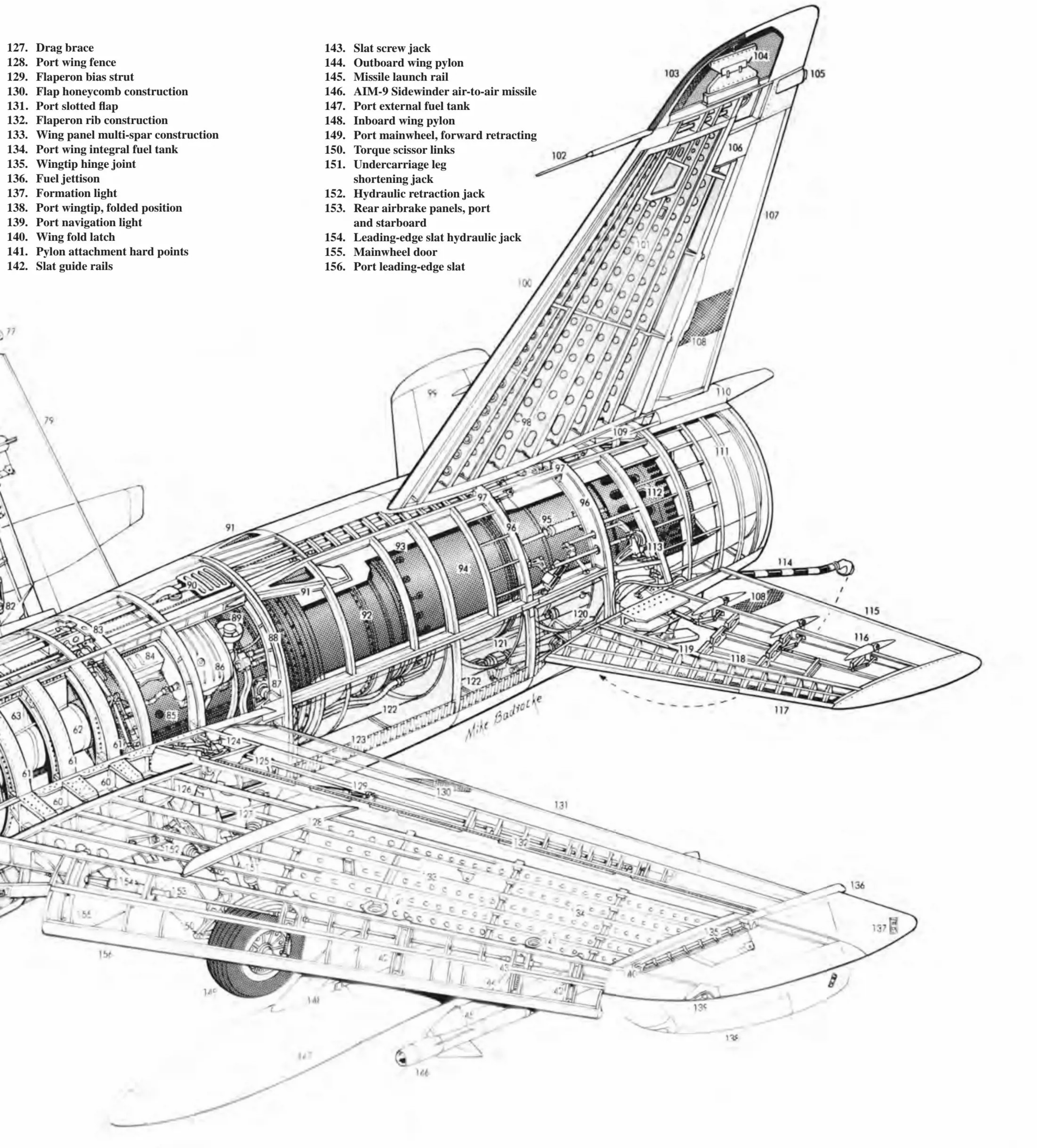
Five Pacific Fleet squadrons flew the Tiger: VF-51, VF-111 (formerly VA-156), VF-121, VF-191 and VF-211 (formerly VF-24), all based at NAS Moffett Field, California when ashore. On the East Coast, VF-21 and VF-33 flew from NAS Oceana, Virginia when not embarked. Fleet service was short, with VF-21 and VF-111 the last to retire the Tiger in April 1961. This was not the end of the story, as Naval Training Command continued to fly the F11F-1 (F-11A) as an advanced trainer with squadrons at NAS Beeville, and NAS Kingsville, Texas.

Grumman F11F-1 Tiger

1. Radome
2. AN/APG-56 ranging radar, not fitted operationally
3. Radar transmitter/receiver units
4. Radar mounting bulkhead
5. Refuelling probe housing
6. Flight refuelling probe, extended
7. Probe operating linkage
8. Gun camera
9. Radio junction box
10. Battery
11. Dynamotor
12. Radio and electronics equipment compartment
13. Front pressure bulkhead
14. Forward airbrake panel, open
15. Emergency Rama air turbine, extended
16. Airbrake hydraulic jack
17. Cockpit section corrugated inner skin panel
18. Rudder pedals
19. Control column
20. Instrument panel
21. Gunsight
22. Armoured windscreen panels
23. Aft sliding cockpit canopy cover
24. Ejection seat face blind firing handle
25. Headrest
26. Pilot's ejection seat
27. Engine throttle lever
28. Side console panel
29. Cockpit pressure floor
30. Nose undercarriage hydraulic jack
31. Nosewheel
32. Twin nosewheels, aft retracting
33. Boarding ladder, extended
34. Nosewheel doors
35. Cannon muzzles
36. Port engine air intake
37. Boundary layer splitter plate
38. Gun feed air bottle
39. Rear avionics and equipment bay
40. Rear pressure bulkhead
41. Cabin air conditioning plant
42. Oxygen bottle
43. Ejection seat launch rails
44. VHF-nav antenna
45. Canopy pneumatic actuator
46. Canopy and undercarriage emergency air bottles
47. Control rod linkages
48. Forward fuselage main fuel tank, total internal capacity 1,003 US gal (3,785 litres)
49. Central ammunition magazine, 150 rounds per gun
50. Ammunition feed chutes
51. 20mm cannon, two per side
52. Cannon bay access door
53. Cartridge case ejection chute
54. Link collector box
55. Catapult strop hook
56. Lower main fuel tank
57. Deck approach lighting
58. Extended chord wing root segment
59. Intake flank integral fuel tanks
60. Wing root attachment fittings
61. Built-up wing attachment fuselage main frames
62. Engine starter housing fairing
63. Intake ducting
64. Dorsal control and cable ducting
65. Starboard wing root joint
66. Wing integral fuel tank
67. Wing fence
68. Leading-edge slat hydraulic jack
69. 150-US gal external tank
70. Leading-edge slat, extended
71. AIM-9 Sidewinder air-to-air missile
72. Slat screw jack and guide rails
73. Folding wingtip segment
74. Starboard wingtip segment
75. Remote compass treatment
76. Formation light
77. Fuel jettison
78. Starboard two-segment spoiler (flaperon)
79. Single-slotted flap, down position
80. Flapper operating linkage
81. Flap external hinge
82. Bias strut
83. Forward engine mounting lug fitting
84. Ignition control unit
85. Wright J65-W-18 afterburning turbojet engine
86. Engine oil tank, 4.36 US gal (16 litre) capacity
87. Main engine mounting trunnion
88. Rear fuselage joint frame (engine removal
89. Oil filler
90. Engine bay air vent
91. NACA-type cooling air intakes
92. Engine turbine section
93. Internal heat shroud
94. Afterburner ducting
95. Variable area afterburner nozzle actuator
96. Fin tailplane attachment main frames
98. Multi-spar fin construction
99. Starboard all-moving tailplane
100. Fin leading edge
101. Fin integral fuel tank
102. Pitot head
103. Fin tip aerial fairing
104. UHF aerial
105. Tail navigation light
106. Rudder mass balance
107. Rudder
108. Control surface
109. Rudder hydraulic actuator
110. Fin root aerodynamic fairing
111. Exhaust nozzle shroud
112. Variable area afterburner nozzle
113. Geared elevator control linkage
114. Deck arrestor hook
115. Geared elevator
116. Elevator external hinges
117. Port all-moving tailplane
118. Tailplane construction
119. Retractable tail bumper
120. Tailplane interconnecting yoke
121. Tailplane hydraulic actuator
122. Rear fuselage fuel tankage
123. Fuel tank bay corrugated inner skin
124. Flap/flaperon hydraulic actuator
125. Combined system hydraulic reservoir
126. Main undercarriage leg pivot fixing



127. Drag brace
128. Port wing fence
129. Flaperon bias strut
130. Flap honeycomb construction
131. Port slotted flap
132. Flaperon rib construction
133. Wing panel multi-spar construction
134. Port wing integral fuel tank
135. Wingtip hinge joint
136. Fuel jettison
137. Formation light
138. Port wingtip, folded position
139. Port navigation light
140. Wing fold latch
141. Pylon attachment hard points
142. Slat guide rails
143. Slat screw jack
144. Outboard wing pylon
145. Missile launch rail
146. AIM-9 Sidewinder air-to-air missile
147. Port external fuel tank
148. Inboard wing pylon
149. Port mainwheel, forward retracting
150. Torque scissor links
151. Undercarriage leg shortening jack
152. Hydraulic retraction jack
153. Rear airbrake panels, port and starboard
154. Leading-edge slat hydraulic jack
155. Mainwheel door
156. Port leading-edge slat





Grumman F11F Tiger

Crew:	One
Length:	46ft 11in (14.31m)
Wingspan:	32ft 8in (9.64m)
Height:	13ft 3in (4.03m)
Empty weight:	14,330lb (6,500kg)
Max T/O weight:	24,078lb (10,922kg)
Powerplant:	One Wright J65-W-18 turbojet rated at 10,500lb st (46.71kN) in afterburner
Max speed:	753mph (1,212km/h)
Service ceiling:	41,900ft (12,771m)
Range:	1,108 miles (1,783km)
Armament:	Four 20mm Colt Mk.12 cannon; up to four AIM-9 Sidewinder 1A or 1C AAMs

Above: ***The Tiger served the Blue Angels for more than a decade. Here two of the short-nose variant perform a mirror manoeuvre.***

The Tiger was high performance as a single-seat trainer. It was good in formation, but had tricky stall characteristics. Students, who had already passed the basic and intermediate flying phases, were checked out in a simulator that had no motion capability or outside visuals before being let loose on the aircraft.

Some will remember the Tiger as 'the jet that shot itself down'. On 21 September 1956 Grumman test pilot Tom Attridge was tasked with firing bursts from the cannons at a series of descending altitudes and supersonic speeds. After the first burst, the aircraft was unknowingly dived into the path of the slowing bullets, and three hit the canopy, nose and engine, which eventually flamed out. Attridge crash-landed in trees short of the Calverton runway, but was able to escape unharmed.

The F11F's stability and good performance made it ideal for the Blue Angels demonstration team, which began flying the short-nose Tiger in 1957 and the long-nose variant in 1962, transitioning to the McDonnell F-4J Phantom for the 1969 season.

A proposed F11F-1P photoreconnaissance version was cancelled, as was a lengthened F11F-1T two-seat trainer. The General Electric YJ79-GE-3 engine was fitted to create the F11F-1F, which had extra sweep at the wing roots and larger intakes. The first of two prototypes flew in May 1956. During testing one reached 1,386.47mph (2,231.31km/h) in level flight and Lt Cdr George Watkins achieved a world record altitude of 76,932ft (23,449m) on 18 April 1958. Later trials included an early thrust-vectoring system.

The Super Tiger was offered to Japan and West Germany, both of which selected the F-104, and to Switzerland, which chose the Dassault Mirage III. More than 20 Tigers survive, mostly in Blue Angels colourschemes.

Below: ***One of the two F11F-1F Super Tiger prototypes, 138647. The J79 engine required a wider rear fuselage. It is preserved today at China Lake, California.***



Douglas A-4 Skyhawk
The Scooter

The versatile Skyhawk was used by the Navy and Marines in the nuclear and conventional strike, close air support, anti-ship, fighter, adversary, electronic warfare, tanker and training roles.

In January 1952 Douglas submitted a proposal to the Navy's Bureau of Aeronautics (BuAer) for a jet-powered carrier attack aircraft to replace the piston-engined Skyraider. Although the AD had a nuclear role, its survivability before and after making an attack was marginal. Ed Heinemann's A4D was designed to accommodate a single nuclear weapon on the centreline, deliver it and escape at jet speeds. His philosophy was to 'simplify and add lightness'. He calculated that every pound (454g) of added equipment increased the overall weight by 10lb (4.54kg) because of the extra structure needed to support it, and the extra fuel needed to carry the item and the structure and so on. By working to eliminate weight pound by pound, by simplifying avionics, leaving off built-in steps and other accessories, the design team were able to bring the XA4D-1 prototype in at 8,169lb (3,706 kg). Eliminating wing-folding reduced weight further and allowed two aircraft to fit side-by-side on aircraft carrier elevators. The engine was the Wright J65-W4-B, giving 7,000lb (31.14kN) thrust. Many early production aircraft used refurbished J65s from USAF F-84s which were not terribly reliable.

From concept to first flight took remarkably little time. The XA4D-1 was roaded to the Edwards Dry Lake in the Mojave desert and flown there by Robert Rahn on 22 June 1954. A further 19 YA4D-1 test aircraft followed, and one was used by test pilot Gordon Gray to set a world 500km closed-circuit speed record in October 1955. Testing resulted in the removal of the rudder outer skins and the addition of a 'sugar scoop' fairing above the jet pipe to cure some aerodynamic problems. The A4D-1 Skyhawks that entered service with VA-72 in August 1956 and VMA-224 in September retained the smooth rudder and were little changed from the test aircraft.

The A4D-1 was followed into service by the A4D-2, with the ribbed 'inside-out' rudder and an inflight refuelling probe. The A4D-2N followed with further improved avionics, allowing a degree of night/bad weather operation, which required a longer nose to house it. The next production version, the A4D-5 introduced the Pratt & Whitney J52-P6B engine with 8,500lb (37.81kN) thrust, five weapons pylons (as opposed to three) and a further nose length increase. In September 1962, the unified US designation system saw the A4D-1 redesignated the A-4A; the A4D-2, the A-4B; the A4D-2N, the A-4C; and the A4D-5, the A-4E. Subsequent models began development under the unified system. The A-4F introduced wing spoilers, and had an electronic countermeasures (ECM) hump fitted as standard on the spine. This was retrofitted to many A-4Es, and later to A-4Cs in the Navy and Marine reserve squadrons, making them A-4Ls. The A-4M for the USMC had the higher-thrust J52-P-408 engine, a larger canopy and the hump.

From August 1964 until January 1973, the Skyhawk flew many thousands of combat missions over Southeast Asia. The 'Tonkin Gulf

Douglas A-4E Skyhawk

Crew:	One
Length:	40ft 3in (12.28m)
Wingspan:	27ft 6in (8.38m)
Height:	14ft 11in (4.54m)
Empty weight:	9,853lb (4,469kg)
Max T/O weight:	24,500lb (11,113kg)
Powerplant:	One Pratt & Whitney J52-P6A turbojet engine rated at 8.500lb st (37.81kN)
Max speed:	673mph (1,083km/h)
Service ceiling:	40,500ft (12,344m)
Range:	1,995 miles (3,211km)
Armament:	Two 20-mm Colt Mk 12 cannon with 100 rounds each; up to 8,500lb of conventional or nuclear stores on external pylons including up to four AIM-9 Sidewinder AAMs

Below: ***Before low-vis tactical paint schemes took over, most US Navy jets had vivid markings like this A-4C Skyhawk of VA-144 'Roadrunners' seen in the 1966-67 timeframe.***
Jim Winchester collection




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Vought F8U-1 Crusader, Bu. No. 143761
VF-142, US Navy
MCAS El Toro, California, 1959

Flying with VF-142 'Ghostriders' at NAS Miramar, California in 1958, 143761 was with VMF-142 at El Toro by the following year. The 'Fighting Falcons' had become the first West Coast squadron to transition to the F8U-1 in January 1958. The Crusader did not last long enough to become an F-8A and is said to have crashed on 3 April 1959 near NAS Alameda, after a collision with another aircraft, with Major T. A. Coleman ejecting, although details are conflicting.



Douglas A-4E Skyhawk, Bu. No. 151022
VA-56, CVW-5, US Navy
USS Ticonderoga, *1965*

Delivered to VA-56 'Champions' on 15 January 1964, 151022 flew from USS* Ticonderoga *during the 'Gulf of Tonkin Incident' and began a second WestPac cruise in September 1965. While being moved from the hangar deck to the flight deck as part of a weapons loading exercise on 5 December it rolled overboard and sank in 16,000ft (4,877m) of water. The pilot. Lt (JG) Douglas Webster, was killed. The aircraft and the one-megaton B43 nuclear weapon it was carrying were never recovered.



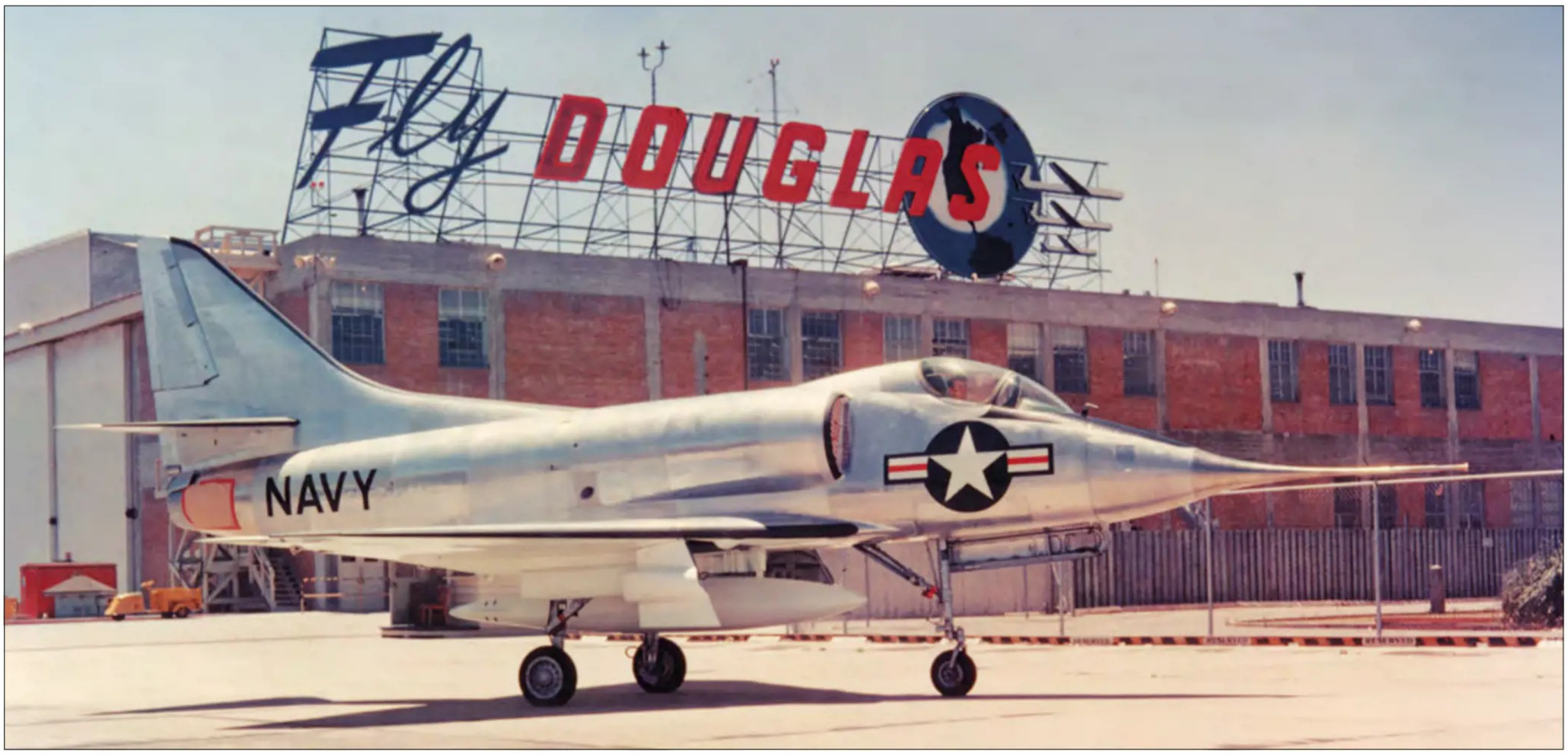
McDonnell Douglas F-4B Phantom II,
Bu. No. 153019
VF-111, CVW-15, US Navy
USS Coral Sea, *1972*

First noted with VF-213 'Black Lions' in 1966-68, this F-4B was with VF-111 'Sundowners' and embarked aboard USS* Coral Sea *on its 1971-72 WestPac cruise. Flying 153019 as 'Old Nick 201' on 6 March 1972 Lt Garry Weiland and Lt(JG) Bill Freckleton shot down a North Vietnamese MiG-17 'Fresco' near Quang Lang with an AIM-9 Sidewinder. Remanufactured as an F-4N, it eventually became part of the inventory of the National Naval Aviation Museum and today is mounted on outdoor display at NAS Key West, Florida.



North American RA-5C
Vigilante, Bu. No. 156609
RVAH-11, CVW-9, US Navy
USS Constellation, *1973*

In May 1969 RA-5C 156609 was delivered to Vigilante Replacement Air Group RVAH-3 'Sea Dragons', at NAS Sanford, Florida. In 1971 it moved to RVAH-11 'Checkertails' as NG-601, then RVAH-12 'Speartips'. The Vigilante was again with RVAH-11 when on a catapult launch from USS* Constellation *off the coast of South Vietnam on 21 April 1973 the fuel tank fell out of the linear bomb bay, the pilot lost control and both crewmembers ejected.


