VULCANS AT BITTESWELL

This paper briefly explores the design and development of the Avro Vulcan Bomber aircraft and their subsequent servicing maintenance and repair in the 1960s -1980s at Hawker Siddeley Aviation Limited (HSA), situated at Bitteswell Airfield, in Leicestershire. Part of the paper will be based on the author's recollections of Bitteswell during that period.

The Avro Vulcan aeroplane has in recent years gained a reputation with the general public bordering on iconic status, probably due in no small part to its total disappearance from the skies; the last flight of the remaining airworthy example *XH 558* being made in October 2015. Designed to be an integral part of the V - Bomber Force comprising the Valiant, Vulcan and Victor, the triumvirate forming Britain's Nuclear Deterrent, the Vulcan was a large and impressive delta-winged aeroplane with an outstanding performance. Unfortunately, the Vulcan's two stablemates both had shortcomings and the Valiant and Victor were somewhat prematurely removed from the nuclear deterrent role, leaving the Vulcan to shoulder that operational burden alone.

Project design work on the Avro 698 aircraft began at Chadderton, Manchester, in January 1947 under the control of Chief Designer Stuart Davies and Technical Director Roy Chadwick. The small design team worked on schemes based on earlier German research into tailless aircraft designs promulgated notably by Walter and Reimar Horten and Dr Alexander Lippisch. Towards the end of the Second World War the Horten brothers produced the experimental Ho. IX turbojet powered all wing fighter- bomber and Lippisch the phenomenal rocket propelled Me.163 interceptor fighter, the latter aircraft seeing limited operational service at the end of that conflict.

Drawing on the remaining available German aeronautical data, much of which had been destroyed at the end of the war to prevent Allied capture, and the previous work of both Armstrong Whitworth with its AW 52 Flying Wing and Northrop Aviation with its XB-35, the Avro design team progressed steadily towards a delta wing concept for the new aeroplane. Roy Chadwick's belief being that aerodynamic efficiency and structural integrity could only be realised with a delta winged design.

Quite early on in the development of the new Avro bomber, the project was dealt a severe blow with the death of Roy Chadwick. Chadwick, whose name will always be associated with the wartime Lancaster, had been a technical passenger on board the ill-fated prototype Avro Tudor 2 civil transport, which crashed on take - off from the company's airfield at Woodford on August 23rd 1947. Four of the six persons on board were killed, including Chadwick. The ensuing enquiry revealed that the aileron control cables had been reversed. This almost unforgivable cardinal error had robbed the design team of its driving force and Avro management were initially fearful that the delta bomber project would not survive. However, with the speedy appointment of William Farren as the new Technical Director, the work once again gathered momentum.

To confirm the basic concept of the delta wing at both low and high speeds, several single seat experimental research aircraft were designed and built by Avro and these were allocated the overall type designation Avro 707. These aircraft were respectively; Prototype *VX 784;* 707B *VX 790;* 707A's *WD 280 a*nd *WZ 736;* 707C *WZ 744* (the latter machine having dual control). Each of the first two aircraft had a single central dorsal air intake for the Rolls - Royce Derwent 8 turbojet engine, but the final three machines had wing- root mounted intakes. Although of delta plan shape, all the aircraft were fitted with a conventional central fin and rudder. Perhaps of all the prototypes *WD 280* was the closest to the final configuration of what was eventually to be the Avro 698 Vulcan.

Extensive testing of high and slow speed handling characteristics of the delta configuration was the intention for the above aircraft. On September 4th 1949 the first flight of *VX 784* being made from the Aeroplane and Armament Experimental Establishment (A&AEE) at Boscombe Down with Lieutenant Eric Esler, Chief Test Pilot of the A&AEE, at the controls.

These early trials concluded that the general handling of aircraft with the delta configuration was very similar to that of conventional aircraft, except for a rather protracted take-off run. Unfortunately, within less than a month Eric Esler was killed when *VX 784* crashed at Blackbushe on September 30th. Although the exact cause of the accident was never fully established, a fault in the airbrake actuation circuit, which locked the airbrake in the extended position, probably precipitated a slow speed stall, recovery from which would have been impossible. Nevertheless, despite this loss of man and machine, testing with 707B *VX 790* continued, the aircraft demonstrating its very stable flying characteristics in loops, rolls and high angles of attack at slow speeds without stalling.

