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From the Left Hand Seat



Those of us who were at Shoreham Airshow, shortly after 1pm on Saturday August 22 will forever remember the sight, sound and feeling as Hawker Hunter T.7 WV372/G-BXFI crashed onto the A27 road before us.

Eleven people died that day and countless others had their lives changed forever.

The tragic event was immediately seized upon by the world's mass media, many of whom took the opportunity to speculate about the incident itself and the airshow industry in general.

Some of the reporting was, frankly, obscene and some of the 'experts' wheeled out by the newspapers, radio stations and TV networks shared distinctly questionable views and opinions.

Here at *Jets*, along with our colleagues at our sister magazines, we fielded countless calls asking us to be 'talking heads' but felt unwilling and unable to do so. Until the AAIB issues its full investigation, nobody can be sure what happened that fateful day and speculation is both pointless and unhelpful.

As we stood silently on the airfield in the aftermath of the accident, it was evident that the accident would have a far reaching impact on airshows and, as we report on page 68 of this issue, the CAA has now announced a review of air display rules and regulations. Pending the findings of the accident report, all civilian-operated Hunters are currently grounded and classic jets are restricted to non-aerobatic displays.

Dark day

August 22, 2015 will go down as a dark day in airshow history, and our sympathy goes out to all those affected. However, one should not lose

sight of the British airshow industry's otherwise excellent safety record.

This is a testament to the regulations that are already in place and it is also worth pointing out that nobody within the airshow boundary was harmed at Shoreham. The CAA will now investigate how the safety of passers-by and those who were watching the show from outside the venue can be further improved.

Farewell XH558

As these words were written in early October, we were preparing to say our final farewells to Avro Vulcan XH558, which has been a prominent part of the air display world since it returned to the skies late in 2007.

Over the subsequent eight display seasons, the public have consistently dug deep into their pockets to keep the last flyable V bomber in the skies but the time has come for the Vulcan to finally retire. However, she will be kept 'live' and available for the public to admire in a special educational facility at the former RAF Finningley – now Doncaster Sheffield Airport.

'Bumper' issue

This 'bumper' 100-page issue of *Jets* is dedicated to the Vulcan, as well as its Victor and Valiant cousins, as we pay special tribute to the aircraft and people that played their part in the V-Force – the UK's strategic nuclear strike force during the 1950s and 1960s.

The team here at *Jets* has worked hard to produce and collate an eclectic mix of articles covering all three V bombers. However, even with the additional pages we've struggled to fit in everything we would've liked – so expect to

see more V-Force material in future issues!

This edition of the magazine also includes the first of our new 'Heroes of Aviation' series, in which we will look at some of the most influential characters within the jet world. These might be pilots, engineers or preservationists – but our first 'hero' is one of the greatest aircraft designers of all time: Clarence 'Kelly' Johnson.

There are plenty more new features to come and regular readers will also notice some subtle 'tweaks' (introduced by our new designer Becky) in this issue as we continue to evolve the magazine.

I hope you enjoy the 'bumper' package we have to offer.



Steve
Stephen Bridgewater
Editor



PS – my editorial photograph this month pays tribute to my very own 'hero of aviation' – my father, Roy, who reached a milestone birthday in recent weeks and came to spend a day "working" at an airshow with his son to celebrate. Congratulations dad – thank you for everything!

JETS PHOTO OF THE MONTH

This month's Photo of the Month comes from RAF Corporal Steve Buckley and, in keeping with our XH558 and V-Force theme, shows the last flyable Avro Vulcan in formation with the RAF Red Arrows. The combination was en route to the Southport Air Show on Saturday September 19, 2015 and, at time of going to press, was thought to be the last time the team will formate with the Vulcan.

The striking formation flew over water, along the coast of the north-west town, having joined up over the sea about 10 miles from Prestatyn and was the highlight of the airshow.

Speaking after the flight, Sqn Ldr David Montenegro, Red 1 and Team Leader of the Royal Air Force Aerobatic Team, said: "Hopefully the Vulcan's shape, grace and iconic design will have been admired and enjoyed by people of all ages once again as they watched this final flypast with the Red Arrows."



Cpl Steve Buckley/Mod/Crown Copyright

CONTENTS

INSIDE THIS ISSUE OF *JETS*:

Regulars...

6 Jet Noise

News from the Jet World

14 Museum Spotlight

Dr Nia Jones visits NASA's Kennedy Space Center

66 Testing Times

70 From the Cockpit YS-11 freighter

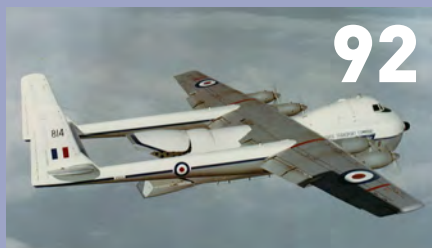
David G Powers recalls his days flying the Japanese-built YS-11 freighter

81 Showtime

The latest airshow reviews

86 Incoming!

Letters to the Editor



92 Classics Compared

Sebastian Morgan compares and contrasts two turboprop powered RAF transports – the Armstrong Whitworth Argosy and the Airbus A400M Atlas

Features...

10 Winkle's Historic Landing

Steve Bridgewater looks at Eric 'Winkle' Brown's historic carrier landing in a Sea Vampire

16 Concordski

Forty years on from its introduction to service Kimberley Hawkins looks at the Tupolev Tu-144

22 Starbuster

Jamie Ewan looks at the troublesome history of the Bell X-2

68 The Future of British Airshows

Details of the CAA's review of air displays in the wake of the recent Shoreham Airshow accident

82 Europlane

Richard Payne explains why the British-designed Europlane jetliner never made it into production

88 Jet Mentor

Steve Bridgewater investigates why the jet-powered derivative of the T-34 Mentor failed to find favour



76 Heroes of Aviation

In the first of a new series featuring the heroes of aviation we focus on the remarkable career of Kelly Johnson



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Front Cover: Toni Hunter via Vulcan to the Sky Trust

V-FORCE SPECIAL

To mark the retirement of Vulcan XH558 the team provide a selection of articles in tribute to the V-Force , including:

26 The Famous Three

Kimberley Hawkins details the development of the Vulcan, Victor and Valiant

34 A Day in the Life of a V Bomber Pilot

Valiant pilot Philip Goodall recalls taking part in a Cold War exercise

38 The Ultimate Deterrent

Dr Dave Sloggett takes a specific look at the nuclear deterrent role played by the V-Force during the Cold War

44 XH558 - A Vulcan Reborn

Richard Freail looks at the history, restoration and future plans for Vulcan XH588

52 V Bomber Survivors

56 Operation Grapple

Pete London takes a close look at the Valiants used to test Britain's early hydrogen bombs

60 Countering the V-Force

Nikolay Yakubovich discusses the USSR's radical Myasishchev M-50 Bouncer strategic bomber

WIN!
V-Force books
& Original
V-Force artwork
See Page 86

Gavin Conroy

Ray Deacon



26



56

Jet Noise

Midland Mystere makeover

The Midland Air Museum at Baginton, Coventry, has completed the renovation of Dassault Mystere IVA '70' in recent weeks. Restoration and repainting of the ex-French Air Force fighter began last year and the white undercoat paint was left to harden over the winter prior to the top coat being applied this spring/summer.

The museum's ex-Saudi Air Force English Electric Lightning T.55 (55-713) has also been completely repainted in recent months and Canberra PR.3 WF922 has been jet-washed in readiness for renovation.

The MAM Mystere has shed its previous Patrouille de France markings in favour of squadron colours and was about to receive the last few stencils and decals when the photo was taken in September



Bruce's Jumbo

Rock star (and airline pilot) Bruce Dickinson is set to captain a specially painted Boeing 747-400 when his band, Iron Maiden, tours the globe to play 35 countries next year. The 'Book of Souls' tour supports the group's first studio album in five years and Dickinson is currently in training to fly the 'Jumbo', which is three times the weight of the Boeing 757 used on previous tours in 2008/9/11. Dubbed 'Ed Force One' (after the band's mascot, Eddie), the 747 will be leased from Air Atlanta Icelandic and will take the band, crew and over 12 tonnes of equipment more than 55,000 miles around the planet



Air-to-air! Lightning II vs A-4 Skyhawk



Florida-based Draken International recently supported operational testing of the RAF's new Lockheed F-35 Lightning II at Edwards AFB by flying its Douglas A-4K fighter jets as simulated adversaries. The large training exercise was initiated by the 323rd Test and Evaluation Squadron and supported by the Joint Strike Fighter Operational Test Team. This was the first time any commercial air services company had provided adversary support for the F-35. Draken flew up to five of their A-4K aggressor aircraft at a time as adversaries in support of F-35 operational testing against both Royal Netherlands Air Force and RAF F-35A and F-35B aircraft, as well as Dutch F-16 Fighting Falcons

BA bids fond farewell to Boeing 737

On September 30, British Airways' last Boeing 737 completed its final sortie – bringing to an end a 35-year association that began in February 1980.

BA operated the 737-200, -300, -400, -500 series and also briefly leased the type from Transavia Airlines in November 1977.

Boeing 737-400 G-DOCX performed the last BA 737 flight when it operated the Gatwick-Turin route as BA2578 and returned as BA2579. The final flight was flown by an all-female pilot team consisting of Captain Christine Scott and First Officer Gillian Tunley.

It was also Captain Scott's last flight, as she retired after the jet landed. "I've been flying the 737 for 19 years, and have loved every moment," she said. "It's a terrific aircraft to fly and has proved incredibly safe, comfortable and reliable for our customers over the past four decades. I can't think of a better way to end my BA career."

On the same day that BA said goodbye to the 737, it also welcomed its first Boeing 787-9, symbolising its continuous cycle of investment in aircraft.



JET ART TORNADO GR.1 RESTORED

The engineers at Jet Art Aviation in Selby, Yorks have completed the year-long rebuild and restoration of Panavia Tornado GR.1 ZA355.

The early specification IDS Tornado is for sale and presents an unusual opportunity for a museum or private owner to acquire a rare, early Tornado. This aircraft first flew in 1980 and was issued to the Tornado Tri-National Training Establishment (TTTE) with tail code B-55, before being allocated to 15 Sqn at RAF Lossiemouth. ZA355 was one of the last GR.1s in operational service and is finished in the all-over grey scheme in which she retired in 2001.

The cockpit is very complete and is fitted with two MB Mk.10A ejection seats, a Head Up Display, stick, throttle etc below the fully operational hydraulic canopy.



ZA355 has been restored but retains its original XV squadron markings on the fin

The Latest News from the World of Jets

Classic jets up for grabs en masse

The recently announced retirement of Air Atlantique co-founder Mike Collett has resulted in a number of classic jets being placed on the market.

Europe's largest collection of post-war classic aircraft – the Classic Air Force – includes two Gloster Meteors, de Havilland Vampires and Venoms as well as Jet Provosts and English Electric Canberra B.2 WK163 (the latter currently stored pending restoration).

Now 72, Mike Collett co-founded the Air Atlantique group in 1977 as a freight and pollution control company and at one time it owned the world's largest fleet of DC-3 Dakota freighters. "The absolute essential is that [the aircraft] keep flying," says Mike. "These are living pieces of history, capable of teaching piloting and engineering skills that could otherwise be lost. Our commitment

has always been to keep these aircraft alive and operational rather than let them become dead museum pieces.

"All other considerations being second to that, I'm open to suggestions. If a committed, well-funded organisation puts a convincing proposition to me then it may well be possible for the whole collection to pass into new ownership. In many ways that's my favourite scenario.

"I'd prefer for them to remain a collection, of course, but if an offer came in for an individual airframe, and I was satisfied that the buyer could maintain it in airworthy condition, then of course I'd give it serious consideration, but I'm more interested in each aeroplane's future as living, flying history than I am in a tempting financial offer."

Other aircraft involved in the sell-off



Jamie Ewan

Gloster Meteor T.7 WA591/G-BWMF is among the jets up for sale at the Classic Air Force. The aircraft is currently the oldest flyable jet anywhere in the world and is seen here at the recent Cosby airshow near Leicester in the hands of Jon Corley

include Scottish Aviation Twin Pioneer G-APRS as well as a Percival Proctor and Prentice and the very rare Avro Anson.



Textron's Cessna Latitude had its UK premiere at the event

Best ever BGAD at Biggin Hill

On September 15, London Biggin Hill airport (LBH) played host to an extremely successful Business and General Aviation Day (BGAD), attended by over 700 visitors and 60 exhibitors. A broad spectrum of aircraft were on static display, including the Textron Cessna Latitude making its UK show debut and a range of King Airs to celebrate the type's 50th anniversary.

Andy Patsalides, Marketing Manager of London Biggin Hill airport commented, "We were delighted to welcome so many friends and colleagues to BGAD for the first time here at Biggin Hill. The event was ... a real showcase for the airport [and] we were especially delighted that by moving the show to London ... it resulted in a significant increase in visitor and exhibitor numbers alike. We were proud to be able to round the day off with a tribute to 'The Few', who flew from Biggin Hill during the Battle of Britain, with a special flying display from a [Biggin Hill-] based Hurricane, completing an outstanding occasion for us."

Lightning II racks up yet more firsts

As the Lockheed Martin F-35 Lightning II rapidly approaches squadron service around the globe, the aircraft continues to clock up 'firsts'.

On July 29 the aircraft successfully refuelled from an overseas tanker for the first time when an Aeronautica Militare (Italian Air Force) KC-767A successfully completed its first USAF F-35A boom receiver certification flight over California's High Desert region.

Italy's KC-767A is the first international tanker to undergo refuelling trials with the F-35 and during the flight the crew completed 25 boom contacts and successfully offloaded 16,000lbs of fuel.

August 14 saw the F-35A fire its 25mm gun at full capacity for the first time. The aircraft fired 181 rounds from its four-barrelled GAU-22/A Gatling gun during a ground test at Edwards AFB. The gun is embedded in the F-35A's left wing and will provide pilots with the ability to strafe air-to-ground or air-to-air targets. In integrating a weapon into the stealthy F-35 aircraft, the gun must be kept hidden behind closed doors, reducing its radar cross section, until the trigger is engaged.

An F-35 Lightning II takes on fuel from an Italian KC-767A on July 29



Lockheed Martin

Waddington Airshow scrapped

The RAF has confirmed the Waddington International Airshow – which did not take place in 2015 due to runway re-surfacing work – will now be scrapped completely due to "significant security concerns and operational risks".

The RAF has conducted a review of its airshow commitments and says that an extensive survey of alternative sites in the East of England indicates it might be possible to move the event to RAF Scampton, although this will not occur until 2017 at the earliest.

Jet Noise



USAF KC-46A TANKER TAKES TO THE SKIES

On September 25 the first Boeing KC-46A Pegasus tanker took off on its maiden flight, from Paine Field, Everett, Washington. It landed later at Boeing Field, Seattle where it will continue the flight test programme. The KC-46A is a multi-role tanker Boeing is building for the USAF that can refuel all allied and coalition military aircraft compatible with international aerial refuelling procedures. It will also be able to carry passengers, cargo and medical patients. The first aircraft to be produced have been flying in cargo configuration since December 2014 but this new variant is the first to fly in tanking configuration



Boeing

SECOND AIRSEEKER ARRIVES FOR DUTY

The RAF's second Boeing RC-135W Rivet Joint – dubbed Airseeker by the MoD – has arrived in the UK, seven months ahead of schedule. The specialist surveillance aircraft was handed over at RAF Mildenhall in August and benefits from more than 60 improvements incorporated since the first aircraft became operational in July 2014. The modifications range from upgrades to the mission systems to improvements to the engines to increase fuel efficiency and durability. The aircraft will soon join the first Airseeker in operations supporting operations against ISIL in Iraq and Syria.



Cpl Chantelle Cooke/Crown Copyright



Jason Vosburgh

Students save Stateside Vampire

Students at the Fairmont State University in West Virginia have rescued former Royal Australian Air Force (RAAF) de Havilland Vampire T.35 N35DS (ex A79-633) from North Central West Virginia Airport in Bridgeport. The project, under the leadership of Assistant Professor of Aviation Technology Jason Vosburgh, will see the jet – which still has its Goblin engine and full instrumentation – preserved and restored as a training aid. Elsewhere, the 2015 Jet Race at the Reno Air Races was won by Pete Zaccagnino flying another ex-RAAF Vampire T.35 (N4816K/A79-613 painted as 'WD186') at a speed of 502.370mph!

Bronco's return

The Bronco Demo Team's North American Rockwell OV-10 Bronco G-BZGL performed its first post-restoration engine runs at Duxford on September 30. It arrived at the airfield 15 years ago and previously served the German Luftwaffe as 99+26

Peter Green



Cirrus Vision approaches certification

On August 25, the FAA issued Type Inspection Authorisation (TIA) for the Cirrus Vision SF50 jet. This initiates formal FAA flight evaluation of the aircraft's design, airworthiness, performance and handling properties and allows Cirrus to move forward with FAA conformity inspections and certification flight tests with an FAA pilot on board the aircraft. For the 2015 season Cirrus has been sponsoring American race pilot Mike Goulian in the Red Bull Air Race series. At the UK round, which took place at Ascot racecourse on August 15-16 and was won in stupendous style by British Airways 777 captain Paul Bonhomme, visitors were also treated to up close access to this mock-up of the Vision jet



Dr Nia Jones

Tonka tails five-ship takes to the skies

RAF Marham recently launched a historic formation consisting of four of its Panavia Tornado GR.4 aircraft, alongside a fifth aircraft from RAF Lossiemouth. Four of the jets carried special centenary painted tail fins commemorating the 100th anniversary of their respective squadrons,

RAF SAC Rob Travis/Crown Copyright



while the fifth jet's tail celebrated 40 years of the Tornado. The centenary jets were aeroplanes from IX(B) Sqn (whose famous green bat is depicted on the tail), 12(B) Sqn, (with the unit's fox on the fin), 31 Sqn (wearing the Gold Star of India in recognition of the unit being the first operational military unit in Indian skies) and XV Sqn. The formation was led by Group Captain Rich Davies, Station Commander of RAF Marham, flying the 40th anniversary jet.

The Latest News from the World of Jets

Iran to receive Chinese fighters?

Chinese media has reported that Iran is close to a deal to acquire a fleet of Chengdu J-10 jet fighters in order to upgrade its air force. While UN arms sanctions against Iran have yet to be lifted following a recent deal to curb the country's nuclear programme, Beijing is said to be nearing an agreement to either sell or lease the fighters to Tehran



Air China's 50th Airbus A330 delivered



Air China's 50th Airbus A330 completed its maiden flight on September 18 and features a special livery that includes the '50th A330 for China' designation. The jet, which is powered by Rolls-Royce Trent 700 engines, will also be China's first A330-300 to offer the increased 242-tonne maximum take-off weight capability

Finnair's first A350XWB

The first Airbus A350XWB destined for Finnair arrived on September 17 after being flown from Toulouse, France, 17 weeks ahead of its scheduled delivery. Finnair will be the first airline in Europe to operate the A350 XWB and the third operator in the world. The airline has acquired a total of 19 A350 XWBs and will operate its fleet on premium long haul routes, beginning with services between Helsinki and Shanghai



FIRST 747-8I FOR KOREAN AIR

Korean Air became the world's first carrier to operate both variants of the 747-8 when it took delivery of its first 787-8 Intercontinental on August 25. The new fuel-efficient jet is the first of ten 747-8 passenger aircraft the carrier has on order and will join the seven 747-8F freighters already in service. Korea's flag carrier currently operates a fleet of 87 Boeing passenger aircraft that includes 737, 747 and 777s. The airline also operates an all-Boeing cargo fleet of 28 747-400, 747-8 and 777 freighters



Next Generation Aero L-39 flies

On September 14, test pilots Miroslav Schützner and Vladimír Kvarda, successfully completed the first flight of the Aero Vodochody L-39NG. This 'Next Generation' trainer features the new Williams International FJ44-4M engine and avionics built around Genesys Aerosystems' multi-functional displays and head-up displays (HUD) by SPEEL Praha. The aircraft will serve to validate the installation of the new engine and avionics in the L-39NG project. Other noticeable improvements include composite wingtips in place of the original tanks.



Aero Vodochody has produced over 3,000 L-39 Albatros aircraft to date and the L-39NG is the new generation of this internationally successful trainer

Jersey Swedes steal show

The Jersey International Air Display always manages to provide an interesting display and, when the weather is great, the venue is one of the best in the world. This year conditions were exceptional and the show featured classic jets in the shape of the Sea Vixen, Norwegian MiG-15UTI and this incredible four-ship from the Swedish Air Force Historic Flight. The Saab J-29 Tunnan, SK60, Draken and Viggen also performed individual displays



Argentine Mirage force retired

A flypast to mark the 103rd anniversary of the Argentine Air Force on August 10 provided what may be the final opportunity to see the air force's last remaining Dassault Mirage III fighters in the air. The jets, which saw combat during the 1982 Falkland Conflict, are set to be decommissioned in November after four decades of service. The 40 aircraft have accumulated 130,000 flying hours and despite having their lifespan extended, repeated problems with the obsolete avionics mean the jets can now only be operated in daylight. This leaves the indigenous FMA IA-63 Pampa as the most potent combat aircraft in Argentine service

WINKLE'S HISTORIC LANDING



Seventy years ago, on December 3, 1945 Captain Eric 'Winkle' Brown became the first pilot to land on and take-off from an aircraft carrier in a jet-powered aircraft. **Steve Bridgewater** looks back at the role the Sea Vampire played in naval trials

Early in the morning of December 3 1945, Royal Navy test pilot Captain Eric 'Winkle' Brown strapped into his de Havilland Sea Vampire F.10 at RNAS Ford, West Sussex.

The weather was marginal, but he proceeded with the checks and readied the aircraft for flight. The jet (LZ551) had begun life as the third prototype Vampire but had now been modified with 40% more flap, longer oleos and a

rudimentary arrestor hook below the jet pipe between the twin booms.

As such, LZ551 was considered to be a very valuable aeroplane and its registration now had a 'G' suffix to denote that it must be guarded at all times when on the ground. It had flown for the first time in Sea Vampire configuration in January 1945 but had previously only flown from land bases. Brown's mission for today was to undertake trial approaches aboard

HMS *Ocean*, which was steaming up the English Channel off Portland Bill.

Steady hand

Brown had been chosen for these trials not just because of his many hours of test flying but because of his specific skillset. On April 4 of the same year he had become the first person to land a tricycle undercarried aeroplane aboard an aircraft carrier – when he flew Bell Airacobra AH574 onto the



The moment history was made. Eric 'Winkle' Brown lands Sea Vampire LZ551/G aboard HMS Ocean on December 3, 1945 for the first time. The nosewheel is still in the air and the aircraft's arrestor hook has made contact with the cables stretched across the ship's deck

"The Captain was announcing the cancellation of the exercise when 'Winkle' Brown burst like a banshee on to the scene and screamed round the ship"

deck of the trials carrier HMS Pretoria Castle.

That had paved the way for the jet trials and although the weather was far from ideal, 'Winkle' opted to get airborne early.

Writing in his excellent autobiography *Wings on my Sleeve* 'Winkle' recalls: "I took off early on the 3rd, partly because I had a certain amount of fuel to burn off before I could get down to the right weight for landing on, partly because the plane was still a prototype."

However, 'Winkle's' early departure meant that he missed a vital signal from HMS Ocean's captain – Caspar John – informing him that the weather was now considered too bad for a landing.

In fact the Captain was actually announcing the cancellation of the exercise over the ship's loudspeakers when 'Winkle' "burst like a banshee on to the scene and screamed round the ship."

Pressing on

'Winkle' recalls that Caspar John was "a very experienced carrier trials captain. He knew me; he knew the situation; he knew the ship. He very quickly weighed up the situation and ordered 'Land On!'"

As such 'Winkle' set up the Vampire on a long final approach towards the stern of the carrier. Due to the choppy seas, the ship was moving a lot more than expected but the aircraft was established on a very steady descent. "The batsman was giving me such a steady signal that it never even crossed my mind that I might have to go round again. I came straight in and made a gentle landing", 'Winkle' writes in a typically understated manner. History had been made and the nature of carrier warfare would never be the same again.

With the aircraft safely on deck, 'Winkle' shut

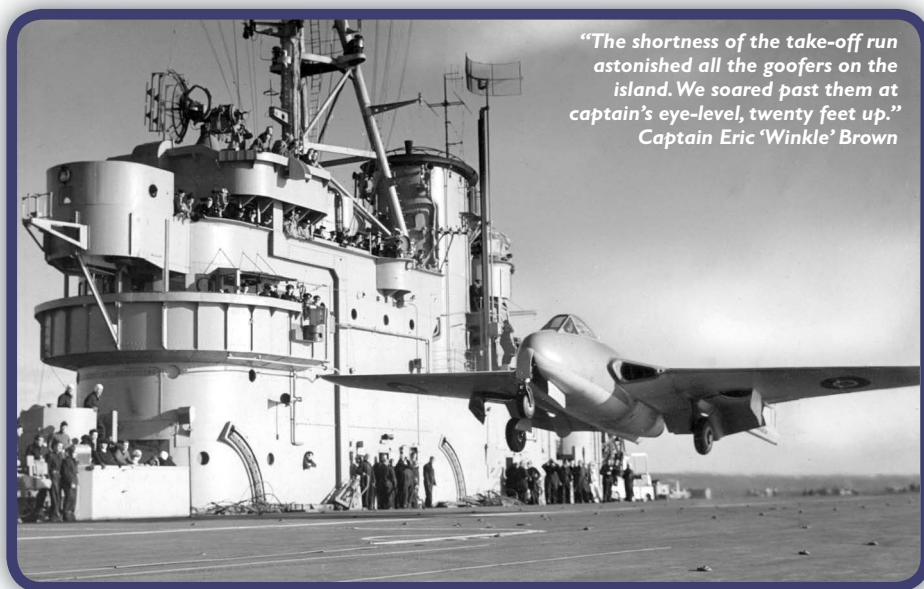
down the engine and deckhands proceeded to refuel the Vampire prior to the trials.

The aircraft was then manhandled back toward the stern of the ship ready for take-off. The Goblin engine started with a shrill whine and on the batsman's signal, 'Winkle' opened the throttle.

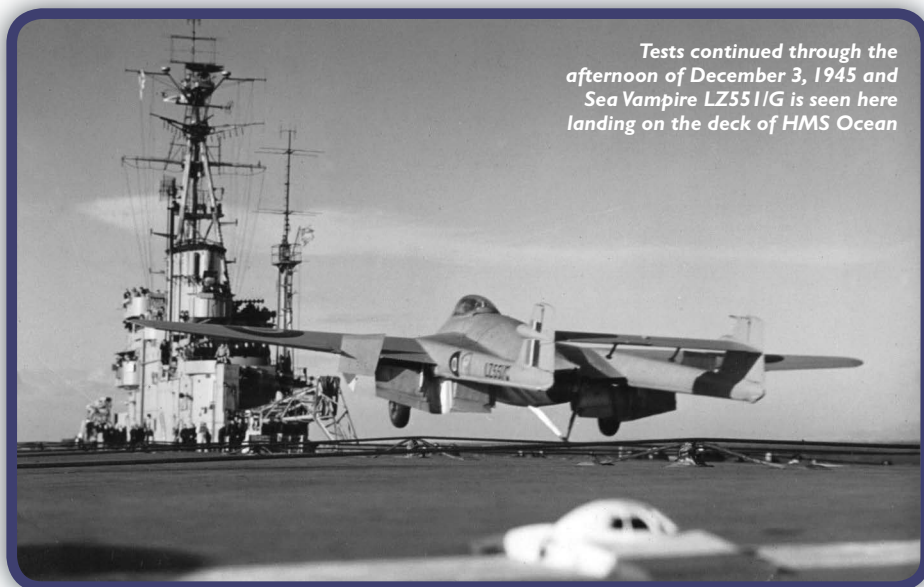
"The shortness of the take-off run astonished all the goofers on the island," he writes in *Wings on my Sleeve*. "We soared past them at captain's eye-level, twenty feet up."

As the day progressed, LZ551/G performed three faultless landings on the deck but on the fourth approach the very large landing flaps struck the arrestor wires and were damaged. The jet was then flown back to RNAS Ford for repairs and modifications. It, and Eric Brown, returned to HMS Ocean three days later with four square feet chopped off the flaps to continue the trials.

The tests aboard HMS Ocean proved



*"The shortness of the take-off run astonished all the goofers on the island. We soared past them at captain's eye-level, twenty feet up."
Captain Eric 'Winkle' Brown*



Tests continued through the afternoon of December 3, 1945 and Sea Vampire LZ551/G is seen here landing on the deck of HMS Ocean

that operating jets from a carrier deck was eminently possible and the Royal Navy promptly ordered 20 Sea Vampire F.20s from de Havilland – these were based on the RAF's FB.5 variant and would become the first jets to enter Fleet Air Arm service.

Rubber decks

Around the same time the Royal Navy also investigated the 'flexible' or 'rubber deck' concept as a method of recovering jet aircraft at sea.

The low power available to early jet aircraft led to the thinking that if the aircraft's undercarriage could be eliminated, it would save valuable weight – and thus increase performance. The space could also be utilised by extra fuel tanks to increase range.

In order to facilitate this, trials were conducted aboard HMS Warrior, the deck of which had been fitted with five

layers of vulcanised rubber with lengths of war-surplus 7.25in rubber fire hose sandwiched between them! The 20 miles of hose would be slightly inflated to help cushion the aircraft as it landed.

Although it now sounds like a ludicrous scheme, the project was considered to have enough merit for de Havilland to convert Vampire F.1s TG286, TG328 and TG426 for trials.

The aircraft were ready by late 1947 and had strengthened nacelles as well as an interconnecting system between the flaps and throttle to allow high power, low speed approaches to be made. They were dubbed Sea Vampire F.21s.

It was Eric 'Winkle' Brown who found himself in the test-pilot role when the first aircraft arrived at Farnborough for evaluation. Flying TG426, 'Winkle' performed a number of nose high, low and slow passes over a rubberised mat on the runway prior

to making the first landing on December 29.

The aircraft approached so low that the arrestor hook dragged along the concrete in front of the mat, and when it eventually caught on the cables it pitched the jet forward with such ferocity that the twin booms sheered off! Luckily 'Winkle' was unhurt.

Lessons learned included the fitting of an airspeed indicator in front of the pilot and the use of a deck hand with a radio to talk the pilot down safely – as he could see very little over the nose due to the high approach angle. A system was also devised that retracted the flaps as soon as the hook struck the arrestor wire – thus reducing the risk of damage to the flaps.

Further trials began in March 1948 using TG328. These went well and VG701 joined the programme three months later.



Sea Vampire F.20 TG701 catching the arrestor cable during rubber deck trials aboard HMS Warrior in February 1949



For the rubber deck trials, a system was devised that retracted the flaps as soon as the hook struck the arrestor wire – thus reducing the risk of damage to the flaps

“The tests proved that operating jets from a carrier deck was eminently possible”

Deck trials aboard HMS *Warrior* finally began in November 1948 and more than 200 successful landings were performed over the next six months.

However, the advent of more powerful jet engines negated the need for undercarriage-less fighters and the programme was eventually cancelled.

Although the Sea Vampire didn't see any major service beyond the trials work, the F.20 variant was used extensively by 703 NAS and 771 NAS as well as Royal Navy Volunteer Reserve units such as 1832 NAS at RNAS Culham, which became the first RNVR unit to embark on a carrier when it carried out training aboard HMS *Implacable* in 1950.

Eric 'Winkle' Brown's brave and historic trials work with the aircraft paved the way for generations of naval aviators. ●



Eric Brown approaches HMS Ocean on December 3, 1945 with the batsman giving him last minute corrections to his heading

NASA'S KENNEDY SPACE CENTER



NASA's Kennedy Space Center and Florida's neighbouring Cape Canaveral have played host to some of the most amazing space missions of our time. *Dr Nia Jones* reminisces over the recently 'suspended' tour of the space coast

A visit to NASA's Kennedy Space Center (KSC) is a must for any visitor to Florida, especially those with children and those with a love of technology, space and adventure.

The razzmatazz, film shows and (frankly, quite incredible) interactive displays are a real treat and up until recently it was possible to get behind the scenes and visit some of the site's incredible history.

However, in recent weeks the KSC

'Then & Now' tour has been cancelled following what NASA describes as "increased threat level at military bases."

The two and a half-hour KSC Bus Tour which took visitors around KSC and Cape Canaveral – the original space centre – offered some truly memorable experiences.

The first rocket launched from Cape Canaveral was a modified German V-2, which was fired from Launch Complex 3 on July 24, 1950 and just nine years

later, the first successful test firing of a Titan intercontinental ballistic missile was accomplished. NASA's Project Mercury and Gemini space flights were launched from Cape Canaveral, as were early Apollo flights using the Saturn I and Saturn IB rockets.

The air-conditioned bus trip, which was narrated by one of NASA's excellent tour guides, took in some of the most historically significant buildings and sites around the Cape as well as the 'new' KSC – which took over as the main launch site in the late 1960s.

History's footsteps

As you made your way around the site you quickly became aware that you were following in the footsteps of history.

The tour would begin at KSC before moving to the Space & Missile Museum at Launch Complex 26 (LC-26) at the Cape Canaveral Air Force Station, which preserves hardware



ABOVE: The only aeroplane on display at KSC is ex-NASA Northrop T-38 Talon N969NA, but there's plenty more to see for anybody interested in flight and technology

LEFT: NASA's Vehicle Assembly Building is so large that it has its own weather, including rain clouds that form inside on very humid days! The 209ft tall American flag on the building is the largest in the world. Each star on the flag is 6ft across and each stripe is 9ft wide

and infrastructure relating to the USA's earliest ventures into space flight and rocketry. The museum itself is located within the original blockhouse, with 2ft thick walls, situated a mere 400 feet from twin launch pads.

LC-26 was the site of the first successful launch of an American satellite (Explorer I in 1958) and 35 other launches between 1950 and 1963 – including the launch of three monkeys (Gordo, Able and Miss Baker) to pave the way for manned spaceflight. Outside, you could stroll through the 'Rocket Garden' and wander around the launch pad.

Next up was a short drive to LC-5/6, where America's manned spaceflight programme took its first steps on May 5, 1961 when Alan Shepard became the first American to fly in space. His small Freedom 7 capsule reached approximately 116 miles high during the 15-minute flight and it was this flight which garnered the commitment from President Kennedy to "... put a man on the surface of the Moon and return him safely to the Earth," before the end of the decade.

