Down in California they've been . . .

HOTTING-UP THE DOUGLAS HOT-ROD

And the new versions of the A-4 Skyhawk now projected may give Heinemann's masterpiece a new lease of life. Already, 2,000 of the bantam bombers have been ordered in five variants and the first export contracts have recently been concluded.

THE DOUGLAS A-4 SKYHAWK first entered service with the US Navy in October 1956 and according to present plans it will remain in front-line operations with the Navy and Marine units at least until 1974. Since the Navy signed the first contract to initiate A-4 development in June 1952, 1,845 examples have been ordered of the four single-seat versions. Production on these contracts will end in April this year, when the two-seat TA-4E will begin to come off the line; present contracts are for a total of 139, extending production into 1967, but eventual procurement may run much higher.

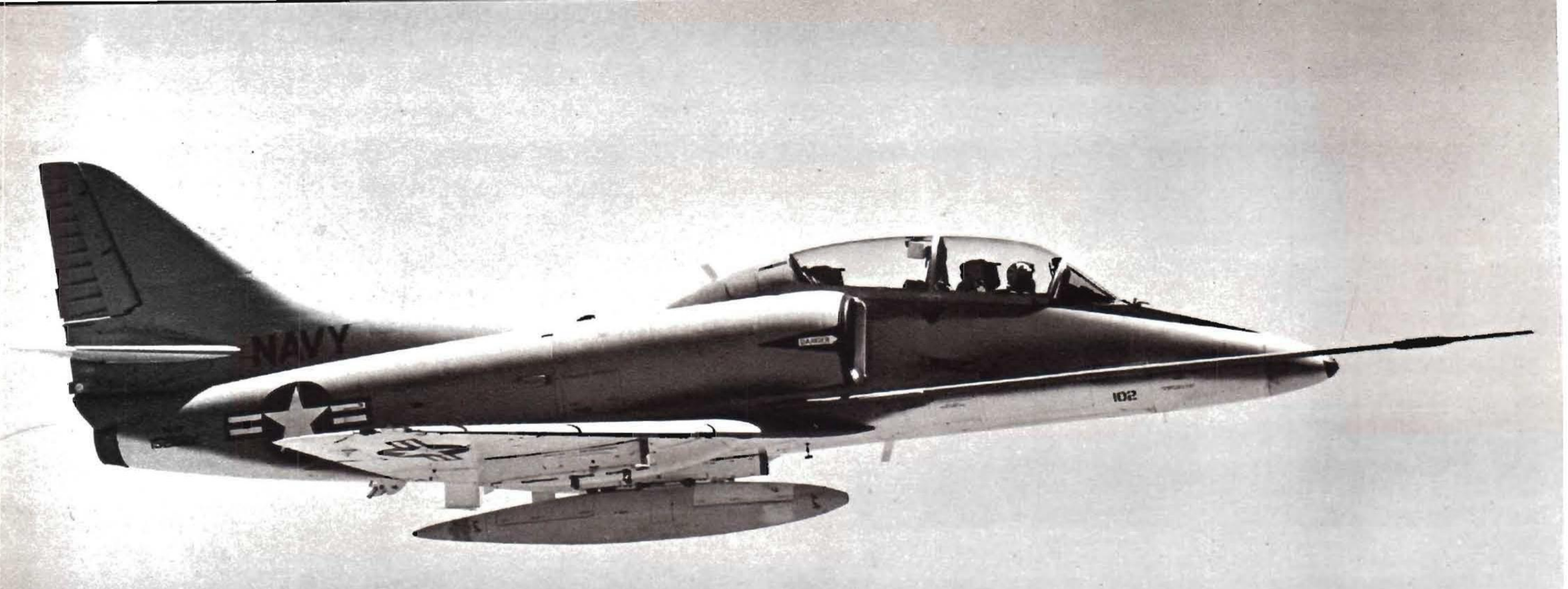
After initial US Navy requirements for the TA-4E have been met, the single-seater will go back into production to meet a recent Australian order for eight A-4Es and two TA-4Es, required for service aboard HMAS *Melbourne*. These ten aircraft are scheduled for delivery by the end of 1967. Meanwhile, work has begun on refurbishing a batch of 50 surplus US Navy A-4Bs which have been purchased by the Argentine Air Force under a $7,180,200 (£2.8 m) deal. The first of these refurbished aircraft flew at the Douglas Tulsa plant on December 31, 1965 and deliveries to the Argentine will begin in June. As part of the deal, Douglas will provide spare parts and technical support for five years.

