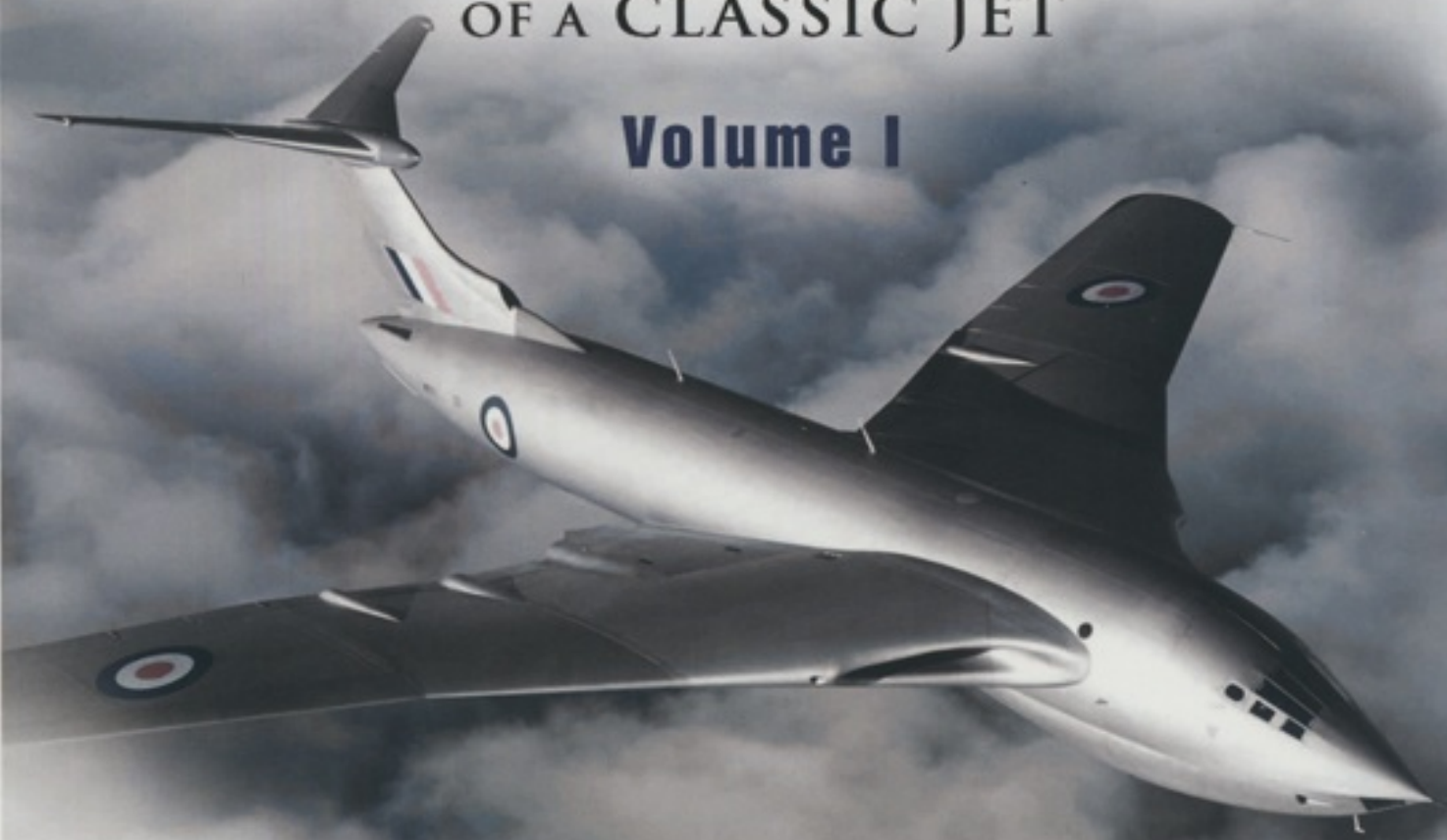


THE HANDLEY PAGE **VICTOR**

THE HISTORY & DEVELOPMENT
OF A CLASSIC JET

Volume I

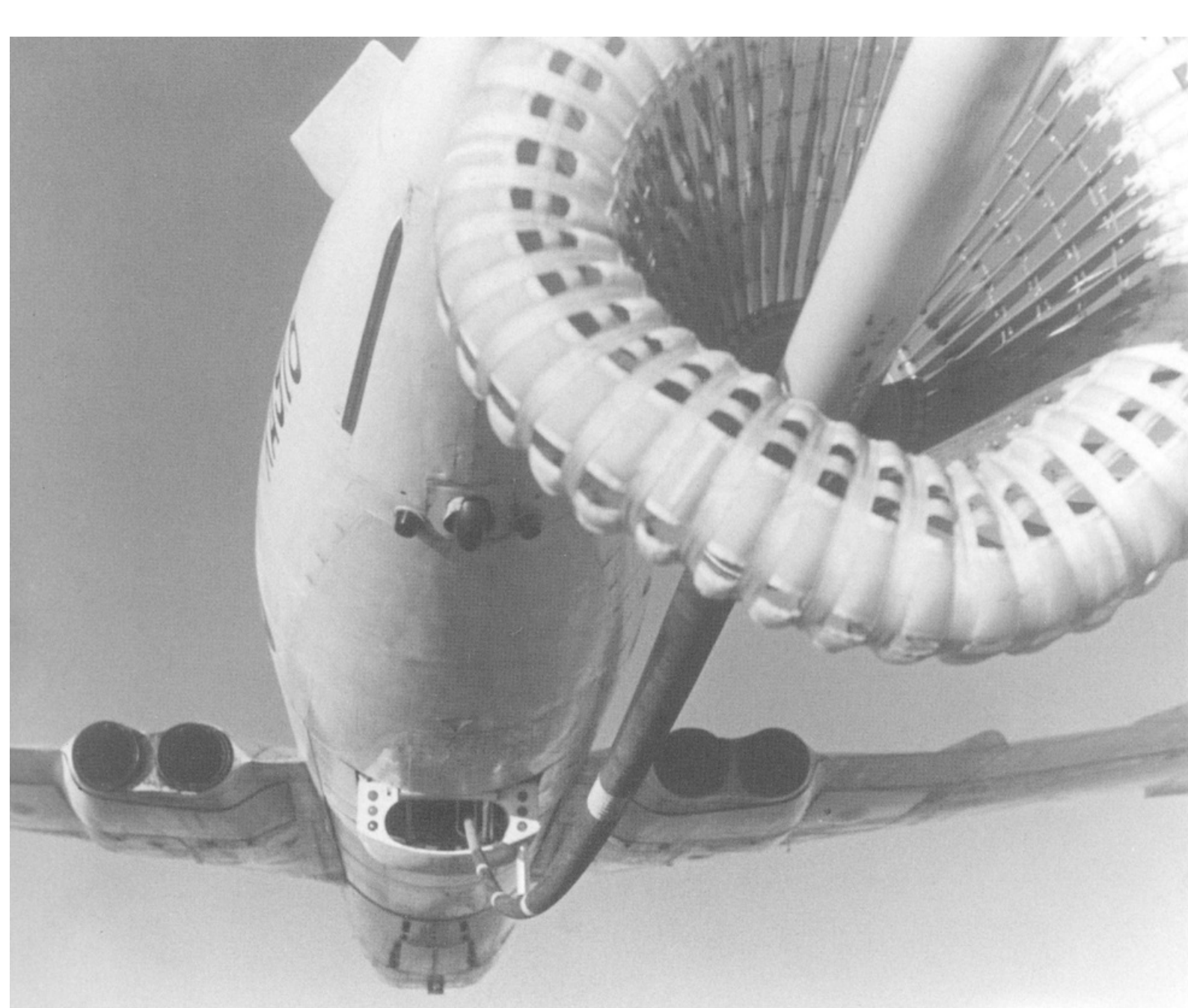


The HP80 Prototype & The Mark I

ROGER R. BROOKS

ARAcS

THE HANDLEY PAGE
VICTOR
VOLUME ONE



Victor BK1 XA 918 refuelling on trials duty with the A&AEE during 1964. Author's collection

**THE HANDLEY PAGE
VICTOR
THE HISTORY & DEVELOPMENT
OF A CLASSIC JET**

VOLUME ONE
THE HP 80 PROTOTYPE AND THE MARK 1 SERIES

ROGER R. BROOKS
ARAS



Pen & Sword
AVIATION

Dedication

To my wife Heather, also known as 'Heater' for support and encouragement over the many years this book has been in development and compilation.

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FOREWORD

I am honoured and delighted to have been asked to introduce this book, which is an indepth study of an aircraft whose design and development, occupied on and off nearly half my working life from 1951. I have great affection for it, not least because it brought me into close working contact with many highly competent people, one of the foremost being the Author. In fact, I did not meet him until long after the parent company Handley Page, went out of business, since I was an aerodynamicist by trade and (unfortunately) had little contact with the RAF people at the 'sharp end' operating and maintaining the aircraft.

Roger Brooks has some 40 years of experience of working at the 'sharp end' with the Victor and other aircraft, and has distilled some of his vast knowledge into this volume. But not only operating aspects, as he has collected a comprehensive archive covering the Victor's design and development story, mainly from those who were there — Godfrey Lee, effectively the 'Father of the Victor', Hedley Hazelden, Chief Test Pilot on the first flight, and many others, and lucidly presents it.

That valuable contribution is enhanced by reference to many Technical Manuals, Reports, Specifications and Brochure, all combining to make this a most valuable contribution to our Aviation Heritage literature.

The collection of statistical data is probably unique, and is usefully supplemented by a careful selection of illustrations.

The amount of ground covered by the Author is clear from the extensive quoted bibliography, but in fact his researches went further, and his experience as a Crew Chief for the aircraft (still continuing with XL231 'Lusty Lindy' operating at Elvington) is very evident in the scope and detail in the data presented.