The tour visited the pad as well as the blockhouse facility, which is complete with much of the original equipment. It really was like stepping through a window into a bygone era.

Other highlights of the tour included LC-14, where the historic launch of John Glen into orbit (not just into space) aboard Friendship 7 took place on February 20, 1962 and the Mercury Memorial. The latter is a metallic structure in the shape of the original Mercury programme logo. Visits were also paid to LC-19 (from where the 12 Gemini flights launched), the original Cape Canaveral lighthouse and LC-34 – the home of the early Apollo flights.

It was LC-34 that played host to one of



LC-14 plays host to the Mercury Memorial, a metallic structure in the shape of the original Mercury programme logo

Included within the general admission price is the Space Shuttle Atlantis exhibition. It tells the story of NASA's 30-year Shuttle programme through film and audio and concludes with a special 'revealing' as Atlantis appears from behind a screen as if she is hanging in space. The effect is quite literally spine tingling! The Shuttle is displayed as only spacewalking astronauts have seen her before – rotated 43.21 degrees with payload doors open and its Canadarm (robotic arm) extended, as if it has just undocked from the International Space Station

All Dr Nia Jones



NASA's worst tragedies when Gus Grissom (a veteran of two flights, one Mercury and one Gemini), Ed White (the first American to walk in Space) and Roger Chaffee perished on January 27, 1967. The crew of the first manned Apollo mission were taking part in a launch rehearsal when the capsule caught fire and over-pressurised. Over 1,300 improvements were made to the Command and Service Module (CSM) after the accident and the moon programme was delayed by more than a year.

Today, LC-34 is abandoned other than a touching memorial to Grissom, White and Chaffee that includes the words "Remember them not for how they died but for those ideals for which they lived."

The bus also made a 'drive-by' of NASA's incredible 525ft-tall Vehicle Assembly Building (VAB) – which at 129,428,000 cubic feet is one of the largest buildings in the world by volume and the largest single-story building in the world – before arriving back at KSC.

Alternative tours

While it is very sad that the 'Then & Now' tour is currently unavailable, visitors to KSC do have alternatives.

The 'Up-Close' tour includes the NASA's KSC headquarters, which has been in place since 1965, as well as the new headquarters building now under construction. You'll also see the newly renamed Neil Armstrong Operations & Checkout Building, where astronaut crews spent the final days before their flights and departed for

the launch pads aboard the Astrovan, as well as the International Space Station Processing Facility, where components of the ISS were built before being ferried into space in the space shuttle's cargo bay.

And you'll visit Launch Pad 39B, one of two pads used for every space shuttle launch from 1981 to 2011. Like the 'Then & Now' tour, the 'Up Close' experience finishes in the Apollo/Saturn V Center where

you'll be able to see and hear what it was like to witness a Saturn V launch from within the original mission control room. This audio/visual show is simply incredible, especially when the seats and windows begin to rattle as the rocket launches. ●

"It really was like stepping through a window into a bygone era"

OPENING HOURS

The Kennedy Space Center is open daily from 9am to 6pm and is also open until 6pm on Saturdays, Sundays and Public Holidays between April 1 and October 31. Admission costs \$50 for adults and \$40 for children and includes access to the Space Shuttle Atlantis exhibition, Shuttle Launch experience, IMAX 3D cinemas and the standard KSC bus tour. Admission also includes a two-day ticket to the nearby Astronaut Hall of Fame (if used within seven days). Additional \$25 fees (\$19 for children) /youths/seniors apply for those wanting to take the 'Up-Close Experience' tour. Costs are also subject to Florida Sales Tax.

CONCORDSKI

“IMITATION IS THE SINCEREST FORM OF FLATTERY”

*Forty years on from its introduction to service
Kimberley Hawkins looks at the chequered history
of the Soviet Union's only supersonic transport*



The Tupolev Tu-144 entered service 40 years ago, on Boxing Day 1975, flying mail between Moscow and Alma-Ata, the largest city in Kazakhstan.

This was in preparation for the Soviet Union's first (and subsequently only) supersonic transport (SST) to commence passenger service on November 1, 1977.

Yet the Tu-144, which was given the reporting name *Charger* by NATO, would conduct only 102 passenger flights before it was withdrawn from scheduled service on June 1 the following year. So what went wrong?

Espionage

With the British and French collaborating on the Concorde programme and the Americans pursuing various SST concepts, it was inevitable that the Soviets would seek to produce a bigger, better and faster rival.

Riding high on the success of Sputnik and other space

achievements, Nikita Khrushchev was not about to let what the Soviet public perceived as a technological lead over the West slip away. He gave his vast spy network their orders and activated a team that included exchange students, executives for the Soviet Aeroflot airline in Paris, and even top KGB agents. Their audacious mission was to steal the blueprints for Concorde!

It wasn't that the USSR lacked first class engineers, in fact the legendary Andrei Tupolev's design bureau was chosen to undertake the work to create the nation's SST. Still, Khrushchev wasn't taking any chances.

The first the West knew of Soviet plans to build an SST came in 1963 when Julian Amery MP (the British Minister for Aviation) and a team of aviation industry experts visited Moscow and were shown a model of what appeared to be a close replica of the then still secret Concorde design. The Anglo-British project was alerted to the possible espionage and conspiracy theorists soon began



Unlike Concorde, which had reverse thrust and powerful anti-skid brakes, the Tu-144 relied on drogue 'chutes to bring it to a halt. Here the aircraft lands at Hannover-Langenhagen airport on April 19, 1972 to appear at the West German Airshow

was only discovered when a Soviet defector blew his cover in 1977.

Early flight

When the news was made public that the Anglo-French Concorde was expected to fly for the first time in early 1969, Khrushchev ordered the Tupolev project, by now christened the Tu-144 and nicknamed 'Concordski' by the sardonic British media, to be accelerated. Khrushchev believed that if the Soviet SST flew first, not only would it steal a march on its rivals, it would also help avoid any allegations of espionage. On December 31, 1968, 80-year-old Tupolev and his team watched with pride as the prototype Tu-144 (CCCP-68001) powered into the skies for the first time – three months before Concorde.

The maiden flight, which took place

“Khrushchev activated a team to steal the blueprints for Concorde”

disseminating stories of a Soviet design team walking around Filton with cameras and tape measures, writing down the dimensions of the first British Concorde.

Whether this is true or not has never been proven, but such an approach was not untypical of the effectiveness of Soviet espionage in the 1960s. However, across the Channel the French authorities began to monitor the movements of Sergei Pavlov. Officially, he was head of the Soviet state-run airline Aeroflot in Paris. Unofficially, he was in charge of the KGB's efforts to steal the plans for Concorde. And the French DST (intelligence agency) suspected as much. If they could prove his guilt they would have all the evidence they would need of the Soviet's espionage.

Surveillance soon proved that Pavlov was receiving Concorde tyre scrapings from an airport employee, whereupon the DST proceeded to feed him a variety of false intelligence to pass back to 'Mother Russia.'

When Pavlov reached the end of his usefulness he was arrested in December 1965 and, to the DST's horror, was found to have actual Concorde landing gear blueprints in his suitcase! Pavlov was deported from France and on his arrival back in the USSR he was promptly promoted to Deputy Minister of Civil Aviation.

However, Pavlov was not the only Soviet spy working on Concorde. Sergei Fabiev went undetected for 15 years and supplied the Soviets with thousands of sensitive documents. He

from Zhukovsky, near Moscow, was not announced in advance to the public in case anything went amiss. The prototype flew a 37-minute sortie and was captained by test pilot EV Elyan along with co-pilot MV Kozlov, test engineer V N Benderov and flight engineer JT Seliverstov. The undercarriage remained down throughout and a MiG-21 flew as a chase plane.

Soon the Soviet propaganda machine began to issue statements claiming the aircraft would be in service by early 1970; the Tu-144 first broke the sound barrier on June 5, 1969, and on July 15 became the first commercial transport to exceed Mach 2.

However, despite the bravado, all was not well behind the scenes. The efforts to be the first into the air had produced an



The Tu-144 continued to fly until 1997 thanks to American investment in a trials programme flown jointly by IBP Aerospace, Tupolev, NASA, Rockwell and Boeing

NASA



Among the invited crowd to see the Tu-144s maiden 37 minute flight at Zhukovsky were 80-year-old Tupolev and his son Alexei. They are seen here with Captain Elyan and his fellow crewmembers: co-pilot Kozlov, leading test engineer Benderov and flight engineer Seliverstov Tupolev Design Bureau

inferior aeroplane with dubious handling qualities, particularly during landing. The Soviets immediately claimed to be working on a second generation SST, but in reality this was a way of remedying the faults on the early Tu-144. As such, the team went back to the drawing board and radically re-engineered the aircraft.

While both Concorde and the Tu-144 prototype had ogival delta wings, the Tu-144's wing lacked Concorde's conical camber. The new version of the aeroplane, which debuted in 1973, replaced this wing with a double delta wing including conical camber. It also

incorporated retractable canards on the side of the forward fuselage to increase lift at low speeds. The latter helped reduce the landing speed to around 180kts, but this was still much faster than its European rival's 160kts.

The British and French took great glee in pointing out that being first in the air is a dubious achievement when contrasted with creating a successful aircraft that flew just three months later!

Tragedy strikes

By 1973 the USSR felt its newly redesigned Tu-144 was ready to

demonstrate to the world and June's Paris Air Salon at Le Bourget would see the eagerly awaited showdown between Concorde and the Tu-144 *Charger*. The test pilots put their aeroplanes through their paces and by day three competitive edges were heating up. In front of a capacity crowd, British pilots John Farley and Andy Jones demonstrated Concorde's power and manoeuvrability impeccably and were treated to a well deserved round of applause upon landing.

During his turn in the Tu-144, Soviet pilot Mikhail Kozlov performed a dramatic take-off and a number of tight 360-degree turns, similar to those that Concorde had just completed.

What happened next is open to conjecture but many believe Kozlov took evading action to avoid colliding with a French Mirage jet that was believed to be covertly filming the display from above. Either way, the Tu-144 entered a negative 'G' pushover during which the engines lost thrust. Kozlov lowered the nose to regain speed but at only 4,000ft he had little margin for error. He began a firm pull-up to avoid the crowd and the aerodynamic forces on the aircraft broke it apart. All six aboard the Tu-144 were killed, as were eight French citizens on the ground.

In its most advanced form (Tu-144LL) the Charger shows off its rakish and stylish looks at Zhukovsky in 1997. From some angles the aircraft is arguably even more beautiful than Concorde

NASA



Tu-144 CCCP-77102 taxis out at the Paris Air Salon on June 3, 1973. Minutes later the aircraft would break up mid-display and crash just outside the airport, killing all six aboard the aeroplane and eight people on the ground. The cause of the accident remains controversial with a popular view that the crew manoeuvred hard to avoid a French Mirage jet fighter that was secretly filming the display Adrian M Balch Collection

The black box recorder was 'lost' and many believe the French and Soviets colluded on the accident report to ensure the French spies were not implicated in the deaths of French nationals, and that the Soviet aircraft's airworthiness was not called into question.

In a post-investigation press release it was stated that "Even though the inquiry established that there was no real risk of collision between the two aircraft, the Soviet pilot was likely to have been surprised." In essence, the deceased Kozlov carried the blame.

Another theory claims that the black box was recovered by the Soviets and decoded. If these stories are to be believed, the accident may have been caused by changes made to the auto-stabilisation input controls prior to the display flights; these being intended to allow the Tu-144 to outperform Concorde's airshow routine.

Regardless of the cause of the accident, the damage to the Tu-144's reputation had been done.

Into service

The early aircraft's inefficient Kuznetsov NK-144 engines were also a hindrance. They did not permit cruise at Mach 2 without afterburner and also suffered from heavy fuel consumption, hence a limited range of around 1,600 miles – far less than the Rolls-Royce/Snecma Olympus 593 turbojet-powered Concorde.

The Tu-144S model, of which nine were produced, featured 44,122lb/thrust Kuznetsov NK-144F turbofan engines that offered better fuel efficiency. The four engines each had separate inlet ducts in each nacelle and variable ramps in the inlets, giving a cruising speed of Mach 1.88 and a longer range of 1,910 miles (still less than half the range of the Concorde).

The engines were actually quieter than the Rolls-Royce Olympus units fitted to Concorde but their location on the



For the type's maiden flight, on New Year's Eve 1968, the Tu-144 was flown with the gear down. It is seen here in formation with the MiG-21 chase 'plane that also served as a training aircraft for those destined to fly the SST Tupolev Design Bureau

SURVIVORS

CCCP-77106	Central Air Force Museum of Russia, Monino, Russia
CCCP-77107	Institute of Aviation of the Kazan State Technical University, Russia
CCCP-77108	Samara State Aerospace University, Russia
CCCP-77110	Museum of Civil Aviation, Ulyanovsk, Russia
CCCP-77112	Auto & Technik Museum, Sinsheim, Germany (illustrated)
CCCP-77114	Stored, Zhukovsky, Russia
CCCP-77115	Stored, Zhukovsky, Russia

Adrian M Balch Collection



airframe made the cabin much noisier.

Aeroflot therefore thought very little of the new aeroplane and this, in part, explains why the Tu-144's introduction to service in December 1975 was merely as a mail-plane. This was a very expensive way of delivering the post and the twice-weekly flights were cut back to once a week in June 1976 and cancelled altogether by December of 1977.

When asked to present the Kremlin with its five-year plan for 1975-1980, Aeroflot neglected to even mention the Tu-144 but the party leaders ordered that the nation's first SST enter passenger carrying flight as soon as possible.

The aircraft eventually entered service as a true airliner on November 1, 1977 on the same Moscow to Alma-Ata route – albeit only once a week. However, the rushed nature of the design continually plagued the aircraft and it was beset with mechanical problems from the start.

After the inaugural flight, the two subsequent crossings were cancelled and a third flight rescheduled. Failures

included a decompression of the cabin on December 27, 1977 and engine exhaust duct overheating. Matters became so bad that Aeroflot insisted Alexei Tupolev himself and the Soviet vice-ministers of aviation industry and civil aviation be present before each scheduled departure to review the condition of the Tu-144 and make a joint decision on whether it could be released into flight!

With Soviet decision-makers being acutely aware

of the aircraft's poor reliability and fearful of possible crashes, they purposefully limited flights to the absolute minimum, while ensuring the aircraft flew sufficiently to maintain its claim of a 'regular service'.

However, on May 23, 1978, the first Tu-144D model suffered a mechanical failure and crashed, killing two members of crew. This was enough to give Aeroflot grounds to refuse to fly what it knew was an inefficient aircraft and considered to be a dangerous one. A week later, on June 1, the type completed its 55th and last passenger flight.

The Tu-144D ('D' for Dal'naya or

“The efforts to be the first into the air had produced an inferior aeroplane”



The canard foreplanes created additional lift and control during slow flight and improved handling in the landing configuration NASA

'long range') variant was powered by the Kolesov RD-36-51 turbojet. This gave the aircraft both the ability to cruise at a comparable speed to the Concorde (Mach 2.0) and a much longer range of around 4,000 miles. On the Kremlin's insistence, the new variant was taken on board by Aeroflot on June 23, 1979, but the aircraft only flew freight services (including longer routes from Moscow to Khabarovsk).

The Tu-144 fleet was finally retired in 1983 – by which time it had completed 102 commercial flights (including mail, passenger and cargo sorties) and amassed just 181 hours flying. The fleet has also notched up 226 failures; 80 of them in flight. Over its 55 scheduled passenger flights, Tu-144s transported just 3,194 passengers – an



Although the Tu-144 flew its last paying passengers in 1978 production of the type did not cease until 1984 by which time 16 airframes had been constructed

Tupolev Design Bureau

average of 58 passengers per flight.

Undeterred, Tupolev continued to manufacture the Tu-144 until 1984, even though no airline wanted to fly the type. A total of 17 examples would eventually be built: the prototype (CCCP-68001), a pre-production Tu-144S (CCCP-77101),

nine production Tu-144Ss (CCCP-77102-77110), and five Tu-144Ds (CCCP-77111-77115). The final production aircraft, Tu-144D CCCP-77116, was

not completed and was left derelict for many years on Voronezh East airfield.

A number of Tu-144s were retained in 'airworthy storage' following their rejection by Aeroflot and one such aircraft was reactivated in 1985 to train pilots for the Soviet Buran space shuttle. Another was used between 1986 and 1988 for medical and biological research into high-altitude atmosphere radiological conditions.

However, perhaps the most unexpected reactivation of a 'Concordski' airframe came in 1995 when Tupolev teamed up with IBP Aerospace, NASA, Rockwell and Boeing to return CCCP-77114 to the skies as a test-bed for a High Speed Commercial Research programme.

The aircraft (which had only accumulated 82 hours of flying time in Aeroflot service) was retrofitted with the engines from the Tu-160 Backfire bomber and received US\$350 million of modifications before being designated as the Tu-144LL ('LL' for Letayuschaya

Laboratoriya or 'Flying Laboratory') in readiness for 27 trials flights that were conducted in 1996 and 1997.

Destined to fail

In retrospect, it is evident that the Tu-144 programme suffered from a rush in the design process. This resulted in problems with design and build quality and an end product that was never truly fit for purpose.

The project was driven by an ideological and politically motivated desire to 'be first' rather than 'be best'. Even after the aircraft had beaten Concorde into the skies, the rivalry continued and the need to be the first into service meant that the Tu-144 was released to Aeroflot after fewer than 800 hours of testing – compared to Concorde's 5,000 hours.

Today the Tu-144 exists only in museums and in storage, although a number of organisations have tried to prise examples out of new Russia for, variously, trials work or attempts at world speed records. Reports emerged of Tupolev offering to restore a Tu-144 to flight to transport the Olympic flame for the 2014 Winter Olympic Games in Sochi – but unsurprisingly this came to nothing.

One suspects it will be a very long time before the world sees another supersonic transport. ●

SPECIFICATION TUPOLEV TU-144D CHARGER



Crew	3
Passengers	120-140 (normally 70-80)
Length	215ft 6in (65.5m)
Height	34ft 4in (10.5m)
Wingspan	94ft 5in (28.8m)
Wing area	4,715sq ft (438.0m²)
Empty Weight	187,400lb (85,000kg)
Max Take-Off Weight	397,000lb (180,000kg)
Max Cruise Speed	1,117kts (1,320mph / 2,124km/h / Mach 2.02)
Ferry Range	1,814 miles (2,920km)
Powerplant	Four Kolesov RD-36-51 afterburning turbojets (44,122lb thrust each)
First Flight	December 31, 1968

Artwork: Andy Hay / www.flyingart.co.uk

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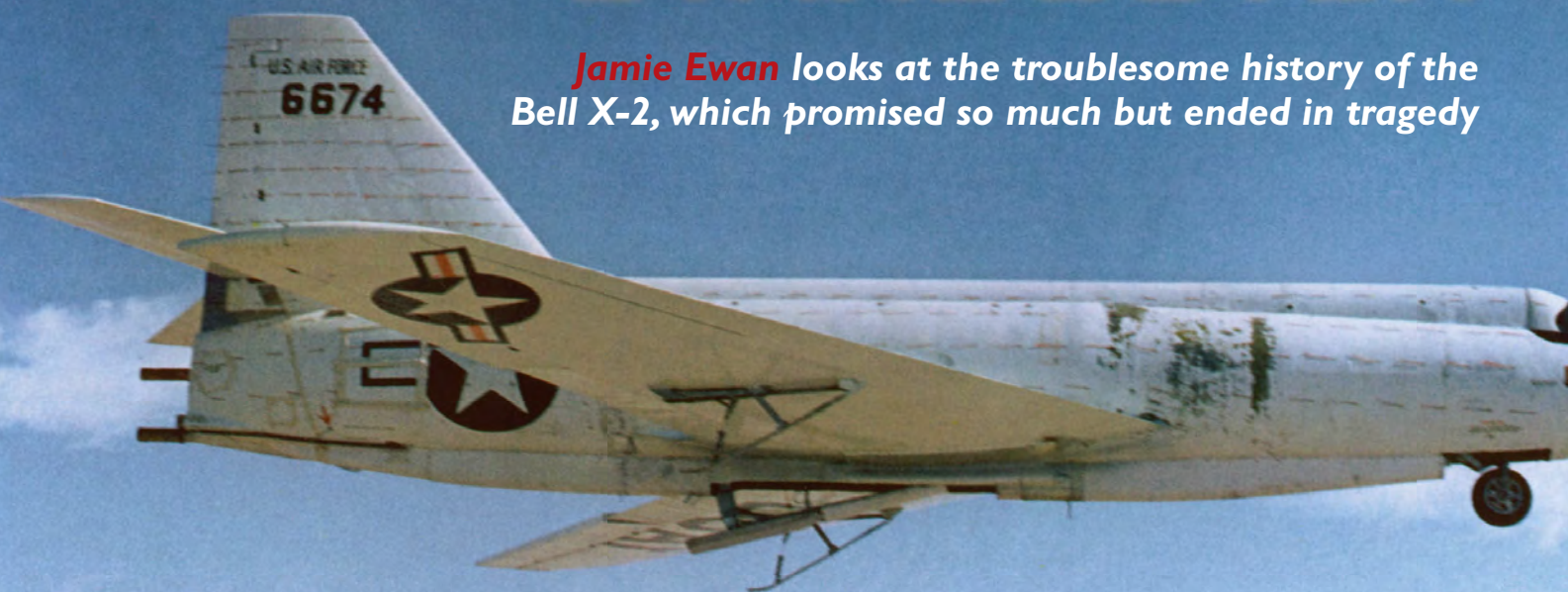
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STARBUSTER

Jamie Ewan looks at the troublesome history of the Bell X-2, which promised so much but ended in tragedy



Three years before Chuck Yeager and the Bell X-1 broke the fabled sound barrier, others were already thinking about what, if anything, lay beyond it.

Many believed the sound barrier to be an impenetrable wall that no man or aeroplane could fly through. However, some, especially those at both the Bell Aircraft Corporation and the United States Army Air Force Engineering Division, felt that the barrier was only there to be broken.

In fact, Bell were so confident that the barrier was breakable that just months after the go-ahead had been given for Project-524 (which resulted in the X-1), the manufacturer proposed a version with a 40-degree swept-wing to determine the effects of high speeds on swept-wing aerodynamics. This was designated the Model 37D.

However, after studying the structure of the X-1 and completing a series of wind tunnel tests, the USAAF turned down the Model 37D, declaring that it would be impossible to mate the existing design with the new wing. Something entirely new would be required.

Thermal thicket

With that in mind Bell, along with the National Advisory Committee for Aeronautics (NACA), returned to the drawing board at their Wheatfield facility in New York and in September 1945 came up with a formal design for their radically advanced Model 52.

On paper, the Model 52 (or X-2 as it would become) was capable of flying at speeds above Mach 3 and heights in excess of 100,000ft – which was incredible for 1945. In fact, the X-2 was way before its time – even for an experimental design.

“The aircraft was essentially a rocket motor with wings, tail and a small cockpit bolted on”

At Mach 3 the X-2 would be the first aircraft to encounter the heat barrier or ‘thermal thicket’, allowing investigation into the structural effects of severe heating caused by aerodynamic friction, as well as stability and control at speeds and altitudes way beyond that of the X-1.

However, the X-2 was beset with development problems from the start. The aircraft was essentially a rocket motor with wings, tail and a small cockpit bolted on. It was just 37ft 10in long, 11ft high and had a wingspan of just over 32ft. The fuselage housed a single liquid-fuelled, throttleable two-chamber Curtiss-Wright XLR25 rocket engine and associated propellant tanks. The engine was fuelled with an ethyl alcohol mix at a ratio of 75/25 with liquid oxygen (LOX) used as an oxidiser. It was capable of giving variable power ranging between 2,500lb/thrust and 15,000lb/thrust.

The fuselage was made of an exotic copper-nickel alloy called K-Monel that provided strength and rigidity at high temperatures as well as being resistant to corrosion from the propellants. Its fabrication, however, called for new technologies and manufacturing processes, which caused yet more delays.

The wings, tail and all-flying horizontal stabiliser were finished in heat-resistant stainless steel with tapers to give it the best possible strength at a reduced weight. With a full fuel load, the X-2’s all up

weight was 24,910lbs while its empty weight sat at 12,375lbs, making it twice as heavy as the X-1.

The proposed flight control system – a version of the Bendix Corporation electrical-powered fly-by-wire flight control system – was replaced by one not too dissimilar to that of a World War Two fighter due to yet more development issues. Pitch and roll was gained through a hydraulically power-assisted irreversible system, while yaw used a conventional cable-pulley-bell-crank linkage system. To allow a larger fuel capacity, the X-2 threw away a conventional undercarriage and instead used a steel belly-skid and a short, un-steerable nose wheel.

The aircraft was fitted with a fully encapsulated emergency egress system that would see the entire nose section come away and deploy a stabilising parachute. Once at a safe altitude, the pilot would bail out and use his personal parachute.

Testing times

On December 14, 1945, Bell presented the Model 52 to the USAAF, which quickly accepted it under project MX-743 and followed up with an order for two airframes (serials 46-6474 and 46-675) in July 1947. Development and flight qualification hurdles led to project delays totalling almost three years, and issues in getting the engine to the flight test stage



MAIN LEFT: X-2 46-674 approaches to land with skids deployed. The aircraft made its first unpowered glide flight on August 5, 1954, and made a total of 17 (four glide and 13 powered) flights before it was lost September 27, 1956. The pilot on Flight 17, Captain Milburn Apt, had flown the aircraft to a record speed of Mach 3.2 (2,094 mph), thus becoming the first person to exceed Mach 3

RIGHT TOP: With the undercarriage deployed, X-2 descends towards the desert landing strip at Edwards AFB

RIGHT MIDDLE: This 1952 photograph shows the X-2 mounted on a special transportation dolly at Edwards AFB. The dolly was steerable and was used for transporting the X-2 around and for towing it off the tarmac after a landing. This was the number two aeroplane (46-675), which was lost on May 12, 1953, on a captive flight over Lake Ontario when it exploded during a liquid-oxygen top-off test, killing the pilot, Jean Ziegler, and EB-50A crewman Frank Wolko

RIGHT BOTTOM: This 1952 photograph shows the second Bell X-2 with a collapsed nose landing gear after its first glide flight at Edwards AFB. The aircraft pitched at landing, slid along its main skid and contacted the ground with the right wingtip bumper skid, causing it to break off. The nosewheel had collapsed upon contacting the ground All via NASA

BELOW: 46-674 drops away from its Boeing EB-50D 'mothership' with Lt Col Frank 'Pete' Everest at the controls



were so complex and time consuming that serious thought was given to cancelling the entire project. However, on November 11, 1950, 46-675 was the first X-2 to roll off the production line at the company's plant in Buffalo, New York.

Bell had decided to mount the first available XLR25 in 46-674 and started a lengthy period of static ground tests. In July 1951, the X-2 began a number of captive test flights below the EB-50A 'mothership', which culminated in a cross-country delivery flight to Edwards AFB in California on April 22, 1952.

Two months later the X-2 took to the air on its first unpowered glide flight in the hands of Bell test pilot Jean 'Skip' Ziegler. Sadly, the success was short-lived due to the nose gear collapsing on touchdown, causing a two-month delay for repairs to be carried out and a redesign of the landing skid. Ziegler was on hand again for the second glide flight on October 10, which went without incident.

Two days later, the X-2 – by now unofficially nicknamed the Starbaster – was turned over to the USAF to start the initial flight test programme, with Captain Frank 'Pete' Everest completing an unpowered glide flight later that day. This would be the first of his twelve trips in the aircraft.

In early 1953, the first airworthy XLR25 engine was finally available for powered flight tests. Installed in 46-675, tragedy struck on May 12 when the aircraft exploded during a routine propellant-system emergency-dump test while mated with the 'mothership' over Lake Ontario; Jean Ziegler and EB-50A observer Frank Wolko were both killed.



Despite the wreckage falling into the lake below – where it remains today – the cause of the explosion was pinned down to an unstable Ulmer leather gasket. The EB-50A, which managed to land safely with a cracked main spar, was beyond economic repair and was subsequently replaced with a modified B-50D; this being designated the EB-50D.

Twelve months later 46-674 – by now fitted

“Kincheloe coasted on a semi-ballistic trajectory to his peak height where over 99% of the earth’s atmosphere was below him!”



Milburn G ‘Mel’ Apt in the Bell X-2 at Edwards AFB in 1956. On September 27 of that year he pushed the rocket-powered aircraft to Mach 3.24 and for a few terrifying moments became the fastest man alive. However the aircraft entered a spin as he attempted to turn it and he was killed after being unable to bail out

with an untested XLR25 motor and NACA scientific instrumentation – was mated with the new EB-50D and flown across to Edwards AFB to undertake four weeks of static testing.

Left behind

By this time, the X-1 had broken the sound barrier and the Douglas D-558-2 Skyrocket had become the first to fly at Mach 2. Meanwhile the X-1A had powered to 90,440ft surpassing the Skyrocket with Mach 2.4 in level flight, and the North American X-15 was just around the corner.

The X-2 programme was on its knees and time was running out for the aircraft to make its intended mark in both the speed and altitude races, something that the USAF, Bell and the NACA knew. The latter was hoping to have a chance to fly the machine for its own research.

August 15, 1954 saw ‘Pete’ Everest became the only man to fly both X-2s when he flew 46-674 on its first unpowered glide; the flight being a success until the aircraft’s inherently unstable landing rollout caused the wingtips to smash into the ground and the damaged aircraft was sent back to Bell for repairs.

Returning from Edwards AFB in February 1955, 46-674 was again damaged on landing at the end of the second unpowered flight in March and suffered a third such incident a month later. Yet again, the machine was ferried back to Bell for repair and further modifications to the landing skid and nose wheel. Bell later solved the instability issue by fitting a wider main skid and shortened the nose wheel oleo by over half.

Powered flights

After a number of aborted attempts (one on October 25 being completed as a glide flight due to a nitrogen leak), Everest flew the first powered flight on November 18, 1955.

With just the smaller of the two thrust chambers ignited (giving 5,000lb/thrust) the X-2 accelerated to a speed of Mach 0.95 – despite a small fire in the engine compartment causing significant damage.

After four months of repairs, a second powered flight on March 24, 1956 saw the larger 10,000lb/thrust chamber ignited and the aircraft reach a speed just shy of Mach 1. Four weeks later on April 25, both chambers were ignited for the type’s first foray past the sound barrier and reaching Mach



The wreckage of Mel Apt's X-2 was taken to NACA's High Speed Flight Station for analysis following the 1956 crash that claimed his life

1.40 at a height of 50,000ft. During May, Everest completed a further three powered flights and pushed the X-2 up to a speed of Mach 2.53.

USAF test pilot Captain Iven C Kincheloe became the second man to fly 46-647 on May 25, 1956 while being checked out on the type to take over as the project's chief pilot. Before leaving the project, Everest flew two more trips in the X-2, the first a minor success while his final flight earned him the title of 'the fastest man alive' for a short period after he reached a speed of Mach 2.87 while gathering data on the principles of aerodynamic heating.

Chasing height

Although the possibility of achieving Mach 3 was just around the corner, a slight shift in focus saw a number of high-altitude missions planned, the first



Test pilot Captain Iven Kincheloe stands in front of Bell X-2 46-674 on the ramp at Edwards AFB. Behind the X-2 are ground support personnel, the B-50 launch aircraft and crew, chase-planes and support vehicles

of which took place on August 3 with a height of 87,750ft achieved. Five days later the aircraft failed to make it beyond 70,000ft. During what would be his final flight on September 7, Kincheloe reached an altitude of 126,200ft – the first piloted machine to reach an altitude higher than 100,000ft.

Despite a new record being set, the Fédération Aéronautique Internationale (FAI) did not recognise or endorse the achievement, and it remained unofficial, although Kincheloe gained the sobriquet 'first of the space men'.

The flight itself saw the X-2 dropped from the 'mothership' at 30,000ft and Kincheloe lit both chambers up at full power six seconds later, before pitching the nose up to around 30 degrees, allowing the machine to accelerate freely along its flight path. With Mach 1.2 achieved at 56,000ft a slight pitch up saw the aircraft at 45 degrees nose up as it passed through 104,000ft. With both the ethyl alcohol mix and liquid oxygen supplies expended, Kincheloe coasted on a semi-ballistic trajectory that would see him through to his peak height – four miles higher where over 99% of the earth's atmosphere was below him!

The end

By now, preparations were underway to transfer the X-2 to NACA, which was anxious to begin its own investigations into aerodynamic heating. However, the USAF was keen to attain Mach 3 and delayed the transfer by two months to allow one more pilot – Captain Milburn G 'Mel' Apt – to check out on the machine.

Having flown a number of chase missions in support of Kincheloe, Apt was aware of the somewhat unusual and temperamental characteristics the X-2 possessed. The use of a primitive flight simulator – the Goodyear Electronic Differential Analyzer – had also allowed him to simulate the mission profile, albeit very crudely.

Scheduled for September 27, 1956 the flight was to be the X-2s thirteenth powered

flight and the type's twentieth overall. Despite a lack of rocket experience, Apt flew a near-perfect flight profile that allowed him to fly the X-2 at its absolute maximum performance.

Reaching 72,000ft 'Mel' dropped the nose to begin his high-speed run that saw him pass through 65,000ft at Mach 3.24. Sadly, both he and the X-2 were lost seconds later:

Following engine shut down, Apt began an abrupt left turn back to Edwards with increasing amounts of aileron and elevator – the reason for him doing this is unknown but lagging instrumentation may have indicated that he was flying slower than he was. The manoeuvre proved fatal and he entered a control divergence known as inertial coupling while still at Mach 3.

Despite fighting to regain control, and initiating the emergency egress system successfully at 40,000ft, Apt was killed – he had been unable to bail out of the capsule before it hit the ground. His body was found partially ejected from his seat in the relatively intact but crushed nose section; the remaining wreckage landed some five miles from the nose. For just a few terrifying moments Captain Milburn G 'Mel' Apt had been the fastest man alive.

It was the end of the X-2 programme. NACA didn't get the chance to answer the unknowns that still lay out past Mach 3 and the jubilation of breaking the barrier was marred with the sadness that a man had been lost in the process.

