OSPREY COMBAT AIRCRAFT • 89

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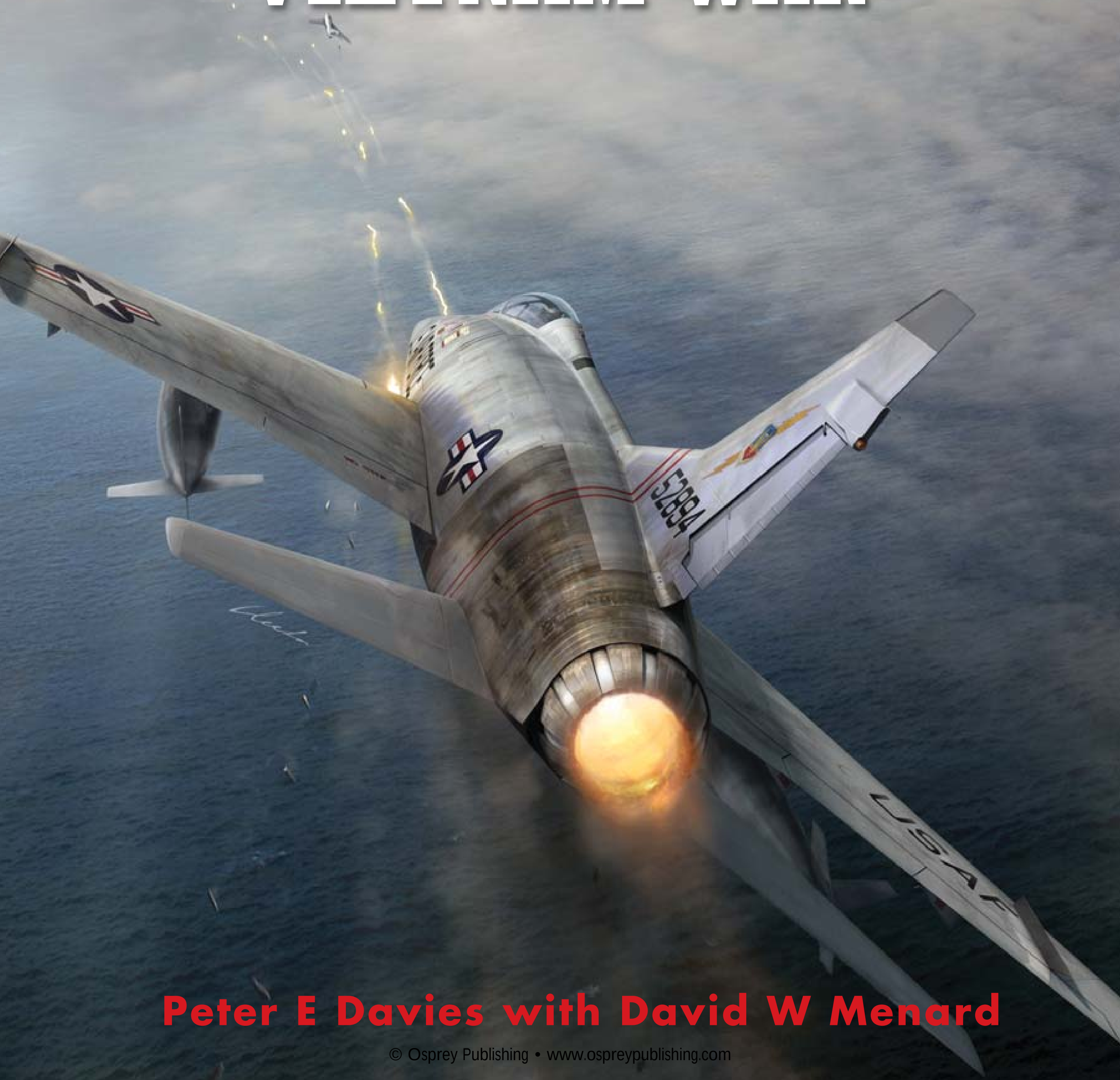
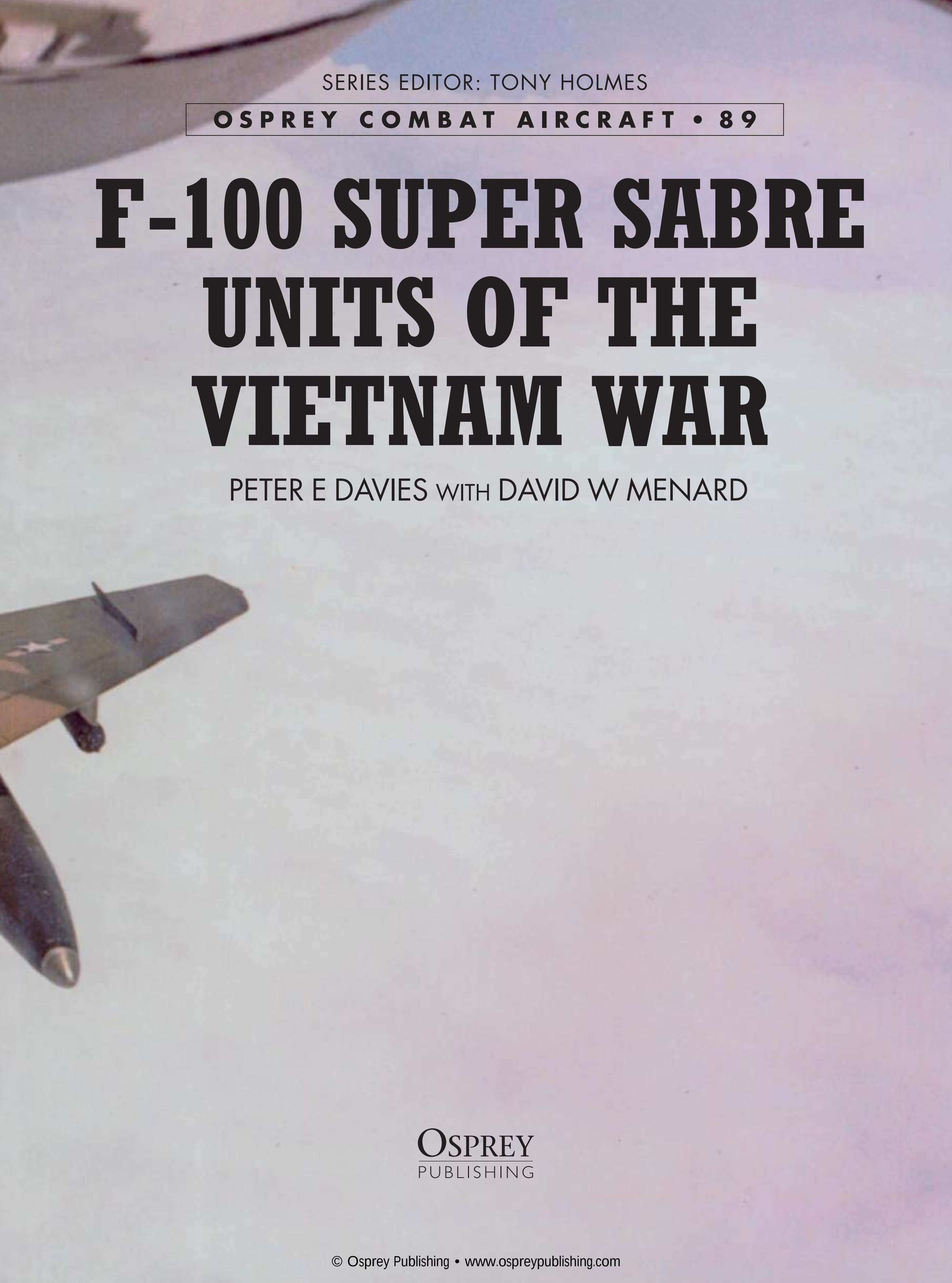


