

A BRIEF HISTORY OF THE UK AEROSPACE INDUSTRY

This final article covers not only the main heading above, but also a brief history of the UK air transport industry and an introduction to UK military aviation. Remember, it was written in 2020 and much has changed since then!

As advised by ADS, the trade association for the Aerospace, Defence & Security industries who are supporters of the ACP, in 2019 the aerospace industry of the United Kingdom was the second largest national aerospace industry in the world and the largest in Europe, with a global market share of 12%, an annual turnover of £35.9 Billion, exports of £34.2 Billion and an employer of 111,000 people. But how did it all start?

As a new technology, in the early days of the last century there was a great deal of interest from a variety of sources, but often it was individuals just enthused by aviation. Between 1909 and 1914 there were about 200 active constructors, although many of them only made one or two planes. But even the production of the larger firms was not very substantial, British and Colonial Aeroplane Company, one of the largest, produced just over 200 planes between 1910 and 1914.

Most of the aviation pioneers, such as Geoffrey de Havilland, Thomas Sopwith, Richard Fairey, Robert Blackburn, Frederick Handley Page, A.V. Roe and the Short Brothers had a training in engineering and their companies were usually privately financed. There were several large engineering companies who also became involved, such as British and Colonial Aeroplane Company in 1910, Vickers in 1911, Armstrong Whitworth in 1912, and Aircraft Manufacturing Company, also in 1912. Along with these companies there was the early development of seaplanes, particularly near Southampton, by companies such as S. E. Saunders (originally boat builders) and Pemberton-Billing (later Supermarine). Finally, there were several French subsidiary companies who built aero-engines.

Unsurprisingly the run up to, and onset of, WWI led to a massive increase in the number of companies engaged in aircraft production. Between 1912 and 1916 aircraft production was moved on to a mass production basis. But it was only by 1917 that production problems and procedures were sorted out such that there was a steady flow of aircraft, engines and spares. By October 1918 there were 1,529 companies involved in the manufacture of aircraft. As well

as aviation companies making aeroplanes there were other engineering companies also involved in making aircraft and engines (usually under licence). Companies such as shipbuilders Harland and Wolff in Belfast, and engineering manufacturer, G & J Weir in Glasgow. The motor industry obviously had a capability to manufacture aeroplanes and, in particular, engines. Austin Motor Company, Daimler Company, D. Napier & Son, Sunbeam Motor Car Company and ABC Motors were all part of the wartime aviation industry. In addition, there were a large number of sub-contractors making such things as propellers, electrical equipment, instrumentation and canvas.

However, once the war was over the vast majority returned to their pre-war activities. The aircraft being produced in 1918 were essentially enhanced versions of the 1914 aircraft. The development of the aviation industry between 1914 and 1918 was more one of production and logistics than scientific or technical.

On 2 January 1918 the Air Ministry was founded and on 1 April 1918 the Royal Air Force was established, independent of the Army and the Royal Navy. Both organisations were to fashion the nature of the aviation industry in the UK. The first task for the government at the end of the war was to dispose of their stocks of aircraft and to deal with those on order. The Ministry of Munitions set up a Disposal Board and sold the entire surplus stock to a private company, Aircraft Disposals Company, with Frederick Handley Page as one of the key personnel.

As soon as the war was finished, and the Government demand for aircraft ceased, some of the remaining aircraft companies tried to diversify into other activities, but with limited success, or simply closed down. For instance, Airco looked at car manufacture and was bought by the Daimler Company, whilst Martinsyde and Sopwith briefly tried motor cycles. By 1920 the British aerospace industry consisted of 28 aeroplane constructors and a dozen aero engine designers. However, much of their work was of a trivial nature and engine orders were so low that Rolls-Royce nearly left the aviation sector.

The aviation industry was left with the core of pre-war producers and a few companies whose interest in aviation had been aroused. This latter category included companies such as the Norwich engineering firm Boulton & Paul, Westland Aircraft, the wartime offshoot of engine manufacturers Petters Ltd, and Gloucestershire, later, Gloster Aircraft Company formed from Cheltenham-based luxury liner outfitters H. H. Martyn. Nonetheless there was still a determination to stay, particularly from the enthusiastic pioneers such de Havilland and Sopwith. As soon as Airco and Sopwith Aviation Company were declared bankrupt (due to the Treasury demanding payment for excess profits) within months Tommy Sopwith and Geoffrey de Havilland both established new companies, H.G. Hawker Engineering later Hawker Aircraft, and De Havilland Aircraft Company.

The Government established a Civil Aerial Transport Committee (that included H.G. Wells and Tommy Sopwith) that reported in December 1918. Their key recommendation was that steps should be taken to foster civil aviation in order, in part, to maintain a manufacturing base that could supply the country's military needs. However, Government policy for civil aviation was, initially, according to the then Secretary of State for Air, Winston Churchill, on 11 March 1920 in the House of Commons, to let it "fly by itself.....any attempt to support it artificially by floods of State money will not ever produce a really sound commercial aviation service which the public will use, and will impose a burden of an almost indefinite amount upon the Exchequer".

Air transport companies were established in 1919–20, several of which were subsidiaries of aircraft manufacturers, such as Handley-Page, Airco and Blackburn Aircraft. A number of the companies failed or found themselves in difficulty due to high operating costs, low demand that was also seasonal, high fares, and heavily subsidised French competition, so it was decided in April 1922 to offer support and by October subsidies were given to individual airlines operating set routes. Furthermore, matters improved when aircraft specifically designed for commercial operation were introduced. The DH.34 and Handley Page W.8 lowered the operating costs for airlines, making them more economically viable. Eventually, however, the state did involve itself fully in civil aviation and on the advice of the Hambling Committee created Imperial Airways in 1924 from the four main air transport companies. That said, the Air Ministry did not actively engage with the development of commercial aircraft, despite the recommendation of the 1918 Civil Aerial Transport Committee, and was later criticised by the 1938 Cadman Report for this.



An Imperial Airways poster from the late 1920s & early 1930s

The Air Ministry worked in the early years on the basis that there would be no war in Europe in the immediate future and that the main requirement for aircraft would be policing the colonies. Such activity would not require sophisticated aeroplanes to be developed. Nonetheless, the Government needed to ensure that the aircraft industry did not shrink to a size dangerous for national defence and that there would be sufficient aircraft and aero engine companies to sustain the United Kingdom's military requirements for the variety of types of aircraft and engines. Consequently, there came into being an arrangement with the Society of British Aircraft Constructors (an early predecessor to ADS) that contracts could be shared around a limited number of companies; this became known as The Ring.

The Air Ministry would draw up a specification which would be given to 'approved firms' who would then submit tenders for prototypes. The Air Ministry would select several prototypes and finally a choice for production would be made. The work was spread out over about 18 aviation companies. The winning company for a tender would not necessarily be given the complete construction work, which on occasions would be spread out to other companies to ensure that they, the other companies, were able to stay in business.