Despite two unofficial records, numerous firsts in aviation and huge amounts of data gained over 20 flights, the Bell X-2 Starbuster was a shattered dream. ●

SPECIFICATION BELL X-2



Crew	1
Length	37ft 10in (11.50m)
Height	11ft 10in (3.60m)
Wingspan	32ft 3in (9.80m)
Wing area	260.00sq ft (24.20m ²)
Empty Weight	12,375lb (5,600kg)
Max Take-Off Weight	24,910lb (11,300kg)
Max Speed	1,820kts (Mach 3.196/ 2,094mph/3,370km/h)
Service Ceiling	126,200ft (38,466m)
Ferry Range	n/a
Powerplant	One Curtiss-Wright XLR25 rocket (15,000lb/thrust)
Armament	Nil
First Flight	November 18, 1955

Artwork Andy Hay / www.flyingart.co.uk



Vulcan, Victor and Valiant – the V-Force trinity



THE FAMOUS THREE

The Vulcan, Victor and Valiant were designed to protect the British Isles from nuclear attack and – if necessary – retaliate. Thankfully they never needed to undertake the role for which they were created. *Kimberley Hawkins* looks at the genesis of the V-Force

In the post-war years, as the world entered the nuclear age, there was an urgent need for Great Britain to develop a bomber capable of dropping a thermonuclear weapon on cities within the Soviet Bloc. The intention

was never to drop such a bomb; it was hoped that merely having the capability would act as a deterrent to the USSR. This was the Mutual Assured Destruction (MAD) concept and worked on the “if you bomb us, we’ll bomb you” principle.

The requirement for a nuclear capable long-range jet bomber was noted as early as July 3, 1945 when the Joint Technical Warfare Committee and a report prepared by Sir Henry Tizard examined the future potential of nuclear weapons. The following year the Air Ministry Staff issued Operational Requirements OR229 and OR230 for the development of turbojet-powered heavy bombers capable of carrying thermonuclear weapons at high altitude and high speed.

The new aircraft would be delivered without defensive armament. In January 1947 the requirements were formulated into Specification B.35/46. This called for a four-engined, swept-wing, jet medium bomber with a cruising speed of 500kts and a ceiling of at least 55,000ft. It needed to be capable of carrying one 10,000lb bomb to a target 1,500 miles from its base.

From the companies which applied, the Ministry shortlisted three manufacturers to submit advanced designs: AV Roe, Handley-Page and Vickers-Armstrongs and it was decided to award contracts to each company as a form of insurance in case one design failed.

Eleven Valiants were modified to B(PR).1 photo-reconnaissance aircraft complete with a removeable crate in the bomb bay carrying up to eight narrow-view/high resolution cameras. Others, such as XD861 were converted into aerial refuellers



Valiant

Vickers' Type 660 was ordered in April 1948 (against Specification B.9/48 which had been written around the design) and in February 1949 two prototypes of the aircraft were ordered. The first was to be fitted with four 6,500lb/thrust Rolls-Royce RA.3 Avon engines, while the second was to be fitted with four Armstrong Siddeley Sapphires.

The aircraft had a shoulder-mounted wing with the engines buried in the wing root. This resulted in a very clean airframe, albeit with an additional engine failure risk: debris from turbine blades could damage the airframe. It also increased the complexity of the design of the main spar, which had to be routed around the engines.

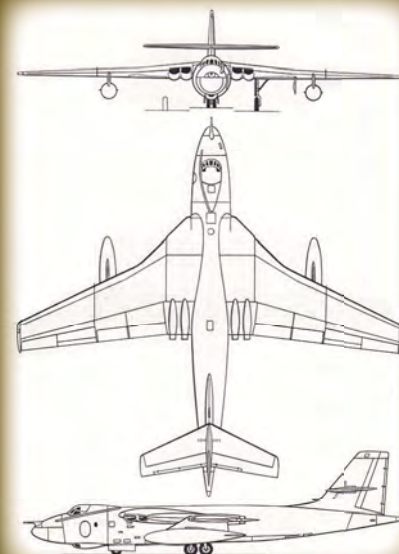
The wing itself had a 'compound sweep' that was patented by Vickers' aerodynamicist Ellyn Richards. This resulted in the wing having a 37-degree angle of sweepback across the inner third of its span, reducing to 21 degrees at the tips to postpone the effect of buffeting and drag at high speed. This gave the aircraft a top speed of around Mach 0.84.

The entire airframe was built from a complex zinc/magnesium/copper aluminium alloy called DTD683 and designed around a strong 'backbone' that supported the wing

the air on May 18 1951 – just 27 months since the contract had been placed. The pilot that day was Joseph 'Mutt' Summers, who had also been the original test pilot on the Supermarine Spitfire. His co-pilot was Gabe 'Jock' Bryce, who would quickly replace Summers as chief test pilot.

A month after its maiden flight the

The Valiant force initially flew in anti-flash white, as evidenced by BK.1 XD812, seen here departing Muharraq in Bahrain in 1963. The aircraft was retired just two years later and scrapped at Foulness Ray Deacon



“The Valiant was the only V bomber to ever drop live nuclear weapons”

spars and bomb bay. The cockpit section was pressurised, allowing the pilot, co-pilot, two navigators and an electronics operator an element of comfort – although only the pilot and co-pilot had ejection seats.

The first prototype (WB210), wearing a gleaming natural-metal finish, took to

Type 660 was given the official name of 'Valiant'; the name selected by a survey of Vickers employees.

Sadly, the prototype suffered an in-flight engine fire in January 1952, all the crew escaping safely except for the co-pilot, who struck the tail after ejecting and

was killed. The Valiant's fuel system was modified to eliminate the fire hazard and the second prototype took to the skies on April 11, 1952. It was fitted with 7,500lb/thrust RA.7 Avon engines instead of the Sapphires originally planned.

The first production Valiant B.1 flew in December 1953 with four 9,500lb/thrust Avon 201 engines. It featured bomb bay doors that retracted up into the fuselage to facilitate bomb loading and the nose wheel could be extended to provide additional ground clearance.

The aircraft was fitted with a sophisticated Navigation / Bombing System (NBS), built around the H2S Mark 9a Yellow Aster radar. The system also included a Green Satin Doppler navigation radar and a Gee-H radio location system.

By the time production ended in



Vickers Type 66 WB210 in its original gleaming bare metal scheme

August 1957, some 107 Valiants (including 10,500lb/thrust, photo-reconnaissance and refueller variants) had been produced.

Anti-flash white

Valiants, as well as other V bombers, were originally finished in silver but once equipped with nuclear weapons they were painted in 'anti-flash' white to reflect the glare of a nuclear blast. Initially the RAF roundels were left in solid red-white-blue but it was later realised that the insignia might be permanently burned into an aircraft by a nuclear blast so they were repainted in a faded pink-white-baby blue.

One Valiant that didn't appear in white was the 'Black Bomber'. Painted gloss black, the prototype B.2 flew for the first time in September 1953 and was designed as a 'pathfinder' to penetrate the target area at low-level and mark it with flares for follow-up strikes. The concept was cancelled in 1955 and the B.2 never entered service.

However, the Valiant B.1 flew with eight squadrons at its peak (7, 49, 90, 138, 148, 207, 214 & 543) and served with distinction in the Suez Crisis in late 1956 dropping bombs on Egyptian targets.

The Valiant also played a vital role in nuclear testing [see page 56] and, as such, was the only V bomber to ever drop live nuclear weapons.

Once the other V bombers were in full service (by 1962) the Valiant force was re-roled as a Tactical Bomber Force, operating at low level to deal with ever-improving Soviet defences. Fatigue meant the fleet was eventually deemed too expensive to maintain and was grounded and retired in 1965.

The Valiant had played its role in the V-Force; it had provided the RAF with a perfectly capable bomber while the more radical and advanced Victor and Vulcan were being developed.



The move to low-level bombing resulted in the Vulcan acquiring camouflage. Here Vulcan B.2 XL392 taxis in at Luqa, Malta in 1974 when in service with 617 Sqn. A sister-ship follows in characteristically smoky fashion!

Richard Freaill/Airspace Images

The 'Mighty Delta'

Perhaps the most famous of all the V bombers was the Avro 698 Vulcan – the radical delta winged leviathan that captured the imagination of generations.

The type would be the second V bomber to fly and traces its history back to Avro's original drawings for a tailless delta with fins on the wingtips and twin Bristol BE.10 (later Olympus) turbojets stacked one above the other in each wing root.

Although the unusual design met favour with the Air Ministry, it was considered risky enough to warrant a series of scaled-down flight-test demonstrators. These small delta-winged jets (christened the Avro 707s) would evaluate the handling characteristics of the wing concept and, by all accounts, showed much promise.

As such, Avro proceeded with a pair of full-scale prototypes even before the 707 programme had been concluded.

The new 698 aircraft would bear much resemblance to the original concept but would shed the twin fins in favour of a single tail and also move the engines from a vertical to 'side-by-side' configuration.

Despite its unusual shape, the airframe was built in a very conventional and traditional style. The majority of the structure was manufactured from standard grades of light alloy and the airframe was broken down into a number of major sub-assemblies to aid construction. The Avro 698 would carry a crew of five (pilot, co-pilot, navigator/radar, navigator plotter and air electronics officer) who were accommodated on two levels within the pressurised cabin.

At the insistence of test pilot 'Roly' Falk, the large aircraft was controlled with a fighter-type stick rather than a yoke control. This would help make the aircraft by far the most manoeuvrable of the V bombers and it was not unheard of for the type to roll and perform Immelmann turns during display flying.

The aircraft's planned Bristol Olympus turbojets were not ready in time for the maiden flight so the prototype (VX770) was powered by four 6,500lb/thrust Rolls-Royce Avons when it first flew on August 30, 1952, with Falk at the controls.

Two landing gear door fairings fell off during the flight, but inspection by a chase 'plane' revealed the aircraft was safe to land, and Falk put it down without incident.

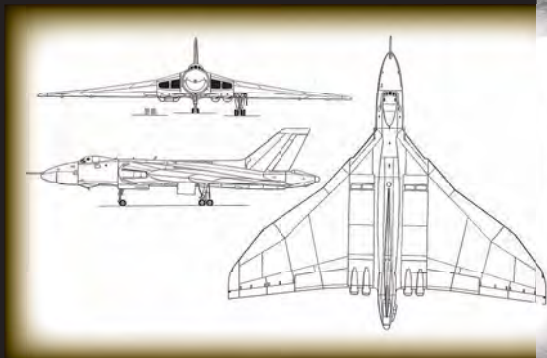
The original plan had called for the aircraft to be named 'Ottawa' (in line with the RAF tradition of naming bombers after cities) but by October 1952 the name 'Vulcan' had been settled upon.

VX770 was re-engined with 7,500lb/thrust Armstrong Siddeley Sapphire Sa.6 turbojets by June 1953 but by the time

The sole Valiant B.2 was designed as a 'pathfinder' to penetrate the target area at low-level and mark it with flares for follow-up strikes. It had a stretched fuselage and a strengthened wing to make it more suitable for low-level flying and the undercarriage retracted rearwards into 'speed pods'



The second prototype Vulcan performed its first flight on September 3, 1953 and just a week later both Vulcan prototypes and the four surviving Avro 707 demonstrators performed a formation flypast at the SBAC Airshow at Farnborough



the second prototype (VX777) performed its first flight on September 3, 1953 the hoped-for Olympus engines were available. These provided 9,750lb/thrust each and just a week later both Vulcan prototypes and the four surviving Avro 707 demonstrators performed a formation flypast at the SBAC Airshow at Farnborough.

In July 1954, VX777 was damaged in a landing incident and was rebuilt with uprated pre-production Olympus 101 engines providing 10,000lb/thrust each. It was also refitted with the more advanced 'kinked' wing in October 1955.

VX770 never received Olympus engines or the kinked wing. It was fitted with Rolls-Royce Conways but tragically the aircraft disintegrated during an airshow at Syerston, near Nottingham on September 20, 1958. The crew were killed.

By then the Vulcan was already in production for the RAF with the first B.1

version flying on February 4, 1955. The type entered service with 230 OCU in early 1957 and was declared squadron-ready in July when 83 Sqn received its first example. A total of 45 B.1s were built up to April 1959 and equipped 44, 50, 83, 101 and 617 Sqs, initially in

'Kinked'

The two prototypes were fitted with a simple delta wing with a 52-degree sweepback but this suffered from buffeting at high speed. The Royal Aircraft Establishment therefore proposed a 'kinked' wing, with the sweep reduced to

"The Vulcan had time for one final 'hurrah' as it was called into combat for the first and last time"

silver but later 'anti-flash' white paint.

The B.1 initially had 11,000lb/thrust Olympus 101 engines but later production shifted to the uprated 12,000lb/thrust Olympus 102 and, finally, the 13,500lb/thrust Olympus 104 units.

42 degrees at one-third span and returned to 52 degrees at two-thirds span.

Although the first five B.1s were delivered with straight wings (in order to meet delivery schedules) they were refitted with the kinked wings while in service.

The aircraft could carry a total bomb load in excess of 21,000lbs within the 29ft by 10ft 6in bomb bay (big enough to fit the 40-kiloton *Blue Danube* fission bomb and the *Green Cheese* anti-ship weapon – although the latter was later cancelled).

An ARI 18074 *Green Palm* voice channel jammer was the B.1's only defensive countermeasures system. This was increased for the 28 B.1A variants which were retrofitted with a *Blue Diver* low-band jammer; *Red Shrimp* high-band jammer; *Blue Saga* radar warning receiver and chaff dispensers as well as a *Red Steer* tail-warning radar derived from the system used on Meteor night-fighters.

However, Avro was already working on the B.2 variant of the Vulcan. This would include the aforementioned countermeasures and retained the



The Vulcan's camouflage was more effective in some areas than others!



Vulcan (and Victor) were to carry the US-built Skybolt air-launched ballistic missile and the Air Ministry felt this was so capable they could reduce the number of bomber aircraft on order. However, the Americans cancelled the programme in 1963, leaving the V-Force with just Blue Steel and freefall weapons. This helped the MoD decide to move the nuclear deterrent to the Polaris submarine-launched missile system

'kinked' wing but the span was also increased by 2ft. The separate elevator and aileron control surfaces were also modified to act as combined 'elevons'.

Early production B.2s were fitted with four 17,000lb/thrust Bristol Siddeley Olympus 201 turbojets but later examples had the 22,000lb/thrust Olympus 301.

The first Vulcan B.2 flew for the first time on August 31, 1957 and the type entered service in July 1960. This variant would eventually fly with 9, 12, 27, 35, 44, 50, 83, 101 and 617 Sqns as well as 230 OCU and the last of 89 B.2s were delivered in January 1965.

Nuclear capable

The Vulcan B.2 formed the backbone of British nuclear strike capability through the 1960s and remained in the role through the 1970s.

The B.2 was originally equipped with the *Yellow Sun* Mk 2 thermonuclear weapon but by 1963 was retrofitted to carry the *Blue Steel* rocket-powered stand-off weapon that could be launched long distances from its ultimate target and accelerated to Mach 2.3.

It had been intended to launch the American-developed Douglas AGM-87A Skybolt missile from beneath the

just 50ft. The aircraft were camouflaged and the avionics changed to include a terrain-following radar capability.

In 1973 the RAF's 27 Sqn was re-tasked as a maritime radar reconnaissance (MRR) operation and nine of the unit's aircraft were modified to Vulcan B.2MRR specification with a LORAN-C navigation receiver.

By now the entire Vulcan fleet was

recently been invaded by hostile forces belonging to Argentina's military junta.

Five Vulcan B.2s were selected to fly with 101 Sqn during *Black Buck* missions conducted as part of Operation *Corporate*. Operating from Wideawake airfield on Ascension Island in the mid-Atlantic, the Vulcans would fly the longest bombing missions ever (at the time). Using eleven Victor tankers for support, the Vulcans set out on the night of April 30/May 1, 1982 with a full load of 21 x 1,000lb bombs. The 7,500-mile round trip took 16 hours and *Black Buck 1* was a success – the Vulcan had finally been blooded.

The final mission, *Black Buck 7*, took place on June 11/12 and by December 1982 the last Vulcan bomber was retired. A small number of K.2 tanker conversions continued in service until 1984 but in March of that year the Vulcan was withdrawn from service completely.

The RAF bowed to public pressure and kept two examples (XL426 and later XH558) on as display aircraft until the end of 1992 but on March 23 of the following year XH558 made the final flight by an RAFV bomber.



Vulcans XM607 and XM597 photographed at RAF Waddington on September 14, 1982 after their return from Ascension Island. XM607 had dropped the first bombs on the Falklands Islands during the Black Buck 1 mission. XM597 took part in anti-radar strikes on May 30 and June 2

"It was not unheard of for the Vulcan to roll and perform Immelmann turns"

wing of the Vulcan. Two aircraft were modified for trials and late production machines were delivered with Skybolt hardpoints. However, the first five launches failed; the USA cancelled the missile and the UK changed its nuclear deterrent to Polaris-equipped submarines.

This meant the end of the road for the V-Force when it came to a nuclear role and the aircraft were relegated to low-level duties, penetrating enemy lines at

getting old and weary and the aircraft was slated to retire in 1982 as the Tornado GR.1 was entering service in the low-level attack role. However, the Vulcan had time for one final 'hurrah' as it was called into combat for the first and last time.

In the type's eleventh hour, it was considered to be the only aircraft capable of dropping conventional bombs onto the runway at Port Stanley on the Falkland Islands, which had



The first five Vulcan B.1s had a pure delta wing but these were later retrofitted with the 'kinked' wing that had the sweep reduced to 42 degrees at one-third span and returned to 52 degrees at two-thirds span



VX770 was later fitted with Rolls-Royce Conways but tragically the aircraft disintegrated during an airshow at Syerston, near Nottingham on September 20, 1958. The crew were killed



The end of an era. Sqn Ldr Joe L'Estrange and his crew (L-R Flt Lts Chris Hickson, Steve Cockbill, Dennis Cheatham and Martin Ford) pose in front of their Vulcan prior to making the last ever operational Vulcan flight on March 13, 1984

Victor

Handley-Page answered Specification B.35/46 with its HP80 design – an aircraft that was perhaps the most unconventional of all three V bombers and one that still looks 'space-age' to this day.

The aircraft was intended to operate at high speed and above the ceiling of contemporary fighters. To achieve this it featured a revolutionary 'crescent' wing, with the sweep decreasing in three steps from 48.5 degrees to 37.5 degrees and finally to 26.75 degrees from the root to the tip. The chord similarly decreased to ensure a constant limiting Mach number across the entire wing and guarantee a high cruise speed.

The wing design had been pioneered by German Dr Gustav Victor Lachmann, who had been working for Handley-Page when war broke out and had initially been interned before being allowed to re-join the workforce. He worked in cooperation with his deputy (Godfrey Lee) and the pair came up with the crescent wing and tested it on a radio-controlled glider before fitting it to a modified Supermarine Attacker for flight-testing under the HP88 designation.

Meanwhile the HP80 design continued to be perfected and in 1952 the prototype (VVB771) was hauled by road from the Handley-Page factory at Radlett



to Boscombe Down for flight trials.

To disguise the aircraft from prying eyes, it was shrouded in wooden frames and wrapped in tarpaulins. 'Geleypandhy/ Southampton' was written on the side, as if it was a boat being transported to harbour ('Geleypandhy' was supposed to be an anagram of 'Handley Page', but it actually decoded as 'Handley-Pyge!').

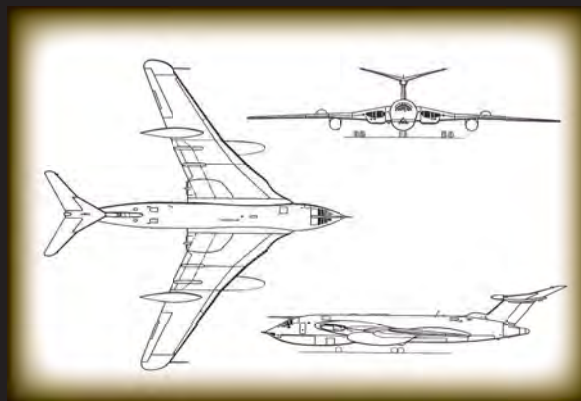
Once reassembled, the HP80 was a striking aircraft. It had four Sapphire turbojet engines buried in the thick

wing roots and a highly swept T-tail with considerable dihedral. The nose bulged to accommodate the cockpit and targeting radar. The original specification called for the entire nose to detach as an escape pod but this was later abandoned.

The aircraft would accommodate a five-man crew, comprising the two pilots seated side-by-side and the navigator/plotter, navigator/radar operator, and air

ABOVE RIGHT: The Victor still looks 'space-age' today, more than 60 years after it first flew

BELOW: Handley Page decided to test its crescent wing and tail design on a smaller aircraft and a Supermarine Attacker fuselage was modified into the one-off H.88. Coded VX330, it actually flew too late to be of much use in the Victor programme and was lost in an accident on August 26, 1951, killing pilot Duggie Broomfield



“It was in the refuelling role that the Victor really made its name”

electronics officer seated facing rearwards. As with the other V bombers, only the pilots were provided with ejector seats; the others relying on 'explosive cushions' inflated by a CO2 bottle that would help them from their seats and towards a the door to bail out!

The aircraft was made mostly of aluminium alloys, which were used in a two-skin sandwich with corrugated filling. Large hydraulic airbrakes were fitted to each side of the tailcone, and the tail also contained a braking parachute.

The HP80 had by far the largest bomb bay of all V bombers and as an alternative to the single 10,000lb nuclear bomb, the aircraft could also carry the 22,000lb Grand Slam or two 12,000lb Tallboy earthquake bombs.

Once in service, the aircraft would also be adapted to carry the Blue Steel stand-off nuclear missile; it was modified to launch the American Skybolt missile – although the latter was cancelled.



Into service

WB771 took to the skies on Christmas Eve 1952 with Sqn Ldr Hedley Hazelden at the controls. It was powered by four 11,000lb/thrust Armstrong Siddeley Sapphire 7 engines and by September 1953 it had been painted black and silver with a red cheatline for its appearance at the SBAC Airshow at Farnborough.

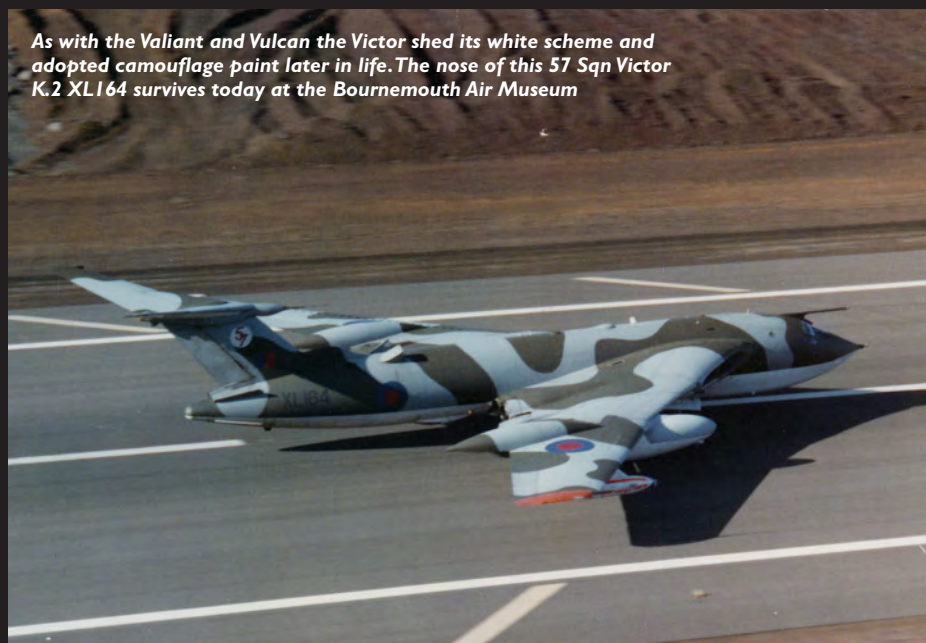
Flight testing revealed some deficiencies and on July 14, 1954 WB771 was lost when the tail unit sheered off at low level. The crew were all killed.

The second prototype (VWB775) already

“The Victor’s wing design had been pioneered by German Dr Gustav Victor Lachmann”

featured a reinforced tail and performed its initial flight on September 11, 1954; the first sorties including a triumphant flypast at that year’s SBAC show.

The first production variant of the HP.80 emerged on February 1, 1956 – by which time the aircraft had been officially named the Victor B.1. Just over a year later, test pilot Johnny Allam ‘accidentally’ broke the sound barrier during a test flight; the Victor becoming the largest



As with the Valiant and Vulcan the Victor shed its white scheme and adopted camouflage paint later in life. The nose of this 57 Sqn Victor K.2 XL164 survives today at the Bournemouth Air Museum

aircraft to exceed Mach 1 at the time.

The aircraft needed a number of ‘issues’ fixing and it did not enter RAF service until November 1957, when the first machines joined 232 OCU. The first operational unit (10 Sqn) began receiving its jets in April 1958.

A total of 50 B.1s were built, equipping 15, 55 and 57 Sqn. The last was delivered in February 1961 by which time production switched to the B.2.

The B.1s were already being modified to B.1A standard with the *Red Steer* tail-warning radar; *Blue Saga* radar warning

receiver; *Green Palm* voice communications jammer as well as *Blue Diver* and *Red Shrimp* radar jammers and chaff dispensers.

The B.2 included all of these as well as 17,250lb/thrust Rolls-Royce Conway 103 turbojets (and substantially larger air inlets to provide greater airflow). The wingspan was also increased by 10ft and the first of 34 B.2s flew on February 20, 1959. The new variant joined 139 Sqn in February 1962 and would also equip 100 Sqn.

Soon the introduction of Soviet surface-to-air missiles made the V Force’s high-altitude tactics obsolete and in common with the other V bombers, the Victors were re-tasked as low-level bombers. For this they received updated navigation radar and rolling map displays and the jets were repainted in a disruptive camouflage scheme from 1964. Twenty-one B.2s were re-engined with 20,600lb/thrust Conway 201s and re-designated as B.2Rs.

Tanking & Spying

The Victor never fired a shot in anger; the closest it got was a deployment to Singapore in response to Indonesian hostility to Malaysia but its services were never needed.

In the mid-1960s, eight Victors were converted to B(SR).2 strategic reconnaissance configuration, the first flying on February 23, 1965. This version featured the *Yellow Aster* radar and accommodated up to 15 film cameras in the bomb bay. The B(SR).2s were operated by 543 Sqn and mostly focused on maritime reconnaissance missions.

The introduction of the B.2 quickly made the early B.1/1A variants obsolescent. Rather than retiring the aircraft, they



The Victor carved a successful post bombing career as a flying tanker



The Victor would soon gain vortex generators atop the wing to improve its aerodynamics. Early examples entered service in this silver scheme, prior to the adoption of anti-flash white across the fleet

were converted to tanker configuration, becoming the B.1A(K2P) variant. The first joined 57 Sqn in February 1966 and was followed by aircraft for 55 and 214 Sqn. Eventually, eleven B.1s and 14 B.1As were modified (as BK.1 and BK.1A, respectively).

Like the Valiant, the Victor was not cut out for low level bombing and the B.2 was retired from the bombing role by 1968. The remaining 24 aircraft were converted to K.2 tanking standard – with the first flying on March 1, 1972. The

aircraft had their bombing equipment removed and the wing was shortened by 18in and strengthened. The aircraft could carry 98,500lbs of fuel and dispense it via three hose reels. The first example entered service with 57 Sqn in July 1975.

It was in the refuelling role that the Victor really made its name. In 1982 the aircraft played a vital part in Operation Corporate, refuelling aircraft en route to the Falkland Island – including the Vulcans of the famous *Black Buck* missions.

Operation Corporate involved more than 600 Victor sorties and decimated the tanker fleet's airframe life. Just 15 aircraft flew on after the campaign and eight of these would go to war one final time following Saddam Hussein's invasion of Kuwait.

As part of Operation Granby, Victors provided tanker services to RAF and US aircraft, flying 229 sorties supporting air patrols over Iraq into 1993.

Almost immediately after their return to the UK, 55 Sqn (the last Victor unit and the last squadron to operate a V 'Bomber') disbanded in October 1993. The V-Force had finally had its day.

That was, of course, until 2007 when Vulcan XH558 returned to the skies for one final swansong... ●

SPECIFICATION VICKERS VALIANT B.1



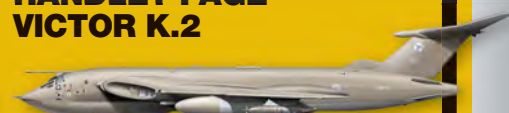
Crew	5
Length	108ft 3in (32.99m)
Height	32ft 2in (9.80m)
Wingspan	114ft 4in (34.85m)
Wing Area	2,362sq ft (219.00m²)
Empty Weight	75,881lb (34,491kg)
Max Take-Off Weight	140,000lb (63,600kg)
Max Cruise Speed	493kts (567mph/913km/h)
Range	4,500 miles (7,245km)
Operational Ceiling	54,000ft (16,500m)
Powerplant	Four Rolls-Royce Avon 204 turbojets (10,000lb/thrust each)
Capacity	One 10,000lb Blue Danube nuclear bomb or 21 x 1,000lb bombs
First Flight	May 18, 1951 (Type 660 prototype) December 1953 (Valiant B.1)

SPECIFICATION AVRO VULCAN B.2



Crew	5
Length	99ft 11in (30.45m)
Height	27ft 1in (8.28m)
Wingspan	111ft 0in (33.83m)
Wing Area	3,964sq ft (368.30m²)
Empty Weight	83,573lb (37,144kg)
Max Take-Off Weight	170,000lb (77,111kg)
Max Cruise Speed	560kts (645mph/1,038km/h)
Range	4,600 miles (7,400km)
Operational Ceiling	55,000ft (16,765m)
Powerplant	Four Rolls-Royce Olympus 301 turbojets (22,000lb/thrust each)
Capacity	One 10,000lb Blue Danube, Violet Club, Yellow Sun or Red Beard nuclear bomb or 21 x 1,000lb bombs
First Flight	August 30, 1952 (Avro 698 prototype) August 31, 1957 (Vulcan B.2)

SPECIFICATION HANDLEY PAGE VICTOR K.2



Crew	5
Length	114ft 11in (35.05m)
Height	28ft 2in (8.57m)
Wingspan	117ft 0in (35.66m)
Wing Area	2,406sq ft (223.50m²)
Empty Weight	89,030lb (40,383kg)
Max Take-Off Weight	205,000lb (93,182kg)
Max Cruise Speed	545kts (627mph/1,009km/h)
Range	6,000 miles (9,660km)
Operational Ceiling	56,000ft (17,000m)
Powerplant	Four Rolls-Royce Conway 103 turbojets (17,250lb/thrust each)
Capacity	One Yellow Sun nuclear bomb or 35 x 1,000lb bombs (B.2) / 98,500lb of fuel (K.2)
First Flight	December 25, 1952 (HP.80 prototype) March 1, 1972 (Victor K.2)

A DAY IN THE LIFE OF A V BOMBER PILOT



*In an exclusive extract from his recently published book **My Target Was Leningrad: V Force: Preserving Our Democracy**, Valiant pilot **Philip Goodall** recalls taking part in a major Bomber Command exercise at the height of the Cold War*

With an automatic gesture I stretched out my hand to stop the incessant ringing of the alarm. I can't sneak many extra minutes this morning as I've got a long day ahead.

From 8.30 until 10.00 I have a simulator trip. I think I'll put the co-pilot in the left hand seat today so he can practice the let-down procedures at Goose Bay and Offutt prior to our trip to the States next week. Then I'm due to take-off at 14.00 to take two co-pilots for their Instrument Ratings. They should both pass without too much trouble.

The first has been on the squadron for two years and is due his captain's course soon; he should make a good captain with a little more experience. The other has just arrived from Cranwell. He's a very keen young man so I think I'll put him through his paces. Then this evening we've got a squash match. Lucky it is at home, as I shall be able to have a break after I land. Funny thing, I never play so well after I have been flying. I wonder why?

Rude Awakening

I was just beginning to realise that the ringing hadn't stopped when in the background I hear

the tannoys blaring "Exercise Buffalo Exercise Buffalo!" It's only ten minutes to three. 'Daddy! Daddy! What's that noise?' Blast! Now the kids are awake. I stumbled out of bed, 'persuade' the children to go back to sleep, get dressed and throw some things into an overnight bag. "See you sometime darling. Better cancel that dinner tomorrow evening... probably see you Thursday or Friday."

I arrive at the Operations Centre, guarded, with the Police checking Identity Cards. After close scrutiny I am allowed in. The rush has now started, with aircrew arriving half dazed and in various forms of dress. I 'sign in' on the



After 20 minutes all my crew have arrived. The Air Electronics Officer was last, with his usual string of excuses, not because he was late but merely because he was last! We all change and collect our target 'Go Bag', ensuring that everything is included. While waiting for the order to disperse and the final preparation of my aircraft, we go to the aircrew buffet for breakfast. It's amazing the huge meal we all eat at three in the morning; eggs, sausages, bacon, tomatoes and piles of toast. I wonder how we could possibly have existed until 7.30?

Suitably nourished we check the weather and the serviceability of the let down aids at the dispersal base; we are ready to go and await our call. Since I am the Detachment Commander, I will take the first dispersing aircraft. However, certain crews remaining at the home station have a higher priority, which means they will be allocated the first aircraft which comes available. This slight delay will allow the ground personnel for the dispersal base to be uplifted and to prepare for our arrival.

“Who do you think you are, arriving this time of the day? Bomber Command, mate!”

Dispersed

Very soon we are allocated an aircraft, the tannoy bellows my name; we're off. We grab our flying kit and hand baggage and are driven out to the aircraft to be met by a cheerful crew chief, who will fly to the dispersal with us. Rapidly we complete our checks and are soon airborne. After obtaining clearance through the airways to save time,

we carry out an ILS at our dispersal base and land. I taxi around and park at the Bomber Command Operational Readiness Platform.

By the time the ground crews have arrived and are busy activating all the facilities -everything from refuelling my aircraft (The Crew Chief

has already had a row over the bowsters – 'They said to me "Who do you think you are, arriving this time of the day", and I said, "Bomber Command, mate") to opening the tins of beans and arranging the delivery of fresh milk and bread, and the newspapers!

Whilst our aircraft is being serviced and refuelled we settle into our five-

readiness board and check my crew: three more still to come. Most of the squadron have arrived, which is not bad since it is only ten minutes since the alert was called.