Fly DOUGLAS
NAVY


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RESCUE
FLIGHT DEC
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Top left: ***The first of nearly 3,000 Skyhawks, XA4D-1, 137812 poses at El Segundo before bring roaded to Edwards AFB for its June 1954 first flight.*** *Jim Winchester collection*

Left: ***An A-4C of VA-76 is moved to one of the forward catapults on USS*** **Enterprise,** ***circa 1965. This aircraft was later refurbished and exported to Malaysia.*** *Jim Winchester collection*

Above: ***Chui Lai, South Vietnam was close enough the action to allow full bomb loads to be carried as seen on this A-4E of VMA-121 'Green Knights'.***

Below: ***The A-4M was a version developed specially for the US Marines, This late A-4M of VMA-311 'Tomcats' has the ALR-45 warning antenna on the tail fin.*** *Jim Winchester collection*





Above: ***Based in Puerto Rico, composite squadron VC-8 was the last US Navy Skyhawk operator. These 'Redtails' TA-4Js were en route to Key West in 2000 after a detachment to Oceana.***
Jim Winchester

Incident' of August 1964 saw the first carrier-based strikes on North Vietnam, the first A-4 combat loss and the first prisoner of war. The Navy's contribution to the 'Rolling Thunder' air campaign, and subsequent operations saw one or two squadrons of A-4s based on almost every attack carrier deployment to WestPac (the western Pacific) up to late 1972, striking both targets in both North and South Vietnam. Combat casualties amounted to 195 USN and 62 USMC Skyhawks in addition to those lost in accidents.

On land, the Marines primarily used the A-4 as a close-support aircraft against Viet Cong targets in the south. At Chu Lai, South Vietnam, a catapult and arrestor system, combined with JATO booster rockets, allowed the Skyhawks to carry the maximum ordnance from a steel-plank runway built in a month by Navy Construction Battalion troops (Seabees). From 1967, the Marines also used the TA-4F two-seater as a forward air control (FAC) platform and naval gunfire spotter.

The Marines had by 1969 received all the US Skyhawk versions from the A-4A through the TA-4F. In that year they decided against purchase of the A-7 Corsair II in favour of a new version known as the A-4M Skyhawk II. This had the most powerful version of the J52 engine, the P408, as well as self-starting capability and a raised cockpit and enlarged canopy for better visibility. A much improved navigation and attack system and a head up display (HUD) made the 'Mike' a much more effective attack platform. Later model Ms had an ALR-45 radar warning system in a fairing atop the tail fin. A few stripped-down 'Super Mikes' were operated as adversaries.

In 1966, Naval Aviation Training Command introduced the two-seat TA-4F followed in 1967 by the non-combat capable TA-4J, and until 1999, many thousands of pilots received their advanced jet training on the Skyhawk. Two-seat and single-seat Skyhawks, once retired from frontline duties, saw extensive use as adversary aircraft with the 'Topgun' school at Miramar from 1969 and later with units on the east and west coasts, Hawaii and the Caribbean. The last US military operator was VC-8 'Redtails', based at NAS Roosevelt Roads, Puerto Rico, who provided target-towing, air-to-air and anti-ship adversary services to the Atlantic Fleet until May 2003 when it retired its TA-4Js, ending 47 years of U.S. military service. In this time, Skyhawks had served with 42 VA (attack), four VSF (fleet defence fighter) nine VC and VFC (composite and composite fighter), two VF (fighter) squadrons, and nine VT (training) squadrons and many other assorted Navy units. The Marines had 30 VMA (attack) and three training squadrons, and 12 H&MS (headquarters and maintenance) squadrons, plus other detachments.

The A-4 was widely exported. Three navies, Australia, Argentina and Brazil, operated the Skyhawk from aircraft carriers. The air forces of Argentina, Indonesia, Israel, Kuwait, Malaysia, New Zealand and Singapore operated them, as have several private contractors, supporting US and NATO forces. A-4s were built in six main single-seat versions from which further export versions were derived. A variety of two-seat TA-4s were created, several of them converted from single-seaters. Production for US and export customers ended in 1979 with 2,960 Skyhawks built, 555 of them two-seaters.

Martin P6M SeaMaster
Fast Flying Boat

Designed at a time of rapid technological change, the P6M was obsolete by the time it was ready for service. It became the last major aircraft designed under the Martin name.

In the late 1940s the US Navy realised that the limitations of its current attack aircraft and seaplanes meant that the Air Force was likely to take over the strategic (nuclear) role in the future. The concept of a 'Seaplane Striking Force' was developed. Along with the R3Y transports and F2Y fighters would be the P6M jet flying boat atom bomber. Convair's SeaMaster design was chosen in 1951. The prototype XPM-1, flew on 14 July 1955 at Middle River, Maryland, George Rodney leading the crew of four.

This first aircraft was lost in December when a control system fault caused it to pull up and enter an outside loop before suffering structural failure and crashing in the Potomac River. In November 1956 the second prototype crashed following a tailplane failure, but this time the four crew ejected.

The P6M used a rotary bomb bay, as used on Martin's licence-built Canberras and the USAF XB-51. This permitted weapons release at high speeds without the drag of conventional bomb doors. The intakes were mounted above the wing to keep them clear of the water spray.

The original position of the engine exhausts caused stress on the rear fuselage which resulted in structural damage. The angle of the exhausts was adjusted after flight testing. The cockpit glazing was modified on later models to give a much better overhead and side view. A beaching cradle allowed the SeaMaster to taxi in and out of the water under its own power.

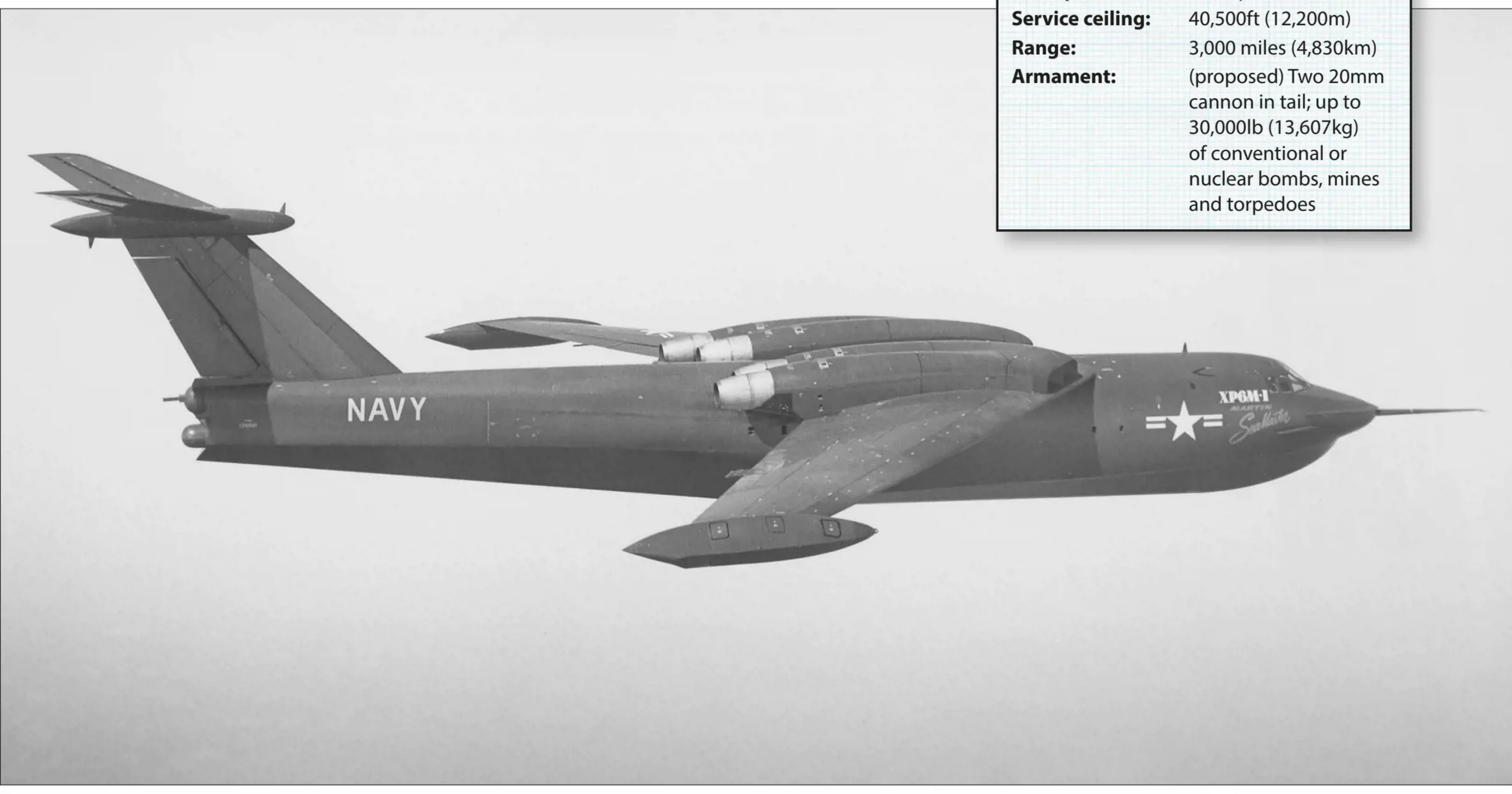
After eight XP and YP test models, the P6M-2 with Pratt & Whitney J75-P-2 engines flew in February 1958. Rising costs saw planned production numbers fall from 24 to 18 to eight, but only three P6M-2s were built.

Below: ***The first of two XPM-1 SeaMasters, 138821, which only flew for three months before succumbing to structural failure.***

The P6M took so long to come to fruition that other developments such as the nuclear-powered aircraft carrier and the Polaris missile submarine had superseded it. Citing "unforeseen technical difficulties" the Navy cancelled the SeaMaster in August 1959 just as it was entering service. All complete SeaMasters were scrapped. Martin gave up aircraft production and decided to concentrate on missiles and electronics instead.

Martin XP6M-1 SeaMster

Crew:	Four
Length:	133ft 1in (40.54m)
Wingspan:	102ft 7in (31.27m)
Height:	32ft 1in (9.75m)
Empty weight:	80,390lb (36,464kg)
Max T/O weight:	160,000lb (72,640kg)
Powerplants:	Four Allison J71-A-4 afterburning turbojets rated at 13,000lb (57.8kN)
Max speed:	600mph (965km/h)
Service ceiling:	40,500ft (12,200m)
Range:	3,000 miles (4,830km)
Armament:	(proposed) Two 20mm cannon in tail; up to 30,000lb (13,607kg) of conventional or nuclear bombs, mines and torpedoes



Vought F-8 Crusader

'Last of the Gunfighters'

After the limited success (at best) of the F6U Pirate and F7U Cutlass, Vought got another chance to produce a carrier jet. The Crusader turned out to be one of the best fighters of its day.

The F-8 was the first carrier-based fighter capable of supersonic level flight and was regarded as a real fighter pilot's aeroplane, with great manoeuverability compared to its contemporaries. It had the best victory-to-loss rate of any US fighter in the Vietnam War, where it served throughout the conflict from sea and land.

The Crusader's origins were in a 1952 US Navy requirement for a supersonic carrier-based fighter. Vought's most successful product was the F4U Corsair, which at this time it was still producing for the Marines, but the Navy accepted their V-383 (F8U) proposal against bids by Grumman (Super Tiger), McDonnell (twin-engined F3H Demon) and North American (F-100 Super Fury).

By the time Vought were awarded a contract in May 1953, Westinghouse had gone back to making refrigerators and a new generation of reliable turbojets was becoming available, typified by the Pratt & Whitney J57, which would be used in different forms on everything from the F-100 Super Sabre to the B-52 Stratofortress and 707 airliner. It was a good choice for the F8U.

At Edwards AFB, California on 25 March 1955 the XF8U-1 prototype made its first flight with test pilot John Konrad taking it through the speed of sound. Testing and evaluation was swift and the F8U-1, soon named Crusader, was in service two years later, entering service with VX-3 and VF-32 in 1957. This was in contrast to some other aircraft of the period (including Vought's own F7U Cutlass), which spent longer in development than they did in the fleet.

The Crusader's most distinctive feature was its variable incidence wing. The whole unit raised up to five degrees for take-off and landing. This kept the fuselage level while providing the optimum of attack for slower speeds. It also prevented the jetpipe scraping the deck and gave the pilot a better forward view.

The F-8 was armed with four 20mm cannon in the forward fuselage. Early models also had a 16-shot rocket pack mounted in the speed brake. Two or four Sidewinders became standard air-to-air armament.

Even before its service entry the Crusader was used to set speed records, both for measured circuits and cross-country point-to-point flights. Crusaders made the first official US flights over 1,000mph (1,609km/h), flew from carriers off the West Coast to carriers off the East Coast, and flew from Los Angeles to New York in under three and a half hours among other milestones.

The Crusader could fly from the smaller *Essex*-class carriers, unlike the Phantom II, although safety margins were small and there were many accidents on and around flight decks.

The F8U-1 (F-8A from September 1962) was followed by the all-weather F8U-1E (F-8B) and the F8U-2 (F-8C) with ventral fins and four AIM-9s. The F-8D deleted the rocket pack, had an improved radar and the J57-P-20 engine. The F8U-2NE (F-8E) was the most numerous new-build version with 286 produced.

The F-8E scored 11 of the Crusader's 19 aerial victories in Vietnam, all of them in 1966-68 and

Below: ***F-8Es of VF-51 (foreground) and VF-53 on USS* Ticonderoga *in 1965-66. Air Wing 5 lost five Crusaders during this cruise, mostly in accidents.*** *Tailhook Association*

Right: ***An F8U-2N (F-8D) assigned to flight test duties with the Naval Air Test Center is prepared for launch from a* Forrestal*-class supercarrier.***

Below rght: ***Armed with 750lb bombs and 5in rockets, a VMF(AW)-235 F-8E taxies out for a close air support mission in South Vietnam. This Crusader ended its days on a Nevada target range.*** *Tailhook Association/Key*




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four with the 20mm cannon. In exchange, NVAF MiGs claimed four of the 21 F-8s lost in combat. Nicknames for the F-8 included 'MiG-master' and 'Last of the Gunfighters' Crusader pilots would say: "When you are out of F-8s, you are out of fighters."

Although not designed with much thought to ground attack missions, the F-8 became an effective bomber in Vietnam, mainly, but not exclusively, with the Marines. The Crusader could carry up to eight 500lb bombs on wing pylons and eight 5in Zuni rockets on Y-shaped fuselage racks. The AGM-12 Bullpup air-to-



Right: ***RF-8G 146848 is seen with VFP-63 when serving aboard USS* Hancock *in 1973. Today it is displayed at Quantico, Virginia.***
Jim Winchester collection.

Below: ***A single two-seat F8U-1T (TF-8A) Crusader was built. Nicknamed the 'Two-Sader', it was used to train Philippines Air Force pilots, but was lost in an accident in July 1978.***





Vought F-8E Crusader

Crew:	One
Length:	54ft 6in (16.61m)
Wingspan:	35ft 2in (10.72m)
Height:	15ft 9in (4.80m)
Empty weight:	17,836lb (8,090kg)
Max T/O weight:	34,044lb (15,442kg)
Powerplant:	One Pratt & Whitney J57-P-20A turbojet engine rated at 10,700lb st (47.6kN) dry and 18,000lb st (80.1kN) in afterburner
Max speed:	1,120mph (1,802kN)
Service ceiling:	58,000ft (17,678m)
Range:	1,000 miles (1,609km)
Armament:	Four 20mm Mk.12 cannon; four AIM-9 Sidewinders or eight Zuni rockets; up to 5,000lb of bombs

ground missile could be carried, but appears to have been rarely used in action. All-weather Marine fighter squadron VMF(AW)-235 were based at Da Nang, South Vietnam in 1968 and its Crusaders were called to support the besieged garrison at Khe Sanh, in danger of being overrun by the North Vietnamese.

As important as the fighters were the photoreconnaissance versions. The unarmed F8U-1P (RF-8A) had a slab-sided nose with vertical oblique and forward camera positions. Key West-based RF-8s played a vital role in the Cuban Missile Crisis in 1962, photographing Soviet missile sites and providing the Pentagon with timely intelligence. In Vietnam they supplied targeting information and post-strike battle damage assessment. Of the 144 RF-8As built, 73 were rebuilt as RF-8Gs with uprated engines and ventral strakes. The last of these was retired from the Naval Reserve in 1987.

Production of new aircraft amounted to 1,261 F-8s, but many older Crusaders were remanufactured. F-8Es became F-8Js; F-8Bs, F-8Ks and F-8Cs, F-8Ls. The F-8J introduced boundary layer control (BLC), a method of blowing engine bleed air over the flaps to give extra take-off lift.

France became the only customer for new-build Crusaders, ordering the first of 42 in 1962. These F-8E(FN)s had a higher wing incidence, larger tailplanes and BLC. These modifications helped them fly from the small French carriers *Clemenceau* and *Foch*. From the late 1980s they were modified as F-8Ps ('P' standing for *prolonge* or prolonged), and the last squadron kept flying them until 1999. The Philippines bought 25 F-8Hs (which they also designated F-8Ps) for use from land bases in 1977. Humid conditions were hard on the aircraft, which suffered from poor reliability, and by 1991, the last one had been withdrawn from service. Hollywood trickery allowed several to appear active again in the movie 'Thirteen Days' representing Key West-based RF-8As.

Below: ***Some fighter Crusaders were issued to reconnaissance squadrons, such as this VFP-63 F-8J seen firing rockets on a training mission circa 1975.*** *Jim Winchester collection*





Douglas F5D Skylancer

The Cadillac

The Skylancer was what the Skyray could have been, but by the time it was in flight test, more advanced aircraft were on the near horizon and only four examples were completed, later contributing to spacecraft research.

Proposed by Ed Heinemann as a "natural development" of the F4D, the production Skylancer would have been an all-weather general-purpose fighter and interceptor using the Aero X-24A fire control system with cannon and rockets. The Navy requirement was later modified to include capability to carry conventional and atomic bombs and Sparrow III AAMs.

Originally, in October 1953 only one XF4D-2 was ordered along with a static test example, then nine more (by now the F5D) in March 1955 and eight more in January 1956. These would be enough to equip one squadron.

The F5D embodied aerodynamic improvements such as increased fineness (length and pointiness), a thinner wing, larger fin and powered rudder served to reduce drag and buffet, increase directional stability and eliminate rudder buzz. An automatic trim change compensator countered the tendency to 'tuck under' at transonic speeds found on the Skyray.

Above: ***The first prototype F5D-1, 132208, later became NASA 212 and was fitted with a modified ogee wing. It survives today in, Oregon.***

The F5D had the same wingspan and area as the F4D, but thicker skins for greater strength. Like the Skyray it had manually folding wingtips.

Bob Rahn took the first F5D-1, 139208, supersonic on its maiden flight on 21 April 1956 and the test programme proceeded without major difficulty. Further refinements to the second F5D, mainly to the wing leading edge and intakes, increased the top speed to Mach 1.63 in level flight. It was a superior dogfighter to the F4D, even with the same engine.
With the anticipated F4H Phantom II and F8U-3 Super Crusader expected to vastly outperform the Skylancer, the decision was taken in November 1956 to scale down the F5D programme, procuring only 11 aircraft to allow for evaluation. This was reduced to eight the following month and the whole programme was cancelled on 1 March 1957.

The Skylancer lived on, however. All four were allocated to NACA (later NASA) at Moffett Field, California and two were bailed back to Douglas as chase and utility aircraft. One NACA F5D was used to support the X-20 Dyna-Soar programme. The proposed spaceplane would glide back to earth after a launch atop a rocket. Future Moonwalker Neil Armstrong flew the Skylancer to develop abort manoeuvres. The type was finally retired in 1970.

Douglas F5D-1 Skylancer

Crew:	One
Length:	53ft 8in (16.40m)
Wingspan:	33ft 6in (10.21m)
Height:	14ft 8in (4.52m)
Empty weight:	17,444lb (7,912kg)
Max T/O weight:	31,204lb (14,154kg)
Powerplant:	One Pratt & Whitney J57-P-8 turbojet rated at 10,200lb st (45.4 kN) dry, and 16,000lb st (71kN) with afterburning
Max speed:	953mph (1,534km/h)
Service ceiling:	57,000ft (17,500m)
Range:	1,335 miles (2,146km)
Armament:	(proposed) Four retractable rocket launchers with 72 2in FFAR rockets, or four 20mm cannon; two AIM-7 Sparrow III AAMs on underwing pylons

McDonnell Douglas F-4 Phantom II

Phabulous



Above: ***A 1960 image of one of the later F4H-1F (F-4Bs) with the larger nose. The inner wing pylons could carry single AIM-7 Sparrow III AAMs as shown, but more normally mounted pairs of AIM-9 Sidewinders.***

The mighty Phantom was built for the Navy, but was adopted by the Air Force. It became the premier US fighter in Vietnam, responsible for the most aerial victories and for much of the bombing effort.

The F3H Demon was the McDonnell Aircraft Company's first swept-wing and supersonic aircraft, but its inadequate and unreliable Westinghouse engines led to it being regarded as something of a failure.

Several company proposals for a twin-engined fighter-bomber development of the Demon eventually morphed into a larger all-new design with the designation F3H-G by 1954. The Navy liked the mock-up, but wanted all missile armament rather than four 20mm cannon. They also specified two seats and General Electric J79 engines in what was first called the AH-1, then F4H-1. Two prototypes were ordered in June 1955

On 27 May 1958 Robert C. Little flew YF4H-1 142259 solo from Lambert Field, at St. Louis, Missouri. This first Phantom was lost in a crash in October 1959. The 45 initial production models were designated F4H-1F (F-4A after 1962). From the 19th aircraft forwards the nose radome was enlarged to house AN/APQ-72 radar, with an infrared sensor added underneath, and the canopy raised, giving the Radar Intercept Officer (RIO) a much improved view. These aircraft later became F-4Bs, as did the subsequent 649 Navy aircraft. The F-4B entered service with training unit VF-121 in 1960 and first saw action in the 'Gulf of Tonkin Crisis' in August 1964.

During the extensive testing process, 15 speed, altitude and climb records were broken. These included a zoom climb to 98,557ft (30,040m), a sustained altitude of of 66,444ft (20,252m), a low-level speed of 902.714mph (1,452.78km/h) over a 3km course and a US coast-to-coast flight in 2 hours 47 minutes.

In what was then a very unusual move, the USAF ordered its own version, which was initially called the F-110A, and later the F-4C. The Air Force specified flight controls for the back seats of their Phantoms, while the Navy's reasoning was that it could not be carrier landed from the rear, so did not.

The Phantom was the first combat aircraft with variable geometry intakes, which optimised airflow throughout the flight envelope through the transonic and supersonic regimes. The Phantom was characterised by the upturn (dihedral) of its outer wing panels and downturn (anhedral) of its all-moving tailplanes, or stabilators. The former corrected roll instability and the latter kept the tail surfaces in clear air at high angles of attack. Under the belly were recesses for four AIM-7 Sparrow missiles, while wing pylons could carry two more, or four AIM-9 Sidewinders, or a combination of fuel tanks and missiles.