There was a particular success in this period in the growth of privately owned light aircraft. In 1924 the Air Ministry initiated a policy of financial assistance to light aeroplane clubs. Despite Air Ministry support what really made the difference was the launch of the De Havilland Gipsy Moth in 1924. An immensely popular aircraft ideally suited to flying clubs and popularised by famous aviators such as Amy Johnson, Jean Batten, and Sir Francis Chichester.

Nevertheless, for airliners in this period the UK lagged behind European countries. In 1931 Belgium operator Sabena was the only other European airline company using British aircraft. The aeroplanes of German manufacturer Junkers and Dutch company Fokker were dominant, and after 1930 American passenger aircraft took a leading part. In 1938 Neville Chamberlain flew a in British Airways Ltd Lockheed 10 Electra for his meeting with Adolf Hitler. The reasons for this were not difficult to find. Imperial Airways largely ignored European routes preferring to focus on imperial markets in Africa and India. Imperial Airways' Handley Page aircraft were comfortable and safe, but slow. There was no competition on these routes, so there was little incentive to spend money on developing new, faster, and more efficient aircraft.



Amy Johnson CBE, the first woman to fly solo from London to Australia

However, the lack of suitable landing airfields in many Empire countries in the inter-War period did lead to Imperial Airways commissioning Short Brothers in 1935 to build 28 flying boat aircraft for passengers and freight (particularly airmail). The Second World War effectively stopped the further development of the flying boat because after WWII there were plenty of suitable land aircraft, notably the Douglas DC-3 as seen below.





English Electric Canberra, the RAF's first jet bomber

The aviation industry was to benefit significantly from aeronautical research carried out in the late 1920s and the 1930s. The academic centres were the University of Cambridge, where they had established a chair in aeronautical engineering in 1919 (most of the leading British aeronautical engineers were Cambridge graduates) and Imperial College, London. For instance, Sir Frank Whittle the inventor and developer of the jet engine and W.E.W. Petter the designer of the Westland Lysander and, after World War Two, the English Electric Canberra, and Folland Gnat, both studied mechanical sciences at Cambridge University.

Much work was also done at the Royal Aircraft Establishment in Farnborough, Hampshire, the research and development organisation under the auspices of the Air Ministry. Research work was, for instance, carried out in wind tunnels, and other projects such as research on electrical heating systems for guns, reliable navigation lamps, better engine magnetos and ignition systems.

Looking back over the years, the British aerospace industry has made many important contributions to the history of aircraft and was solely, or jointly, responsible for the development and production of the first aircraft with an enclosed cabin (the Avro Type F), the first jet aircraft to enter service for the Allies in World War II (the Gloster Meteor), the first commercial jet airliner to enter service (the de Havilland Comet), the first aircraft capable of supercruise (the English Electric Lightning), the first supersonic commercial jet airliner to enter service (the Aérospatiale-BAC Concorde), the first fixed-wing V/STOL combat aircraft to enter service (the Hawker Siddeley Harrier), the first twin-engined widebody commercial jet airliner (the Airbus A300), the first digital fly-by-wire commercial aircraft (the Airbus A320), and the largest commercial aircraft to enter service to date (the Airbus A380). And so we return to today. Domestic companies with a large presence in the British aerospace industry include BAE Systems (the world's fourth-largest defence contractor, Cobham, GKN, Hybrid Air Vehicles, Meggitt (a supporter of the ACP), QinetiQ, Rolls Royce (the world's second-largest maker of civil aero engines and another supporter of the ACP) and Ultra Electronics.



Rolls-Royce Trent 1000

Foreign companies with a major presence include Boeing, Bombardier, Airbus (including its Astrium, Cassidian and Surrey Satellite Technology subsidiaries), Leonardo, General Electric (including its GE Aviation Systems subsidiary, a

further supporter of the ACP), Lockheed Martin, MBDA (37.5% owned by BAE Systems), Safran (including its Messier-Dowty and Turbomeca subsidiaries) and Thales.



One leg of a Messier-Dowty undercarriage for a Boeing 787

Current manned aircraft in which the British aerospace industry has a major role include the AgustaWestland AW101, AgustaWestland AW159, Airbus A320 family, Airbus A330, Airbus A340, Airbus A380, Airbus A400M, BAE Hawk, Boeing 767, Boeing 777, Boeing 787, Bombardier CRJ700, Bombardier C Series, Bombardier Learjet 85, Britten-

Norman Defender, Britten-Norman Islander, Eurofighter Typhoon, Hawker 800, Lockheed Martin C-130J Super Hercules and Lockheed Martin F-35 Lightning II. Current unmanned aerial vehicles in which the British aerospace industry has a major role include BAE Taranis, HAV 304 Airlander 10, QinetiQ Zephyr and Watchkeeper WK450.



An Airbus wing under construction at Broughton

This section concludes with a reminder that within those overall UK aerospace figures quoted at the beginning, in 2019 the rapidly growing space element employed 42,000 people and had a turnover of £14.8 Billion, £5.5 Billion of which were exports. In addition to such programmes as Skylon, SABRE and Sutherland Spaceport, 40% of small

satellites in operation around the planet were manufactured in the UK, many by Surrey Satellite Technology. ADS advise that the UK space sector has grown by 60% since 2010, and that commercial vertical and horizontal launch demand is worth a potential £3.8 Billion to the UK over the 2020s.



A line-up of 'Surrey Satellites'

A BRIEF HISTORY OF THE UK AIR TRANSPORT INDUSTRY

Air transport in the United Kingdom is the commercial carriage of passengers, freight and mail by aircraft, both within the UK and between the UK and the rest of the world.

In the past 25 years the industry has seen continuous growth, and the demand for passenger air travel in particular, prior to the Covid-19 pandemic, was forecast to increase to 465

million passenger flights by 2050. The UK has the largest aviation network in Europe and the third highest number of passengers carried of any country, behind only the United States and China. By 2019 the industry was contributing £22 Billion to the UK economy and employed over 230,000 people.

CIVIL AVIATION AUTHORITY

The Civil Aviation Authority (CAA) is the statutory corporation which oversees and regulates all aspects of civil aviation in the United Kingdom. It is a public corporation of the Department for Transport, liaising with the Government via the Standards Group of the Cabinet Office. Its areas of responsibility include:

- ▶ Supervising the issuing of pilots' licences, testing of equipment, calibrating of nav aids, and many other inspections (Civil Aviation Flying Unit).

- ▶ Managing the regulation of security standards, including vetting of all personnel in the aviation industry (Directorate of Aviation Security).

- ▶ Overseeing the national protection scheme for customers abroad in the event of a travel company failure (Air Travel Organisers' Licensing – ATOL).

AIRPORTS

Although the number of airports in the UK runs into hundreds, many are smaller aerodromes dealing with general aviation rather than air transport. In terms of the latter, statistics are collected from 59 main airports, and the largest concentration of services is located in the London and South East of England area.