Exercise 'Buffalo' is a major exercise of Bomber Command which includes everyone including the crews and aircraft already on continuous alert, or QRA, as we say. The whole Command, including the Operational Conversion Unit, practices the procedures necessary to launch the force in the retaliatory role. Other Commands in the RAF assist by providing manpower, mainly for the dispersal bases, and, of course transport aircraft, as the ground personnel for the distant dispersals are all flown in.

It is not surprising therefore that the Operations Centre is a hive of activity as this is the nerve centre of the station's generation plan. The Technical Cell keeps a running record of the serviceability state of the aircraft and the progress of preparing them for war missions.

About the Author

Philip Goodall entered the RAF in 1953 and was posted for jet training on the Meteor and Canberra. In 1954, he was posted to the Middle East to fly the Valiant where he was engaged with Egyptian activities on the Suez Canal. Goodall joined 90 Sqn and was a member of the only V-Force crew to be awarded the Malayan General Service medal. In 1959, he was awarded the 'Queen's Commendation for Valuable Services in the Air' and became Flight Commander on 7 Sqn flying the Valiant. In 1967, he commanded 27 Sqn with the Vulcan at Scampton with one flight fitted with the Blue Steel on constant alert. In 1972, Goodall was posted to the Headquarters of Strike Command with responsibility for producing the RAF Nuclear War plans



The author, second left, with Sqn Ldr Wilson and the crew of a Valiant in which they attacked Egypt in 1956 during the Suez War

berth caravans which are parked a few yards from the aircraft. These will be our accommodation for the next few days. With their bunk beds, electric radiators and built-in wash basins, they are most comfortable, as they rightly should be.

The co-pilot returns to the aircraft to check the state whilst I inspect the dispersal. Meanwhile the navigators and the Air Electronics Officer correct the route plan for the latest meteorological information. The dispersal accommodation is all shipshape and in good condition, as I expected. The ground crew are still positioning the ground equipment, which was naturally all serviceable as it is regularly serviced by a maintenance party. The cooks are hard at work; tea and biscuits have already been served and brunch will be available for the ground crew in half an hour. The telephones and the link to Bomber Command are all working. The teleprinter is not yet available as the operators from another Command have not yet arrived. However, there is a queer looking antiquated aircraft in the circuit which probably has them on board. I check with base; the second aircraft is airborne and the others should be off within the hour.

Cockpit Ready

I return to the aircraft as the servicing has just been completed.

We run through all the checks and leave the aircraft 'Cockpit Ready'. This means that when power is switched on the aircraft is immediately ready for engine start. As we

are on normal readiness we can leave the aircraft. This seems a good opportunity to have the shave I missed a few hours ago.

Soon all the aircraft have arrived. They have all been refuelled and serviced and our readiness reported to Bomber Command. We had a little trouble with one aircraft but fortunately the spares backing meant the aircraft was unserviceable for a very short time. The ground crew have all eaten and have been split into their various shifts leaving starting parties at each aircraft. The aircrew have settled in; the latest planning winds and met information has been passed through

"The siren blasts. We all dash madly to the aircraft"

from Bomber Command; we are ready.

A wholesome lunch passes uneventfully. The rosters are all drawn up. Duty Met... Duty Officer... and it is my turn to carry the 'Go Bag'. Wheee... The siren blasts. We all dash madly to the aircraft. I get in first as I have to start the engines, but there is no panic as we are only being brought to cockpit readiness.

I put on my helmet and hear the 'Bleep Bleep' of Bomber Command coming over the radio, which means we are in direct contact with the Bomber Controller. We all strap in and wait. 5, 10, 25, 45, 70 minutes pass. It's alright for those chaps in the back, they can move around but my

behind is already getting sore!

This is the Bomber Controller...

Are we going? My finger is on the starting button.

Revert to normal readiness, I say again...

Just another practice.

We return to the dispersal mess and that excellent Sergeant Cook has already a mixed grill ready for us. The papers have arrived and the bridge school has formed. We will probably be here for three or four days, possibly less, with luck. The quiet mutterings of the card-players are suddenly broken by an explosion from my navigator: "Just look at this! Why the hell don't those flaming reporters make a little effort to get their facts right?"

He has just found an article on the nuclear deterrent. If it was only the daily comics which misrepresented the truth it would not be too bad, but the informed press seem to do even more damage. For example, how many people know that out of a total Defence Budget of approximately £1,850 million only £110 million is spent on the operation of Bomber Command? The

country has never had such good value for its money. One could almost coin a phrase: "Never has so much nonsense been said by so many about so few, from whom so much is owed and from whom so little is heard."

Well, I didn't play squash and I'm miles from home for the next few days. But it worked well today as it will always work. The aircraft were all serviced, armed and dispersed as planned. We are here and ready to go. I believe that my being here means that my children and all other children have a better chance of leading the life they want to. I know we can do what we have been trained to do, but I pray and believe we will never have to do it.

Wheee... Oh hell! Here we go again. I'll curse... but I believe in what I'm doing. ●



A 90 Sqn Valiant on standby at the dispersal at RAF Honington

All Author via Fonhill Media unless stated



At the height of the Cold War an anti-flash white Valiant awaits the call to arms

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THE ULTIMATE DETERRENT

Dr Dave Sloggett takes a specific look at the nuclear deterrent role played by the Vulcan, Victor and Valiant during the Cold War

Today, people from across the globe flock to see the last airworthy Vulcan at airshows.

The sight and sound of the mighty delta-winged bomber leaves people awestruck and few can help but be thrilled by its incredible manoeuvrability.

However, during the dark days of the Cold War when devastating nuclear conflict appeared only to be just around the corner, it was the Vulcan and the other members of the V-Force triad that ensured it never turned into Armageddon. During their heyday the Vulcan, Victor and Valiant fulfilled an important stop-gap role as the designated holders of Britain's nuclear deterrent – particularly when the nature of the Soviet threat rapidly changed.

Survivability

In addition to delivering their nuclear payload deep behind enemy lines, the V-Bombers were, crucially, designed to be 'survivable'. Any belief that the bombers could be eliminated from the strategic equation in the opening salvos of a war ran the risk that an unstable political situation might see the Soviets gamble and conduct a pre-emptive strike.

Therefore, the question that had to be continually assessed was 'just how many bombers would actually arrive over their target?' And, equally importantly, would those that remained present a sufficient deterrent to the Soviets?

"A 15-minute warning suddenly became a five-minute warning"

Taking the Vulcan as an example, the nuclear weapons it could carry would certainly have been able to deliver a hammer blow against the Soviet regime if an airframe were to penetrate enemy defences.

While the *Blue Danube* nuclear weapon was a fission device capable of yielding between 10-12 kilotons (similar to that obtained in the Hiroshima detonation), its replacement (called *Yellow Sun*) was a hydrogen weapon with two different yields available.

One, with the *Green Grass* configuration, involved a 'physics package' that would

provide 400 kilotons. The second, the *Red Snow* configuration, was a British version of the W-28 design developed in the USA and had a yield of 1.1 Megatons – sufficient to devastate large areas of any urban conurbation targeted by the RAF.

The Vulcan could therefore carry quite a punch if it were able to reach its target. However, as time moved on, developments in Soviet ballistic missile technology quickly reduced the certainty that large elements of the V-Force would be launched in time to make a viable retaliation.

Time Deficit

By the 1960s the flight times of Soviet nuclear armed Short Range Ballistic Missiles (SRBM), such as the SS-21, reduced to almost match the time it took the V-Force to become airborne. As such, the question of whether sufficient numbers of Vulcans could survive a pre-emptive attack by the Soviets became a cause for concern. Then, when short-range Intercontinental Ballistic Missiles (ICBM) were moved to even closer locations in Eastern Europe, what had been a 15-minute warning of the launch of Soviet Intercontinental Ballistic Missiles (ICBM) suddenly became a five-minute warning. At this point the V-Force moved into 'time deficit'.

Two options existed: one was to maintain sufficient aircraft aloft during periods of crisis – but this was not considered practical. It would also create problems if a pre-emptive strike by the Soviets led to

communications with the airborne force being disrupted. Some degree of 'positive control' of the force had to be maintained.

The alternative was to launch on warning and then recall the V-Force if it proved to be a false alarm. While outwardly this may seem straightforward, it was anything but, as a number of technological deficiencies combined to make a launch-on-alert strategy dangerous.

As the Soviet bomber threat gave way to the ballistic missile threat, the speed with which the UK could come under attack dramatically decreased from a matter of hours to just a few minutes. At best, the warning available from the Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales on the North Yorkshire moors was reduced to close to five minutes.

Four-minute warning

This led to the introduction of what became known as the four-minute warning. This was

not, as some people might imagine, the time left before the first detonation occurred. It was the point at which the impact point for each missile system could be verified as being in the UK. This would have been the trigger for the V-Force to become airborne from its dispersed locations.

Throughout the Cold War, the notion of aircrew being on Quick Reaction Alert (QRA) always had two dimensions. The first was highly reminiscent of the Battle of Britain, with pilots taking off to intercept and engage an enemy before it could get to its launch points. As Soviet bombers carried ever longer-range stand-off missiles, this question of time became increasingly important. Shooting down the bomber before it got to its weapon release point was vital. In a time of crisis this led to fighters maintaining Combat Air Patrols (CAP).

However, V-Force itself also had to maintain a QRA capability because

A pair of Avro Vulcan B.2s scramble from RAF Scampton during the Cold War. Exercises were frequent and QRA aeroplanes were often brought to readiness and dispersed to bases around the globe. Thankfully the aeroplanes never needed to be used for their designed role. For your chance to win this unique and original artwork, commissioned specially by Jets magazine, turn to page 86 now!

Andy Hay /
www.flyingart.co.uk

if "the balloon went up", it had to take off quickly to survive.

Why, some might ask, did it take four minutes to issue such a warning? The answer is that it was a question of detecting and then tracking the incoming missiles or bombers. While early warning satellite technology was in its infancy in the late 1960s and early 1970s, a large-scale launch

are a vast improvement on the early form of BMEWS technologies that were available in the 1960s. These massive radars were mechanically, not electrically, driven and could take ten seconds to sweep through the 120-degree field of view sector they were covering before turning back in the other direction.

Initial ability to detect missiles in flight

"Soviet air defence radars could not simply look westward and had to have an omni-directional capability"

of Soviet missiles should have been detected. However, there were numerous potential sources of false alarms, such as forest fires and other sources of huge infrared signatures, such as the sun glinting off clouds.

False alarms

Even the BMEWS radars were not entirely perfect and also had a high false alarm rate. During their early development, the prospect of launching a nuclear reprisal against the Soviet Union when no actual attack had taken place was the subject of a number of major television documentaries. Genuine concerns existed at the time over the degree to which the V-Force might be launched as a result of false information.

Today's phased array radar technologies

depended upon them crossing the radar horizon. A few moments would then elapse before a series of readings could be taken from the radar system to create a track that enabled the aim-point of the missiles to be determined. At this point the BMEWS radar system was able to confirm that specific parts of Britain were now under attack and the signal to scramble the V-Force would have been flashed across bomber command.

While the Vulcan often demonstrated its ability to be airborne in just over two minutes at airshows of the period, in practice this would be very hard to achieve across the whole force during operational conditions. This was despite numerous important innovations to improve the start up time of the aircraft, such as the ability



By 1960 grave concerns already existed in the British Government about the continued viability of gravity bombs as a means of delivering a nuclear attack. The development of the Blue Steel missile was supposed to provide a solution to this problem. While 53 missiles were built, and carried below both Vulcans and Victors, it quickly became clear that simply being able to stand-off and deliver a nuclear weapon from afar was not the only criterion that would decide if the V-Force were going to remain effective



The replacement of the Blue Steel with a much longer-range GAM-87 Skybolt missile built in the USA was supposed to elongate the lifetime of the V-Force. However, in 1962, when the future vulnerability of the V-Force was questioned in detail, Skybolt was also cancelled, leaving Blue Steel as the V-Force's sole stand-off weapon!

to start all four engines at the same time.

Holding aircrew on QRA also had its human dimension and crew fatigue would quickly set in. Nevertheless, the rivalry between squadrons and stations ensured that a plentiful supply of film footage reached the Pathé newsreels that portrayed the speed with which the V-Force as a whole could be mobilised on their nuclear missions.

Dispersal

Another important facet in trying to improve the survivability of the nuclear

deterrent was the ability to disperse the V-Force. Airfields across Britain and those in places such as Gibraltar, Malta and Cyprus were potential dispersal points for the aircraft.

The launch of a nuclear strike mission from Cyprus would have created a number of different axes along which the targets, such as Moscow, would have been attacked. The Soviet air defence radars could not simply look westward and had to have an omni-directional capability. Soviet air defence fighters also had to be

deployed to try to engage low-flying British bombers from different directions, and the outcomes of such engagements at low level would have been hard to forecast.

This was a crucial aspect of the way in which the capabilities of the V-Force, as a whole, were viewed by the Kremlin. In their risk calculus the Russians had to ensure that any pre-emptive strike against RAF bases would be able to destroy a significant number of the bombers before they could become airborne.

Dispersing the British aircraft was seen to complicate the targeting process that would have been undertaken by the Soviets. To be sure of knocking out as many of the V-Force as possible, they would have to target every potential dispersal point. But that idea also carried risks. What if the ever-observant Soviets were to mistake a routine dispersal as preparations for an imminent attack? In fact, the mere act of trying to disperse aircraft to help improve their deterrent effect may inadvertently been seen as a covert declaration of war and a plan to conduct a pre-emptive strike against the Soviet Union.



A Victor crew scramble to their aircraft in readiness to launch to their dispersal field



A trio of Handley Page Victor B.1s make their way towards the runway as they prepare to take off

Reaching the target

For Britain this created the prospect of the country being peppered by nuclear weapons as all the potential V-Force launch bases would have been attacked in a pre-emptive nuclear strike. This is not a pleasant thought but was typical of the kind of analysis that prevailed in the Cold War. Nuclear deterrence in those days became a matter for mathematical analysis and operational assessment.

The other complicating factor was that improvements to the Soviet air defence systems, especially around the main targets, meant that the number

“Instructions were kept vague in order not to have an impact on crew morale”

of British bombers likely to reach the point at which they could pull up and release their weapons was uncertain.

This final manoeuvre over the target itself was highly risky, even with the bombers carrying electronic warfare systems (to jam the Soviet air defence systems). This quite naturally led to the consideration of using stand-off weapons that could be released remotely, removing the need for the aircraft to penetrate deep into Soviet

territory. By 1960 grave concerns already existed in the British Government about the continued viability of gravity bombs as a means of delivering a nuclear attack.

The development of the Blue Steel missile was supposed to provide a solution to this problem. While 53 missiles were built, it quickly became clear that simply being able to stand off and deliver a nuclear weapon from afar was not the only criterion that would decide if the V-Force were going to remain effective.

The replacement of the Blue Steel with its range of 150 miles with a much longer-range

GAM-87 Skybolt missile built in the USA was supposed to elongate the lifetime of the V-Force. However, in 1962, when the future vulnerability of the V-Force was questioned in detail, Skybolt was also cancelled, leaving Blue Steel as the V-Force's sole stand-off weapon. That situation remained as the status quo until the introduction into service of the Polaris missile system.

After effects

What happened after a bomb detonated was anyone's guess. Great Britain would have been a radioactive desert, hardly a

Demonstrating its anti-flash white scheme to great effect Victor XA930 cruises high above the clouds. This airframe was delivered to the RAF in September 1957 and initially served as a trials aircraft with A&AEE at Boscombe Down before joining 10 Sqn in 1963. It later served with 232 OCU, 55 and 57 Sqs before being converted into a B(K).1 tanker in 1965 and later re-designated K.1 when it lost its bombing capability



Of course it is worth noting that the RAF were joined by their American counterparts with many British bases housing USAF Strategic Air Command bombers during the Cold War period. Here the crew of an RAF Victor and USAF B-66 Destroyer pose for the camera





A trio of Vulcan B.2s cruise out towards their targets during a mid-60s exercise

welcoming place for any remnants of V-Force. Instructions as to what to do next were always kept vague in order not to affect crew morale. Recovery to an operational NATO airbase, wherever one might be once a nuclear exchange had started, was usually seen to be a preferred option.

Despite the various attempts to improve survivability, optimistic analysis suggested that only around 20% of the V-Force would arrive over their prepared targets. Pessimistic assessments suggested even fewer would complete their missions.

While Moscow has always been seen to be of specific significance to Russia and the occupiers of the Kremlin, it was by no means the only target of interest and those bombers that did penetrate the Soviet air defence systems might have to be re-tasked at the last moment so as to ensure the final strike missions created the widest possible retaliatory impact on the Soviet Union.

In the era before the advent of satellite communications, the issue of trying to re-task or in the event of some form of last-minute political rapprochement,

recall the V-Force was one that scientists wrestled with in the early 1970s.

Long range communications using High Frequency (HF) radio systems were the only means available to communicate with the aircrews in flight. But if nuclear weapons were detonated, this mechanism for maintaining command and control of the missions would quickly become disrupted. Recall messages would also have been broadcast by the BBC on Long Wave using unique patterns of words, resembling the messages used to instruct the French Resistance in World War Two.

The twin concerns around survivability, plus the decision to move away from the Blue Steel stand-off weapon, which would have helped to mitigate one of these elements, meant that the days of the V-Force carrying the UK's nuclear deterrent were numbered.

Today the public look back nostalgically upon the last flyable V-Bomber. However, the Vulcan was a high technology package that could have spelled the end of civilisation as we know it, and as XH558 prepares for her final curtain it is important to remember the part she paid in protecting the world from Armageddon. ●



The Vulcan, Victor and Valiant all played a vital role in providing the Cold War nuclear deterrent



A pair of Vulcans overfly the Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales on the North Yorkshire moors



XH558

A VULCAN REBORN

The 'Delta Lady' has had a prominent presence on the UK display scene for the last eight years.

Richard Freail looks at the history, restoration and future plans for Vulcan XH588



With a rainbow appearing within her vapour 'blink' and vortices streaming from her wingtips, XH558 cuts a dashing figure on September 12, 2015

Gavin Conroy



Avro Vulcan B.2 XH558 enjoyed a remarkable operational career with the RAF, undertaking a number of roles which encompassed a significant part of the Cold War. She entered service the year before the Berlin Wall was constructed and retired the year after the Soviet Union ceased to exist. Her post-military life is an even more incredible story of dogged determination, persistence and triumph against all odds. It is one that has placed XH558 at the hearts of the British public.

Avro Type 698 Vulcan B.2 XH558 was ordered for the RAF under a contract for 17 examples placed on September 30, 1954. Built at Avro's Woodford factory near Stockport, the airframe was partially plumbed for the later cancelled Douglas Skybolt long-range nuclear stand-off missile – something that would prove useful in later service. XH558 completed her maiden flight in May 1960 and became the first B.2 in RAF service when delivered to 230 Operational Conversion Unit (OCU) at RAF Waddington, Lincolnshire on July 1.

In June 1961, XH558 transferred to RAF Finningley, South Yorkshire, where she served in operational roles including taking up residence in Hangar 3 as part of the Quick-Reaction Alert strategy for V-Force deployment, ready to fly East if the alarm sounded. XH558 moved back to her former base in February 1968 serving with the RAF Waddington V-Force Wing which comprised 44, 50 and 101 Sqns.

New roles

From 1965 onwards, a small fleet of Handley Page Victor SR.2 aircraft operated in the strategic reconnaissance role with 543 Sqn, but with that unit due to disband in 1974 there was a pressing need for a replacement. A decision was made to convert nine Vulcans for this role and in August 1973, XH558 was flown to Bitteswell, Leicestershire, a former operational RAF base but now used by manufacturers for flight testing, overhaul and maintenance of aircraft. Here, the aircraft was converted to a Maritime Radar

Reconnaissance role and designated the Vulcan B.2(MRR) to be operated by 27 Sqn which was reformed at RAF Scampton on November 1, 1973. Some of the MRR aircraft, including XH558, had the ability to carry air-sampling pods fitted to the redundant Skybolt missile hard points under the wings.

The drawdown of the Vulcan fleet started at the end of 1981 and 27 Sqn disbanded in March 1982; two aircraft with MRR capability, including XH558, transferred to 44 Sqn at Waddington to continue the role temporarily.

The Falklands conflict in 1982 highlighted the lack of capacity within the RAF's tanker fleet and so six Vulcans, again including XH558, were chosen to be converted quickly for AAR operations as an interim measure. XH558 was flown to Woodford in June 1982 and converted to K.2 standard, joining 50 Sqn at RAF Waddington in October. Shortly after delivery, XH558 went to the A&AEE, Boscombe Down, for tanker trials before returning to her unit. In 1983, the refuelling equipment was removed from '558 for use in the Vickers VC-10 tanker conversion programme; 50 Sqn disbanded in March 1984 and in September '558 was flown to RAF Marham for disposal. After 24 years of service, the end of the road had arrived for XH558.

Airshow icon

Despite its withdrawal from service, displays – which were very popular with the public – continued with Vulcan B.2 XL426 (now preserved by the Vulcan Restoration Trust at London Southend Airport). An unexpected and surprising decision was taken to maintain airshow appearances but with a different airframe, as XL426 was quickly running out of flying hours.

While equipment was being stripped out of '558, Vulcan XH560 was chosen as the display aircraft. However, a study of relevant paperwork revealed that this airframe only had



“In 32 years of service she had undertaken roles as diverse as trainer, bomber, reconnaissance, tanker and display aircraft”

about 160 flying hours remaining whereas XH558 was not due a major service for another 600hrs. Consequently, XH560 went to meet the scrap man while '558 was restored to airworthy condition and flown back to Waddington to join the Vulcan Display Flight.

In 1985, she underwent a Service Embodied Modification and was restored to B.2 standard, albeit some internal equipment was missing and there was a minor external difference. She was flown to RAF Kinloss and sprayed in an all-over camouflage scheme with the Lincoln coat of arms and Union Flag on the fin. The Panther's head emblem of I Group, Strike Command, was placed either side of the fuselage, just forward of the intakes. She returned to Waddington in November

1985 and replaced XL426, undertaking her first display in May 1986 at Bournemouth.

The end beckons...

Many more displays followed but by 1991 XH558 had amassed the most flying time of any Vulcan at 7,300hrs. A major service was due at 7,400hrs and the rear spar would require modification if flying was to continue. The following year, 1992, was declared as XH558's last flying season and then she would be offered for sale. In September 1992, the last displays were undertaken. XH558 made appearances at RAF Leuchars and RAF Finningley's 'Battle of Britain At Home' airshows on Saturday September 19, and then made her final public appearance at Cranfield, Bedfordshire the following day – where

she was flanked by the RAF Red Arrows as a fitting tribute to long and distinguished service. On Monday September 21, 1992 crowds gathered on the roads and fields around RAF Waddington; just before 10.30am, without any fuss or commotion, XH558 made a straight in approach and landed. The career of Vulcan B.2 XH558 was at an end for a second time – or so it seemed.

The public response to '558's withdrawal had been huge and surprised those in the corridors of power. Numerous petitions and campaigns were mounted on her behalf; politicians became involved with questions being asked in Parliament. A suspension in the sale of the aircraft, the continuation of currency flights for aircrew and the retention of the ground crew seemed to offer some hope, but it was not to be. Even with outside sponsorship, the MoD could not justify the RAF operating a single example of a complex and costly 1950s aircraft. The issue was further complicated by the impending retirement of the HP Victors from the AAR role, and the consequent loss of V-bomber engineering, ground and aircrew experience. The final blow came on January 27, 1993 when the MoD announced that XH558 would be sold; in 32 years of RAF service she had undertaken roles as diverse as trainer, bomber, reconnaissance, tanker and display aircraft.

The invitation for bids by tender went out in early February 1993 and prospective purchasers had to provide details of their



Airshow-goers show their support for XH558 at Cranfield in September 1992. Although many assumed their efforts to see the Vulcan fly again would be futile, they eventually got their wish! Charles Troop



On March 23, 1993 Sqn Ldrs Paul Millikin and David Thomas climb down from piloting XH558 at Bruntingthorpe on March 23, 1993 at the end of her 'final' sortie

intentions and how they would be achieved. The MoD intended to safeguard the Vulcan as best as it could within government guidelines; the airframe could be neither exported nor broken up for scrap. The successful bidder was announced in early March: David Walton who was both a pilot and successful businessman, with his family owning and operating the former bomber base at Bruntingthorpe.

His bid had significant advantages: the near 10,000ft (3,000m) runway allowed easy delivery; the Vulcan would be kept indoors, possibly in a specially constructed museum; she would be

maintained in taxiable condition and shown to the public and, to underpin his intentions, David Walton was also bidding for a substantial quantity of spares to sustain live operations.

On March 23, 1993 piloted by Sqn Ldrs Paul Millikin and David Thomas, the Vulcan made her final sortie in the hands of the RAF. With, reportedly, just 18hrs flying time remaining she made one last nostalgic tour of places that had been involved in her manufacture, maintenance and operation:

Woodford; Coningsby; Cottesmore; Marham; Scampton and Lincoln Cathedral. Some 3½hrs later she touched down at Bruntingthorpe and was greeted by another large gathering.

As David Walton received XH558's documentation, he announced he was aiming to construct a hangar and visitor centre and was recruiting a team of volunteers to help

maintain the aircraft. In a shrewd move, Walton had also bid for, and won, approximately 600 tonnes of Vulcan spares, including Bristol Siddeley Olympus 202 turbojets still in their crates with full documentation.

In July, XH558

performed two fast-taxi runs at Bruntingthorpe's 'Big Thunder' Airshow, and again in July 1994. The Vulcan joined the civilian register as G-VLCN in February 1995, and the 'XH558 Supporters Club' was launched in April 1997.

Challenges

In 1997, David Walton teamed up with Dr Robert Fleming to examine the possibility of flying XH558 again. Exploratory talks were

LEFT: XH558 completed her maiden flight in May 1960 and became the first B.2 in RAF service when delivered to 230 OCU at RAF Waddington, Lincolnshire on July 1 the same year

BELOW: For her final display, at the Dreamflight Airshow at Cranfield, Beds on September 20, 1992 XH558 was escorted in by the RAF Aerobatic Team

“XH558 was not due a major service for another 600hrs”

held with the Civilian Aviation Authority (CAA) and British Aerospace – both of which had declared previously that they would not agree to a civilian operated ex-military nuclear bomber being flown. Despite this, by mid-1999 there was general agreement between the parties that the aircraft could be returned to airworthy status and so the Vulcan Operating Company (VOC) was formed.

Key amongst the many significant issues that lay ahead were two fundamental challenges: the first, technical and the second, funding. While other ex-military jets were frequently owned and operated by civilians, nothing as large or complex as the Vulcan had been contemplated previously. Her return to flight would require the active support of all the Original Equipment Manufacturers (OEMs) – over 100 companies – as well as a fully professional organisation at Bruntingthorpe to restore, maintain and operate the airframe, powerplants and systems. If the first challenge seemed daunting, the second might sink the project before it really got started: several million pounds would need to be raised to restore XH558, and that feat would have to be repeated regularly to ensure her continued operation.

Staff from Marshall Aerospace conducted a two-month long 'health-check' in 1999 to assess the aircraft. A permanent team started to form at Bruntingthorpe: Dr Fleming became a full-time member; Andrew Edmonson joined as Engineering Manager and Trevor Bailey, with significant experience of Vulcan XL426 at Southend, came on-board as 'Crew Chief'. The relationship between VOC at Bruntingthorpe and VRT at Southend assisted, with the latter helping with fund raising and spares.

In 2001, the term 'Vulcan to the Sky' (VTTS) was devised to provide a vision of what was to come. However, the year was to prove disappointing as there was no major backer and the Heritage Lottery Fund (HLF) refused a VTTS application for a grant, prompting a deluge of letters of complaint. It was evident that XH558 would not be airborne to celebrate the Vulcan's 50th anniversary in August 2002.

Kick start

However, the following year proved a major milestone and kick-started the project



again. By January 2003, over 100 aerospace companies had signed up, including all of the OEMs, to support XH558 – the technical challenge was well on its way to being met. Invited to re-submit its grant bid to the HLF, the VTTS emphasised the proposed educational programme as well as the return to flight; establishing a VTTS Trust; purchasing the aircraft for the Trust and gifting her to the nation on retirement. Later in the year it was announced that VTTS had been successful and would eventually receive £2.7m. The organisation had also been busy raising money and now held a fund of £1.3m.

In early 2005, XH558 transferred from the Waltons to the VTTS Trust, and the Trust and Marshall Aerospace formalised the agreement to start work. The full RAF overhaul, described as a 'major plus', would

“XH558 has now flown more hours than any other Vulcan”

take at least 12 months and involved a programme of inspection and rectification as well as a fatigue life extension to the rear spar. One of the early tasks was to decide what needed to stay and what could be dispensed with. A lot of equipment and wiring was surplus and removed: the MTOW of the Vulcan reduced from



Since her return to flight XH558 has appeared in formation with aircraft as diverse as the Gnat Display Team's Folland Gnats, the BBMF Lancaster and the Vans RV-8s of the RV8ors. This summer she was briefly escorted through RAF Lakenheath's airspace by a pair of USAF F-15 Eagles *USAF/ Senior Airman Trevor T McBride*

204,000lbs (92,700kg) in RAF service to 175,000lbs (79,500kg) under civilian regulations. Later in the year, the nose section of Vulcan B.2 XM602 arrived from the Avro heritage Centre, Woodford, for use as a procedures trainer for the crew.

As time moved on, no insurmountable engineering problems were encountered but the work took longer than expected. However, finances were becoming stretched and it was estimated that by late 2005 there would be a shortfall of £350k; in early 2006 this had risen to £500k but by May 2006 it stood at £850k. In August the shortfall reached a not inconsiderable £1.2m and 30 full-time staff were placed on a month's redundancy notice. The Vulcan's roll-out was due at the end of August and Dr Fleming declared that, no matter what, it would



Whenever she makes an airshow appearance, XH558 has been the undisputed star and the 'Vulcan Effect' has seen people jamming surrounding roads in an attempt to get a glimpse of the aeroplane. Here she appears in front of an appreciative audience at the 2010 Goodwood Revival *Jeff Bloxham via VTTS*

happen. And it did – XH558 was overflown by the RAF Battle of Britain Memorial Flight's (BBMF) Avro Lancaster bomber, while the VTTS and the great British public had joined forces to raise over £1m in cash and pledges.

Vulcan – to the sky!

The engines were fitted in May and June 2007, but XH558 was going to miss out on an invite to join a flypast down the Mall, London, to celebrate the end of the Falklands War 25 years previously. Fuel tests in July were followed by engine tests on the pan at Bruntingthorpe; the mighty howl of '558's four Olympus engines at full power was heard on August 20, for the first time since 1993. In October, slow (90kts) and fast (120kts) taxi runs were completed – the latter with raised nosewheel and brake chute streamed. The following day, Thursday October 18, 2007, large numbers of invited guests, supporters and members of the press gathered at Bruntingthorpe: at 1226hrs her crew (Sqn Ldrs David Thomas, Al McDicken and Barry Masefield) lifted XH558 off runway 24 and flew away for some basic handling trials. Around half-an-hour later she taxied back in to thunderous applause.

Testing continued for several months and on July 3, 2008, XH588 was granted her Permit to Fly by the CAA. She was flown immediately to RAF Waddington where pilot David Thomas gained his Public Display Authorisation just in time for the Vulcan to fly on Saturday July 5, 2008 before a packed airshow crowd. XH558 performed a flypast with Avro designer Roy Chadwick's other masterful creation, the Avro Lancaster, and then commenced her first public solo display for 16 years.

Final curtain

Since then, Vulcan XH588 has flown at numerous venues and become, once again, a firm favourite of the British public. Along the way, there have been technical



The names of many of those who pledged money to keep XH558 in the skies were painted inside her cavernous bomb bay

Steve Bridgewater

XH558 was converted to K.2 standard at Woodford in 1982, joining 50 Sqn at RAF Waddington in October. In 1983, the refuelling equipment was removed from '558 for use in the Vickers VC-10 tanker conversion programme

PRIMAIA Collection



hiccups and financial issues but all have been overcome to reach a now familiar point in the XH558 story: she is to be grounded again, but this time it will be permanent. As the aircraft becomes older – she has now flown more hours than any other Vulcan – and more difficult to maintain, the three technical authorities, BAE Systems, Marshall Aerospace and Rolls-Royce, have collectively withdrawn their support from the end of 2015.

After her few remaining displays and a farewell tour across the UK, XH558 will land for the final time at Robin Hood Airport, Doncaster; the former RAF Finningley, having moved there in May 2011. There are ambitious plans for her though, and her engines will not remain silent.

Project Etna starts a new chapter in the life of '558 and the four pillars of the scheme aim to continue the educational aspect of her story and involve the

public, who have unerringly followed and supported the aircraft. The first pillar is the Vulcan Aviation Academy which will provide skills for the aviation industry, including pilots, operations and engineering; the second is the Vulcan Heritage Centre, the home of XH558 – currently the old V-Force Hangar 3 – which will accommodate visitors and private and corporate events; the third is Heritage Aircraft Engineering, building on the team's skills and leading other aviation

projects and finally the Etna Centre, a new initiative to change perceptions, particularly for the young, through hands-on experience of exciting technologies.

