*Aviation / Aerospace*

# Avro Vulcan

## High-Altitude Long-Range Heavy Bomber [ 1956 ]

*The Avro Vulcan was an impressive design feat as 1950s bombers went - though the aircraft itself saw only limited combat action for its time aloft.*

The Avro Vulcan formed the second point on the triangle in the British "V-Bombers" collection - a series of three high-altitude, long range, nuclear-capable systems developed during the Cold War from a post-World War 2 British Air Ministry requirement. The three aircraft

making up this defensive triangle became the Vickers Valiant, the Avro Vulcan and the Handley Page Victor - entering into service in that very order. The Vulcan formed an integral part of the British strategic nuclear air arm throughout the height of the Cold War years and could also double as a conventional bomber, as it did in the British Falklands War against Argentina - interestingly enough assisted with in-flight refueling by a tanker form of the Handley Page Victor. The Avro Vulcan would be Avro's one and only jet-powered aircraft design to enter production.

## Development

British Air Ministry Specification B.35/46 was born in early 1947. The specification called for a nuclear-capable platform able to operate out of reach of enemy air defenses and provide exceptional range from British and allied bases as needed. Avro answered the call and devised an all-new design centered around a straight, delta-wing arrangement. This design was unique in that it featured vertical tail surfaces at the extreme wingtips as opposed to a traditional tail section, offering up a great deal of surface area for improved payload, fuel load and maneuverability. The lack of a true tail section meant that, in some ways, the design was in fact a flying wing. The cockpit was positioned well forward on the fuselage, ahead of the wings and engines, and featured four engines in a staggered internal placement- two engines to a wing. The engines were to be fed by a single large rounded intake. The massive expanse of the wings would have also provided maximum space for internal armament in the form of bomb bays mounted outboard of the dual engine arrangements. Avro designated the new design Type 698 and received the British Air Ministry contract in December of 1947. Along with the Avro design, approval of the Valiant and Victor were also granted, essentially beginning the formation of the V-bomber triangle.

In initial Air Ministry contract called for several forms to be built including two prototypes. Along with this commitment included the construction and delivery of several flight demonstrators. The demonstrators, designated as Type 707, proved an important part of early development of the Vulcan and were produced in five examples - Type 707, Type 707A (2), Type 707B and Type 707C. The Type 707 was a unique design in and of itself, featuring a spine-mounted air intake. Type 707 to the skies on her maiden flight on September 4th, 1949 but was involved in a fatal crash just 26 days later. The accident revealed that the airbrake system had not closed, leading the system to enter a stall and eventually crash - and as no ejection seat system was offered to the test pilot, both man and system were lost in the event. Despite this major setback, the overall design (albeit at low-speed testing) proved sound. A new revised design appeared in the Type 707B and flew a year later, this time with an ejection system in a lengthened nose assembly. The Type 707A was used as a high-speed test platform and completed as two examples while a Type 707C existed as well, this becoming a test platform and featuring side-by-side seating, a single vertical tail fin and a straight-wing delta arrangement. In all, testing revealed the aircraft to be extremely agile considering the type and size of the aircraft, no doubt due to the large area delta-wing design choice. These development models eventually gave rise to the Type 698 prototype.

The Type 698 prototype first flew on August 30th, 1952. The first prototype was fitted with Rolls-Royce brand engines of 6,500lbf thrust each. Engines were retained in the wingroots based on the original design and featured rectangular intake openings. The straight delta wing was used as was the single vertical tail fin. Later that year, the aircraft design received her official designator of "Vulcan". The first prototype was later lost in a fatal air show accident in September of 1958. The second prototype, this fitting an Olympus 101 series engines

of 10,000lbf, soldiered on in testing. Both prototypes featured a delta wing with 52 degree sweepback. The second prototype was later fitted with a "kinked" wing design that showcased differing degrees of sweepback separated into different sections of the wing leading edge.

The initial production model became the Vulcan B.Mk 1. Twenty-five such machines were ordered in 1952 and the first Vulcan squadron became operational in 1957 (this delay in years was caused by yet another fatal accident). B.Mk 1's were similar to the two prototypes. Early production models were finished the straight delta wings but these were later revised to the kinked wing design. In many ways, the production models mimicked the prototype with the exception of the kinked wing. Production models were now being fitted with an Olympus 101 series engine of 11,000lbf thrust (each). This rating was progressively uprated until reaching the Olympus 104 series with 13,500lbf thrust. A total of 45 Vulcan B.Mk 1 models were eventually delivered.



