Vulcan Restoration Trust

Preserving Vulcan XL426 at London Southend Airport
www.avrovulcan.com

Fact Sheet No 1: Avro Vulcan History

With its gigantic, delta-shaped wing and sleek, graceful lines, the Avro Vulcan is without doubt one of the most distinctive aircraft produced in Britain since the Second World War. It is also one of the most important. Its pioneering design was fundamental in furthering our understanding of advanced aerodynamics, and helped develop technologies that would later be incorporated into the design of Concorde. As part of the Royal Air Force's 'V-force', the Vulcan was at the spearhead of the West's nuclear deterrent, and played a vital role preventing conflict during the darkest days of the Cold War.

The genesis of the Vulcan can be traced back to January 8th, 1947, when the Air Ministry issued a requirement for a 500-knot, four-engine jet bomber capable of carrying a 10,000lb payload over a range of 3,000 miles. By coincidence, this was the very same day the British Government formally authorised development of the UK's own nuclear weapons. Britain had been frozen-out of any joint programme with America with the passing of US Atomic Energy Act, and it was clear to the government that if Britain was retain its position as a world power, it would have to develop its own nuclear weapons and the means of delivering them.

Tried and tested

Rocket technology was, at that time, still in its infancy. Although the Germans had made great strides in rocket development during the Second World War, their most advanced design (the V-2) was far from capable of carrying the sort of payload required for the first generation of nuclear weapons. It would be many years before a satisfactory nuclear missile system could be developed, and so Britain decided to rely on a tried-and-tested method for carrying its first atomic weapons - the long-range strategic bomber.

Submissions were received from six aircraft companies in response to the Air Ministry's requirement and, from these, two designs (from A V Roe and Handley Page) were selected for development. The performance required of the new aircraft was way beyond anything previously undertaken by the British aircraft industry and, consequently, the Avro and Handley Page designs were extremely advanced, both structurally and aerodynamically. Only too aware of the likelihood of long development programmes, as well as the very real possibility of complete failure, the Air Ministry also chose to develop the less advanced, but less complex, design submitted by Vickers. Later named the Valiant, it would become the RAF's first four-engine jet bomber when it entered service in February 1955.

First flight

Development of the Avro design continued at the company's factory at Chadderton, Manchester. As part of the development programme, Avro constructed five approximately one-third flying 'scale models' designated as the Avro 707, to explore various facets of the flight envelope. The first prototype of the full-size bomber, designated Avro 698 (the name 'Vulcan' was not bestowed until October 1952) was readied for its maiden flight during the summer of 1952.

The aircraft was taken by road to the company airfield at Woodford, near Stockport, where it was assembled and took to the air for the first time, in the hands of Avro Chief Test Pilot,

Roly Falk, on August 30th 1952. The following week the prototype (VX770) made a sensational first appearance at the Farnborough Air Show. At the time, it was the largest delta-winged aircraft ever built, Falk showing-off the new bomber to an extremely appreciative crowd.

Both the Avro and Handley Page designs had been ordered into production for the RAF in July 1952, although problems with the design of the Vulcan's wing, which necessitated a complete redesign of the leading edge, delayed its entry into service until July 1956. The Handley Page bomber - by now known as the 'Victor' - began entering service in November 1957. Together, the Vulcan, Victor and Valiant were known as the 'V-bombers', and collectively they formed what became known as the 'V-force'. The new bombers were flown by elite, hand picked crews, in what was the most powerful aerial strike force the RAF had ever possessed.

The Vulcan had a 5-man crew: the pilot and co-pilot sat facing forward on the cockpit's upper deck, whilst the two navigators and the Air Electronics Officer (AEO) sat lower down, at a rearward facing 'desk'. In some aircraft, there was also provision to carry two passengers (usually ground crew on transit flights) in extra seats at the lower level. Only the pilot and co-pilot were provided with ejector seats. In the event of an emergency, the crew on the lower deck had to escape via the crew entry door in the floor of the cockpit; a potentially hazardous task, particularly if the aircraft's undercarriage was not retracted.

Into service

The first mark of Vulcan (the B1) entered service initially with 230 Operational Conversion Unit, based at RAF Waddington, near Lincoln. The first operational unit, 83 Squadron, formed shortly afterwards at the same base, followed by 101 Squadron at RAF Finningley, Yorkshire, and 617 Squadron at RAF Scampton, also near Lincoln. These first squadrons were equipped with *Blue Danube*, Britain's first atomic bomb, and *Violet Club*, an early thermonuclear weapon. Both of these were later superseded by *Red Beard* and *Yellow Sun*, another thermonuclear device. The squadrons could also be armed with conventional weapons, the Vulcan being able to carry 21 1,000lb 'iron' bombs.