I feel sure this is a book which will be on most serious aviation historian's bookshelf, and will quickly get dog-eared with use, but I hope the aircraft enthusiast will also use it — at least he will know that this is the real, unassailable 'gen' compiled by someone who knows the aircraft inside out.

A.H. Fraser-Mitchell
Sometime Chief Aerodynamicist Handley Page Ltd
Vice President, Handley Page Association

January 2005

INTRODUCTION AND ACKNOWLEDGMENTS

Over the past 40 years or so, many books have been written on the Handley Page Victor and the Force aircraft in general. This book is not in the same vein as those. It is written as a Data File and subdivided into sections dealing with specific variations of this unique aircraft. It is intended as a reference book and you do not have to read all of it, just the relevant items that appeal to you. The accuracy of data in this book is backed up by the source material, which I have quoted the main items in the bibliography. It is by no means the definitive history of this aircraft as a considerable amount of very interesting data is not available for a variety of reasons by a few organisations for strange excuses.

I would like to produce a second edition within the next few years containing additional information on this book and the Victor in Service with the Royal Air Force from 1957–1993. Contributions for the same are welcomed from all readers, no matter what they contain, and should be sent to the publisher.

I would like to thank the following for their assistance and guidance over the years in the course of developing the Data File.

The following members of the Handley Page Association:

Harry Fraser-Mitchell, Peter Cronbach, John Allam, Spud Murphy, Peter P. Baker, Jock Still, John Rudeforth, Alan Dowsett, John Harding, John Smith, Chris Scivyer, Brian Bowen, Mike Wilson, Harry Rayner, David Blades and Steve Mills. Finally, to all those members who I have spoken to over the past many years.

The following past Members of Handley Page Ltd and the Handley Page Association:

Godfrey Lee, Hedley Hazelden, Ian Bennett, Bob Williams, Gordon Roxborough, Reginald Stafford, Charles Joy, R.H. Sandifer, Dr G.V. Lachmann, W.H. MacRostie, C.O. Vernon, F.R.C. Houndsfield and John Tank. For being allowed access to the articles they wrote for the HP Bulletin nearly 50 years ago and in particular to Ray Funnell for access to his archives.

