SECRET

HAWKER SIDDELEY AVIATION LIMITED

THE VULCAN DETERRENT

A REVIEW OF CURRENT DEVELOPMENTS AND PROPOSALS FOR THE FUTURE

ADVANCE STATEMENT

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AVRO VULCAN MK.2.

SUMMARY

The AVRO Vulcan, which has been in service with Bomber Command since 1956, forms the major part of the British manned aircraft deterrent. It has proved itself capable of being adapted to keep in step with the changing aspects of deterrent philosophy.

With the adoption by the Royal Air Force of the air launched ballistic missile the Vulcan is now being developed to carry two 'Skybolt' missiles. This programme, combined with the development of a rapid engine start technique, forms the latest stage in ground based airborne deterrents.

However, advanced thinking considers that by 1968 the ground based deterrent may well be ineffective, and that the future lies in the airborne deterrent. This brochure describes a direct development of the Vulcan, the Phase 6, which carries four 'Skybolts' and has an airborne endurance of twelve hours. The Vulcan Mk. 2 aircraft can be converted to Phase 6 standard in a retro-fit programme so that no more than fifteen aircraft are ever out of service.

The engines are a direct development of the current Olympus, The military systems are already in use in the Vulcan. Thus full use is made of the experience being gained in developing and operating the present Vulcan force.

It is argued, thus, that Britain will be able to maintain an effective and continuous deterrent force well into the 1970's and avoid the discontinuity and expense which would result from commencing a new 'Skybolt' airborne system at this time.

THE VULCAN DETERRENT

Current Developments

VULCAN B MK. 1	1956
VULCAN B MK. 1A	1960
VULCAN B MK. 2	1960
VULCAN BLUE STEEL	1961
VULCAN 2 SKYBOLTS	1964

Future Proposal

VULCAN PHASE 6 LONG ENDURANCE MISSILE CARRIER WITH 4 SKYBOLTS	1967

THE CURRENT DEVELOPMENT PROGRAMME

The AVRO Vulcan was originally designed to meet the requirements of Specification B.35/46 for a high performance medium bomber aircraft. The Vulcan contract was placed with A.V. Roe & Co. Limited in 1948, and the first prototype aircraft flew in 1952. A second prototype flew in 1953, and the first production Vulcan Mk.1 flew in 1955.

VULCAN B. MK. 1 and B. MK. 1A

The Vulcan B. Mk. 1 aircraft entered service with the R. A. F. in 1956, and production was completed in 1959 after 45 aircraft had been built. Initially designed to carry Blue Danube, these aircraft are now in service with the capability of carrying the latest free-falling nuclear stores. The last 28 production Mk. 1 Vulcans are being converted to Mk. 1A aircraft by fitting electronic counter-measure equipment in a retro-fit programme to be completed in 1962.

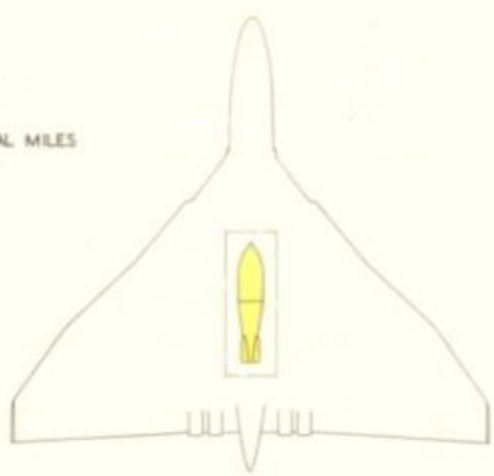
VULCAN B. MK. 2

It became apparent in 1955 that the Mk. 1 Vulcan airframe would not allow the full performance gain, made possible by the rapid development of the Olympus engine, to be utilised. The design of a completely new outer wing of greater area and span was therefore undertaken and the first Vulcan B. Mk. 2 fitted with this new wing flew in 1958. Production Vulcan B. Mk. 2 aircraft are now in squadron service with the capability of carrying free-falling nuclear stores. These early production aircraft are fitted with Olympus 201 engines of 17,000 lbs. thrust, and achieve a height over target of 52,400 ft. compared with 50,000 ft. on the Vulcan Mk. 1 aircraft. When the later Olympus 301 engines of 20,000 lbs. thrust are fitted a further gain in height over target of 2,300 ft. will be achieved. All Vulcan Mk. 2 aircraft are fitted with electronic counter-measure equipment.

1956

MK.1 VULCAN - FREE FALLING STORE

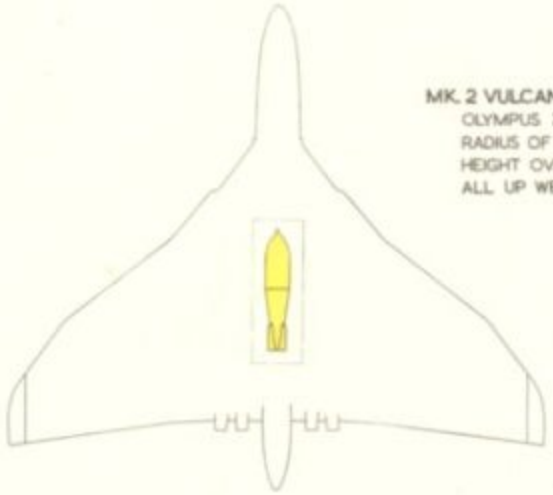
OLYMPUS 104 (13,500 LB.) ENGINES	
RADIUS OF ACTION	1,830 NAUTICAL MILES
HEIGHT OVER TARGET	50,000 FEET
ALL UP WEIGHT	166,460 LB.