The project plans to develop a new purpose-built centre where these activities can be co-located on the edge of the airport and where XH558 can have easy access to the taxiways, so that her mighty howl does not become a dim and distant memory. ●

Crowds rush to the fence line to watch 'the people's aeroplane' land

Steve Bridgewater



The author would like to thank Richard Gotch, Richard Clarke and Ian Homer at the Vulcan to the Sky Trust for their valuable assistance with this article. Further information about XH558 can be found at <http://www.vulcantotheskysky.org/>

RIGHT: Project Etna starts a new chapter in the life of XH558 and aims to continue the educational aspect of her story and involve the public who have always supported the aircraft. The project includes the Vulcan Aviation Academy which will provide skills for the aviation industry as well as the Vulcan Heritage Centre and the Etna Centre – the latter a new initiative to change perceptions, particularly for the young, through hands-on experience of exciting technologies via VTTS



JETS

Avro Vulcan XH558 was the last airworthy V-bomber. Returned to the sky thanks to donations by the Heritage Lottery Fund and millions of pounds gifted by the general public the aircraft flew for eight further display seasons. By the time these words are read she will have made her final landing Neil Bury via Vulcan to the Sky Trust





THE SURVIVORS

A precious few V-Bombers have survived into the 21st century. Most are on static display, a few are capable of ground running but just one has been restored to airworthy condition



Vickers Valiant B(K).1 XD818 - RAF Museum, Cosford, Shrops

The RAF Museum's National Cold War Exhibition at RAF Cosford, Shropshire is home to the sole surviving Vickers Valiant airframe. Valiant B(K).1 XD818 was issued to 49 Sqn at RAF Wittering in November 1956 and took part in the Operation Grapple H Bomb tests at Christmas Island the following year. The aircraft was retired in 1965 and placed on display at RAF Marham. In 1982, the Valiant transferred to the RAF Museum at Hendon, London, where it remained until 2005 when it was moved by road to Cosford *Steve Bridgewater*



Vickers Valiant B.1 XD875 - Highland Aircraft Preservation Society, Inverness, Scotland (nose)

XD875 was the last Valiant ever built and performed its maiden flight on August 27, 1957. The jet was scrapped following an accident in November 1962 at RAF Wittering. The nose section was saved and passed through various hands, including owners at Bruntingthorpe and Newark before moving north of the border.



Handley Page Victor B.1A(K2P) XH648 - Imperial War Museum, Duxford, Cambs

XH648 first flew in November 1959 and was delivered to 57 Sqn at RAF Honington. In April 1964 it was assigned to 55 Sqn and lost her white paintwork in favour of camouflage for low-level sorties. The jet was soon converted to aerial refuelling configuration but retained its ability to drop bombs (hence the B.1A(K2P) standard). The aircraft was retired in 1976 and flown to the newly opened Imperial War Museum at Duxford. Although it was initially kept 'live', XH648 is now a purely static exhibit *Steve Bridgewater*



Handley Page Victor K.2 XH672 - RAF Museum, Cosford, Shrops

XH672 was ordered as a B.1 but produced as a B.2. Conversion to SR.2 status followed, before the aircraft was finally transformed into a K.2 tanker - the last Victor to be modified as such. It served with 543, 57 and 55 Sqs and is a veteran of Operation Granby. It is displayed in the National Cold War Exhibition complete with the Maid Marion nose art it gained while flying in the Gulf.

Steve Bridgewater



Handley Page Victor K.2 XL231 - Yorkshire Air Museum, Elvington, Yorks

XL231 is owned by Andre Tempest and on loan to the Yorkshire Air Museum, where it is kept in 'live' taxi-able condition. The jet first flew in December 1961 and joined 139 Sqn at RAF Wittering. It was later converted to carry the Blue Steel missile and then, in 1970, became the development aircraft for the K.2 conversion programme. It played an active role in the Falklands campaign and flew in Operation Granby (the first Gulf War) as Lusty Lindy; a name it retains to this day. It flew into Elvington on her retirement in October 1993 and has been maintained in impeccable condition ever since.



Handley Page Victor K.2 XL164 - Bournemouth Air Museum, Hurn, Dorset (Nose)

XL164 first flew in May 1963 and took part in Operation Granby as *Saucy Sal*. In 1993 it was retired from 55 Sqn in 1993 and went to Brize Norton as a ground instructional airframe. It was scrapped in 1995 and although badly damaged in the process the nose section was saved by Peter Vallance for his Vallance Byways Collection at Gatwick. In recent times the nose has transferred to the Bournemouth Air Museum.

Jamie Ewan

Surviving Valiants

XD816	B(K).1	Brooklands Museum, Weybridge, Surrey (nose)
XD818	B(K).1	RAF Museum Cosford, Shropshire
XD826	B(K).1	Cockpit Collection, Romford, Essex (nose)*
XD857	B(K).1	Norfolk & Suffolk Aviation Museum, Flixton, Suffolk (nose)
XD875	B.1	Highland Aircraft Preservation Society, Inverness, Scotland (nose)

* marked as WZ826



Handley Page Victor K.2 XM715 - Cold War Jets Collection, Bruntingthorpe, Leics

XM715 is another 'live' V-Bomber and performs regular engine runs and fast taxi runs at Bruntingthorpe. The jet previously served with 139, 100 and 543 Sqs as well as 232 OCU as a B.2, prior to being converted to K.2 standard for 55 Sqn. XM715 flew in Operation Granby as *Teasin' Tina* and today it retains that nose art as well as a depiction of Victor Meldrew – a reference to her 'Meldrew 1' callsign when it was delivered to Bruntingthorpe on her retirement flight. In 2009 the jet inadvertently got airborne during a fast taxi run – technically making it the last Victor to fly!

Jamie Ewan



Handley Page Victor K.2 XM717 - RAF Museum, Hendon, London (Nose)

XM717 first flew as a B.2 in March 1963 and, after conversion to K.2 standard, was operated by 55 Sqn in Operation Granby as *Lucky Lou*. The aircraft performed its final flight on October 1, 1993 and after scrapping the nose was saved for display at the RAF Museum.

Steve Bridgewater

Avro Vulcan B.1 XA893 - RAF Museum Cosford, Shrops (nose)

The nose of **XA893** is the oldest Vulcan artefact to be preserved, as the airframe dates from January 1956. The nose was a familiar exhibit at RAF Cosford for decades but in recent years it has been removed from public view. Steve Bridgewater



Avro Vulcan B.2 XL318 - RAF Museum, Hendon, London

The RAF Museum's Vulcan B.2, **XL318** is on display within the Bomber Command Hall – which it dominates! The jet performed its maiden flight in August 1961 and was retired 20 years later, in December 1981. It was then dismantled and moved by road to the museum in Central London – the only time a Vulcan has been successfully dismantled and reassembled. The aeroplane was in place by February 1982 and the museum was literally constructed around it.

Steve Bridgewater



Avro Vulcan B.2 XL319 - North East Aircraft Museum, Sunderland, Tyne & Wear

XL319 was delivered to the RAF in October 1961 and served with 617, 44 and 83 Squadrons at Waddington and Scampton before being retired and flown to Sunderland in January 1983 (when this photograph was taken). An ongoing effort continues to renovate and conserve the aircraft, which is kept outdoors.

All KEY Archive unless stated



Surviving Victors

XA917	B.1	Privately owned, Cupar, Fife (nose)
XH592	B.1A	Privately owned, Bruntingthorpe, Leics (nose)
XH648	B.1A(K2P)	IWM Duxford, Cambs
XH670	B.2	Cockpit Collection, Romford, Essex (nose)
XH669	K.2	Cockpit Collection, Romford, Essex (nose)
XH672	K.2	RAF Museum Cosford, Shrops
XH673	K.2	RAF Marham, Norfolk
XL160	K.2	Norfolk & Suffolk Aviation Museum, Flixton, Suffolk
XL164	K.2	Bournemouth Air Museum, Hurn, Dorset (nose)
XL190	K.2	RAF Manston History Museum, Manston, Kent (nose)
XL191	K.2	Estate of Walter Soplat, Newbury, Ohio, USA (nose)
XL231	K.2	Yorkshire Air Museum, Elvington, Yorks
XM715	K.2	Cold War Jets Collection, Bruntingthorpe, Leics
XM717	K.2	RAF Museum, Hendon, London (nose)
Simulator	K.2	Yorkshire Air Museum, Elvington, Yorks (nose)
Simulator	K.2	Newark Air Museum, Winthorpe, Notts (nose)



Avro Vulcan B.2A XM575 -
East Midlands Aeropark,
Castle Donington, Derbs

XM575 was delivered to the RAF in May 1963, entering service with 617 Sqn and going on to serve with 101, 50 and 44 Sqs. The aircraft took part in the Falklands victory flypast over London in October 1982 and was retired the next year, flying into East Midlands Airport where it has been on display at the Aeropark ever since. Her APU was run up regularly until the museum relocated close to a housing development and the noise was deemed unacceptable!

Avro Vulcan B.2 XL426 - Vulcan Restoration Trust, Southend, Essex

XL426 was the 44th of the 88 Vulcan B2s built and made her first flight on August 23, 1962. It would serve with 83 and 617 Sqs before becoming the founding aircraft of the Vulcan Display Flight in 1984. It was retired two years later and flown to Southend after being acquired by Roy Jacobsen, who had plans to return XL426 to the sky as a civilian display aircraft. The aircraft was registered G-VJET but would never fly again. Today, it is looked after by the Vulcan Restoration Trust charity, which has returned the jet to running condition. In 2005 the team took the decision to withdraw XL426 from taxiing 'service' to carry out a programme of in-depth restoration and repair work. This will eventually see XL426 return to high-speed taxiing condition. Phil Whalley/Avpics



Avro Vulcan B.2 XM598 - RAF Museum, Cosford, Shrops

XM598 was originally built in 1963 to carry the Skybolt stand-off missile but this project was cancelled. However, the redundant Skybolt fixtures were put to use during the South Atlantic Campaign in 1982 when XM598 carried Martel and Shrike anti-radar missiles during Black Buck missions as part of Operation Corporate. On May 1, 1982 XM598 was the lead aircraft for Black Buck 1 but the cockpit window refused to pressurise and XM607 took over to fly the mission. XM598 was flown into retirement at Cosford in January 1983 and is now on display within the National Cold War Exhibition. Steve Bridgewater



Avro Vulcan B.2 XM594 - Newark
Air Museum, Winthorpe, Notts

XM594 was built as a Blue Steel carrying B.2 and was delivered to the RAF on July 9, 1963. It flew with 27 Sqn and was pooled into the Scampton Blue Steel Wing until 1970 when it reverted to the conventional free-fall bombing role. The Vulcan would go on to serve 101 and 44 Sqs until February 7, 1983 when it was flown to Newark and retired. XM594 was originally kept partially 'live' but is now a well-kept static exhibit with regular cockpit access available to museum visitors.

Steve Bridgewater

Avro Vulcan
B.2 XM597
- National
Museum of
Flight, East
Fortune,
Scotland

XM597 entered service with 12 Sqn in August 1963, then served with 35, 50, 9 and 101 Sqs, including taking part in Black Buck missions during the Falklands conflict. On April 12, 1984 XM597 was flown into preservation at East Fortune. The aircraft has remained on display at the museum ever since.



Avro Vulcan B.2 XM603 - Avro Heritage Society,
Woodford, Cheshire

XM603 first flew from Woodford on November 15, 1963 and served with 9, 12 and 35 Sqs before being retired in 1982 and flown 'home' to Woodford. Although it had been intended to preserve XM603 'as is' the imminent Falklands Crisis saw the jet utilised as a 'plumbing prototype' for the K.2 conversion. Later the aircraft was repainted into an anti-flash white scheme and the refuelling probe and radar thimble were removed to represent an early Vulcan. The aircraft's future was in some doubt when BAE departed Woodford; however, her longevity now seems a little more secure.

Avro Vulcan B.2
XM607 - RAF
Waddington,
Lincs

Perhaps the most famous of all static Vulcans is XM607, which dropped a string of bombs on the Falkland Islands during the famed Black Buck raid in 1982. Today the aircraft is on display as a gate guardian at RAF Waddington. Once the home of the Vulcan fleet, the base now accommodates the RAF's Rivet Joint, Sentry, Sentinel and Shadow aircraft – an example of the latter is seen here departing over XM607. Jamie Ewan



Avro Vulcan B.2 XM612 - City of Norwich Aviation Museum, Norwich, Norfolk

XM612 first flew in February 1964 and operated with 9, 12, 35, 44, 101 and 50 Sqs prior to being selected as a Black Buck aeroplane in 1982. It was a reserve aircraft for a number of the Operation Corporate missions but never dropped bombs in anger. After retirement it was acquired by the City of Norwich Aviation Museum through the generosity of John Hale and was delivered on January 31, 1983. It has remained on external display ever since.

Avro Vulcan
B.2A XJ824
- Imperial
War Museum,
Duxford, Cambs

XJ824 first flew from Woodford on April 24, 1961 and flew with 27, 9 and 35 Sqs as well as 230 OCU before being retired in March 1982. On March 13 of that year it was flown to Duxford and was one of the first residents in the (then) newly built Superhangar (today AirSpace). XJ824 is one of only three Vulcans preserved under cover (the others being XL318 and XH558) but is seen here on a rare outside appearance.



Avro Vulcan
B.2A XL360 -
Midland
Air Museum,
Coventry,
Warks

XL360 flew into Coventry's Baginbton airport on February 4, 1984 ending a career that had begun on March 1, 1962 when the Vulcan was delivered to 617 Sqn at Scampton. The jet would also fly with 27 and 83 Sqs as well as 230 OCU. Today XL360 is named City of Coventry and takes pride of place within the excellent Midland Air Museum. Steve Bridgewater



Avro Vulcan
B.2 XM655 -
655 MaPS,
Wellesbourne
Mountford,
Warks

When XM655 landed at Wellesbourne Mountford airfield on February 11, 1984, hopes were high that it could be maintained in airworthy condition. However, the aircraft was destined to remain ground-bound when a lack of funding and support, combined with the airport's short runway, led to plans being abandoned. In 1992 the airport owners acquired the airframe and a group of enthusiasts set about restoring it to taxi-able condition. The aircraft is limited to 80kts due to runway length but it is a regular performer and also played a vital crew training role for XH558.



Avro Vulcan B.2
XM569 - Jet
Age Museum,
Staverton, Glos
(nose)

Vulcan XM569 was delivered to the RAF in January 1963 and performed its last flight 20 years later on February 2, 1983 when it was delivered to the Wales Air Museum at Cardiff (Rhoose) Airport. Sadly, being near the sea, the salt air quickly made corrosion a big problem and after the museum folded, XM569 was scrapped. Luckily the nose section was saved and after a period in Woking (painted as a rocket with silver fins!) the Vulcan was moved to the Jet Age Museum at Staverton. Steve Bridgewater



Surviving Vulcans

XA893	B.1	RAF Museum Cosford, Shrops (nose)
XA903	B.1	Privately owned, Stranraer, Scotland (nose)
XH537	B.2MRR	Bournemouth Aviation Museum, Hurn, Dorset (nose)
XH558	B.2	Vulcan to the Sky Trust, Doncaster Robin Hood Airport, Yorks (flyer!)
XH560	B.2	Cockpit Collection, Romford, Essex (nose)
XH563	B.2MRR	Privately owned, Over Dinsdale, Yorks
XL318	B.2	RAF Museum, Hendon, London
XL319	B.2	North East Aircraft Museum, Sunderland, Tyne & Wear
XL361	B.2	Goose Bay, Canada
XL388	B.2	Aeroventure, Doncaster, Yorks (nose)
XL426	B.2	Vulcan Restoration Trust, Southend, Essex
XL445	K.2	Norfolk & Suffolk Aviation Museum, Flixton, Suffolk (nose)
XM569	B.2	Jet Age Museum, Staverton, Glos (nose)
XM573	B.2	Strategic Air and Space Museum, Nebraska, USA
XM575	B.2A	East Midlands Aeropark, Castle Donington, Derbs
XM594	B.2	Newark Air Museum, Winthorpe, Notts
XM597	B.2	National Museum of Flight, East Fortune, Scotland
XM598	B.2	RAF Museum Cosford, Shrops
XM602	B.2	Avro Heritage Society, Manchester (nose) (Stored)
XM603	B.2	Avro Heritage Society, Woodford, Cheshire
XM605	B.2	Castle AFB, Atwater, California, USA
XM606	B.2	Eighth Air Force Museum, Barksdale AFB, Louisiana, USA
XM607	B.2	RAF Waddington, Lincoln, Lincs
XM612	B.2	City of Norwich Aviation Museum, Norwich, Norfolk
XM652	B.2	Privately owned, Welshpool, Powys (nose)
XM655	B.2	655 MaPS, Wellesbourne Mountford, Warks
XJ824	B.2A	Imperial War Museum, Duxford, Cambs
XL360	B.2A	Midland Air Museum, Coventry, Warks
XJ823	B.2A(MRR)	Solway Aviation Society, Carlisle, Cumbria



OPERATION GRAPPLE

Specially modified to conduct weapons tests of early hydrogen bombs Vickers Valiants took part in Operation Grapple. Pete London takes a close look at this essential part of Britain's development of thermonuclear defence systems

Britain's first atomic bomb was *Blue Danube*, a 10,000lb weapon with an explosive force of ten kilotons, later increased to sixteen kilotons – that's to say, corresponding to 16,000 tons of TNT. But by 1954 the country's armed services Chiefs of Staff had concluded even this huge destructive power would be insufficient to obliterate major enemy targets with a single strike. By then too, the United States and the Soviet Union had exploded massively more powerful thermonuclear (hydrogen) bombs.

In June 1954 the Conservative government approved a programme to create a British thermonuclear weapon, aiming for a yield (the explosive energy dissipated when a nuclear explosion occurs) of between five and ten megatons. The bomb would weigh between 9,000 and 12,000lb, and would be delivered by Britain's emerging V-bomber force.

Two months later, as hydrogen weapon

development began, the RAF's 1321 Flight formed at RAF Wittering using the Vickers Valiant and was charged with trials of *Blue Danube*.

Practice in dropping, and evaluation of the bomb's drop characteristics, took place using Suffolk's Orfordness range; Sqn Ldr Dave Roberts made the first release from Valiant WP201 on July 6, 1955. The *Blue Danube* casings contained telemetry equipment, and ballast to replicate the actual weapon. Two more crews joined 1321 Flight, led by Sqn Ldr Edward Flavell and Flt Lt R N 'Bob' Bates. The unit briefly became C Flight of 138 Sqn, before re-forming in May 1956 as 49 Sqn.

Further trials were planned, consisting firstly of ground detonations of *Blue Danube* in the Montebello Islands off Western Australia; the exercise was coded *Operation Mosaic*. Provided all went well 49 Sqn would then carry out *Operation Buffalo*, an air drop using South Australia's Maralinga test-ground. This would be followed by *Operation Grapple*,



The first Grapple detonation, May 15, 1957: the mushroom cloud of Short Granite, released by Valiant XD818

air drops conducted in the Pacific. *Grapple's* purpose would be to assess trial warheads in the megaton range, and generate sufficient data to allow development of an operational British hydrogen bomb.

Christmas Island

For the Operation *Grapple* tests, Christmas Island was chosen – an isolated Pacific atoll well over 300 miles south of Java and 1,600 miles northwest of Perth. On March 12, 1957 the first *Grapple* Valiant, XD818, arrived on the island, flown by 49 Sqn's CO Wing Cdr Kenneth Hubbard.

The *Grapple* Valiants received numerous modifications. Nose radomes were replaced by metal nose fairings, while metal anti-flash shutters were fitted to windows on the flight deck, bomb-aiming and crew positions. The navigation and bombing system equipment was removed and a panel inserted for the special weapons. To record drop characteristics and the explosions, cameras and instruments were fitted inside the bomb bay and in a modified tailcone.

Control surfaces were reinforced to allow for shock waves from the explosions; aerials employing Bakelite were specially-treated, and strain and pressure-detecting instruments installed around the airframe. Each aircraft received a white cellulose paint



Crew of Grapple Valiant XD823. Left to right:
Flight Lieutenant Donald Briggs (co-pilot),
Flight Lieutenant Wilfred Jenkins (bomb-aimer),
Dave Crowther, Paddy Scanlon,
Squadron Leader Arthur Steele (captain),
crew chief Roy Quinlan *Author's Collection*

scheme to reflect the blinding flash from the detonation; kept scrupulously clean, the paint was repaired if at all damaged. All exterior black rubber seals were painted white or replaced by white seals.

By mid March 1957, four aircraft (XD818, XD822, XD823 and XD824) had arrived and their crews were practising visual bombing techniques from 45,000ft using standard 100lb bombs. The first *Grapple*

exercise was also rehearsed using a 10,000lb high-explosive bomb. All went well.

Historic mission

On the morning of May 15, 1957 Shackletons also based at Christmas Island confirmed the drop area was free of shipping, while Canberras conducted weather reconnaissance and prepared for air sampling duties.



Valiant XD818 on Christmas Island,
where facilities for maintenance were
somewhat improvised *Author's Collection*

After a final inspection of the device by Aldermaston's scientists, Valiant XD818 was loaded with the thermonuclear warheads behind security screens. Piloted by Ken Hubbard, the aircraft left Christmas Island at 09.00 local time, its 10,000lb weapon codenamed *Short Granite*. The area selected for the drop was Malden Island, an uninhabited speck 400 miles south of Christmas Island.

XD818 climbed to 45,000ft, followed by the grandstand Valiant flown by Sqn Ldr B T Millett. After runs over the target to check navigation and the telemetry instruments, Hubbard made his live run flying at Mach 0.76. XD818's bomb-aimer, Flt Lt Alan Washbrook, released the weapon at 10.36 hrs; 50 seconds later, at 8,000ft, it exploded.

Hubbard had lowered his window anti-flash screens, and turned XD818 away from the explosion in a specially-developed escape manoeuvre. This involved a 60-degree bank to port through 130 degrees, at a constant speed of Mach 0.76 and maintaining an accelerometer reading of 1.7 G, then a roll-out and flight away from the shock-wave.

The technique had been devised by Vickers test-pilot Brian Trubshaw, to keep the aircraft tail-on to the bomb at the point of detonation while avoiding a high-speed stall through too tight a turn. The manoeuvre was successful, XD818 experiencing only brief and mild turbulence from the blast.

Six minutes after detonation the window shutters were raised and Hubbard circled the drop site, observing the bomb's towering mushroom cloud, before returning to Christmas Island. His historic mission had lasted 2hrs 20mins.

“Each Valiant received a white cellulose paint scheme to reflect the blinding flash from detonation”

Although *Short Granite* yielded an explosive force of 300 kilotons, the scientists' prediction had been one megaton – the equivalent of a million tons of TNT. That said, as the narrator put it during the subsequent Atomic Weapons Research Establishment (AWRE) film of the event, “man had made his own sun.”

Further drops

The second live drop was made on May 31 by Valiant XD822, with a smaller warhead coded *Orange Herald* intended for the *Blue Streak* ballistic missile. Flown by Dave

Roberts and his crew, again Malden Island was the target. Initially all was well, the bomb released as planned. At that point though XD822's specially-fitted accelerometer failed, giving a false reading; pulling into its escape turn the aircraft stalled, but Roberts quickly recovered and flew safely away from the blast. Again, brief and moderate turbulence was experienced. A huge fission bomb rather than a thermonuclear device, *Orange Herald* yielded a power of 720 kilotons.

On June 19, Valiant XD823 with Sqn Ldr Arthur Steele made the third release, the bomb code-named *Purple Granite* and weighing around 6,000lb. The aircraft experienced two shocks: one from the bomb's direct blast, the other (and stronger) reflected off the sea.

Grapple had generated considerable information on the performance of the bombs so far produced. However, the Chiefs of Staff and AWRE felt more testing was necessary before the final form could be decided of the warhead for Britain's planned operational thermonuclear weapon, *Yellow Sun*. Accordingly three further trials were planned. Operation *Grapple X* took place during October and November 1957; *Grapple Y* during April and May 1958; and *Grapple Z* during August and September 1958.

Initially four 49 Sqn Valiants travelled to Christmas Island for *Grapple X*, though aircraft were rotated as servicing in Britain

Valiant line-up on Christmas Island during Operation Grapple

Key Collection



Seen with its servicing platform, Valiant XD824 flew as the Grapple Y grandstand aircraft and also participated in Grapple Z

James Gray via Author



required. Using data from earlier tests Britain had developed a new thermonuclear weapon known as Round C, which was simplified and, it was expected, would prove much more powerful than previous bombs.

The three later *Grapple* drop zones were not Malden Island but instead an offshore point south-east of Christmas Island itself,

expectation of around 1.0 megaton. Gratifying perhaps, though such disparity prompts the question of how much control the scientists had over their work at that point.

‘A second dawn’

During the following year Christmas Island's Valiants conducted *Grapple Y* trials with

weapon. XD818 piloted by Flt Lt Sinclair ‘Tif’ O’Connor flew grandstand. The bomb’s force was measured at 1.2 megatons, the only such British weapon dropped using the blind radar bombing technique. Bombing error improved to 95 yards, compared with an average 245 yards with the visual bombing technique. Subsequently a film of the event was released by *Pathe News*, whose awestruck commentator described the explosion as “a second dawn”.

On September 11, 1958 Valiant XD827 with Sinclair O’Connor performed the seventh airborne trial, *Grapple Z*’s final drop. XD824 was the accompanying Valiant, piloted by Sqd Ldr H A ‘Tony’ Caillard. The bomb was code-named *Halliard*, a three-stage weapon with two fission components followed by one thermonuclear stage. For the drop it was intended blind radar bombing be used again, but a fault in the radar site’s transmitter meant the visual technique was adopted. Once more release was from 45,000ft, while as predicted the bomb’s yield was 800 kilotons.

Valiant trials of Britain’s nuclear weapons ended with *Grapple Z*. Further tests (*Grapple M*, *N* and *O*) planned for 1959 and 1960 were abandoned. The aircraft travelled back to Wittering and were subsequently returned to their earlier forms, the only V-bombers ever to drop atomic or nuclear bombs. ●

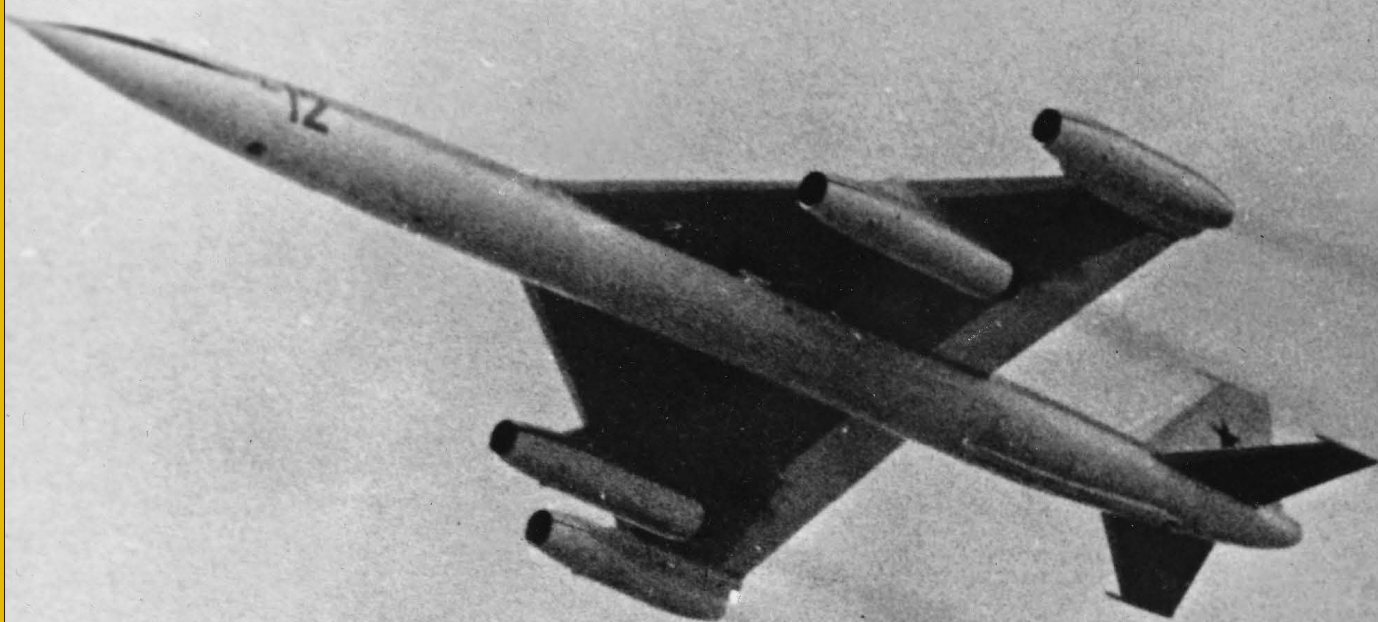
“Hubbard turned XD818 away from the explosion in a specially-developed escape manoeuvre”

around 20 miles from the airfield. The Valiants flew an elongated oval course off the island’s eastern side, ending in the bombing run and known as the ‘race track’. No special precautions were taken to protect those below, apart from the issue of anti-flash glasses and the instruction, announced over tannoy, to sit on the ground and turn away at the time of detonation.

On November 8, 1957 Valiant XD825 flown by Barney Millett released Round C, with XD827 as grandstand aircraft piloted by Bob Bates. The explosion was measured as 1.8 megatons, massively exceeding AWR’s

an even more powerful bomb. On April 28, XD825 piloted by Bob Bates dropped the new weapon; the grandstand aircraft, XD824, was flown by Sqd Ldr G M ‘Bill’ Bailey. XD825 experienced considerable turbulence but landed unharmed; that time, as AWR had accurately predicted, the yield was a power of three megatons. Just one detonation was carried out during *Grapple Y*, the largest British nuclear test ever.

Grapple Z saw two bombs exploded. On September 2, Valiant XD822 with ‘Bill’ Bailey and his crew released Flag Pole off Christmas Island, a smaller form of the *Grapple Y*



COUNTERING THE V-FORCE



Nikolay Yakubovich discusses the radical Myasishchev M-50 Bounder strategic bomber that was designed to elevate Mutual Assured Destruction to supersonic levels

In July 1961 an event occurred in the skies over Moscow, which astonished not only the layman but also aviation experts. An enormous four-engine aircraft with a delta wing performed a flypast in the aviation parade at Tushino airfield, and after lighting the afterburners, faded into the distance.

Much was written about this aircraft overseas, but it was not seen again in the air. The secret was revealed seven years later when the M-50 aircraft became an exhibit at the aviation museum in Monino near Moscow.

The history of the M-50 began in the 1950s when not even all fighter designs were

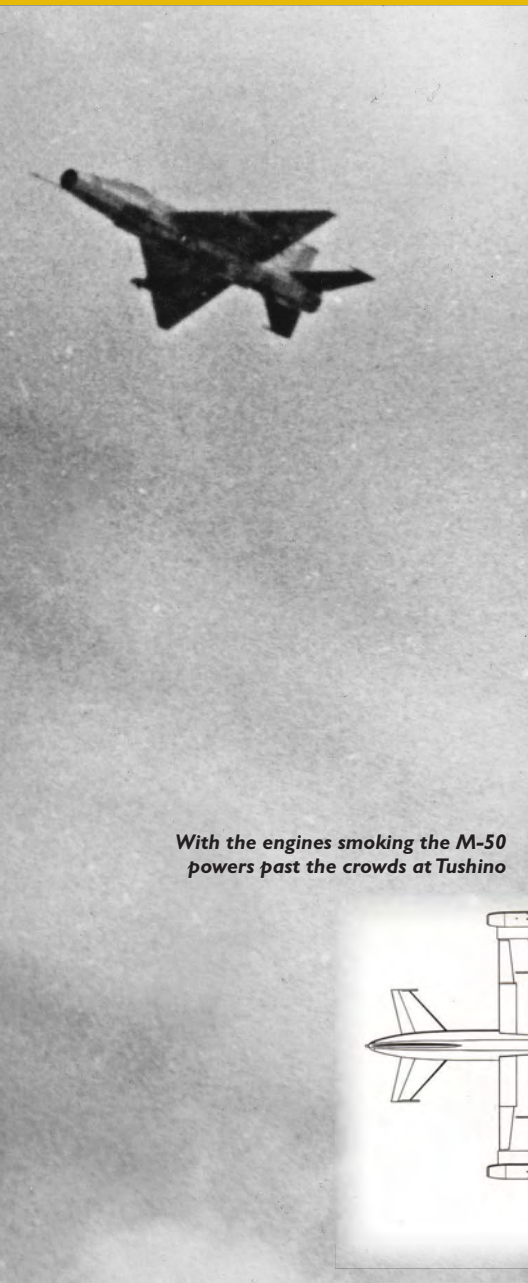
capable of supersonic speeds, yet this was a bomber, and a strategic bomber at that.

According to the specification issued by Vladimir Myasishchev's Experimental Design Bureau Number 23, this aircraft should have been capable of developing a maximum speed of 972kts, and 810-864kts in the cruise at altitudes up to almost 50,000ft. The practical flight range with a bomb load of 11,023lb was estimated at 8,077 miles.

The original concept called for the aircraft to consist of two stages, from which the first stage would be jettisoned close to the target. This being the case, an order came through to investigate the possibility of using

the second stage as an independent bomber and to establish its flight performance characteristics based on the results of state testing. Three examples of this detachable long-range bomber would need to be manufactured and the first was to be handed over for testing in 1957.

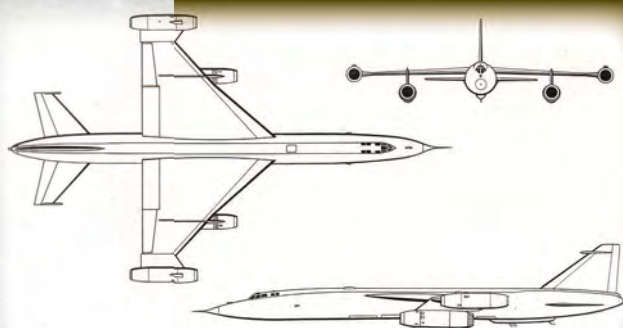
Experimental Design Bureau Number 23 produced a detailed design for a 'Detachable Long-range Bomber' but this was to remain on paper. During the following year the bureau examined many different variants for this aircraft's configuration, and in the end they opted for a 'pure' long-range bomber with a classic shape and with a higher



With the engines smoking the M-50 powers past the crowds at Tushino



The Bounder was an incredibly futuristic looking aeroplane. Unfortunately, for the USSR, it never lived up to its promise



The Bounder's unique design is evident in this image, taken at Monino in August 2001. The aircraft has been on display at the museum since 1968 **KEY** – Steve Bridgewater

cruising speed. This was to be designed first and foremost around four turbofan engines with an NK-6 afterburner chamber. There were alternative variants that would employ the VD-9 and M16-17 turbojet engines.

Irreconcilable differences

Many issues can arise when developing a new aircraft, and the answers to these questions can be found through scientific research work. In creating what would become the M-50 it seemed that the designers would have to reconcile the irreconcilable.

Given the high specific fuel consumption of the turbojet engines of the era, not only would it be necessary to ensure a high supersonic speed, but also a vast flight range. In order that these ideas might be realised, the designers decided to reduce the number of crew to two, leaving just a pilot and navigator who would be housed in a cockpit behind protective armour in K-3 ejector seats.