Douglas made a major effort last year to sell to Canada an export version of the Skyhawk known as the CA-4E (single-seat) and CA-4F (two-seat). In competition with the A-7A Corsair II and F-5A Freedom Fighter, the CA-4E was unsuccessful, but a further development with Rolls-Royce Spey engine has more recently been offered to various European air forces seeking a new tactical fighter-bomber. The Spey A-4 is one of the types which has been evaluated by the Belgian and Netherlands Air Forces in the current search for new equipment for the reconnaissance, strike and close support roles. Douglas has made proposals to five European countries (including Belgium, Holland and Italy) for co-production, with preliminary design and flight testing to be done in the USA and the remainder of research, development and production shared between the participating countries.

IMPROVEMENTS WITH THE SPEY

The Spey A-4 is based on the proposed CA-4E airframe which was a single-seat development of the TA-4E, incorporating many of the latter's improvements plus new features of its own. Like the TA-4E, the CA-4E has a 9,300 lb st (4 220 kgp) Pratt & Whitney J52-P-8A turbojet, lift dumpers, steerable nose-wheel, zero-zero ejection seat and modernized electronics. In addition, the wing and fuselage store positions have been strengthened, to

Douglas added to the versatility of the Skyhawk by designing for it multiple bomb racks which can be installed on three store stations and can each carry six bombs, as shown in this picture. Each of the outer store stations is carrying an ASM-7 Bullpup A air-to-ground missile. Heading this page is a picture of three A-4Es from Navy attack squadron VA-56.



The first of two prototypes of the TA-4E in flight with a fuel tank on the fuselage strong-point. First flown on June 30th and August 2, 1965, respectively, the two TA-4Es had flown 295 hours in 225 flights by the beginning of 1966.

permit maximum loads of 4,600 lb (2 086 kg) on the fuselage, 2,600 lb (1 180 kg) on each inner wing position and 1,000 lb (454 kg) loads on the outer pylons. The maximum weight is increased by 2,920 lb (1 325 kg) to 27,420 lb (12 440 kg), and low pressure tyres are introduced for operations from unprepared fields.

All these features are offered in the Spey A-4, but use of the Rolls-Royce turbofan offers 41 per cent more thrust and 17-24 per cent lower cruising sfc compared with the J52-P-6A in the standard Navy A-4E, with consequent performance improvement. The Spey version in the Skyhawk is the RB.168-20, rated at 12,000 lb st (5 443 kgp) and specified also for the HS 801 (maritime Comet); it is essentially an unreheated version of the RB.168-25R specified for the F-4K Phantom II and is a military version of the RB.163-25 in the later Tridents and One-Elevens.

The Spey weighs some 470 lb (213 kg) more than the J52 and has a frame diameter 3.5 in (8,9 cm) greater. To accommodate this larger engine, the fuselage of the Skyhawk is deepened by 5 in (12,7 cm) aft of the self-sealing fuel tank behind the cockpit, and is lengthened by a 10 in (25,4 cm) section just aft of the cockpit. The engine air intakes are enlarged to match the greater air mass flow requirement, the minimum cross-section of the inlet duct being increased from 3.3 sq ft to 5 sq ft (0,31 to 0,46 m²). The changes to the fuselage involve a small increase in fin area by increasing the chord and the overall height of the fin.