1960

MK. 2 VULCAN - FREE FALLING STORE

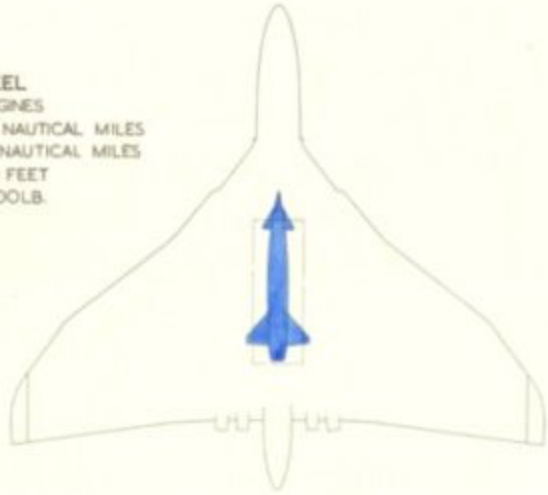
OLYMPUS 201 (17,000 LB.) ENGINES	
RADIUS OF ACTION	1,670 NAUTICAL MILES
HEIGHT OVER TARGET	52,400 FEET
ALL UP WEIGHT	184,700 LB.



1961

MK. 2 VULCAN - BLUE STEEL

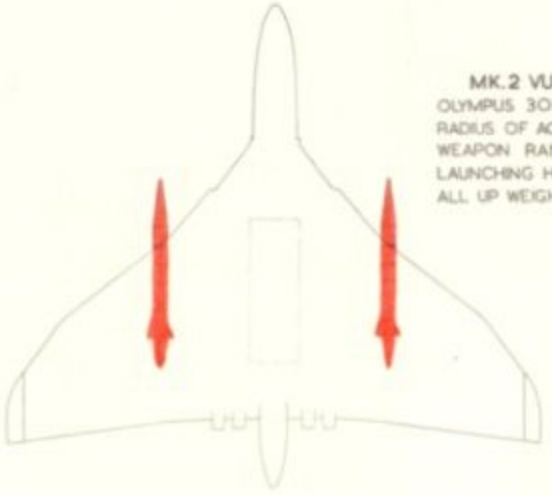
OLYMPUS 201 (17,000 LB.) ENGINES	
RADIUS OF ACTION	1,600 NAUTICAL MILES
WEAPON RANGE	100+ NAUTICAL MILES
LAUNCHING HEIGHT	51,000 FEET
ALL UP WEIGHT	190,900 LB.



1964

MK. 2 VULCAN - SKYBOLT

OLYMPUS 301 (20,000 LB.) ENGINES	
RADIUS OF ACTION	1,380 NAUTICAL MILES
WEAPON RANGE	950+ NAUTICAL MILES
LAUNCHING HEIGHT	49,900 FEET
ALL UP WEIGHT	210,000 LB.



CURRENT DEVELOPMENT

Vulcan - Blue Steel

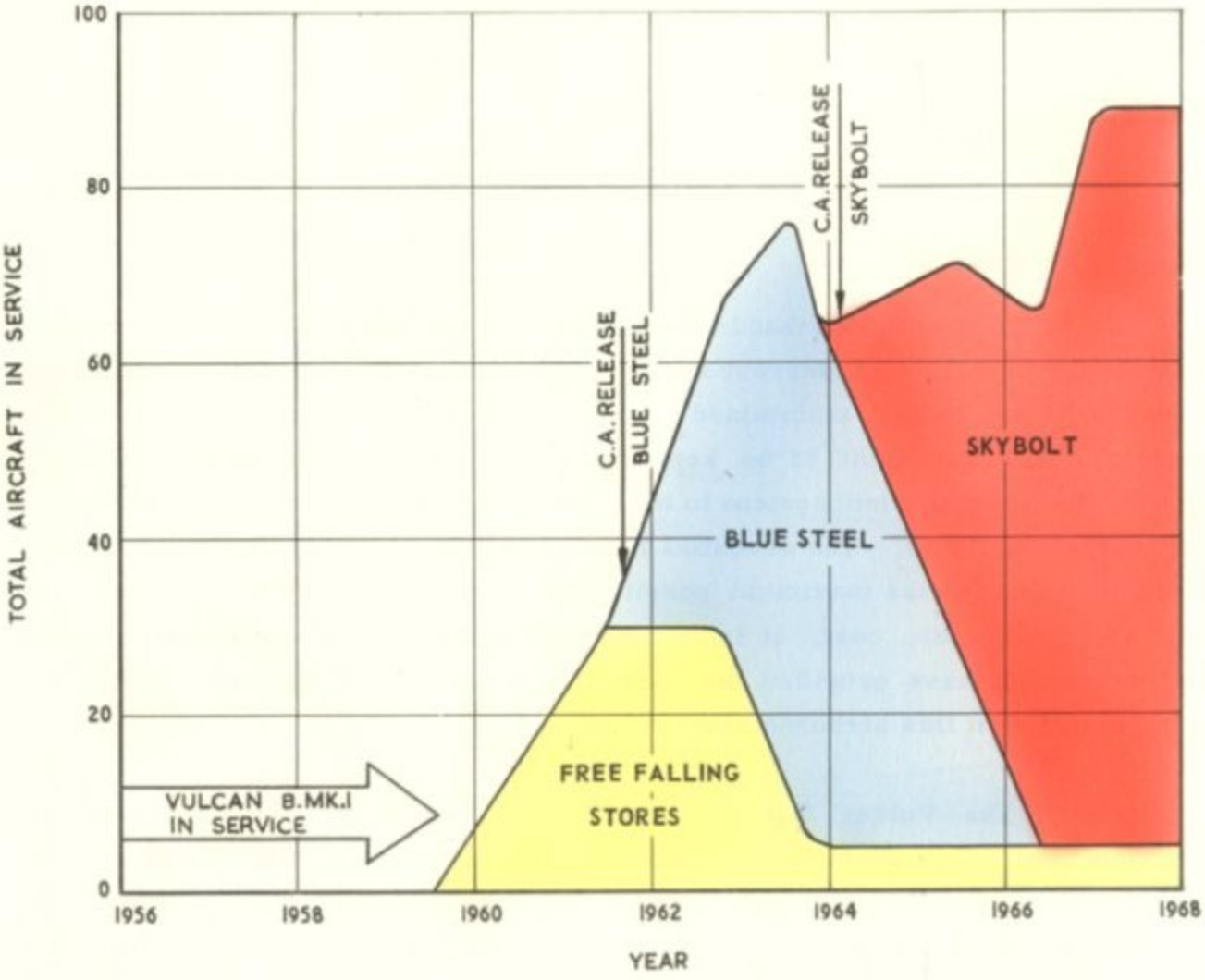
As the improvement of both ground launched and air launched anti-aircraft missiles continues, the vulnerability of an aircraft attacking with free falling stores becomes such that successful attack is no longer possible; at this stage it is necessary to introduce some form of stand-off bomb which will enable the parent aircraft to attack the target from sufficient distance to reduce its vulnerability to an acceptable level. The initial stage of stand-off deterrent is the Vulcan Mk. 2 fitted with the AVRO Blue Steel missile, with a range of 100 nautical miles. The Vulcan - Blue Steel weapon system is due to go into service in 1961, and all production Vulcan Mk. 2's from the 26th aircraft will be capable of carrying this store.