Heathrow is the largest and busiest airport in the country, the busiest in Europe, the 2nd busiest in the world by international passenger traffic, and the 7th busiest by total passenger traffic. In 2019 it handled a record 80.88 million passengers involving 475,861 aircraft movements, and that year was voted by World Airport Awards the 8th best in the world. Terminal 5 was voted the world's best airport terminal and the world's best airport retail complex.

On 25 October 2016, a new northwest runway and terminal was adopted as central Government policy. In late June 2018, the resultant National Policy Statement, Airports, was debated and voted on by the House of Commons; the House voted 415–119 in favour of the third runway. On 27 February 2020, in an application for judicial review brought by environmental campaigning groups, London councils, and the Mayor of London, the Court of Appeal ruled that the Government's decision to proceed with building the third runway was unlawful as the Government's commitments to combat climate change under the Paris Agreement were not taken into account. In response, the Government announced it would not appeal against the decision, but Heathrow announced its intention to appeal to the Supreme Court.



Proposed Heathrow third runway, associated new central terminal and business park

Heathrow is also a cargo gateway and usually has up to 20 dedicated cargo aircraft using its facilities every day, the largest group of which are operated by DHL who also lease cargo aircraft to British Airways for weekend operations. DHL is the third largest air freight operator in the world with 75 aircraft serving 150 destinations. However, it is dwarfed by UPS Airlines with 519 aircraft (including chartered planes) serving 766 destinations, and FedEx with 688 aircraft serving 375 destinations, but the highest volume in terms of freight.

Stansted and East Midlands airports have both experienced large growth in freight handling over the past decade, and these two airports are the major hubs for express freight operations.

Gatwick airport, with 46.6 million terminal passengers and 280,700 aircraft movements in 2019, is the second largest in the country. Following considerable consultation, Gatwick has prepared a major growth programme which was due to commence in 2020.

AIR TRAVEL & OPERATORS

The advent of budget carriers, such as EasyJet (one of whose senior training Captains is a member of the ACP Management Team) has had a significant impact on air travel in the UK. They are responsible for the growth of regional airports and the growth of overall air travel which has been at the expense of traditional carriers who, since 2000, have experienced flat or declining traffic levels. In response, traditional carriers have lowered costs to compete more effectively on price, leading to lower prices on the short haul routes served by this sector, especially in business fares. They have also limited or reduced capacity and in some cases launched budget subsidiaries of their own.

The vast majority of all passengers travelling by air to or from the UK are carried by UK airlines. In 2019 the five most popular were, in descending order: British Airways; Virgin Atlantic; EasyJet; TUI Airways; and Jet2.com. The top ten

most popular airlines operating in the UK, in addition to the above, are made up by Emirates, Qantas, Etihad, Qatar and KLM.

In 2017 the UK operated the largest air transport fleet in the EU, 1312 aircraft. Together the two largest airlines as measured by passenger numbers were British Airways and EasyJet who account for nearly half of the 127 million passengers flown on UK airlines. In terms of capacity, both available and used, British Airways is again the largest airline, whilst EasyJet is pushed into third place by Virgin Atlantic Airways. British Airways passenger flights also account for over 50 per cent of all cargo carried by UK airlines, and when combined with its cargo operations the airline carries over 60 per cent of all cargo carried by UK airlines.

Just over a fifth of all terminal passengers are travelling on domestic routes only, whilst half are travelling between the UK and the European Union. Outside the EU, the US, the

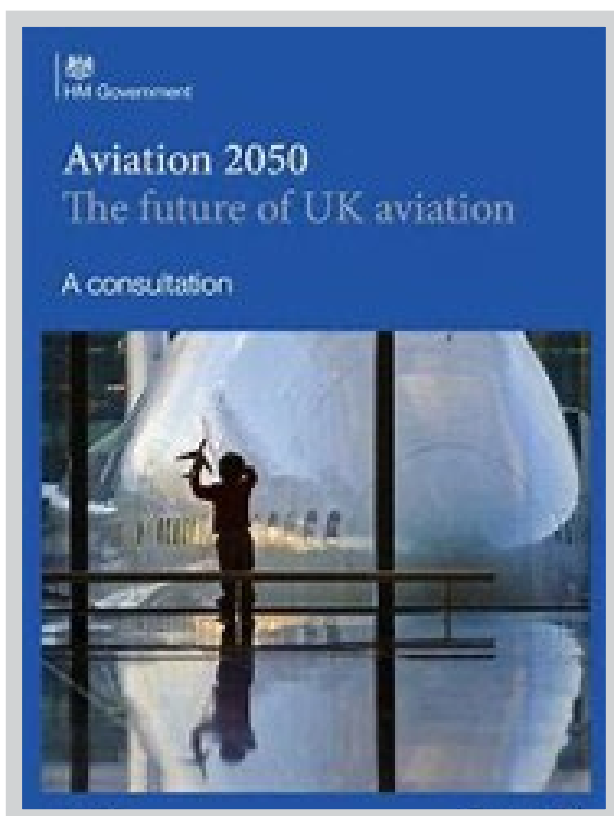
Far East, Switzerland and the Middle East together account for just over half of all passengers flying between the UK and the rest of the world, with the USA exceeding the other three combined in terms of passenger numbers. The advent of budget carriers has had a significant effect on passenger travel profiles, with strong growth in business travel from regional airports, and a significant increase in inbound traffic generated for the purposes of non-UK residents visiting friends and relatives based in the UK. The UK has a low usage for domestic (internal) flights which, and after a high in 2005/06, has been in decline. In the year 2010/11 just 18.4 million internal passengers were carried (compared with 1,352 million rail journeys in the same period).

The current availability of airport capacity has been identified as an important constraint on the ability to meet the increasing demand for air travel. In many cases airport capacity is already fully used in meeting current demand. In December 2003 the Government published *The Future of Air Transport* White Paper which detailed the Government's approach to the future development of air transport. The White Paper did not authorise or preclude any development, but sought instead to define a "national strategic framework for the future development of airport capacity" over the next 30 years. The principal conclusion was that the two extremes of failing to provide additional airport capacity, and

encouraging growth without regard for the wider impacts, were equally unacceptable options. Instead a "balanced and measured approach" to the future of air transport in the UK was adopted. The Government's approach was designed to cater for the forecast growth in demand, thus supporting economic prosperity nationally and enabling people to travel at reasonable cost, whilst at the same time managing and mitigating the environmental impacts of aviation and ensuring that the costs associated with them are reflected in the price of air travel.

Since then Government policy on air transport has been cancelled, revised and reinstated, reviewed again, further consulted on with the latter exercise taking the form of a consultation entitled '*Aviation 2050: The future of UK Aviation*'. This was published in December 2018 and contains the following principal sections: building a global & connected Britain; ensuring aviation can grow sustainably; supporting regional growth & connectivity; enhancing the passenger experience; ensuring a safe & secure way to travel; supporting general aviation; encouraging innovation & new technology. A resulting White Paper has yet to be published. With Covid-19 having now intervened a long-term policy is most unlikely to be decided until the consequences of the pandemic have been ascertained.