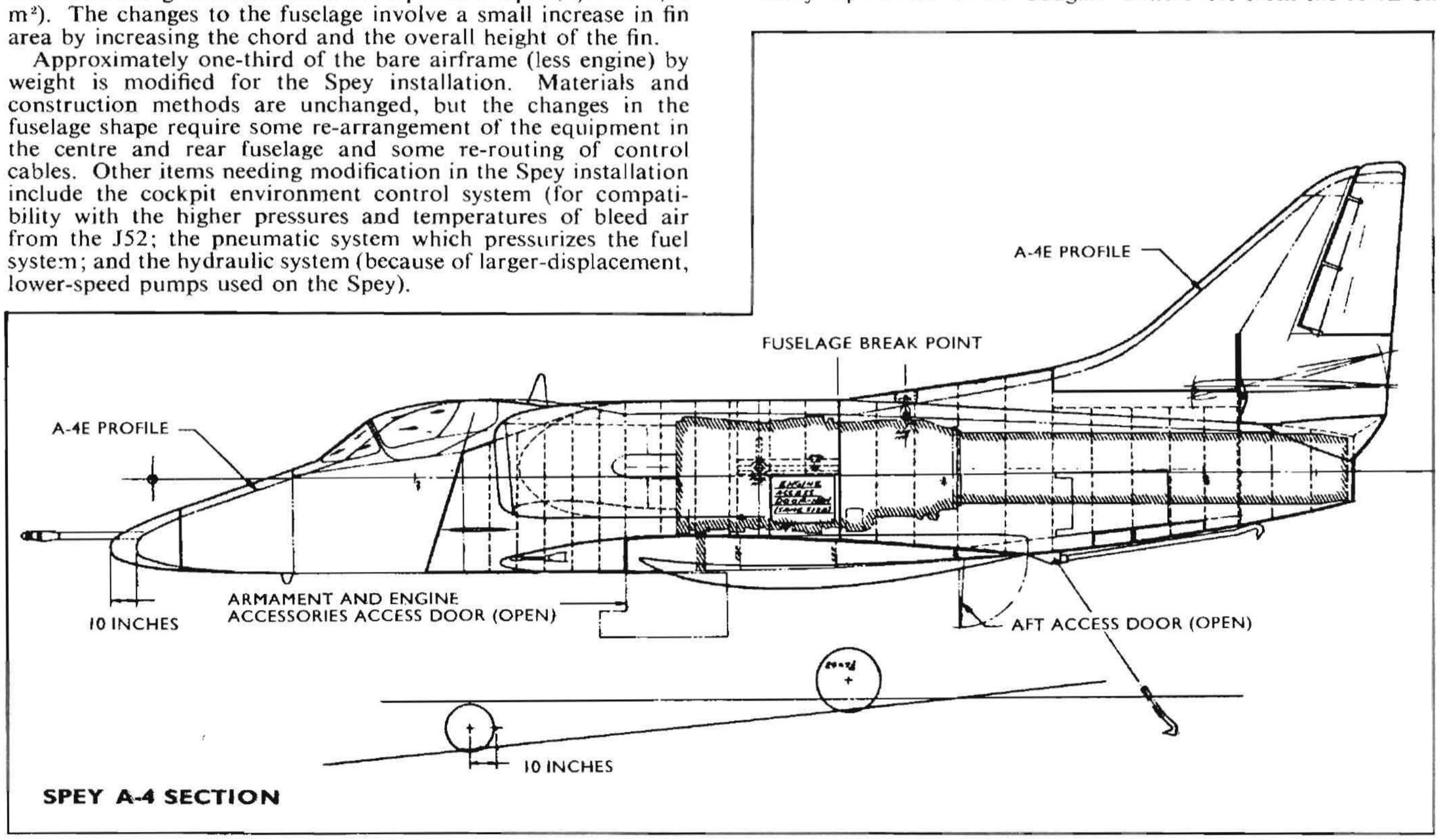
Approximately one-third of the bare airframe (less engine) by weight is modified for the Spey installation. Materials and construction methods are unchanged, but the changes in the fuselage shape require some re-arrangement of the equipment in the centre and rear fuselage and some re-routing of control cables. Other items needing modification in the Spey installation include the cockpit environment control system (for compatibility with the higher pressures and temperatures of bleed air from the J52; the pneumatic system which pressurizes the fuel system; and the hydraulic system (because of larger-displacement, lower-speed pumps used on the Spey).

The Spey A-4 has an empty weight of 10,739 lb (4 871 kg), compared with 9,853 lb (4 470 kg) for the standard A-4E. As already noted, there is a 2,920 lb (1 325 kg) difference in maximum weights and the maximum ordnance load is increased to 12,000 lb (5 443 kg). Key points of the Spey A-4's performance are its ability to take-off in 3,840 ft (1 170 m) at max weight; its 2,750 naut mile (5 095 km) ferry range without refuelling and its Mach 0.92 max speed (590 knots—1 093 km/h) at 35,000 ft (10 670 m).