Vulcan - Skybolt

The concept of the use of the Vulcan as a missile carrier is taken a stage further with the introduction of the Vulcan - Skybolt weapons system. Two 'Skybolts' can be carried per aircraft and the strike range of the missile is 950 nautical miles. The radius of action of the aircraft carrying two 'Skybolts' throughout the flight is 1, 360 nautical miles. The present 'Skybolt' retro-fit programme is such that the last 21 production Vulcan Mk. 2's will go into service fully equipped for the 'Skybolt' role. It is then proposed to modify in a retro-fit programme the majority of the early Mk. 2 aircraft and all the Mk. 2 Blue Steel aircraft.

Rapid Engine Start

To counter the increased vulnerability of aircraft on the ground to surprise attack by missiles, considerable development has gone on to increase the rapidity with which the Vulcan can become airborne. Full simultaneous starting of four engines will be introduced by 1963, and will enable the aircraft with two 'Skybolts' to be more that 10 miles from its base within three minutes of an alert being given.



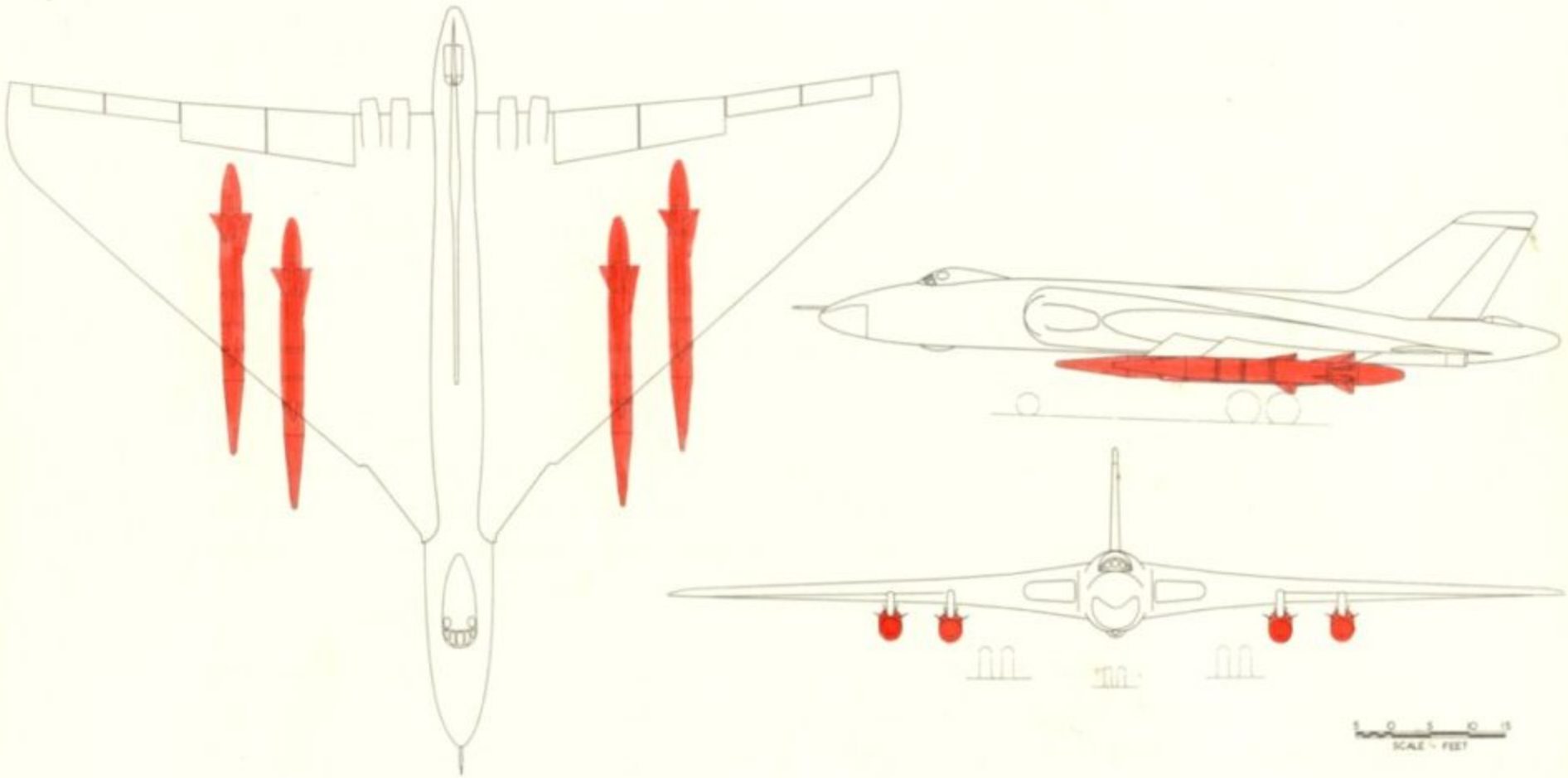
VULCAN B. MK.2 DEVELOPMENT PROGRAMME

PROPOSALS FOR THE FUTURE

Airborne Alert