Peter E Davies with David W Menard



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# F-100 SUPER SABRE UNITS OF THE VIETNAM WAR

PETER E DAVIES WITH DAVID W MENARD

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# DEVELOPMENT

The North American Aviation (NAA) F-100 Super Sabre's immediate predecessor, the XP/F-86 Sabre, was ordered in 1945 while the company's most famous product, the P-51 Mustang, was still fighting in World War 2. In the drastic shrinkage that ravaged the aviation industry post-war, the company survived by developing its original, straight-wing, jet-powered XP-86 design into a swept-wing, 618 mph success that first flew on 10 October 1947 and quickly became the USAF's principal fighter. On 26 April 1948 it was the first Western combat aircraft to exceed the speed of sound in a shallow dive. Total production reached 8117 aircraft, and the F-86 served with 26 air forces. During the Korean War its official kill ratio exceeded eight-to-one against the broadly equivalent, and in some respects superior, MiG-15.

More than a year before the F-86 first fought MiGs in late 1950, NAA's Chief Engineer Ray Rice and Head of Design Ed Schmued had already commenced work on its replacement. Their initial goal was sustained supersonic speed in level flight, which required two main innovations – an afterburning engine and a more sharply swept wing. Based on captured German documentation into swept wing designs, the company's Chief Aerodynamicist Ed Horkey had conceived the 35-degree swept wing for the F-86. This was increased to 45 degrees for the new design, known as the NA-180 'Sabre 45'.

The F-86's performance was limited mainly by its early General Electric J47 engine. Its structure required a relatively fat fuselage and its thrust was limited to 5910 lbs. For the NA-180, the much longer, 42 inches wide, two-stage Pratt & Whitney J57 was chosen. This revolutionary powerplant originated in 1948 as the government-funded JT3 for Boeing's XB-52 Stratofortress, and it soon became the first turbojet to exceed 10,000 lbs thrust. The engine used an innovative two-spool, 16-stage axial flow compressor offering higher compression and improved fuel consumption. For supersonic applications, an additional afterburner section increased maximum thrust to 16,000 lbs with a massive, sudden, 'on or off' power boost that could not be graduated as in later engines like the J79 that powered the F-4 Phantom II. More than 21,000 J57s were built for a wide range of jets including the McDonnell F-101 Voodoo, Convair F-102 Delta Dagger and the Boeing 707.

The J57 needed a long intake duct to control the airflow to the engine, and this, combined with the 20 ft afterburner section and additional fuel and equipment, resulted in an airframe that was roughly ten feet longer than the F-86A's and 15,000 lbs heavier when loaded. The F-100A's wings spanned less than 20 inches more than the F-86A's, although they were almost 100 sq ft greater in area.

Gun armament were retained, with the four manually-charged 20 mm M-39 cannons that replaced the Sabre's six Browning 0.50-in machine guns giving the new fighter far greater hitting power. Produced by General Electric's Pontiac Division from 1953, the M-39 fired belt-fed


**Provision of an afterburner that added almost 50 percent extra thrust was one of the F-100's main innovations. This early F-100A-10-NA has the weight-saving short tail and reduced rudder area that caused major stability problems. The fin and rudder were subsequently increased by 27 percent on 70 early F-100As and 108 more that were already on the production line. Wingspan was also increased by 26 inches at that stage. Bearing the serial 53-1529, this aircraft was transferred to the air force of the Republic of China, and it is presently on display at Chiayi air base (*Author's collection*)**

M-50-series ammunition. Space and weight restrictions in the F-100 limited each gun to 200 rounds, giving around eight seconds of firing time. Four magazine boxes were situated close to the cockpit, with shell cases being ejected from chutes in the lower fuselage and spent links collected internally. Automatic purge doors opened during gun firing to prevent the build-up of explosive gases within the weapons bay.

Alarmed by the emergence of the very capable MiG-15 in Korea and apprehensive about the next generation of Soviet fighters, the USAF encouraged NAA to push the 'Sabre 45' concept beyond conventional technology as fast as possible. This in turn meant that an order for two YF-100A prototypes placed on 7 December 1951 also funded a number of design and manufacturing innovations.

Huge investment in milling and forging machines, using new metals such as titanium, allowed radically new airframe structures to be built. The main fuselage was assembled from two hollow halves, each stretch-pressed from a single sheet of metal. Wing-skins were tapered from root to tip, and they also had integral stiffeners milled into them for the first time, rather than the traditional structure using spars and wing-ribs. This all meant simpler, lighter structures with fewer components and fasteners. The F-100 (officially named Super Sabre in December 1951) was also cheaper than later 'Century Series' aircraft, although it was the first fighter to cost more than $1 million per copy.

