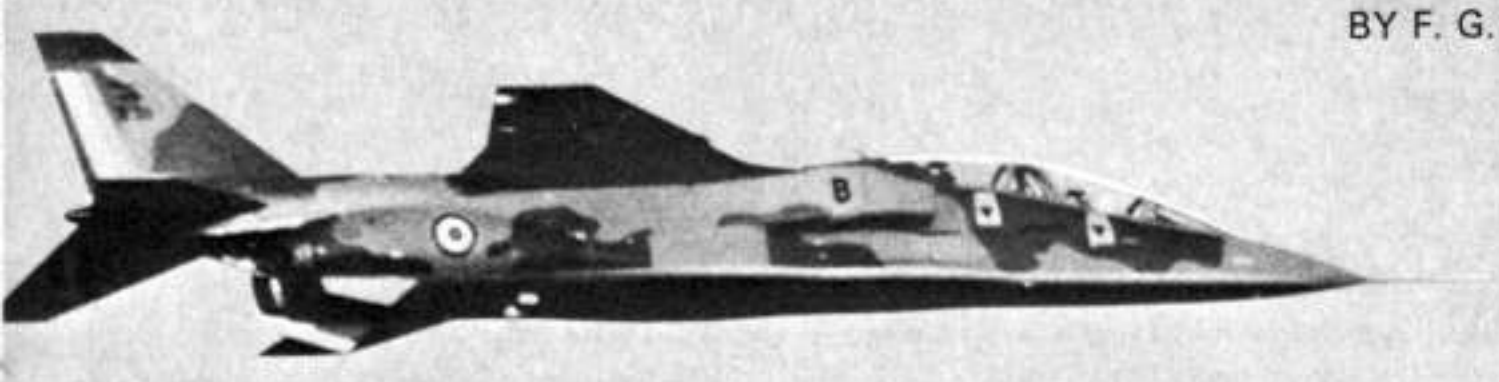
BY F. G. SWANBOROUGH



THE JAGUARS

ARE COMING

SOME TIME DURING THE NEXT YEAR OR SO, an RAF pilot will strap himself into the cockpit of a sleek, purposeful-looking aeroplane for a sortie which will be a little more than just routine. It will mark the RAF's formal acceptance of the first example of its newest warplane, the BAC/Breguet Jaguar. With operational conversion units receiving their first aircraft before the end of 1972, the Jaguar is expected to phase into full-scale operational RAF service in the UK and Germany in 1973-74, adding a potent new tactical support capability to the Service.

Although in the early days of project design Jaguar was regarded by the RAF primarily as a two-seat trainer, with only a secondary application in the strike role, changes in Britain's aircraft procurement policies and defence commitments have resulted in steadily increasing emphasis upon the tactical support version. The final step was the new government's decision in 1970 to delete Jaguar from its planned application as an advanced trainer but to increase the force of single-seat strike versions to nine squadrons. As a result, only sufficient trainers to equip an operational conversion unit and provide one for each operational squadron are now retained in the programme.

Numerically, therefore, the Jaguar is the most significant combat aeroplane purchased from the home aircraft industry since the Hunter. Qualitatively, it shows every promise of being just as significant in its contribution to modernising the RAF's ground-attack inventory. But Jaguar is notable also as the first warplane designed and built as an international project to reach operational service.

The concept of international collaboration in aeroplane ventures was embraced wholeheartedly by Britain during the 'sixties, for sound reasons. Launching a single new aircraft project to meet the combined requirements of two or more nations means that the certain market is enlarged from the start, thereby reducing both the unit cost of production aircraft for each customer and the initial investment required from each country to cover research and development costs.

It is a matter of history that not all Britain's attempts to collaborate with European partners have been successful. Nevertheless, the trio of Anglo-French helicopters (Gazelle, Puma and Lynx), the Panavia MRCA and Jaguar itself show every sign of vindicating the concept. Jaguar is not only cheaper than it would have been as an all-British programme, because of the longer production run, but also benefits from the combined inputs of two fine design teams and two highly respected fighting forces.

The operational role

Jaguar's role in the RAF is as a tactical strike and close support aircraft. This role calls for a number of special qualities. To understand the requirements, it is necessary to consider the kind of battle situation for which aircraft of this type are primarily needed.

That situation is likely to be one in which opposing ground forces are in close contact in a non-nuclear battle – typically represented by the Vietnam war and the Arab-Israeli conflict and not really so very different, in terms of the fighting environment, from the Allied offensive into Europe after D-Day. Tactical air support is needed to attack small, specific and possibly moving targets close to the front line – troop concentrations, gun emplacements, tanks, radar and missile sites, and so on. Aircraft for this mission will be required to fly at low altitudes, in a hostile environment. Target information may come from forward air controllers, or from reconnaissance sweeps, or 'targets of opportunity' may be spotted by the pilots during standing patrols.