It is probable that in the late 1960's and early 1970's, the vulnerability of any ground based deterrent system will have reached the level where its effectiveness is no longer maintained. When this stage is reached it will be necessary for the deterrent to be kept completely mobile and continuously in operation. The most efficient system to meet this requirement is the long endurance missile carrying aircraft. The essential requirement is for an aircraft carrying at least four missiles for the maximum possible duration. In order that this may be achieved at an economic cost, it is proposed that the Vulcan - Skybolt weapons system, which will have provided the front line deterrent in the mid 1960's, be developed to perform this airborne alert role.

The Vulcan Phase 6 aircraft designed to meet this operational requirement, can carry four 'Skybolt' missiles for a total airborne endurance of 11.5 hours. This can be compared with the 7 hour endurance of the Vulcan Mk.2 aircraft with two 'Skybolts'.



AVRO VULCAN PHASE 6

THE VULCAN PHASE 6

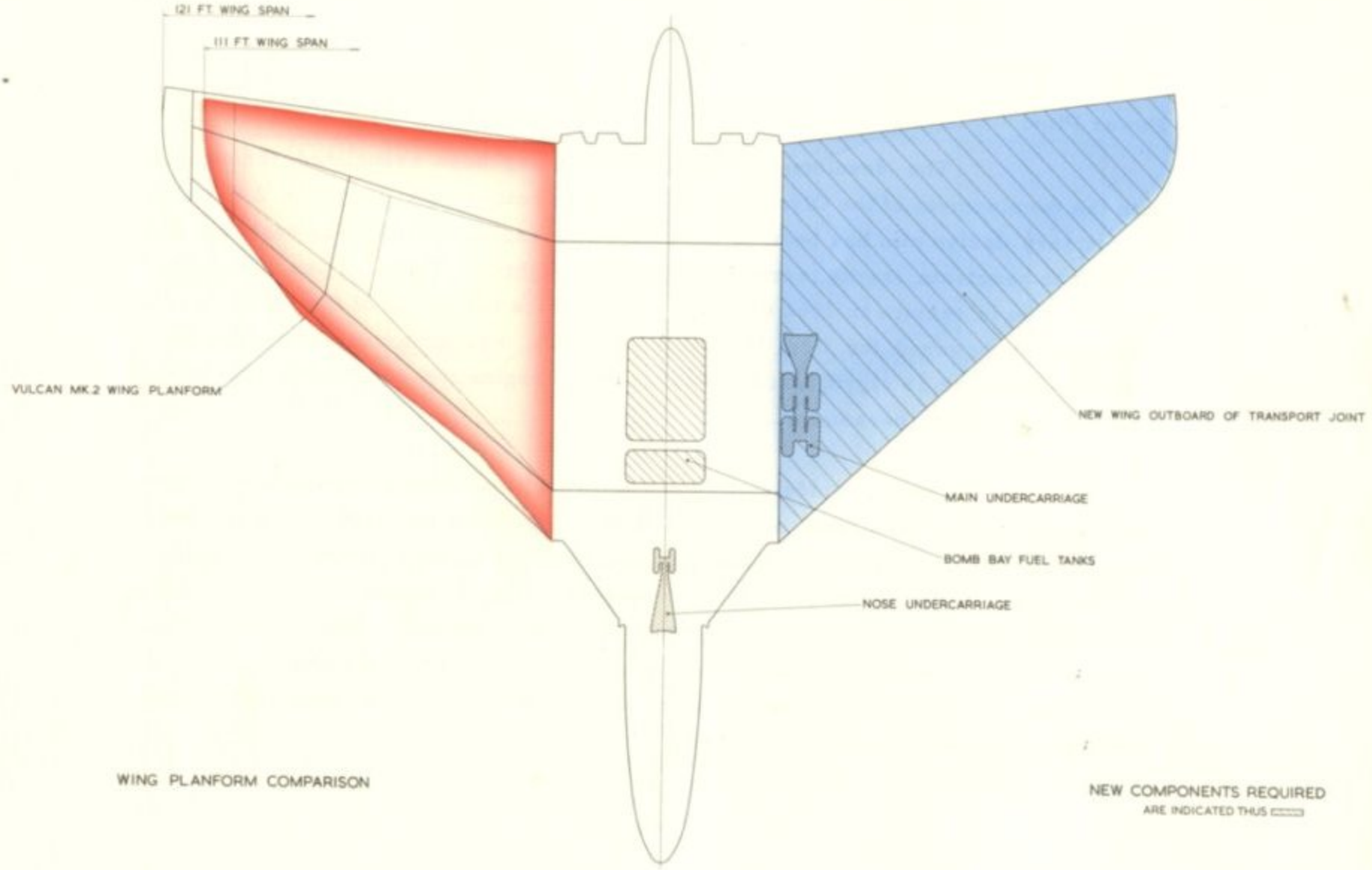
The Vulcan Phase 6 proposals are basically a collection of modifications that can be made retrospectively to a Vulcan Mk. 2 aircraft. These are outlined below:-