Vietnam showed up the foolishness of dispensing with guns, as restrictive rules of engagement and poor missile reliability meant that many enemy MiGs escaped. A centreline gun pod was a partial answer and used by the USAF but moved the centre of gravity too far forwards for catapult launches, so was not carried by Navy Phantoms.

The first F-4 aerial victory – and loss – came in an April 1965 engagement with Chinese fighters near Hainan Island. In the years 1965-70, five F-4s were lost to MiGs, while Phantom crews claimed 13 kills. This ratio was unacceptable, and spurred the development of better training in air combat techniques, notably the formation of the Navy Fighter



Left: ***F-4B 'Miss Sandy' of VF-32 'Swordsmen' was a rare example of a named Navy Phantom. Upgraded to F-4N standard, it crashed near Dallas in 1978.***

Bottom: ***An F-4J of VF-121, the West Coast training squadron, lands at Miramar in 1978. It later became a QF-4S drone and served until 2003.***

Right: ***Like other US Navy tactical aircraft, the F-4 received toned-down colours as represented by this VF-301 F-4S flying low over the California desert in June 1984.***

Weapons School, or 'Topgun' at NAS Miramar. Dogfighting against dissimilar types was emphasised and less reliance put on long-range missiles. Most Navy kills were made at short range with AIM-9s.

In the last phase of the war, the kill/loss ratio improved. In 1972-73 24 US Navy and one USMC F-4 shot down MiGs, for three losses against them. The overall Navy rate in Vietnam was 3.68 MiGs destroyed per aircraft lost of all types. The only US Navy aces of the war were Lt Randy Cunningham and Lt(JG) Willie Driscoll of VF-96, who shot down five MiG-17s, including three in a single dogfight.

An unarmed reconnaissance version with a camera nose was developed as the RF-4B. All 46 were supplied to the Marines. The F-4G designation was first used by the Navy for 13 F-4Bs equipped with a datalink that would allow control via autopilot by an air- or ship-based controller. This could also allow hands-off carrier landings. Most were converted back to F-4Bs but some datalink features were incorporated into later variants.

The F-4J was the first major upgraded Navy version, fitted with AN/AWG-10 fire control system with AN/APG-59 radar (and removal of the IR sensor), more powerful J79-GE-10 engines, slotted tailplanes and other improvements. The wing surface had a bulge to accommodate low-pressure tyres. There were 522 new-build F-4Js delivered up to 1972.

Taking over from the F-11 Tiger in 1969, the F-4J was the biggest and heaviest display aircraft used by the Blue Angels. The oil crisis of the early 1970s saw the team downsize to the A-4F Skyhawk in 1974.




VF-301
NAVY
103
03



Left: ***One of the rarest US Phantom II variants with 46 built was the Marines' RF-4B reconnaissance aircraft. All were concentrated in VMFP-3 at El Toro from 1975-1990. J****im Winchester collection.*

From 1978, 248 surviving F-4Js were converted to F-4Ss with slatted outer wings, 'smokeless' J79-GE-10B engines, upgraded radar and structural strengthening. In similar fashion, 226 F-4Bs had become F-4Ns in 1972-74, with improved avionics and airframe strengthening but without the slats.

From the mid-1970s F-14s replaced Navy F-4s in the fleet air defence role and F/A-18s taking over attack missions in the 1980s, with the Marines using the Hornet for both. The Phantom was phased out of the fleet and relegated to Reserve units, the last of which, VF-202 'Superheats', retired the F-4S in May 1987. Marine Phantoms lasted until 1991 with VMFA-321 'Hell's Angels'.

The last Navy operated Phantoms were QF-4 drones, used by units such as VX-4 and the Pacific Missile Test Center at Point Mugu, California and finally retired in 2004.

Below: ***The Phantom drones were not just for target practice and were used to support many programmes. This QF-4S was in service at Point Mugu in 2001.*** *Jim Winchester*

McDonnell Douglas F-4J Phantom

Crew:	Two
Length:	63ft 0in (19.2m)
Wingspan:	38ft 5in (11.7m)
Height:	16ft 5in (5.0m)
Empty weight:	30,328lb (13,757kg)
Max T/O weight:	61,795lb (28,030kg)
Powerplants:	Two General Electric J79-GE-8B/8C/10 turbojets rated at 11,870lb st dry, 17,900lb st in afterburner
Max speed:	1,470mph (2,370km/h)
Service ceiling:	54,700ft (16,673m)
Range:	1,956 miles (3,148km)
Armament:	Up to 18,650lb (8,459kg) of ordnance on nine hardpoints, including AIM-9 and AIM-7 AAMs, conventional and nuclear bombs, rocket pods and air-to-surface missiles



North American A-5/RA-5 Vigilante

The Vigi

Designed as an atomic bomber, but with an over-complex weapons delivery system, the Vigilante found its true value as a high-speed reconnaissance aircraft, providing valuable intelligence for strike planning and damage assessment.

The Vigilante began as the privately funded NAGPAW (North American General-Purpose Attack Weapon) intended to replace the less-than-successful piston-engined AJ Savage. The US Navy imposed strict performance requirements including a Mach 2 top speed and the ability to launch at maximum weight from a carrier in no-wind conditions. Frank Compton's team revised the NAGPAW to meet these demands and produced a sleek aircraft with two General Electric J79 engines fed by variable hinged intakes, a large wing and a single tail. The tail surfaces were all single-piece slab units, but the wing featured leading- and trailing-edge flaps and complex spoilers.

The pilot had a hinged canopy and a large wraparound windscreen, whereas the weapons systems operator sat behind in a separate cockpit with only small windows. Optimised for low-level attacks at high-speed, one unique feature of the A3J was its linear bomb bay. A 'train' of fuel tanks and the nuclear weapon (usually a Mk.28) were fitted in a cavity between the engines. Two other weapons could be carried on wing pylons, but these were rarely used for anything but fuel tanks.

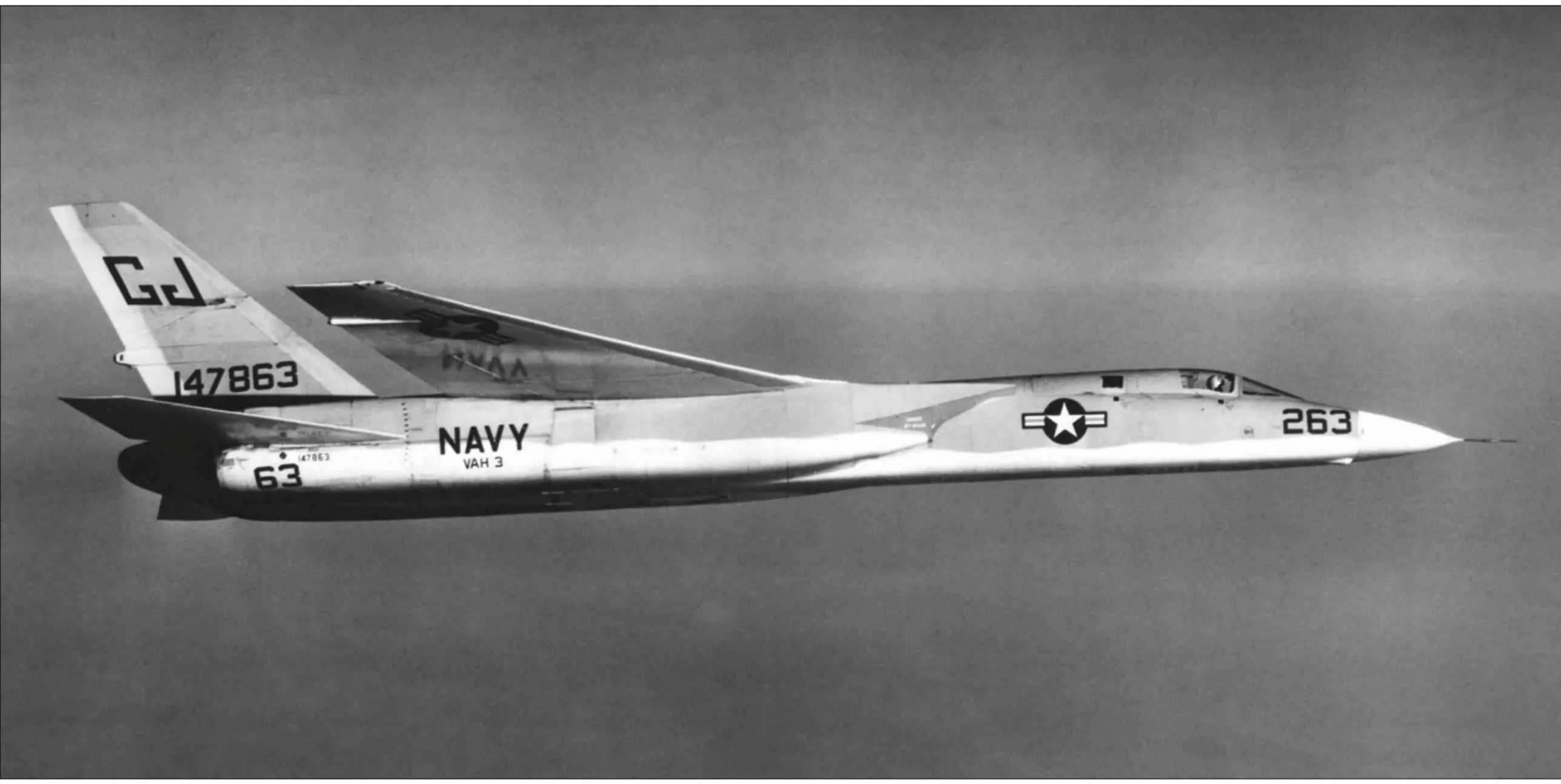
The first of two YA3J-1 Vigilante prototypes, 145157, was flown on 31 August 1958 by Dick Wenzel. Hydraulic failure caused the loss of the second YA3J-1 on its 49th test flight. The prototypes were followed by 33 A3J-1s, later designated A-5As. The Vigilante entered fleet service during 1961.

The main bombing tactic was for the Vigilante to run towards the target before pulling up and releasing the bomb/fuel package, which would climb in a parabolic arc before falling on the target. The aircraft would complete a half-Cuban manoeuvre and exit the target area as fast as possible. Level

North American RA-5C Vigilante

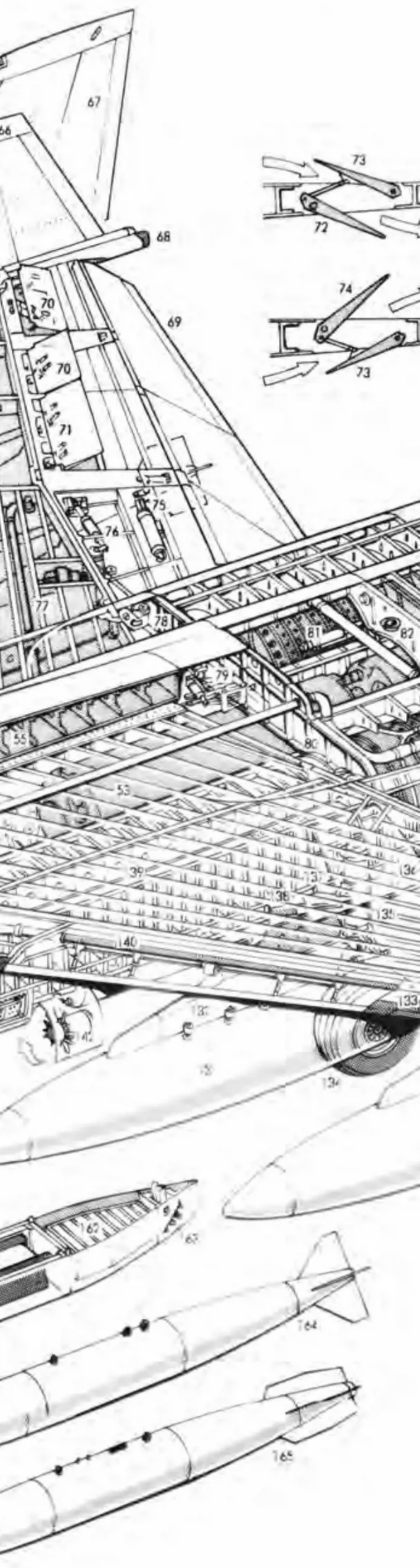
Crew:	Two
Length:	73ft 3in (22.33m);
Wingspan:	53ft0 in (16.15m)
Height:	19ft 5in (5.90m)
Empty weight:	34,350lb (15,481kg)
Max T/O weight:	61,000lb (21,670kg)
Powerplants:	Two General Electric J79-8 turbojets each rated at 17,000lb st (78.8kN) thrust in afterburner
Max speed:	1,388mph (2,234km/h)
Service ceiling:	52,100ft (15,900m)
Range:	2,050 miles (3,300km)
Armament:	One Mk.27, Mk.28, or Mk.43 nuclear weapon carried internally, provision for two more on wing pylon

Below: ***The Vigilante had a relatively short career as a bomber, this one in particular, being delivered to VAH-3 in July 1961 and crashing off Brazil in September 1964.***



North American Rockwell RA-5C Vigilante

1. Pitot head
2. Upward-hingeing glass fibre radome
3. Radar scanner
4. Scanner mounting and tracking mechanism
5. Refuelling probe, extended
6. Refuelling light
7. Refuelling probe housing
8. General Dynamics Electronics AN/ASB-12 radar equipment
9. Cockpit forward pressure bulkhead
10. Downward-hingeing radar equipment module
11. Television optical sight
12. Underfloor equipment bay, TACAN and ADF units
13. Pilot's side console panel with engine throttle levers
14. Instrument panel shroud
15. AN/ASB-12 Projected Display Indicator (PDI)
16. Frameless windscreen panel
17. Upward-hingeing front cockpit canopy
18. Canopy hinge mechanism
19. Pilot's North American HS-1A 'zero-zero' ejection seat
20. Seat mounting sloping bulkhead
21. Canopy external controls
22. RAN's optical site
23. Underfloor equipment bay, bombing computer, VHF communication and radar altimeter units
24. RAN's instrument console
25. Upward-hingeing rear cockpit canopy
26. Radar-Attack Navigator's (RAN) HS-1A 'zero-zero' ejection seat
27. Cockpit sloping rear pressure bulkhead
28. Liquid oxygen converted (2)
29. Nosewheel housing
30. Flight refuelling feed pipe
31. Nosewheel shock absorber leg strut
32. Nosewheel hydraulic steering unit
33. Taxying light
34. Forward-retracting nosewheel
35. Torque scissor links
36. Hydraulic retraction jack
37. Avionics equipment racks
38. AN/APR-18 Defensive Electronic Countermeasures (DECM) antenna
39. IFF-SIF antenna
40. Avionics equipment bay access hatches port and starboard
41. Intake boundary layer diverter
42. Port engine air intake
43. Intake duct framing
44. Variable-area intake hinged ramps
45. Extended wing root fairing
46. Boundary layer spill ducts
47. Intake ramp hydraulic actuator
48. Forward fuselage bag-type fuel tank, total internal capacity excluding bomb bay fuel cans 2,715 US gal (10,283 litre)
49. Forward fuselage sump tank
50. Boundary Layer Control (BLC) air supply duct
51. Wing panel forward mounting bulkhead
52. Centre fuselage bomb bay
53. Bomb bay fuel can (maximum 3), 295 US gal (1,117 litre) each
54. Wing panel centreline joint rib
55. Dorsal ('top cap') fuel tank
56. Starboard wing integral fuel tank
57. Refuelling line
58. Wing root AN/ALQ-41 and ALQ-126 DECM antennas
59. Starboard wing pylons and internal tanks
60. Three-segment leading-edge flap hydraulic motors and screw jack actuators
61. Leading-edge BLC air duct
62. AN/ALR-45 DECM antenna
63. Starboard leading-edge flap, down position
64. Outer wing panel hinge joint
65. Starboard navigation light
66. Formation light
67. Starboard outer wing panel folded position
68. Aft AN/ALQ-41 and ALQ-126 DECM antennas
69. Starboard plain flap, down position
70. Starboard roll-control spoilers
71. Spoiler tandem hydraulic actuators
72. Outboard spoiler panel
73. Spoiler deflectors
74. Inboard spoiler panels
75. Flap hydraulic jack
76. Spoiler control linkage
77. Fuel transfer line
78. Wing rear spar bolted attachment joint
79. Wing control system cable linkage
80. Wing rear spar and undercarriage leg mounting bulkhead
81. Starboard engine installation
82. Upper anti-collision beacon
83. Rear fuselage saddle tank
84. Engine bay close-pitched frame structure
85. Starboard all-moving tailplane
86. All-moving fin
87. Fin hydraulic actuator
88. Fin/tailplane mounting bulkhead
89. Fin pivot mounting
90. Two-spar and rib fin torsion box structure
91. Fintip hinge joint
92. Folding fintip hydraulic jack
93. TACAN/UHF duplex antenna
94. Fin honeycomb trailing-edge panel
95. AN/APR-45 DECM antenna
96. Tail navigation light
98. Fuel system vent
99. Fin honeycomb trailing-edge panel
100. Bomb bay fuel tank
101. AN/ALQ-41 and ALQ-126 DECM antennas
102. Bomb bay detachable tailcone
103. Fuel jettison
104. Port variable-area afterburner nozzle
105. Tailplane honeycomb trailing-edge panel



106. Port all-moving tailplane
107. Tailplane two-spar and rib torsion box structure
108. Tailplane pivot mounting
109. Tailplane hydraulic actuator
110. Deck arrestor hook
111. General Electric J79-GE-10 after burning turbojet engine
112. Engine bleed-air ducting (BLC system)
113. Engine accessory equipment
114. Hinged engine bay access hatches
115. Port inboard spoiler panels
116. Port flap rib structure
117. Port plain flap
118. Outer spoiler deflector
119. Port wingtip folded position
120. AN/ALQ-41 and ALQ-126 DECM antennas
121. Wing fold hydraulic lock jack
122. Wing tip rib structure
123. Port wing tip formation light
124. Port navigation light
125. Wing fold hydraulic jack
126. Port wing tip hinge joint
127. Port three-segment leading-edge flap
128. Two-spar and rib wing torsion box structure
129. Corrugates spanwise stiffiners
130. Port wing integral fuel tank
131. 400 US gal (1,514 litre) external fuel tanks
132. Port wing pylons
133. AN/ALR-45 DECM antenna
134. Port mainwheel, forward retracting
135. Main undercarriage leg strut
136. Mainwheel leg door
137. Leg pivot mounting
138. Hydraulic retraction jack
139. Wing root mounting rib
140. Leading-edge BLC air duct
141. Wing root AN/ALQ-41 and ALQ-126 DECM antennas
142. Emergency ram-air turbine, extended
143. Ground power and cooling air connections
144. Flasher pod, night photography, mounted on inboard pylon station
145. Flasher unit ram-air generator
146. Ventral sensor canoe fairing
147. Passive Electronic Countermeasures unit (PECM), replaces forward bomb bay fuel can (sensor station 6)
148. Sensor station 5, electronic equipment rack
149. Sensor station 4, camera housing
150. Sensor station 1, KA-51 forward camera
151. Sensor station 2, KA-50A vertical camera
152. Sensor station 3, high-band antennas
153. Sensor station 4, module 2 camera equipment
154. KA-58A panoramic camera
155. KA-57A panoramic camera
156. Sensor station 4, module 1 camera equipment, 2x KA-53A oblique cameras
157. Sensor station 4, module 3 camera equipment, 2x KA-51A vertical night cameras
158. Lower anti-collision beacon
159. Sensor station 7, AN/AAS21 infra-red detector
160. Sensor station 8, sideways-looking airborne radar (SLAR)
161. Recording units
162. Radar transmitter/receiver
163. Sensor station 3A high-band antennas
164. Mk.28 free-fall nuclear weapon
165. Mk.43 parachute-retarded nuclear weapon

bombing was also possible, and all modes were controlled by the sophisticated ASB-12 bombing computer. This compared the radar and/or TV picture with target images stored on magnetic tape. Thissomewhat inflexible system did not allow for targets of opportunity.
In December 1960, a standard A3J-1 demonstrated the ability to carry a 4,409lb (2,000kg) load from a carrier to 91,446ft (27,872m). Only 18 of the improved A3J-2 (A-5B) with a hump-backed fuselage containing extra fuel, larger flaps and fully-blown leading-edge flaps were built.

Shortly after the Vigilante entered service, the Navy finally admitted that strategic bombing was also possible, and all modes were controlled by the sophisticated ASB-12 bombing computer. This compared the radar and/or TV picture with target images stored on magnetic tape. Thissomewhat inflexible system did not allow for targets of opportunity.
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Above: ***Vigilantes were one of several types to wear camouflage schemes during operations off USS* Kitty Hawk *in Southeast Asia in 1965-66. This was an RVAH-13 'Bats' RA-5C.*** *NHHC*

the surviving aircraft to RA-5Cs tactical reconnaissance platforms. The RA-5C fleet consisted of 18 converted A-5Bs, 43 A-5A conversions and 79 new-build aircraft. The total series production was 156 airframes. Many A-5B features such as the hump back and extra pylons were incorporated in the RA-5C, giving increased take-off weights and range.

Below: ***An RVAH-3 'Sea Dragons' RA-5C touches down at NAS Key West. This aircraft is now displayed at Sanford International Airport, Florida, once home of the A-5 RAG.***

All bombing equipment was removed and replaced by reconnaissance gear, including a ventral canoe fairing with several cameras and a side-looking airborne radar (SLAR) installation.

RA-5Cs were extensively used in Vietnam where they were able to both outpace MiGs and their escort Phantoms.

There were 18 combat losses between October 1965 and December 1972. Total attrition was 78 A-5s and RA-5Cs out of total production of 120 Vigilantes.

The last 'Vigi' was retired in November 1979 and the tactical reconnaissance role taken over by the RF-8G Crusader and, from 1981, F-14s with the TARPS camera/sensor pod. A dozen Vigilantes are preserved today.

XF8U-3 Crusader III
Super Interceptor

The XF8U-3 was one of the most high-performance combat aircraft to fly, but it was beaten by the more versatile Phantom II. It has been described as "the best airplane the Navy ever cancelled."

The F8U-1 was entering service as a day fighter when the Navy requested an all-weather interceptor. Vought adapted the Crusader design with a new engine, powerful radar and guided missiles to create the XF8U-3, although some argued it deserved a new designation (F9U).