In the late 1950's, the Vulcan B.Mk 1 had her countermeasures suite revised, becoming the Vulcan B.Mk 1A. Soviet defense technology advanced to the point that operation of the Vulcans in their originally intended mode was now in danger. As such, the aircraft was fitted with chaff dispensers, a tail warning radar ("Red Steer"), a radar warning receiver, and jammers. Twenty-eight B.Mk 1s were converted in this fashion with conversions taking place from 1959 into 1963. B.Mk1A's and the future B.Mk 2 models are clearly discernable thanks to the addition of the ECM gear in the tail cone.

The Vulcan B.Mk 1 was followed by the Vulcan B.Mk 2 with development beginning in 1955. The system featured a revised and lengthened wing (increased from 99 feet to 111 feet), new Bristol Siddeley Olympus 201 series engines of 17,000lbf thrust engines (later production models would feature the Olympus 301 at 22,000lbf thrust), updated electrical system, in-flight refueling probe, a reinforced undercarriage (necessitated by the addition of the new engines), the countermeasures suite mentioned in the B.Mk 1A upgrade above and overall improvements to the aircrafts performance. First flight of the B.Mk 2 prototype occurred on August 19th, 1958 with deliveries beginning two years later and making up 89 total production examples.

It should be noted that a commercial version of the Vulcan was also in considered but this led to nothing more than completion of a small scale model. The aircraft (designated Type 722 Atlantic) would have seated between 90 and 115 passengers and presented flying speeds just under Mach 1. The idea was dropped due to a lack of interest in the market though the Vulcan in a passenger airliner form would have been quite a sight over commercial airports to say the least.

The Vulcan B.Mk 3 was a proposed carrier of the Skybolt missile but this design was ultimately dropped once development of the Skybolt in America had ceased. Eight B.Mk 2 models were converted to Maritime Radar Reconnaissance platforms (B.Mk 2MRR)) and 6 more were modified as in-flight refueling tankers (K.Mk 2)). A total of 134 Vulcan B.Mk 1 and B.Mk 2 models were constructed along with the two Type 698 prototypes.

## Design

Design of the production Vulcans was indeed impressive. Its flying wing origins were clearly visible in the final production delta-wing configuration. The leading edges of the wings were not a true smooth curve but in fact featured angles of varying degrees, eventually bringing the leading wing edge down to the end of the clipped wingtips - a "kinked" delta shape. The wings were fashionably contoured to extend outwardly from the fuselage, giving the aircraft its smooth overall appearance and housed the four engines, fuel and main landing gears. Intakes for the engines were intelligently mounted at each wingroot and the entire component (from intake to engine exhaust) ran the length of the delta wing. The fuselage itself was streamlined highly, with the cockpit mounted behind a nose cone assembly and just before the wingroot intakes and fuselage extending well forward of the wingroots and some distance aft of the wing trailing edge. Fuel was cleverly split between either wing and a central fuselage location, all monitored in-flight by a fuel management system. The bomb bay was centrally held in the fuselage and could be fitted with additional fuel for increased range.

The undercarriage consisted of two main landing gears (retracting forward outboard of the engines) and a nose gear positioned behind and underneath the wingroot intakes. Each main gear was fitted with an eight-wheel bogie and retracted forwards while the nose gear and its two wheels interestingly retracted backwards. The empennage featured a single large dorsal fin extending from about the midway portion of the fuselage, with the base of the fin extending vertically out from about the extreme end point of the engines. The noticeable tail cone housed a drag chute to improve the aircrafts landing distance - this was a large aircraft after all.

Anyway you view it, the Vulcan maintained a distinct look about her even in the wild age of 1950's aircraft design. When viewed in silhouette form from above or below, the type appeared as no other bomber design had before it. It is no wonder that the aircraft has been such an endearing design to fans of aviation for decades since its introduction.

## Cockpit

The Avro Vulcan provided accommodation for five standard crew personnel consisting of the pilot and copilot, a systems operator, a navigator and a radar operator along with additional seating for two more. The pilot and copilot had a view out of the front of the cockpit through a five panel windscreen with framing as well as circular windows to the sides allowing for viewing to the left and right. Ejection seats were afforded to the pilot and co-pilot only - but not the entire crew - they would have to bail out of the aircraft the old fashion way.