From the Royal Air Force:

Aircrew

Air Vice Marshal John Herrington, Flt Lt Pancho Painting, Flt Lt Eric Anstead, Flt Lt Alan Fisher, Air Commodore 'Spike' Milligan, Flt Lt Terry Filing, Sdn Ldr Jerry Mudford, Flt Lt Ken Norman, Air Commodore David Bywater, Flt Lt Alan Gardener, Sdn Ldr C.R. 'Pop' Miles, Sdn Ldr M Reade, Wing Commander Dave Griffiths, Flt Lt David Coleman, Group Captain Tony Ringer, Sdn Ldr Gordon Stringer, Flt Lt R.T. Hayward, Flt Lt John Bussey, Sdn Ldr Tim Mason, Sdn Ldr Al Stephenson, Sdn Ldr Bob Tuxford, Sdn Ldr Tony Cunnane, Wing Commander Barry Neal, Flt Lt Al Skelton, Wing Commander Bob Prothero, Flt Lt John Ledger. All the Victor captains and crews I flew with on the Mk 1 and Mk 2 Tanker Fleet as their Crew Chief.

Crew Chiefs

Bill Swann, David Haylett, John Kent, Sid Harding, Dave Parsons, Robbie Honnor and Brian Martin.

Ground Crew

~~Dennis Robinson, Gordon Stringer, Jim Jones, Jim Gosling, Paul Goss, Duncan Curtis, Mick Crook, Dave Wynn-Jones, Don Williams (Australia), Robin Cooper, Stan Jones, Pete Claydon, Tony Regan, Rick Gill and Doug Gawley.~~ Also, thanks go to all those whose names I have failed to remember.

Finally, my grateful thanks go to the following from many walks of life for their interest in the Victor and assisting in many ways:

Andre Tempest (Owner Victor XL231 'Lusty Lindy'), Martin Garland and BAE Systems Woodford Heritage Centre, Graeme Rodgers (NZ), Garry O'Keefe, The Victor Association, Ken Ellis, Jarrod Cotter and Duncan Cubbitt of *Fly Past*.

Cover credits:

The Front Cover: First Prototype of the HP 80 WB771 flown by Sdn/Ldr Hazelden On a test flight 1953. *Authors Collection via HPA*

The Back Cover: Top Picture: Victor B1 XA918 second production aircraft on development flying: *Authors Collection via HPA*

Second Picture: Victor B1 XH592 15 Squadron arriving at RAAF Richmond, Sydney NSW Australia on the 20/6/61 after a high speed run from England and on the last leg from Darwin beating the record time by 20 minutes. Captained by Wing Commander Tony Ringer seen here descending from the aircraft, the time from England was 19hours. *Photo and data via Graeme Rodgers New Zealand*

Third Picture: Front Cabin of Victor B1A(K2P) XH648 57 Squadron now with the IWM at Duxford. *Heather Brooks*

Fourth Picture: Victor K1A XH618 57 Squadron RAF Marham 1972. *Authors Collection*

Bottom Picture: HP 80 WB771 Banking to Port with Wheels down, Flap both nose and main down and airbrakes open. *Authors Collection HPA*

ABBREVIATIONS

AAPP	Airborne Auxiliary Power Plant
A&AEE	Aircraft and Armament Experimental Establishment
AAR	Airborne Air Refuelling
AC	Alternating Current
ADF	Automatic Direction Finding
AEO	Air Electronics Officer (RAF Aircrew)
AMU	Air Mileage Unit
ARC 52	UHF Radio
ARI	Airborne Radio Installation
AVCAT	Aviation Jet Fuel (used by Royal Navy on Carriers)
AVTUR	Aviation Jet Fuel (Jet A1)
AVTAG	Aviation Jet Fuel JP4 Wide Cut Gasoline type fuel
AwC or AWC	Awaiting Collection
C of G	Centre of Gravity
CAT 3/Cat 3	Category 3 (Aircraft Repair Status)
CAU	Cold Air Unity
C(A)	Controller of Aircraft (Military CAA)
CL	Buffet Boundary Measurement
CRE	Central Reconnaissance Establishment
c/s	Call Sign
C/T	Continuation Training
CWP DC	Contractors Working Party (HP or HAS)
DC	Direct Current
DF	Direction Funding
DOR	Director of Operational Requirements
DTD	Directorate of Technical Development
DV	Direct Vision (small opening windows in the cabin)
EAS	Estimated Air Speed
ECM	Electronic Counter Measures
FEAF	Far East Air Force (RAF)
FI	Fatigue Index
FSII	Fuel System Icing Inhibitor

G4B	Aircraft Compass System Mk 1 Victor
GP	General Purpose
GPU	Ground Power Unit
HDU	Hose Drum Unit
HF	High Frequency
HLBSP	High Level Blue Steel Profile
HP	High Pressure/Handley Page
HZ	Hertz (frequency of electrical power)
IAS	Indicated Air Speed
IFF	Identification Friend or Foe
ILS	Instrument Landing System
IMN	Indicated Mach Number
IRT	Instrument Rating Test
JARIC	Joint Airborne Reconnaissance Intelligence Centre
JIB	Joint Intelligence Branch
JPT	Jet Pipe Temperature
JMC	Joint Maritime Control
KVA	Kilo/Volt/Amps
KW	Kilowatt
Ldg	Landing
LL	Low Level
LLBSP	Low Level Blue Steel Profile
LV	Low Voltage (24/28VDC)
M.A.P.	Ministry of Aircraft Production
Mcrit	Critical Mach Number
MF	Medium Frequency
MFS	Military Flight System (used in Mk 2 Victor/Vulcan)
Min Tech	Ministry of Technology
MOA	Ministry of Aviation
MRR	Maritime Radar Reconnaissance (H2S+ R88 Camera)
M.U.	Maintenance Unit (RAF)
MV	Medium Voltage
NBC	Navigation Bombing Computer
NBS	Navigation Bombing System (H2S+NBC)
N/F	Not Flown
NGTE	National Gas Turbine Establishment
NM	Nautical Miles

OCU	Operational Conversion Unit
ODM	Operating Data Manual
PE	Pressure Error
PFCU	Powered Flying Control Unit
PR	Photographic Reconnaissance
PSI	Pounds Per Square Inch (pressure)
PTR 175	UHF/VHF Radio
QFI	Qualified Flying Instructor
R.A.E.	Royal Aircraft Establishment
RAT	Ram Air Turbine
RATO	Rocket Assisted Take Off
RBS	Radar Bombing System
RCM	Radio Counter Measures
RE	Royal Engineers
RPM	Revolutions Per Minute
RRF	Radar Reconnaissance Flight
Rtn	Return/Returned
RWR	Radar Warning Receiver
SARAH	Search and Rescue Aircraft Homer
SARBE	Search and Rescue Beacon
SBAC	Society of British Aircraft Constructors
SOC	Struck off Charge
SOO	Special Order Only (modifications)
SSR	Secondary Surveillance Radar
TEZ	Total Exclusion Zone (South Atlantic)
Tkr	Tanker
T/O	Take Off
TRU	Transformer Rectifier Unit
Trg	Training
TTF	Tanker Training Flight
TX/RX	Transmitter/Receiver (Radio/Radar)
U/C	Undercarriage
UDF	Ultra High Frequency Direction Finding
UHF	Ultra High Frequency
U/S	Unserviceable
VHF	Very High Frequency
VISRBS	Visual Radar Bombing System