To react quickly to calls for attacks on specific targets, aircraft must operate from bases close to the front line, which presupposes the ability to fly from small fields with semi-prepared surfaces. A heavy and varied weapon load must be accommodated, and an accurate navigation and weapon delivery system is vital because of the transient nature of the targets. The aircraft must also be capable of longer sorties for reconnaissance behind the enemy's lines, suggesting the need for external fuel as an alternative to weapons.

To keep under the enemy's radar net, the aircraft must operate for much of the time at altitudes below 500 ft, where it must have excellent manoeuvrability coupled with a high subsonic speed. It must also be able to resist a high degree of battle damage from small arms fire or heavier calibre weapons. A built-in gun armament is valuable, for attacking primary targets, to make defenders 'keep their heads down', and for self-defence against interceptors.

This is the kind of tactical situation which it is part of the RAF's responsibility to anticipate. Such a battle might have to be fought on the European mainland; but in other parts of the world, too, the threat of possible British involvement remains. The RAF units equipped for tactical ground support are therefore divided between No 38 Group of Air Support Command, which maintains maximum mobility for deployment to any part of the globe, and RAF Germany, which is part of Britain's commitment to NATO. It is expected that the nine squadrons of Jaguars will be divided approximately equally between these two commands. Two-seaters with full operational equipment and capability will be bought by the RAF in the ratio of one for every five single-seaters and will be used at the OCU and in the squadrons for continuation training.

When any new aircraft is introduced into service, it is usually looked upon as a replacement for an older type, but Jaguar has no real predecessor in the RAF. The last aeroplane adopted by the Service for the close-support role was the Hunter. In No 38 Group, ASC, the ground-attack Hunters have been replaced by the much more specialised V/STOL Harrier, whilst in Germany the responsibility is shared between Harriers and Phantoms. The latter type, purchased primarily as a replacement for the Lightning in its original interceptor and air superiority role, has also proved effective in tactical roles, notably in Vietnam and the Middle East. But the Phantom remains pre-eminently an interceptor and is far from being optimised for the tactical support role. In terms of airfield performance, navigation and weapon-aiming accuracy and ferry range, the Jaguar can out-perform the Phantom; in terms of range/load performance from limited runways, Jaguar again has the advantage.

RAF requirements for the single-seat Jaguar called for ability to carry a heavy and varied weapon load

To the extent that the Jaguar replaces anything in the RAF, therefore, it replaces the Phantom and the squadrons of the latter type now in Germany are scheduled to join Strike Command in the air defence role once the Jaguars get into service. The eventual tactical 'mix' by the end of the decade, therefore, will comprise Jaguars and Harriers for tactical support and the MRCA for longer-range interdiction/strike, while the Phantom will have become the basic interceptor. Beneath this front-line structure will be the new advanced trainer which is at present the subject of a design competition between Hawker Siddeley and BAC, and which is being bought to fulfill the training role in which, five years ago, the RAF had cast the Jaguar.

Evolution of the programme

Although Jaguar has been a joint Anglo-French programme since 1965, its roots lie in independent studies in the Operational Requirements branches of the Royal Air Force and the French Air Force *(L'Armée de L'Air)* going back to 1963 or earlier. During 1963, RAF studies of the then-current training sequence pointed up the need for a new type to replace the Gnat and Hunter in the advanced training role. The sequence then (and still today) began with a short period on the piston-engined Chipmunk for pilot suitability assessment, followed by basic training to 'wings' standard on the BAC Jet Provost. Then followed 70 hours on the Gnat, after which pilots destined for fighter squadrons required another 75 hours on the Hunter.

This is a costly arrangement and, with both Gnat and Hunter nearing the end of their RAF lives by 1975, there was obvious scope for a single aircraft to replace both. An Air

The French Navy's Jaguar M during trials on the carrier *Clemenceau* in July 1970

Staff Target requirement was therefore drawn up outlining this need, to stimulate design activity within the aircraft industry, and noted that the new aircraft might have a secondary counter-insurgency role. Project designs were prepared in several drawing offices, full integration within BAC and Hawker Siddeley not at that time having been achieved. Within the BAC group were the English Electric (Warton) P45, the Hunting (Luton) H.155, and some designs by the former Supermarine design team at Weybridge. In the Hawker Siddeley group were the Hawker HS.1173 and Folland Fo147 projects. Before formal consideration of these designs by the Air Staffs was possible, however, Anglo-French collaboration had been approved at government level and new plans were adopted.

France had begun studying a new advanced trainer somewhat earlier than Britain. In its very early stages, the French requirement also placed emphasis on the training role, with a secondary interest in the tactical combat possibilities of the aircraft, called the ECAP *(école appui,* or support trainer). However, by 1963, this had changed to ECAT *(avion d'école et d'appui tactique)* and the emphasis has switched firmly to the tactical role with a secondary application as a trainer.