With John Konrad doing the honours, the first XF8U-3 flew on 2 June 1958, only a week after the XF4H-1 Phantom II, despite work on it having started a year later. A pre-production batch of 19 was ordered with anticipation of large orders.

The variable-incidence wing was retained, although the wing itself was different. To provide lateral stability, large retractable ventral fins were fitted. These were so large they could only be lowered in flight. Boundary Layer Control (BLC) was introduced for slow-speed control. This system was later applied to production F-8J Crusaders.

Three AIM-7 Sparrows could be carried semi-recessed in the lower fuselage. The nosewheel bay was offset to allow one missile to fit beside it.

The XF8U-3 had very similar performance to the XF4H-1, although its range was achieved without external fuel tanks, which the Phantom almost always carried. The short flight test programme did not allow time for record attempts to show its full potential.

The workload on the single pilot was extremely high. In a theoretical high-speed engagement he only had two radar sweeps in which to launch the missiles, while also flying the aircraft. The Phantom's crew of pilot and radar intercept officer could concentrate on their respective tasks.

The second aircraft flew on 27 September 1958 and flew only about 50 hours. The XF8U-3 reached a speed of Mach 2.39 in testing. The structural limitations of the windscreen prevented faster flight, but it potentially could have reached Mach 2.9, making it one of the fastest fighters ever.

With the government facing financial strictures, Congress ordered the Navy to cancel one of its two fighter programmes and the Crusader III was the loser. The arguments of those who wanted two engines and two seats won out. In December 1958, funding was cancelled and the programme was terminated. Three aircraft had flown and a fourth was nearly complete. Five more were in various states of assembly.

The XF8U-3 was praised for its performance and flying qualities but never underwent carrier suitability trials, so more issues may have arisen before it became operational.

All three aircraft were bailed to NASA, which used them for atmospheric research. Sent to storage at Litchfield Park, Arizona, they were scrapped by 1960.

XF8U-3 Crusader III

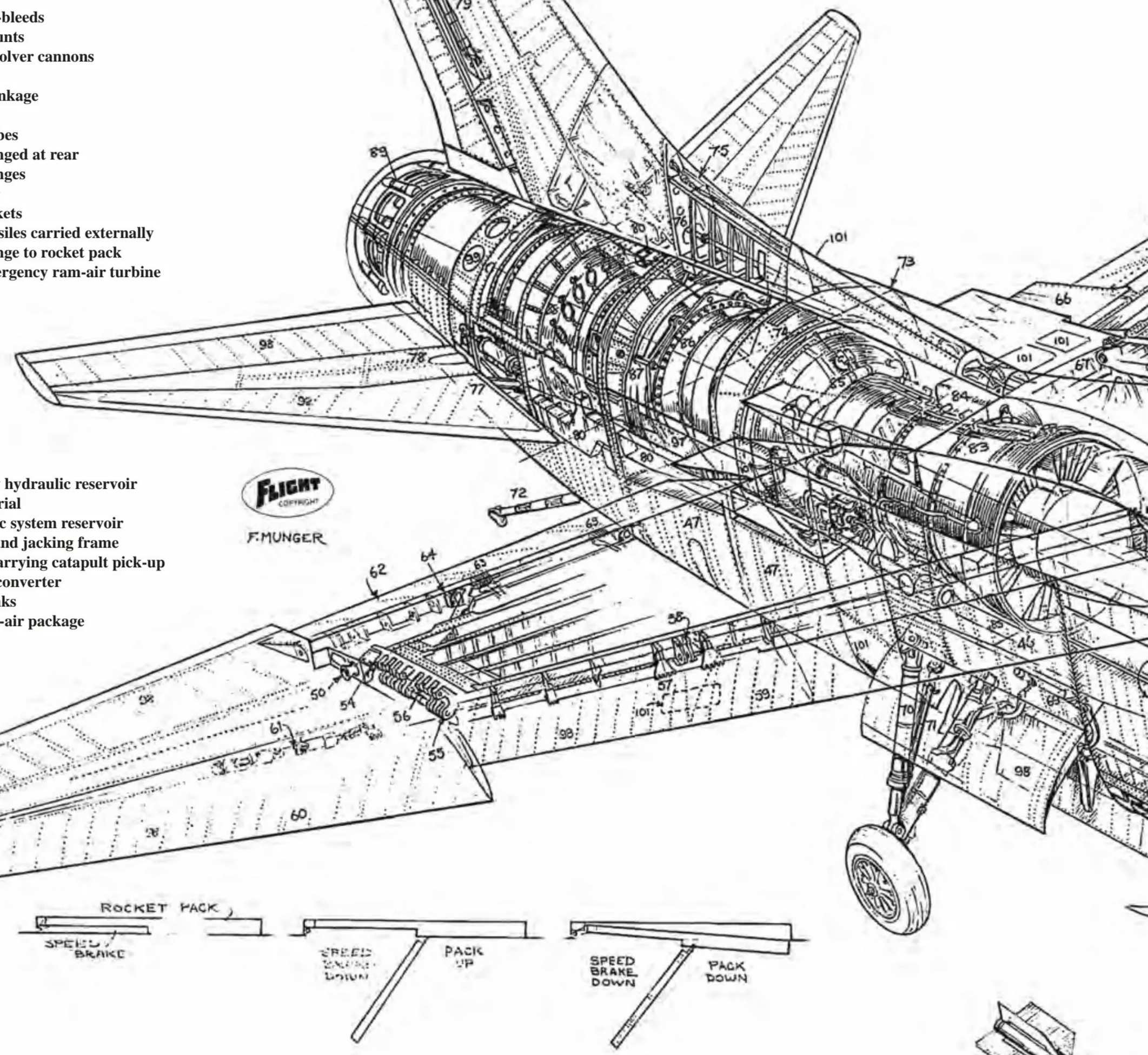
Crew:	One
Length:	58ft 8in (17.88m)
Wingspan:	39ft 11in (12.16m)
Height:	16ft 4in (4.98m)
Empty weight:	21,860lb (9,915kg)
Max T/O weight:	38,770lb (17,590kg)
Powerplant:	One Pratt & Whitney J75-P-8 turbojet engine rated at 16.500lb st (73kN) dry and 29,500lb st (131kN)
Max speed:	1,454mph (2,340km/h)
Service ceiling:	60,000ft (18,288m)
Range (combat):	1,040km (645 miles)
Armament:	Three AIM-7 Sparrow and four AIM-9 Sidewinder AAMs

Below: ***One of the striking-looking XF8U-3s gets airborne. The ventral fins in their stowed position can just be seen just below the tailplane. Prominent on the fuselage side is one of the three semi-recessed Sparrow III AAMs the Crusader III could carry.***



Chance Vought F8U-1 Crusader

1. Radar scanner, nose hinged for access
2. Angle of attack vane
3. Radar and electronics
4. Electronics bay
5. Nose cone hinges
6. Radar cooling outlet
7. Pendant rudder pedals
8. Pedal adjustment
9. Wing-incidence switch
10. Port console, power-lever unit
11. Wing-incidence lock
12. Emergency undercarriage selector
13. Arrester hook selector (u/c to port); see inset panel diagram
14. Chance Vought 30lb seat
15. Canopy jack
16. Three rear-vision mirrors
17. Canopy latches
18. Gun trough air-bleeds
19. Gun barrel mounts
20. Four 20mm revolver cannons
21. Gun bay vents
22. Ammunition tankage
23. Static vents
24. Eight rocket tubes
25. Rocket pack hinged at rear
26. Rocket pack hinges
27. Heat exchanger
28. Folding-fin rockets
29. Sidewinder missiles carried externally
30. Speed brake hinge to rocket pack
31. Marquardt emergency ram-air turbine
32. Actuator for 31



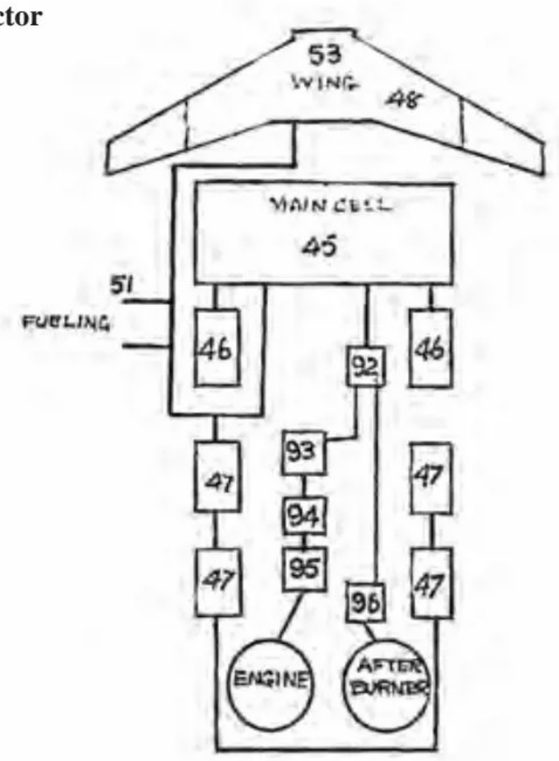
33. Access to utility hydraulic reservoir and ARN-14 aerial
34. Utility hydraulic system reservoir
35. Slinging point and jacking frame
36. Keel member carrying catapult pick-up
37. Liquid oxygen converter
38. Lagged air trunks
39. HamStan cabin-air package
40. Air ducts

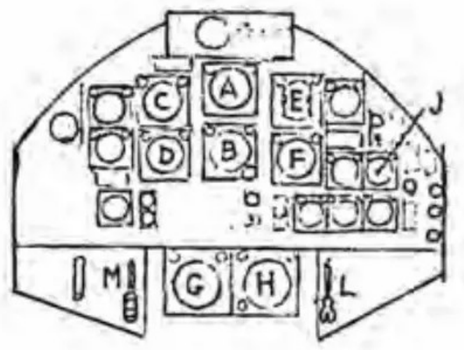
41. Grouped loom of electric cables
42. Bleed-air duct
43. Engine air duct
44. Self-locking hydraulic wing actuator
45. Main fuel cell: all tanks transfer to main cell which has triangular level floor, inverted-flight pumps, main and emergency pumps and fuel quantity monitor
46. Starboard mid fuel cell
47. Aft cluster cells feeding main via transfer pump in port aft cell (see inset fuel diagram)
48. Multi-spar integral-tank wing
49. Fuel feed pipes
50. Fuel transfer through wing fold
51. In-flight refuelling probe (extended)
52. Refuelling probe door
53. Centre-section fuel tank
54. Wing-fold actuator
55. Wing down locking lugs
56. Multi-lug wing hinge
57. Leading edge hinges
58. Inner leading-edge actuator anchor
59. Inner-section droop: up, cruise, down
60. Outer-section droop: as for 59
61. Outer leading-edge actuuator
62. Drooping aileron
63. Aileron jack anchor
64. Aileron hinges
65. Aileron activators
66. Drooping trailing edge
67. Wing pivot and slinging point
68. Forgwed root rib
69. Undercarriage door linkage
70. Undercarriage compression leg
71. Undercarriage drag strut and actuator

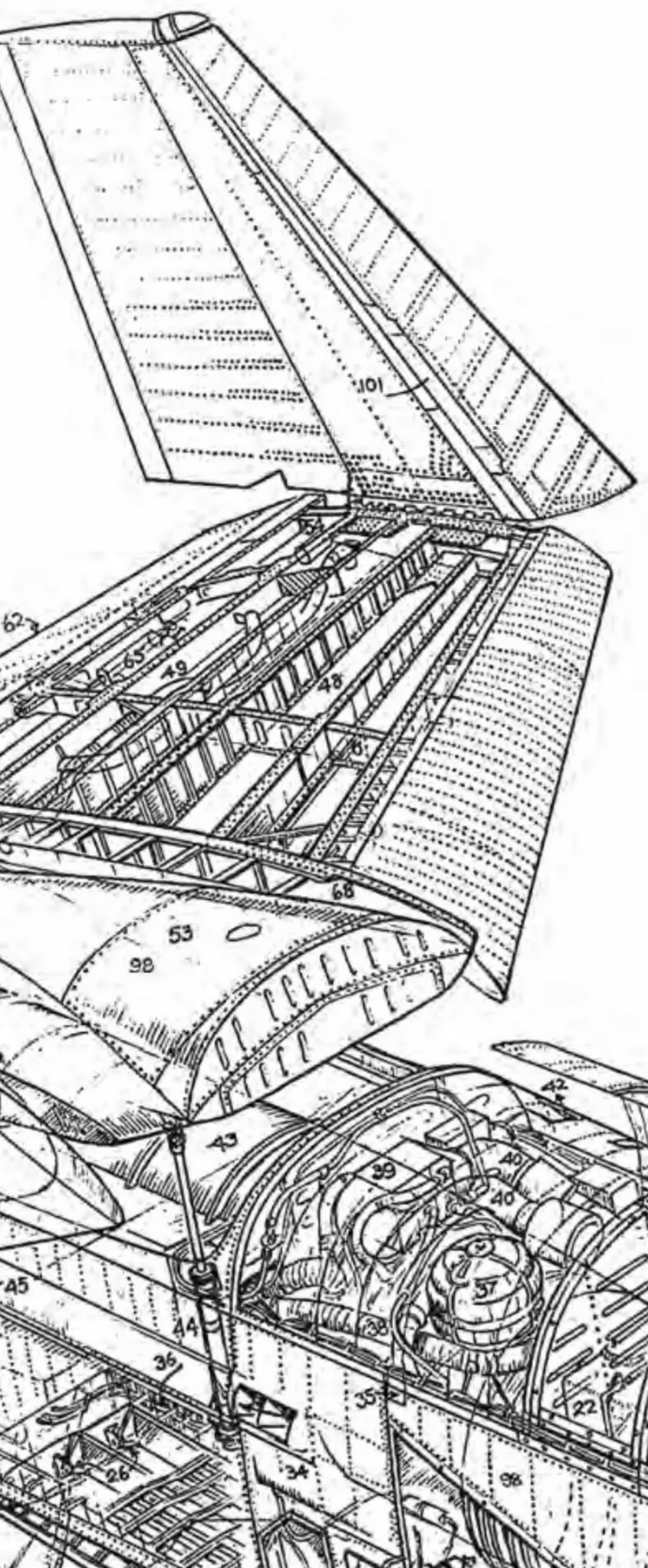
72. Arrester hook (partly extended)
73. Rear fuselage detachable for engine access
74. Air-bleed louvres port and starboard
75. Electric cable-loom in dorsal spine
76. Control run in dorsal spine
77. Horizontal-tail actuator package
78. Slab tailplane, arc of movement about 17deg
79. Single rudder actuator
80. Services trunk (port and starboard) with branch to fin
81. Dielectric fin tip
82. Navigation lights
83. J57-P-12 compressor casing
84. Saddle oil tank
85. Compressor bleed for accessory power
86. Pratt and Whitney J57-P-12 turbojet powerplant rear support ring
87. Powerplant rear support
88. Afterburner, two burner rings
89. Eight nozzle actuators
90. Communications aerial
91. Navigation aerial
92. Fuel shut-off valve
93. Engine-driven pumps
94. HamStan fuel control
95. Fuel/oil heat exchanger
96. Afterburner control (Ceco)
97. Engine shrould
98. Magnesium skin panels
99. Plenum vents
100. Combat camera window
101. Access panels

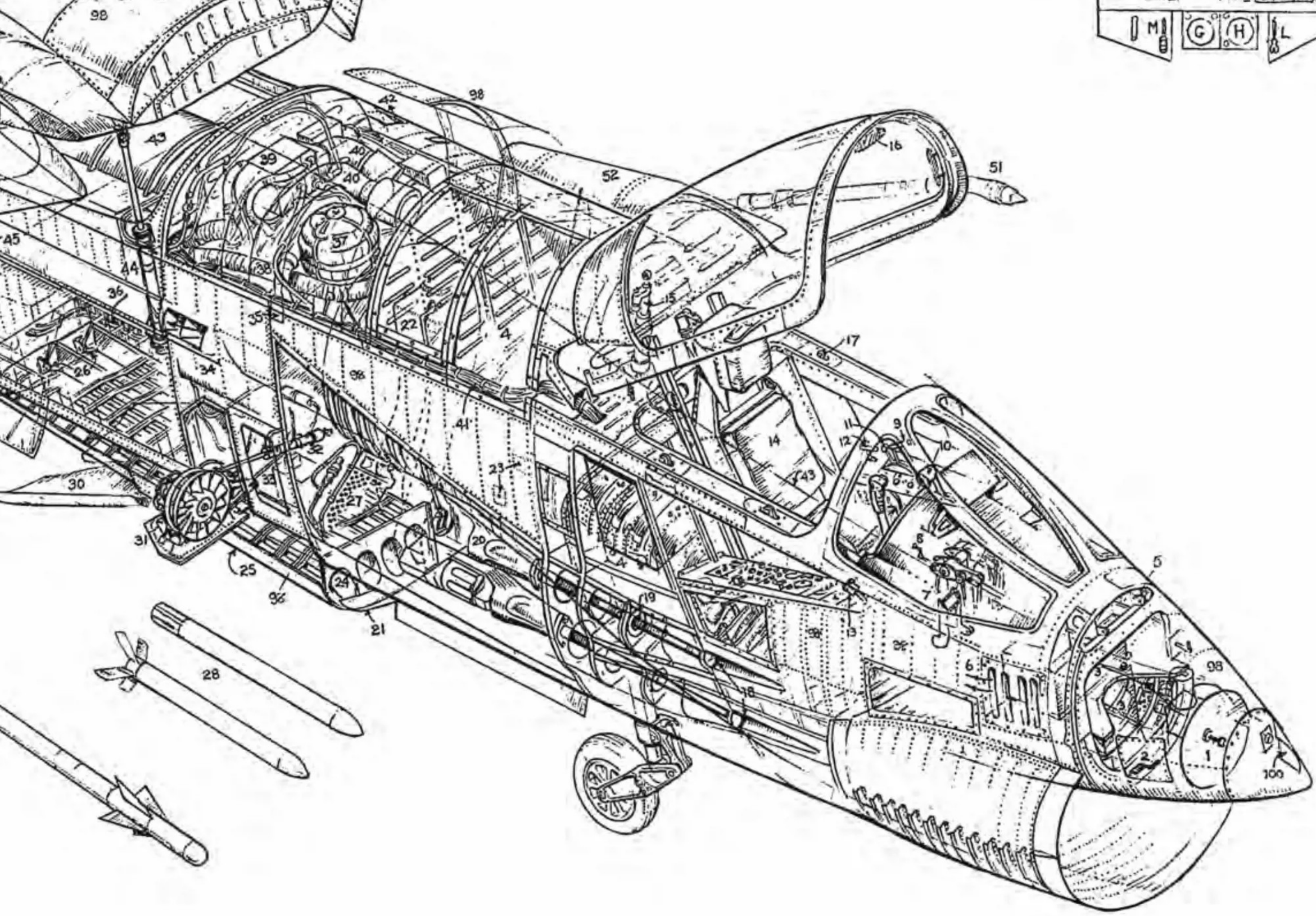
Instrument panel

A. Compass
B. Horizon
C. ASI
D. Altimeter
E. Turn-and-bank
F. VSI
G. Distance element, ARN-21
H. VHF navigation cross-pointer
L. Hook selector
M. Gear selector









Grumman A-6 Intruder
Heavy Hitter

The Intruder made its combat debut in Vietnam as an all-weather 'bomb truck', but reached maturity with the A-6E model during the 1970s

By the mid-1950s, the US Navy was proposing an attack aircraft to fly missions at night and in weather conditions that kept the current carrier jets on deck. In 1957 they issued their requirements and Grumman's design was selected in December. The prototype Grumman YA2F-1 that Robert K. Smyth first flew on 19 April 1960 featured a bulbous radar nose and Pratt & Whitney J52 engines located in the forward fuselage with pivoting exhausts to reduce take-off distances. The two-man crew sat side by side on Martin-Baker ejection seats. There was no internal bomb bay, all weaponry being carried on external pylons. The wing had long-span leading- and trailing-edge flaps.

The Intruder's bulbous nose contained a powerful Norden multi-mode radar with terrain-following capability. As part of a sophisticated navigation and attack package, this allowed the Intruder to strike targets at night and in bad weather, following a long run at low level to avoid radar detection.

The production A-6A Intruder dispensed with the novel exhausts and had a revised tail. Split wingtip airbrakes were added and perforations made in the fuselage side airbrakes as they were otherwise too effective. The Intruder entered service in early 1963 with VA-75 'Sunday Punchers'.

Despite some initial problems, and a high initial loss rate, the A-6 went on to be the most effective night-attack platform in Vietnam. A total of 59 Navy and 25 Marine Corps Intruders were lost on combat missions between June 1965 and 1973, a low figure in relation to their numbers. Two of these fell to MiGs and ten to SAMs.

Developed during the war, the A-6B was a SAM-suppression version able to launch the AGM-78 anti-radiation missile. The A-6C was another special version with electronics for tracking vehicles on the Ho Chi Minh trail. From 1970 the KA-6D tanker appeared with some avionics replaced with a hose reel system in the under fuselage. The KA-6D was the principal carrier-based tanker throughout the 1970s and 1980s, serving in squadrons alongside A-6Es. The EA-6A was developed for the USMC as a jamming aircraft for shore and carrier operations. A large fin pod contained the bulk of the ECM equipment.

The A-6E was the longest-serving attack model, equipped with a new terrain-avoidance

Below: ***A section of colourful A-6As of VMA(AW)-224 in the 1970s. The fuselage airbrakes are the early perforated type, which was later smoothed over and then welded shut.*** *Hofstra University Library*

Right: ***The KA-6D tanker variant could usually be distinguished from its attack brethren by a coloured band around the rear fuselage as well as extra drop tanks.*** *NHHC*







Grumman A-6E Intruder

Crew:	Two
Length:	54ft 9in (16.69m)
Wingspan:	53ft 0in (16.15m)
Height:	16ft 2in (4.93m)
Empty weight:	27,613lb (12,525kg)
Max T/O weight:	60,400lb (27,397kg)
Powerplants:	Two Pratt & Whitney J52-P-8B turbojets rated at 9,300lb st (41.4kN) each
Max speed:	806mph (1,297km)
Service ceiling:	42,200ft (12,925m)
Range:	1,011 miles (1,627km) fully loaded
Armament:	Up to 8165kg (18,000lb) of conventional or precision bombs, guided missiles including AGM-62 Walleye, AGM-84 Harpoon, AGM-88 HARM and AGM-123 Skipper

Left: ***Loaded with Mk 82 unguided bombs, an A-6 of VA-52 'Knightriders' launches from USS* Kittyhawk *during the Vietnam War.***
Mennella Collection, The Museum of Flight



Above: ***Just enough markings remain on this low-vis A-6E TRAM to identify it as belonging to VA-34 'Blue Blasters' as part of CVW-7 in the late 1980s/early 1990s.*** *US Navy*

radar and other new avionics. Those with undernose Target Recognition Attack Multisensor turret were designated A-6E (TRAM). The turret integrated the Forward Looking Infrared (FLIR) and laser sensors used for target identification and self-contained laser guided bomb delivery. VMA(AW)-121 was the first Intruder squadron to receive the TRAM system.