VMMU

Victor Major Maintenance Unit

ZULU

Greenwich Mean Time

BIBLIOGRAPHY

V Force, Andrew Brookes, Book Club Associates, 1982
Crash, Andrew Brookes, Ian Allan, 1991
Handley Page Victor, Andrew Brookes, Ian Allan, 1988
RAF Nuclear Deterrent Force, Humphrey Wynn, HMSO, 1994
Handley Page Aircraft, C H Barnes, Putnam, 1976
Thunder and Lightning, Chris Allen, HMSO, 1991
Tests of Character, Don Middleton, Airline
Aim Sure 75 Years of XV Squadron, Flt Lt T W Jones, Palka Druck, 1990
Jet Adventure, Geoffrey Norris, Phoenix House, 1962
Handley Page Bulletins, nos. 213, 220, 225, 228, 229, 230, 231
Handley Page Repair Reports
Handley Page Brochures, various, HP 80, Mk 1
Handley Page Victor Servicing School Notes Mk 1
Handley Page Test Pilots Flying Log 1952–1970
Handley Page Flight Test Observers Reports
Handley Page Victor Mk 1 Tanker Final Conference Report
Handley Page Victor Low Level Role Report
Handley Page Victor Wing Tip Fuel Tanks Report
Handley Page Victor Thrust Augmentation Report
A&AEE Boscombe Down/HP Test Pilot Reports, various
Royal Aeronautical Society Transcripts of Lecture (Victor)
The following Air Publications were used for checking data accuracy only:
AP 101B-1100 Victor All Marks
AP 101B-1101 Victor B Mk 1
AP 101B-1103 Victor B Mk 1A

Bomber Command/Strike Command Victor Servicing School Notes (all Marks) Release to Service Data

My extensive collection of a wide variety of books, magazines and other records and data sources collected over thirty-five years.

Interviews and discussions with Handley Page Flight Test and Ground Test Staff, Aerodynamicists, Production Engineers and many production staff. A&AEE Test Pilots and Flight Test Engineers.

PART ONE

The HP 80

From its Concept to Flight

The Requirements that lead to the HP 80 and later the Victor

*This article is based on the paper by G H Lee ARCS, BSc, DIC, FRAes
Deputy Chief Designer of Handley Page in 1954 and presented to the
Royal Aeronautical Society Handley Page Memorial Lecture on 26 May 1976.*

‘Unassailable Aerodynamical Logic’ – an enduring theme for Handley Page Ltd

As for the most of the British Aircraft History, the jet age started for Handley Page in 1945, when the war had been won and we had the chance to consider properly the implication of jet propulsion, until then used only in the fighter installations. Two events in that year should be recorded.

1. The setting up by the Ministry of Aircraft Production of the Swept Wings Advisory Committee comprising of representatives of the official Establishments [RAE etc] and the aircraft manufacturers.
2. In September–October sent a team, to Germany to find out about the German work on tailless and swept wing aircraft.

In June 1945 Sir Frederick Handley Page was confident that a replacement for the Avro Lincoln would be needed and as the specification for the twin engine jet bomber had been issued it seemed logical for Sir Frederick that the 4 engine aircraft would be next. On the 14th June 1945 he issued a private and confidential memorandum addressed to R.S. Stafford, Frank Ratcliffe and Godfrey Lee in this memorandum requested an immediate investigation of two classes of bomber one of 100,000lb all up weight with four turbojets of the size of the AJ65 (Avon) or two of twice that size the other a 60,000lb aircraft with two AJ65 engines and he suggested that they should have wings incorporating a 40 degree sweep.



The late Sir Frederick Handley Page. Author's collection

The real start of the Victor design was in the course of the next few months actually undertaken in September–October when a visit to the German aeronautical research establishments at Gottingen and Volkenrode with a MAP fact finding team was undertaken by Godfrey Lee as the representative of Handley Page. It was, as part of this visit that the concept of the swept wing as a means of enabling aircraft with reasonably thick wings to fly at high subsonic speeds without drag rise first became understood. From this there stemmed the realisation that by combining a swept wing with a jet engine one could have an efficient high subsonic speed aeroplane capable of carrying a good payload over long range. Work on this concept began at Handley Page in about November 1945

In January 1946 after work on the HP72 heavy transport had been abandoned, the designations HP72A and HP75A were used as a cover for Godfrey Lee's investigations into the possible jet propelled high-speed bomber of 90,000lb all up weight. The HP 75A with a front rider plane was quickly ruled out in favour of the 72A with 45 degree swept wings and wing tip rudders having a small swept tail plane and elevators to balance nose down pitching moments caused by either flap lowering at low speed or compressibility at high speed. With no operational requirement yet promulgated by the Air Staff to guide him, Godfrey Lee put forward an inspired proposal on the 25th February 1946 for a design of 2100sq ft, 122ft span, aspect ratio 7, wing loading 43lb/sq.ft to carry a 10,000lb bomb at 520 knots true air speed over a still air range of 5,000 statute miles; the wing root thickness /chord ratio was to be 16%, with a 9 ft diameter body accommodating a crew of four in a pressurised nose compartment. Avon (AJ65) engines were larger than the ideal size for this aircraft and Godfrey Lee suggested scaling them down to 5,600lb. Two days later Reginald Stafford approved this proposal and instructed C.F. Joy the Chief Draughtsman to prepare a brochure for submission to the Principal Director of Technical Development (Stuart Scott-Hall) by the end of March 1946; this brochure was to demonstrate the projects effectiveness as a bomber. At this stage the number HP 80 was allocated and so started the HP80/Victor project way back in March 1946.