In addition to scheduled services undertaken by such airlines as BA and EasyJet, and chartered services undertaken by such companies as Jet2 and TUI, there are also private executive & business aviation companies such as NetJets, and industrial aviation companies such as the Bristow Group who operate both fixed and rotary wing aircraft.





Interior of a NetJets' private aircraft



A Bristow Group Sikorsky S-76

AIRCRAFT LEASING

Many of these airlines and aircraft operators lease the aircraft they use rather than own them. They do this for two main reasons: to operate aircraft without the financial burden of buying them; and to provide temporary increase in capacity.

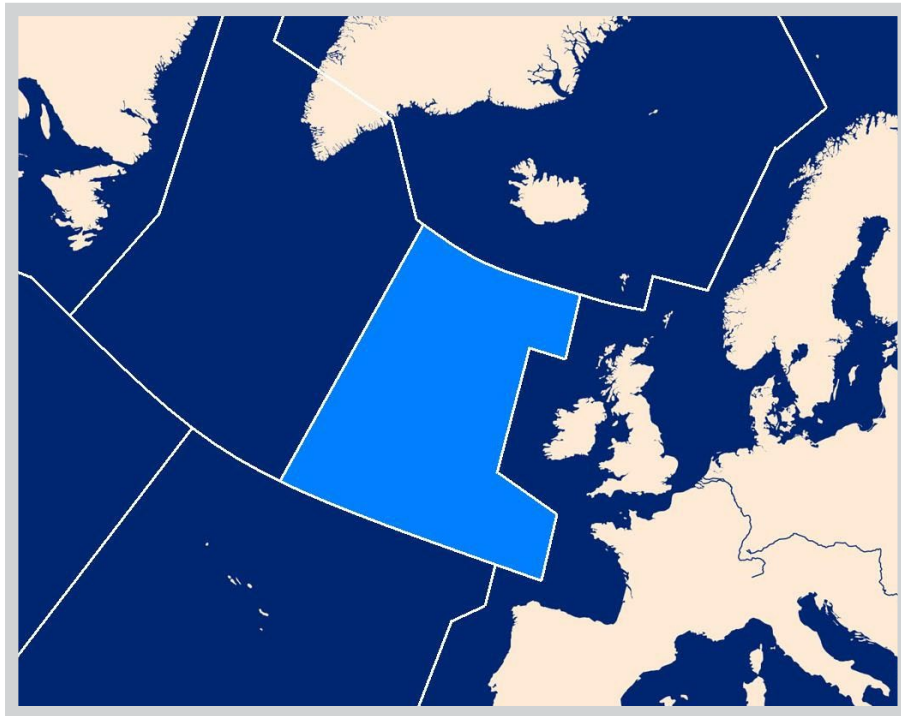
The industry has two main leasing types: wet-leasing, which is normally used for short-term leasing, and dry-leasing

which is more normal for longer-term leases. The industry also uses combinations of wet and dry. For example, when the aircraft is wet-leased to establish new services, then as the airline's flight or cabin crews become trained, they can be switched to a dry lease. The two largest lessors are AerCap who own the largest wide-body fleet, and GECAS who own the largest narrow-body and regional aircraft fleets.

AVIATION SCHOOLS

There are 195 aviation schools in the UK covering, between them, fixed wing and rotary wing courses, flight attendant training, aircraft dispatch, maintenance and air traffic control. Leading Edge Aviation at Oxford Airport is a supporter of the ACP, as is the Resource Group.

ATS Holdings, formerly National Air Traffic Services and commonly referred to as NATS, is the main air navigation service provider in the United Kingdom. It inherited the traditions of UK air traffic control, which (founded over Croydon Airport) was the world's first air traffic control regime. It provides en-route air traffic control services to flights within the UK flight information regions and the Shanwick Oceanic Control Area and provides air traffic control services to 14 UK airports.



Shanwick Oceanic Control Area

MRO&L

The Maintenance, Repair, Overhaul & Logistics sector is another very important element of UK aviation being a major contributor to the economy in terms of industrial activity and economic output.

It involves 57,000 employees, has a turnover of £15 Billion, and the participation of over 1,300 companies. Services include: IT / Aviation Software; Parts & Logistics Support;

Airframe (Heavy Checks); Engines; Landing Gears; APUs; Components; Line Maintenance. Whilst a significant element of this is through the support activities of original equipment manufacturers there is also an appreciable independent contribution in a wide range of service provision. In addition, there is a complete sector providing airside equipment and associated training.

AVIATION TRADE & PROFESSIONAL BODIES

The aviation industry in the UK, like so many others, has its own trade and professional bodies. For example, concerning trade: Airlines UK; the British Airport Services & Equipment Association; the British Aviation Group (BAG); and the British Business & General Aviation Association (BBGA). And then professional bodies

such as the British Airline Pilots Association (BALPA) and, of course, one of the ACP's principal supporters, the Royal Aeronautical Society. To these we should add two particularly aviation orientated City of London Livery Companies: The Honourable Company of Air Pilots; and the Worshipful Company of Coachmakers & Harness Makers.

SUPPORTING SERVICES

Furthermore, there are the professional firms that provide services in respect of aviation finance, insurance and law (such as our legal counsellors, REN Legal) all of which can be found via their professions' directories; and on a sombre note, the Air Accident Investigation Branch (AAIB) of the UK Department of Transport.

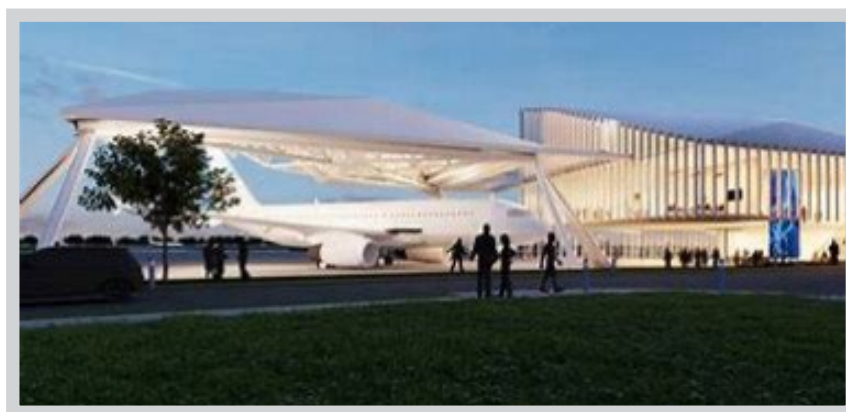
A UNIQUE UNIVERSITY

Finally, there is one unique UK university we must mention - and not just because it was where we launched the ACP on 27 September 2019 and the Vice-Chancellor, Professor Sir Peter Gregson, is our Honorary Vice-President - Cranfield.