Although the two 707 A prototypes were ostensibly built to determine high speed handling characteristics, one of them, *WD 280,* in fact spent most of its flying hours assessing the slow speed features of the delta wing, especially in Australia where the aircraft had been transported in April 1956. This particular aircraft was the first to sport what was to become a very prominent Vulcan feature, the so called Phase 2 Wing, with a cranked leading edge. Eventually *WD280* was withdrawn from service and sold to an Australian private citizen with whom the aircraft now resides, apparently in good condition in the owner's small garden!

Meanwhile, detail drawings of the prototype Avro 698 were proceeding with the actual cutting of metal beginning in 1951. Among other things, some data accumulated from the experimental test flying indicated that the proposed size of the fin of the Avro 698 could be reduced in size. A revision of the wing fuselage interface was also carried out with maximum thickness of the aerofoil being move further forward which resulted in a twofold improvement: firstly, in air intake efficiency and secondly and perhaps more importantly, an increase in attainable maximum speed due to a change in the point where compressibility drag took place.

Construction of the yet unnamed prototype continued and work progressed through 1951 and into 1952, with the company working feverishly in the hope that the aircraft might make an appearance at the Society of British Aircraft Constructors (SBAC) Show at Farnborough in September 1952. Finally, on Aug 30th 1952 the Avro 698 prototype *VX 770*, resplendent in its gloss white anti-flash finish, made its first flight from Woodford with Roland "Rolly" Falk at the controls. The flight, which was of nearly thirty minutes duration, was only slightly marred by the loss of two rear undercarriage fairings, which were seen to be torn from the aircraft and fall to the ground by observers in the Woodford Control Tower. A Vampire aircraft and an experimental Avro 707 were dispatched to investigate whilst the prototype was still in the air, but other than the loss of the fairings nothing else seemed amiss and *VX 770* landed without further mishap.

Test Pilot Falk was very pleased with the general handling of *VX 770* and claimed it was easier to control than the Anson, a much smaller twin piston engined Avro aircraft from the 1940s. The prototype did indeed attend the 1952 SBAC Show making daily appearances throughout, although no landings were carried out at Farnborough. After the SBAC Show there was much speculation on a suitable name for the big delta aeroplane. Eventually, in keeping with the other V bombers (Valiant and Victor), the name Vulcan was selected.

Whilst flight development went ahead with *VX 770* work continued on the construction of the second prototype, *VX 777*. Changes were also made to the engines, a switch being made from Rolls - Royce Avons to Armstrong Siddeley Sapphires. The Avro design team however wanted to install the Bristol BE10 engines, but their development was way behind that of the airframe, so the Sapphire was the interim choice. Eventually all production Vulcans had variants of the Bristol Olympus engine, certainly in the Vulcan era among the most powerful and noisiest jet engines in the Western World.

The first production Vulcan was *XA 889* and this machine was delivered for acceptance trials to Boscombe Down in March 1956. This aircraft was not quite up to service standards in several respects, mostly in equipment and therefore could not be considered an operational aircraft.

In July 1956 the RAF received into service its first production Vulcan, *XA 897*, which was actually the ninth production machine. This particular aircraft was also destined unfortunately to be the first Vulcan casualty, and in doing so highlighted a serious shortcoming that was to cast a shadow over the aeroplane right to the end of its operational career. It was decided to embark on long range Operational Reliability Trials (ORTs) with this machine, not solely for the purposes of testing the new aircraft, but also as an excuse to obtain diplomatic and publicity kudos. The flight plan was to encompass a tour of New Zealand and Australia, with a scheduled return to the UK via Singapore and Ceylon; the last stage from Aden to London Heathrow beginning on 1st October 1956.

The crew of *XA 897* for the ORTs comprised six members, including the aircraft captain, Squadron Leader Donald Howard and the highly decorated Air Marshal Sir Harry Broadhurst, C in C Bomber Command. The remaining crew members comprised three RAF Squadron Leaders, one being a qualified Vulcan pilot who occasionally assisted in flying the aircraft, and a Technical Representative from Avro.