The late Godfrey Lee, 'Father of the Victor'. Heather Brooks

The brochure was issued to the Director of Operational Requirements Group Captain Silyn-Robert and with his deputy Group Captain Cooper they visited HP Cricklewood on the 19th July 1946 to discuss the third draft which had been issued in June 1946 of the Air Staffs requirements for a long range bomber mainly derived from the Handley Page proposal, but containing several operational innovations. These included the visual bombing facility as a back up to the possible delay and failure of the radar bomb sight, a Flight Engineer's station, unless the engine controls could be simplified, Electronic Counter Measures operator in a separate cabin near the tail, reached by a tunnel from the main cabin and if possible a jettisonable main pressure cabin. A bomb bay load of 30,000lb was to be carried with normal tanks full, but bomb bay tanks were to be allowed to achieve maximum range with a 10,000lb bomb.

Members of the Telecommunication Research Establishment (TRE) visited HP Cricklewood on the 2nd November 1946 to discuss radar equipment, the main feature being the H2S Mk 9 Scanner 6ft long and rotating on a vertical axis within a large radome below the flight deck floor, in addition were Gee and Rebecca Mk4 for short-range navigation, IFF and ECM, the latter requiring a tail paraboloid scanner of 18inch diameter facing aft, the estimated total weight of the radar equipment was 1,500lb and all aeriels would be suppressed. The TRE wanted the H2S scanner to be pressurised but this was virtually impossible and the idea was abandoned. It later came to the notice of C.F.Joy that the DO

insisted that the crew cabin being as small as possible to reduce the vulnerability, even if it were at the expense of crew comfort and that the whole pressure cabin should be jettisonable because the use of ejection seats at 50,000ft and 500mph was considered likely to be fatal. The whole cabin would be broken down on large parachutes with the crew strapped in 25g seats falling nose first and relying on the nose structure to absorb the shock of impact

Two pilots were required and it was agreed that locating the ECM operator in the tail was impracticable because of the large size of the proposed nuclear weapon, which might be 6 ft diameter and up to 30 ft long. The Air Staff intentions were made known by Stuart Scott-Hall when he visited HP Cricklewood on the 25th November 1946; they wished to replace the AVRO Lincoln in 3 years time by a four jet bomber capable of delivering a 10,000lb nuclear weapon at 500mph from a height of 45,000ft the still air range being 3,500miles; as a later development the range would have to be increased to 5,000 miles and the operational ceiling to 50,000ft these data being formally promulgated in the Air Staff Operational Requirement No. 230. Godfrey Lee estimated all up weight to be 90,000lb for 3,500 miles using a swept wing and 121,000lb for a conventional straight wing. A further meeting was held with the Principal Director of Technical Development on 14th January 1947. After Handley Page had submitted their proposal to meet OR230, the official view was that both the structure weights and drag estimates were optimistic, so that the design cruising speed would not be released. The DOR now wanted the cruising speed to be raised to 575mph which meant that the all up weight also would have to rise to 100,000lb in order to attain the 3,500 miles still air range. Specification B35/46 was issued on 1/1/47 and approved by the Director of Aircraft Research and Development on the 24/1/47 and issued with OR 230 on 24/3/47. In view of the large wind tunnel test programme involved, the prototype HP80 could not be expected to fly until 1951. Apart from the exploration of the new problems of tip stall, high lift sections, stability and various methods of boundary layer control, a firm choice between tailed and tailless types still had to be made. Charles Joy proposed to begin the drawing office programme on the 1/10/47 allowing 21 months until June 1949 for the basic layout and 30 months to March 1950 for the completion of the powered flying control system. All drawings for the first prototype would be completed by June 1951 and the external drawings for the fully equipped prototype by March 1952. The target date for the first flight of the flying shell was March 1952 and for the fully equipped aircraft September 1952. It was a tremendous programme for the small design team but not impossible, so the HP80 tender was submitted.

On the 28th July 1947 Sir Fredrick Handley Page received a telephone call from Stuart Scott-Hall stating that the HP80 was to be ordered along with the AVRO 698 subject to the confirmation of the high-speed wind tunnel test results to approve the theoretical basis of the design.

We were started on the 'Victor'

The Basic Design Concept

Specification B35/46 called for an aircraft capable of carrying a considerable bomb load (10,000lb) over a range of 1,500 miles from a base that might be anywhere in the world. The aircraft will be required to attack targets at great distance inside enemy territory. And it must be assumed that it will be tracked by radar and other methods for a large part of its flight. It must therefore be capable of avoiding destruction by making the inevitable attack from ground and air launched weapons difficult.

To achieve this the aircraft must have the following:

1. A high cruising speed which should be such that the attacking fighters will have to fly at a speed at which they might become unmanoeuvrable.

2. The design must be such that the aircraft can turn rapidly and without loss of height or much loss of speed when at maximum cruising height. The height being 35,000 to 50,000ft.
3. The carrying of adequate warning devices to detect the approach of ground launched weapons and the proximity of approaching aircraft.
4. The carrying of defensive equipment such as jamming devices for guided missiles.
5. The size of the pressure cabin must be as small as possible.
6. Visual and electronic bomb-aiming positions are required.
7. Maximum performance is the ultimate aim and must not be sacrificed for ease of maintenance.
8. It must be possible to operate from existing Heavy Bomber airfields at the maximum load weight which must, therefore, not exceed 100,000lb.
9. The aircraft must be suitable for large-scale production. It is stated in the Specification that the economic production of 500 aircraft at a maximum of 10 per month was proposed.

HP 80/Victor Specification and Design Concept

The combination of sweep and range seemed to us to lead to the need to have both high sweep (fairly high sweep) and moderately high aspect ratio. For us combining high sweep and high aspect ratio gave rise to the tip stall problem. Therefore the Crescent wing was evolved. We came to the crescent wing by arguing that the high sweep was essential at the root for structural reasons and to provide adequate stowage for engines and undercarriage. It was then argued that if we reduced the sweep over the outer parts of the wing we would reduce at the tip where it mattered, the adverse effects from sweep that gave rise to tip stall. In particular it was expected that this would reduce the trouble from the outwardly drifting boundary layer over the rear of the wing, it being assumed that the boundary layer from the highly swept parts of the wing would stream off the wing before reaching the wing tip. We had to accept a weight penalty from the thin outer wing of about 22 degrees sweep and 6% t/c at the tip but felt that since this part of the wing is the least highly loaded the extra weight was acceptable; stowage problems did not arise in the outer wing. We decided that to go from 53 degrees to 22 degrees at one kink was too sudden so we put in an intermediate section at about 35 degrees.