A principal reason for this change of emphasis was the realisation that the Mirage IIIV V/STOL close-support project would not reach the operational targets set for it. An important part of this role was 'carpet-sweeping' ahead of the nuclear-armed Mirage IVs of the *force de frappe – ie,* knocking out enemy radar and anti-aircraft missile sites along routes to the targets. This remains today as part of the mission for the French Air Force Jaguars and explains some of the differences in equipment between French and British versions.

A full-scale design competition for the ECAT was launched in France, projects being submitted by the two nationalised concerns, Sud and Nord, and by three 'independents', Breguet, Dassault and Potez. (Through rationalisation of the French industry, Sud and Nord have become a single entity in Aérospatiale, Breguet is owned by Dassault, and Potez has quit aircraft production.) As a result of this competition, the Breguet Br 121 project was selected by the French Air Staff early in 1965.

Apart from the difference in emphasis on roles, the British and French requirements differed at this stage in other significant respects. France wanted the trainer version of ECAT in service by the end of 1970, with the tactical version following about two years later, while the RAF was talking about 1974 as the earliest in-service date for its new trainers. Both Services were interested in good field performance but the RAF specified a top speed of Mach 1·7 (1,123 mph) at high altitude while the French would be satisfied with Mach 1·1 (726 mph). France also made the unit price one of the most

In the RAF, the two-seat Jaguar will be used for operational training

important design objectives, with the ceiling price pegged (in 1963) below £0·5 million; the RAF was more willing to accept a higher cost for its higher performance aeroplane.

However, international collaboration had become politically desirable, and the two Air Staffs were not unwilling to discuss rationalisation of their needs. As early as March 1964, the first joint Anglo-French provisional operational requirement was issued to industry, for a dual-purpose, advanced, two-seat pilot-training/light strike aircraft. This document specified the interest of the French Air Force primarily in the operational version, and of the RAF and Royal Navy in the trainer, and also indicated that the aircraft might use variable geometry.

At that time, variable geometry tended to be regarded as a panacea for all problems, following the launching by the US Department of Defense in November 1962 of the TFX programme, in the polymorphic shape of the General Dynamics F-111. Variable geometry would indeed be valuable for the close-support aeroplane, by combining good short-field performance (wings forward) with excellent gust alleviation (wings back) at the very low altitudes required for under-the-radar penetration. But a 3% weight penalty, for the wing hinges, was a high price to pay in this kind of aeroplane, and a more definitive joint requirement document dated October 1964 indicated that the vg aeroplane would be difficult to achieve in the proposed time scale.

Early in 1965, therefore, Anglo-French studies diverged along two independent lines – one for a variable geometry interdictor/strike aircraft (the AFVG) and the other for a fixed-wing trainer/tactical support aircraft (Jaguar). These programmes became the basis of the Memorandum of Understanding signed by the respective Ministers of Defence, Messmer and Healey, on 17 May 1965.

By this time, France had selected the Breguet 121 as the ECAT aeroplane; and Dassault was working on variable-geometry versions of its Mirage fighter. Among the British design studies were a series of alternatives by the former English Electric Company at Warton whose partnership with Vickers on the TSR-2 had provided the foundations for British Aircraft Corporation. These parametric studies, under the design number P.45, included single and twin engined, fixed and vg layouts. The May agreement named BAC as the British partner both to join with Breguet for the smaller aeroplane based on the existing Br 121 designs, and with Dassault on the vg type, taking the P.45 as the basis.

Breguet had originally designed the twin-engined Br 121 around alternative engine proposals while the P.45 studies used either a single Rolls-Royce RB 168 or two RB 172s. Correctly interpreting the trend of official thinking, both RR and Bristol Siddeley concluded agreements with French companies – Turbomeca and SNECMA respectively – to collaborate in developing new engines. When the Anglo-French agreement was signed, however, it provided for engines for both the new aircraft to be jointly developed. Bristol Siddeley (now a division of Rolls-Royce) would work with SNECMA on a version of the French company's M45 for the AFVG and Rolls-Royce with Turbomeca on the engines for the strike-trainer.

The deal was a tidy package, equitably sharing responsibilities, but two years later France unilaterally pulled out of the AFVG. Among the consequences of this decision were a further delay in the in-service date of the RAF's new interdictor/strike aeroplane (now the Panavia MRCA – a further descendant of the P.45), and a bias in favour of France in the spread of design leaderships on the Anglo-French programmes. But work on the Jaguar continued smoothly and, if the AFVG highlighted the difficulties inherent in international collaboration, then it can be said that Jaguar proves the advantages.