On the October 1st 1956 at Heathrow to greet the return of the Vulcan was a VIP reception committee, consisting of high ranking RAF personnel, Air Ministry Officials, the media and family members of the crew. Squadron Leader Howard was instructed to land at Heathrow and this may have weighed heavily with him. Unfortunately, being winter, there was fog and rain at Heathrow, visibility being down to about 3000 feet. Under normal circumstances an aircraft captain, without an injunction to do otherwise, may perhaps have elected to divert to an alternative airport or RAF base. Squadron Leader Howard elected to land at Heathrow as instructed. Although the subsequent enquiry found no specific fault with the landing talkdown procedure or the piloting of the aircraft by Squadron Leader Howard, the Vulcan was well below the descent flightpath and somewhat off the centreline when it struck soft ground fairly lightly three- quarters of a mile short of runway 10L. The aircraft engines were opened up and the Vulcan attempted to gain height. The seriously damaged main undercarriage was forced backwards, piercing the wing structure ahead of the flying control surfaces, rendering the latter inoperative. The aircraft began to turn to starboard losing height. Squadron Leader Howard, using his Martin Baker ejection seat, exited the aircraft first, followed by Sir Harry Broadhurst seated in the right hand ejection seat. The remaining crew were left to their fate and all were killed when the Vulcan hit the runway, exploded and caught fire. This must have been a dreadful spectacle for the assembled VIPs to behold, especially the relatives of those remaining on board.

The subsequent RAF Court of Inquiry pinpointed faults in the altimeter which probably had given erroneous height readings and also made some criticism of the talkdown procedure by the Air Controller, although nothing more could be found that directly contributed to the crash. Squadron Leader Howard was pretty much exonerated. It should be said that although the weather was not good at Heathrow on that particular October morning, commercial airline traffic was still continuing to operate as normal.

The crash first highlighted the fundamental problem with the Vulcan's crew compartment whereby in an emergency situation it was very difficult for those members not equipped with ejection seats to exit a stricken aircraft. This problem remained with the Vulcan to the end of its service life and many crewmen died as a consequence. Martin Baker, the world's foremost ejection seat manufacturers, did in fact conceive a feasible mock-up installation to provide ejection seats for all Vulcan crew members, but that was as far as it went. The Air Ministry together with the Treasury inevitably did a cost/ benefit analysis and found in favour of doing nothing! On one or two occasions crewmen did make good their escape from Vulcans in the process of crashing, but these instances were rare and mostly crewmen

perished. Anyone who has ever been in a Vulcan cockpit will we acutely aware of the difficulty of egress, even when the aircraft is sitting nicely on the ground!

In actual fact both Squadron Leader Howard and Sir Harry Broadhurst had been lucky as they benefitted from a modification to the ejection sequence that had been introduced immediately prior to the New Zealand /Australia flight. Previously two distinct actions were required to eject; firstly to jettison the hood/canopy and secondly to pull down the face blind to operate the ejection seat. The timely modification permitted a sequenced ejection procedure initiated solely by the actuation of either ejection seat face blind. It is unlikely that either Howard or Broadhurst would have survived had not this modification been incorporated.

The Avro 698 design concept was to provide the RAF with a bomber aircraft capable of delivering both conventional and thermonuclear weapons at high subsonic Mach numbers, at high altitudes, over considerable distances; the main potential target being of course the Soviet Union and its acolytes forming the Warsaw Bloc. The weapons deployed by the V Bomber Force were constantly evolving to meet changing circumstances. Of course the Soviet Union had not been slow in countering the threats posed by the British V Bomber Force and the US Strategic Air Command (SAC) by developing a range of sophisticated fighter aircraft, supplemented by surface to air missiles (SAMs), all controlled by radar. It was therefore becoming harder for conventional aeroplanes to penetrate Soviet airspace without being detected.