Airframe

A new outer wing with greater span to give improved aerodynamic efficiency and a considerable increase in fuel tank capacity, is fitted outboard of the existing transport joint. Pylons on the lower surface of the wings carry the four 'Skybolt' missiles. A new undercarriage is fitted to cater for the greatly increased all-up-weight of 350,000 lb.

Some structural strengthening to the centre section is necessary to cater for this increase in all-up-weight. Fuel tanks are fitted in the bomb bay for the airborne alert role, but these can readily be removed to allow conventional stores to be carried.

Because of the increase in utilisation of an aircraft on airborne alert, great attention has been paid to producing a structure with a long fatigue life. The Vulcan Phase 6 will be designed to have a life of 20,000 hours.

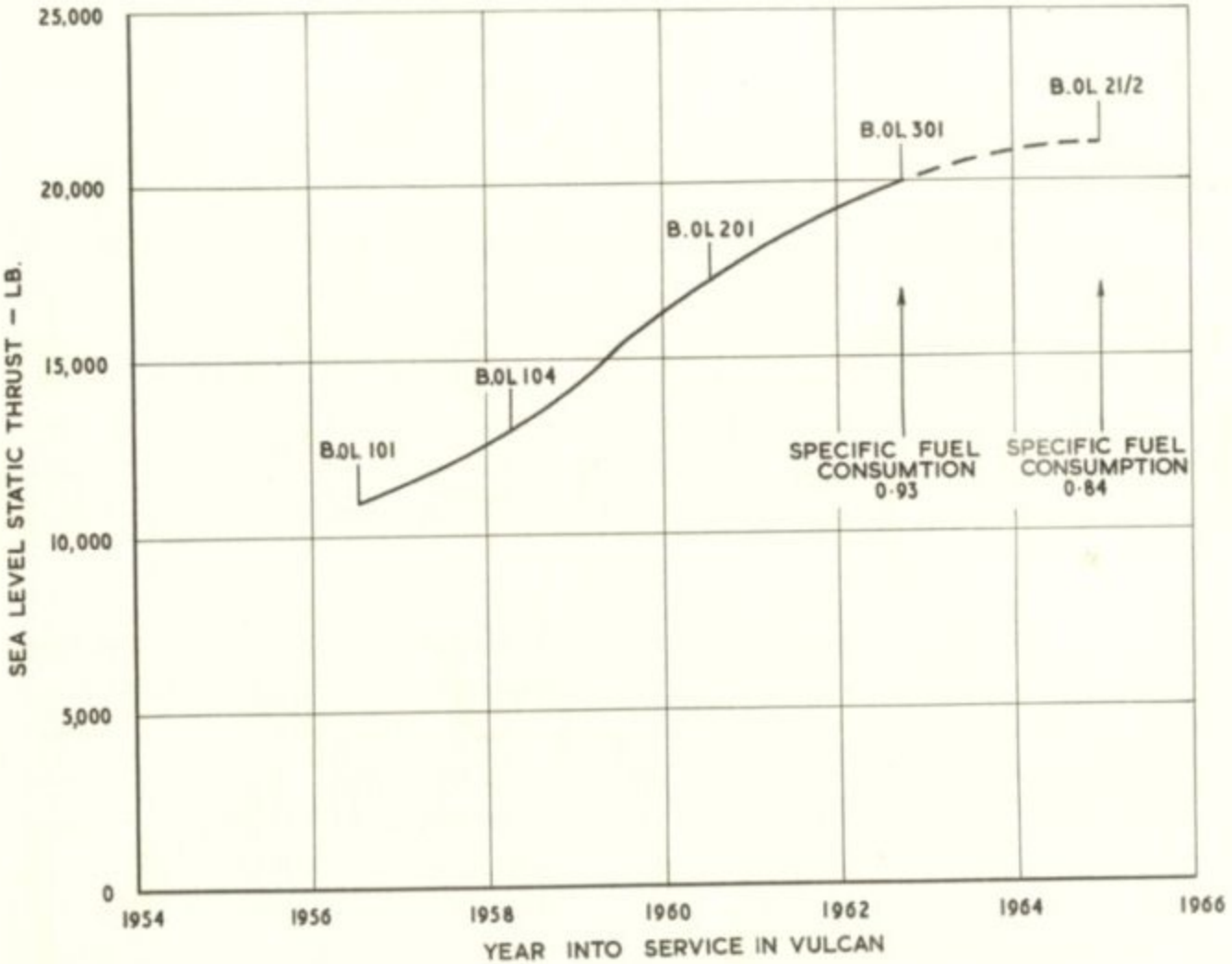


COMPARISON OF AVRO VULCAN PHASE 6 WITH VULCAN MK.2

Power Plant

The development of the Vulcan has been associated throughout with the development of the Olympus engine. For both the Mk. 1 and Mk. 2 Vulcan, the primary design aim has been to produce more engine thrust, thus enabling the aircraft to penetrate enemy territory at greater heights. The Olympus 301 engine which will be in service in 1962 develops almost twice the thrust of the Olympus 101 engine which powered the first Vulcan B. Mk. 1's. For airborne alert however, height is no longer as significant as endurance and engine fuel consumption becomes the important design parameter.

Bristol Siddeley Engines Limited have, therefore, considered how the Olympus can be developed to meet the needs of an airborne alert aircraft. They have proposed a modified form of the Olympus 301 engine, the Olympus 21/2 engine, for use in the Vulcan Phase 6. This incorporates many design features which have been developed for the Olympus 22 engine in the TSR. 2 aircraft. The Olympus 21/2 gives a 10% improvement in fuel consumption compared with the present Olympus 301 engine. Olympus 301 engines from Vulcan Mk. 2's can be converted to the Olympus 21/2 standard during overhaul.