Early F-100s had flapless wings with no internal fuel and powered inboard ailerons to counter the phenomenon of 'control reversal' that occurred when thin wings twisted under the aerodynamic loads placed on outboard ailerons at high speeds. The quest for supersonic flight produced a wing with a thickness/chord ratio of only seven per cent. Automatic Kruger slats were attached to the leading edge to improve low-speed handling and add lift at takeoff. These slats slid down or retracted on roller tracks depending on the aerodynamic loads on the wing to reduce the stalling speed. Checking their movement manually became part of the pilot's pre-flight inspection, as Maj Dick Garrett recalled;

'Those aerodynamically retracted slats had a nasty habit of developing sticky rollers, causing one wing to have extended slats and the other to have the slat retracted. This usually happened at slow airspeeds, when pulling high gs or when flying with a high angle-of-attack, the "Hun" snap rolling in the direction of the retracted slat.'

Conscious of a tendency for swept-wing jets to pitch up sharply when the tailplane was blanked off at high angles-of-attack, the F-100 designers placed the innovative one-piece, powered slab tailplane as low as possible on the rear fuselage, out of the vortices streaming back from the wing.

The fuselage contained all 750 gallons of internal fuel in five bladder tanks, which were not self-sealing in an effort to save 400 lbs of weight. A large hydraulic 'barn door' speed brake could be extended from below the fuselage at speeds below 500 knots to rapidly decelerate the jet and improve turn rate in combat.

As a daytime, clear weather fighter, the F-100A required no radar apart from a simple gun-laying set, making it one of the last fighters with a single air intake starting at its nose. The intake's thin outer lip was the end result of wind-tunnel tests in the new facility that NAA had acquired in 1949. These tests also prompted the decision to lengthen the fuselage by nine inches and reduce the thickness/chord ratio of the vertical and horizontal tail surfaces to 3.5 percent.

The J57 engine and its afterburner extended for 24 ft inside the fuselage, the latter also accommodating a comparatively spacious cockpit and three hydraulically operated landing gear units. Main gear units had multi-disc brakes and an anti-skid system, while the nose-gear had steering (which doubled as a shimmy damper) and two small wheels to allow the unit to fit below the air intake duct. Weight-saving and drag reduction were major priorities in the search for speed. Even the 60-lb fixed tail bumper was replaced by a lighter, retractable unit. Early test flights revealed that this approach had gone too far in the case of the vertical stabiliser, where, against the advice of designer Ed Schmued, its height had been reduced by more than two feet, thus interfering with the F-100's basic control 'metabolism'. In pilot 'Moose' Moseley's estimation, 'the "Hun" was a rudder aeroplane. The slower you got the more rudder you used, and you stayed away from the ailerons as they were trouble. You didn't slow down, and were careful of the roll mode'.

Driven by the urgent need to stay ahead of rapid Soviet fighter design progress, the USAF sought to accelerate its own procurement process by putting approved designs straight into production before flight testing was completed, rather than waiting in the traditional way for a series of one-off prototypes to refine and evolve the designs up to production standard. Known as the Cook-Craigie policy, it presumed that advanced design techniques and wind-tunnel testing would engender aircraft that could be 'flown off the drawing board'. Flight testing would then serve to prove the design, and any consequent minor modifications could be made during production without big changes to the production jigs and drawings. Applied to the contemporaneous F-102 Delta Dagger, this approach resulted in a fighter that was unable to achieve its intended supersonic performance without major airframe re-design in the light of initial testing *after* production had begun.

Adhering to the Cook-Craigie policy, the USAF ordered 273 F-100As on 26 August 1952 while the first prototype YF-100A was still under construction – 'YF' indicated a 'pre-production' machine rather than an 'XF' experimental prototype. This first aircraft, 52-5754, was completed on 24 April 1953, and flight testing began at Edwards AFB, California. Test pilot, and World War 2 ace, George 'Wheaties' Welch went supersonic during the aircraft's first two flights on 25 May, and the first 100 hours of tests revealed no problems apart from the need for hydraulic dampers to cure rudder flutter. Phase II evaluation involved eight USAF pilots, including such legends as Chuck Yeager and Pete Everest, to assess the fighter's suitability for squadron use.