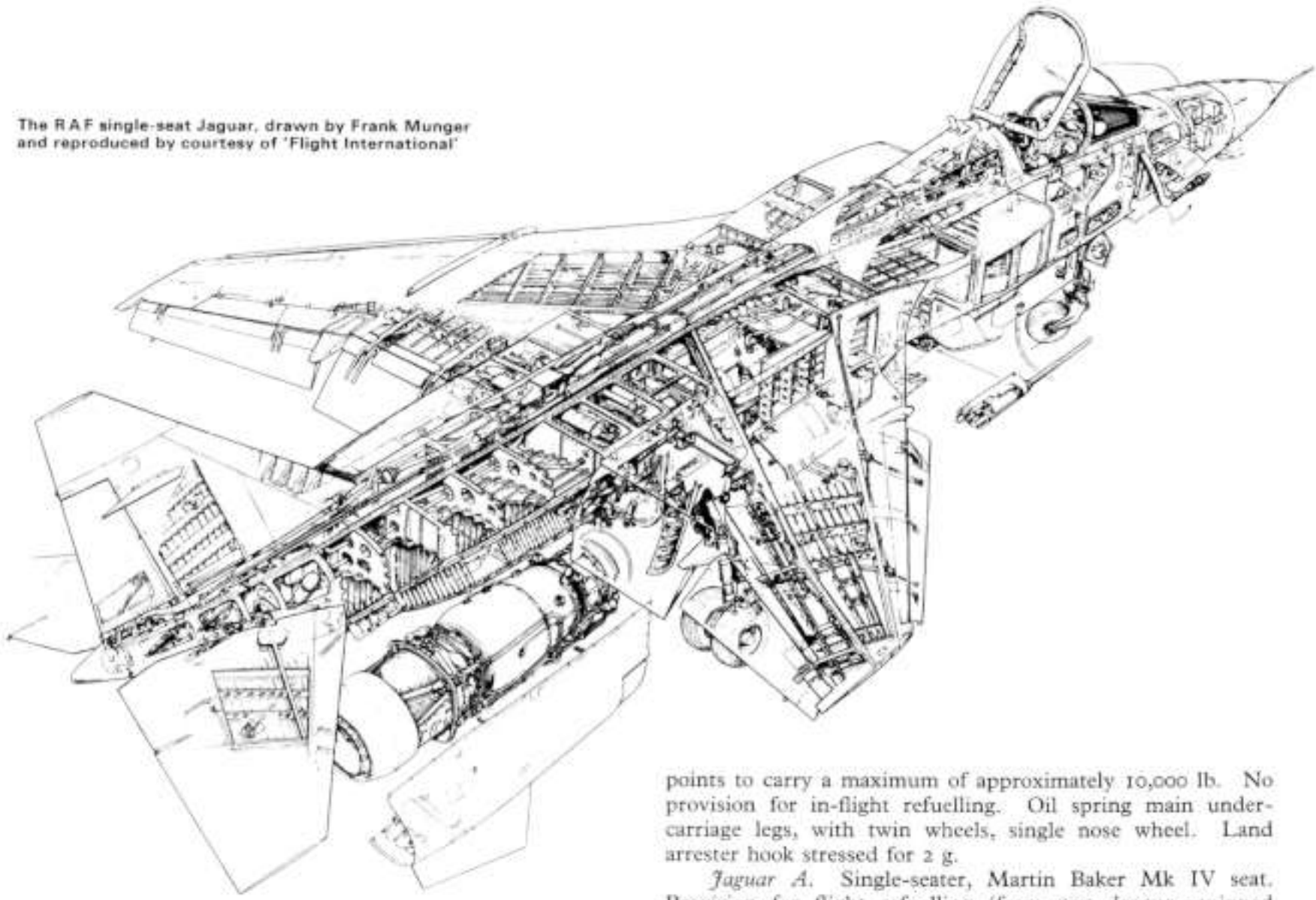
The Jaguar variants

Three versions of the Jaguar were projected at the time of the original 1965 Memorandum of Understanding. These comprised the French single-seat tactical aeroplane, and two-seat trainers in both French and British variants. The two signatories to the agreement committed themselves to the purchase of 300 aeroplanes – 150 trainers for the RAF and 75 of each variant for the French Air Force. The RAF continued to study the tactical version without any commitment to buy.

Little time was lost by the Breguet and BAC design teams in refining the basic Breguet 121 design to meet the new combined requirement. Whilst overall layout remained unchanged, major redesign was needed to increase the supersonic performance and permit a more extensive nav/attack system to be carried. The RAF initially insisted on the latter to obtain a trainer to cover the full spectrum of operational flying, with the useful result that no significant changes were needed when the RAF decided to buy the tactical Jaguar.

The changes to the Breguet 121 design, primarily to accommodate the 'British' parts of the requirement, included a thinner wing, higher gross weight (the original French target was about 16,000 lb), higher engine thrust, improved fatigue life, redesigned forward fuselage to improve the instructor's view from the rear cockpit, and internal redesign to accommodate the British nav/attack system. Inevitably, the aircraft unit cost rose, but the fully-equipped RAF strike Jaguar today is still less than £1 million per copy.