## Armament

Being designed as a bomber, it was only fitting that the Vulcan could mount up to 21,000lbs of ordnance held in an internal bomb bay. Ordnance could consist of conventional or - more importantly - nuclear weaponry. Conventional bombing was covered through use of 21 x 1,000lb bombs. Nuclear munitions varied as they were constantly being developed or improved upon but included the Blue Steel Mk 1 stand-off missile.

## Operation Service

The Vulcan series of bombers saw limited use in combat aggression. Vulcan B.Mk 1 model bombers were sent as an intimidation factor during the Malayan Insurgency. Beyond that, they were used to showcase the types reach

to the Soviet Union by conducting regular global flights to and fro. Operations with American forces and other NATO allies were a common occurrence. The only true combat actions involving the Vulcan came in the 1982 Falklands War between Argentina and Britain. Vulcan B.Mk 2 bombers were used in small numbers during the conflict and succeeded in providing Britain with an intimidating force - though actual damage caused to enemy ground targets from the Vulcan raids (known as the "Black Buck" raids) was rather minimal.

On May 1st, 1982 a lone Vulcan bomber made up the first combat sortie in the Falklands War when it dropped its bombs over Port Stanley, rendering the main runaway unusable to Argentine fighters (quick repairs did allow slower, lighter aircraft to land and take-off as normal in time). Five Vulcans made up the Vulcan strike force on Ascension island (two to be held in reserve) and a total of seven missions were ultimately flown with varying degrees of success. The first, second, and seventh missions were conventional bombing raids while missions three, four, five, and six were missile raids with Shrike anti-radar, air-to-surface missiles fitted. Missile missions five and six were successful attacks against Argentine radar though the mission six aircraft ("Black Buck 6") suffered a broken refueling probe on its return trip and was forced to land at Rio de Janeiro, Brazil - the crew an aircraft returned nine days later wen the war ended.

Discover related topics

Plane

Ww2 Planes

Ww2

Bomber

V Bomber Bases

Vulcans flew under Argentine radar, popping up to surmise the situation when required. When tracked by enemy radar, the Vulcan's ECM suite proved up to the task. In the initial Port Stanley raid the crew managed to release their bomb payload on the runway within a 1-second window of opportunity provided for by the targeting computer before flying over the target. The Vulcan then immediately climbed away from danger as Argentine ground guns opened fire. Once safe, the aircraft was greeted by a refueling tanker and was able to land safely back at Ascension Island to much cheer. The presence of the Vulcan in Argentine airspace proved a detrimental psychological tool for Argentine civilians who now feared their major cities were within reach of British bombers. Additionally, the Argentines had lost use of the one runway on the Falklands that would have played a major role in its air defense plans. For all the preparation and execution, the Vulcan managed only one direct hit on the runway itself but this action proved that the strip would not play a major supporting role for Argentine fighters. The Ascension Island missions marked the longest sorties of any bomber aircraft in the history of military aviation.

After the Falklands War of 1982, the Vulcan's career as a dedicated bomber was all but over. Several were converted as an interim measure to fulfill a tanker role gap while the Vickers VC10 airframes were being modified for the job. Six such Vulcan B.Mk 2 models were converted for the role and became the Vulcan K.Mk 2. These Vulcans lasted until 1984 as the VC10s came online.

## Conclusion

It is no doubt the Avro Vulcan has achieved status as a classic British bomber. Despite its rough development that included losses of life, the system fared well during a period in history that needed it most. The reach of the nuclear-capable platform was exactly what the doctor had ordered in a world where showing off power was seemingly more important that using it. Despite its limited production totals and very limited combat exposure, the distinct design and qualities of the Vulcan have made her a one-of-a-kind aircraft.



## Specifications

BASICS [+]

| Service Year | Origin | Status |
|---|---|---|
| 1956 | United Kingdom | RETIRED<br>*Not in Service.* |

| Crew | Production |
|---|---|
| 5 | 136<br>UNITS |

MANUFACTURER(S) [+]

Avro / A.V. Roe - UK

(View other Aviaton-Related Manufacturers)

OPERATORS [+]

United Kingdom

(OPERATORS list includes past, present, and future operators when applicable)

## ROLES [+]

✓ **Ground Attack (Bombing, Strafing)**

Ability to conduct aerial bombing of ground targets by way of (but not limited to) guns, bombs, missiles, rockets, and the like.