Douglas estimate that there is currently a market for about 2,000 low-cost ground attack aircraft, to replace F-84s, F-86s and other obsolescent aircraft. The competition for this market is growing, not only from other US manufacturers (primarily Northrop with the F-5A and Ling-Temco-Vought with the A-7A) but also from the European industry, primarily with the BAC/Breguet Jaguar (see Vol 21 No 6 p 371). At $764,000 (£272,000) complete with all-weather navigation equipment, the Spey A-4 is among the lowest priced of the available types, and is offered in quantity in less than two years from go-ahead.

THE SKYHAWK TRAINER

Design of the TA-4E was undertaken to meet US Navy requirements for an advanced tactical trainer to supplement and eventually replace the TF-9J Cougar. Differences from the A-4E on



SPEY A-4 SECTION

which the trainer was based comprise, primarily, the longer front fuselage incorporating two seats in tandem under a single long canopy; and the uprated J52-P-8A engine, the same model as used by the Navy in the Grumman A-6A Intruder.

Both pilots in the TA-4E have Douglas Escapac 1C ejection seats, with zero altitude capability and a speed range of 0-600 knots (1 110 km/h). The rear seat is raised 9 in (22 cm) above the front to give a good view ahead, and a blind flying hood is available in the rear cockpit.

The TA-4E retains the five external store positions of the A-4E plus two 20 mm MK 12 guns in the wing roots with 100 rounds per gun. The fuselage strong point has a carrying capacity of 3,575 lb (1 620 kg); each inner wing station can carry 2,240 lb (1 015 kg) and the outer wing stations will take 570 lb (258 kg) each. Among the stores which can be carried in various combinations are 250 lb (113 kg) MK 81 bombs, 500 lb (227 kg) MK 82 bombs, napalm or fuel tanks, mines, rocket pods or 20 mm gun pods, air-to-surface missiles or buddy in-flight refuelling packs.

Internal fuel capacity of the TA-4E prototypes was reduced by 140 US gallons (527 l) compared with that of the single-seat A-4, because the additional cockpit limited available fuselage space. To overcome this in the projected CA-4F export two-seater, Douglas designed a saddle tank over the engine behind the rear cockpit, and this is expected to be adopted in production TA-4Es for the US Navy.

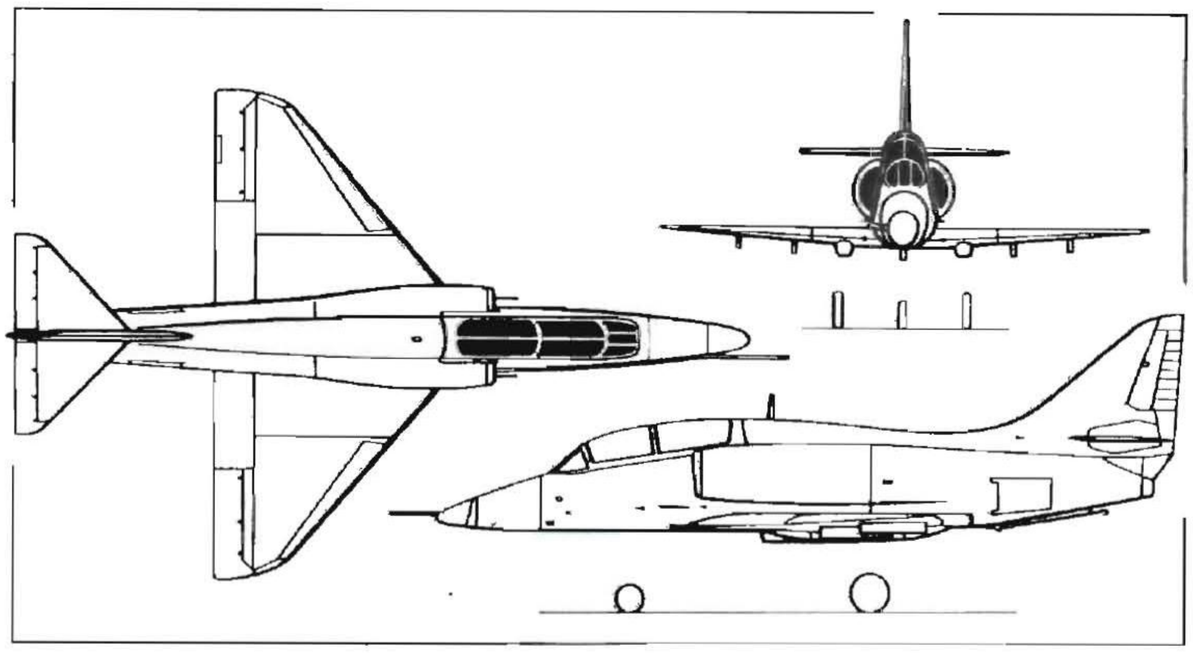
The TA-4E electronics are basically the same as used in the A-4E with duplication in the two cockpits where necessary. Equipment specified as standard includes:

APG-53A	terrain clearance radar (forward cockpit)
AJB-3A	low altitude bombing system (forward cockpit, with all-attitude reference repeated in rear)
ARC-51	UHF communication (both cockpits)
ARR-69	UHF auxiliary receiver (both cockpits)
ARA-50	ADF (both cockpits)
ASN-41	dead reckoning navigation (forward cockpit)
ARN-52	TACAN (either cockpit)
APX-64	IFF radar beacon (forward cockpit)
APN-141	radar altimeter

The Skyhawk has a Douglas-designed Bendix flight control system which provides stability augmentation, attitude, altitude and heading hold, pre-selection of heading and control stick steering by the pilot. The consoles for this system can be installed in either cockpit. Ailerons, rudder and elevators are all hydraulically-actuated through tandem packs, either one of which will operate the system if the other fails. There are two independent 3,000 psi (211 kg/cm²) hydraulic systems, each with its own reservoir, pump and warning system. Also hydraulically operated are the landing gear, nosewheel steering, flaps, fuselage speed brakes and spoilers. The variable incidence tailplane is actuated electrically.

Based as it is upon a carrier-qualified combat aircraft, the TA-4E is compatible with USN aircraft carriers and a deck-landing hook is standard equipment. The stalky undercarriage permits stores with a diameter of up to 31 in (0,78 m) to be carried on the fuselage centreline when the aircraft is being catapulted. The approach speed is 133 knots (246 km/h) at the maximum arrested landing weight of 14,500 lb (6 577 kg) and the maximum weight for steam-catapult launch is 24,500 lb (11 113 kg).

The first prototype of the TA-4E made its first flight on June 30, 1965 and the second on August 2nd. Work had already begun on



Introduction of the second seat in the Skyhawk fuselage reduces the capacity of the standard fuel tank from 240 to 100 US gal (909 to 378 l). The capacity can be restored by adding a 210 gal (796 l) dorsal tank behind the cockpits as shown above; the modification was designed for the CA-4F and is applicable to the TA-4E.

An A-4C from Squadron VA-36 (USS Shangri-La) poses with some of the ordnance which can be carried. In addition to the variety of bombs, this array includes ASM-7 Bullpup A and GAR-8 Sidewinder 1A missiles, LAU-3A/A 19-shot 2.75-in rocket packs, and LAU-10/A 4-shot 5-in Zuni rocket packs. The aircraft itself is carrying two fuel tanks and a Douglas-developed D704 in-flight refuelling store.

	A-4E (J52-P-6)	TA-4E (J52-P-8A)	CA-4E (J52-P-8A)	A-4E (SPEY)
Empty weight lb (kg)	9,853 (4 469)	10,602 (4 810)	9,937 (4 507)	10,739 (4 871)
Take-off weight (clean) lb (kg)	16,216 (7 355)	15,783 (7 160)	16,300 (7 395)	17,058 (7 737)
Take-off weight (max) lb (kg)	24,500 (11 113)	24,500 (11 113)	27,420 (12 437)	27,420 (12 437)
Take-off distance (clean) ft (m)	1,710 (521)	— —	1,610 (490)	1,200 (366)
Take-off distance (max) ft (m)	5,280 (1 610)	5,280 (1 610)	6,320 (1·926)	3,840 (1170)
Max speed (clean) knots (km/h)	585 (1 084)	574 (1 064)	581 (1 076)	590 (1 093)
Combat radius with 4,000 lb (1 815 kg) bomb load, naut miles (km)	290 (537)	390 (723)	330 (612)	412 (764)
Ferry range, naut miles (km)	2,195 (4 068)	2,200 (4 080)	2,120 (3 930)	2,750 (5 095)
Stalling speed (approach) knots (km/h)	92 (170)	100 (185)	92 (170)	96 (178)
Landing distance, ft (m)	3,410 (1 040)	3,040 (927)	1,600 (488)	1,750 (533)