Navy A-6Es led the 'Eldorado Canyon' attack on Libya in 1986 and dropped many kinds of precision and 'dumb' weapons in Operation *Desert Storm*. During the Gulf War ten Navy squadrons aboard six carriers flew Intruders, as did two land-based Marine Corps squadrons. Only four Intruders were lost to enemy action during the conflict. By now the A-6 was a much more capable aircraft, able to carry a wide range of precision ordnance as well as 'dumb' munitions such as cluster bomb dispensers In Desert Storm the missions were long-range strike by day and night, suppression of enemy air defences and anti-ship strike.

The Intruder was expected to carry on into the twenty-first century, in the form of the A-6F Intruder II, which was to have F404 engines, new graphite/epoxy wing structure and all-new avionics. The first A-6F flew in August 1987, but the programme was cancelled before the second aircraft flew a year later. Some 33 later production A-6Es had the new wing, made by Boeing, before production ended in January 1992. The last two A-6E squadrons, VA-75 and VA-196, were retired just over five years later in March 1997. A number have been preserved, but some surplus aircraft were dumped off the coast of Florida to create an artificial 'Intruder Reef' to promote marine life.



Right: ***The first of five A-6F Intruder II prototypes, built with metal wings rather than the composite unit intended for production aircraft. Note the extra weapons pylon.***

General Dynamics F-111B

Ain't Got That Swing



Above: ***Rollout of the first F-111B at Bethpage, New York on 11 May 1965.The aircraft was roaded to Calverton for its first flight. It was scrapped in December 1969.***

The F-111B served to prove that the needs of the US Air Force and Navy were quite different. It was cancelled in 1968 after nearly $400m had been wasted. Some of its technology proved useful in the F-14 programme.

Spiralling costs of combat aircraft and the diverse range of warplanes in US military service encouraged the US Defense Department to seek 'commonality' between the services' equipment. Flagship for this philosophy was to be the variable-geometry or 'swing-wing' TFX (Tactical Fighter eXperimental), in F-111A bomber form for the Air Force and as the F-111B fleet defence fighter for the Navy. The Navy's version would carry a Hughes AN/AWG-9 pulse-Doppler radar and an armament of six Hughes AIM-54 Phoenix missiles

The F-111B prototype, 151970, made its first flight at Calverton, New York on 18 May 1965, flown by Ralph 'Dixie' Donnell and Ernie von der Heyden.

As early as 1964 General Dynamics warned the Navy that the F-111B would not meet its requirements. They were right. The Navy's weight limit was 55,000lb (24,958kg), but early tests indicated a fully equipped F-111B would weigh 78,000lb). A Super Weight Improvement Program (SWIP) was followed without irony by three separate Colossal Weight Improvement Programs (CWIPs). The first F-111B had individual ejection seats but subsequent examples had a capsule system. The extra weight of this negated much of the weight-saving gains made in other areas.

The Navy and USAF versions began to diverge. The F-111A and F-111B were intended to have 85 per cent common parts, with the radar, cockpit instrumentation and nose landing gear being the main differences. The F-111B also had longer wings. The nose of the B was shorter than the A due to the need to fit on the elevators of aircraft carriers.

Range was less than specified, requiring more fuel and adding weight. Two of the five F-111Bs were lost during testing. Testifying before Congress, a Navy admiral said: "all the thrust in Christendom couldn't make a fighter out of that airplane". Funding was stopped in May 1968, but flying continued. Carrier trials began on USS *Coral Sea* in June 1968, which went well enough but proved that carrier suitability was marginal.

Much of the F-111B's weapons system and avionics (developed by Grumman) found its way into the F-14 Tomcat, which eventually filled the Navy's fighter requirement.

General Dynamics F-111B

Crew:	Two
Length:	68ft 10in (21.22m)
Wingspan:	70ft 0in (21.34m) extended, 33ft 11in (10.34m) swept
Height:	16ft 8in (5.10m)
Empty weight:	46,100lb (20,910kg)
Max T/O weight:	86,563lb (39,264kg)
Powerplants:	Two Pratt & Whitney TF30-P-1 afterburning turbofans each rated at 18,500lb st (82.3kN)
Max speed:	1,450mph (2,334km/h)
Service ceiling:	65,000ft (19,800m)
Range:	2,100miles (3,390km)
Armament:	(proposed) Six AIM-54A Phoenix air-to-air missiles; one 20mm M61 Vulcan cannon

LTV A-7 Corsair II

The SLUF



Above: ***The third Corsair II prototype, YA-7A 162582, is seen loaded with inert bombs. It was struck off charge in February 1968.***

Vought's last aircraft was cost effective, easy to fly and maintain, and in its later versions, a sophisticated attack platform. It was one of a handful of Navy aircraft to be adopted by the USAF.

Seeking a supplement and eventual replacement for the A-4 Skyhawk, the US Navy drew up its VAL (light attack aircraft) requirement in 1963. By February 1964 Ling-Temco-Vought Aeronautics (LTV) had been awarded the contract to build its A-7 Corsair II design, which first flew on 27 September 1965 in the hands of John Konrad. LTV had emerged from a merger of Vought electronics company Ling Ltd. and aircraft company Temco in 1961.

The design of the A-7 was based on that of the F-8 Crusader although there was no common structure. Its proportions earned it, perhaps unfairly, the nickname SLUF, for 'short little ugly fucker'. The A-7 had a larger, non-hinged, wing with less sweep and six underwing weapons pylons, a shorter fuselage and a turbofan engine – the Pratt & Whitney TF30-6 rated at 11,350lb (52.6kN) thrust. It was designed for greater survivability and maintainability, with armour plate around the cockpit area, and many access panels for avionics. A pair of Mk 12 cannon was fitted to the forward fuselage of the A-7A.

The Corsair II could carry up to 9,500lb (4,307kg) of conventional ordnance on a typical mission profile and also had a nuclear strike role with the B28, B43 and B57 special weapons. A very large ventral airbrake allowed for stable dive attacks.

The first A-7A squadron, VA-147, began service in February 1967 and by December, the type was in action in Vietnam, the Corsair II eventually equipping 29 fleet light attack and three reserve light attack squadrons

After 193 A-7As, there were 196 A-7Bs with additional ECM equipment and a refined TF30-P8 engine giving 1,000lb (4.64kN) more thrust, although this didn't cure numerous problems with the TF30 mainly relating to compressor stalls. Some of these were due to the the low-slung intake ingesting superheated steam from the carrier catapults. The avionics of the early A-7s were not particularly good or reliable and the aircraft's speed was criticised, as was its manoeuvrability, particularly by A-4 Skyhawk pilots.

The USAF was impressed enough with the Corsair II to order the A-7D with the Allison TF41 turbofan (based on the Rolls-Royce Spey), a 20mm Vulcan cannon and improved avionics that greatly improved its bombing accuracy and allowed for the use of precision weapons.

The Navy took onboard most of these improvements with the A-7E, of which 535 would be built, but delays saw an interim order for 67 A-7Cs with the TF30 engine and Mk 12 cannon. The A-7E entered combat in Vietnam in May 1970

The Corsair gradually supplanted the Skyhawk on carrier decks. A total of 99 Corsairs were lost in the Vietnam conflict up to 1973, 15 of them to SAMs. This was the lowest loss rate of any US tactical aircraft in the war. There were 60 two-seat Navy TA-7C trainers, and six EA-7Ls used as electronic aggressors, mainly by VAQ-34. This unit was notable for having some of the first female US Navy jet pilots, and was the first to be commanded by a woman, Cdr Rosemary Mariner, in 1991.

A-7Es were used in Vietnam, Grenada, over Libya and in the 1991 Gulf War. In operation



Above: ***A-7As of VA-147 1967-69 aboard USS Ranger. The aircraft in the foreground, 153152, was later sold to Portugal.***

Right: ***A pair of EA-7L electronic adversaries of the Naval Air Weapons Center (NAWC) at Pt. Mugu, California make a final flyby before retirement in 1991.***

Desert Storm the two remaining operational units, VA-46 and VA-72 flying from USS *John F. Kennedy*, employed 'dumb' bombs, Mk 7 cluster bombs, AGM-88 HARM and AGM-62 Walleye missiles and used a datalink pod to guide AGM-86E SLAM land-attack missiles launched by A-6E Intruders. Two lengthened YA-7F aircraft were converted with afterburning Pratt & Whitney F100-PW-220 engines and new avionics in 1989, but no orders were forthcoming. The Navy's last A-7s were retired in May 1991, followed by the Air National Guard's A-7Ds in 1993.

The only new-build export sales for the Corsair II went to Greece, for 60 A-7Hs and five TA-7H models based on the A-7E. The 44 A-7Ps and six TA-7Ps for Portugal were rebuilt from A-7As. Fourteen surplus A-7Es and four TA-7Cs were supplied to the Royal Thai Navy for land-based use in 1995.



LTV A-7E Corsair II

Crew:	One
Length:	46ft 22in (14.06 m)
Wingspan:	38ft 9in (11.8m);
Height:	16ft 1in (4.88m)
Empty weight:	19,127lb (8,676kg);
Max T/O weight:	42,000lb (19,050 kg)
Powerplant:	One Allison TF41-2 turbofan rated at 15,000lb st (69.7kN)
Max speed:	69mph (1,112km/h)
Service ceiling:	43,000 ft (13,106 m)
Range:	2,861 miles (4,604km)
Armament:	One M61A1 Vulcan cannon; conventional or nuclear bomb load up to 20,000lb (9,072kg); various missiles including AGM-62, AGM-65, AGM-86 and AGM-88



Right: ***The Corsair's final war was Operation Desert Storm in 1991. These A-7Es flew with VA-72 'Blue Hawks' from USS* John F. Kennedy.**

Below: ***An A-7E of VA-81 in low-vis markings in the pattern for USS* Forrestal*, circa 1982, The squadron flew the Corsair from 1971 to 1987.*** *Jim Winchester collection.*





Grumman EA-6B Prowler

Family Model Jammer

The EA-6B Prowler was a four-seat derivative of the A-6 Intruder designed for electronic warfare (EW) and suppression of enemy air defences (SEAD). Its capabilities progressively increased over a career that spanned nearly 50 years.

Work began in 1966 for a replacement for the EKA-3B Skywarrior in the electronic jamming role based on the A-6 Intruder, using some systems from the EA-6A operated by the Marines. The new version, designated EA-6B and later named Prowler, would have four crew, a pilot and three electronic countermeasures operators (ECMOs). They sat under two hinged canopies which were covered in gold film to protect them from electronic emissions. The fuselage was stretched by 1.37 meters 4ft 6in (1.37m) and the wings and landing gear were strengthened to cope with the increased weight.

The Prowler inherited the EA-6A's 'football' tail fairing containing the system's primary receivers, which detect radar signals and pass them to the central computer. Transmitters were mounted in fairings on the tailfin sides. Five pylons could carry the AN/ALQ-99 Tactical Jamming System (TLS) pod, which used a propeller-driven generator to supply power.

Converted from an A-6A, the first EA-6B, 149481, flew on 28 May 1968 in the hands of Don King. The first three aircraft were converted from A-6As, followed by five new-build development aircraft. The next 23 Prowlers were built to 'basic' standard with EW capability limited to four frequency bands. These were followed by 25 Expanded Capacity (EXCAP) aircraft with ALQ-99A, which could jam eight frequency bands. The EA-6B ICAP (Increased Capability) followed from 1976. There were 45 new-builds and 17 earlier aircraft rebuilt to this standard. From 1980 the ICAP-II appeared, largely embodying software changes, but also allowing for an offensive capability for the first time. The Prowler could now carry the AGM-88 High-speed Anti-Radiation Missile (HARM), which could target enemy radar emitters. This added the destruction of enemy air defences (DEAD) mission.

Above: ***A VMAQ-2 Prowler carrying an AGM-88 HARM anti-radiation missile. This aircraft was retired in 2019 to the National Air & Space Museum.*** *USMC*

A Vehicle Enhancement Program (VEP) saw some aerodynamic and structural improvements and two additional HARM pylons. The upgrades were designated with different block numbers, up to ICAP II Block 89A before the final ICAP III, which had a new main receiver and a Link-16 secure datalink.

Entering fleet service with VAQ-132 'Scorpions' in 1971, the EA-6B saw some service in Vietnam in 1972–3, providing ECM support for six carriers as the conflict neared its conclusion, and escorting the 'Linebacker' B-52 bombing raids against North Vietnam.

In 1977 the Marines began replacing their EA-6As with EA-6Bs. Following the retirement of the USAF EF-111 Raven – which shared many EA-6B systems – in 1998, the Prowler was operated as a joint services (USN/USMC and USAF) asset.

The HARM missile was first fielded by VAQ-140 in 1985 and first used in Operation Desert Storm, then in the Balkans conflicts of the 1990s. In Iraq and Afghanistan they proved

Grumman EA-6B Prowler

Crew:	Four
Length:	59ft 10in (18.24m)
Wingspan:	53ft 0in (16.15m)
Height:	16ft 3in (4.95m)
Empty weight:	31,572lb (14,321kg)
Max T/O weight:	65,000lb (29,484kg)
Powerplants:	Two Pratt & Whitney J52-P-408 turbojets rated at 11,200lb st (49.8kN) each
Max speed:	651mph (1,048km/h)
Service ceiling:	41,200ft (12,550m)
Range:	1,099 miles (1,769km)
Armament:	Up to four AGM-88 HARM anti-radiation missiles



capable of jamming signals from cell phones and simple remote controls used to activate roadside bombs.

Prowler production finished in July 1991 with the 170th aircraft. With attrition reducing the EA-6B fleet, consideration was given to building more Prowlers or developing a new EW version based on refurbished A-6Es. This did not come to pass. The Prowler's final conflict was Operation Inherent Resolve against ISIS in Iraq and Syria. The Navy replaced the Prowler with the EA-18G Growler in 2016 and VMAQ-2 'Death Jesters' retired the type in 2019.

Left: ***A VAQ-134 'Garudas' Prowler on a low-level mission with three ALQ-99 jamming pods and two external fuel tanks.***

Below: ***The radiation symbol helped LSOs distinguish the Prowler from the A-6 Intruder, although the latter was long gone by 2005 when this VAQ-138 jet was seen on USS* Carl Vinson *in the Persian Gulf.*** *Jim Winchester*



Grumman F-14 Tomcat

Grumman's Last Cat



Designed to intercept threats to the carrier group and destroy them with long-range missiles, the F-14 developed into a multirole aircraft capable of reconnaissance and bombing missions, supplanting numerous other carrier types and seeing service in many conflicts.

The F-14 arose out of a 1968 competition to find a new fleet defence fighter for the US Navy following the failure of the General Dynamics F-111B. The Phoenix missiles and AWG-9 radar of the F-111B were deemed worthy of further development for use and were required to be incorporated in the new fighter.

In January 1969 Grumman was awarded the contract with a two-seat, twin-tailed, swing-wing design using two Pratt & Whitney TF-30 turbofans, also inherited from the F-111B. The prototype F-14 first flew on 21 December 1970, but was lost on its second flight due to hydraulic failure.

Excluding the prototype, eleven YF-14s were allocated to the test programme and made their first flights between May 1971 and March 1972, with the exception of the F-14B, which flew in September 1973 with Pratt & Whitney F401 engines.

In total three F-14s were lost before service entry, which was not a great number compared to some other programmes, however, serious engine problems occurred on a number of other occasions and continued to plague the F-14 even after it entered fleet service. The TF-30 engines were prone to failure due mainly to manufacturing defects. Compressor stalls were also a problem and could occur when an F-14 was flown at too high an angle-of-attack, and brought in and out of afterburner.

Above: ***The Tomcat's role evolved from pure air defence adding ground attack. This F-14B of VF-103 Jolly Rogers was flying a close air support mission when seen over Iraq in August 2004.*** *US Navy*

Although the original F110 installation was abandoned, the idea was revived with the F-14A+ in 1987. In total 38 new F-14A+ Tomcats were built and 32 were converted from F-14As. The first Navy squadron to receive the F-14A+ was VF-101 'Grim Reapers' at NAS Oceana, in April 1988. VF-101's role as the Fleet Relenishment Squadron (FRS) saw it fly all production variants of the Tomcat to train Fleet crews. The F-14A+ was redesignated F-14B in 1991, reusing the designation of the original F101-powered aircraft.

The F-14B's main external differences were the larger exhaust nozzles, removal of the glove vanes, the addition of radar warning receiver (RWR) antennas under the gloves and a modified gun gas purge door beside the gun port. The radar fire control system was redesignated AN/AWG-15F.

Below: ***A line-up of seven F-14A development aircraft at NAS Point Mugu in March 1972. Of the first 12 Tomcats, five crashed or were written off in testing.*** *US Navy*



The F-14's role was to defend a carrier battle group at long range against missile-carrying bombers such as the Tu-22M 'Backfire'. Using the radar in combination with that aboard the E-2 Hawkeye to detect and track intruders, the Tomcat could engage them first with the AIM-54 Phoenix at a range of up to 115 miles (184 km) hen deal with any survivors with the AIM-7, AIM-9 and finally the cannon. The F-14 could carry a maximum of six AIM-54s, but in practice would be too heavy to land back aboard a carrier without firing or dumping some of the expensive missiles, which cost $1m apiece even in the early 1970s. In November 1973 a test saw an F-14 fire six AIM-54s at target drones, hitting four. This was the only time a full load of Phoenixes was launched.

The first carrier launch was made from the USS *Forrestal* on 15 June 1972, and the first full arrested landing on 28 June, aboard the same ship. Production deliveries to VF-124 'Gunfighters' for conversion of fleet pilots began on the last day of 1972.

The Tomcat's maiden operational cruise followed in September 1974. Two *Enterprise* squadrons (VF-1 and VF-2) covered the final US evacuation of Saigon in 1975, but saw no combat. During the 1980s Tomcats twice tangled with Libyan fighters over Mediterranean waters Libya claimed as its own territory. In 1981, F-14s from the USS *Nimitz* destroyed two Sukhoi Su-22s, and in 1989, Tomcats from Kennedy brought down a pair of MiG-23s, also with Sidewinders. In the 1991 Gulf War, Tomcats saw little air-to-air action, but one shot down an Mi-8 'Hip' helicopter.

In the 1990s the F-14 was given a strike role, which helped extend its career. Using LANTIRN targeting pods, F-14s could drop a variety of laser-guided bombs, later supplemented by JDAM satellite-guided weapons. 'Bombcats' saw action over the Balkans, Iraq and Afghanistan In a scenario never envisaged when the F-14 was designed, Tomcats were used in the close air support role in Afghanistan and even used their cannon on strafing runs.

Right: ***The Tomcat was built around its weapons system, which paired the AWG-9 radar with the AIM-54 Phoenix missile, seen here being launched from a VF-111 'Sundowners' F-14A.*** *US Navy*

As the F-14B began to enter service in 1988, Grumman was already test-flying prototypes of an enhanced F-14D version that combined the F110 engines with new sensors. The main improvement was the AN/APG-71 radar, which was essentially a digital version of the AN/AWG-9, using the same transmitter and power supply, the core of the old radar. A new digital processor replaced the four analogue processors of the AWG-9, allowing 24 targets to be tracked simultaneously and giving a detection range of 320 nautical miles (593km) against a bomber-sized target Electronic counter-countermeasures (ECCM) provisions were built in to the radar.

One of the few visual differences between an F-14A/B and a D was the infrared search and track (IRST) sensor mounted under the nose







radome next to the television camera set (TCS). The IRST could identify non-stealthy airborne targets at up to 115 miles (185km) distance and also had uses in the air-to-ground role, picking up the thermal signature of vehicles and buildings.

Following the 9/11 attacks in the US in September 2001, three F-14 squadrons were on the two carriers in the Middle East when the order came to prepare for retaliatory action against the Taliban and al-Qaeda in Afghanistan. On the third night of the campaign, dubbed Operation Enduring Freedom, VF-14 led the first long-range tactical strike of the war, flying 1,700 miles (2,736km) from USS *Enterprise* to Mazar-e-Sharif and back. Changing from their assigned defensive counter air (DCA) mission to a time-sensitive strike, a pair of F-14As destroyed three MiG-21 fighters and two transport aircraft while being engaged by multiple AAA guns and man-portable surface-to-air missiles.

In Operation Iraqi Freedom, which began in March 2003, the Iraqi Air Force made no appearance on any F-14 mission, so the Tomcat's air-to-air weaponry was not employed. All the air-to-ground ordnance in the F-14's inventory was utilised, however, from 2,000lb JDAM bombs to the 20mm Vulcan cannon. The F-14A could only employ unguided or laser-guided bombs, whereas the F-14B and D had a digital data bus and could use JDAMs.

Left: ***An F-14B of VF-143 'Pukin' Dogs' catches a wire aboard USS* John F. Kennedy *in the North Arabian Sea at the end of an Operation Enduring Freedom mission in April 2002.*** *Jim Winchester*

Grumman F-14D Tomcat

Crew:	Two
Length:	62ft 8in (19.10m)
Wingspan:	64ft 2in (19.54m) spread; 38ft 3in (11.6m) swept
Height:	16ft 0in (4.88m)
Empty weight:	41,780lb (18,951kg)
Max T/O weight:	33,724kg (74,349lb)
Powerplants:	Two General Electric F110-GE-400 turbofans rated at 14,000lb (62.3kN) dry and 23,100lb (102.8kN) in afterburner
Max speed:	1,241mph (1,997km/h)
Service ceiling:	53,000ft (16,150m)
Range:	1,842 miles (2,965km)
Armament:	One M61 Vulcan 20mm cannon; maximum ordnance 14,500lb (6,577 kg), including two AIM-9, four AIM-7 Sparrow and four AIM-54 Phoenix AAMs; LGB and JDAM bombs



Above: ***The F-14 was used as an adversary aircraft, representing Soviet-designed aircraft such as the Su-27 and MiG-31. This NSAWC F-14A was visiting NAS Oceana in 2000.*** *Jim Winchester*

In late March 2003 VF-154 was ordered to send five F-14s to Al Udeid Air Base in Qatar. This was the first time in many years a naval fighter or attack unit had flown combat operations both from land and sea during the same conflict. One VF-154 F-14A was lost after technical difficulties over Iraq in April, the pilot and Radar Intercept Officer (RIO) being rescued by an HH-60G Pave Hawk helicopter.