✓ **Aerial Refueling (Tanker)**

Dedicated or converted airframe used to deliver fuel to awaiting allied aircraft.

## DIMENSIONS & WEIGHTS [+]

| Length | Width/Span | Height |
|---|---|---|
| 99.9 ft (30.45 m) | 111.0 ft (33.83 m) | 27.2 ft (8.28 m) |

| Empty Wgt | MTOW | Wgt Diff |
|---|---|---|
| 106,000 lb (48,081 kg) | 249,122 lb (113,000 kg) | +143,122 lb (+64,919 kg) |

(Showcased structural values pertain to the Avro Vulcan B.Mk 2 production variant)

## POWER & PERFORMANCE [+]

**Installed:** 4 x Bristol Siddeley Olympus 301 turbojet engines developing 20,000 lb of thrust each.

| Max Speed |
|---|
| 646 mph (1,040 kph \| 562 kts) |

| Ceiling | Range |
|---|---|
| 55,003 ft (16,765 m \| 10 mi) | 4,598 mi (7,400 km \| 13,705 nm) |

♦ MACH Regime (Sonic)

Sub | Trans | Super | Hyper | HiHyper | ReEntry

RANGES (MPH) Subsonic: <614mph | Transonic: 614-921 | Supersonic: 921-3836 | Hypersonic: 3836-7673 | Hi-Hypersonic: 7673-19180 | Reentry: >19030

(Showcased performance specifications pertain to the **Avro Vulcan B.Mk 2** production variant. **Compare this aircraft** entry against any other in

## ARMAMENT [+]

21,000 lbs of internally-held ordnance, typically conventional drop bombs or nuclear payload.

Also supporting 1 x "Blue Steel" MK.1 stand-off missile; AGM-45 "Shrike" anti-radar, air-to-surface missiles at underwing hardpoints.

### Supported Types


## HARDPOINTS [+]

Hardpoint Mountings: 2

## VARIANTS [+]

Type 698 - Prototype Model Designation; two examples produced; fitted with 4 x Rolls-Royce 6,500lb thrust Avon RA.3 turbojet engines.

B.Mk 1 - Initial Production Model Designation fitted with Olympus turbojet engines; straight wing leading edge.

B.Mk 1A - Modified Mk 1 models fitted with electronic countermeasures equipment in revised tail cone.

B.Mk 2 - Olympus 301 engines; provision for Blue Steel nuclear stand-off missile; improved powerplant and performance; reinforced landing gears; lengthened wings.

B.Mk 2MRR - B.2 bomber models converted for use as Maritime Radar Reconnaissance aircraft; eight conversion models in all.

## RATINGS [+]

### General Assessment

Firepower

Performance

### Overall Rating

The overall rating takes into account over **60 individual factors** related to this aircraft entry.

Survivability

Versatility

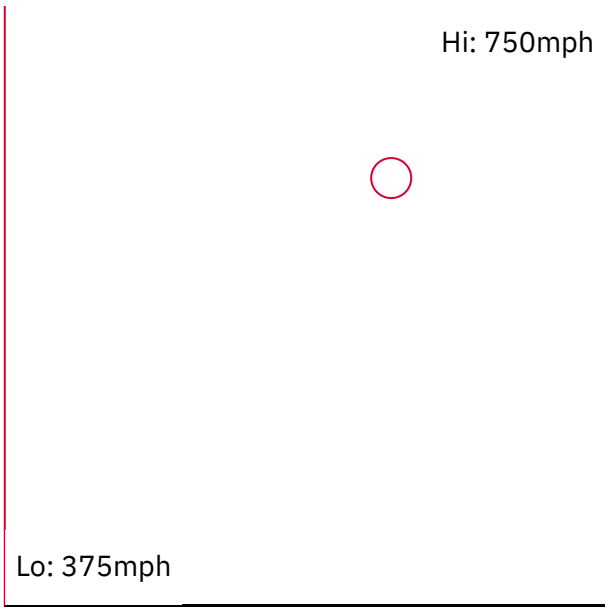
Impact

Values are derrived from a variety of categories related to the design, overall function, and historical influence of this aircraft in aviation history.

84

Rating is out of a possible 100 points.

## Relative Maximum Speed




This entry's maximum listed speed (646mph).

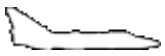
Graph average of **563** miles-per-hour.