The R A F single-seat Jaguar, drawn by Frank Munger and reproduced by courtesy of 'Flight International'



The three initial versions were identified as Jaguar A (for *appui*) the French single-seater; Jaguar E *(école)* the French trainer; and Jaguar B, the British two-seater. Two more variants were officially added early in 1967. On January 16, an amendment to the Memorandum of Understanding increased the two countries' commitment to a total of 200 each and changed the distribution of variants. The extra French aircraft were for the Navy *(Aéro-navale)*, comprising 10 trainers and 40 single-seaters to a new specification for operation from aircraft carriers, called Jaguar M *(maritime)*.

The cancellation, during 1965, of new British aircraft types, including the TSR2 and the HS.1154, had by now increased the significance of the strike Jaguar. The British 'buy' therefore changed to 110 trainers and 90 of a new single-seat version, the Jaguar S (for strike). The trainers were still intended to replace the Gnat/Hunter sequence, while the single-seaters were earmarked to equip five squadrons – three in Germany, two in No 38 Group.

Then, in October 1970, the first White Paper on Defence by the new Conservative government increased the number of single-seaters to 165 and assigned 35 trainers for use in support of the Jaguar S force.

The differences between the five Jaguar variants now in production can be summarised as follows:

Jaguar E. The 'basic' aeroplane, a two-seater designed for advanced flying training rather than operational training. Martin Baker Mk IV ejection seats for each occupant, cleared for use at zero level and speeds down to 90 knots. Twin gyro platform with compass facility but no automatic navigation equipment. TACAN and an independent gyro gun sight are carried. Two DEFA 30 mm guns, with 150 rounds each, in fuselage gun-bay on port side, and five external stores points to carry a maximum of approximately 10,000 lb. No provision for in-flight refuelling. Oil spring main undercarriage legs, with twin wheels, single nose wheel. Land arrester hook stressed for 2 g.

Jaguar A. Single-seater, Martin Baker Mk IV seat. Provision for flight refuelling (from any drogue-equipped tanker) via retractable probe in forward starboard fuselage. Two DEFA guns with 150 rpg, in fuselage bays. Five external strong points and same weapons as Jaguar E. Nav/attack system based on that in Mirage IV, with a twin gyro platform and Doppler providing inputs to a navigation computer and bombing computer. Other equipment includes a computer for the AS 37 Martel anti-radar air-to-surface missile, an air data computer, TACAN, VOR/ILS, an incidence probe, radio altimeter and ECM (radar detection).

Jaguar M. Single-seater with Martin Baker Mk IX rocket ejection seat for zero-zero operation. Provision for flight refuelling and for carriage of buddy-pack for operation as refuelling tanker. Two DEFA guns; weapons and nav/attack system similar to Jaguar A with addition of laser rangefinder. Carrier deck and hard surface undercarriage, with large-diameter single wheels on oleo main legs and twin nose wheel on extensible leg for higher absorption rates and high angle of attack for catapult launching. Structural beefing for catapulting and for a 5·5 g arrester hook.

Jaguar S. Single-seater, Martin Baker Mk IX seat. Provision for flight refuelling. Two Aden 30 mm guns in fuselage bays with 150 rpg. Five external points and total weapon capability as for Jaguar A. Nav/attack system built around inertial platform and central navigation digital computer, with projected map display and head-up display, plus laser rangefinding. Other equipment includes TACAN, radio altimeter and incidence probe.

Jaguar B. Two-seater with Martin Baker Mk IX ejection seats. One Aden gun, in fuselage port side bay, with 150 rpg. Weapons provision and nav/attack system to same standard as Jaguar S without laser rangefinder. No provision for in-flight refuelling.

Up to 2,000 lb can be carried on the centreline strongpoint and each inner wing strongpoint

Weapons and weapon systems

All Jaguars (except the Jaguar B) are armed with two 30 mm guns with 150 rounds. The five strongpoints – one on the fuselage centre line, two beneath each wing – provide Jaguar with an overall external load capability, in round terms, of 10,000 lb.

The centreline point and two inner wing positions can each carry up to 2,000 lb weight, while the outboard wing points are capable of carrying about 1,100 lb (these weights are exclusive of pylons, bomb carriers, etc). Fuel tanks can be carried on the three inboard points only. The pylons themselves are made by BAC as part of the wing assembly and incorporate ML Aviation weapon ejection release units in the British Jaguars and Alkan units in French aircraft.

In common with most modern tactical aeroplanes, Jaguar can carry a very large variety of external stores, but the more immediate requirements of the initial customers call for a relatively conservative range of weapons to be cleared for use. In the case of the RAF, the maximum planned load is eight 1,000 lb free-fall or retarded bombs (pairs on the three inboard pylons, singles outboard). Alternatives are thirteen 540 lb bombs (triples inboard, pairs outboard), SNEB air-to-ground unguided rocket pods, 28 lb practice bombs or reconnaissance flares.

