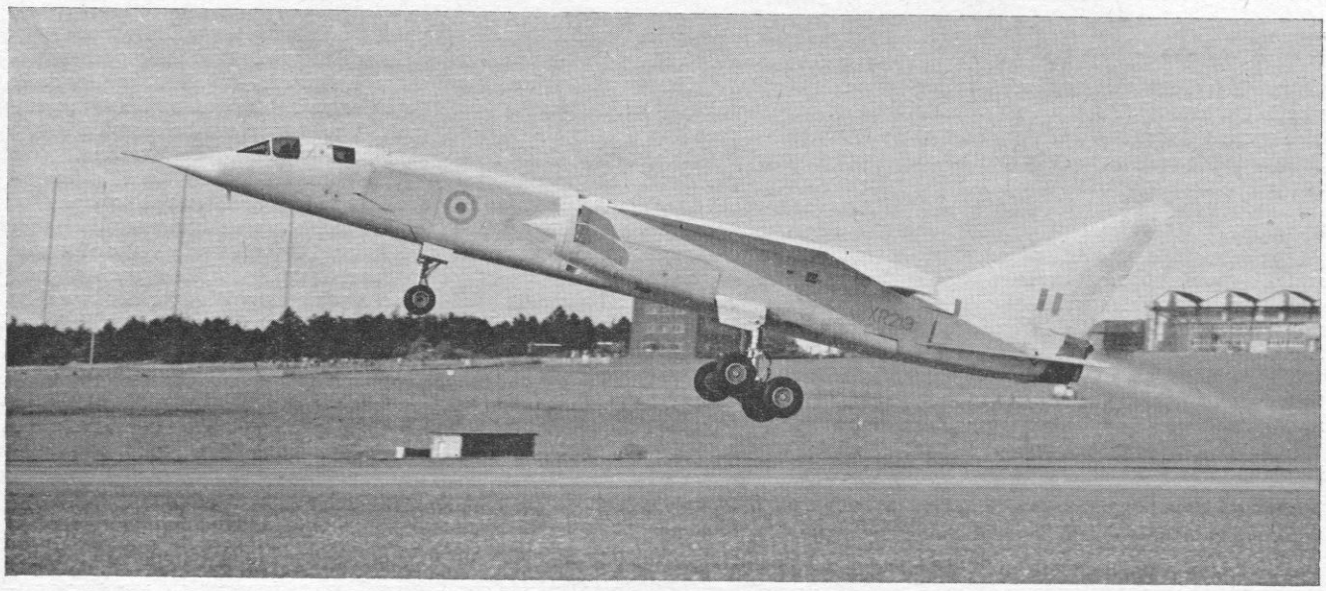

Piloted by Roland Beamont and with Donald Bowen as navigator, the TSR-2 takes off from Boscombe Down on its maiden flight. The undercarriage was kept extended throughout the flight and speed was limited to 250 knots

TSR-2

The most important weapon in Britain's armoury

FOLLOWING THE SUCCESSFUL first flight of the BAC TSR-2 on 27th September, the manufacturers have released additional information on this aircraft which, we firmly believe, will comprise part of the most important single weapons system in Britain's armoury during the coming decade.

In the tactical strike-reconnaissance role, for which it was originally designed, the TSR-2 will be capable of carrying out its tasks in any weather and at low-level supersonic speeds that present known defensive systems with an almost impossible problem. In future "limited wars" where sophisticated air opposition might be encountered, TSR-2 would be one of the few aircraft that could "get through" to its target.

In the strategic role TSR-2 will be fully capable of forming part of the nuclear deterrent, not only before the introduction of the Polaris submarines but also, later, to supplement the Polaris force. The details that follow have been provided by the British Aircraft Corporation.

First flight

Piloted by Mr. R. P. Beamont, deputy chief test pilot of BAC, with Mr. D. J. Bowen, chief test navigator, TSR-2, as observer, the aircraft took off from Boscombe Down in perfect weather at 15.28 hrs. After a short take-off run, it climbed away, accompanied by two chase aircraft—a Lightning T.4 piloted by Mr. J. L. Dell (chief test pilot of the Preston Division of BAC), and a Canberra piloted by Mr. John Carrodos, a Lightning experimental pilot of the Preston Division.

With the chase aircraft in close attendance, TSR-2 XR219 made two wide circuits of the airfield between 7,000 and 10,000 ft. before touching down for a perfect landing after a 15-minute flight. Earlier in the day, the aircraft had completed a short engine run and the last of its series of taxi-ing trials.