## City-to-City Ranges

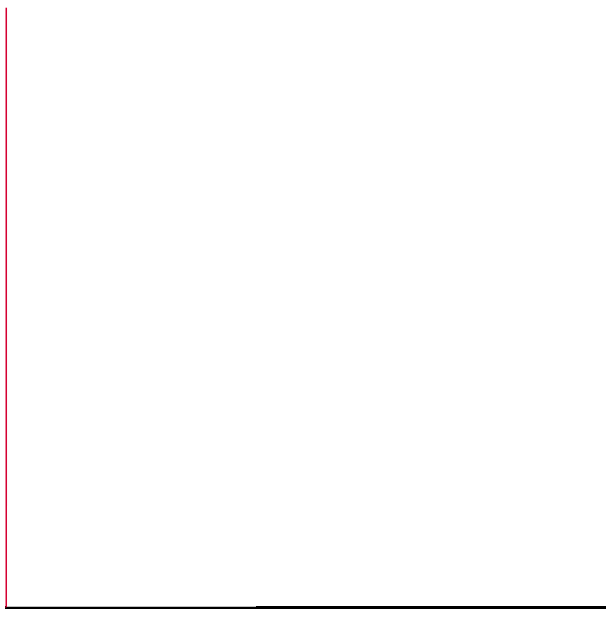
| | | |
|---|---|---|
| NYC | ——— | LON |
| LON | ——— | PAR |
| PAR | ——— | BER |
| BER | ——— | MOS |
| MOS | ——— | TOK |
| TOK | ——— | SYD |
| SYD | ——— | LAX |
| LAX | ——— | NYC |

Avro Vulcan B.Mk 2 operational range when compared to distances between major cities (in KM).

## Max Altitude Visualization

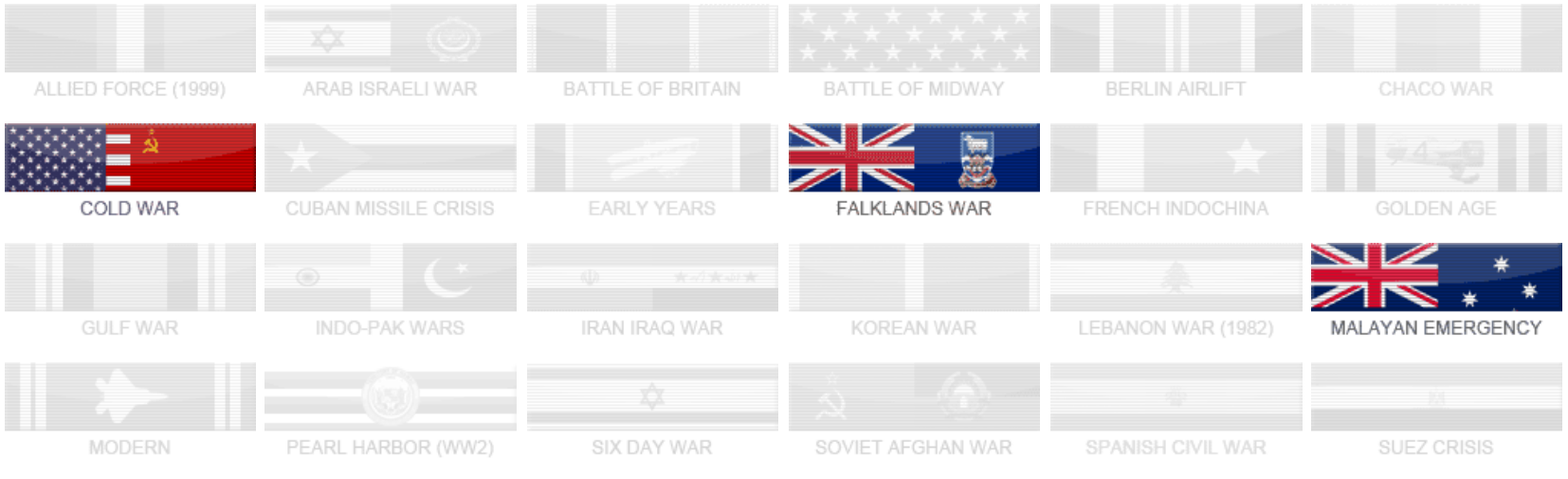


## Design Balance



The three qualities reflected above are altitude, speed, and range.

## HONORS [+]



## Images Gallery


Image from the United States Department of Defense DIVIDS image database.