For the French anti-radar role, Jaguar A will carry Martel air-to-ground guided missiles on the three inboard pylons. Provision is made for Sidewinder air-to-air missiles and other weapons which may be required by future Jaguar customers.

As already indicated, the navigation/attack system for the RAF Jaguars is among the most comprehensive yet applied to a close-support aeroplane. The heart of the system is the Elliott MCS 920M navigation and weapon-aiming digital computer, with outputs to a head-up display and a projected map display. The inputs to the computer include position, distance and directional navigation information from Elliott's E.3R inertial platform; TACAN; radio altimeter and air data from the separate Elliott unit.

The MCS 920M unit is the smallest of a range of Elliott digital computers, with a word store capacity of 8,192 words and a weight of only 28 lb. Use of a digital unit was regarded as essential by the RAF in order to obtain the necessary flexibility and capacity for all future needs. Only an inertial velocity sensor can provide such a computer with inputs of sufficient accuracy.

The projected or moving map display is based on work undertaken at the RAE, Farnborough. The computer maintains a constant check on aircraft position in relation to the known starting point, for which the inertial platform can be callibrated with high accuracy. This position is then projected on to the screen against back-projected colour maps, automatically selected by the computer. Maps covering a total of 750 nautical square miles can be stored in the unit as 35 mm transparencies, at the standard scales of quarter million or half million, which can be selected by the pilot.

A feature of the central computer is that it can be used to fly the aeroplane to any pre-selected point. A pilot finding a target of opportunity when flying at, say 600 mph at 200 ft would have difficulty in returning to attack such a target without the computer's help. However, if target bearing and distance are fed into the computer as soon as it is seen, the aircraft can be flown back to the right position for target acquisition and successful aiming and release. The addition of the Westinghouse/Ferranti laser rangefinder closes one of the most significant gaps in weapon-delivery accuracy.

As visual search remains an important part of the Jaguar mission, a head-up display is essential. This equipment, produced by the Specto Division of Smiths Industries, projects on to the windscreen the information needed for the particular phase of flight and makes it unnecessary to refer to the conventional cockpit instrumentation.

Head-up information is presented either as numerals or symbols. The projection system is so arranged that these symbols are focussed at infinity ahead of the pilot, allowing him to scan the outside world without continually refocussing his eyes. The information presented includes height, airspeed, heading, vertical speed, time-to-go and weapon aiming information. Target information having been fed to the central computer, the head-up display will provide commands to the pilot whose task, put simply, is to fly so that a projected dot remains in the centre of a symbol representing the aircraft.

Development of the nav/attack system for the British Jaguar has proceeded in phase with prototype testing of the aircraft itself. The full system has been extensively tested on ground rigs both by Elliotts and by BAC. Components have undergone flight testing in Hastings and Comet aircraft provided by RAE, Farnborough, and a complete system has been installed in a Canberra for additional flight testing.

Typical stores 'mix' of fuel tank, bombs and SNEB rocket pods

Power plant development

Rolls-Royce Ltd began the project studies which eventually provided the basis for the Jaguar power plant in the early 'sixties. Initial interest was in the potential commercial market for a relatively small turbofan, of 4,000-5,000 lb thrust, designated RB.172. In 1963-64, military versions began to be considered for the British AST 362 design studies, and about this time also the engine was offered to the French companies involved in the ECAT design competition. The possibilities of joining with a French partner also began to be explored, on the initiative of Rolls-Royce Ltd.

On 11 February 1965 Rolls-Royce announced its agreement with Turbomeca SA to develop a 2,000 kg (4,400 lb) thrust engine, designated RB.172/T.260. Rolls-Royce and Turbomeca agreed to share design, development and production equally. The agreement was confirmed in official agreements between the two governments, and a joint company, Rolls-Royce Turbomeca Ltd was set up.

A small joint team of design engineers worked at the Turbomeca works in Bordes to establish the final specification during 1965. Named the Adour, the new engine was conceived as a compact, robust, two-shaft turbofan with a 1:1 bypass ratio and a short tailpipe incorporating a reheat system giving fully-modulated boost from 30% to 50% of maximum dry thrust. Competitive designs were prepared by the two companies, the best design being selected after detailed comparative tests and rig testing of major components.