Over the years the charismatic Tomcat appeared in numerous movies, including *The Final Countdown* (1980), Top Gun (1986), *The Hunt for Red October* (1990), *Executive Decision* (1996), *Speed and Angels* (2006) and *Top Gun: Maverick* (2023) and in TV series such as *Supercarrier*, *J.A.G* and *NCIS*.

In the mid-to-late period of the Tomcat's career between 1980 and 2005, the Safety Center recorded 114 serious F-14 mishaps, not all of which resulted in an aircraft loss. There were 47 aircrew fatalities.

During the 33-year service history of the F-14 in the USN it equipped 25 fleet squadrons, two training squadrons and four reserve units plus assorted test and evaluation outfits and the famous 'Topgun' fighter weapons school. The last two fleet units, VF-31 and VF-213 retired their Tomcats and transitioned to the Super Hornet in 2006.

An F110-powerd Super Tomcat 21 with AN/APG-71, more fuel capacity and a wider range of precision weapons was proposed, by Grumman in the 1990s, followed by a Advanced Strike F-14 or ASF-14 with F119 engines incorporating 3D thrust-vectoring, a fly-by-wire control system and other features that would have made it essentially and all-new aircraft. Funding was directed to the F/A-18E/F Super Hornet instead.



Right: ***VF-213 'Black Lions' was one of the last two Tomcat squadrons, completing its final cruise in March 2006. The squadron's 'CAG Bird' F-14B is seen preparing for approach to USS*** **Theodore Roosevelt.** *USS Navy*

Lockheed S-3 Viking

War Hoover

Designed as an anti-submarine warfare (ASW) platform, the Viking found use in many other roles from surface attack to electronic surveillance and bombing to transport and tanking and saw action in several conflicts.

In the 1960s the Navy spent a long time studying a replacement for the piston-engined Grumman S-2 Tracker, but were reluctant to proceed until new ASW systems were developed and high-bypass turbofan engines came along. The threat from new, quiet Soviet submarines required higher dash speeds and more sophisticated sensors.

Won by Lockheed in August 1969, the VSX competition sought a modern aircraft able to operate from Essex-class carriers, and although development of the S-3 was comparatively swift, these ships had all been retired from combat duties by the time it was in service.

The Viking was a high-winged aircraft powered by two underslung TF34 turbofans, which led to the nicknames 'Hoover' and 'War Hoover'. The wings folded over the top of the fuselage and the tail fin hinged horizontally for carrier storage. The nose contained a AN/APS-116 radar, and amagnetic anomaly detector (MAD) boom could extended from the base of the tail.

A weapons bay could carry bombs, depth charges or torpedoes. Up to 60 sonobuoys were housed in a launcher array on the lower rear fuselage. The four crew positions comprised one pilot, a Copilot Tactical Coordinator (COTAC), an acoustic sensor operator and a non-acoustic sensor operator. The COTAC had a clear windscreen beside the pilot, but the back-seaters had small windows and frangible panels above their heads, which they would pass through in the event of an ejection.

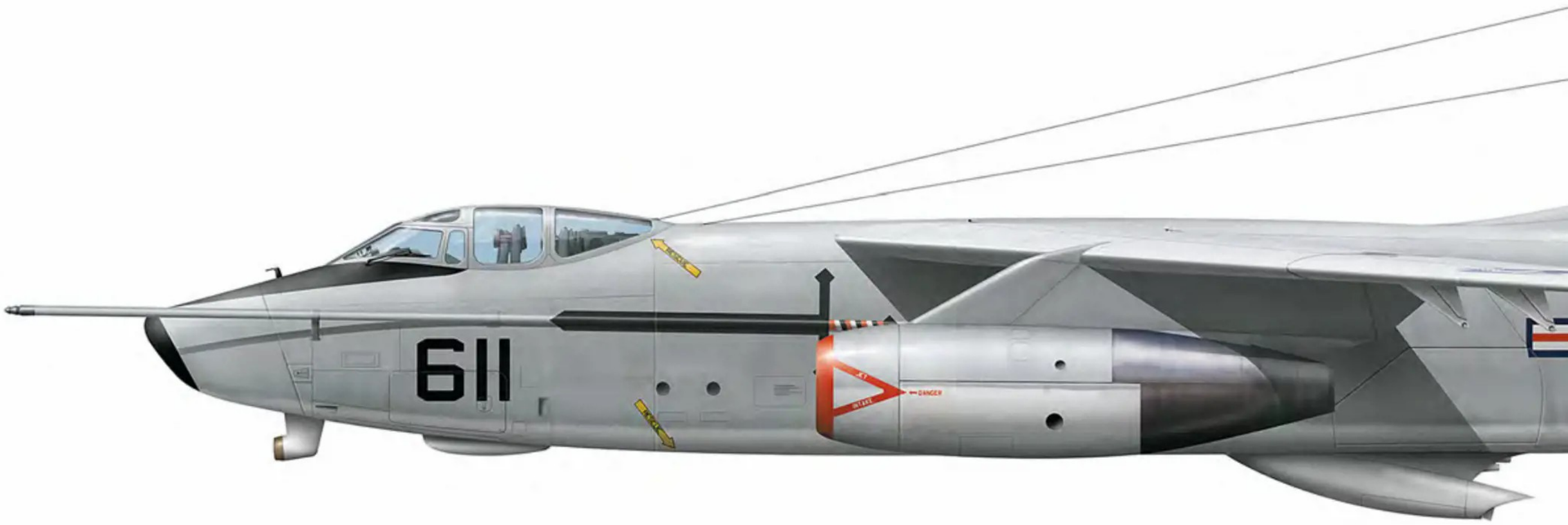
On 21 January 1972 the first YS-3A, 157992, flew at Palmdale, California crewed by 'Chris' Christiansen and Lyle Schaefer. It was followed by seven more prototype and preproduction

Lockheed S-3B Viking

Crew:	Four
Length:	53ft 4in (16.26m)
Wingspan:	68ft 8in (20.93m)
Height:	22ft 9in (6.93m)
Empty weight:	27,558lb (12,500kg)
Max T/O weight:	47,598lb (21,590kg)
Powerplants:	Two General Electric TF34-GE-400 turbofan engines rated at 9,250lb st (41.1kN) each
Max speed:	518mph (833km/h)
Service ceiling:	40,000ft (12,192m)
Range:	2,630 miles (4,232km)
Armament:	Up to 4,900lb (2,200kg) ordnance, including AGM-84 Harpoon, AGM-65 Maverick and AGM-84 SLAM and SLAM(ER) missiles, torpedoes, rockets and bombs and B57 nuclear depth bombs

Below: ***The colourful markings of an S-3A serving with VS-22 'Checkmates' in the 1970s. This aircraft served until the type's retirement in 2009.*** *Jim Winchester collection*




611
DANGER


500
RECOVERY


107
USS NIMITZ
JET
DANGER
INTAKE
NAVY


55
VAQ129



Douglas KA-3B Skywarrior, Bu. No. 142649
VAH-10, CVW-2, US Navy
USS Ranger, *1968-69*

Delivered in December 1958 as an A-3B bomber, 142649 flew with VAH-2 and VAH-8 before conversion to a KA-3B tanker aircraft in July 1967. Returning briefly to VAH-2, it was operated by VAH-10 with West Coast Air Wings until conversion to an EKA-3B electronic warfare platform, it transferred to VAQ-132 'Scorpions' in 1970 and then to VAQ-134 'Garudas'. It was issued to VAQ-308 'Griffins' in 1972. On 29 October 1972 it crashed shortly after take-off at Buckley ANGB, Colorado on a return flight to NAS Alameda, California. The two crew were killed.



Grumman A-6E Intruder, Bu. No. 155637
VA-52, CVW-15, US Navy
NAS Whidbey Island, Washington, 1979-1981

Built as an A-6A, and later converted to an A-6E, 155637 spent most of its career from 1969 to 1981 with VA-52 'Green Knights' In 1984 it was with VMA(AW)-242 'Batmen' and by 1988 it was flying with Fleet Replenishment Squadron (FRS) VA-128 'Golden Intruders', which trained Navy and Marine A-6 crews. On 5 May 1988 it failed to clear a ridge on a night low-level training flight and crashed near Dog Mountain, Washington, killing both crew.



Grumman F-14A, Bu. No. 160390
VF-41, CVW-8, US Navy
USS Nimitz, *1981*

Delivered to VF-84 in 1978, 160390 was transferred to VF-41 'Black Aces' by 1981. In this aircraft on 19 August that year Lt. Lawrence Muczynski and Lt(JG) James Anderson shot down a Libyan Su-22 'Fitter' in the Gulf of Sidra Incident. It flew with VF-103 and then VF-84 again and was in service with VF-213 'Black Lions' on 24 October 1994 when it crashed while landing on USS* Abraham Lincoln. *The RIO ejected safely, but Lt Kara Hultgreen, the first female F-14 pilot, was killed.



Boeing EA-18G Growler, Bu. No. 166899
VAQ-129, US Navy
NAS Whidbey Island, Washington, 2011

In service with VAQ-129 'Vikings' by 2010, 166899 was selected to wear a 'retro' colour scheme to mark the Centenary of Naval Aviation (CoNA) the following year. It represented that worn by a F4U-4 Corsair from VBF-85 'Sky Pirates' aboard USS* Shangri-La *in 1944. It has since been returned to a standard colour scheme and noted in 2017 with VAQ-209 'Star Warriors', in 2021 with VAQ-132 'Scorpions' and with VAQ-138 'Yellow Jackets' in 2022.



aircraft. One YS-3A crashed during testing. Carrier qualifications began in November 1973 and service began with training unit VS-41 'Shamrocks' in February 1974, the Viking becoming operational with VS-21 'Fighting Red Tails' in 1977.

The turbofans gave excellent fuel economy and long flight endurance, suiting the Viking to other roles. A transport version was developed in 1976 to supplement the Grumman C-2A Greyhound in the Carrier Onboard Delivery (COD) role. Electronic and ASW equipment

Below: ***In its later years the Viking had a true strike role with weapons such as the AGM-84H SLAM-ER as seen on this VS-32 'Maulers' S-3B aboard USS* Enterprise *in mid-2004.***
Jim Winchester



Above: ***An S-3B Viking of VS-30 conducts refuelling training with TA-4J Skyhawks of VC-8 'Redtails' near Key West, Florida in March 2000.***
Jim Winchester

was removed and the US-3A could carry six passengers and a loadmaster and up to 4,680lb (2,125kg) of freight internally, as well as cargo in underwing pods. Only seven conversions were made and the variant was retired in the early 1990s.

From 1989 a further 16 Vikings were converted to the ES-3A Sea Shadow for the signals intelligence (Sigint) mission. The sonobuoy launchers and MAD gear were removed and a Texas Instruments AN/APS-137(V)1 radar with an inverse synthetic aperture radar (ISAR) imaging capability added. The two Sigint Viking squadrons, VQ-5 and VQ-6 supplied detachments to carrier air wings, but were disestablished in 1999.

The ASW mission became less important, taken over largely by SH-60 helicopters aboard escort ships. When the KA-6D Intruder retired, the Viking was given the mission of refuelling tanker, topping up the fuel tanks of aircraft after launch on a long-range mission and before they made a carrier approach.

The last of 187 Vikings produced was delivered in August 1978. From 1988 119 S-3As were converted to S-3Bs. These had an improved FLIR system and radar, chaff/flare dispensers and AGM-84 Harpoon missile capability. In Operation Desert Storm, S-3 Vikings sank several Iraqi warships trying to escape to Iran and carried out conventional overland bombing missions against targets such as radar sites with unguided bombs and cluster bombs.

US president George W. Bush landed in an S-3B aboard the USS *Abraham Lincoln* on 1 May 2003 as it neared San Diego on its return from operations in the first phase of Operation Iraqi Freedom. The VS-35 aircraft was designated 'Navy One' for the flight.

The sea control squadrons retired the Viking in 2009, but VX-30 at Pt Mugu, California, flew two S-3Bs on range control duties until 2016. Another was assigned to NASA's Glenn Research Center at Cleveland, Ohio from 2004 to 2021. In 2016 South Korea agreed to purchase up to 20 S-3s for land-based patrol duties, but the deal did not proceed.

Boeing (McDonnell Douglas) F/A-18 Hornet

Swing Role Revolutionary

From the second half of the 1980s the (then) McDonnell Douglas F/A-18 Hornet had a significant impact on the capabilities and make-up of the US Navy's carrier air wings.

Its ability to undertake both air defence and attack roles decreased the number of types operated at sea, easing logistics, while increasing the striking power of the carriers' air wings. A visible sign of the new combat aircraft's swing role ability was the adoption of the Strike Fighter Squadron (VFA) identity in place of the Navy's traditional Attack (VA) or Fighter (VF) unit prefixes.

The Navy's Air Combat Fighter requirement of the mid-1970s pitted the General Dynamics YF-16 Fighting Falcon and Northrop YF-17 Cobra – both designed for a US Air Force programme – against each other, with the latter twin-engined aircraft emerging as the preferred basis for a new aircraft for carrier operations. Under the original agreement signed between Northrop and its partner McDonnell Douglas for the USAF evaluation, the lead for any sea-based variants would be taken by the latter company, based at Long Beach, California.

Once it became clear that the YF-17 would form the basis of the F-18 naval fighter and attack aircraft to replace the McDonnell Douglas F-4 Phantoms and LTV A-7 Corsair IIs, a requirement for up to 780 aircraft, relations became the two companies became acrimonious, as Northrop was limited to selling the proposed F-18L land-based variant on the export market.

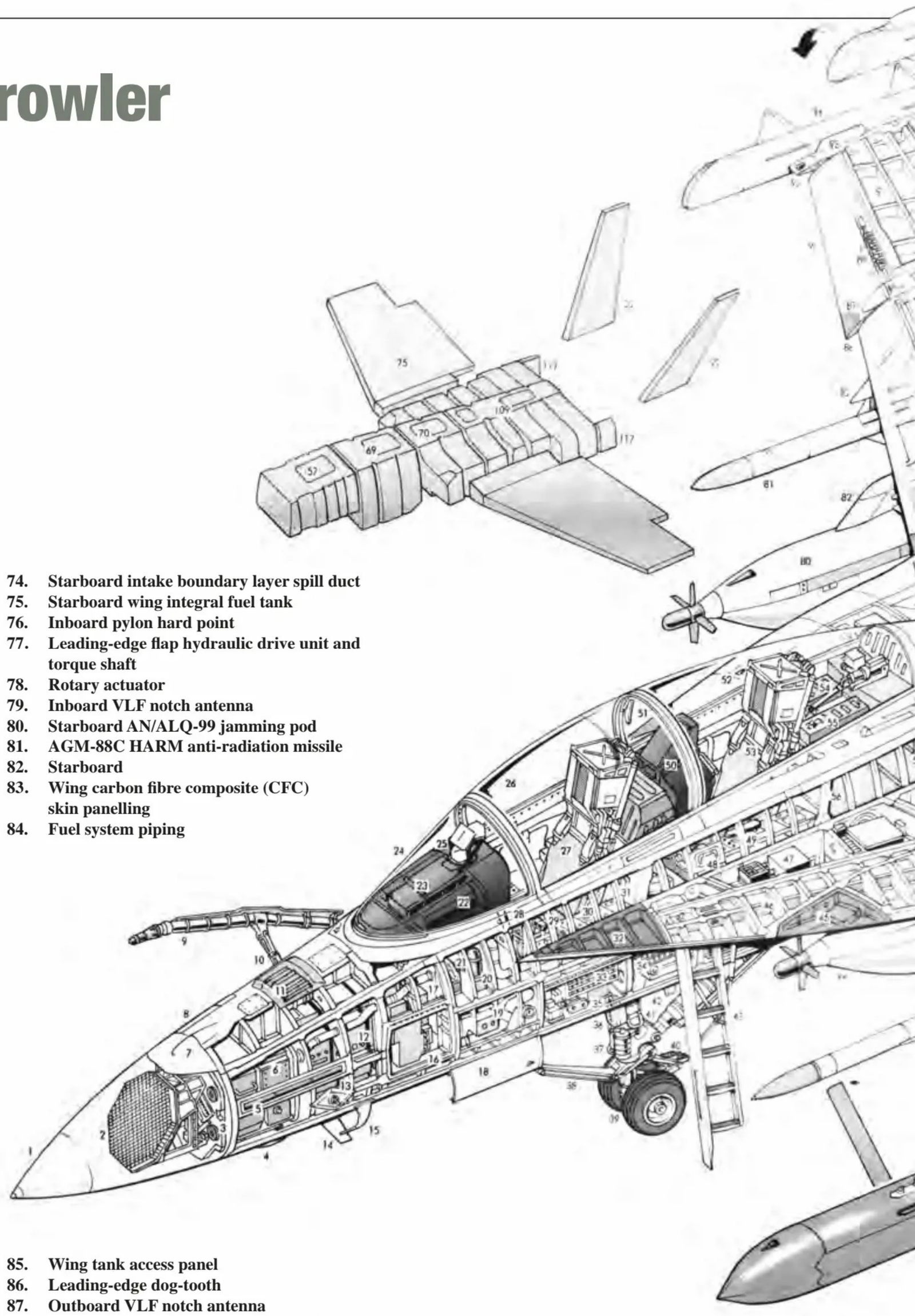
What became the Hornet was originally expected to be procured by the US Navy in three versions, the F-18 fighter and A-18 for strike/attack, plus a conversion trainer, but the latent multirole capabilities of the aircraft – largely thanks to the Hughes AN/APG-65 radar – were such that the same airframe could easily undertake both combat roles. This resulted in the adoption of the non-standard designation F/A-18 for all US Hornets in April 1984.

No prototypes of the Hornet were produced as such, as the initial 11 for the research,

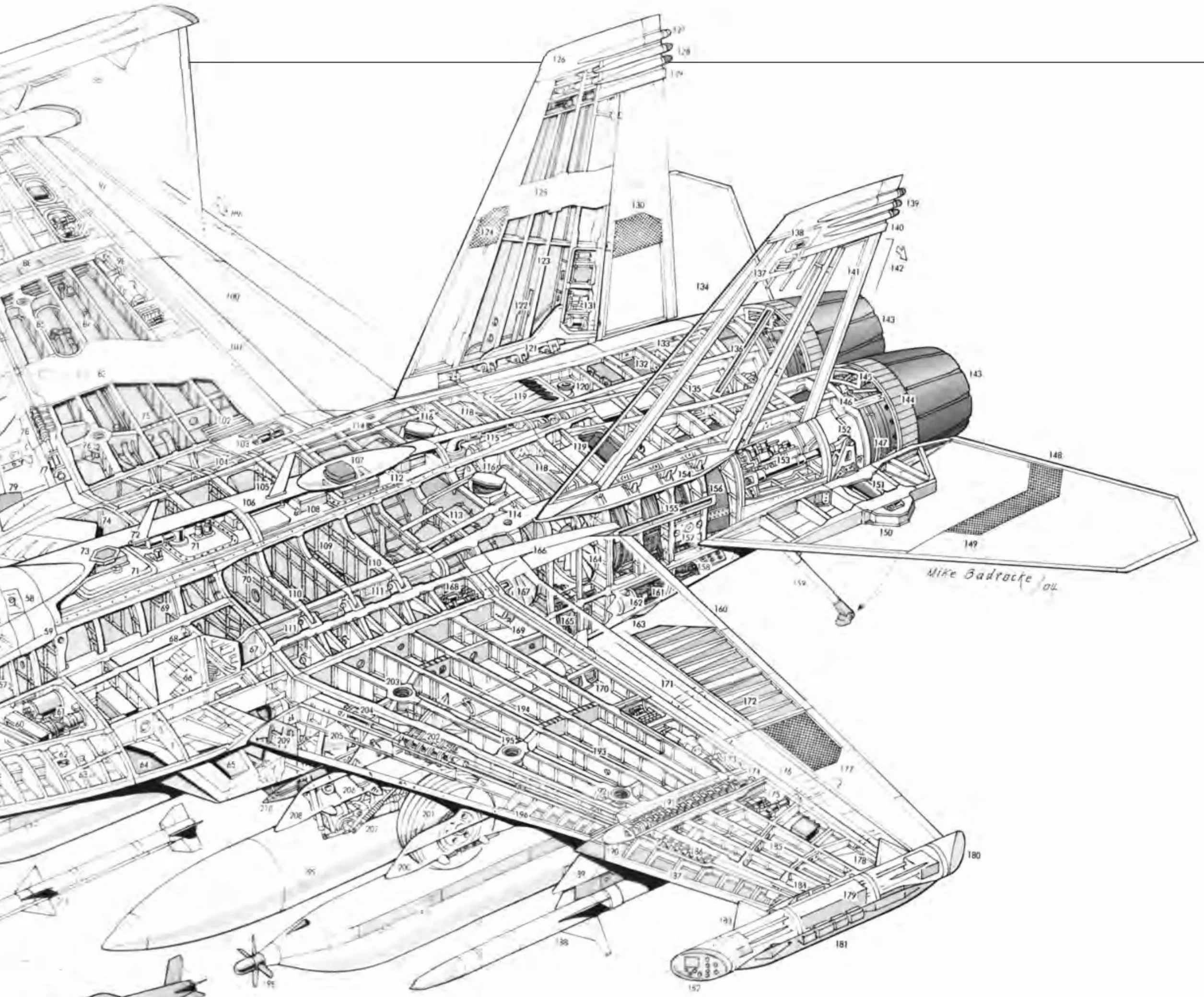
Below: ***The Hornet was the longest-served mount of the Blue Angels demonstration team, flying the F/A-18A/B from 1986 and the C/D (shown here over NAF El Centro) from 2010-2020.*** *US Navy*