Cranfield is the UK's only university with its own airport; it specialises in technology and management. The forerunner of Cranfield University was the College of Aeronautics, created in 1946 and based at the then RAF Cranfield, Bedfordshire. Through the 1950s and 1960s the development of many aspects of aircraft research and design led to considerable growth and diversification into other areas such as manufacturing and management, but at its core is still aeronautics with four specialist research

interests: Aircraft Design; Applied Aerodynamics; Advanced Engineering Design; Dynamics, Simulation and Control.

One particularly important event in 2020 will be the opening of the University's Digital Aviation Research and Technology Centre - very fourth industrial revolution. DARTeC consists of a central building containing advanced digital research laboratories. Adjacent to the building will be a 'hanger laboratory' capable of housing the University's own Boeing 737-400 and enabling next generation MRO experimentation. The building will be digitally connected to Cranfield's airport and airspace management systems, including the Digital Air Traffic Control Centre and multiple advanced radar systems. Airborne digital communications research will be undertaken using the University's flying laboratory, a Jetstream 31.



DARTeC

A BRIEF INTRODUCTION TO UK MILITARY AVIATION



An F-35 pilot's helmet; in the cockpit the wearer can see - everywhere!

ROYAL AIR FORCE

The Royal Air Force is the United Kingdom's primary aerial warfare force. It was formed towards the end of WWI on 1 April 1918 by the amalgamation of the Royal Flying Corps and the Royal Naval Air Service. Following the Allied victory over the Central Powers later in 1918, the RAF emerged as the largest air force in the world at the time; it was also the first independent air force. After WWI the Service was dramatically cut and its inter-war years were relatively quiet with the RAF taking responsibility for policing the British protectorate of Iraq and undertaking a number of minor actions within the British Empire. The RAF's naval aviation branch, the Fleet Air Arm was founded in 1924, but handed over control to the Admiralty on 24 May 1939.

Prior to, and during, WWII the RAF underwent rapid expansion in equipment and personnel, part of which was the 'British Commonwealth Air Training Plan' of 1939 under

which Commonwealth countries trained and formed 'Article XV Squadrons' for service with RAF formations. Many individual personnel from these countries, and exiles from occupied Europe, also served with RAF squadrons. By the end of the war the Royal Canadian Air Force had contributed more than 30 squadrons to serve in RAF formations; similarly, approximately a quarter of Bomber Command's personnel were Canadian. Additionally, the Royal Australian Air Force represented around nine percent of all RAF personnel who served in the European and Mediterranean theatres.

In the Battle of Britain in 1940, the RAF defended the skies over Britain against the numerically superior German Luftwaffe. In what is perhaps the most prolonged and complicated air campaign in history, the Battle of Britain contributed significantly to the delay, and subsequent indefinite postponement, of Hitler's plans for an invasion of the United Kingdom (Operation Sea Lion).



Although it is the Supermarine Spitfire that most people associate with the RAF in the Battle of Britain, the most numerous RAF aircraft in the battle was the Hawker Hurricane.

The largest RAF effort during the war was the strategic bombing campaign against Germany by Bomber Command. While RAF bombing of Germany began almost immediately upon the outbreak of war, under the leadership of Air Chief Marshal Sir Arthur Harris, these attacks became increasingly devastating from 1942 onward as new technology and greater

numbers of superior aircraft became available. The RAF adopted night-time area bombing on German cities such as Hamburg and Dresden, and developed precision bombing techniques for specific operations, such as the “Dambusters” raid by No. 617 Squadron, or the Amiens prison raid known as Operation Jericho.



Operation ‘Chastise’ – the Dambusters Raid.

Following victory in WWII the RAF underwent significant re-organisation, as technological advances in air warfare saw the arrival of jet fighters and bombers. During the early stages of the Cold War, one of the first major operations undertaken by the Royal Air Force was in 1948, the Berlin Airlift codenamed Operation Plainfire. Between April 1948

and the lifting of the Russian blockade of the city in May 1949, the RAF provided 17% of the total supplies delivered during the operation, using Avro Yorks and Douglas Dakotas flying to Gatow Airport, and Short Sunderlands flying to Lake Havel.



The Berlin Blockade was one of the first major international crises of the Cold War. During the multinational occupation of post-World War II Germany, the Soviet Union blocked the Western Allies' railway, road, and canal access to the sectors of Berlin under Western control. Consequently, the Western Allies organised the Berlin Airlift to carry supplies to the people of West Berlin.

The Americans and British then began a joint operation in support of the entire city. Aircrews from the United States Air Force, the Royal Air Force, the French Air Force, the Royal Canadian Air Force, the Royal Australian Air Force, the Royal New Zealand Air Force, and the South African Air Force flew over 200,000 sorties in one year, providing to the West Berliners necessities such as fuel and food, with the original plan being to lift 3,475 tons of supplies daily. By the spring of 1949, that number was often met twofold, with the peak daily delivery totalling 12,941 tons. By this time the airlift was clearly succeeding, delivering more cargo than had previously been transported into the city by rail.

Before Britain developed its own nuclear weapons the RAF was provided with American nuclear weapons under Project E. However, following the development of its own arsenal, the British Government elected on 16 February 1960 to share the country's nuclear deterrent between the RAF and submarines of the Royal Navy, first deciding on 13 April to concentrate solely on the RAF's V bomber fleet. These were initially armed with nuclear gravity bombs, later being equipped with the Blue Steel missile. Following the development of the Royal Navy's Polaris submarines, the strategic nuclear deterrent passed to the Navy's submarines on 30 June 1969. With the introduction of Polaris, the RAF's strategic nuclear role was reduced to a tactical one, using

WE.177 gravity bombs. This tactical role was continued by the V bombers into the 1980s and until 1998 by Tornado GR1s.

For much of the Cold War the primary role of the RAF was the defence of Western Europe against potential attack by the Soviet Union, with many squadrons based in West Germany. With the decline of the British Empire, global operations were scaled back, and RAF Far East Air Force was disbanded on 31 October 1971. Despite this, the RAF fought in many battles in the Cold War period. In June 1948 the RAF commenced Operation Firedog against Malayan terrorists during the Malayan Emergency. Operations continued for

the next 12 years until 1960 with aircraft flying out of RAF Tengah and RAF Butterworth. The RAF played a minor role in the Korean War, with flying boats taking part; and from 1953 to 1956 the RAF Avro Lincoln squadrons carried out anti-Mau Mau operations in Kenya using its base at RAF Eastleigh. The Suez Crisis in 1956 saw a large RAF role, with aircraft operating from RAF Akrotiri and RAF Nicosia on Cyprus, and RAF Luqa and RAF Hal Far on Malta as part of Operation Musketeer.

In 1957 and 1958 the RAF participated heavily during the Jebel Akhdar War in Oman with both Venom and Shackleton

aircraft. And in the Borneo Confrontation during early 1960s RAF aircraft were also involved, but due to a combination of deft diplomacy and selective ignoring of certain events by both sides, it never developed into a full-scale war.