the first production batch of 35 ordered earlier in 1965 and the first of these is likely to fly in April. A second order for 104 has subsequently been placed and total procurement up to and including fiscal year 1967 is expected to be 152.

THE SKYHAWK FAMILY

US Navy and Marine Corps squadrons now operating Skyhawks over Vietnam are benefiting in a very real way from experience gained during the Korean War, for the A-4 was conceived in the period 1950-1952 when some tough lessons were being learnt over Korea with an earlier generation of combat aircraft. In the same period, the Douglas company conducted a series of design simplification studies which led early in 1952 to a proposal to the Navy's Bureau of Aeronautics for a lightweight fighter-interceptor. This proposal attracted Navy backing for the Douglas method of reducing weight and achieving a breakthrough in simplification, but the aircraft most needed at that time was a Skyraider-replacement in the ground-attack role. On June 21, 1952, the Navy placed a contract with Douglas for such an aircraft, then known as the XA4D-1. Its design gross weight was to be 15,000 lb (6 800 kg), exactly half the figure which the Navy had originally specified for a jet replacement for the AD-1 Skyraider. Other requirements were a top speed of 500 mph (805 km/h), combat radius of 460 miles (740 km) and the ability to carry 1,000 lb (453 kg) bombs.

An initial design target empty weight of 8,136 lb (3 690 kg) increased to 8,400 lb (3 810 kg) by the time the first Skyhawk was built, but the permitted gross weight went up to the remarkable figure of 22,000 lb (9 980 kg), of which total more than 8,000 lb (3 630 kg) could be in the form of external bomb-load over short distances. Both empty and maximum weights have increased in later models, and the A-4E can carry a maximum of 9,155 lb (4 150 kg) externally, and has greatly improved payload/range characteristics compared with the original model.

Design of the Skyhawk was directed by Ed Heinemann, then Douglas chief engineer at the El Segundo plant and the small size of the aircraft soon led to the appellation "Heinemann's Hot-Rod". Two prototypes and ten pre-production aircraft had been ordered initially, and the first of these flew on June 22, 1954, just two years after the formal contract was placed. Operational status was achieved just over two years later, on October 26, 1956, with USN Attack Squadron VA-72.

The first production version of the Skyhawk was the A-4A (originally A4D-1). It was powered by the 7,700 lb st (3 493 kgp) Wright J65-W-4B turbojet, an American-built version of the Armstrong Siddeley Sapphire, and had three external stores points, one under the fuselage and two under the wings. Production of the A-4A totalled 165, but even before deliveries to VA-72 began on September 9, 1956, Douglas had begun flight development of a new version, the A-4B (A4D-2).

SECOND ATTACK MODEL

First flown on March 26, 1956, the A-4B had 28 per cent new structure and equipment for improved performance and new roles, and was powered by a 7,700 lb st (3 493 kgp) J65-W-16A engine. The fuselage and landing gear were strengthened, the rudder and tailplane were redesigned, dual hydraulic flight controls were fitted, a single-point pressure fuelling system was introduced and provision made for in-flight refuelling, with a long probe extending forward from the starboard fuselage side. A new compass and a dead-reckoning navigation computer were introduced and provision made for air-to-ground missiles to be carried. In all, 542 examples of this version were built; most have now been relegated to second-line duty or declared surplus and as already noted, 50 have been sold to the Argentine Air Force.

On August 21, 1959, the third major Skyhawk variant, the A-4C, made its first flight. Originally designated A4D-2N, this had 15 per cent new structure and equipment to improve its capability for night and all-weather operations. Terrain clearance, navigation and ground ranging radar were added; with a new lengthened nose structure to accommodate the radome. Other new equipment comprised the AJB-3 all-attitude reference and loft bombing system and TPQ-10 ground control bombing system, an improved gunsight and the Douglas Escapac ejection seat. Production continued until 1961, a total of 638 coming off the El Segundo line. Some 20 Navy and Marine squadrons were operating this version of the Skyhawk in 1965.