On May 1st. 1960 an event occurred that was to have very serious political and military ramifications. For several years the United States had been covertly roving with impunity across Soviet air space photographing military installations from extremely high altitudes using an almost unknown aircraft called the Lockheed U2. The U2, with its long slender high aspect ratio wings, could fly at altitudes in excess of 80,000 feet, totally out of range of Soviet Fighters or Surface to Air Missiles. On the day in question Francis Garry Powers was piloting a U2 on a covert photography mission over the Soviet Union at an altitude of 70,000 feet when his aircraft was hit by a SAM. The capture of Powers and his subsequent and embarrassing show trial conducted by the Soviet Union did little to improve an already serious Cold War situation. It also brought home to Service Chiefs that conventional bombers flying over Soviet territory could now be easily picked off and new strategies would be required.

One of these strategies that actually pre-empted the U2 incident was the so called stand-off bomb. This was a missile with its own propulsion unit that could be dropped from a parent aircraft; the missile then independently making its own way to the target whilst the parent aircraft turned away. In effect this was an early version of the cruise missile. Avro at Woodford was granted a contract to develop such a missile and by 1957 trials with scaled down models had commenced. The new missile was allocated the title Blue Steel and was to be carried externally on the Vulcan on the aircraft centre line in the ventral position; the

bomb doors being suitably modified to accept the curvature of the missile body. To obtain a snug fit between the aircraft fuselage and missile body one of the missile's vertical fins was folded down whilst being carried. The fin immediately extended upon the missile being released. The propulsion unit for production missiles was a 16,000lb thrust Armstrong Siddeley Stentor Rocket motor, fuelled by High Test Peroxide (HTP), an extremely volatile and dangerous substance demanding very careful handling. The other fuel component was kerosene. Surgical standards of cleanliness were required when handling HTP to prevent spontaneous combustion taking place. Not an ideal situation when dealing with a nuclear tipped missile! Copious supplies of water were always necessary with HTP.

Early trials with Blue Steel were carried at the Aberporth range in Wales, but later testing was undertaken at Woomera in Australia where two Vulcan B2 aircraft, *XH 538* and *XH539,* were allocated to the test programme. In operation when released from the parent aircraft, the missile initially dropped 300 feet and the folded fin extended, the main rocket motor started followed by a secondary booster which propelled the missile to around 70,000 feet and a speed of Mach 2,5 (1,800mph). The missile carried its own independent constantly updated inertial navigation system which guided the weapon to its target to a maximum range of 100 nautical miles and to within 100 yards of true position. Blue Steel was an extremely capable missile which was Britain's main nuclear deterrent until the role was transferred to the Royal Navy's Polaris equipped nuclear submarines in 1969. The weapon was also carried on the Handley Page Victor, although it was not a happy combination as the ground clearance was considerably less than that of the Vulcan.

Avro continued with the development of the Blue Steel stand-off bomb and envisaged achieving higher speeds and greater range with a Blue Steel 2 missile. Greater power would have been supplied by 4 Bristol Siddeley Ramjets and 2 solid fuel booster rockets and the missile would have attained a speed of Mach 3,0 (2,160 mph) at 70,000 feet with a useful range of 800 miles. However, this was not to be as the Government cancelled the project in December 1959, preferring to entrust the nation's nuclear deterrence to the Blue Streak Rocket, which in true British fashion was itself subsequently cancelled!

Another air launched nuclear missile that involved the Vulcan was the American conceived Douglas GAM -87A Skybolt. This was originally designed to be carried by SACs Boeing B52 and Convair B58 Bombers. The Americans were never wholeheartedly in favour of this missile whose performance would have been similar to that of Blue Steel 2. American and British politics became deeply entwined over it, involving Presidents Eisenhower and John F. Kennedy and Prime Minister Macmillan. At least two Vulcans, *XH 537* and *XH 563,* were allocated to the Skybolt project with the former aircraft having modifications to carry two wing- mounted aerodynamic Skybolt test vehicles. Schemes were even drawn up for a Vulcan B Mk.3 designed to carry six wing-mounted Skybolts. This aircraft would have had more powerful engines and ironically ejection seats for all its crew members! On December 19th 1962 President Kennedy informed Prime Minister Macmillan that the Americans were

cancelling Skybolt, but offering Britain several options, none of which were taken up. That same day (Dec.19th) a Boeing B52 successfully air-launched a Skybolt test missile which then proceeded to travel its target 1000 miles away!