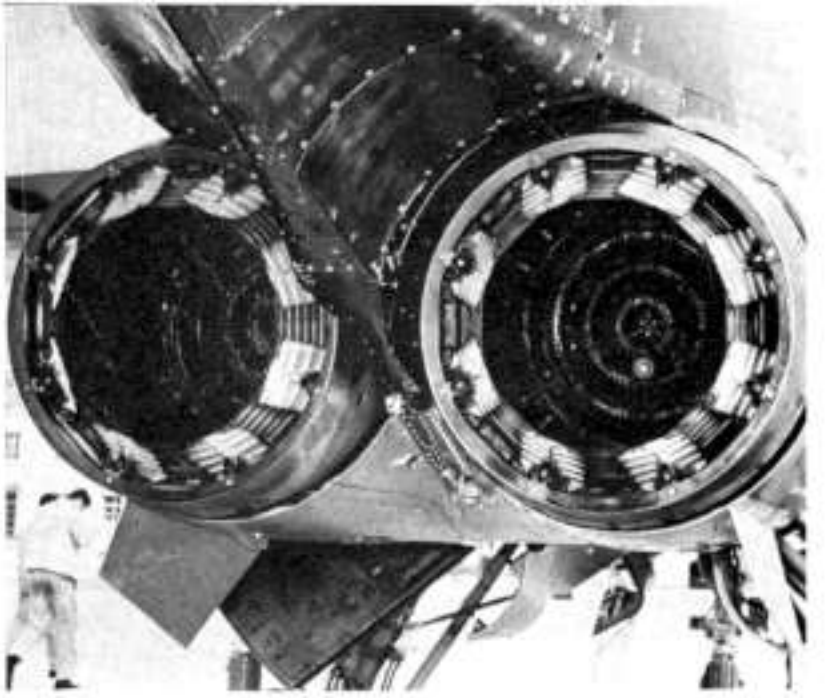
Adour production is based on a single source for each component. Broadly, Turbomeca is responsible for the front end of the engine and Rolls-Royce for the rear end, while the jet pipe, including afterburner, is designed by Rolls-Royce but produced in France under sub-contract to SNECMA. Separate assembly lines have been set up by Rolls-Royce at Derby and Turbomeca at Tarnos, near Biarritz.

The Adour first ran in May 1967 and about 12,000 hrs had been accumulated by March 1971, including 7,650 hrs on the bench and 1,850 hrs in facilities used extensively to simulate high-altitude conditions. A 150-hr endurance test was completed at the French facility at Saclay in August 1970 and a second similar test was concluded more recently as part of the Type Approval Programme. Following inspection of the test-run engine during January 1971, Type Approval is expected to be obtained at a basic dry thrust rating of the order of 5,000 lb and a reheated thrust rating of more than 7,000 lb.

A development batch of 36 engines preceded the production units and includes the engines for the first seven prototype Jaguars. Delivery of production Adour Mk 101 engines began early in 1971. Apart from five more engines earmarked for development work and two for the B-08 prototype, all these early engines will power French production Jaguars, regardless of country of build. All engines are completely interchangeable.

Flight testing

The task of bringing a new combat aeroplane to the point of operational use is a complex one. Flight testing naturally represents a major part of this task, and eight prototypes have been assigned to the programme. The first five were built by Breguet at Villacoublay, followed by three assembled by BAC at Warton. Of these, the final aircraft – the first British trainer – is assembled from the first set of production components, whereas the other seven prototypes were hand-built as experimental aircraft. Two additional airframes have been assigned to static test programmes to establish structural strengths and fatigue life.



Jaguar's twin-Adour installation

Above and below, characteristic ground views of Jaguar

The two-seater shows off its clean lines

The flight test programme is fully integrated so that any phase can be covered by more than one prototype – an essential precaution against possible delays – and is shared between the two manufacturers, being centred upon Warton and Istres.

By early 1971, the total of Jaguar flying was approaching 800 hours, including nearly 200 hours on the two British single-seaters. Almost all the basic flight envelope had then been covered and the flutter programme was almost complete. Some engine testing still had to be done but most of the development flying in the middle months of 1971 was to be concerned with weapon carriage and release.

In the course of flight testing, some small external changes have become evident on Jaguar. In particular, two ventral fins have been added, and the height of the original fin has been increased to improve stability when the largest external weapon loads are carried. Small strakes were added to the nose of the prototypes for spinning trials but are not a feature of the production aircraft. Other changes have been associated with the flying control system – for example, changes in the angular settings of the outer flap portions and in the degree of leading edge slat used for combat. The air brakes have been changed from plain to perforated type and enlarged.

One significant change is the introduction of a part-throttle reheat system. Originally, following conventional practice, reheat could be selected only when the engines were at maximum dry thrust and gave an immediate thrust boost of about 30%, which was then variable up to maximum reheat boost of 50%. However, Jaguar's lift and drag characteristics in the approach configuration were such that, if one engine was inoperative, the power required from the remaining engine was more than the maximum dry figure but less than the minimum reheat figure. The part-throttle reheat system makes it possible for the pilot to select any thrust from minimum dry to maximum reheat.

Other development areas involving various aspects of the engines and equipment have been no different in scale or nature from those encountered by other new aircraft. Certainly no special difficulties appear to have resulted from the bi-national nature of the programme. Both British and French ideas have been adopted with advantage, especially the French practice of allowing Air Force teams to check the maintainability of the aircraft at an unusually early stage. Project pilots from all three Services with Jaguars on order are attached to the manufacturer's test teams and the three customers have also set up a joint servicing team *(équipe de marque)* to help ensure that Jaguar meets servicing requirements from the outset.