Afterwards, Mr. Beamont said: "The aircraft handled perfectly. I expected to have to work much harder than I did during the flight, but we had no trouble at all. I have just signed what we call the 'snag sheet' and there are no snags at all on it.

"The whole flight went according to plan. We completed everything we had planned to complete, and I think we have a winner in this aeroplane. It has been a long wait for this flight but we have got off to a good start. It was a thoroughly enjoyable flight."

In a statement later, Mr. Julian Amery, then Minister of Aviation, said: "The TSR-2 is probably the most complex airborne weapon system ever to be developed. Yet less than four years have passed between the placing of the development order and the first flight.

"The TSR-2 will go into service with the R.A.F. in about three years' time. It will be a formidable addition to Britain's military power."

TSR-2 is a two-seat, shoulder-wing aircraft, with a wing span of 37 ft., a length of 89 ft., and a height of 24 ft. No details of its performance may be released, but it can be said that it is capable of a speed in excess of Mach 2 at altitude and of flight at about the speed of sound at very low level.

Although it was designed as a tactical strike-reconnaissance aircraft, TSR-2 possesses a payload/range performance which gives Britain's defence planners a very useful strategic bonus.

TSR-2 is capable of carrying both nuclear and conventional weapons and of delivering them with unprecedented accuracy with little or no regard for the weather and over considerable ranges. It possesses a short field performance which enables it to operate from forward airstrips in any part of the world and has the most advanced navigation/attack system in the world.

The aircraft is fitted with automatic terrain-following equipment which enables it to operate at very low level and to penetrate below defence radar curtains at very high speed.

Olympus engines

TSR-2 is powered by two Bristol Siddeley Olympus 320 turbojet engines with reheat. A developed version of this engine will power the Concorde supersonic airliner. Olympus engines are capable of developing over 33,000 lb. thrust.

The aircraft has been designed and built by BAC's Preston and Weybridge Divisions. Weybridge has been responsible for design and development of the fuselage and the electronics and armament installations, and Preston for the wings, rear fuselage, engine installation, fuel system, powered flying controls and autostabilisers. The first aircraft have been assembled at Weybridge. Production will continue to be shared by the two Divisions.

BAC are building a pre-production batch of twenty aircraft, which will carry out both manufacturers' and Service development flying, and an initial production batch of thirty for the Royal Air Force,

TSR-2 . . .

which plans TSR-2's introduction to service in the latter half of the 1960s. Initial development flying will be carried out in Britain and later flying may be carried out at the Woomera range in Australia.

Design

The aircraft configuration was determined by four main requirements:

(i) The performance and minimum gust response required for low-level penetration in all weathers, by day and night.

(ii) The need for high supersonic speeds (in excess of Mach 2) at altitude to dodge fighter defences.

(iii) The need for long range both at low altitude for strike and for ferry at altitude.

(iv) The need for STOL capability for operation from forward airfields.

The thin delta wing planform provides the optimum compromise between small area and low gust response (essential for low-level supersonic flight) and an adequate aspect ratio for STOL performance. The aircraft has an all-moving fin and all-moving, fully powered tailplane which replaces the conventional elevators and ailerons. Adoption of this "taileron" design leaves the full span of the wing trailing edge free for full-span blown flaps, for which air is bled from the two engines. The turned down wingtips counteract the dihedral effect of the delta wing form.

The rear fuselage of the aircraft has been kept as short as possible to allow the maximum ground incidence. The nose undercarriage is also capable of being extended or shortened so that the aircraft can sit on the runway at different angles, the nose-high attitude having the effect of increasing lift and so of shortening the take-off run. The blown flaps combine with the very high thrust/weight ratio to give excellent STOL performance.

The landing gear has been designed to ensure the strength necessary for operation from rough surfaces, and the relatively large wheels have low-pressure tyres to withstand the high impact and single-wheel loads at high speeds when operating from soft dispersed areas.

A large tail parachute, which can be reefed, is used for braking when landing on small airfields.

Construction

Structural design and choice of materials have been dictated by the need to reconcile the demands of high-altitude, high-speed flight with the problems of low-altitude flying.

The wings and fuselage of TSR-2 are largely of integral construction, with stiffened skins machined from stretched billet. This technique was pioneered at Weybridge on the Vanguard airliner and extended on the VC10 and BAC One-Eleven. Where these aircraft had comparatively thick skins, however, TSR-2 has much thinner skins and sections, and the necessary stiffness is derived from integrally machining deep flanged stringers. To complement the milling equipment at Weybridge, the Preston Division has installed numerous skin-millers at its Accrington factory.