Perhaps the most bizarre scheme associated with the Vulcan was the proposal to carry three diminutive Folland Gnat fighter aircraft under the fuselage and wings of the bomber. The Gnats were effectively to be manually piloted stand-off bombs each armed with a nuclear device. It would appear that the Gnat pilots were destined for a one way mission! Needless to say this proposal was never proceeded with. Suicide missions are not really in the British character!

Another incident in the Vulcan story was a loss of the first prototype, *VX 770,* at an Air Show at Syerston, Leicestershire, on September20th 1958. The aircraft broke up in mid- air and the subsequent inquiry found that the machine had been overstressed whilst performing manoeuvres outside its speed/g limits. Overstressing of the airframe was always a consideration with such a large and powerful aeroplane as the Vulcan, although Test Pilot Rolly Falk demonstrated on the first day of the 1955 SBAC Show with *XA 890 t*hat the aircraft could be upward barrel rolled without detriment. However, Falk was forbidden to repeat the manoeuvre as it might encourage service pilots to do the same, with possibly serious consequences for the bomber fleet!

On this very point of rolling large aeroplanes, the author of this paper discussed the matter some years ago with the late Alex Henshaw, who was during in the war years Chief Test Pilot of Vickers - Armstrongs, Castle Bromwich. Henshaw regularly rolled Lancaster Bombers whilst on test from Birmingham and discusses it in his autobiography, *Sigh for a Merlin*. Henshaw's reply to the author was along the lines that it all depended how you did it and when done correctly was not in the least way detrimental to the airframe. Alex Henshaw was probably the greatest aerobatic exponent of the Spitfire and certainly flew more machines of that type than any other single person. Henshaw was an outstanding man and test pilot in the same mould as the late Eric "Winkle" Brown.

Bitteswell Airfield was situated just over the Warwickshire county border in Leicestershire and was located at the junction formed by the A5 and A 4303 (A427) roads, approximately two miles West of Lutterworth. The airfield was built to the standard wartime pattern of inter-crossing runways in 1941 and 1942. In 1942 it was used as a satellite airfield for Bramcote and in 1943 a satellite for nearby Bruntingthorpe. During 1944 it reverted back to a satellite for Bramcote. Throughout this period several successive RAF Operational Training Units (OTUs) were there. The RAF vacated Bitteswell in 1946.

Sir W G Armstrong Whitworth Aircraft Ltd, (AWA) who were based at Whitley and Baginton started to use Bitteswell from late 1943, primarily as a flight test airfield in connection with the Lancaster production programme. It is worth noting at this juncture that after AV Roe, AWA was the second largest producer of Lancaster Bombers during the war and was the

only production unit to manufacture the Bristol Hercules engined version of the Lancaster- the Mk II. Three hundred examples of the Mk II Lancaster were built, mainly as an insurance against the lack of availability of Rolls – Royce Merlin engines. The threat of a shortage of Merlins never materialised during the war years.

AWA continued to use the site after the departure of the RAF and it became the company's main flight test facility although Baginton airfield, which was owned by Coventry Corporation, was also still used. It was not until 1956 that AWA purchased Bitteswell airfield and all its facilities from the Air Ministry and subsequently the company initiated a process of development and improvement, installing high-intensity sodium runway lighting giving all weather capability. The Control Tower was equipped with the necessary VHF and UHF Radio equipment. The three runways were of the standard wartime concrete and asphalt type linked by a surrounding perimeter track with hard standings at various points for aircraft dispersal. Each of the runways was 150 feet wide and their lengths were respectively (04) 5999 ft.; (18) 4228 ft. and (11) 4200 ft.

The Bitteswell infrastructure was split into two main areas, namely the Old Site, situated near to the A 5 – A 4303 road junctions and the New Site located on the far side of the airfield towards Bittesby Spinney. The Old Site comprised a group of four, probably wartime hangars, supplemented by a larger pair of detached hangars, one of which in the 1960s was the paint shop. At approximately the half way point between the Old and New Sites was the Control Tower and associated emergency facilities, together with a single T2 Type Hangar. The New Site comprised five hangars, grouped two and three. Scattered round both sites were a number of smaller mostly brick buildings of wartime construction. These were utilised for a number of purposes, including a radio /electronics room, instrument test laboratory, maintenance workshops, etc.