What would have been the RAF's most significant role of all time occurred in 1962, especially during the weekend of 27-28 October when the UK nuclear force (V bombers, Canberras and Thor missiles) were on stand-by, some as little as 15 minutes readiness to launch. Thankfully the Cuban Missile Crisis was resolved and Armageddon never happened.



The three V bombers: Victor, Valiant and Vulcan

One of the largest actions that did take place by the RAF during the cold war was the air campaign in the 1982 Falklands War, in which the RAF operated alongside the Fleet Air Arm. During the war, RAF aircraft were deployed in the mid-Atlantic at RAF Ascension Island and a detachment from No. 1 Squadron was deployed with the Royal Navy,

operating from the aircraft carrier HMS *Hermes*. RAF pilots also flew missions using the Royal Navy's Sea Harriers in the air-to-air combat role. Following a British victory, the RAF remained in the South Atlantic to provide air defence of the Falkland Islands based at RAF Mount Pleasant which was built in 1984.



The Harrier, flown by both RN and RAF pilots in the Falklands War, was able to, literally, stop in mind air and fire its missiles giving the Argentinian pilots a serious problem!

With the collapse of the Soviet Union and the end of the Cold War, the RAF's focus has returned to expeditionary air power. Since 1990 the RAF has been involved in several large-scale operations, including: the 1991 Gulf War; the 1999 Kosovo War; the 2001 War in Afghanistan; the 2003 invasion and war in Iraq; and the 2011 intervention in Libya. Since then the RAF has been involved in: the UK's contribution to NATO's Baltic Air and Southern Air policing missions;

the military intervention against ISIL; support to French operations in Mali; international humanitarian and disaster relief operations; and support to the UK authorities in respect of flooding and the Covid-19 pandemic. Additionally, in recent years fighter aircraft on Quick Reaction Alert have been increasingly required to scramble in response to efforts made by the Russian Air Force to approach British airspace.



QRA: Typhoons into the night to deter 'The Bear'

Five major defence reviews have been conducted since the end of the Cold War: the 1990 Options for Change; the 1998 Strategic Defence Review; the 2003 Delivering Security in a Changing World; the 2010 Strategic Defence and Security Review; and the 2015 National Security Strategy and Strategic Defence and Security Review. The first four all resulted in steady reductions in manpower and numbers of aircraft, especially combat aircraft such as fast-jets. As part of the 2010 Review, the BAE Systems Nimrod MRA4 maritime patrol aircraft was cancelled due to over-spending and missing deadlines. Other reductions saw total RAF manpower reduced by 5,000 personnel to a trained strength of 33,000 and the early retirement of the Joint Force Harrier aircraft, the Harrier GR7/GR9. The 2015 Review by the Cameron Government attempted to redress some of the (later admitted) damage done by the 2010 Review.

The current Johnson Government has advised that there will be an “Integrated Security, Defence and Foreign Policy Review” in 2020 which is intended to shape the UK’s defence and security needs for the present decade. Originally it was intended to be concluded in time for the Government’s 2020 Comprehensive Spending Review due in the fourth quarter of the year; how the Covid-19 pandemic will affect both in terms of finance and timing remains to be seen.

The Review will cover all aspects of the UK’s place in the world, from the role of our diplomatic service and approach to development, to the capabilities of our Armed Forces and security agencies. Its remit is to:

- ▶ define the Government’s ambition for the UK’s role in the world and the long-term strategic aims for our national security and foreign policy;
- ▶ set out the way in which the UK will be a problem-solving and burden-sharing nation, examining how we work more effectively with our allies;
- ▶ determine the capabilities we need for the next decade and beyond to pursue our objectives and address the risks and threats we face;
- ▶ identify the necessary reforms to Government systems and structures to achieve these goals.

The RAF’s mission is to support the objectives of the Ministry of Defence which, today, are to “*provide the capabilities needed to ensure the security and defence of the United Kingdom and overseas territories, including against terrorism; and to support the Government’s foreign policy objectives, particularly in promoting international peace and security*”.

The RAF describes its mission statement as “... [to provide] *an agile, adaptable and capable Air Force that, person for person, is second to none, and that makes a decisive air power contribution in support of the UK Defence Mission*”. The mission statement is supported by the RAF’s definition of air power which guides its strategy. Air power is defined as “*the ability to project power from the air and space to influence the behaviour of people or the course of events.*”

The professional head of the RAF is the Chief of the Air Staff (CAS), an Air Chief Marshal. CAS is the senior military member of the Air Force Board, and sits alongside his fellow Chiefs of Staff for the Army and Navy, plus the Commander, Joint Forces Command and the Vice Chief of Defence Staff, on the Chiefs of Staff Committee chaired by the Chief of Defence Staff, the professional head of the UK Armed Forces.

While it used to be the case that the RAF was structured into a number of functional and geographic commands such as Fighter, Bomber, Training, Coastal, Signals, Far East, Middle East, etc., today with the much reduced size of the Service there is only one command: Air Command. It is headed by CAS with two deputies, both Air Marshals.

The Deputy Commander (Operations) has responsibility for the RAF’s expeditionary, engineering, logistics, and communications units, medical operations units, and RAF Music Services. In November 2018, 11 Group was further formed as part of Air Command. The Deputy Commander (Operations) acts as the Deputy to the CAS and oversees day-to-day operations. The Deputy Commander (Capability) has responsibility for Personnel and Training. Air Marshal Sir Richard Garwood KBE CB DFC (who wrote the Foreword to Sandy’s Spitfire) was Deputy Commander (Operations) from April 2010 to April 2013.



Air Command

- ▶ **No. 1 Group** (Air Combat): controls the fast-jet force and the RAF's intelligence, surveillance, target acquisition and reconnaissance (ISTAR) capabilities.
- ▶ **No. 2 Group** (Air Combat Support): controls the Air Mobility aircraft and the RAF's Force Protection assets.
- ▶ **No. 11 Group** (Multi-domain operations group): leads air and space operations.
- ▶ **No. 22 Group** (Training): responsible for the supply of qualified and skilled personnel.
- ▶ **No. 38 Group** (Air Combat Service Support): responsible for engineering and logistics, communications and medical operations.
- ▶ **No. 83 Group** (Expeditionary Air): the RAF's operational headquarters in the Middle East.
- ▶ **No. 34 EAW**, based at RAF Waddington: ISTAR operations.
- ▶ **No. 38 EAW**, based at RAF Brize Norton: air transport operations.
- ▶ **No. 121 EAW**, based at RAF Coningsby: multi-role operations.
- ▶ **No. 135 EAW**, based at RAF Leeming: fighter operations.
- ▶ **No. 138 EAW**, based at RAF Marham: fighter operations.
- ▶ **No. 140 EAW**, based at RAF Lossiemouth: fighter operations.
- ▶ **No. 901 EAW**, based in the Middle East: voice and data systems.

Each Group is commanded by an Air Vice Marshal except No. 83 which is commanded by an Air Commodore.