Yeager was among the first to note the YF-100A's lack of longitudinal stability at speed, particularly when carrying external fuel tanks. Everest had reservations about the fighter's high landing speed and slow control and engine response at low speeds – quirks that were to catch pilots out throughout the F-100's career. On 29 October 1953 he used the first prototype to break the world speed record, but keeping the jet stable beyond 767 mph at an altitude below 150 ft proved difficult. Production continued nevertheless, and another 93 examples were ordered despite the fact that five more testing phases were still to be completed.

NAA decided in October 1954 that expanded production of future variants required a second plant. Accordingly, the former Curtiss-Wright factory in Columbus, Ohio, was established as an additional source. However, the eventual production total of 2294 F-100s – less than NAA had hoped for, and only a quarter of the F-86 total – could have been achieved at the company's main Inglewood plant in California.

The first 60 Inglewood-built F-100As were quickly pressed into service with the 479th Fighter (Day) Wing at George AFB, California, from 29 September 1954, wing CO, Lt Col M G Long, flying the first example (53-1541) in. A number of his pilots were Korean War MiG killers, and they immediately began to explore the F-100A's superiority over their previous F-86Fs. Stability problems soon emerged, and NAA's 'tech rep' to the 479th, Jack Bailey, recalled how a pilot showed him 'the numerous paint marks where his helmet had hit the canopy. He was unable to describe exactly what had happened, but it appeared that he had experienced the same kind of inertial coupling which would later claim the life of George Welch and ground the F-100 for the rest of 1954'.

Indeed, on 12 October 1954 the ninth production F-100A (52-5764) disintegrated at 20,000 ft during the last in a series of maximum g/maximum speed dives for the NAA Palmdale Flight Test Center, killing George Welch. Photographic evidence of this accident, as well as a similar incident just two days later, showed that earlier concerns about the F-100A's reduced vertical tail and rudder area were justified since the short vertical surface on Welch's aircraft had failed during an uncontrollable supersonic yaw for which it could not provide adequate directional stability. Operational F-100As were grounded for three months in the wake of this crash, during which time all aircraft were fitted with larger tails at the company's expense.

Although handling was significantly improved, two more F-100As were lost in a 48-hour period due to control problems, bringing the total written off to six, and triggering another prolonged grounding, exacerbated by a three-month strike at the NAA factory. The 479th FDW's initial operational capability was delayed until September 1955, and the last of 122 F-100As was finally delivered at the end of that year.

The aircraft was proving to be such a handful that at least one pilot asked to be relieved from flying duties rather than face the F-100A again. This was a time of experimentation and consequent risk for jet pilots.

In one nine-month period of 1956-57, Royal Air Force aircrew casualties included one fatality per week on average, most of them in early jet fighters – USAF statistics were even worse.

The USAF was already re-casting the F-100 as a fighter-bomber rather than an interceptor. A similar future awaited most of its fighters as Tactical Air Command (TAC) adopted a nuclear strike role (under Strategic Air Command influence) in the mid-1950s. Fighter pilots would have to wait for the F-15A before a 'pure fighter' re-emerged.

For the follow-on F-100C, intended to replace TAC's nuclear-capable Republic F-84F, NAA added 422 gallons of extra fuel in sealed wing spaces and two extra bolt-on stores pylons to each wing. The crucial range extender, however, was in-flight refuelling through a short, straight probe beneath the right wing. Although this made the F-100 the world's first fighter to possess such a capability, regularly placing the short probe in a tanker's refuelling 'basket' (preceded by an unstable aluminium funnel) was not easy, as Col Tom Germscheid recalled;

'It was virtually impossible to see the end of the probe from your normal cockpit position. You had to guess where it was and hit the basket with pretty good acceleration so as to engage the latch. You would look for the hose to "snake" when you hit the basket. If you didn't see it snake as you advanced the last ten feet then you had almost certainly missed the drogue, and the basket was probably beating up your wing slats or fuselage sides. Later, they put a bend in the extended probe, raising the tip up about three feet. You could then see it from the cockpit out of your peripheral vision, and this made refuelling a piece of cake.'