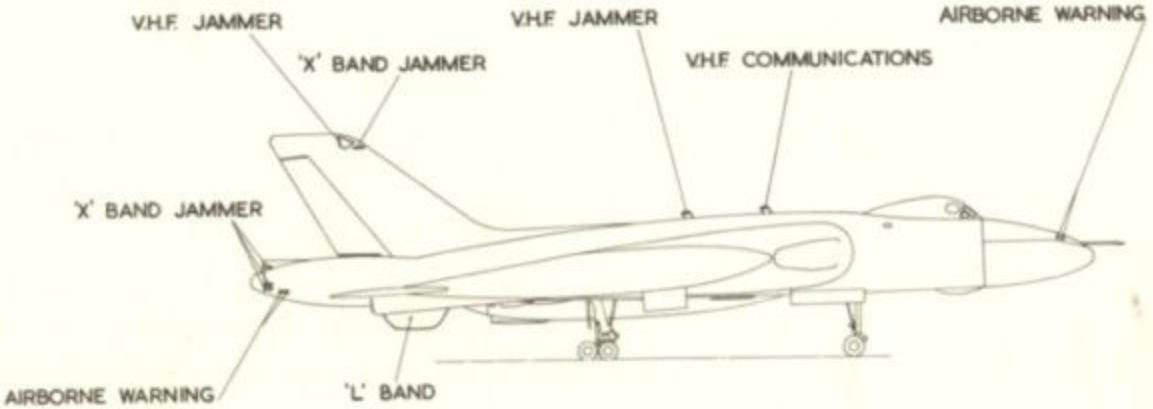


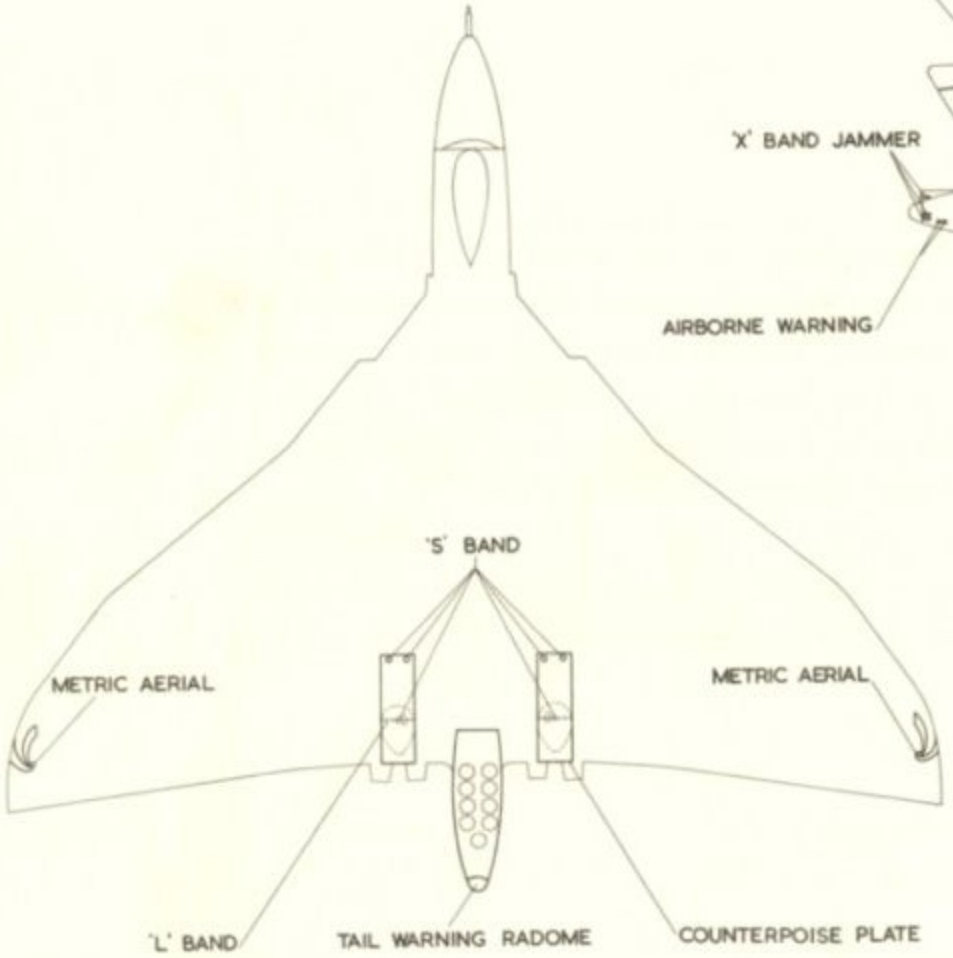
DEVELOPMENT OF OLYMPUS ENGINES

Airframe Systems

Airframe systems form a major part in the development cost of a new aircraft. On the Vulcan Phase 6, every effort has been made to retain the existing Vulcan Mk.2 systems. Of the conventional aircraft systems, major changes are required only to the fuel system to cater for the greatly increased fuel capacity and to the electrical system, where more electrical power is required for the two additional 'Skybolt' missiles. The flying control system, auto pilot and auto stabilisation system can be re-adjusted to meet the changes due to the revised wing planform.

It is, however, the systems developed for specifically military purposes which represent the biggest saving in the development on the Vulcan Phase 6 aircraft. The communications and conventional navigation systems, the bomber navigation system and the military flight system, fully developed for the Mk.2 Vulcan are all retained without modification. By 1964 the Vulcan Mk. 2 will be equipped with comprehensive electronic counter measure equipment which will provide jamming facilities on all probable radar frequencies. The complete system, developed in close conjunction with the Radar Research and Development Establishment will be retained without further modification on the Vulcan Phase 6.





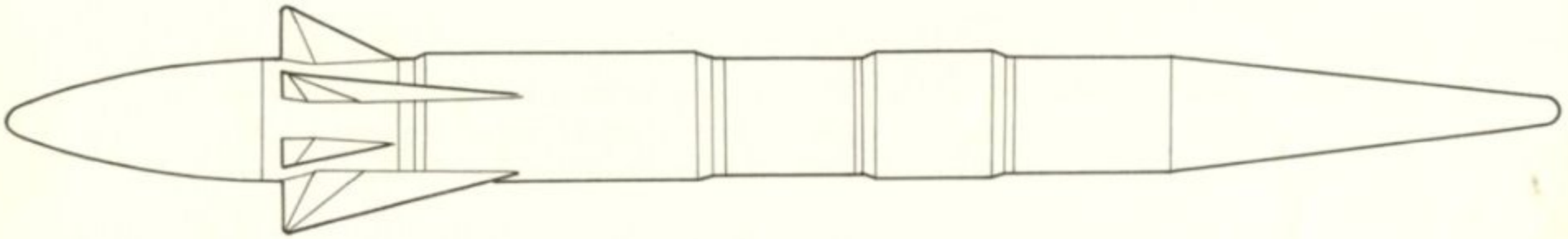