There are currently nearly 34,000 regular uniformed personnel, and over 4,000 Auxiliary and Reserve uniformed personnel, most of whom are based on stations across the UK and overseas. An RAF station is normally subordinate to a Group and commanded by a Group Captain. Each is usually divided into the following wings, all commanded by a Wing Commander: Operations; Forward Support; Depth Support; Tactical Imagery Support; Base Support.

In addition, there are ten Expeditionary Air Wings (EAWs), each under a Wing Commander, to support operations; wings currently active are as follows:

- ▶ **No. 902 EAW**, based in the Middle East: helicopter services.
- ▶ **No. 903 EAW**, based at RAF Akrotiri, Cyprus: operations against ISIL.
- ▶ **No. 906 EAW**, based in the Middle East: transport services.

A flying squadron is an aircraft unit which carries out the primary tasks of the RAF. RAF squadrons are somewhat analogous to the regiments of the British Army in that they have histories and traditions going back to their formation, regardless of where they are based, which aircraft they are operating, their current role, and so on. They can be awarded standards and battle honours for meritorious service. Whilst every squadron is different, most flying squadrons are commanded by a Wing Commander and, for a fast-jet squadron, have an establishment of 12 aircraft.

An excellent example of a front-line flying squadron is No. II(AC) Squadron based at RAF Lossiemouth and operating the Typhoon FGR4 as part of the Nation's Quick Reaction Alert Force amongst many other duties. The first fixed-wing squadron in the world (by seconds) their history is very impressive and can be seen at <https://www.raf.mod.uk/our-organisation/squadrons/ii-ac-squadron/> 'Shiny Two' are strong supporters of Project AA810 and, indeed, flying the Spitfire in the reconnaissance role, brought back the first aerial photographs of the D Day landings on 6 June 1944.



Schools & Colleges

- ▶ **Central Flying School** – CFS standardises flying training across the Air Force and ensures standards and safety are maintained.
 - ▶ **No. 1 Flying Training School** - formerly the Defence Helicopter Flying School – basic helicopter training, based at RAF Shawbury.
 - ▶ **No. 2 Flying Training School** – gliding training, based at RAF Syerston.
 - ▶ **No. 3 Flying Training School** – Elementary Flying Training, based at RAF College Cranwell, with a squadron at RAF Wittering.
 - ▶ **No. 4 Flying Training School** – Basic Fast Jet Training and Advanced Fast Jet Training, based at RAF Valley.
 - ▶ **No. 6 Flying Training School** – flight training for the University Air Squadrons, based at RAF stations throughout the UK.
- The British military operate a number of joint training organisations within Air Command:
- ▶ Defence College of Aeronautical Engineering.
 - ▶ Defence College of Electro-Mechanical Engineering.
 - ▶ Defence School of Communications and Information Systems.
 - ▶ Defence School of Marine Engineering.

And then there is the Defence Academy of the UK which is part of the Ministry of Defence with a 3* officer as its Director General. The Academy is responsible for post-graduate education and the majority of command, staff, leadership, defence management, acquisition and technology training for members of the UK Armed Forces and MOD civil servants. It is also the MOD's main link with UK universities and

international military educational institutions. The Academy has three strategic partners: King's College London; Serco UK and Europe; and Cranfield University who provide the academic and facilities support. The Academy also houses the RAF Centre for Air & Space Power Studies. The RAF Air Warfare Centre, which is a research & testing organisation, is based at RAF Cranwell.

Current and projected equipment inventory

The RAF maintains an operational fleet of various types of aircraft, described by the RAF as being "leading-edge" in terms of technology. This largely consists of fixed-wing aircraft, including: fighter and strike aircraft; airborne early warning and control aircraft; ISTAR and SIGINT aircraft; aerial refuelling aircraft; and strategic and tactical transport aircraft. The majority of the RAF's rotary-wing aircraft form part of the tri-service Joint Helicopter Command in support of ground forces. The inventory is as follows:

- ▶ **F-35B** variant of the RAF's and Fleet Air Arm's Lightning II organised under a single administrative structure called the 'Lightning Force' which forms part of Air Command and comprises two front-line squadrons, an operational conversion unit (OCU) and an operational evaluation unit (OEU). The intention is to purchase 138 aircraft in total.
- ▶ **Eurofighter Typhoon.** It was announced in the 2015 Strategic Defence and Security Review that the RAF would retain its Tranche 1 Typhoons and use them to stand up an additional two squadrons making a total of seven, plus an OCU and an OEU, all based at RAF Coningsby and RAF Lossiemouth. The aircraft will remain in service until 2040, ten years longer than previously planned. The Government also promised to invest further in Typhoon air-to-ground capabilities and in a new active electronically scanned array (AESA) radar, as well as completing integration of the Storm Shadow and Brimstone missiles with the Typhoon. 107 Tranche 2 and 3 Typhoons will be equipped via "Project Centurion", allowing them to launch Meteor, Brimstone and Storm Shadow missiles. 24 Tranche 1 Typhoons will be retained for UK Quick Reaction Alert purposes. The final aircraft of the 160 ordered was due to be handed over in August 2019.

- ▶ **Team Tempest.** At the 2018 Farnborough Airshow, UK Defence Secretary Gavin Williamson announced Team Tempest, a joint program office consisting of government divisions alongside BAE Systems, Leonardo, MBDA and Rolls-Royce that would develop, by 2025, a new design of fighter aircraft with £2 Billion of funding. This will develop new technologies and means of production under the Future Combat Air System Technology Initiative. It is likely to involve technology from Italy and Sweden, and leverage the UK's Eurofighter Typhoon experience. See also Tempest fugit by Tim Robinson of the RAeS dated 21 July 2020.
- ▶ **Poseidon.** The UK is acquiring nine Boeing P-8 Poseidon aircraft which are being based at RAF Lossiemouth in Scotland by 2025, the first two of which are now in service. The aircraft include an overland surveillance capability which could eventually replace the surveillance capability lost by the retirement of the Sentinel R1 in 2025. The RAF plans to operate its P-8s with U.S. weapons such as MK54 torpedoes and Harpoon anti-ship missiles initially, with a possible transition onto British weapons in the future.
- ▶ **Sentry E-3D.** Fully integrated with the ISTAR force, the Boeing E-3D is an Early Warning and Command & Control aircraft designated AEW1 by the RAF. It operates from RAF Waddington and is likely to remain in service until 2035
- ▶ **Wedgetail.** In 2018 the RAF announced plans to upgrade its airborne early warning facility. Initially this was planned as an upgrade of the E-3D Sentry fleet, which would mirror the Sentry Block 40/45 upgrade undertaken by the USAF. However, owing to the significant cost of such a project, estimated at approximately £2B, it was thought that it would be more cost-effective to procure a new system instead. The eventual selection of the Boeing

E-7 was seen as advantageous, in part due to its level of commonality with the P-8 Poseidon, as well as enabling greater co-operation with the RAAF who are already operating the system. A deal was signed in March 2019 that will see the RAF procure five E-7 aircraft for approximately £1.5B. The aircraft will operate from RAF Waddington.