Boeing EA-18G Growler



1. Composite radome
2. AESA radar scanner
3. Radar mounting bulkhead
4. Low-band antenna
5. Electro-luminescent formation lighting strip
6. Active electronically scanned (AESA) radar equipment module
7. Faired gun muzzle aperture (not used on G model
8. Refuelling probe forward door
9. Retractable in-flight refuelling probe
10. Probe actuating link
11. Combined interrogator antenna
12. LR-700 receiver electronics suite, pallet mounted
13. Incidence transmitter
14. Lower VHF/UHF/L-band antenna
15. Pitot head
16. Nose electronics compartment access hatch
17. Cockpit front pressure bulkhead
18. Nosewheel door
19. Ground power socket
20. Avionics ground cooling-air fan and ducting
21. Rudder pedals
22. Instrument panel, with advanced multi-function colour LCD displays
23. Instrument panel shroud
24. Frameless windscreen panel
25. Head-up Display (HUD)
26. Upward-hinging cockpit canopy
27. Pilot's Martin-Baker NACES zero-zero ejection seats
28. Control column
29. Engine throttle levers
30. Port side console panel
31. Seat mounting sloping bulkhead
32. Boarding step
33. Forward fuselage lateral equipment bays, three per side
34. Nosewheel leg pivot mounting
35. Landing light
36. Deck approach signal lights
37. Nosewheel steering unit
38. Catapult launch bar
39. Twin nosewheels, forward-retracting
40. Torque scissor links incorporating hold-back fitting
41. Nosewheel hydraulic retraction jack
42. VHF/UHF/L-band antenna
43. Folding boarding ladder
44. Fuselage centreline AN/ALQ-99 jamming pod
45. Very Low Band (VLF) notch antenna, port and starboard
46. Boarding ladder stowage
47. Leading-Edge Extension (LEX) equipment bay
48. Hand hold
49. ECMO's side console-mounted hand controllers, port and starboard
50. ECMO's display console
51. Canopy centre arch
52. Starboard position light
53. Electronic Countermeasures Officer (ECMO)'s NACES ejection seat
54. Canopy operating strut
55. Rotary actuator
56. Cockpit sloping rear pressure bulkhead
57. No.1 fuselage bag-type fuel tank total internal fuel capacity 2,060 US gal (7,798 litres)
58. Canopy hinge point
59. Forward fuselage swinging point
60. Liquid cooling system (LCS) heat exchanger
61. LCS reservoir pump and cooling fan
62. Port position light
63. Leading-edge extension (LEX) rib structure
64. Port 'caret-type' fixed-geometry engine air intake
65. Perforated intake wall bleed-air spill duct
66. Boundary layer bleed-air ducts
67. Bleed-air spill duct
68. LEX/fuselage frame attachment joints
69. No.2 fuselage bag-type fuel tank
70. No.2 fuselage bag-type fuel tank
71. Tank access panels
72. VHF/UHF/L-band antenna
73. GPS antenna
74. Starboard intake boundary layer spill duct
75. Starboard wing integral fuel tank
76. Inboard pylon hard point
77. Leading-edge flap hydraulic drive unit and torque shaft
78. Rotary actuator
79. Inboard VLF notch antenna
80. Starboard AN/ALQ-99 jamming pod
81. AGM-88C HARM anti-radiation missile
82. Starboard
83. Wing carbon fibre composite (CFC) skin panelling
84. Fuel system piping
85. Wing tank access panel
86. Leading-edge dog-tooth
87. Outboard VLF notch antenna
88. Wing fold hinge fairing porous panel
89. Outboard leading-edge flap rotary actuator
90. two-segment leading-edge flap
91. Outer wing panel dry bay
92. Wing tip position light
93. Formation light fairing
94. Starboard
95. Outer wing panel folded position
96. Drooping aileron
98. Wing fold hydraulic jack
99. Aileron and flap differential movement as airbrake function
100. Starboard
101. Hinged flap shroud
102. Spline-tapered wing skin attachment plate
103. Flap hydraulic actuator
104. Starboard
105. VHF/UHF/L-band antenna
106. Dorsal fairing access panels
107. SATCOM antenna
108. Dorsal equipment bay
109. No.4 fuselage bag-type fuel tank
110. Machined titanium fuselage main bulkheads
111. Wing panel bolted attachment joints
112. No.4 tank bay access panel
113. Ram air from intake duct to ECS
114. Rear fuselage slinging points
115. Environmental control system (ECS) equipment bay
116. ECS hinged auxiliary intake doors
117. Fuselage fuel vent tanks, port and starboard
118. Primary (port) and secondary (starboard) heat exchangers
119. Heat exchanger exhaust ducts
120. Engine pressure balance vent
121. Starboard fin bolted attachment points
122. Fin integral vent tank
123. Multi-spar fin torsion box structure
124. Leading-edge structure, CFC skin with honeycomb core
125. Torsion box CFC skin panelling
126. CFC fin tip fairing
127. Rear position light
128. RWR receiving antenna fairings
129. Fuel jettison
130. Starboard rudder, CFC skin with honeycomb core
131. Rudder hydraulic actuator
132. Starboard engine bay
133. Rear engine mounting support structure



134. Starboard all-moving tailplane
135. Flight data recorder
136. Fin formation lighting strip
137. Fin fuel vent
138. Anti-collision beacon port and starboard
139. Port EW transmitting antenna fairings (inert on G model)
140. Fuel jettison
141. Port rudder
142. Differential rudder operation as airbrake function
143. Variable area afterburner exhaust nozzles
144. Nozzle sealing flaps
145. Engine bay vent, above and below
146. Variable area nozzle 'fueldraulic' actuator (3)
147. Afterburner duct
148. Port all-moving tailplane
149. CFC tailplane skin panel on aluminium honeycomb substrate
150. Tailplane pivot support structure
151. Pivot mounting
152. Tailplane hinge arm
153. Tailplane hydraulic actuator
154. Port fin root attachment joint
155. Aft fuselage formation lighting strip
156. General Electric F414-400 after burning low-bypass turbofan engine
157. Main engine mounting
158. FADEC engine controller
159. Deck arrestor hook
160. Port single-slotted flap
161. Engine accessory and fuel management equipment
162. Oil tank
163. Engine bay venting ram air intake
164. Compressor intake
165. Airframe-mounted accessory equipment gearbox
166. Trailing-edge flap fixed root fairing
167. Intake duct-mounted stationery compressor radar return shielding device
168. Port flap hydraulic actuator
169. Ventral flap hinge
170. Wing jacking point
171. Port hinged flap shroud panel
172. Flap CFC rib and skin structure
173. Wing fold hydraulic jack
174. Rotary actuator
175. Port aileron hydraulic actuator
176. Hinged aileron shroud panel
177. Port aileron CFC skin on honeycomb core substrate
178. Aileron ventral hinge
179. Port wingtip multi-band (low, medium and high) receiving pod
180. Aft quadrant antenna fairing
181. lateral antenna fairing
182. Forward quadrant antenna fairing
183. Aligned Very Low Band receiving antenna
184. Wingtip formation light
185. Outer wing panel machined spar and rib unitary structure
186. Leading-edge flap rotary actuator
187. Outboard leading-edge flap segment
188. AGM-88C HARM anti-radiation missile
189. Outboard pylon and missile launch rail adaptor
190. Outboard VLF notch antenna
191. Wing fold hinge joint
192. Outer pylon hardpoint
193. Multi-spar wing torsion box structure
194. Port wing integral fuel tank
195. Intermediate pylon hardpoint
196. Inboard leading-edge flap CFC structure
197. Port AN/ALQ-99 jamming pod
198. Jamming pod and generating turbine
199. 275 US gal (1,250 litre) external fuel tank, 400 US gal (1,817 litre) alternative
200. Intermediate wing pylon
201. Port main wheel
202. Inboard leading-edge flap segment rotary actuator
203. Inboard pylon hard point
204. Leading-edge flap hydraulic drive unit
205. Mainwheel leg pivot mounting
206. Shock absorber strut
208. Port inboard stores pylon
209. Inboard VLF notch antenna
210. AIM-120C AMRAAM
211. Joint Stand-Off Weapon (JSOW), submunitions or 500lb HE unitary warhead
212. Folding wing surfaces



Left: ***The third full-scale development Hornet aboard USS* America *during carrier suitability tests in October 1979.*** *Jim Winchester collection*

Right: ***The 'CAG Bird' (literally) of VFA-82 'Marauders' in 2004. The art was supposed to represent an eagle, but other CVW-1 squadrons on USS* Enterprise *described it as a duck.*** *Jim Winchester*

development test and evaluation phase were considered full-scale development (FSD) aircraft. The first F/A-18A was rolled out at Lambert Field, St Louis on 13 September 1978 and the corporation's chief test pilot, John Edward 'Jack' Krings, completed the maiden flight on 18 November 1978. All FSD aircraft had been delivered by March 1980, including a pair of two-seat TF-18As, the variant soon being redesignated F/A-18B to highlight its combat capabilities, although in US service its role was primarily pilot conversion.

The Hornet was destined for both the US Navy and US Marine Corps and the initial examples went to the fleet replacement units VFA-125, VFA-106 and VMFAT-101, while VMFA-314 worked up on the new aircraft at NAS Lemoore, California, from August 1982 before returning to MCAS El Toro, California, to be declared operational on 7 January 1983. The first frontline US Navy squadron, VFA-113, accepted its initial Hornet in August 1983. That unit and VFA-25 completed the type's first operational deployment aboard USS *Constellation* as part of Carrier Air Wing 14 between February and August 1985.

The aircraft was first used in anger in April 1986, when two US Navy and two US Marine squadrons operating from USS *Coral Sea* participated in Operation Eldorado Canyon, primarily suppressing air defence systems during the raids on Libyan targets. A total of 17 Hornet units were involved in Operation Desert Storm, with two F/A-18Cs of VFA-81 dispatching a pair of Iraqi Mikoyan-Gurevich MiG-21s (or Chinese-built F-7s) with AIM-7 Sparrows on 17 January 1991, the first day of combat. On the same day during a different mission, Lt Cdr Scott Speicher's VFA-81 F/A-18C was shot down at long range by a missile fired by an Iraqi MiG-25. Although he ejected, he did not survive the shoot down.

The F/A-18C was the second major version, the first flying on 3 September 1983 and production examples followed, after the last of 371 F/A-18As was delivered. It introduced additional weapons to the Hornet's arsenal, including the AIM-120 AMRAAM, had revised avionics, a new ejection seat, and was to be compatible with an interchangeable reconnaissance nose (with cameras instead of the internal M61A1 cannon) until that project was cancelled. Externally, the F/A-18C displayed few differences from the 'A. Upgrades during the production run meant that F/A-18Cs from the 138th aircraft on were night attack capable, equipped with podded targeting and forward-looking infrared systems, night-vision goggles and revised cockpit avionics. The AN/APG-65 was replaced by the APG-73 in new production F/A-18Cs from 1994, while 'As retrofitted with the radar and compatible with the AIM-120 were designated F/A-18A+s. Around two years earlier the original General Electric F404s powerplants were supplanted by the more powerful Dash 402 version.

Prior to night attack capabilities being introduced in the single-seater, the Marines had acquired F/A-18D two-seaters with similar systems for its All-Weather Attack Squadrons (VMFA[AW]). Dual controls were not fitted as standard and, in addition to serving in the attack role, the 'Ds were operated as airborne forward air controller (FAC(A))platforms. Around 60 were also configured to perform reconnaissance as F/A-18D(RC)s. Production of both the 'C and 'D ended in 2000, with the Marines receiving the last two-seatert, three

Below: ***Despite the overall greyness of modern USN jets, one aircraft of each unit is allowed some colour. This F/A-18C was with VFA-131 'Wildcats'.*** *Jim Winchester*





years after McDonnell Douglas had merged with Boeing. A total of 1,480 first-generation Hornets were built for US forces and five international customers.

More than 40 US Navy and Marine Corps squadrons flew Hornets over the years, with many of them deployed to combat zones more than once. In addition to supporting operations against Libya and the many operations in Iraq, they were used over Bosnia and Kosovo, and from October 2001, in Afghanistan.

The Hornet was replaced on the decks of US Navy aircraft carriers by the Super Hornet, with the final deployment to sea by the type on the USS *Carl Vinson* ending in March 2018. What had become known as the 'legacy Hornet' officially departed active Navy service on 1 February 2019, although it continued to be flown by secondary units – notably adversary squadrons – with the Reserves. The last official flight by a Navy F/A-18C was performed by the Navy's East Coast FRS VFA-106, at NAS Oceana, Virginia, on 2 October 2019.

Unlike the Navy, the Marines elected not to replace its Hornets with Super Hornets but to fly them until sufficient Lockheed Martin F-35 Lightning IIs became available. This was made possible by a service life expansion programme to raise permissible flight hours from 6,000 to 10,000 hours, while the fleet is also in the process of having its radars upgraded to the active electronically scanned AN/APG-79(v)4.

Below: ***Illustrating the multi-role capabilities of the Hornet is this F/A-18D(RC) of VMFA(AW)-224 on a 2017 Inherent Resolve mission carrying GBU-31 JDAM bombs and is fitted with the ATARS (Advanced Tactical Airborne Reconnaissance) sensor nose.*** *USAF*



Boeing (McDonnell Douglas) F/A-18C Hornet

Crew:	One
Length:	56ft 0m (17.07m)
Wingspan:	36ft 6in (11.43m) without wingtip missiles
Height:	15ft 4in (4.66m)
Empty weight:	23,050lb (10,455kg)
Max T/O weight:	56,000lb (25,501kg)
Powerplant:	Two General Electric F404-GE-400 turbofans rated at 16,000lb (71.2kN) each with afterburner, or -402s rated at 17,700lb (78.7kN) each with afterburner
Max speed:	1,190mph (1,915km/h) at high altitude
Service ceiling:	50,000ft (15,240m)
Range:	1,800 miles (2,073km) in ferry configuration with drop tanks
Armament:	One 20mm (0.787in) M61A1 Vulcan cannon and up to 15,500lb (7,030kg) of munitions or stores on nine external stations

Naval Aviation Safety
No Easy Days

The jet age brought new challenges for naval aviators and flight deck crews. Accidents were frequent, and often deadly. Several innovations, to carriers and their systems, to aircraft and to training and operating procedures, brought the rate down to the same, if not better, than land-based operations.

Early jets suffered from poor engine reliability – flame-outs were common and most fighters were single-engined. Ejection seats were almost as unreliable and could not be used below about 90 knots (167km/h). Normal procedure was to slide the canopy back for launch and landing, where in some types the forward frame came between the pilot and seat. Later 'zero-zero' seats allowed ejection at sea level (or even below) and at no forward airspeed.

The next generations of jet engines, typified by the J52 turbojet used in the A-4E/F Skyhawk and A-6 Intruder, and the TF41 and TF30 turbofans in the A-7E and F-14A, respectively, were much better, although these engines did have teething problems in their early years. With increased thrust-to-weight ratio, later engines allowed a pilot to recover from a marginal catapult shot, accelerate after a stall, and avoid obstacles during low-level flight.

Engine instruments went from providing almost no troubleshooting information to very nearly complete diagnostic capability. For example, the only engine warning light in the A-4A Skyhawk read, *FIRE*. It was not very reliable and about 20% of the time in tropical environments and all the time in heavy rain, it was illuminated because of contact with moisture. It was usually covered with tape. In the A-4B a hydraulic-system-failure warning light was added, but the fire-warning light was not fixed. In about 1961, an angle-of-attack indexer and gauge were added to the A-4B, which improved angle of attack and airspeed measurement and control during a carrier approach and landing. With the additional accuracy, many pilots were shocked to learn that they had been flying approaches in a turn at 125 knots (232km/h) indicated airspeed regardless of aircraft weight, which was at least ten knots (19km/h) too slow.

In the 1950s, the Navy was operating new, high-performance jet aircraft from World War Two-era *Essex*- and *Midway*-class carriers with wooden decks and only slightly modified procedures and equipment. The addition of the angled flight deck was a major safety improvement. The space was still very limited, however, on both classes of carrier. In the 1960s and 70s, larger decks introduced with the *Forrestal*-class provided a much needed margin of safety. The increased width of the decks allowed more error in lining up with the centerline when landing and increased separation from parked aircraft. The longer decks enabled a greater distance from the ramp to the target landing wire which significantly reduced the likelihood of ramp strikes.

Catapult and arresting gear failures were common with the hydraulic systems used until the late 1950s. They also inflicted significant pain on the pilot because of their short length of stroke and quicker acceleration and deceleration compared to the steam catapults and improved arresting gear introduced from 1954-55. Catapult reliability and performance improved even further with nuclear-powered carriers, which could produce more steam for launching aircraft with more fuel and ordnance which permitted extended flight operations. The improved cats also increased the margin of safety between the speed of the aircraft at launch and its stall speed. The invention of the mirror landing aid system by the British allowed replacement of the paddles used by the landing signal officer (LSO) to help the pilot land. With the increased visibility of the mirror, a pilot could see the glide path marker – a bright orange reflection called the "meatball" which indicated that the aircraft was on, above or below the glide path – farther out from the ship. After contact with the "ball," a normal visual approach under the guidance of the LSO was flown. The mirror was replaced by the Fresnel lens optical landing system in the late 1960s. FLOLS was larger than the mirror and it was positioned further forward in the port catwalk for better visibility.

Training during the 1950s was fairly undisciplined, especially on fleet squadrons.

Below: ***Following a landing from a mission over Korea, the brakes on F2H-2 Banshee 124983 failed and the VF-172 jet went over the side of USS* Essex. *Lt (JG) Archie Tredwell escaped before it sank.***





Above: ***As his F8U-1 goes off the angle of USS* Franklin D. Roosevelt*, Lt (JG) Terry Kryway of VF-11 'Red Rippers' begins the ejection sequence. A hard landing broke off a wheel and started a fire in the undercarriage bay. Kryway was rescued with minor abrasions after this mishap on 21 October 1961.***

Flying extremely low and fast or 'flat-hatting' was an everyday occurrence. Wild dogfights took place directly overhead the carriers and naval air stations. Except for the mandatory completion of some competitive exercises and instrument qualification requirements, there was very little structure to training. With the introduction of the replacement air group (RAG) concept in 1958-59 this began to change. Written tests had to be passed, and training proceeded in a somewhat structured form with approved syllabi. Training standards were established: for example, ten daytime carrier landings (traps) and six night traps were required to be carrier qualified in type; and refresher landings were required after a specified period.

In the 1960s, the naval aviation training and operating procedures standardization (NATOPS) programme was introduced. More disciplined training took hold, and knowledge of safe weapons delivery, navigation, and emergency procedures was imparted and tested for compliance.

Mishap statistics fell as a result of these and other improvements. In 1959, 461 Navy and Marine aircraft (including transports and helicopters) were completely destroyed and 309 people were killed; in 1970 it was 264 aircraft lost and 231 fatalities; by 1980 it was 112 aircraft and 91 deaths; in 2000 it had fallen to 24 aircraft and 46 lives lost. The major mishap rate fell from 25.7 per 100,000 flight hours to 1.99 over the same period. The ten-year average rate from 2013-23 was 1.0 with seven serious manned aircraft mishaps in Fiscal Year 2023.

Below: ***The crash barricade saved many aircraft in difficulty, including this S-3B Viking of VS-29 which landed aboard USS* Abraham Lincoln *in November 1990 with a damaged landing gear.*** *NARA*



Boeing (McDonnell Douglas) F/A-18 Super Hornet

A Bigger 'Bug'



Above: ***The main recognition features of the 'Super Bug', including the larger wing, wing-root extensions and intakes are displayed in this action shot of two VA-136 'Knighthawks' F/A-18Es.*** *US Navy*

The F/A-18 Super Hornet is the prime combat asset operated from the decks of the US Navy's aircraft carriers today, undertaking air defence, strike, tanker and electronic attack roles.

The cancellation of the stealthy General Dynamics/McDonnell Douglas A-12 Avenger II in 1991 left the US Navy without a replacement for the Grumman A-6 Intruder carrier-borne attack aircraft. The same year, McDonnell Douglas put forward a proposal for a growth version of the F/A-18 Hornet, with a 2ft 10in (86cm) stretch to the fuselage, larger wings and flying surfaces, as an alternative. The leading-edge root extensions (LERXes) above the intakes were also increased in size. Together, the changes allowed more fuel to be carried internally and on external fuel tanks, increasing range by 38% over the smaller variant, while adding another two stores stations (to make 11) increased the number of munitions that could be carried. Other modifications reduced the radar cross section including included burying the highly-reflective fan blades of the General Electric F414 powerplants – more powerful than the smaller siblings' F404s – behind an S-bend duct inside rectangular-section intakes that replaced the D-shape units of the earlier aircraft.

Unlike the 'legacy' Hornet, both single- and two-seat versions of the Super Hornet were to be used by operational squadrons. An engineering and manufacturing development (EMD) contract was awarded in June 1992, due to run for seven and a half years. It covered development of both planned versions and covered construction of five F/A-18E single-seaters and two F/A-18F two-seaters, plus three ground test articles. Test pilot Fred Madenwald completed the maiden flight of E1, the first F/A-18E, on 29 November 1995 from Lambert Field, St Louis, Missouri. The second F/A-18E first flew on 26 December 1995, with the initial F/A-18F making its maiden flight on 1 April 1996. The first aircraft was delivered to the Naval Air Warfare Center at Patuxent River, Maryland, on 14 February 1996 at the start of a three-year flight test programme, while the last of the seven EMD aircraft arrived at the base on 1 February 1997.

It was quickly discovered that the Super Hornet had a tendency to depart from

controlled flight after suffering wing drop in certain flight regimes, which was cured by adding fences and other aerodynamic refinements to the wings. Although the fleet was grounded briefly after cracks were discovered in the F414's stator vanes in October 1997, the test programme was relatively trouble-free; by mid-January 1999 the EMD fleet had accumulated 4,000 flight hours.

Low-rate initial production (LRIP) was approved in March 1997, with the first batch covering eight F/A-18Es and four F/A-18Fs. The first from this lot flew on 6 November 1998 and was accepted by the US Navy on 18 December, eventually going to VX-9, responsible for the operational test and evaluation of the Super Hornet. On 15 February 2000 it was announced the Super Hornet was "operationally effective and operationally suitable", and recommended for introduction to the US Navy fleet.

Three LRIP contracts were issued, for a total of 30 F/A-18Es and 32 F/A-18Fs, before the first multi-year buy for 210 aircraft was signed, covering procurement in Fiscal Years (FY) 2000 to 2004. In addition to supplanting the 'legacy' Hornet with the US Navy, it was also decided it would also replace the Grumman F-14 Tomcat in the fleet air defence role.