The crew's seats were located behind

one another in a tandem arrangement, and furthermore the crew would embark and eject through hatches in the underside of the fuselage. In order to solve any issues that may arise in flight, it was necessary to make the aircraft fully automated. However, provision was made to transfer to manual control when necessary during take-off, landing and in-flight refuelling as well as in the cruise.

One considerable innovation was the 120/208 Volt alternating current generators that were used in place of the traditional sources of direct current and had a frequency of 400 Hz.

The aircraft used an ABSU-50 flight-navigation and automatic aircraft control system and an electrically signalled control system was also proposed to control the engines.

By now dubbed the Myasishchev M-50, the new bomber was designed to fly at speeds ranging from 168kts to 1,243kts at altitudes of up to 52,494ft. Its take-off weight reached 253 tonnes, of which the fuel accounted for 170 tonnes. It was also proposed that the aircraft would refuel in flight twice during very long-range flights. This being the case, it was necessary to ensure stable and controlled flight across all flight modes, which meant that an all-moving vertical and horizontal stabiliser would be required. In order to make the airframe lighter, milled, solid-drawn outer skin panels were used. These transformed the wing into a powerful torsion box.

To begin with the aircraft was created as a means of delivering aerial bombs, although the possibility of accommodating cruise and ballistic missiles on the aircraft was proposed even at the design stage.

The designers finally put their faith in the M16-17 engine producing 46,297lb/thrust and by the beginning of 1961 this was the most powerful augmented bypass turbojet engine being developed in the Soviet Union.

Maiden flight

In December 1955 the air force was presented with a detailed design for the second variant of this aircraft, and by May 1 of the following year a model had been produced. The chief test-pilot was appointed in the September of that year, but the engines failed to materialise on time. In order not to lose time VD-7BA engines (producing 24,250lb/thrust each) were installed on the prototype variant of the aircraft, which had been designated the M-50A.

As preparations continued for the first flight, the design team began work on the M-52 variant in May 1959. This was to be a development of the M-50 and sealed the fate of the M-50A as an experimental aircraft.

On October 27, 1959 test-pilot Nikolay Goryaynov took the M-50A into the air on

all of a sudden a decision was taken to demonstrate it to the public at the aviation parade in Moscow in July 1961.

M-52

The long-range M-52K system was a further development of the M-50, and was designed for area bombing as well as striking specific ground targets.

This system was developed in accordance with a government decree dated July 31, 1958 and incorporated the already-built M-52 aircraft, the X-22 cruise missile and the K-22U control and guidance system.

The M-52 was to be produced in two variants: as a two-seat combat and three-seat trainer aircraft. In the first variant the pilot and navigator were seated side-by-side, while in the second the instructor would sit to the right of the student, and the navigator's position was moved forward, behind the pilot's instrument panel.

The first variant of the M-52 that was put forward saw all the engines mounted on pylons under the wing. Subsequently



The bomber is towed out across a snow covered Zhukovsky airfield in late 1959

rejected in view of its excessive performance and this was replaced by a traditional tailfin with a rudder. An additional balancing horizontal fin was mounted on the top of the tailfin, which angled downwards only when the aircraft entered a nose up attitude.

The nose section of the aircraft was then shortened in comparison with that of the M-50A, which reduced the dynamic loads on the fuselage and its weight. A flight navigation system was introduced that employed the 'PN' radar.

Aside from the 11,023lb of freefall aerial bombs the aircraft's armament included RAT-52M rocket propelled torpedoes and naval mines. It was also to incorporate the X-22 cruise missile and X-44 air to ground missiles carried along the sides of the fuselage.

Armed and deadly

If the aircraft were to carry missile armament alone, it was proposed that an additional fuel tank be carried in the cargo compartment. It was envisaged that the M-52 be fitted with a firing assembly in the stern of the aircraft consisting of 23mm GSh-23 guns and a 'Krypton' radar sight.

In the opinion of the military, this would be sufficient to protect the aircraft from attacking fighters that employed optical, or infrared sights, as well as from 'Nike' anti-aircraft missiles

“It seemed that the designers would have to reconcile the irreconcilable”

its first flight. Subsequently the aircraft was fitted with inboard VD-7MA engines with an afterburner chamber in order to break the sound barrier, but the outboard engine nacelles retained their VD-7BAs.

The M-50A had completed 18 test flights when, in 1960, a decision was taken to curtail work both on this project and on the M-52, which by this time had been manufactured. The aircraft stood on the airfield for nearly two years, but

however the M-50A's engine layout was chosen. Intake bullets were placed at the entrance to the intake assemblies, which further reinforced the fact that the aircraft was designed for flight at high supersonic speeds. Fins appeared at a later stage on the outboard engines and these small, low aspect ratio aerodynamic surfaces increased the aspect of the wing, and in turn enhanced the aerodynamic efficiency of the aircraft.

The all-moving vertical stabiliser was later



The M-50 was coded 'Blue 12' when it appeared at Tushino in July 1961 but had originally worn the markings of 'Yellow 023' when flight testing began at the Experimental Design Bureau Number 23 airfield in May 1959



Today the M-50 can be found on display at the Monino museum near Moscow
Steve Bridgewater

using infrared or passive guidance systems. Furthermore the 'Krypton' was able to detect targets at a distance of up to 4.6 miles, and lock onto them at a distance of nearly 3 miles.

The 'Roza-1' active jamming system provided defence from attacking fighters using a radar sight, and once an interceptor's radar system had locked on the 'Avtomat-2' took over and created a cloud of chaff. The M-52 was defended from forward fighter attacks by the Roza-1 system as well as TRS-45 rocket-propelled projectiles carried in front of the wing in the forward section of the fuselage. These unguided projectiles put up curtains of chaff directly in line with the

"It would be necessary to ensure a high supersonic speed and a vast flight range"

M-52's heading and could also be used to defend the aircraft from anti-aircraft missiles.

The aircraft relied on four M16-17B (RD16-17B) engines producing 40,786lb/ thrust but the use of augmented M16-17Fs or NK-6Ms was not ruled out. The aircraft was assisted on take-off by S3-42M launch accelerators using a liquid fuelled rocket engine producing an extra 37,479lb/thrust for a period of around a minute.

Restricted range

In April 1959 Experimental Design Bureau Number 23 presented the customer with a model of the M-52K. However, the most complex task in creating both the M-52 missile carrier and the earlier M-50 lay in

ensuring the required range.

With a design take-off weight of 363,762lb the M-52's range when operating as a bomber would not exceed 2,548 miles. According to the Experimental Design Bureau's calculations this parameter would not exceed 1,429 miles in flight with two missiles. This was almost half that stipulated in the Soviet governmental decree. Only if the aircraft flew with a single missile would the lower limit of the specification of 2,516 miles be reached.

However, even though a cruise speed of 972kts was projected, in order to reach the hoped for range the speeds would need to be reduced to transonic speeds of between 430-540kts at an altitude of between 18,000 and 28,000ft for more than half of the sortie. The rest of the flight would see the aircraft accelerate to a speed, consistent with Mach 1.7 and gain altitude.

The military also noted that the thrust to weight ratio of the M-52 ruled out the possibility of attaining a supersonic cruising speed with a take-off weight of 396,000lb.

A bitter disagreement broke out over where the M-52 was to be based. Experimental Design Bureau Number 23 argued in accordance with the specification that the aircraft should be based at the best-equipped airfields with a runway length of no less than 3,000m. The military demanded that the runway length be reduced to 2,500m. As a result, the designers proposed that a central, jettisonable, four-wheeled undercarriage truck be fitted for take-off in an overloaded configuration.

Survivability

A vertical take-off variant using launch accelerators with a total thrust of 793,664lb was also examined and designers claimed that by setting the accelerators at an angle of around 53 degrees to the horizontal they could provide a zero-length take-off. They claimed they would also accelerate the aircraft

to a speed of 300kts in 15 seconds and allow it to attain an altitude of 984ft over a distance of 1,500-2,000m. In this case the take-off weight of the M-52 increased to 478,403lb.

It was anticipated that this would increase sharply the 'survivability' of long-range aircraft in the case of a pre-emptive strike by a likely enemy.

It was also proposed that the aircraft use arrester gear, similar to that used on aircraft carriers. A long-range naval reconnaissance variant the M-52R was examined.

In order to achieve the required range Experimental Design Bureau Number 23 proposed modifying the M-52A missile carrier by enhancing the aerodynamic efficiency and reducing the weight of the airframe.

This, however, only served to make the project more complicated and did not produce the required results. At that time the Soviet aircraft industry was not able to solve the principle issue – creating a highly efficient engine. This appeared some 15 years later.

Like most of the early 1960s supersonic strategic bomber projects around the world the M-50/52 programme was terminated due to the development of Intercontinental Ballistic Missiles and, to a degree, the priority assigned to the Soviet space programme. The M-52 would never take to the skies. ●

SPECIFICATION MYASISHCHEV M-50 BOUNDER



Crew	2
Length	188ft 7in (57.48m)
Height	27ft 1in (8.25m)
Wingspan	115ft 2in (35.10m)
Wing Area	3,128sq ft (290.60m ²)
Empty Weight	187,393lb (85,000kg)
Max Take-Off Weight	440,925lb (200,000kg)
Max Speed	1,053kts (1,212mph/1,950km/h)
Service Ceiling	54,134ft (16,500m)
Ferry Range	4,598 miles (7,400km)
Powerplant	Two Dobrynin VD-7F afterburning turbojets (30,865lb/ thrust each) and two Dobrynin VD-7 non-afterburning turbojets (24,000lb/ thrust each)
Armament	66,000lb of bombs or missiles
First Flight	October 27, 1959

Artwork: Andy Hay / www.flyingart.co.uk

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Testing Times

In a special pre-Christmas 'Testing Times' the team put the latest jet-related books and products to the test. We suggest you leave the magazine surreptitiously open while dropping hints about possible presents...!



BOOK
**Vulcan XH558 -
Fifty Five Years,
Eight Seasons**
VTTS
Pages TBC,
hardback,
B&W & colour
ISBN TBC
£20.00.

This new book celebrates the entire flying life of Vulcan XH558 and will be richly illustrated. From the type's development, it follows '558 through RAF operational service into the Vulcan Display Flight and eventual retirement. It deals with 'The Bruntingthorpe Years' and reveals the challenges of the incredible return-to-flight restoration project. Each of the last eight display seasons since returning to the skies are documented before concluding with a look at plans for '558's future.

The book will contain spectacular images captured throughout the 2015 season, including the last ever landing at Robin Hood Airport. Due for completion after the final flight, this book is available to pre-order and will be published in early December in time for Christmas!

BOOK

Tornado in Pictures – The Multi-Role Legend

David Gledhill &
Darren Willmin
Fonthill Media
96 pages,
softback,
B&W & colour
ISBN 978-1-78155-463-0
£14.99.

Fresh from the success of his Tornado F3 in Focus book [see Jets Sept/Oct p52] former Tornado F2 and F3 navigator David Gledhill returns with this book looking at the history of the multi-role Panavia Tornado. It also includes both IDS and ADV versions of the aircraft and focuses on the 'Tonka's' role in fighter-bomber, fighter, reconnaissance and electronic suppression roles. It also looks at the jet's participation in the Cold War, Gulf Wars, Kosovo and Afghanistan as well as modern conflicts against ISIS in Iraq and Syria.

Lavishly illustrated with both Gledhill's own unique in-service images and photographs taken by aviation photographer Darren Willmin, this book will appeal to everyone with an interest in this iconic aircraft.



BOOK

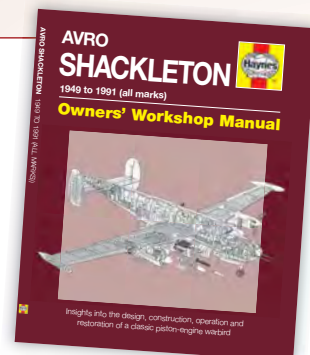
Avro Shackleton Manual

Keith Wilson
Haynes
208 pages, hardback,
B&W & colour
ISBN 9780857337696
£25.00.

The latest Haynes Manual focuses on 'The Growler', 'The Old Grey Lady', 'The contra-rotating Nissen Hut' – or, simply, the Avro Shackleton!

Of course it's not jet or turboprop powered, but this book is so good (and the subject matter such a core part of the Cold War history we celebrate at Jets) that we couldn't not include it here. After all, who doesn't like 'Ten thousand rivets flying in close formation'?

As you'd expect, the book looks at the development and history of this delightful old aeroplane, but it also provides a wonderful insight into the restoration of a potentially flyable 'warbird'. The Shackleton Preservation Trust's Shackleton MR2 (WR963), currently under restoration at Coventry Airport, forms the basis for much of this



manual and its restoration and operation are discussed in detail.

The book also includes many first-hand accounts of what it was like to fly and maintain the 'Shack' in RAF service, including recollections from Sqn Ldr Mike Rankin who operated the aircraft within Coastal Command around the world, and over the Christmas Island nuclear tests in 1958.

As well as providing close-up views of the Shackleton inside and out, the manual is also packed with more than 300 archive and air-to-air photographs, many of which are previously unpublished, plus a range of original RAF technical illustrations.

BOOK

Thor Ballistic Missile – the USA and UK in Partnership

John Boyles
Fonthill Media
240 pages, hardback,
B&W & colour
ISBN 978-1-78155-481-4
£25.00.

Faced with worrying advances in Soviet missile technology, in the mid-1950s the USA sought to develop a missile to act as a stop-gap until the Atlas Inter-Continental Ballistic Missile (ICBM) became operational. Intense inter-service rivalry followed before the USAF gained the upper hand. The UK, keen to improve its 'special relationship' with the US and still

smarting from the Suez Crisis, agreed to accept 60 Thor missiles to be operated by RAF crews. Covering activities on both sides of the pond this book is a thoroughly researched, documented account of the USAF and RAF's collaboration, featuring a number of previously unpublished photographs, plans and diagrams of the missile sites and equipment, and the anecdotes of the servicemen who took part in this exchange.



BOOK

RAF in Camera – 1950s & 1960s

Keith Wilson

Pen & Sword

304 & 302 pages, hardback,

B&W & colour

ISBN 9781473827950 &

ISBN 9781473837768

£35.00 each

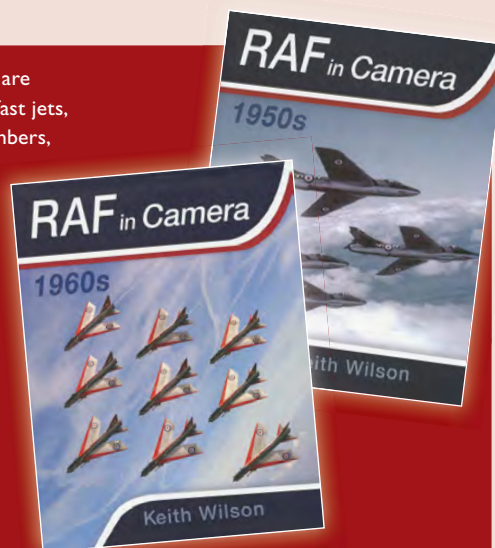
These two books provide a photographic account of the 1950s and 1960s, both important decades for the RAF which saw significant change. Each year is allocated its own chapter with a description of developments and events. While the text is

informative and important, it is the magnificent photographs that really grab the reader's attention. These have come from the archives of the Air Historical Branch but we're sure they have received much love and attention from the author to ensure their appearance and presentation is top notch.

These were periods of great technological advances in aviation which are mirrored by the progress in photography: the 1950s volume contains predominantly black and white images and the second volume, mainly colour photos.

All types of RAF aircraft are featured: from props to fast jets, trainers, transport, V-bombers, helicopters and test aircraft. In all, there are around 600 historic images in each volume, all well-captioned with relevant and interesting information.

These are two beautifully produced volumes and we make no apology for saying again: the photographs are wonderful! Highly recommended!



BOOK

Famous Russian Aircraft – Sukhoi Su-24

Yefim Gordon & D Komissarov

Crecy Publishing

320 pages, hardback, B&W & colour

ISBN 9781857803709

£39.95.

Developed in the Soviet Union in the 1960s, the Su-24 tactical bomber has become one of the most successful aircraft in its class. Featuring delta wings and auxiliary lift engines to improve its field performance, the first prototype turned out to be “more of a liability than an asset” and the aircraft was redesigned to have variable geometry wings.

The Su-24 had its baptism of fire in the Afghan War and was also exported to Iraq, Iran, Algeria, Libya and Syria, seeing action in some of these countries. At home, Russian Air Force Su-24s were heavily involved in the first and second Chechen campaigns and the type has undergone a mid-life update, allowing it to carry precision-guided munitions.

This new book covers all variants including Su-24MP ECM aircraft and includes a look at the type's service in the Afghan war.

Illustrated with over 750 photographs (many hitherto unpublished) as well as line drawings, colour side views, insignia, unit badges and nose art, this latest addition to the Famous Russian Aircraft series will be of interest to aviation enthusiasts and scale modellers alike.

T-SHIRTS

Flyinggraphics

Sizes: M, L, XL, XXL & XXXL

www.flyinggraphics.com

£18.00.

Formed by Scott and Tom Sullivan, Flyinggraphics has achieved what many thought to be impossible – they've made aviation themed t-shirts 'cool'!

Their stylish and innovative garments are likely to appeal in equal measure to the die-hard enthusiast and the fashion lover – at last, here's an enthusiast's t-shirt you can wear to the pub without feeling you've donned your 'anorak'!

Some, such as the Buccaneer themed shirt, include schematic drawings as well as lists of units and squadrons (depicted on the back almost like the tour dates on a rock music shirt!).

Others (including the 'Bear Hunter'

– our personal favourite) are more stylised, whereas a number of World War Two subjects are catered for with 'Boys Own'-style cartoons.

Jet related subjects in the current range include the Tornado, Jaguar, F-4 Phantom, Buccaneer, F/A-18, Hunter, Lightning, VC10, MiG-29 and Typhoon plus – quite aptly for this special issue of *Jets* – the Vulcan, Valiant and a very stylish 'V-Force' shirt.

In case you hadn't guessed, we like these t-shirts a lot!



WATCH

6B Watches

6B - HS9 - MK2 Pilots

www.6bwatches.com

£1,795.00.

Surrey-based 6B watches is owned and run by ex-RAF technician Carl Evans, who has a keen interest in military aviation as well as horology and has combined his two passions to create very desirable limited edition chronographs. Carl launched his first watch (the MK1) in September 2013 as a limited edition of 20 – and they quickly sold out. He has now followed this up with the new MK2, which has a limited run of 50 units.

Working on the assumption that less is more, 6B is keen to produce watches that are designed and made with a military style and feel. Dials are highly readable and functional and there is the minimum of cluttered engraving on case backs. 6B uses Swiss made mechanical movements for its watches, with handsets and dials also manufactured in Switzerland.

Each watch comes with two handmade straps - a 'vintage military' NATO-style pull though in dark brown (lined with soft goatskin leather) and a nylon strap complete with a home machined buckle.

As well as designing the watches, Carl also designs and physically makes the presentation cases and also the straps that compliment each watch. Each MK2 watch is individually numbered and packaged within a choice of two presentation cases; either a ceramic-coated aluminium case or with an oak case.

THE FUTURE OF BRITISH AIRSHOWS

In the wake of the recent Shoreham Airshow accident, the CAA has announced a review of air display policies.

Those who witnessed the tragic accident at Shoreham Airshow, shortly after 1.20pm on Saturday August 22, will be forever haunted by what they saw.

Eleven members of the public lost their lives that day and Andy Hill, the pilot of Hawker Hunter T.7 WV372/G-BXFI, was seriously injured, when the jet crashed onto the A27 road just outside the airfield.

Those eleven people, including three who were reportedly watching the show from outside the airfield boundary, were the first people to be killed at British airshow for decades and the accident is the worst in this country since John Derry's de Havilland DH.110 crashed at Farnborough in 1952, killing 29 spectators.

The 2015 airshow 'season' has seen tragic accidents here in the UK and around the globe. Before the season had started, David Jenkins was lost when his Edge 360 aerobatic aeroplane crashed during the media launch for the Old Buckenham airshow and, as reported in the previous issue of *Jets*, Kevin Whyman was lost when his Folland Gnat crashed during the CarFest North show in August.

Nobody else was hurt in those incidents, testimony to the fact that current display flying legislation in the UK has been continually honed to protect those on the airfield/display venue itself.

This is contained within the 'Flying Displays and Special Events: A Guide to Safety and Administrative Arrangements' document (CAP 403) which is published by the Civil Aviation Authority (CAA) and was reviewed and updated earlier this year.

However, following the Shoreham accident, the CAA "believes that it is right to go further and to carry out a comprehensive review to ensure that proportionate, risk-based measures are in place to reassure the public, the aviation community and the CAA Board that all is being done to ensure public air displays in the UK operate to the very highest safety

standards and that air shows remain safe."

According to the CAA "The Military Aviation Authority (MAA) will support this Review and ensure that any lessons for military air displays are read across into military regulations, which were also reviewed and updated in parallel with the earlier CAA work."

Review

The Review is supported by UK Department for Transport Ministers and an independent, external panel of experts – the Independent Challenge Panel – chaired by Geoffrey Podger CB, will oversee the review and critically challenge the CAA's recommendations.

According to the CAA, "The Review will evaluate existing civil guidance on flying

- The location and characteristics of the air display venue, including displays not over a recognised aerodrome, coastal locations, and the surrounding area/infrastructure.

Other issues may arise during the course of the Review.

"The Review will also consider what lessons can be learnt from any other air display incidents both in the UK and other countries, as well as how other countries authorise air displays. It will also consider any forthcoming European legislation that may impact on this activity. The Review will consider the CAA's internal procedures for assessing and approving flying displays and participants, the relationship that the CAA has with display organisers, such as the British Air Display Association (BADA) as well as

"Membership of the Challenge Panel includes representatives from the flying display community"

displays and special events, and the danger they may pose to the public. To do this the Review will consider the following issues:

- The competency and experience of pilots flying at air displays.
- The attitudes of pilots and organisations to safety standards.
- The skill levels pilots flying at air displays must have to perform different aerobatic manoeuvres.
- The physiological challenges of, and medical fitness to perform aerobatic, high performance and display flying,
- The age, condition and performance, as well as the regulatory framework that governs aircraft used at air displays.
- The range of permitted manoeuvres, in particular for high performance or vintage jet aircraft.
- The content of the air display.

others present at air shows also responsible for public safety, such as the Health and Safety Executive and emergency services.

"Emerging information from the Air Accidents Investigation Branch (AAIB) will be considered promptly by the Review which will identify any further actions that it determines to be immediately necessary to protect the public in relation to air displays."

Independent Challenge Panel

The CAA continues: "The Review will have an Independent Challenge Panel for the Review. The Panel's Chair is independent of the CAA and the aviation display community but has knowledge of public safety issues. Membership of the Challenge Panel includes a

consumer/public representative as well as representatives from the flying display community and the MAA. The CAA will provide support to the Challenge Panel.

"The Panel's role is to provide constructive challenge to the thinking of the Review. It will advise on the efficacy and applicability of any recommendations that might result from the review for both the general public and the flying display community, as well as provide guidance on the priority of any recommendations. The Panel will ensure that any proposals meet the overarching objective of the project to ensure that all is being done to ensure public air displays in the UK operate to the very highest levels and safety standards and that air shows remain safe."

The regulatory body also points out that "The Review will engage fully with the air display community, including organisers and pilots, as well, where feasible those who attend or are in the vicinity of air displays."

Governance

The Review is overseen by a Steering Board, chaired by Mark Swan, CAA Group Director Safety and Airspace Regulation Group (SARG) and there is a Project Board, chaired by Tony Rapson, Head of the General Aviation Unit (GAU).

The Project Board will guide and direct the project to a successful conclusion in terms of timeliness and meeting objectives. Tony Rapson is responsible for reporting direct to the Steering Board.

The CAA continues: "The work of the Project Board will be informed by Working Groups. The Project Board, with the agreement of the Steering Group, will decide on the number and make-up of the Working Groups as the Review progresses."

"The Project Board will:

- Manage the Review's relationship with stakeholders, including the public, and the broader aviation community.
- Ensure that recommendations are fit for purpose and then, beyond the final report, consider how to ensure they are fully implemented.
- Ensure that the project has the resources it needs to be successful.

"Challenge to the CAA's work will be carried out by an Independent Challenge Panel and monthly updates will be provided to the CAA Board and to the Department of Transport (DfT). The European Aviation Safety Authority (EASA) will also be kept informed of the progress of the Review as it progresses."

Working Groups

The CAA concludes by pointing out that: "The Working Groups, in line with but not limited to the tasks set out in the scope of the review, will be asked to go back to first principles and:

- Assess the adequacy of the current provisions to aircraft in scope of the review.
- Assess the adequacy of current provisions to pilots in scope of the review.
- Assess the safety objective of each provision.
- Assess the impact location may have on an air display.
- Assess whether this safety objective remains sufficient in the light of the Shoreham and other disasters.
- Assess whether there is additional evidence to amend the provision.
- Make recommendations to the Project Board for changing current provisions, with an indication of the likely impact, both on public safety and the aviation community.

"The Steering Board will meet monthly throughout the life of the Review, and the Project Board will be updated weekly and meet as necessary for the same period. Frequency of meetings after publication of the final report will be assessed at the time. The Independent Challenge Panel will meet three or four times during the course of the Review. It will meet on its own to form its own views on the interim and final reports, and then with the Chairs of the Steering and Project Boards to challenge the findings, conclusions and recommendations of the CAA. The Chair of the Independent Challenge Panel may ask or be invited to address the CAA Board."

The CAA says the review will produce an interim report by the end of October and its final report early in the New Year. We'll carry more news in *Jets* as it becomes available. ●



Seen in happier times Hawker Hunter T.7 WV372/G-BXFI taxis in after a display at the RAF Waddington Airshow, near Lincoln, in 2013. On August 22, 2015 the jet failed to recover from an aerobatic manoeuvre at the Shoreham Airshow and crashed onto the A27 road that runs parallel to the airport, killing eleven people.

Steve Bridgewater

GOVERNANCE GROUPS

Steering Board

- Mark Swan (Chair)
- Tony Rapson (Chair, Project Board)
- Philip Clarke (Review Business Manager)
- David Oastler (Consumer Policy Group and Review Deputy Business Manager)
- Padhraic Kelleher (SARG ISP)
- Mark Shortman (GAU and AAIB)
- Sarah Doherty (Deputy Head of CAA Policy Programmes Team)
- Cdre Paul Chivers (MAA)
- Dan McCafferty (Project Manager)
- Others colleagues, for example, from the CAA's Legal Team and Communications Team, may be co-opted onto the Steering Board.

Project Board

- Tony Rapson Chair (Project Board) (with Padhraic Kelleher as deputy)
- Philip Clarke (Review Business Manager)
- David Oastler (CPG and Review Deputy Business Manager)
- Mark Shortman (GAU and AAIB)
- John Romain (Aircraft Restoration Company)
- Ed Bellamy (GAU)
- Dom Marino (PPT)
- Stuart Mitchell (CAA Medical Department)
- Matthew Bennett (CAA Legal Team)
- Sqn Ldr Rich Thornton (MAA)
- Mike Alcock (DfT)
- Dan McCafferty (Project Manager)
- Chairs of Working Groups as needed

Independent Challenge Panel

- Geoffrey Podger (CB Chair)
- John Turner (BADA)
- Keith Richards (Chair, CAA Consumer Panel)
- AVM Gary Waterfall CBE (MAA/ MoD)
- Barbara Cooper (Kent County Council)
- Philip Clarke (Review Business Manager)*
- David Oastler (CPG and Review Deputy Business Manager)*
- Dan McCafferty (Project Manager)*

*as required

NAMC YS-11



David G Powers recalls his days flying the Japanese-built YS-11 freighter around North America, Alaska and the Caribbean

You never forget your first...Well...freighter, that is. After leaving active duty as a US Naval Aviator, I embarked on what I thought would be a straightforward career as an airline pilot, and I was elated when Pan American hired me. I mean, few airlines exude history like Pan Am, and being an aviation history enthusiast, I felt like I just came home. I was comfortable at Pan Am, and I didn't even have to switch my white hat. My life's career was now on track, soon to entail several years as a senior Boeing Seven-Four captain flying the Rio Rocket (the round trip from Miami to Rio de Janeiro) twice a month. Then, of course, Pan Am went out of business. Pity.

For the next several months I puttered around, doing a bit of flying in the Reserves,

and looking for another airline gig. The industry was in one of its cyclical slumps at the time, so even though I was technically proficient and marketable, finding another airline job eluded me. Then, an old buddy of mine came through town on a layover. He was flying for a freight airline called

"Would it bother you to fly the YS-11?"

Airborne Express, of which he spoke quite glowingly. He said I should apply, and that he would hand carry my resume into the chief pilot's office, if I wanted. I still had my sights set on a major passenger carrier, but thought flying freight would be OK, at least until the big guys started hiring again.

At the time I went in for my interview, Airborne Express was flying three aircraft types: the Douglas DC-8, the Douglas DC-9, and one aeroplane I was not all that familiar with, the NAMCYS-11. Now I knew of the YS-11, but not a lot about the YS-11. Interested in all aspects of aviation, I knew the YS-11 existed, that it was about the size of a ConvairLiner; what was basically a big turboprop built by the Japanese. I remember that the chief pilot, during my interview, asked me, "Would it bother you to fly the YS-11?" It was sort of a trick question. Myself, like many pilots at this time in our careers, were looking for bigger, jet powered equipment, so to some the YS-11 could have been seen as a step down. I think he was gauging my reaction. Personally, I love any kind of flying, so I truthfully answered,



MAIN LEFT: The YS-11 was a capable airlifter and served airlines such as Airborne Express well

RIGHT TOP: To facilitate the handling of cargo engineers at Airborne came up with the C-Container. This was a small plastic box that could roll around on its own set of wheels, and was just the right size to fit through the normal passenger door of an airliner. Once inside the fuselage, a row of rails engaged the bottom portion of the container, and floor locks secured them in place

David G Powers

RIGHT MIDDLE: With the seats removed the YS-11's capacious cabin could accommodate 11,904lb of freight

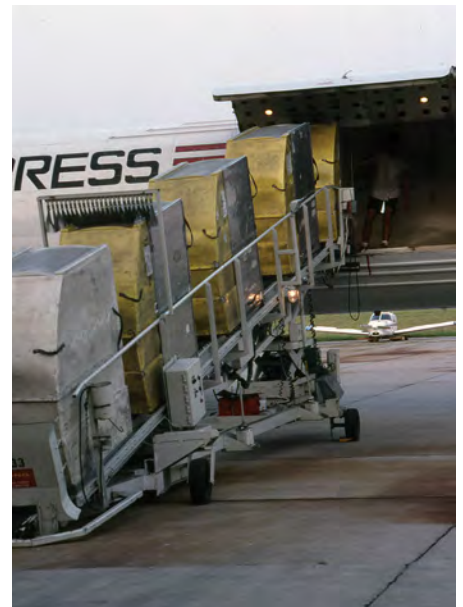
David G Powers

RIGHT BOTTOM: The YS-11's cockpit was one of the author's favourite places

David G Powers

BELOW: N218P joined Airborne Charter Express in June 1980 following an earlier career with Piedmont Air Lines (as Roanoke Valley Pacemaker). It joined ABX Air in 1989 and flew until 1997 when it was withdrawn from use. In June 2003 it was reportedly exported to Mexico, but the trail then goes cold...

Tom Singfield Collection



"No it would not bother me at all, and yes, I would like to fly your YS-11s." I got the job.

Fast-track to Express

There was an old joke at Airborne Express: The systems ground school course did not just teach you the aircraft, it taught you how to *build* the aircraft. After a couple of weeks of that, it was off to flight training, and since there was no simulator for the YS-11, this was all done in the real thing. We flew during the day, while the aircraft hauled freight at night. Then it was a check ride, several Initial Operating Experience (IOE) flights on the line, a final line check, and it was done. So about two months after I was hired, I was on the line as one of the newest Airborne Express YS-11 first officers.

I should note that during my tenure



"The big Rolls-Royce Dart 542-10J turboprop engines put out over 3,000shp each, with water methanol injection"

flying the YS-11, Airborne Express was not really a cargo airline, nor a freight airline; rather, it was an express airline. Although we did haul our fair share of general cargo, our main book of business was overnight express; those little cardboard envelopes – called express packs – containing contracts, blueprints, and such, that had to get from one business to another business, overnight. This was before the era of e-commerce, so we serviced almost exclusively the business-to-business client.

To facilitate the handling of all this express, the engineers at Airborne came up with the C-Container: Legend has it that the 'C' stood for the initial of the guy who came up with the idea, although I never knew his

name, nor whether this rumour was even true. Anyway, the C-Container was a small plastic box that could roll around on its own set of wheels, and was just the right size to fit through the normal passenger door of an airliner. Once inside the fuselage, a row of rails engaged the bottom portion of the container, and floor locks secured them in place. Many scoffed at the C-Container, but the idea had many advantages, the least of which was Airborne Express not having to modify an existing airliner with an expensive cargo door. Lots of money saved there. Additionally, one or more C-Containers could be packed for individual clients, who could load and unload them at their offices. Simple belt loaders were certainly cheaper

than a K-Loader, and easier to maintain, too. Airborne even had specialised ramp trailers – Dragon Wagons – by which a single person could deliver up to 22 C-Containers planeside in one fell swoop.

Fit for duty

Airborne Express was a very frugal company, typically buying used equipment and refurbishing it for a new role. From a fleet of retired bread delivery trucks, which became the ramp maintenance vans, to passenger airliners turned in to freighters that hauled the express, Airborne executives saw the value of pre-owned gear; and the YS-11s were no exceptions. By the time I was hired, Airborne operated eleven YS-11s, all of which began their flying careers with Piedmont Airlines, as passenger birds, being delivered between 1967 and 1969. In 1979, Airborne began to buy the airframes, some of them directly from Piedmont, while a few had been purchased by a small commuter/cargo operator, called Pinehurst Airlines, before being bought by Airborne. In any case, by October 1981, Airborne was flying 13 YS-11s within its express network.