Performance

Full details of Jaguar's performance are classified, but the information available gives a good indication of the aircraft's purposefulness. Typical gross weights for representative combat missions are between 22,000 lb and 23,000 lb and over 30,000 lb carrying maximum external loads.

Figures which follow are based on an engine thrust rating of about 4,600 lb dry and 6,900 lb with full reheat, and at weights for typical tactical missions. The take-off distances are a ground roll of less than 2,000 ft with the total distance to clear 50 ft of under 3,000 ft. Landing distances are less.

Flying a lo-lo-lo tactical mission with no external fuel, the range is over 300 nautical miles, and this can be increased by 50% using external fuel. Further increases in range – to more than 700 nautical miles – are possible using a hi-lo-hi mission profile. For ferrying, with maximum fuel and no armament, the range is well over 2,000 nautical miles. Max speeds are Mach 1·1 at low altitude (a true airspeed of about 836 mph) and Mach 1·6 at high altitude (1,056 mph).

Jaguar B can fly a 3-hour training sortie at high altitude. For the low-altitude training mission, it has an endurance of 1 hr 20 min, including 20 min at Mach 0·9 at heights below 500 ft.

Programme and service introduction

Jaguar E is scheduled to enter service with the French Air Force early in 1972 following initial deliveries by the end of this year. Initial production for France comprises 25 each of the E and A versions, deliveries of the latter starting during 1972. The first 10 aircraft, with early production engines and without part-throttle reheat, will form a trials squadron in France.

The 40 Jaguar M ordered by the French Navy are earmarked for service with Flotilles 17F and 11F, at present equipped with Etendard IVMs for service aboard the carriers *Foch* and *Clemenceau*. Ten Jaguar E will similarly replace the Etendards used by Flotille 59s for training.

The RAF's first production Jaguar S is scheduled to fly in mid-1972. The first batch of aircraft, probably including some trainers, will be assigned to the Operational Conversion Unit to be formed at Brawdy, in Pembrokeshire. According to present plans, the first operational Jaguar squadron will start to form in No 38 Group, ASC, during 1973.

An active sales campaign is now under way to sell Jaguar round the world. Marketing the aeroplane is the responsibility of SEPECAT *(Société Européenne de Production de l'Avion d'Ecole de Combat et d'Appui Tactique)*, the company set up jointly by BAC and Breguet to manage the Jaguar development and production programme.

Market surveys indicate as many as 70 nations having a potential requirement for an aeroplane of the Jaguar type in one or other of its major roles within the next decade, so the export potential is clearly good. Jaguar's actual introduction into service in a few months' time can be expected to crystallise the interest of several potential customers, especially in those areas where BAC and Dassault/Breguet influence is already strong, such as the Middle East and South America. ⊙

Main emphasis in current development flying is on weapon carriage and release

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British Aircraft Corporation is proud to play a central part in the continuing development of the strength and efficiency of the Royal Air Force. Today, as at every time in the RAF's history, aircraft designed and built at the factories of BAC are serving with squadrons at home and overseas, meeting wide-ranging commitments. And in the years ahead the Corporation — both in its own independent right and through major collaborative programmes — will continue to provide the aircraft and weapons essential to maintain the fighting strength of the Royal Air Force.

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the most powerful aerospace company in Europe

MRCA is Europe's solution to Europe's defence. It constitutes the most advanced aircraft programme yet undertaken for NATO. The combined requirements of Britain, Germany and Italy make the MRCA programme the largest in Europe in terms of quantity of production aircraft planned. It has brought into being the powerful aerospace combine of Panavia — uniting the huge resources of BAC, Messerschmitt-Bölkow-Blohm of Germany, and Fiat of Italy to meet the requirements of three NATO air forces and one navy.

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jaguar

The 1970s outlook on defence requirements

Jaguar is an aircraft designed for the 1970s. It is the most modern and cost-effective warplane in production today and has the flexibility and development potential to keep pace with new defence requirements as they arise in the future. Single-seat strike and two-seat operational trainer versions are in production by BAC and Breguet Aviation to meet initial British and French orders for 400 aircraft.

TRAINING

Nearly every jet pilot in the RAF has been trained on BAC aircraft. In the 1970s, vital roles will be played by the Jet Provost Mk 5—which is now in full service—and the Jaguar operational trainer.

SUPPORT

The RAF's VC10 and Britannia stem from BAC's unrivalled experience of turbine-engined transport development — a background which they share with the BAC One-Eleven and the supersonic Concorde.

DEFENCE

The Mach 2 Lightning—a key element of RAF and NATO strength—and the revolutionary Rapier missile system provide powerful evidence of BAC's ability to match changing defence needs.

STRIKE

In the 1970s, the main increase in RAF strikepower will derive from two advanced aircraft developed by BAC in collaboration with European partners—Jaguar and the Panavia MRCA.

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