USAF tankers at that stage were piston-engined KB-50 Superfortresses, whose top speed approximated to the F-100C's 250-knot stalling speed, or the even slower KC-97 Stratofreighter. Refuelling required tanker and fighter to descend in a 'toboggan' manoeuvre so as to sufficiently reduce the F-100's angle-of-attack. The 'basket' had an inertia reel system that was supposed to retract the hose slightly when then F-100 made contact. Sometimes this did not work, and a 'whiplash' wave motion over-flexed the short refuelling boom, snapping it off. Unexpected turbulence could do the same to the longer, curved boom, which could also be left badly bent out of shape. Things had improved by the time Jerry Key joined the 522nd TFS at Cannon AFB, New Mexico, in 1967;

'When I got into the "Hun" all the hard work was already done, and I always thought refuelling was a real hoot. I liked doing it as it took more skill than in the later A-7D, where the pilot simply had to fly formation aft of the tanker and let the boom operator do the work.'

The F-100C had the more powerful J57-P-21 engine, making it the fastest Super Sabre of them all.

**The F-100C's two extra pylons gave the Super Sabre strike capability. A centreline stores position was also available, wired for a nuclear store but more often used for an SUU-21 dispenser with BDU-33 or Mk 106 practice bombs or a tow-dart target rig. In combat, the centreline station occasionally held a camera pod, but it was never used for weapons carriage during the war (*Rockwell International*)**

It also had better yaw and pitch damping, as well as the M-1 bombing system to deliver a 5500-lb maximum bomb-load. Many pilots converting to the F-100C from the F-84F were delighted that it required around half the take-off run of their previous steed. A new avionics package included TACAN, a radio compass, ILS and an AN/APG-30A radar ranging set for the A-4 gunsight. Subsequent additions included the MA-2 low altitude bombing system (LABS), an MB-3 autopilot (rated as 'notoriously terrible' by pilot Alex Martin) and clearance for stores including cluster bomb units, MK series bombs and (for Air National Guard F-100Cs only) the AIM-9 Sidewinder.

A typical training load for the formerly 'clean' day fighter at this time would see it in '1-E3' configuration – 250-gal tanks on the left outboard and right inboard pylons and a 275-gal 'banana' tank on the right intermediate pylon balancing out a universal weapons pylon (nuclear) on the left intermediate. The remaining right outboard pylon often carried practice bombs. All external tanks had to be empty for a safe landing with this asymmetric load. Vietnam War F-100C/Ds usually carried Mk III 'stretched' 335-gal or big 450-gal 'bags' when deploying.

By January 1957 476 F-100Cs had been produced, a number of which gave more than 30 years of service flying with US and foreign air forces.

The F-100D became the main variant, with a peak number of 70 airframes per month emerging from the two NAA factories in 1957 for a total of 1274 aircraft. First flown on 24 January 1956, the D-model had another four-inch height extension to the vertical stabiliser and an AN/APS-54 tail warning radar antenna housed above the rudder. It was 1200 lbs heavier than the F-100C, and in later D-models this weight difference was to increase still further, making inboard trailing edge wing flaps a vital addition for safe landings. These kept touchdown speeds to around 150 knots. F-100Ds also had a new centreline hard point to take a Mk 28 nuclear store (requiring modifications to the air-brake for adequate clearance of this projection) and an improved zero altitude/minimum airspeed ejection seat.

The unprecedented expense involved in building Century Series fighters meant that the creation of two-seat trainer versions of these aircraft were low on the US government's list of priorities. However, towards the end of the Super Sabre's production cycle a two-seat version, designated the F-100F, was finally ordered.

During the F-100's first 100,000 flight hours, 95 major accidents and six fatalities gave it the worst safety record to date for an American supersonic fighter. These worrying statistics would soon be surpassed by the Lockheed F-104 Starfighter, however, crashes of which resulted in the deaths of 18 pilots in the early years of the programme.

The initial cadre of Super Sabre pilots had to transition straight onto the fighter from other more docile types. Following a series of accidents, NAA proposed a two-seat 'TF-100C' in May 1954, and a modified C-model (54-1966) with an F-100D vertical stabiliser and a second cockpit in a three-foot forward fuselage extension went supersonic on its first flight on 3 August 1956. It was followed in March 1957 by the first true F-100F, which featured D-model wings, only two guns and a weight increase of about 1000 lbs. Although the training attrition rate was not significantly reduced following the service introduction of the