Piedmont's original airframes were built as YS-11A-205s, a specification that was changed to YS-11A-500, with a small increase in gross takeoff weight when the airframes were converted to freighters. The purchase of the YS-11 fleet actually predated the development of the C-Container, so all these aircraft sported large aft cargo doors, and were then later converted to handle the C-Container. Prior to the advent of the C-Container, express

NAirborne Charter Express YS-11 N158P is seen here at Dallas in May 1980. The aeroplane was built as JA8687 and first flew in January 1967 before joining Piedmont as N158P Tidewater Pacemaker. After being converted into a freighter it joined Airborne Charter Express in 1979 and flew with the carrier until 1989 as both N158P and N911AX. It then joined ABX Air but was withdrawn from use in 1997. By 2003 it had been reactivated and joined Gabon Express as 3C-QRM and later 3D-CYS. It was last reported in service with Trans Air Cargo Service in the Democratic Republic of Congo Tom Singfield Collection



NAMCYS-11

With the close of World War Two, the Japanese aircraft industry was prohibited by treaty from building aircraft, either military or commercial. The treaty did not, however, prevent various Japanese aircraft companies from cashing in on the lucrative maintenance, repair, overhaul and modification niches. Therefore, in 1952, when the treaty was finally amended to allow full aircraft construction, several Japanese firms were in a position to at least investigate the production of a domestic passenger airliner. Unfortunately, it was soon quite apparent that no company had the capability to independently produce such an airliner on their own. So, enter the Japanese government.

With a generous subsidy to offer, the Japanese government called on six aircraft companies to pool their efforts and build an airliner. In 1957, a joint government/industry consortium – called the Transport Aircraft Development Association (TADA) – was founded to co-ordinate the effort. In December 1958, TADA presented to the public, and more importantly the airline industry, a full-scale mockup of what was now called the YS-11. In this first iteration, the YS-11 concept was a 40-seat, unpressurised, twin-engine turboprop that was touted as perfect for the short to medium airline segment, with a not unreasonable \$1 million dollar (1958 US) price tag.

In June 1959, TADA was re-organised under the new title Nihon Aircraft Manufacturing Corporation (NAMC), with six principle players, namely: Fuji (tail and nacelles), Japan Aircraft (ailerons and flaps), Kawasaki (wings), Mitsubishi (forward fuselage and final assembly), Shin Meiwa (aft fuselage), and Showa (honeycomb structures and tooling). Producing a power plant within this consortium was both cost and time prohibitive, so non-indigenous engines were investigated, including units from Pratt & Whitney, Allison, and Rolls-Royce. NAMC would handle the sales and later customer service for the YS-11.

First flight of the prototype YS-11 was logged on August 30, 1962. The configuration had been changed slightly, upping the

capacity to 60 passengers in a pressurised cabin. Rolls-Royce Dart turboprop engines were now standard. Over the years, several different configurations were offered, basically increasing the gross weight while not actually enlarging the dimensions of the airframe. In addition to the standard YS-11-100, a gross take off weight increase resulted in the YS-11A-200 (the YS-11A-100 was not built), while a -200 now configured for mixed passenger/cargo layout was called a YS-11A-300. The YS-11A-400 was a pure freighter, with a large cargo door on the port-side just forward of the wing. All -400 series birds were destined for the Japanese military, a few of which were used as navigation trainers. A straight passenger airliner, the YS-11A-500 was the result of another weight increase over that of the YS-11A-200. Likewise, the YS-11A-600 was simply a YS-11A-300, the mixed passenger/cargo configuration, with an increased gross take off weight. Finally, one more weight increase would have been realised in the YS-11A-700, which was never built. It should be noted that most of these upgrades could be applied to existing airframes.

Several dedicated configurations were flown only by the Japanese military, including the YS-11M (transport aircraft), the YS-11P (a VIP transport), and the YS-11T (an anti-submarine warfare trainer). Other ideas, like the YS-11S – a four-engine Short Take Off and Landing (STOL) transport – never made it off the drawing board.

A total of 182 YS-11s were built, a number that includes the prototypes, and both civil and military airframes, a production run which was sadly not enough to break even. The last airframe was delivered in 1974. Not surprisingly, sales were initially quite brisk in Japan and Asia, however, outside that region interest was not up to predictions. Much of the Western world opted for the Fokker F-27, which was cheaper than the YS-11, to fill this role. There were a few prolific Western YS-11 operators, Piedmont Airlines and Cruzeiro do Sul, for example, but other large orders were not forthcoming. Understandably, the Japanese military was a major customer:

YS-11A JA-8714 appeared at the 1968 SBAC Airshow at Farnborough as part of a sales push for the type. It was later leased to Korean Air as HL5206 before transferring to Philippine Airlines as RP-C1417 in 1974. From there it went to the USA and flew with Mid Pacific Air as N125MP from 1985 until 1989 before being placed into storage. In 1998 it was acquired by KFS Aviation and registered S9-CAP but a year later became XA-TQP with Alcon Servicios Aereos. It was later impounded for drug trafficking in Colombia and was impressed into the Fuerza Aerea Colombiana as EJC-122 Awyr Aviation Archive



was loaded into large fabric hampers, like the linen hamper used in a hotel.

As I mentioned, when I signed on there were 11 airframes on the line, as two of the original batch were removed from service for maintenance reasons. Additionally, in 1990, Airborne bought two airframes – YS-11-125s (note there was no 'A' in this designation) – that had originally been bought by Cruzeiro do Sul in 1967, and after a number of subsequent airlines, ended up in the Pinehurst fleet. Airborne never flew these birds, using them solely as a source of spare parts.

Musical cruise

Like I said, I am fine flying just about anything. Give me a machine with wings, including rotary wings, and a motor, and I'm a happy man, so when I began flying the YS-11, well, I was a happy man. A typical work cycle began around 4.00am at our hub in Wilmington. The YS-11 could carry 21 C-Containers, equating to a max payload of over 12,000lbs, and as such was usually dispatched to smaller communities within the system. Another mission for the YS-11 was an even earlier departure, carrying super-priority express packs for the larger markets, like Washington DC or Chicago, Illinois. These flights were then followed up by either a DC-8 or DC-9, bringing in a normal load.

"When the wing picked up ice the YS-11 would sing"

Our pair of big Rolls-Royce Dart 542-10J or -10K turboprop engines put out over 3,000shp each, with water methanol injection. A wet take-off, which was the norm, was with flaps set at ten degrees, while a dry take-off was flaps at 15. The take-off roll was not exactly breathtaking, but it was not that much slower than the heavily loaded jets I would fly later. Climb-out could be described as sedate.

The YS-11 was originally a pressurised airliner; however, when Airborne cut the gaping cargo door in the fuselage it was decided that for the operational requirements planned, the new door would not be sealed for pressurisation. Since the door was not tightly sealed, it had a tendency to wiggle around a little bit in flight, often setting off a glaring red master warning light in the cockpit. After the usual expletives, we would pull out the emergency checklist, and go through the procedure. I always had to smirk, the first step of the procedure required one of the pilots – always the first officer, of course – to get up, go in the back, and check to see if the door was actually closed. If the door was closed, then the flight could continue. I really think there would be more readily obvious indications, in addition to the red warning light, which would give

clues that the door was open. Anyway, I never found one open, the problem always amounting to a maladjusted micro-switch.

Now unpressurised, we cruised in the YS-11 at a maximum of 10,000ft, so the old desire of flying over the weather did not now apply to us. We had an aged monochrome radar unit that always seemed to attenuate in the rain, which resulted in doing our share of bouncing around in the weather. In the winter, one thing that I found humorous was that when the wing began to pick up ice the YS-11 would begin to sing. Evidently, the way ice formed, especially in the wing root area, would cause the airflow to create a whistling sound. Although we always kept an eye out, it was nice to know the YS-11 would sing to you when it was starting to ice up. Pneumatic boots did a good job of cracking off the ice.

In the United States, as in many parts of the world, aircraft are restricted to 250kts below 10,000ft, so since we flew at or below that altitude, our 240kts cruise speed worked out just fine. The controls were not boosted, so yoke forces were a bit heavy, but manageable. The vertical stabiliser and rudder are quite large, meaning single engine work was no sweat, even the dreaded V1 cut on take-off. There was plenty of stab and rudder to keep flying in a straight line.

SPECIFICATION NAMC YS-11A



Artwork: Andy Hay / www.flyingart.co.uk

Crew	2
Payload	64 passengers or 11,904lb of freight
Length	86ft 3in (26.30m)
Height	29ft 6in (8.99m)
Wingspan	105ft 0in (32.00m)
Wing area	1,020sq ft (94.83m ²)
Empty Weight	32,187lb (14,600kg)
Max Take-Off Weight	51,808lb (23,500kg)
Max Speed	245kts (282mph/454km/h)
Service Ceiling	22,900ft (6,982m)
Ferry Range	1,367 miles (2,200km)
Powerplant	Two Rolls-Royce Dart 542-10K turboprops (3,030shp each)
First Flight	August 30, 1962



N915AX joined Airborne Express in 1981 and served the carrier until 1988 when it was transferred to ABX Air. It had first flown on February 23, 1968 and previously served Piedmont as N189P 'Cherokee Pacemaker' David G Powers

Gone fishing

Ask any airline pilot about an arrival to a major airport, and they will tell you that oftentimes, due to flow, you will get slowed miles away from your designation. Even though the YS-11's cruise speed was somewhat stately it could still integrate easily with the 747s, and A340s coming in to a busy airport. Landings and rollout were straightforward, even though we didn't have reversible propellers. No problem, because when those huge Dowty-Rotol propeller blades went to ground fine pitch, selected by the pilot just after landing, the YS-11 would stop on a dime.

After the outbound leg, we would be taken to a hotel, and would try, often in vain, to get a good day's sleep. Around 9.00pm, it was back out to the airport to fly the leg back into our hub. One round trip complete, we would hang around the pilot's lounge, grabbing a bite to eat, watching TV, reading, dozing, or doing what airline pilots do best: discussing our lives as airline pilots.

I later upgraded to the DC-9, then the DC-8 (my favourite airliner), then to the 767. Airborne Express sold off the YS-11 fleet back in October 1997. A mechanic told me that many time and/or cycle limited components were approaching their limits, and some, like the landing gear struts, were very rare, indeed.

I never did try to get on with another passenger carrier, once I found out that Airborne Express was the best-kept secret in the industry. Yes, it was night flying, but since our clients were essentially businesses we rarely flew on the weekends, and these

3 to 4 day layovers were always at the outstations, never at the Wilmington hub. For years we had an extensive network, so your weekend layover could be almost anywhere in North America and the Caribbean, and you were getting paid to be there.

There were times when I could be salmon fishing in Alaska one weekend, only to be tarpon fishing in Puerto Rico the following weekend. I could be skiing in Park City, Utah one weekend, and be golfing in Hilton Head, North Carolina the next. And,

"Since the door was not tightly sealed, it had a tendency to wiggle around a little bit"

if the out-station happened to be your home town, you got to sleep in your own bed. My old Navy buddies, flying for the big passenger airlines, asked me why I stayed at Airborne Express. My answer, "What, are you joking? Why would I ever leave this?"

All good things come to an end. While it is beyond the scope of this article, suffice it to say that in 2003, Airborne Express entered into a disastrous business deal, which appeared promising, but in the end spelled the demise of Airborne Express. Again – pity.

If asked again whether or not I would like to fly the YS-11, my answer would sincerely be the same, "Yes, I would like to fly your YS-11s." ●

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Tom Kaminski provides insight into the USAF's premier bomber, which has been used in three campaigns.

USAFE Phantoms - *Wild Weasels and Recce*

In the second instalment of this two-part article, Doug Gordon looks at United States Air Forces in Europe (USAFE) Wild Weasel and recce Phantoms and their role in the 1991 Gulf War.



Raptors in Europe

Spangdahlem Air Base in Germany hosted the first ever USAF F-22A Raptor training deployment to Europe this summer. Aviation News Assistant Editor James Ronayne provides a round-up of their visit.

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HEROES OF AVIATION

Clarence 'Kelly' Johnson
1910 - 1990



One of the most important people in aviation history?
Clarence 'Kelly' Johnson
Lockheed

In the first of a new series featuring the heroes of aviation, John Greenwell looks at the remarkable career of Lockheed's legendary aircraft designer Clarence 'Kelly' Johnson

Small teams, no bureaucracy, no lengthy documentation, few meetings and quick prototypes were all essential to Clarence 'Kelly' Johnson's success in creating some of the world's most remarkable aeroplanes.

During his four decades at Lockheed Aircraft, the man *Time Magazine* described as "perhaps the most successful aviation innovator since Orville and Wilbur Wright" was the brains behind the SR-71 Blackbird and countless other iconic Lockheed aeroplanes. He can justifiably be termed an aeronautical genius.

Born in Ishpeming, Michigan on February 27, 1910 to parents of Swedish extract, Clarence Johnson was just 13 years old when he won a school prize for his first aircraft design.

It was during school that he earned the 'Kelly' nickname that would stay with him throughout his life. He was initially ridiculed for his name, with the other boys calling him 'Clara', but one day he tripped up a bully so badly the boy broke a leg. The other boys decided henceforth that he was not a 'Clara' after all, and started calling him 'Kelly' in reference to the popular song *Kelly With the Green Neck Tie*. The nickname was said to reflect his fierce and pugnacious personality.

Throughout his life Johnson lived by the motto "Be quick, be quiet, be on time" and he graduated from the University of Michigan at 23 with a Masters in aeronautical engineering. He joined Lockheed the same year as a tool designer on a salary of \$83 a month, but

just weeks into the job he told his new employers that their latest aircraft – the Electra – was flawed and dangerous!

Luckily, Johnson's managers chose not to fire the young engineer and, instead, asked him to work on the problem. Within months he came up with the twin-fin configuration that would later appear on so many of his classic designs. This brought Johnson to the attention of Lockheed management, and he was soon promoted to flight test engineer, stress analyst, aerodynamicist, and weight engineer before becoming chief engineer in 1938 (at the age of just 28).

Before the start of World War Two, Johnson would go on to design (or have major design input into) civilian aircraft as diverse as the Lockheed Model 9D Orion, Model 10 Electra, Model 12 Electra Junior and Model 18 Lodestar.

However, with war evidently on the horizon, Johnson and his team turned their attention towards military aircraft. The Lodestar was quickly converted into a patrol bomber (the PV-1 Ventura) but



ABOVE: Johnson's real genius came to the fore when he created the YP-38 Lightning – the first US fighter to exceed 400mph



RIGHT: Before the start of World War Two, Johnson would go on to design – or have major design input into – civilian aircraft including the Model 18 Lodestar. The type would go on to be converted for military service

MAIN: The Lockheed F-94 Starfire was developed from the T-33 Shooting Star in the late 1940s as an all-weather, day/night interceptor. It was the first jet-powered all-weather fighter to enter combat during the Korean War

RIGHT: Clarence 'Kelly' Johnson with an early wind tunnel model of the Lockheed Electra, complete with the original single fin. Johnson's insistence that the design was flawed earned him the respect of Lockheed bosses and initiated his stellar career



Johnson's real genius came to the fore when he created the P-38 Lightning – the first US fighter to exceed 400mph.

The radical, twin-boomed Lightning first flew in 1939 and was followed by the triple-finned L-749 Constellation – this initially being designed to meet an airliner specification from TWA's Howard Hughes but later converted into a military transport for the USAAF.

Jet age

Johnson was described by his colleagues as "creative, dynamic, ambitious, and unafraid to question others' expertise and ideas" and this was never more evident than when he set about delivering the USAF's first ever jet fighter.

The project came about after he had dinner with a senior air force official in 1943 and claimed he could have a jet fighter ready to fly in just six months! North American Aviation had already delivered its P-51 Mustang after just 102 days – but that was a relatively low technology piston-engined fighter whereas the new jet technology was still very much unproven.

The triple-finned L-749 Constellation was initially being designed to meet an airliner specification from TWA's Howard Hughes



The YC-130 is listed among Johnson's achievement but he merely oversaw the design. In fact he is reported to have disliked the aeroplane USAF



Johnson flew back to Lockheed's factory at Burbank, California and walked into company president Robert Gross' office to present the new project. The company was already working to maximum capacity for the war effort, with staff operating three shifts a day, six days a week to

who eventually delivered the engine was detained by the police because Lockheed officials could not vouch for him.

The aircraft would emerge as the XP-80 Shooting Star and the first prototype (44-83020) – nicknamed Lulu-Belle but also known as "the Green Hornet"

"Johnson's dream team included Mary G Ross, the nation's first Native American female aero-engineer"

produce almost 30 aeroplanes a day. It would have been very easy to reject such an outlandish plan but Gross held Johnson in high regard and approved the jet project without hesitation.

Johnson immediately began creating his design 'dream team' and simply walked around the factory collecting the 28 people he wanted to work with – including Mary G Ross, the nation's first Native American female aero-engineer.

With such a technologically advanced aircraft at stake, secrecy was of the utmost importance; however, space was at a premium and Johnson had to set up his research facility next to the wind tunnel, shielded from view by engine crates and roofed by a circus tent!

The design process began on June 26, 1943 and the aircraft was created around the blueprint dimensions of a British Halford H-1 B turbojet (later to become the de Havilland Goblin). However, the team didn't actually have access to the powerplant until very late in the design process. That said, the project was so secret that only five of the people working on it knew that they were developing a jet-powered aircraft, and the British engineer

destroyed by foreign object damage during the run-up and the first flight was delayed until a second engine could be delivered from Britain. This was the only other H1 engine in existence and had previously been used in the prototype de Havilland Vampire but was quickly installed into the XP-80 to allow Lockheed test pilot Milo Bercham to perform the aircraft's maiden flight on January 8, 1944.

Skunk Works

Johnson's uber-secret Advanced Development Programme was situated so close to a plastic factory that the smell was almost intolerable. It was reputedly engineer Irv Culver who coined the 'Skunk Works' nickname and this has gone on to become a common phrase for all research and development offices. But 'Kelly' Johnson's Skunk Works was not only the original, it was a far from normal design studio.

He aimed to break with the increasing formality in which aircraft were designed and hark back to the time when machines were created by small teams. He was said to detest meetings and to resent the intrusion of committees or bureaucrats, but his methodology worked and his team delivered results. Johnson hated working to strict specifications and insisted on being allowed to 'freestyle' in order to deliver the best product and allow his designers' genius to freely flow.

Often his engineers were not provided with finished drawings and were encouraged to work from vague sketches and, if possible, to develop parts directly on the aeroplane itself. If Johnson felt something used up valuable time without benefiting the project, it was banned – often including visits by the customer! Reports were also limited to 20 pages at most and meetings to 15 people or less.

Johnson tolerated errors – with the

because of its paint scheme was delivered to Muroc Army Airfield on November 16 – just 143 days after design had begun and well within Johnson's 180-day promise. It also came in under budget.

Unfortunately, the Halford engine was

The XF-104 Starfighter flew for the first time on March 4, 1954; its design was shaped by Johnson's visit to pilots fighting in the Korean War USAF



The Lockheed XF-90 was built in response to the same USAF requirement that led to the McDonnell XF-88 Voodoo. Lockheed received a contract for two prototypes and the aircraft was developed by Willis Hawkins and the Skunk Works team under 'Kelly' Johnson. The XF-90 first flew on June 3, 1949 with Tony LeVier and was the first USAF jet with an afterburner



caveat that they were made just once and all he asked from his team was for hard work, good communication, and unwavering honesty. He earned unparalleled loyalty.

Johnson ran the Skunk Works by 14 distinct rules (see box) and these are still in use to this day. Reportedly he also had an unofficial 15th rule that he passed on by word of mouth – this being: “Starve before doing business with the damned Navy. They don’t know what the hell they want and will drive you up a wall before they break either your heart or a more exposed part of your anatomy.”

Starfighter

Flushed with success from the successful P-80 Shooting Star project, Johnson and his team at Lockheed would go on to create the two-seat T-33 derivative as well as the XF-90 (the first USAF jet with an afterburner) and the F-94 Starfire (the first jet-powered all-weather fighter to enter combat) as well as the unmanned X-7 test bed that exceeded Mach 4 while testing ramjet technology.

In December 1951 Johnson visited Korea to speak with USAF personnel fighting in the Korean War about what they wanted from the next generation of jet fighter. The pilots, many of whom were flying the F-86 Sabre, requested a small, simple aircraft with high performance and upon Johnson's return the Skunk Works immediately began working on radical new concepts.

Several studies were conducted including small 8,000lb designs up to large 50,000lb machines but Johnson settled on a concept of building the smallest, lightest and most aerodynamic airframe around the largest engine possible – the new General Electric J79.

The resulting L-246 would remain fundamentally unchanged by the time the aircraft joined USAF service as the F-104 Starfighter.

Spyplanes

The Skunk Works would soon develop a reputation for building some of the world's best and most radical spyplanes – something that traces its history back to 1955 when Lockheed received a contract from the CIA to build an aircraft capable of flying over and photographing sites of

strategic interest in the USSR. Just nine months later the U-2 performed its maiden flight from Groom Lake in the Nevada desert and the aircraft was in operation over the Soviet Union by July 1956.

Johnson's design, codenamed CL-282, was based on the Lockheed XF-104 but with long, slender wings and a shortened fuselage. It would reach an altitude of 73,000ft and was, essentially, a jet-powered glider. Strategic Air Command's General Curtis LeMay reputedly walked out during a CL-282 presentation, saying that he was not interested in an aeroplane without guns but the CIA was sold on the idea.

The aircraft first flew on August 1, 1955 with test pilot Tony LeVier at the helm. Johnson had given him firm instructions to land the new aeroplane on its main undercarriage but each time LeVier



A proud Clarence 'Kelly' Johnson poses with a U-2 late in his career Lockheed



The U-2 was initially operated by the CIA but later taken on board by the USAF. The original concept was based upon an F-104 fuselage with extra long wings. Here, early U-2s await their next sortie from Groom Lake USAF Museum

A Lockheed U-2 leads a Lockheed SR-71 in flight – two of Kelly Johnson's most important designs aloft together for a rare photo opportunity USAF



tried this, the jet bounced back into the air. Eventually he tried a conventional tailwheel landing and the aircraft settled down perfectly – it was a rare occasion when Johnson was not right. However, it didn't pay to prove the point and stories abound that later that evening the engineer challenged the test pilot to an arm wrestle. LeVier arrived at work the next day with his hand bandaged. Johnson had had the last word after all.

Johnson's team predicted that the U-2 would have a limited operational life over the Soviet Union and the CIA agreed. Sure enough, U-2 overflights ceased after Francis 'Gary' Powers was shot down during a mission over Russia on May 1, 1960, but by now the Skunk Works was already a year into the follow up contract. Worth a reported \$96 million, the new project was to create a Mach 3+ capable aircraft dubbed the A-12 (later SR-71) and invariably known as the Blackbird.

The aircraft was to be produced from Titanium, but at the time the supply of this metal was mostly controlled by the Soviet Union, so the CIA had to set up a dummy corporation in order to acquire sufficient stock. As such, the new aircraft did not fly until 1962.

Legacy

The SR-71 was perhaps Johnson's most important, successful and memorable design but Tony LeVier described his colleague's entire aircraft portfolio as "the airplanes [that] kept us out of World War III."

In total, Johnson designed or took a major part in the creation of 40 military and civilian aircraft and was rewarded with countless medals and honours for his

service to aviation, engineering and mankind.

He and his team developed America's first operational jet fighter in less than six months, and launched the U-2 in just nine months, created the first production aircraft to fly at twice the speed of sound (the F-104) and the world's fastest and highest-flying aeroplane (the SR-71).

'Kelly' Johnson was offered the position of Lockheed company president an unprecedented three times, but declined each time to oversee the Skunk Works, where he remained a senior advisor even after his formal retirement in 1975.

But it was perhaps Hall Hibbard, Johnson's boss at Lockheed, who summed him up best. Referring to Johnson's Swedish ancestry he once remarked: "That damned Swede can actually see air."

Clarence 'Kelly' Johnson passed away of natural causes in 1990 at the age of 80. He changed the world forever. ●

Clarence 'Kelly' Johnson's Rules of Management

- 1** The Skunk Works manager must be delegated practically complete control of his program in all aspects. He should report to a division president or higher.
- 2** Strong but small project offices must be provided both by the military and industry.
- 3** The number of people having any connection with the project must be restricted in an almost vicious manner. Use a small number of good people (10% to 25% compared to the so-called normal systems).
- 4** A very simple drawing and drawing release system with great flexibility for making changes must be provided.
- 5** There must be a minimum number of reports required, but important work must be recorded thoroughly.
- 6** There must be a monthly cost review covering not only what has been spent and committed but also projected costs to the conclusion of the program. Don't have the books 90 days late, and don't surprise the customer with sudden overruns.
- 7** The contractor must be delegated and must assume more than normal responsibility to get good vendor bids for subcontract on the project. Commercial bid procedures are very often better than military ones.
- 8** The inspection system as currently used by the Skunk Works, which has been approved by both the Air Force and Navy, meets the intent of existing military requirements and should be used on new projects. Push more basic inspection responsibility back to subcontractors and vendors. Don't duplicate so much inspection.
- 9** The contractor must be delegated the authority to test his final product in flight. He can and must test it in the initial stages. If he doesn't, he rapidly loses his competency to design other vehicles.
- 10** The specifications applying to the hardware must be agreed to well in advance of contracting. The Skunk Works practice of having a specification section stating clearly which important military specification items will not knowingly be complied with and reasons therefore is highly recommended.
- 11** Funding a program must be timely so that the contractor doesn't have to keep running to the bank to support government projects.
- 12** There must be mutual trust between the military project organization and the contractor with very close cooperation and liaison on a day-to-day basis. This cuts down misunderstanding and correspondence to an absolute minimum.
- 13** Access by outsiders to the project and its personnel must be strictly controlled by appropriate security measures.
- 14** Because only a few people will be used in engineering and most other areas, ways must be provided to reward good performance by pay not based on the number of personnel supervised.

SHOWTIME

This time the Jets team visits shows at Bournemouth, Church Fenton, Dunsfold, Duxford and Old Sarum



The annual Wings and Wheels event at Dunsfold, Surrey took place on August 29-30 and included a display by the Flyvåpnets Historiske Skvadron MiG-15UTI (N104CJ). The aircraft, which is actually a 1952 Polish licence-built SBLim-2, is painted in a simple all over silver scheme with the red star and red '18' codes that featured on an aircraft flown by famed Soviet cosmonaut Yuri Gagarin before he became a household name **Jamie Ewan**



The Old Sarum Airshow took place on September 12-13 under blue skies. The sole classic jet in the flying programme was Avro Vulcan B.2 XH558 but this "went tech" en route to the show. Luckily, jet enthusiasts could console themselves with the exhibits of the resident Boscombe Down Aviation Museum, including the nose of former RAF Lyneham gate-guard Comet XK669, Meteor UI6 WK800 and the attractive former ETPS Hawker Hunter XF375 **Steve Bridgewater**



A plethora of classic jets descended upon the ex-RAF Church Fenton for the inaugural Great Yorkshire Airshow on September 26. These included the Classic Air Force's de Havilland Venom and Gloster (AW) Meteor NF.11, the Flyvåpnets Historiske Skvadron MiG-15UTI, the Gnat Display Team's Folland Gnat T.1 pair and Avro Vulcan B.2 XH558. Hunting-Percival Jet Provost T.3 XN637 was on hand to show off a type based at Church Fenton during the base's heyday – the jet being flown by RAF Tornado GR.4 pilot Ollie Suckling in his first public display appearance **Jamie Ewan**



Now in its eighth year, the Bournemouth Air Festival took place between August 20-23 and saw a number of vintage and contemporary jets take to the skies. These included the RAF Hawk T.2 Role Demo Team and Eurofighter Typhoon along with the MiG-15 and a farewell from Avro Vulcan B.2 XH558. On Saturday and Sunday de Havilland Sea Vixen FAW.2 XP924 (G-CVIX) took centre stage as Royal Naval Reserve pilot Commander Simon Hargreaves OBE showed the jet off against a flotilla of Royal Navy vessels sat off the coast **Jamie Ewan**



The Battle of Britain Anniversary Airshow at IWM Duxford on September 19-20 saw few jet appearances but did include USAF F-15s, an RAF Typhoon, the Red Arrows and a very rare appearance by a BAe 146 from 32 Sqn at RAF Northolt. The squadron took part in the defence of south-east England based at RAF Biggin Hill during the opening weeks of the Battle of Britain. **Steve Bridgewater**



At the Great Yorkshire Airshow at Leeds East Airport (formerly RAF Church Fenton), Vulcan XH558 joined forces with Folland Gnats XR538 (G-RORI) and XR992 (G-MOUR) for a number of formation passes. During their last pass the three aircraft performed a 'Missing Man' tribute to their friend and colleague Kevin Whyman who was tragically lost earlier this year when his Gnat crashed **Jamie Ewan**



Europlane

THE LAST BRITISH BASED LARGE AIRLINER PROJECT

The combined efforts of four countries saw the quiet, spacious Europlane poised on the brink of existence for nearly two years. Richard Payne explains why this British-based jetliner never made it into production

In 1970 the British Aircraft Corporation (BAC) was marketing itself as the most powerful aerospace company in Europe. Its Commercial Aircraft Division at the time had the jewel of European industry – Concorde, of which high hopes were still envisaged, whilst the One Eleven line had been boosted by the stretched series 500 and new 475 short field variant.

As its next big subsonic transport (the last VC10 being delivered in the February of that year) – Weybridge/Hurn was looking to the 270-seater plus Three Eleven, for which much interest had been attained from

airlines around the world, including that of BEA. However, the surprise win by the Conservatives which was followed by the collapse of Rolls-Royce saw any hopes of its launch or of Britain re-joining the Airbus programme as a major partner collapse.

For BAC, the loss of what would have been its major commercial programme for the 1970s and beyond was immense and it was imperative that to maintain the design and production teams, a new project was found.

Collaboration

At the Paris Air Salon of 1971, BAC

revealed its QSTOL project (Type C aircraft) – a 140-seater high-wing jetliner powered by four Rolls-Royce/Snecma M45S engines. At the same time Aerospatiale of France unveiled a similar study dubbed the A904. Other studies were also being undertaken in Europe by companies including HFB (part of MBB) and Saab and it was natural that these companies would end up talking to each other.

On February 15, 1972 it was announced that having been working on joint studies since the beginning of the year, BAC, MBB and Saab were going to collaborate on the development of a new quiet, short-take-off



and landing aircraft. Initial studies were looking at a 100-seater airliner with a relatively wide body six-abreast fuselage to use a 600m runway with a range of 500nm.

The new joint company was to be British registered and based at Weybridge. The new company was to have a British Chief Executive, a German technical Director and a Swedish finance/programme director.

It was agreed to undertake a six-month study which would focus on both the vehicle to be proposed as well as the market place. The QSTOL Type C aircraft demonstrated in model form at the 1971 Paris Air Salon seemed to signify the middle ground in terms of design – with passenger capacities ranging from 70 to 200 seats and engines from the M45S and General Electric/Snecma CFM56 to Rolls-Royce's RB211 – these could be powered by two, three or four engines possibly with blown flaps and augmentor wings.

Europlane design

By April the new company called Europlane Ltd had formally been incorporated at Weybridge. Each of the three companies (BAC, MBB, Saab-Scania) were to have

equal shares in the new concern.

In August 1972, it was revealed that British Air Services were evaluating the various Europlane options against other options including Hawker Siddeley's proposed HS146. A few weeks later at the 1972 Farnborough SBAC Airshow it was announced that CASA of Spain were also joining the group taking an equal 25% share with the other three partners.

BAC's Farnborough stand featured a prominent Europlane display, its six-month initial marketing studies having looked at four major designs ranging from a 60-seater with four engines mounted on an unswept high wing, a similar 80-seater unswept twin engined high-wing design and a 115-seater high wing but with twin engines mounted on lower fuselage mounted sponsoons. The final design seated 180 passengers and again featured a high wing with two underwing

pylon mounted engines of 45,000lb/thrust – this was to have a range of 500nm. These designs formed part of a group of some 30 studied, with various arrangements. It was hoped that a final definitive design would emerge by early 1973.

By October 1972, the new project was now being regarded more as a Douglas DC-9 replacement, powered by RB211 engines with a conventional runway performance. Whilst the first design study had looked at machines with 60 to 180

“Launch costs of the all-new airliner were put at £200 million”

seats, the second design study, which would finalise the design (around March 1973) was only looking at an aircraft with between 120 and 180 seats. At this time it was envisaged that the first flight would take place in 1977.

With noise now becoming a major consideration the studies were

looking to use the wing design to shield forward radiated noise, with the rear noise lobes being taken care of by the tail and fuselage design.

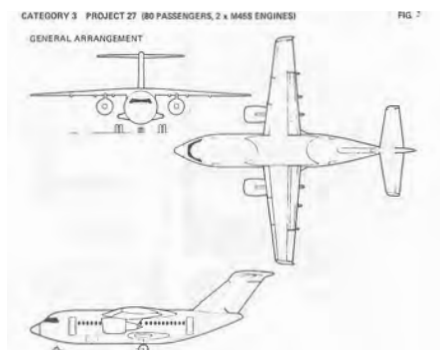
In an effort to make the project an all encompassing European aircraft, invitations were sent out to both the Italian and French industries but these overtures came to nothing. By March 1973, some 50 personnel from the four companies were now involved in the project. The launch costs of the all-new airliner were being put at £200 million and it was hoped this would be shared jointly by BAC, MBB, Saab and CASA and their respective governments. The size of the aircraft was now fixed to be between 180 and 200 seats with power provided by two RB-211 or GE CF6 engines.

The technology proposed for the aircraft was looking to be based on existing knowledge – a lot of the wing aerodynamics coming from work carried out by BAC on

the Three Eleven. Similarly work carried out by Saab on the flight deck for its Viggen was being utilised. The first markets were expected to be Europe – although a smaller market was envisaged in the USA.

The big reveal

In mid May, Europlane finally revealed its new project. The Quiet Take-off and Landing (QTOL) airliner was to be a low-wing design and as was common with BAC designs featured a T-tail with twin engines (either Rolls-Royce RB-211 or General Electric CF6) mounted high up on the rear fuselage. This, it was felt, achieved the best all round noise shielding effect. It would carry between 180 and 200 passengers with seating at 2-3-2 abreast in a double lobe wide body fuselage of 15ft 9in diameter. The design had a very similar resemblance to BAC's Three Eleven, albeit smaller. Large flaps and full span leading edge slats would gain good



Project 27 was the twin M455S engined 80-seater high-wing study

airfield performance and be quieter. The rear fuselage was upswept quite sharply for adequate ground clearance on rotation.