Apparently there were turbojet sound suppression pens situated on the airfield, but the author of this paper cannot ever recall seeing them. Undoubtedly there was such a facility as a certain Hugh Reeves, an inventor/engineer attached to the RAF, lost his life at Bitteswell on October 22nd 1955, whilst conducting sound suppression tests on a Sapphire engine of a Hawker Hunter Mk 5. He was ingested into the intake of the suppressor unit. Although not related to sound suppressors a previous fatal accident had occurred at Bitteswell on January 5th 1949 when Sidney Cook, an AWA engineer, was sucked into the intake of a Gloster Meteor. Vulcan engines were certainly run at power without resort to any sound suppression whatsoever at Bitteswell and nearby Lutterworth certainly knew when it was taking place!

Danger also lurked at the opposite end of an aeroplane under power on the ground. Clearly delineated in red on the first page of the Vulcan Manual was a large arc of danger at the rear of the aeroplane when the engines were running. The author cannot now quantify, from the distance of fifty years, the actual extent of that area of danger, but remembers stones and other debris being blasted seemingly for very long distances when the engines

were running at full power. The later Vulcan B2s had Olympus engines that delivered in the region of 20,000 lbs of thrust each, 80,000lb in total. This equates very approximately to 80,000 hp.

Running a Vulcan on the ground at power could be a little fraught. A colleague who was at Bitteswell related to the author some time ago that upon one occasion a Vulcan undergoing an engine tests almost rode over the wheel chocks and a serious incident was only narrowly averted. A Vulcan at full throttle could probably never have be held fully on the wheel brakes alone. There was always the slight concern of engine ground fires and at least two Vulcans were completely destroyed in this manner, although fortunately these incidents did not occur at Bitteswell.

Bitteswell really came to the aid of the Vulcan when the aircraft started to adopt the role of a low level bomber, seeking to penetrate enemy territory below the radar curtain to deliver its weapons. This mode of attack took its toll on the airframe of an aeroplane that had been principally designed as a high altitude bomber. Whilst perhaps not ideal for the task the Vulcan soldiered on, and with strengthening, modification and maintenance it continued to perform it duties well beyond the point at which the nuclear deterrent role passed from the RAF to the Royal Navy in 1969. This was not the case with the Handley Page Victor, which was withdrawn as being unsuitable in the low level role, leaving the Vulcan to shoulder the burden alone. The Vickers Valiant, the first of the V Bombers, had been withdrawn some years previously due to serious structural deficiencies found in the wing spar structures after the loss of one aircraft, resulting in the scrapping of the Valiant fleet virtually overnight!

Before a particular aircraft was delivered to HSA Bitteswell for modification, repair and or maintenance, it had certain items of sensitive equipment removed by RAF personnel. This equipment was predominantly in the form of Electronic Counter Measures (ECMs), situated primarily in the tail of the aircraft. Apart from the nuclear weapons themselves, these electronic devices were probably the most closely guarded of all the Vulcans secrets. To preserve the safe flying characteristics and trim of the aeroplane when bereft of this heavy equipment, sets of weights or ballast were installed in the airframe, particularly at the rear of the machine. The installed weights at the rear of the Vulcan amounted to nearly one ton of ballast. The absent ECMs had numerous, rather bizarre code names, some of which are probably still on the secret list and these units were referred to only occasionally at Bitteswell, usually in hushed undertones. Nothing was really known about them and there was only scant knowledge of their approximate function. The ECMs equipment obviously got very hot in operation and this necessitated several external ram air scoops and ducts on the airframe in their vicinity.

The author seems to recall that during the Cold War era in which this paper is set, a rather junior RAF electronics mechanic was apprehended attempting to divulge ECMs secrets to a third party. This was deemed so serious at the time, that at his trial and subsequent

conviction, the judge handed down an exemplary sentence. This was obviously designed to deter any likeminded individuals from compromising national security. The electronics mechanic must have thought that the sky had fallen in on him!