The first active US Navy unit to receive the aircraft was VFA-122, the Fleet Replacement Squadron, which was established at NAS Lemoore, California, in January 1999, although it only accepted its initial Super Hornet on 17 November. In the third quarter of 2000 the second unit, VFA-115, began transition from the F/A-18C to F/A-18E. It deployed aboard the USS *Abraham Lincoln* from 24 July 2002, the first time a frontline Super Hornet squadron had operated from an aircraft carrier. On 6 November 2002 VFA-115 aircraft dropped four GPS-guided Joint Direct Attack Munitions on a surface-to-air missile site in southern Iraq, marking the combat debut of the aircraft.

Additional squadrons that became early adopters of the Super Hornet – converting from the F/A-18C to the F/A-18E – included (in order) VFA-22, -137, -81, -105 and -146, while F/A-18Fs went to VFA-86. The first former Tomcat operator to receive F/A-18Es was VFA-14, while VFA-41 replaced its F-14As with F/A-18Fs. VFA-41 completed the first operational deployment by the F/A-18F on the USS *Nimitz* from March to November 2003. Others that previously flew the swing-wing fighter that received Super Hornets between FY 2002 and 2007 were VFA-102, -2, -154, -32, -103, -211, -213, -11, -31 and -143.

At least 34 US Navy Strike Fighter Squadrons (VFA) have flown Super Hornets, with the aircraft becoming the primary combat asset flying from the service's aircraft carriers. All Super Hornets were destined for the US Navy, as the US Marine Corps declined to operate the type; it did not want to risk funds being diverted from its purchase of Lockheed Martin F-35B Lightning IIs, instead retaining its 'legacy' Hornet fleet until the new VSTOL aircraft became available.

Although Super Hornets were built in two main variants, upgrades were introduced across the whole fleet via Blocks common to both. The first 144 aircraft were Block Is, the baseline configuration with an AN/APG-73 radar, with other items were added as they became available. From FY 2002 production was to Block II standard, with a revised forward fuselage that introduced a fibre optic data network and revised crew station. From July 2006 the AN/APG-79 active electronically scanned array was evaluated in the aircraft by VX-9, leading to it being installed in new-build and retrofitted to existing aircraft. VFA-213 became the first to field aircraft configured to accept the radar in mid-2006, but delays meant it was only installed and operationally deployed by VFA-22 from May 2008. Other Block II upgrades included compatibility with the AN/ASQ-228 ATFLIR pod and Joint Helmet Mounted Cueing System.

Development of Block III avionics upgrades – customizable touchscreen, advanced network capabilities and improved (17 times more powerful) mission computing – as the Advanced Cockpit System began in April 2019. The life of the airframe was also extended to 10,000 from 6,000 flight hours, but plans to add conformal fuel tanks are understood to have been abandoned.

The third member of the Super Hornet family, the EA-18G, started as a private venture known as the F/A-18F C2W, which was announced in August 1995 as a potential replacement for

Boeing (McDonnell Douglas) F/A-18F Super Hornet

Crew:	Two
Length:	60ft 1in (18.31m)
Wingspan:	44ft 9in (13.62m)
Height:	16ft 0in (4.88m)
Empty weight:	32,081lb (14,552kg)
Max T/O weight:	66,000lb (29,937kg)
Powerplant:	Two General Electric F414-400 turbofans, each rated at 13,000lb (58kN) dry, or 20,000lb st (98kN) with afterburner
Max speed:	1,190mph (1,915km/h) at 40,000ft (12,190m)
Service ceiling:	52,300ft (15,940m)
Range:	2,070 miles (3,330km) ferry range with drop tanks
Armament:	One 20mm (0.787in) M61A1 Vulcan cannon and up to 17,750lb (8,050kg) of munitions or stores on 11 external stations



Right: ***Carrying two laser-guided bombs and an AGM-65 Maverick missile, a VFA-41 F/A-18F patrols the skies of Iraq in 2005. Increased 'bring-back' of unused weapons to the carrier was one driver of the Super Hornet requirement.*** *USAF*





Above: ***An EA-18G Growler on the first test flight with underwing pods fitted. The wingtip pods contain AN/ALQ-218 EW equipment. Additional electronics replace the Super Hornet's gun and ammunition.*** *Boeing*

Above right: ***An F/A-18E Super Hornet from VFA-14 'Tophatters' makes a gear-down flyby of USS* John C. Stennis. *The 'Pizza Box' antenna housing ahead of windscreen is another recognition feature of the 'Rhino.*** *US Navy*

the Grumman EA-6B Prowler. It was planned to transplant much of the existing equipment from the Prowler, including the AN/ALQ-99 jamming system pods, to the Super Hornet. A demonstration flight using the first F/A-18F carrying three pods and two fuel tanks was conducted in November 2001, leading to further trials the following year.

Key to the new aircraft was the ability of the Super Hornet's crew of two to operate the electronic warfare systems managed by the Prowler's four occupants. After the US Navy was satisfied this was possible, a five-year system development and demonstration (SDD) contract was awarded on 29 December 2003 and the F/A-18F C2W became the EA-18G. Replacing the 'P' in Prowler with the 'G' of its designation gave the EA-18G its Growler nickname, officially adopted by the US Navy in October 2005, although 'Shocker' had been a popular choice among aviators.

Two pre-production EA-18Gs were created by modifying F/A-18Fs on the line, the first flying on 15 August 2006, with both going to Patuxent River for the SDD. The first production aircraft flew on 10 September 2007 and was delivered to the US Navy two weeks later.

The initial example arrived with the training unit, VAQ-129, on 3 June 2008, while VAQ-132 became the first operational squadron, attaining its initial operating capability in September 2009. It later completed the Growler's first combat tour, flying from Al Asad in Iraq from November 2010. The first deployment at sea was completed by VAQ-141 aboard USS *George H W Bush* from May 2011.

The number of Growlers to be acquired increased from 85 to 114 by January 2010 after plans to add three expeditionary electronic attack squadrons, with the 100th delivered in May 2014. Total procurement had risen to 160 by Fiscal Year 2016 to equip 16 electronic attack squadrons.

Compared to the wide acceptance of the 'legacy' Hornet overseas, exports of the Super Hornet have been limited to just Australia (24 F/A-18Fs and 13 EA-18Gs) and Kuwait (22 F/A-18Es and six 'Fs). The final 17 Super Hornets for the US Navy were ordered in March 2024, taking total procurement to 715 aircraft.

Below: ***The Super Hornet has replaced the S-3B Viking in the tanker role. This VFA-2 'Bounty Hunters' jet carries four 475 US gal (1800 litre) 'jugs' and a 'buddy' refuelling pod.*** *US Navy*



Lockheed Martin F-35C Lightning II

Carrier-based Stealth

After a long development programme, increasing numbers of Lockheed Martin F-35C Lightning IIs are joining the fleet, bringing new capabilities to the Carrier Air Wings.

Under the Joint Strike Fighter (JSF) banner, what became the F-35 Lightning II was conceived as a stealthy, low-cost, multirole aircraft able to replace a variety of fighter and attack types with three US services. Huge numbers were originally to be acquired in three versions, comprising the F-35A Conventional Take-Off and Landing (CTOL) aircraft for the US Air Force; the F-35B Short Take-Off and Vertical Landing (STOVL) version for the US Marine Corps and the F-35C Carrier Variant (CV) for the US Navy. Key features of all three variants were tested by the X-35A, 'B and 'C precursors during the original weapon system concept demonstration against the Boeing X-32, before approval to proceed to development as the F-35 was authorised that October. Although spiralling costs, development delays and shortfalls in performance have plagued the programme, it continues to be the largest project within the US Department of Defense.

A considerable number of alterations to the basic airframe were required so that the F-35 could operate from an aircraft carrier. A larger wing, fin and elevator, plus additional control surfaces, were used, while a stronger landing gear with twin nose wheels was fitted to cope with the higher sink rates of carrier landings. The wings can be folded to save space on carriers.

Five F-35C development aircraft were ordered, with the first making its maiden sortie on 6 June 2010 in the hands of Lockheed Martin Test Pilot Jeff Knowles. The fourth aircraft was cancelled, with the last of the development F-35Cs joining the flight test programme on 30 November 2012. The test programme highlighted some deficiencies, with the naval variant demonstrating the worst case of wing drop of all the three models. During arrestor landing trials undertaken in 2011 the aircraft repeatedly failed to catch a wire, which was cured by redesigning the tailhook.

In March 2011 the US Navy and Marine Corps set a requirement for a total of 340 F-35Cs, a figure that has remained constant over the years. An initial four F-35Cs examples were funded in Low Rate Initial Production 4 (LRIP-4) during Fiscal Year (FY) 2010 and by FY 2019 a total of 85 F-35Cs had been ordered in successive LRIP lots, with additional aircraft in LRIP-15 (2022) onwards.

The first production F-35C completed its maiden flight on 14 February 2013, with the initial delivery to the Navy occurring on 22 June. In addition to going to test units VX-9 Detachment Edwards AFB and VX-23 at NAS Patuxent River, Maryland, early F-35s were delivered to VFA-101 from June 2013. This was US Navy component of the Joint Integrated Training Center at Eglin AFB, Florida, that included units of all three services. The squadron acted as the Fleet Replenishment Squadron (FRS) for the aircraft until disbanding on 23 May 2019.

Lockheed Martin F-35C Lightning II

Crew:	One
Length:	561ft 6m (15.70m)
Wingspan:	43ft 0in (13.11m)
Height:	14ft 9in (4.48m)
Empty weight:	34,800lb (15,785kg)
Max T/O weight:	70,000lb (31,751kg)
Powerplant:	One Pratt & Whitney F135-PW-100 turbofan, rated at 28,800lb (128.2kN) dry, 43,000lb (191.3kN) with afterburner
Max speed:	Mach 1.6
Service ceiling:	50,000ft (15,240m)
Range:	1,380 miles (2,222km) on internal fuel
Armament:	One 25mm GAU-12 cannon on externally mounted pod, two AIM-120C AMRAAMs and two GBU-31 Joint Direct Attack Munitions or two AIM-120Cs and up to eight GBU-49 or 53 Small Diameter Bombs in internal bay; other munitions cleared for internal and external carriage



Left: ***An F-35C Lightning II from VFA-147 'Argonauts' lands on USS George Washington (CVN 73) while underway in the Atlantic Ocean, in December 2023.***

The initial F-35C for the West Coast FRS, VFA-125, arrived at NAS Lemoore, California, on 25 January 2017, taking over the duties and many of the assets of VFA-101 when it inactivated. The first operational squadron was VFA-147, which began transition from the F/A-18E Super Hornet to the F-35C after receiving its first four in December 2017. The F-35C achieved its initial operating capability



Above: ***The main recognition feature of the F-35C is its longer-span folding wings. These two 'Cs from VX-23 were conducting carrier suitability trials aboard the USS* Nimitz *in November 2014.*** *US Navy*

on 28 February 2019, with VFA-147 completing the aircraft's first deployment at sea, on the USS *Carl Vinson* with Carrier Air Wing Two, from August 2021 to February 2022.

VFA-97 received its initial F-35C in October 2021 to replace its F/A-18Es at NAS Lemoore as part of Joint Strike Fighter Wing Pacific, followed by VFA-86 by late 2023, which also replaced the single-seat version of the Super Hornet. By late 2024 they were joined at NAS Lemoore by VFA-115 second half of 2024, which has previously been forward deployed with F/A-18Es at MCAS Iwakuni, Japan. Its place in Japan was taken by VFA-147, which became the first forward deployed squadron with the F-35C.

On 30 July 2020 the first pair of F-35Cs for the US Naval Fighter Weapons School arrived at NAS Fallon, Nevada. The unit, commonly known as Topgun, is responsible for developing new tactics for the operational fleet.

A total of 80 F-35Cs were originally planned to be delivered to the US Marine Corps to equip five squadrons, which would operate as part of the US Navy's Carrier Air Wings, replacing F/A-18Cs that performed a similar role with the service. In early 2016 the number for the Marines was cut to 67 'for planning purposes', with the 13 unwanted aircraft transferred to the US Navy requirement, raising the total number expected to be acquired by the service to 273.

VMFA-314 at MCAS Miramar, California received its first F-35C in January 2020 and deployed on the USS *Abraham Lincoln* to January to August 2022. The second Marine squadron to transition to the F-35C VMFA-311 at NAS Miramar in April 2023, followed by VMFA-251 at Cherry Point in September 2024.

Below: ***Like the Navy, Marines have adopted the F-35C without a great deal of urgency or enthusiasm. The nearest VMF-314 'Black Knights' aircraft sports the 25mm pod-mounted cannon.*** *USMC*



Navy Fighter and Attack Projects

Pogos, Doritos and Missileers



In the post-war years the Navy began numerous projects that never reached the fleet, a few of which made it as far the flight test stage. Others were cancelled before ever leaving the ground or seeing a ship's deck.

The need for air defence for smaller vessels led to the construction of three tail-sitter designs, one jet and two turboprops. The Ryan X-13 Vertijet began as a BuAer-sponsored effort in 1947 to test the viability of submarine-based aircraft. The project moved to the USAF in 1953 with a contract for a full-scale testbed, which first flew (horizontally) in December 1955 with a Rolls-Royce Avon engine and later demonstrated successful vertical take-offs and landings. The Convair XFY-1 'Pogo' with an Allison XT-40 turboprop and Lockheed XFV-1 'Salmon' with a YT-40 were the result of a separate 1948 Navy specification. They both flew in mid 1954, but the Salmon only ever took off vertically before the concept was abandoned. Although the idea had some merit, not enough thought was put into how, once the mission was over, the pilot would bring the aircraft back to the landing pad or ship and land while looking over his shoulder. Wind tunnel tests showed that a rate of descent greater than 10ft (3m) per second could lead to the Pogo tumbling out of control. The pilot experience level required for all three designs was too great and the limited performance of the aircraft once in horizontal flight was not enough to justify further development.

In 1957 BuAer submitted a Request for Proposals (RfP) for a Fleet Air Defence (FAD) aircraft, intended to destroy attackers a long distance from the carrier. This emphasised the carriage of a battery of large AAMs over aircraft performance. Grumman, Vought, Lockheed, NAA and Boeing submitted eight different designs, ranging from advanced new concepts to modified ASW and patrol planes. Douglas won, in July 1960 with its F6D Missileer, which was essentially an F3D SkyKnight with pylons for eight AAM-N10 Eagle missiles and a large radar. The main airframe difference was larger intakes for TF-30 turbofans.

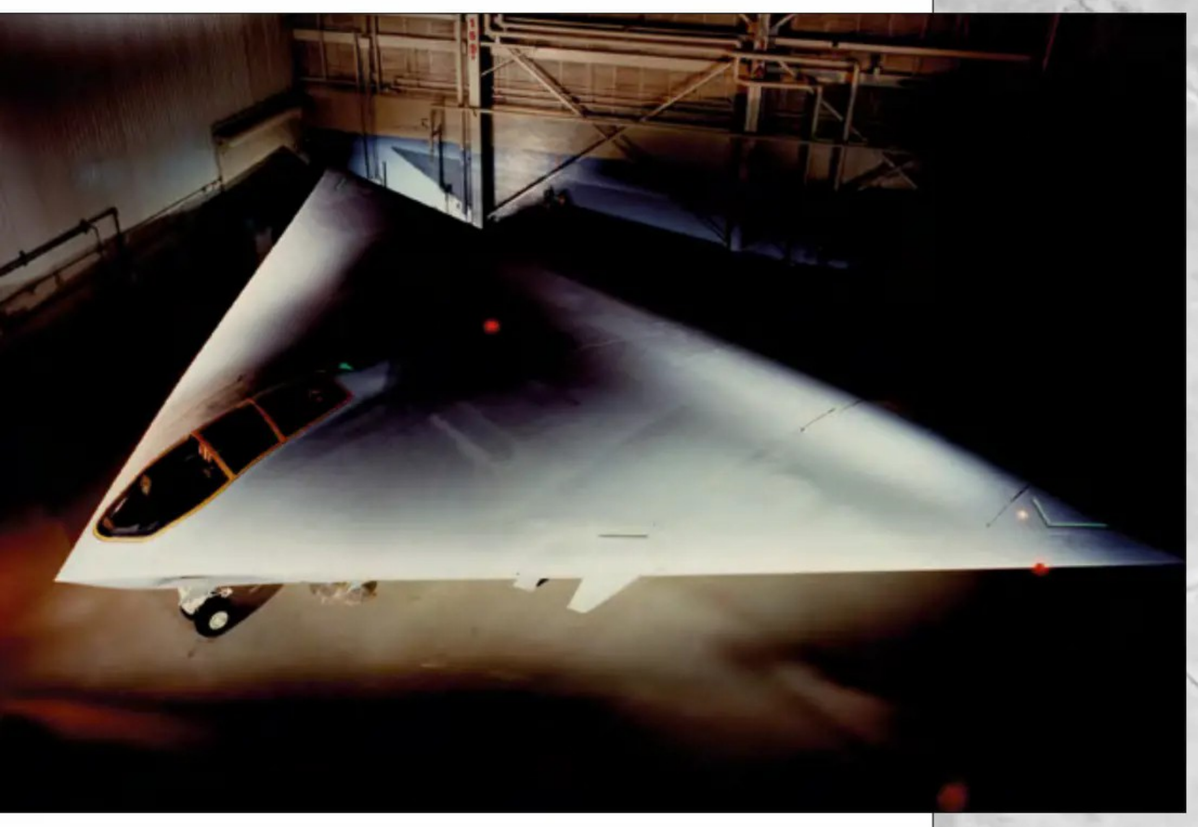
The programme was controversial, with much opposition to a subsonic aircraft and was cancelled in April 1961, as was the Eagle missile. The TF-30 engines found their way into the F-111B then the F-14A Tomcat, as did much of the technology for the AWG-9 radar. The fire-control system for the AIM-54 Phoenix owed much to the ASG-18 system which had originally been developed for the abortive F-108 Rapier project for the USAF.

Above: ***An artist's impression of the Rockwell XFV-12 VTOL fighter. Thrust would have been adequate for forward flight, but not for getting airborne in vertical take-off mode.***

In 1972 the Navy began a programme for a follow-on to the AV-8A Harrier for use on the proposed small aircraft carriers called Sea Control Ships. Rockwell (successor to North American) responded with the XFV-12A, which was partly comprised of components from other aircraft, mainly the A-4 Skyhawk and F-4 Phantom. The engine may have been left over from F-14B Tomcat testing. The thrust from this was ejected through a type of venetian blind arrangement in the wings and canards to provide vertical lift. This was called a 'thrust augmentor wing'. Lab tests proved that instead of 55% of engine thrust being available for vertical lift, only about 25% was, enough to lift only 75% of the aircraft.

Right: ***The Convair XFY-1 Pogo standing on its small castoring landing gear. Getting aboard was just the first of the test pilot's problems.***

Below: ***Few images of the A-12 other than artists' impressions and mock-up photos ever emerged. Over $2bn was spent for little tangible result.***



Increasing costs saw only one prototype completed, and it seems it never flew beyond some tethered trials in 1978. Eventually it was cancelled, as was the class of ship for which it was intended. Rockwell preferred to ignore this inglorious chapter in its history.

The most notorious cancelled Navy project was the General Dynamics/McDonnell Douglas A-12 Avenger II. The two manufacturers appropriated the name of an earlier Grumman product for their proposed stealth replacement for the A-6 Intruder all-weather attack bomber. Sadly the Avenger II was not destined to be a classic like the wartime TBF.

Intended to use more sophisticated stealth techniques than the USAF's F-117A Nighthawk, the A-12 was a trapezoidal shape with smooth, rather than faceted, surfaces for scattering radar beams. Its appearance led to the nickname of 'Flying Dorito'.

With two 13,000lb-thrust (7.8kN) General Electric F412-400 turbofan engines, it would have carried more weapons than the F-117 and had an air-to-air capability. Developed largely in secrecy and without proper oversight, the cost rose to a reported $100m each and the weight was up to 30% above specification. Plans to buy 620 for the Navy and 238 for the Marines was cancelled by Defense Secretary Dick Cheney in January 1991, just before the Gulf War and a few months before the prototype's expected first flight. The issue was out of the courts for years and only settled, five trials and two appeals later, in favour of the manufacturers in 2014.

Navy UCAVs

Drones on the Flight Deck

The Navy has a long history of unmanned (or uninhabited) vehicles used mainly as aerial targets and weapons research, but has great plans for combat and support roles, and expects 60% of the future carrier air wing to consist of autonomous vehicles in the future.

Amidst a confusing range of programmes and acronyms, the Navy has sponsored three jet Unmanned Combat Air Systems (UCAS) vehicles that have reached the flight-test page. Under the Navy's Unmanned Combat Air System Demonstrator (UCAS-D) programme, Scaled Composites at Mojave built the arrowhead-shaped X-47A Pegasus for Northrop Grumman and it first flew on 4 February 2003 at China Lake, California. It lacked naval features such as a tail hook but reportedly had weapons bays capable of carrying two 500lb dummy bombs. The powerplant was a Pratt & Whitney Canada JT15D rated at 3,190lb st (14.2kN) and wingspan was 27ft 10in (8.5 m).

The X-47A was followed by the altogether different Northrop Grumman X-47B, the first of which (AV-1) flew on 4 February 2011 at Edwards Air Force Base. The undercarriage was first raised for cruising flight on the ninth flight in September.

A second X-47B flew in November and testing soon moved to NAS Patuxent River, Maryland. The X-47Bs are larger than the 'A, with a wingspan of 62ft (18.9m) and a maximum take-off weight of 44,500lb (20,185kg). The wingtips fold for carrier operation, but there is no weapons capability. The engine was a Pratt & Whitney F100-220U turbofan producing 14,590 pounds-force (64.9 kN)



Above: ***The Scaled Composites/Northrop Grumman X-47A was a small demonstrator only flown from land from 2003 until the J-UCAS programme was cancelled in 2006.*** *NG*

Carrier trials began on USS *Harry S Truman* in 2012 with basic compatibility and deck operation trials and were wholly successful. A second round begun in May 2013 saw the X-47B make catapult launches and arrested landings aboard USS *George H. W. Bush*. By April 2014, night operations were being tested and the X-47B proved it could be integrated into normal air wing activities. For these achievements the X-47B programme was awarded the prestigious Collier Trophy for aviation innovation in 2014.

In April 2015 the X-47B AV-2 demonstrated autonomous aerial refuelling when it took on 4,000lb (1,814kg) of fuel from an Omega

Below: ***In 2013-14 The X-47B made carrier landings and take-offs and proved it could be integrated into an air wing, but the Navy's unmanned stealthy strike effort was shelved.*** *NG*