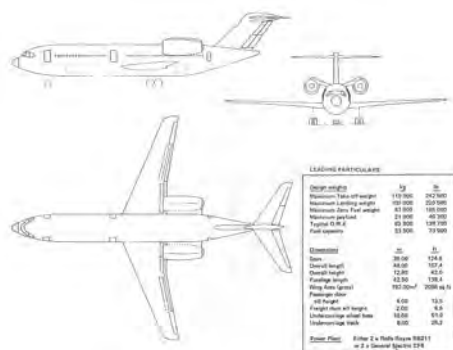
Underfloor capacity for freight was being provided by two large holds fore and aft of the main wing and a quick turnaround would be provided by four large doors. On the chosen design, forward noise was shielded by the wing whilst rearward arc noise was reduced by a full length cowl and acoustic treatment.

It was hoped that a full go-ahead could be given in mid 1974; this would enable a first flight in 1977 and entry into service by early 1979. The design encompassed potential for future development allowing for fuselage plugs, if needed, to increase capacity to up to 270 seats, and for increases in range by the mid-80s. It would fly over ranges of 500 miles from 1,200m runways or up to 2,300 miles from runways of 1,700m. The 90db noise footprint was envisaged to cover a noise-affected area some 1/20th of that of the short haul jets then in service.

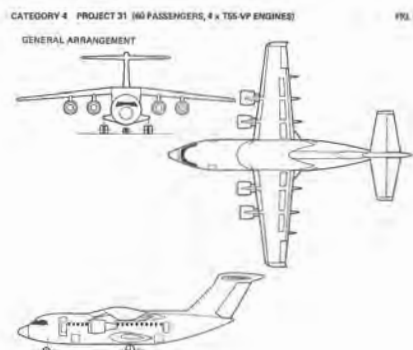
It was predicted that there would be some 1,350 aircraft in this market by 1985 – with a break even figure put at 350 aircraft and a unit cost of about £5.3million. The third and final phase of the study was to cost about £1million; it would refine the design and conduct customer specification surveys – with 25 airlines to be visited. It also set up the international project management and it was hoped the production split would mirror the company shareholding – but this would depend on the division of work. A full go-ahead was expected by June 1974.

Stalled

However, by October 1973 talks had still not taken place with the respective four governments and over 30 airlines. All was not well in the outside economy either: the deepening fuel crisis, rising inflation and a world recession did not bode well for any all-new airliner projects. The announcement in December that the project was to be shelved and would be reviewed in six months time did not come as a major surprise with the Weybridge team were redeployed



The Europlane's general arrangement, showing the similarity to its BAC Three Eleven predecessor – with its low-wing, T Tail and rear mounted engines



Project 31 was the smallest of the design studies as shown at Farnborough 1972 with 60 seats, powered by four T55-VP engines



BAC's 1971 140-seat QSTOL design shown at the Paris Air Salon featured four engines mounted under a high wing. The similarity to Hawker Siddeley's smaller HS146 is evident

An artists' impression of the Europlane, which would have kept BAC in the large airliner stakes

All Brooklands Museum Collection/BaE Systems
via author unless stated



back amongst their individual companies.

In the event, the project was not revived but a new group was formed out of its studies. EURAC - known as the 'Group of Six' - made up of Aérospatiale, Dornier, MBB, VFW-Fokker and the British concerns Hawker Siddeley and BAC was announced at the 1974 Farnborough Air

Show. These companies announced they were going to work together to meet European airlines' future requirements.

The 'Group of Six' identified two main segments: Type A, a 170/210-seater and Type B for a jetliner of over 110 seats. To save money, it was decided to develop these from existing designs - namely the A300 for Type A and the Trident and BAC One Eleven for Type B (although Aérospatiale put forward a brand new project dubbed the A200).

Dassault later came into the frame making

through its British Aerospace stake of 20%, did capture at least some of the market.

However, this was not to be a British-based project and while the European JET study was set up at Weybridge in 1977 (looking at a new narrowbody airliner) this programme was soon absorbed by Airbus and transferred to Toulouse.

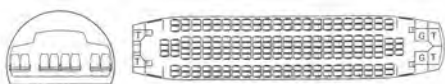
Sadly, although it tentatively existed for nearly two years, Europlane never seemed quite real. MBB was very heavily involved both financially and in a design capacity in the French-led Airbus A300,

CATEGORY 1 PROJECT 4 (173 PASSENGERS, 2 x RB211-22B ENGINES)
GENERAL ARRANGEMENT

FIG 3



INTERIOR ARRANGEMENT



Largest of the studies revealed at Farnborough was Project 4; a 173-seater high-wing airliner which featured twin RB-211's mounted under the wing

“In an effort to make the project a European aircraft, invitations were sent out to both the Italian and French industries but these came to nothing”

it a 'Group of Seven' and bringing with it both the Mercure and a stretched variant the Series 200, which was aggressively pushed by the French. Ultimately, the Type B requirement was met by the all-new A320 albeit many years later.

And so came about the Europlane replacement project: the Airbus A300B10, later renamed the A310 and on which BAC,

and Aérospatiale could certainly see that any stretched Europlane variant would encroach on the A300 market. This would have meant MBB having involvement in two potentially competing designs. It was also very doubtful that Europe could have supported two wide body airliner projects, and so Europlane died and with it the last British-based large airliner project. ●

Incoming! Letters to the Editor



HAVE YOUR SAY

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While we try to reply to all correspondence it is not always possible to reply individually to every letter. Please note, letters may be edited for style or length.

You can also send comments via our Facebook page or on Twitter at @JetsMonthly

Model Mates Sought

I have just been reading the July/August 2015 edition of *Jets*. I greatly enjoy the magazine as it covers the period of my early interest in aviation and my 12 years service in the RAF from 1959-1970.

I particularly enjoyed the Memory Lane article as I served with 131 MU at Khormaksar from 1964-66. As a Corporal General Fitter I worked in the metalwork shop with the local Arab tradesmen. As a young lad's first overseas trip this was quite an eye opener!

Highlights of my time there included scrounging flights with my mate Jock as 'supernumeraries' on

the Blackburn Beverly on various supply missions around the Radfan Mountains. I enclose a photo of a Beverly up in the mountains. I was often amazed at the loads the Beverly could carry, as evidenced by the road roller being loaded!

Much of my spare time was spent in the station model aero club – we had a hut that reputedly was built from two Vampire packing cases! As such it wasn't RAF property and we were able to do much as we liked inside, so long as the surrounds were kept clean! We built a fair variety of models as can be seen in the photo. I wonder if any of my aeromodelling mates read *Jets*?

Dave Harper Brisbane, Australia (by e-mail)



Homeward bound French Jaguar

After reading your excellent Jaguar article in the Sept/Oct issue of *Jets*, I thought your readers might like a photo that I took of a French Jaguar during the first Gulf War. It is seen here at King Khalid International airport being loaded into a Transall for the flight back to France.

Ian Simpson (by e-mail)

WIN!

V-Force books and original V-Force 'QRA Scramble' artwork

To mark the retirement of the last flyable V Bomber we have teamed up with Fonthill Media and Andy Hay at flyingart.co.uk for a special giveaway.

First prize is the original artwork commissioned exclusively by *Jets* to illustrate Dr Dave Sloggett's V-Force article on page 38 of this issue. The unique artwork is produced by flyingart.co.uk's Andy Hay and depicts a trio of Avro Vulcans taking off from RAF Scampton on a QRA launch at the height of the Cold War.

We also have three runner-up prizes of copies of the new book *My Target was Leningrad – V Force: Preserving our Democracy*. Published this year by Fonthill Media (ISBN 978-1-78155-181-3), the book is written by former Valiant and Vulcan pilot Philip Goodall and is the human story behind the Cold War, not just a list of technical facts and bomber data. This is the chilling story of what really

happened and how close the world came to World War Three and a nuclear apocalypse.

To be in with a chance to WIN either the artwork or a copy of the book, simply answer the question below.

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JET MENTOR

While Beech's T-34 Mentor was a sales phenomenon, its jet-powered derivative was not. Sixty years on, **Steve Bridgewater** investigates why



“Although the Jet Mentor proved viceless, lack of power limited the aircraft to a maximum speed of 256kts”

The Model 73 was very manoeuvrable but was let down by its engine power

Walter Beech put his name to some of the world's most popular and best selling aircraft of all time – most notably the Beech Model 17 Staggerwing the twin-engined Beech 18 Expeditor and the T-34 Mentor.

The latter was developed as a private initiative by Beech (under the Model 45 designation) as there was no military budget available for a new training aeroplane in the post-war era. The prototype first flew in December 1948 but production did not begin until 1953; three years after Walter Beech had passed away at the age of 59 following a heart attack.

The USAF received its first T-34A Mentor in late 1953 and the US Navy took delivery of its first T-34B Mentor variant in 1955; the type would go on to serve with air arms around the globe. By the time production ended in 1990 more than 2,300 piston-engined and turboprop-powered examples had been produced.

Even though Walter Beech was more of an entrepreneur than a designer, the company he founded gained a reputation for innovation.

As such, following his death, the company continued to go from strength to strength and the management team saw the potential to convert the successful Mentor into a jet-powered trainer. By now jet-powered fighter aircraft were the norm and



The Jet Mentor shared much commonality with the earlier T-34 Mentor



Visibility from the large canopy was excellent but it got very hot and an air conditioning system was needed. This, in turn, took valuable power away from the gutless engine



N134B aloft on an early test flight in a polished bare metal scheme

the USAF began looking for a purpose-built trainer to teach students the nuances of jet flying at an early stage in their instruction.

Dubbed the Model 73 Jet Mentor, the new aircraft was another privately funded initiative by Beech Aircraft and to keep costs as low as possible, the aircraft utilised many of the same components as the T-34A Mentor.

The cantilever monoplane had a low-wing with seven-degree dihedral and four-degree incidence. The wing itself was equipped with simple flap-type ailerons, single-slotted flaps and dive brakes and also accommodated the electrically-retractable main undercarriage units.

Design and construction of the prototype (registered N134B) proceeded at quite a pace and the aircraft was ready to perform its maiden flight on December 18, 1955 in the hands of test pilot Tom Gillespie.

In the first 30 days the aircraft logged some 45 test flights, and these indicated that calculated characteristics would be met, although the performance was well below par.

The Jet Mentor boasted a capacious tandem cockpit with ejector seats for both student and instructor. The cockpit was also fitted with an effective air conditioning system to mitigate the 'greenhouse' effect of the large glass canopy; however, this was shown to soak up valuable power from the already miserly Continental J69-T-9 turbojet.

The engine was a development of the French Turbomeca Marboré II powerplant and produced just 920lb/thrust, yet the aircraft itself weighed in at 4,521lbs. Although the Jet Mentor proved to have fairly viceless handling and good manoeuvrability, the lack of power limited the aircraft to a maximum speed of 256kts

and a cruise of 213kts. It also resulted in a maximum range of just 450 miles.

Beech entered the Jet Mentor into the USAF's competition for the first generation of all-jet basic trainers; this itself being an extension of the 1952 request for proposals for a Trainer Experimental (TX) programme.

Other competitors included the Temco TT-1 Pinto (which used the same J69-T-9 powerplant) and the Cessna Model 318. The latter used a pair of J69s and its lightweight, twin-engined layout found much favour with USAF officials. Likewise, they were impressed with the Cessna's side-by-side seating which permitted student and instructor to interact more closely than in the tandem seating fitted to the Jet Mentor. The TX contract was awarded to the Cessna and the T-37 was born.

The US Navy was also looking for a jet trainer; but it opted for the Pinto. However, the aircraft never entered service as the spool up time of these early jets was considered dangerously slow in the event of a carrier 'wave off'. Ironically, the Navy eventually went back to the piston (and later turboprop) powered T-34 Mentor for its training needs.

Of those aircraft entered into the TX competition, some 1,269 T-37s were eventually produced; Temco built 15 Pintos but the Jet Mentor was destined to become a one-of-a-kind oddity.

Beech retained the Model 73 for occasional flight-testing duties and eventually parked it ignominiously behind a hangar at its Wichita headquarters. The aircraft was finally donated to a local vocational technical school in the mid 1960s and remained at the college for 40 years before being transferred to Wichita's Kansas Aviation Museum. ●

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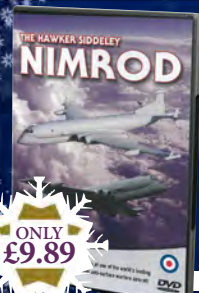


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The second prototype A400M (EC-402) displays at the Farnborough International Airshow. This airframe first flew on April 8, 2010
Airbus Military



AIRBUS MILITARY A400M ATLAS VS ARMSTRONG WHITWORTH ARGOSY

Sebastian Morgan compares and contrasts two turboprop-powered RAF transports

“THE WHISTLING
WHEELBARROW
AND THE GRIZZLY”



Philippines Air Lines Argosy RP-C1192 seen at rest in June 1978. The aircraft began life as XP450 for the RAF and first flew in November 1962. It served with 267, 215 and 70 Sqs before being retired in February 1975. The ex-RAF Argosies did not meet UK CAA airworthiness requirements and surplus airframes were limited to service overseas. XP450 became RP-C1192 in 1976 but was broken up in Manila in 1983

Tom Singfield Collection

By the end of World War Two, Armstrong Whitworth (AW) was one of the largest aircraft producers. During the war it had provided a number of bomber designs but in the post-war years the company's production capacity was mostly being utilised to licence produce other designers' aircraft – including the Avro Lincoln, Gloster Meteor, Hawker Sea Hawks and early Hawker Hunters.

However, not wanting to be left behind, the AW design team also set about creating radical and innovative projects such as the AW.52 flying wing (of which only one ever flew), the AW.171 supersonic VTOL flying wing (which never left the drawing board) and the AW.650 Argosy. The latter would go on to be the company's most successful post-war design and the last aircraft to be designed and produced by the Coventry-based manufacturer.

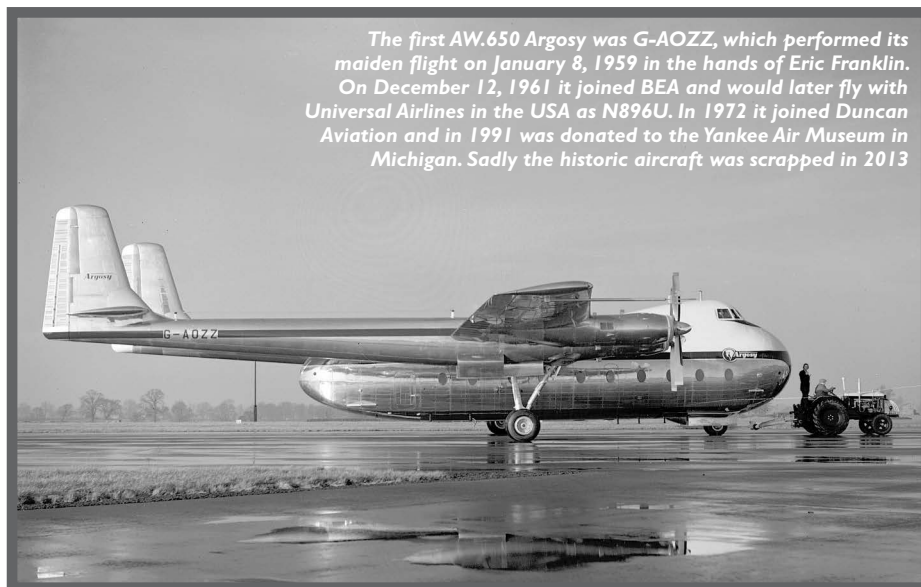
The Argosy came about in response to the Air Ministry's Operational Requirement 323 (OR323) of 1955. OR323 called for a medium-range cargo aircraft capable of lifting 25,000lb of freight. It also needed a range of 2,000



An Argosy approaching completion at Armstrong Whitworth's factory at Bitteswell, Leics



The first Argosies to enter service were those ordered by Miami-based Riddle Airlines. N6501R joined the carrier in February 1960 and two years later transferred initially to Capitol Airlines and then Zantop Air Transport as N601Z. On October 14, 1965 it crashed when it suffered "fuel exhaustion" and deadstick landed on an interstate in Ohio. It lost a wing as it went under an overpass and caught fire but the crew escaped unhurt



The first AW.650 Argosy was G-AOZZ, which performed its maiden flight on January 8, 1959 in the hands of Eric Franklin. On December 12, 1961 it joined BEA and would later fly with Universal Airlines in the USA as N896U. In 1972 it joined Duncan Aviation and in 1991 was donated to the Yankee Air Museum in Michigan. Sadly the historic aircraft was scrapped in 2013

miles while carrying 10,000lbs of cargo.

AW's first attempt at creating an aircraft to meet the specification led to the twin-engined AW.66 (and a civilian transport offshoot subbed the AW.65). These had large doors at either end of the fuselage to allow quick loading and unloading of freight and tail surfaces carried on two closely spaced booms growing out of the upper sides of the fuselage.

Two become four

The fallout from MP Duncan Sandys' 1957 Defence White Paper would also spell the end for OR323 but by now AW had already decided to press on with the civilian version of the aircraft as a private venture. It soon became

construction soon gave light to the 'Whistling Wheelbarrow' nickname! AW had originally planned to call the aircraft the 'Freightliner' but in July 1958 this name was changed to 'Argosy' – a name recycled from a three-engined Armstrong Whitworth airliner of the 1920s.

To keep development costs as low as possible and expedite production, the wing design was taken from the Avro Shackleton and this enabled the prototype (G-AOZZ) to perform its maiden flight from Coventry's Baginton Airport on January 8, 1959. The Series 100 version received Federal Aviation Administration (FAA) type certification on December 2, 1960.

A car ferry version (dubbed the AW.670) was also offered at this point

"The suggestively shaped nose led RAF crews to christen the Argosy the 'Whistling Tit!'"

apparent however that the new aircraft would need more power and the AW.65 was redesigned around four Rolls-Royce Darts and redesignated as the AW.650.

The new aircraft would have a high wing and a wide tailplane that was fitted between twin tail booms. These booms extended rearwards from the inner two engine nacelles and flanked the bulbous fuselage pod. This had large sideways-opening doors at either end and a small flight deck mounted high in the nose to give an unobstructed cargo space measuring 10ft by 47ft. This could accommodate 28,000lb of cargo or up to 89 passengers. The fuselage sill height was specifically chosen to match that of a flatbed lorry to aid cargo loading and unloading.

The aircraft's distinctive pod and boom

but was never built. This would have had an extension behind the cockpit for an upper passenger cabin, with the existing cargo space used to carry cars.

Military use

Although requirement OR323 had been long cancelled, the RAF still needed an aircraft to replace its piston powered Vickers Valetta and Handley Page Hastings transports that were now reaching obsolescence. In mid-1959, the Air Ministry drew up a specification for a military derivative of the AW.650 Argosy, which was by now demonstrating excellent performance.

The RAF envisaged using the aircraft as a medium-range transport as well as a paratroop and supply aircraft.

AW set to work on modifying the

aircraft and the resultant AW.660 was significantly different. The cargo floor was strengthened and the rear cargo doors were changed from a side opening design to a 'clam shell' style with a built-in loading ramp. The latter would allow the air dropping of cargo while doors were fitted to either side of the rear fuselage to enable paratroopers to exit at speed. The new doors were tested on the second Series 100 civilian Argosy from July 1960.

At the front the nose door was sealed and the aircraft fitted with a 3ft diameter pimple-like weather radome – the suggestively shaped nose led to RAF crews christening the aircraft the 'Whistling Tit'!

The military version of the Argosy had Dart 101 turboprops and twice the range of the earlier AW.650. The first of 56 RAF machines took to the skies on March 4, 1961.

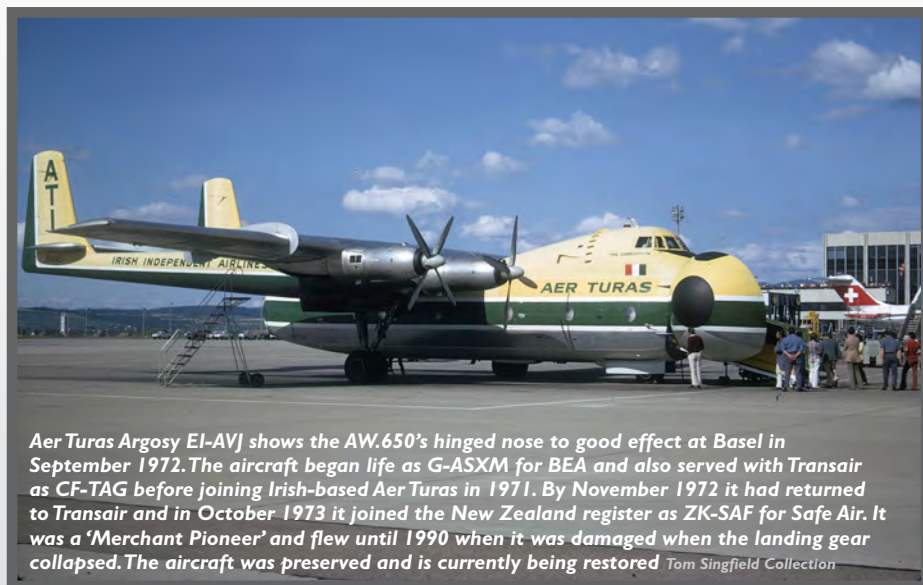
The RAF aircraft had a capability to accommodate 69 troops, 48 stretcher cases or 29,000lbs of freight. It could carry the Saracen and Ferret armoured cars as well as the 4.13in howitzer gun.

Modified

AW's decision to use the Shackleton wing limited the Argosy's freight carrying ability and, as such, reduced its appeal to civilian airlines.

British European Airways (BEA), for example, decided the Series 100 would not offer a profitable yield and this led AW to design a new wing. It was of the same aerodynamic design as before but benefited from a modern 'failsafe' structure that made it both stronger and lighter.

This new wing was fitted to an airframe



Aer Turas Argosy EI-AVJ shows the AW.650's hinged nose to good effect at Basel in September 1972. The aircraft began life as G-ASXM for BEA and also served with Transair as CF-TAG before joining Irish-based Aer Turas in 1971. By November 1972 it had returned to Transair and in October 1973 it joined the New Zealand register as ZK-SAF for Safe Air. It was a 'Merchant Pioneer' and flew until 1990 when it was damaged when the landing gear collapsed. The aircraft was preserved and is currently being restored Tom Singfield Collection

that also featured larger cargo doors, stronger landing gear and integral fuel tanks within the wings – the Series 200 was born. The first example flew on March 11, 1964 and was followed by six Series 220s with more powerful engines.

Into service

The first Argosies to enter service were the aircraft ordered by Miami-based Riddle Airlines whereas BEA debuted the type in the UK.

BEA aircraft boasted Rolamat conveyor systems and the first example (G-APRN) took to the skies on September 21, 1961. The type replaced the Douglas DC-3 Dakota in BEA service and nine would eventually join the airline.

Elsewhere in the UK, the Argosy served with Air Bridge Carriers, Elan Parcel Service and Sagittair and the type also flew in Australia, Canada, Gabon, Ireland, Luxembourg, New Zealand, Philippines, the USA and Zaire.

The RAF allocated Argosies to 70 Sqn in Cyprus, 105 Sqn in the Middle East, 215 Sqn in Singapore as well as 114, 115 and 267 Sqns at home. The type also served with 242 OCU and 6 FTS.

All the 56 RAF Argosies were built and operated as C.1 variants that could be used in full passenger fit, full cargo fit or combinations thereof. The type could also be used for air dropping, casualty evacuation and VIP duties and some were later converted for different uses

"A New Zealand-based example was used as a UFO lure"



G-APRN first flew in May 1959 and spent a period as the company demonstrator before being delivered to BEA in November 1961. The airline returned it to the manufacturer in 1965 in a part-exchange deal for a Series 200 airframe. It was sold on to the USA where it became N897U with Universal Airlines and Nittler Air Transport. The aircraft returned to the UK as G-APRN in 1971 to join Sagittair at East Midlands Airport and later Air Bridge Carriers. It was damaged beyond repair in 1982 when the right main gear collapsed on landing at Belfast, Northern Ireland

including 12 that became E.1 aircraft for calibrating airfield navigation aids.

In addition to cargo and passenger carrying roles, the Argosy also enjoyed more colourful adventures – including a New Zealand-based example that was used as a UFO lure in 1978 for a TV network. This was in response to reports by cargo pilots that bright lights had chased their aircraft across the Cook Strait (later investigation proved the lights were the mast lights of trawlers working below).

Elsewhere, Argosies 9Q-COA and 9Q-COE were employed by Otrag Range Air Service in the Republic of the Congo as an inexpensive method of launching satellites. Sadly the project was abandoned before its success (or otherwise) could be proven.

The RAF's 70 Sqn at RAF Akrotiri, Cyprus retired the final Argosy C.1 in February 1975; the aircraft having been gradually replaced in RAF service by the Lockheed C-130 Hercules since 1970. The final RAF Argosy to fly was an E.1 variant, which was retired by 115 Sqn in 1978.

In civilian use, the Argosy flew on until 1991 when American cargo airline Duncan Aviation finally withdrew its last example.

Future Large Aircraft

The Lockheed C-130 Hercules continues to serve the RAF with distinction but in 1982 the Future Large Aircraft (FLA) programme was launched to create a new generation of military transport.

The Future International Military Airlifter (FIMA) group was set up by Aérospatiale, British Aerospace (BAe), Lockheed, and Messerschmitt-Bölkow-Blohm (MBB) to develop a replacement for the C-130 Hercules and C-160 Transall but the various requirements of different air arms (and



“Even at 100 tonnes take-off weight the A400M can get airborne from a 980m runway and land on a 770m strip”

the complications of international politics) caused slow progress. In 1989 Lockheed left to develop its upgraded C-130J Super Hercules and was replaced in the syndicate by Italy's Alenia and Spain's CASA.

In 1993 a new group was set up to meet the requirements of the air forces of Belgium, France, Germany, Italy, Spain, Turkey and the UK. The new aircraft was to be a joint project shared between seven nations – although Italy soon withdrew from the programme.

The new design was positioned as an intermediate sized aircraft between the Lockheed C-130 and the jet-powered Boeing C-17. Power was originally to come from the SNECMA M138 turboprop but in 2002 a new request for proposal (RFP) resulted in applications from Pratt & Whitney Canada (with the PW180) and Europrop International. The latter proposed was a new design, dubbed the TP400-D6 and this was chosen to power the new aircraft in May 2003.

Airbus Military – the Madrid-based subsidiary of Airbus Industries, took over management of the project with design and construction work to be shared between BAE Systems (UK), EADS (Germany, France and Spain), Flabel (Belgium) and Tusas Aerospace Industries (Turkey). Final assembly would take place in Seville, Spain. In April 2005, South Africa joined the partnership receiving a contract for fuselage components.

The aircraft, which was rebranded



as the Airbus A400M, was envisaged to substantially increase the range of earlier transporters as well as doubling the cargo carrying capacity – both in terms of payload and volume.

The cargo hold itself is 58ft 1in long, 13ft 1in wide and 12ft 7in tall and can accommodate up to 81,600lb of freight. It can also be configured as a pure cargo transport or troop transport (or combinations thereof) as well as a casualty evacuation aircraft. An optional hose-and-drogue refuelling system can also be fitted.

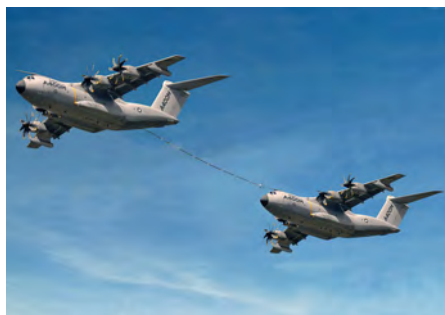
Technology

From the offset, the A400M was designed to operate from short, unprepared airstrips and even at a 100 tonnes take-off weight the aircraft can get airborne from a 980m runway and land on a 770m strip. This

“In November 2010 Airbus CEO Tom Enders was among the first paratroop jumpers”

is helped by the computerised fly-by-wire flight control system that enables the crew to operate to the edge of the flight envelope with full protection.

Like other Airbus aircraft, the A400M has a full glass cockpit and side stick controllers – in fact most of the aircraft systems are based on those of the A380. There are two



A ‘Buddy Buddy’ refuelling system allows the A400M to either give or receive fuel inflight
Airbus Military

electrical systems that provide redundancy protection against battle damage.

Much of the airframe is manufactured from carbon fibre reinforced plastic, including the eight-bladed scimitar propellers fitted to the four 11,000shp Europrop TP400-D6 engines – the most powerful turboprop engine in operational service in the West. To reduce torque, the two propellers on each wing turn in opposite directions.

Within the cockpit a forward-looking infrared enhanced vision system (EVS) camera improves the view of terrain ahead in low-visibility conditions. These images are displayed on the Head Up Display (HUD) as is the Multi-Colour Infrared Alerting Sensor (MIRAS) missile warning sensor.

Delays

The prototype A400M (F-WWMT) had been due to perform its maiden flight in 2008 but delays to the project meant the aircraft didn't take to the skies until December 11, 2009.

In early 2009 Airbus Military announced



Unusually, the large eight-bladed propellers turn in different directions with one rotating clockwise and one anticlockwise on each wing to reduce torque *Steve Bridgewater*

that the first A400M delivery would be postponed from 2009 until at least 2012. Media reports also suggested that the aircraft was overweight and may not achieve the ability to airlift 32 tons. Airbus CEO Thomas Enders also went on record to say that the programme might need to be abandoned completely unless changes were made to the design or the customers' requirements. This would obviously result in time delays and price increase and the South African Air Force soon announced that it was considering alternatives to the A400M. It subsequently cancelled its order completely. By now the project was quoted as being €5 billion over budget and four years behind schedule.

The delays resulted in the RAF leasing (and subsequently purchasing) eight Boeing C-17s to fill the capability gap. The UK also looked at acquiring additional C-130Js in place of the A400M.

By the end of 2009 Airbus acknowledged that the programme could lose at least €2.4 billion and would not break even without sales outside NATO countries. The seven European nations announced they would continue to support the programme but Airbus requested a €5 billion subsidy, threatening to scrap the programme unless €5.3 billion was added by partner governments.

In November 2010, Belgium, Britain, France, Germany, Luxembourg, Spain and Turkey finalised their contracts and agreed to lend Airbus €1.5 billion – but by now the programme was three years behind schedule.

The UK and Germany also cut their orders, with the UK reducing its requirement from 25 to 22 aircraft and Germany slashing its list from 60 to 53. This reduced the order book from 180 to 170.

In the meantime, flight-testing of the A400M progressed with four prototypes flying under the names Grizzly 1 to 4. The first aircraft had performed 39 hours of flying by the time Grizzly 2 (EC-402) took to the skies on April 8, 2010. The third A400M took to the air in July 2010 and the fourth on December 20 of the same year.



ZM400 was the first A400M to join the RAF, which now has seven of an eventual 22 examples in service *Airbus Military*



An A400M provides a dramatic demonstration of its defensive measures

Airbus Military

The type passed ultimate-load testing of the wing in July 2010 and in November 2010 the first paratroop jumps were performed – with Airbus CEO Tom Enders among the first jumpers.

By September 2011 the total hours flown had increased to 2,100 hours and 684 flights and on March 14, 2013 the A400M

received its Type Certification from the European Aviation Safety Agency (EASA)

Operational

Production of the first production A400M began in January 2011 and the type was officially renamed the 'Atlas' in July 2012. The first aircraft (F-RBAA) was

delivered to the French Air Force on August 1, 2013 and they would perform the A400M's first operational mission, a flight to Mali, on December 29, 2013.

Turkey would be the next nation to receive the A400M, when the first was delivered in April 2014. The UK then received the first of 22 examples in November and the type was declared operational at RAF Brize Norton in March the following year. By September 2015 the UK had become the A400M fleet leader in terms of flying hours, with 900 hours flown over 300 sorties, achieved by the fleet of four aircraft.

Germany received its first A400M in December 2014 and although it has reduced its order from 60 to 53 airframes, it only plans to operate 40 aircraft and hopes to sell the remaining 13.

Malaysia was the next nation to receive an aircraft (in March 2015). It will ultimately receive four airframes and, to date, is the only non-European country to purchase the A400M.

As deliveries continue, Spain is expected to receive the first of its 27 examples in 2016; Belgian is gearing up to receive the first of its seven airframes between 2018 and 2020 and Luxembourg will accept its first and only example in 2019.

By now the unit cost of each A400M has reportedly risen to €152.4m but the resulting airframe is undoubtedly one of the most capable transport aircraft in military service anywhere in the globe.

The Atlas will be a familiar sight in European skies for decades to come and is a worthy successor to the Argosy. ●



SPECIFICATION ARMSTRONG WHITWORTH AW.650 ARGOSY

Crew	4
Capacity	54 paratroops, 48 stretchers or 29,000lb of cargo
Length	86ft 9in (26.44m)
Height	29ft 3in (8.92m)
Wingspan	115ft 0in (35.05m)
Wing Area	1,458sq ft (135.50m²)
Empty Weight	56,000lb (25,401kg)
Max Take-Off Weight	105,000lb (47,627kg)
Max Cruise Speed	220kts (253mph/407km/h)
Range	3,450miles (5,552km)
Powerplant	Four Rolls-Royce Dar 101 turboprops (2,470shp each)
First Flight	January 8, 1959 (AW.650 prototype)

Artwork: Andy Hay / www.flyingart.co.uk



SPECIFICATION AIRBUS MILITARY A400M ATLAS

Crew	3 or 4
Capacity	116 paratroops, 66 stretchers or 81,600lb of cargo
Length	148ft 0in (45.1m)
Height	48ft 3in (14.70m)
Wingspan	139ft 1in (42.40m)
Wing Area	2,423sq ft (225.10m²)
Empty Weight	168,654lb (76,500kg)
Max Take-Off Weight	310,852lb (141,000kg)
Max Cruise Speed	422kts (485mph /781km/h)
Range	5,406 miles (8,700km)
Powerplant	Four Europrop TP400-D6 turboprops (11,000shp each)
First Flight	December 11, 2009

Artwork: Andy Hay / www.flyingart.co.uk



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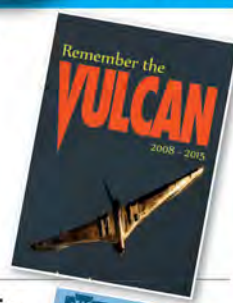


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