THE COMPREHENSIVE E.C.M. EQUIPMENT IN SERVICE IN 1964, WILL REPRESENT OVER 300,00 AVRO DESIGN MAN-HOURS.

E.C.M. DEVELOPMENT

Armament

With the present development of the Vulcan - Skybolt weapons system, a major part of the programme is devoted to ensuring compatibility of the complete 'Skybolt' system with the existing Vulcan aircraft systems. When the Vulcan - Skybolt weapons system goes into service, in 1964, close co-operation between Douglas Aircraft Co., and A. V. Roe & Co. Limited over a period of 5 years will have ensured that the missile aircraft integration is complete.

On the Vulcan Phase 6 aircraft no additional development will be necessary when the number of 'Skybolts' carried per aircraft is increased to four.



BASIC DESIGN CONSIDERATIONS	STRUCTURAL CLEARANCE	AERODYNAMIC CLEARANCE	ELECTRICAL SYSTEMS	COOLING SYSTEMS	NAVIGATION SYSTEMS	GROUND EQUIPMENT
GROUND CLEARANCE ADEQUATE FIELD OF VIEW FOR ASTRO-TRACKER	PYLON DESIGN MISSILE STRENGTH CLEARANCE FOR VULCAN FLIGHT ENVELOPE AEROELASTIC COMPATIBILITY ACOUSTICAL COMPATIBILITY	MISSILE RELEASE CHARACTERISTICS SHOCK FREE FLOW OVER ASTROTRACKER WINDOW	ELECTRO-MAGNETIC COMPATIBILITY PROVISION OF CORRECT POWER FOR MISSILE BOTH IN QUANTITY AND QUALITY INTEGRATION OF AIRCRAFT AND MISSILE ELECTRICAL SYSTEMS	PROVISION OF REFRIGERATION SUPPLY FOR MISSILE AND COMPUTOR EQUIPMENT IN AIRCRAFT	INTEGRATION OF MISSILE NAVIGATION SYSTEM WITH AIRCRAFT BOMB/NAV. SYSTEM	COMPATIBILITY OF EXISTING VULCAN EQUIPMENT WITH MISSILE REQUIREMENTS