Whilst the author cannot now recall in detail all the modifications and repairs that were undertaken at Bitteswell, they were extensive and much of the Vulcan fleet passed through HSAs hangar doors at some point or another. Most if not all of this work was carried out at the New Site, where each of the hangar gables had suitable notches cut in the steelwork to provide clearance for the tip of the Vulcan's tailfin. Each Vulcan did, however, usually make one peregrination to the Old Site to be resprayed in the paint shop. This journey entailed the aircraft being towed from the New Site round the "peri-track" of the airfield to a point where the machine was taken across the A4303 (A427) road into the Old Site. It seems inconceivable today, when passing between the huge Magna Park warehousing complexes occupying the former airfield, that Vulcan bombers were perambulated across a fairly quiet main road at this point, with merely a couple people to stop the traffic if necessary! Very surreal!

One abiding memory the author has of Bitteswell, as an apprentice, was of a certain day just before morning tea break when he was summarily instructed by the leading hand to go to a certain Vulcan, occupy the pilot's seat and undertake to operate the foot brakes, if required, whilst the aircraft was being towed by tractor back to the apron adjacent the the New Site Office Block. He was also instructed to apply the handbrake when the aircraft came to rest. All this was carried out with the author locked in splendid isolation in the Vulcan cockpit. Everything went satisfactorily and nobody checked the author's work. However, the author could not help wondering throughout that interminable fifteen minute break whether he had fully and securely applied the hand brake! A multitude of scenarios presented themselves – of a severely bent Vulcan and a demolished Office Block – the net result of the the machine careering down the slight slope to create total destruction! Would the chocks alone hold such a heavy machine? What were the penalties for negligently destroying government property and writing off millions of pounds of taxpayers money? Did they still put people in the Tower? At last the bell signalled the end to that nail- biting fifteen minutes and surprise surprise the Vulcan was still precisely where it had been parked! Oh Joy! The leading hand obviously had more faith in the author than he had in himself. It did, however, reinforce an important point with the author, which he has retained to the present day, "To Check and Check Again"!

Work on Vulcan bombers continued at Bitteswell until June 8th 1981 when the last machine to receive modifications and remedial work, *XJ 824,* departed the airfield on that date. This particular aircraft still survives and is in the Imperial War Museum's collection at Duxford. Work at Bitteswell continued for another four years, but eventually in 1985 the entire airfield and facilities were closed and sold for commercial development. On the former airfield is now located the Magna Park warehousing complex, conveniently situated for both

the M1 and M6 motorways. The roads names in Magna Park give a slight clue as to the former activities carried on before Magna Park arrived, however they are not necessarily a true record of the aircraft actually associated with the former airfield site.

Some of the aircraft actually associated with Bitteswell may be summarised thus; Wellington, Lancaster, Lincoln, Flying Wing, Meteor, Meteor Night Fighter, Sea Hawk, Javelin, Hunter, Apollo, Argosy- Civil and Military, Vulcan, Shackleton and Gnat.

It will be noted that there has been no attempt to give the service career of the Vulcan or discuss its part in the Falklands Campaign, the only occasion when the aircraft dropped bombs in anger. This has been a conscious decision, the excuse being it would take a paper more comprehensive than this to do the subject justice. The Vulcan bomber was a major component in the policy of nuclear deterrence and Mutually Assured Destruction (MAD) and whether one is in favour of such weapons or not it surely must be conceded that the Vulcan served that policy well, as distasteful as it may be to all those who understandably abhor nuclear weapons.

There may be an impression that the Vulcan was built in large numbers, but in actual fact only 136 machines in total were constructed, including two prototypes. Fifteen Vulcans were lost (11%) due to crashes and other accidents, including two machines that were destroyed in engine ground fires. Most were ultimately scrapped, but a few remain in museums and some of these permit access to the cockpit area.

Vulcans to see in the Midlands Area :

The Midland Air Museum Coventry has Vulcan B Mk2 *XL 360*

Wellesbourne Mountford Airfield has Vulcan BMk2 *XM 655*

The Cold War Section of the Cosford Aerospace Museum has Vulcan BMk2 *XM 598*

The Jet Age Museum at Gloucester Airport has a Vulcan front fuselage and cockpit accessible to visitors.

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