Powered by four Bristol Siddeley (later Rolls Royce) Olympus turbojets, the Vulcan B1 had a top speed of 625mph and could reach heights of up to 55,000 feet. 97 feet long, and with a wingspan of 99 feet, it carried no defensive armament, relying on speed and height for protection from Soviet fighters and surface-to-air missiles (SAMs). The Vulcans were painted in all-over white, to protect their sensitive electronics from the extreme heat of nuclear explosions. They were also designed to be flown 'blind', the cockpits blacked-out by screens and curtains to shield the crews from the fierce light of the nuclear 'flash'.

Bigger and better

However, even as the first B1's were entering service, Avro was already working on the development of a second generation Vulcan, equipped with more powerful versions of the Olympus and capable of even greater range and height. These improvements were essential if the V-force was to keep one step ahead of the Soviet defences, which were continually being re-equipped with better fighters and more potent SAMs.

The new Vulcan, the B2, featured a redesigned wing, the span being increased to 111 feet, and was fitted with a new range of electronic countermeasures (ECM) equipment to 'jam' Soviet defensive radars. This was housed in an extended fairing in the rear fuselage. Later on, this ECM equipment was also retrofitted to a number of Vulcan B1's, these aircraft being re-

designated as B1A's. The prototype Vulcan B2 made its first flight on 4th March 1959, with the first operational squadron forming at RAF Scampton in 1960.

The B2 could also carry a new 'stand-off' missile, developed by Avro, called *Blue Steel*. Powered by its own rocket engine, *Blue Steel* could be launched at a range of over 100 miles from its target. This meant that the launch aircraft was no longer faced with the dangerous prospect of flying directly over its target, as was necessary with the older free-fall weapons. *Blue Steel* became operational with the V-force in 1963 and equipped the Vulcan squadrons at RAF Scampton, whose aircraft had to be specially modified to carry the new missile.

Quick Reaction Alert

In terms of numbers, the 1960s saw the Vulcan force at its height, the type serving with nine operational squadrons during the course of the decade. The introduction of the B2, and the consequent expansion of the Vulcan force, saw the formation, in 1962, of a new Vulcan wing at RAF Coningsby, Lincolnshire, although the wing subsequently moved to RAF Cottesmore, Leicestershire, just two years later. The V-force provided a very creditable nuclear deterrent, with RAF Scampton's *Blue Steel* Vulcans and RAF Wittering's similarly-armed Victors, at its spearhead. From 1962 onwards, the V-force adopted a posture of Quick Reaction Alert (QRA), whereby one aircraft from each squadron (later increased to two) was held at 'cockpit readiness'. The 'V-force' stood at constant alert, in much the same way as Fighter Command had done so during the Battle of Britain, awaiting the call to 'scramble' in response to any Soviet attack.

The QRA aircraft stood specially constructed dispersal pans, called Operational Readiness Platforms (ORP) built at the end of the V-force runways. A special system called 'Simstart' meant that all four of the Vulcan's engines to be started simultaneously (and its flight instruments and flying controls brought on line) in the space of just 20 seconds - all at the touch of a single button! This enabled crews to get their aircraft airborne sometimes within two minutes of the 'scramble' being sounded, adding greatly to the V-force's credibility as an important part of the West's nuclear deterrent.

Provision was also made to disperse the V-force's aircraft to airfields throughout the country during times of tension, avoiding the possibility of a 'knock-out' blow being delivered by a pre-emptive strike. ORPs were constructed at 27 designated dispersal bases, in addition the V-force's own airfields. The V-force's highest state of readiness was reached during the 1962 Cuban Missile Crisis, although it was decided not to disperse its aircraft in case this was misinterpreted by the Soviets as a preparation for a nuclear attack.

Switch to low level

From the mid-1960s onwards, the Vulcan's white paint-scheme was replaced by green and grey camouflage, the change in colour being a very visible sign of a change in tactics from high-level to low-level attack. The shooting down from a height of over 60,000 feet of CIA pilot, Gary Powers, in his U-2 spy plane over the Soviet Union in 1960, had showed that Soviet SAM technology had advanced to the stage where the V-force could no longer rely solely on speed and height for protection.

The switch to low-level operations seriously reduced the effectiveness of *Blue Steel*, which could now only be launched from a range of 25 miles. Consequently, the task of destroying primary targets was passed to the *Yellow Sun* squadrons, the *Blue Steel* units being restricted to peripheral targets.

Responsibility for the British nuclear deterrent was handed over by the RAF to the Royal Navy, and its Polaris submarines, on June 30th, 1969. QRA ceased on midnight that day and brought to an end the longest period of constant alert ever maintained by a British military force.