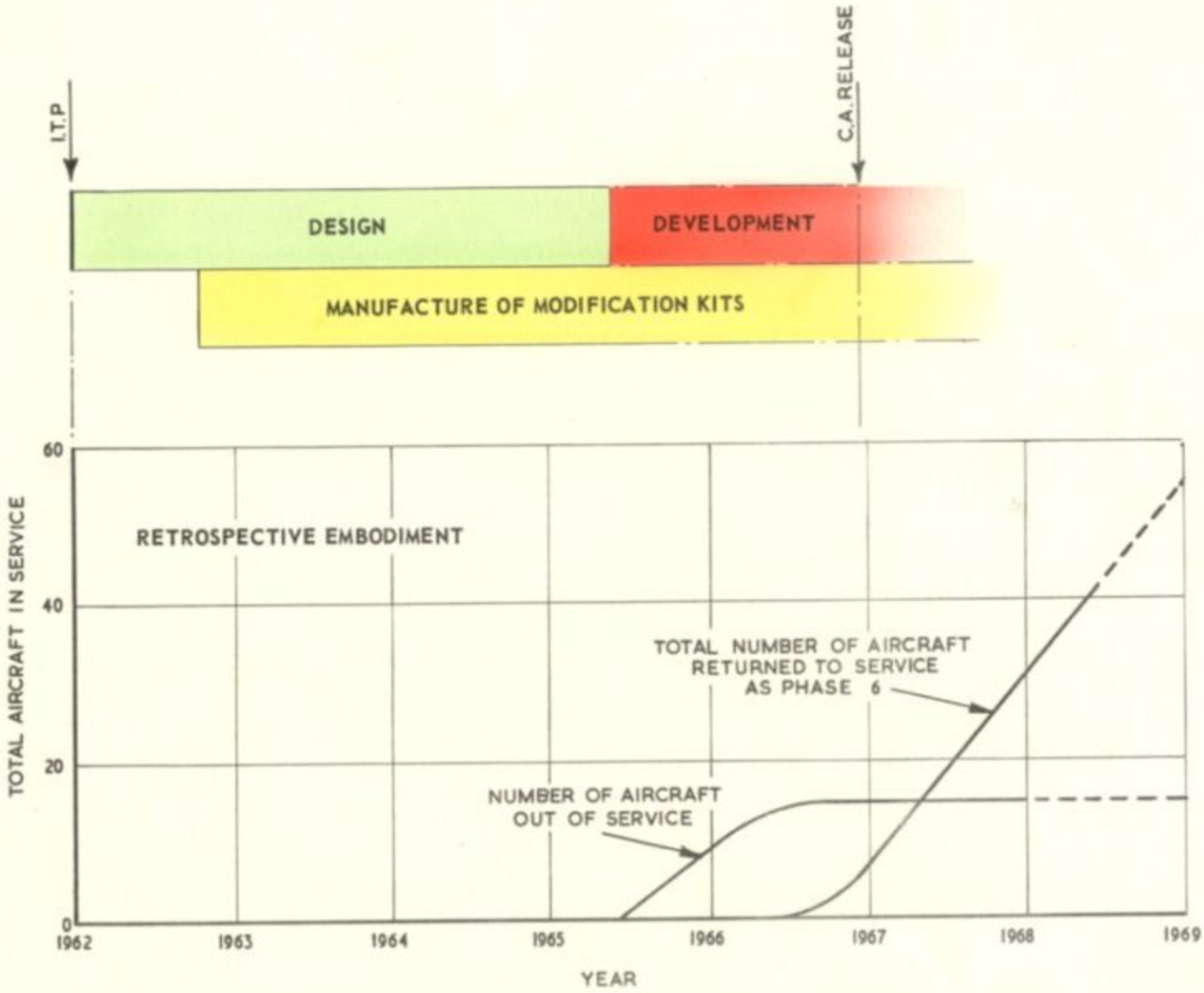
VULCAN SKYBOLT INTEGRATION

DEVELOPMENT PROGRAMME

The Vulcan Phase 6 aircraft can be developed either by a retro-fit programme to existing Vulcan Mk. 2 aircraft or by building new aircraft. In either case the first flight of the Vulcan Phase 6 aircraft will be four years after the receipt of an Instruction to Proceed, and C.A. Release would follow one year later.

In the programme illustrated it is assumed that the aircraft are built in a retro-fit programme, and that no more than 15 aircraft are held at one time. After the fifth aircraft, deliveries would be made at a rate of two aircraft a month. If an I. T. P. were received in January 1962, more than 50 Vulcan Phase 6 aircraft could be in service, providing airborne alert capability, by the end of 1968.

A similar programme applies to the production of new aircraft, and with the facilities available to Hawker Siddeley Aviation Limited both a new build and a retro-fit programme could be run concurrently if required.



VULCAN PHASE 6 DEVELOPMENT PROGRAMME

APPROXIMATE COST

An estimate has been made of the cost of converting Vulcan Mk. 2 aircraft to Vulcan Phase 6 standard, and also of the construction of new Vulcan Phase 6 aircraft. These figures based on a total production of 75 aircraft are approximate and are provided for comparative purposes only.

Conversion of Vulcan Mk. 2 aircraft to Vulcan Phase 6 standard	£600,000 per aircraft
Construction of new Vulcan Phase 6 aircraft	£1,500,000 per aircraft
Development charge for airframe	£5,000,000
Development charge for engine	£1,500,000

The primary difference between the cost of conversion and new build is the price of new engines and equipment necessary for the new aircraft.

It would therefore be possible to provide a fleet of 75 Vulcan Phase 6 aircraft by retro-fitting Vulcan Mk. 2 aircraft for £51,500,000. A total fleet of 150 aircraft, 75 being new construction, would be provided for £164,000,000.