The final sweep on production aircraft after further wind tunnel testing at 1/4 chord was to end up as 47.5 degrees at station 60–212 the inner wing, 40.5 degrees at station 312–330 the intermediate wing and 32 degrees at station 330–660 the outer wing.

We first intended that the HP 80 should be to all intents and purposes, tailless, since we thought we had enough sweep to do this. We had wing-tip fins and rudders and pitch control was obtained from symmetrical deflections of the elevon (we knew that tip stall was better with elevons up). To help balance the nose down pitching moment from the big Fowler flaps we introduced a small all moving swept tail plane mounted above the fuselage on a very short fin; this was to be moved so that the trailing edge up when the flaps were lowered.

However there were worries about the bad effect of tip fins on tip stall and some fears, not clearly defined that these tip fins might lead to asymmetrical conditions with objectionable yawing moments under some unspecified conditions, possibly at high Mach number

Because of this feeling it was decided to delete the tip fins and go for a conventional fin and rudder. Having got this far we also went for a 'conventional' tail plane and elevator. We put this on top of the fin primarily to get it out of the way of the jet efflux and also because we wanted to avoid the fairing and structural problems of a tail part way up the fin. We knew at this time that this arrangement was bad from the tip stall point of view but we decided that we could fix this with nose flaps or something similar.

Having got a thick wing root with a maximum depth of approximately 6 ft we decided to put the engines inside the wing immediately outboard of the fuselage to save nacelle drag and to avoid an

serious yawing moment from a cut engine, thus easing the design requirements for the fin and rudder. The undercarriage retracted into the wings thanks to a 4 wheeled 8 tyred bogie outboard of the engines.

Because of the way in which the engines and the undercarriage were installed the centre wing main structure was limited to a torque box ending at about 30% chord. At the fuselage side this torque box had a large kink and passed across the fuselage in a span-wise direction.

There was an important aerodynamic advantage to this centre wing box structure. Because of the high sweep, the centre wing spar structure was well forward of the C of G of the aeroplane when it crossed the fuselage. This meant that all the moveable military load (bombs or reconnaissance crates) was aft of the rear spar and thus we could mount the wing centrally on the fuselage with consequent drag and Mcrit (Critical Mach Number) advantages; further the whole fuselage cross section was available for useful load fuel at the top and military stores below thus minimising the cross section area diameter to 10ft.

Wing Design – High Speed

The aim was a constant critical Mach number across the span. After an arbitrary choice of taper ratio initially about 2.5 to 1 but later increased to about 4 to 1 and sweep we had at our disposal the following items by means of which we could effect the super velocities so as to get the desired critical Mach number.

1. Fairing Shape and Thickness,
2. Camber.
3. Twist

When we got our first wing designed a model was tested in the old RAE high-speed wind tunnel (Which was no longer in use over 30 years ago) The results showed the drag rise coming in too early around about Mach 0.8 I understand. There was at that time evidence that the trouble was on the outer parts of the wing. It was a mixture of pressure plot data and indications of shock wave positions so we reduced the thickness of the outer wing by 2% chord throughout making the necessary changes to the shape of the intermediate wing, which remained unaltered at its inboard end. This fixed it and we were from there. At the wing root we got a favourable interference from the mid wing arrangement. One can I suppose, argue that if one looks at the wing fuselage intersection in plan there is an obvious wasting of the intersection line, remember it is a 6ft thick wing passing centrally through a 10ft diameter fuselage and thus there is automatically a good root fairing. We actually thought of it rather differently though the result is the same. What we said was that if you plotted, along the length of the fuselage, the cross-sectional area of the fuselage outside the wing you then had the distribution of the added area.

Low Speed

As design proceeded there was continual pressure for more wing depth at the root for stowage of engines, undercarriage etc. This led, by insidious steps to the gradual increase in the root chord until the taper ratio had increased to about 4:1 and the inner kink on the trailing edge had been eliminated: the aspect ratio was now down to about 6. When we at last got a model of this into the low speed wind tunnel the pitch-up at stall was terrible. We tried all sorts of leading edge devices with out much success.

Drastic measures were called for so we decided to increase the chord of the outer wing by a 20% forward extension: this new leading edge ran inboard to intersect the leading edge of the intermediate wing much further inboard than it formally had; the outer kink was now about half-way from the

fuselage side to tip instead of $\frac{2}{3}$ as originally. This combined with a droop nose flap on the new large outer wing gave an acceptable answer then anyway. The nose flaps were, I think, hinged at about 12.5% chord from the leading edge and went down about 45 degrees. An automatic control system was designed based on the signal provided by a pressure ratio switch which made an electrical contact when the differences in the pressure coefficient between holes on the top and bottom surfaces of the wing reached a pre-set value. The nose flap was lowered by the stored energy of a hydraulic accumulator and came down in a second. This quick action was necessary to beat the increase in drag. Chord Line (CL) raising was slow and the hydraulic pumps had to recharge the accumulator to full pressure before the flaps retracted so that it might be ready for action again. This was later demonstrated to be acceptable by flying at high Mach numbers with nose flaps down.

Aerodynamic Controls

We started the design in 1946 and had to design the biggest aeroplane that we had ever done, with swept wings and a flight envelope going up to a pretty high subsonic Mach number. In these circumstances we decided that manual controls were *not* so we went for duplicated power operated controls with no manual reversion. The aileron jacks were independent, i.e. not connected across the wing from port to starboard, so we put in a fixed upwardly deflected tab to cut down b_0 and b_1 ; to reduce b_2 we also had a geared tab. Rolling power on the Victor is very high because when we changed over from elevons to ailerons and elevator we did not reduce the size of the ailerons and they are larger than normal. The rudder had a geared tab. We gave up the idea of an all moving tailplane for mainly structural reasons (the HP 88 had such an item) and went instead for a very small fixed tail-plane just something to hold the hinge brackets with a very large elevator. The elevator had an enormous horn balance (the outer 60% of the span I should guess) and was deliberately overbalanced for all normal flight conditions. We did this so as to reduce the hinge movement (saving size and weight of the jack.) at maximum flight M; positive and negative movements were about equal in magnitude and it seemed to work all right. Service experience seems to justify our decisions as the Victor has flown at Mach numbers in excess of 1.0 on a few occasions. Although the prototype did a lot of flying without auto stabilisation, we ultimately added first a yaw damper and then a Mach trimmer. These were more important on the B2 versions with the Conway and the great altitude capability.