The biggest redesign of the Skyhawk came in 1961 when plans to install the Pratt & Whitney J52 came to fruition after some delay. The first A-4E with this engine flew on July 12, 1961, other changes adding up to 29 per cent new structure and equipment. The 8,500 lb st (3 855 kgp) J52-P-6A permitted a further increase in weight and load-carrying ability, matched by general fuselage and wing strengthening. Two additional stores stations were introduced, one under each wing, and new equipment included TACAN, Doppler navigation, MK 9 toss-bombing system, radar altimeter and the AJB-3A low altitude bombing system.

When production of the A-4E for the US Navy ends in April, 500 will have been built; eight more are on order for delivery to the Royal Australian Navy in 1967.

By the Spring of 1965, Skyhawks had flown over 1,700,000 hours, in the course of which they had established the best reliability record of all USN attack aircraft. The mean time between failures which would be serious enough to cancel or degrade a mission is 23.6 hours, and using standard methods of assessment, this indicates that the A-4 has a 90 per cent probability of completing any particular 2½-hour mission.

Maintenance records are also outstanding for a carrier-based aircraft, USN combat squadrons having shown an average of 12.8 maintenance man-hours per flight hour. This reflects not only the basic simplicity of the Skyhawk design, but also the care taken to provide good accessibility. The safety record of the A-4 is also one of the best of all Naval jet tactical aircraft.

A-4s have been operational in Vietnam flying two primary missions—close support of South Vietnam troops and interdiction against targets in North Vietnam. Confirming experience with the type in other areas, the A-4s have achieved excellent availability rates—in the region of 95 per cent—and combat flying has not increased the maintenance man-hours significantly. The A-4 has also shown that it can absorb considerable damage and yet remain airworthy.

In a world of constantly escalating costs and growing complexity, the A-4 continues to vindicate its designers' philosophy of simple, straightforward design and stringent weight-saving techniques. The A-4E is still one of the cheapest tactical fighter-bombers on the market, and its cost-effectiveness, which was excellent in 1956, is still so good today that the 15-year-old design can hold its own in company with much newer types and—as the Australian purchase indicated only a few months ago—can still be shown to be the best aeroplane for the job.

DOUGLAS TA-4E SPECIFICATION

DIMENSIONS: Span, 27 ft 6 in (8,37 m); length, 42 ft 6in (13,0 m); height, 15 ft 4 in (4,67 m); wing area, 260 sq ft (24,15 m²); sweepback, 33.2 deg.
WEIGHTS: Empty, 10,602 lb (4 810 kg); operating weight empty, 11,295 lb (5 123 kg); take-off weight, clean, 15,783 lb (7 160 kg); max take-off weight, land or catapult, 24,500 lb (11 113 kg).
PERFORMANCE: Typical configuration for familiarization and instrument training; two 300 US gallon (1 135 l) external tanks; take-off weight, 20,396 lb (9 251 kg) with 8,568 lb (3 886 kg) of fuel. Take-off distance to 50 ft (15,2 m), standard day temperature at sea level, 4,810 ft (1 466 m); range, 1,350 naut miles (2 500 km); mission time, 3.2 hr; max speed at combat weight (60 per cent fuel) of 16,969 lb (7 697 kg), 549 knots (1 017 km/h) at sea level, 498 knots (923 km/h) at 35,000 ft (10 668 m); combat ceiling, 38,700 ft (11 796 m); stalling speed at landing weight of 12,935 lb (5 867 kg), 104 knots (193 km/h); landing distance from 50 ft (15,2 m), standard day temperature at sea level, 3,150 ft (960 m).
POWER PLANT: Type, one Pratt & Whitney J52-P-8A turbojet. Military rating, 9,300 lb st (4 218 kgp); normal thrust, 8,200 lb st (3 720 kgp). Fuel capacity, 560 US gal (2 120 l) in wing, 100 US gal (378 l) in fuselage, up to two 300 US gal (1 135 l) and one 400 US gal (1 510 l) tanks external.