Operating at Mach 2 plus, TSR-2 is approaching the limits of light alloys. Some accepted light alloys have had to be developed to higher levels and, at the "hot end" of the aircraft, more advanced materials have been used.

Extensive research had first to be carried out by BAC on structural materials, including the transparencies used for the windscreen, canopies and radome, hydraulic system seals, fuel system sealants, etc.

A high order of precision was necessary during manufacture to ensure effective sealing of the fuel tanks and to give the required standards of interchangeability on items such as the fins, tailerons and airbrakes.

The two Bristol Siddeley Olympus 320 turbojets are installed in tunnels in the rear fuselage of the aircraft. The engines have fully variable intakes and variable-area nozzles and a reheat system controllable over the entire range by a single lever.

Bristol Siddeley also provide the Cumulus 50-h.p. single-shaft gas turbine used on TSR-2 as an on-board auxiliary power unit to supply pneumatic power for engine starting and cockpit and electrical air-conditioning and shaft power for electrical and hydraulic services on the ground.

Systems and equipment

BAC have taken direct responsibility for the design and development of TSR-2 as a fully integrated weapons system, co-ordinating every aspect of airframe and system design.

This has entailed laying down the outline of each system, agreeing on its specification with the sub-contractor, and ensuring that the elements of each system function in accordance with requirements. The corporation have introduced a method of "integrated systems checking" to facilitate check-out and servicing. All major elements are fitted with pick-off points for automatic check-out, giving what is believed to be the most comprehensive automatic check-out system yet developed. The automatic check-out equipment itself is supplied by Hawker Siddeley Dynamics Ltd. and is a development of TRACE.

To enable the aircraft to navigate to its target and attack in any weather, TSR-2 has been given the most advanced navigation/attack system in the world. It employs a forward-looking Ferranti radar which provides terrain-following signals to the aircraft, a Doppler radar (supplied by Decca Radar Ltd.) which measures ground speed and drift angle to a very high level of accuracy, and a sideways-looking radar (EMI Electronics Ltd.) to correct the Doppler/inertial fixes. The stable platform used in the Doppler/inertial system is supplied by Ferranti. Another EMI radar, looking sideways and downwards, is fitted as an aid to aerial reconnaissance and to provide a moving-target indication.

EMI also supply the Linescan reconnaissance equipment—in effect, an electronic "eye" scanning the ground below the aircraft. The output can be recorded in the aircraft or transmitted back to base.

The forward-looking and sideways-looking radars feed into a complex of digital and analogue computers (supplied by Elliott Flight Automation) and thence to the automatic pilot. Pilot and navigator have moving map displays developed by Ferranti from work done by R.A.E. Farnborough, and a "head-up display", projected on to the windscreen, focused on infinity, so that the pilot can fly on his instruments while still observing the terrain.

Flying controls for the TSR-2 have been developed by H. M. Hobson Ltd. in collaboration with the Preston Division of BAC. The requirements dictated by the need to combine high-speed low-level capability and supersonic all-weather capability set a problem greater than anything previously encountered in Europe. New materials, processes and techniques had to be developed, and extensive test facilities had to be created for the project.

Crew environment

A considerable programme of research and testing has been devoted to the problems of crew environment, particularly in the turbulent conditions of high-speed, low-level flight. Aspects of crew environment which have had to receive special attention include air conditioning and refrigeration, the provision of instruments capable of being read and manipulated under the worst conditions of flight, development of special clothing and harness, and development of an emergency escape system. The two rocket ejection seats have been designed, developed and manufactured by the Martin-Baker Aircraft Co. in close association with BAC.

A previous article on TSR-2 with scale tone drawing, based on information available at the time, appeared in the December 1963 issue.

NORWICH FILM SHOW

THE WAVENEY FLYING Group are holding a combined aero enthusiasts film evening at the Assembly House, Norwich on Wednesday, 18th November at 7.30 p.m. Films will include: "Fools, Geniuses and Daredevils" (inter-war development of flying and the barnstorming days); "The Sky's the Limit" ("Tiger" Club and 111 Squadron Hunters demonstrate aerobatics); "Sweinfort" (U.S.A.F. film of B-17 Flying Fortress operations from East Anglian airfields, Bassingbourn, Honington and Framlingham); "Red Pelicans" (C.F.S. aerobatic team); "All Hands to Flying Stations" (R.N. carrier operations); and, "Crossover" (U.S.A.F. F-100 aerobatic team). Further details and tickets for the show can be obtained from the Waveney Flying Group, Broadland House, Oulton Broad, Lowestoft, Suffolk.