Fuselage

There is not much more to add to what has already been said in connection with the wing design. We made a very smooth pointed nose with the windscreen faired into the lines without the usual step. This kept down the local shock waves and gave a very quiet cockpit. The bulge or chin below the nose resulted from putting the radome under the bomb aimer.

Engine Air Intake

Right from the start we knew that swept wing leading edge intake was going to be difficult but we went ahead with it because of the very encouraging results obtained from A.V.A. Gottingham with such an arrangement. We had the wind tunnel test report by a man called Scheerer I think or else A. Walz.

For the Mk 1 with the Sapphire engines we just sliced off the nose section of the wing section and contrived to keep the engine air intake entirely within the original profile. The problems were to get good efficiency throughout the large range of inlet velocity/flight velocity ratios and to avoid shock waves at high Mach numbers through a fairly large range of incidence. There was the tendency under static conditions for the air to be concentrated in the outer corner of the intake; it came out as a low

thin triangle, with rounded corners, due to the high thickness taper on the inner wing. The need to supply two engines added more complications. We decided on a single inlet with division into the two separate trunks well back in the wing when we had got the air behaving nicely. The absence of a central division on the leading edge reduced the length of the intake; if we had to push the intake for the outer engine still further outboard we would have been in real trouble with the extreme outer corner, for the wing depth would have been very small indeed.

Starting with the German results and with much wind tunnel testing (many pressure plots on the lips) we got it acceptable, including the engine out cases. Later it was discovered that during the take-off run there was quite a large supersonic patch at the outer corner of the intake; the tolerant Sapphirin did no more than lose a bit of thrust under those conditions.

Dive Brakes (later called Air Brakes)

These were formed from sections of the fuselage near the rear on each side of a roughly trapezoidal plate swung forward and outwards leaving a gap between the leading edge of the air brake and the fuselage side. At full deflection it had moved out about 60 degrees. Since the above arrangement resulted in a convex face of the air brake facing forward we put strakes on the top and bottom edge to increase drag. At first the strakes were of equal depth but there was a pitching moment when the brakes were deployed; we cured this by making the top strake a lot bigger than the lower one.

These air brakes worked very well; they gave good braking without pitch or undue buffet at all Mach numbers up to the maximum. The pilots liked it so much that they used them for speed control on the final approach; they set up a reasonable thrust and adjusted the speed /angle of descent with the air brakes as one would on a glider since this was more precise than operation of the throttles.

Structural Design

We are committed to a thin wing (or relatively thin) and this lead to quite a high bending end load. Because of high flight Mach number we imposed a quite stringent waviness criterion to avoid the risk of local areas having little shock waves.

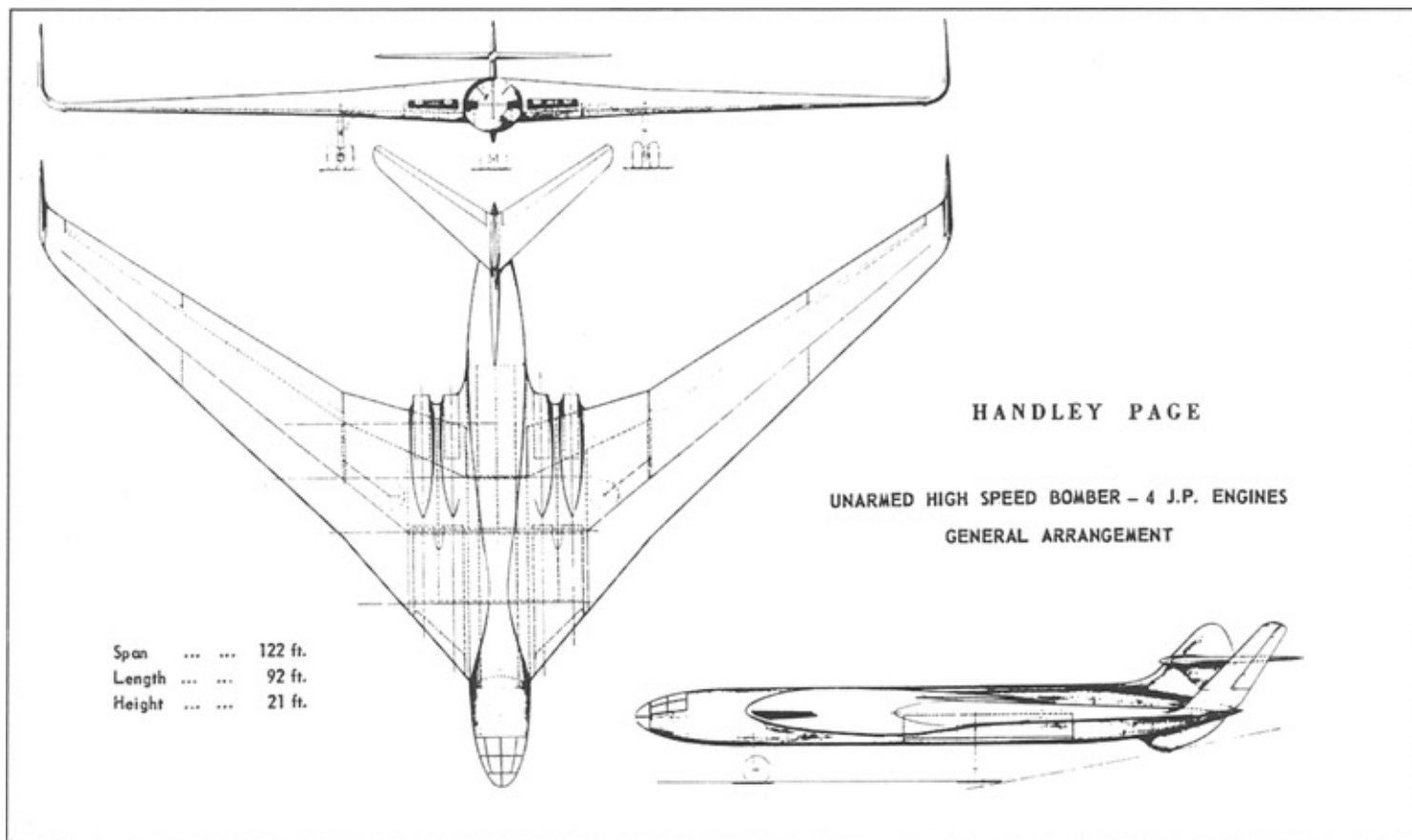
We decided quite early to use sandwich construction which, because of its bending stiffness and strength, could carry end load (the main bending end-load) without the elastic in-flight buckling typical of conventional skin/stringer construction and which could also take internal (fuel tank) and external pressure loads without significant distortion. (*For a complete description of the structural design of the Victor by the then Assistant Chief Designer (Structures) R H Sandifer*)

Flutter on the Victor

From the start of the design we paid much attention to flutter. We were concerned firstly with the problem of estimating flutter derivatives for a swept wing where the mach number went well beyond the critical, and secondly, we had two other problems, the flutter characteristics of a crescent wing and a T tail, both new to Handley Page.