Following the hand-over, the Vulcan force was re-tasked to the low-level conventional bombing role, although it retained a tactical nuclear capability using the WE177B parachute-retarded bomb. From 1969 to 1975, two squadrons (Nos. IX and 35) were assigned to the Near East Air Force Bomber Wing at RAF Akrotiri, Cyprus, whilst in the UK, the reduction of the Vulcan force meant that operations were now centred on just two bases, RAF Scampton and RAF Waddington.

Engine test-bed

The Vulcan's large size, excellent ground clearance, high speed and outstanding altitude performance made it an ideal vehicle for testing high-performance jet engines. Throughout the 1950s, '60s and '70s, a small number of Vulcans were assigned to testing duties, including the development of the Olympus engine for Concorde and the ill-fated TSR-2 programme, as well as the RB199 which went on to power the Tornado.

From 1973 to 1982, the Vulcan was also used in the strategic reconnaissance role. Specially converted aircraft, designated Vulcan B2 MRR, were operated from RAF Scampton by 27 Squadron on long-range maritime radar reconnaissance sorties. The squadron also had a secondary role which involved high-altitude missions, fitted with underwing 'sniffer' pods, taking samples of the upper air for scientific analysis.

Falklands War

In November 1981, it was decided to withdraw the Vulcan from service in June 1982. However, the Argentinean invasion of the Falkland Islands in the spring of 1982 gave the Vulcan an extended lease of life, and an unexpected swansong at the end of its distinguished RAF career. With the collapse of the diplomatic talks aimed at achieving a peaceful solution to the crisis, the British set about liberating the islands by force. Between April 30th and June 11th, the RAF carried out five long-range sorties against the Falklands using Vulcans detached to Wideawake Airfield, Ascension Island, in the mid-Atlantic. Code-named Operation 'Black Buck', three of the sorties were conventional bombing missions against the runway at Port Stanley Airport (in order to deny its use to high-performance Argentinean fighters) and two were Shrike missile sorties against radar sites on the islands.

The raids were the longest bombing missions in the history of aerial warfare (a record subsequently broken by USAF B-52s during the 1990 Gulf War), each requiring massive support from the RAF's fleet of Victor K2 tankers. The Victor, the Vulcan's V-force compatriot, had been withdrawn from bombing duties at the end of the 1960s, and since then had been the mainstay of the RAF's air-to-air refuelling fleet. Each 'Black Buck' involved a round trip of some 8,000 miles and lasted upwards of 15 hours. 'Black Buck 1' succeeded in damaging the runway at Port Stanley (and the Argentineans never deployed their front-line fighters to the Falklands) and 'Black Buck 5' and 'Black Buck 6' damaged and destroyed Argentinean radar sites.

The raids, however, were not without their difficulties. On the return leg of 'Black Buck 6', problems encountered during an air-to-air refuelling hook-up caused part of Vulcan XM597's refuelling probe to break off. The crew were forced to divert to Rio de Janeiro where XM597 was impounded by the Brazilian authorities. Following negotiations, the aircraft was eventually released eight days later.

Final duty

Following the liberation of the islands, the RAF was tasked with providing an 'air-bridge' for fuel and supplies between Ascension Island and the Falklands. This put a tremendous strain on the Victor tanker fleet, a situation foreseen even before the war had been won. A decision was made to convert six Vulcans to air-to-air tankers as a 'stop-gap' until the introduction of VC-10 tanker aircraft in the mid-'80s. The Vulcan tankers, designated Vulcan B2 (K), had a single hose-drum unit (HDU) fitted into the rear tail-cone (which had previously housed ECM equipment) and three additional fuel tanks fitted in the bomb-bay.

The tankers were operated from RAF Waddington by 50 Squadron, which by the end of 1982 was the sole surviving Vulcan unit. The B2 (K) proved itself to be a solid and reliable air-to-air refuelling platform. 50 Squadron flew over 3,000 hours on Vulcan tanker missions and it was with much regret that the squadron was disbanded, and the Vulcan withdrawn from operational service, on March 31st, 1984.

A total of 135 Vulcans were built, the final example (XM657) entering service with the RAF in January 1965. Following its withdrawal from service, the RAF kept a single Vulcan (XL426 from 1984 to 1886 and XH558 from 1986 to 1992) airworthy for air display appearances. Operated by the Vulcan Display Team from RAF Waddington, the Vulcan continued to thrill airshow crowds for nine years, until XH558 gave its last display at the Cranfield Dreamflight Airshow on September 20th, 1992. The final RAF Vulcan flight took place on March 23rd, 1993, when XH558 was delivered to its new owner C Walton Ltd at Bruntingthorpe, Leics.

Nineteen complete aircraft are still in existence in museums, private collections and as gate-guardians. Sixteen of these are in the UK and four are in North America. All are Vulcan B2s. Sadly, no B1s have survived. There are also ten nose/cockpit sections remaining, two of which are from Vulcan B1s and another which is believed to be from a static test airframe.