- ▶ **Rivet Joint.** A total of three Boeing RC-135 Rivet Joint signals intelligence aircraft, ordered to replace the Nimrod R1 which was retired in 2011, are now in service as of 2017. These became known as Airseeker when they entered RAF service in 2014. The aircraft is an extensively modified Boeing C-135 Stratolifter with onboard sensors which enable the crew to detect, identify and geolocate signals throughout the electromagnetic spectrum. The crew can then forward information in a variety of formats to a wide range of consumers via the onboard secure communications suite. The aircraft operate from RAF Waddington.
- ▶ **Sentinel R1.** The five Raytheon Sentinel R1s, which are based on the Bombardier Global Express, also operate from RAF Waddington. They are airborne battlefield and surveillance aircraft and will remain in service until 2025.
- ▶ **Shadow R1.** The Beechcraft Shadow R1 will remain in service until “at least” 2030. An additional two aircraft will also be procured for a total of eight in service by 2025. The squadron operates from RAF Waddington in the ISTAR role.
- ▶ **C-17.** The RAF operates eight Boeing C-17A Globemaster III heavy-lift strategic transport aircraft from RAF Brize Norton.
- ▶ **Atlas.** 22 Airbus A400M will replace the Hercules C-130K. Cargo capacity is doubled over the latter aircraft, both in payload and volume, and range is increased substantially. The Airbus A400M operates in many configurations including cargo transport, troop transport, medical evacuation, and electronic surveillance. The aircraft, which are based at RAF Brize Norton, can operate on short, soft landing strips as well as be used for long-range, cargo transport flights.
- ▶ **Hercules C-130J.** The 2015 Strategic Defence and Security Review included a reprieve for some of the Hercules fleet, with the Government announcing “We will upgrade and extend the life of our C-130J aircraft, allowing them to support a range of operations until 2030”. It had been reported that the Army’s senior leadership was unhappy with the retirement of the Hercules aircraft, due to uncertainty regarding the A400M’s and C-17’s effectiveness in some tactical roles. Consequently, the RAF will retain 13 C-130J-30s and 1 C-130J in its inventory, now extended to 2035. The aircraft operate from RAF Brize Norton.
- ▶ **Voyager.** Based on the Airbus A330, Voyager is the RAF’s sole refuelling tanker which also operates as a strategic airlift transport. The aircraft is in service as the KC. Mk 2 equipped with two underwing pods for refuelling fast jet aircraft, and as the KC. Mk 3 with an additional centre line hose for use by large aircraft. One is fitted for use by the HM The Queen, the Prime Minister and senior ministers. There are nine in service at RAF Brize Norton, plus a further five available from Air Tanker Services.
- ▶ **Hawk.** The BAE Systems Hawk T1 has been in service since 1976 and is used by the Red Arrows Display Team, and by 100 Sqn in the aggressor role. The T2 version, which has been in service since 2009, is used as an advanced fast-jet training aircraft. There is a total of 104.
- ▶ **Chinook HC2 & Puma HC2.** There are 62 of the former and 24 of the latter helicopters operating within the tri-service Joint Helicopter Command, with the heavy-lift Boeing Chinooks based at RAF Odiham and the medium-lift Westland Pumas at RAF Benson.
- ▶ **MQ-9 Reaper.** The RAF operates ten General Atomics MQ-9A Reaper UAVs in the ISR & attack role from RAF Waddington. They will convert to the MQ-9B version.
- ▶ **Protector RG.1.** The MQ-9 Reapers will be replaced from 2024 by up to 26 General Atomics Protector RG.1s; they will be operated from RAF Waddington.
- ▶ **Zephyr 8.** The Airbus Zephyr is a solar-powered stratospheric UAV able to fly at the edge of space for months at a time. Currently, the RAF operates 3 of them.

► **Swarming Drones.** On 11 February 2019 the UK Secretary of State for Defence announced that the UK will develop 'swarming drones' to defeat enemy air defences. A new squadron at RAF Waddington will be formed to control these drones.

► **FCAS.** The Future Combat Air System (FCAS) (also known as the Unmanned Combat Air System) aims to deliver a UCAV by 2030. FCAS will be built in co-operation with France, utilising technology from the BAE Taranis and Dassault nEUROn technology demonstrators. In the RAF, FCAS will operate alongside Typhoons and F-35 Lightning IIs. As a UCAV, FCAS will utilise stealth technology to reduce its radar cross-section

(its radar signature is reportedly the size of a dragonfly). It will feature a high degree of autonomy enabling it to complete a large part of its missions without human control. Additionally, technology from FCAS may also be incorporated into manned platforms; and a manned option for FCAS has not been ruled out.

► **ARTEMIS.** The then Secretary of State for Defence, Penny Mordaunt, announced at the Air & Space Power Conference on 17 July 2019 that a joint US-UK team, ARTEMIS, would be formed to launch and research small military satellites. 23 Squadron will reform as the RAF's first dedicated space squadron.



*Artemis is the Greek goddess of the hunt, the wilderness, wild animals, the Moon, and chastity.
Artemis is the daughter of Zeus and Leto, and the twin sister of Apollo.*



FLEET AIR ARM

The Fleet Air Arm (FAA) is one of the five fighting arms of the Royal Navy and is responsible for the delivery of naval air power both from land and at sea.

The FAA will operate the F-35B Lightning II in a Maritime Strike Role, the AW159 Wildcat and AW101 Merlin in both Commando and Anti-Submarine roles, and the BAE Hawk in an aggressor role.

The FAA is currently commanded by the Assistant Chief of Naval Staff (Aviation and Carrier Strike) a Rear Admiral appointment. The FAA currently comprises circa 5,000 service personnel, nine helicopter squadrons, eight support & training squadrons, and two fixed wing squadrons, one for the F35B and one for the Hawk T1.



ARMY AIR CORPS

The Army Air Corps (AAC) is a component of the British Army, first formed in 1942 during the Second World War by grouping the various airborne units of the British Army (which are no longer part of the AAC).

Today, there are eight regiments (seven Regular Army and one Reserve) of the AAC as well as four Independent Flights and two Independent Squadrons deployed in support of British Army operations across the world. They are located in Britain, Brunei, Canada, and Germany. Some AAC

squadrons provide the air assault elements of 16 Air Assault Brigade through Joint Helicopter Command. The Corps consists of circa 2,000 regular service people; however, the AAC also draws an additional 2,600 personnel from the Royal Logistics Corps and the Royal Electrical & Mechanical Engineers. Principal aircraft are the Boeing Apache AH-64D Longbow attack helicopter, the Wildcat Mk1 in the reconnaissance, command & control, and transport roles, the Gazelle in the observation role, the Bell 212 optimised for jungle operations, and now the Airbus 135 Juno in a training role at RAF Shawbury.