We tackled the problems on a broad front, calculation, wind tunnel test, ground resonance test and finally flight test; mixed up with this there was also a dropped model or two to try and get high Mach conditions. The calculations owed much to help received from the Flutter Section of the SM Department of the RAE and the use of the RAE analogue flutter computer. The wind tunnel tests were similar to those carried out by the Boeing Aircraft Company, since we had seen their model building technique on a visit to Seattle in 1949. The Boeing models consisted of a light-alloy skeleton to provide the elastic properties, the aerodynamic shape being formed by numerous balsa wood boxes with the gaps between them being sealed by very thin rubber membranes while the mass distribution was brought up to that required by the addition of weights within the contour. Handley Page adopted the

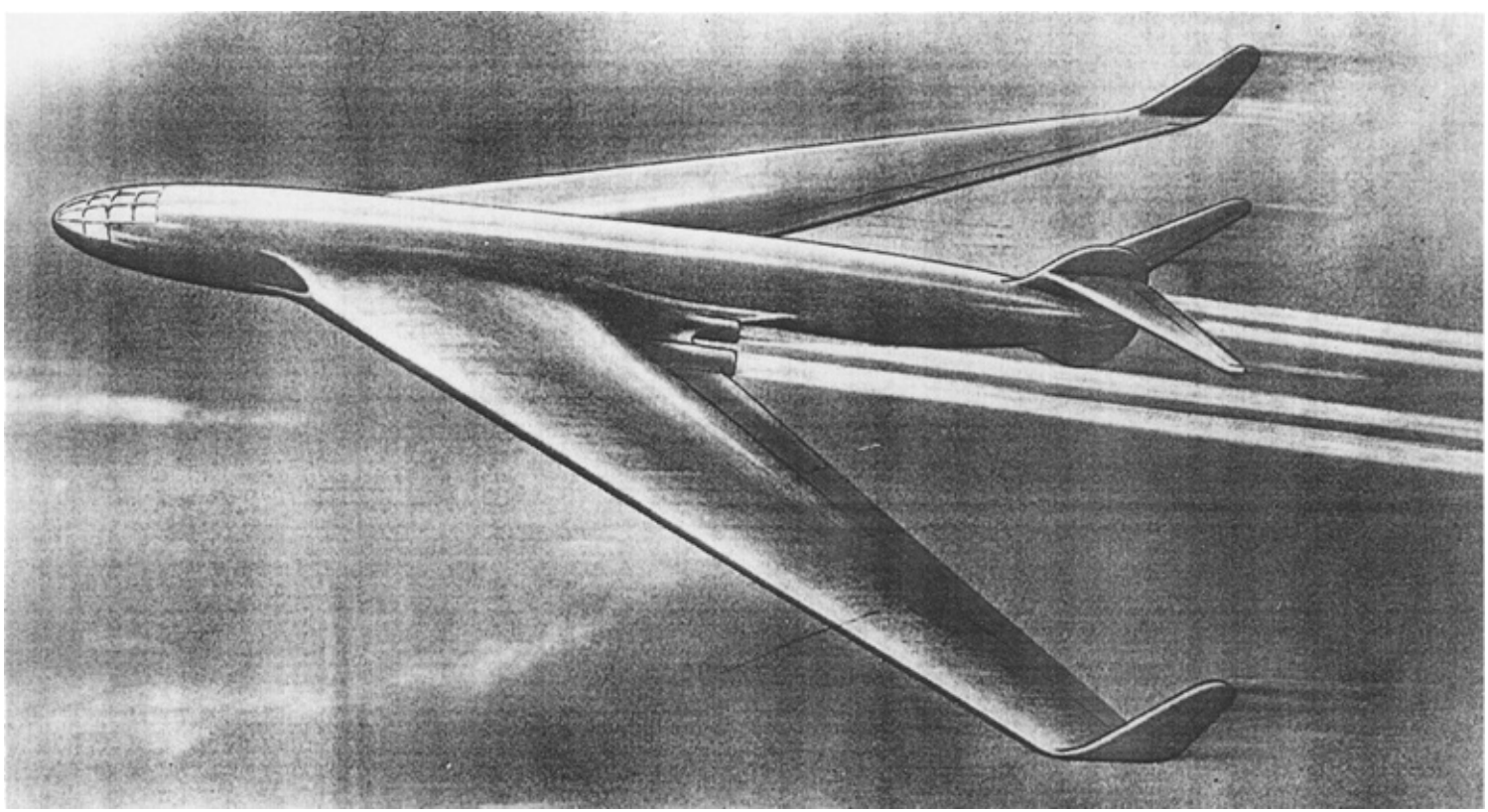
technique for the low speed wind tunnel models. As far as the wing was concerned we were entirely successful. On the tail unit, however, despite all that we did, there was a flutter incident with fatal results to the crew. The accident happened during a low altitude high speed run at Cranfield for the purpose of calibrating the static pressure orifice; tail unit flutter occurred and this component broke away.



Unarmed High Speed Bomber

To begin with this accident was very puzzling because we had assessed (or checked) the flutter speed by three independent means and each time the result showed that the flight programme could be safely undertaken. These three checks were:

- 1 An assessment of the flutter speed based on low-speed wind tunnel tests.
- 2 The calculation of the flutter speed using ground resonance tests results.
- 3 We did rudder jerks up to speeds slightly higher than that attained when flutter occurred.



Unarmed High Speed Bomber in Flight, Model 1.

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