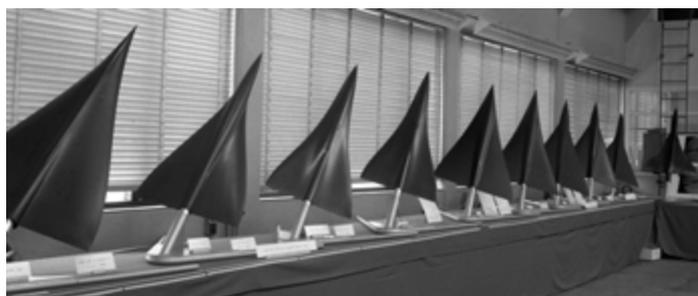




*PAPI Light Box*



*Array of Concorde wind tunnel models*

**RAE Bedford Legacy** Over the nearly 50 years of its operation, the Royal Aircraft Establishment at Bedford made many major contributions to aeronautical science and technology. In this issue we highlight work on PAPI and Concorde. A feature of all international airports round the world is a visual guidance system known as PAPI. This system of red and white indicator lights was devised at RAE Bedford, initially as an aid to local experiments.

**Origins of Precision Approach Path Indicator (PAPI)** (by Tony Smith) In 1973 the Dept of Transport tasked BLEU to investigate the operational feasibility of operating passenger flights from city centres, seen as a way of reducing journey times, especially for business travellers. The basic parameters envisaged for such Short Take-Off & Landing (STOL) operations included a 4000 x 50 ft runway used by a 100-seat twin-jet aircraft that would have a final approach speed of 90kt. To reduce the noise footprint the aircraft would fly a precision approach at an angle of 6 degrees. The operation (day, night, low visibility) was to use a Decision Height of 100ft, with the aircraft coupled to an instrument landing guidance system to a height of 50ft. From this point the pilot would flare the aircraft manually.

To evaluate the concept BLEU had two aircraft capable of steep approaches at around 90kt, a Varsity and a HS 748. In discussion with Nigel Hughes who was leading the project we identified two new requirements to support the flight trials: firstly, some form of precision visual glide-slope aid that would enable pilots to manually fly the whole 6 degree approach whilst achieving a flight path accuracy comparable to that expected from a coupled approach; and secondly, some additional lighting and marking in the touchdown area to enhance textural cues for the flare. This latter requirement is not covered here. The outline of a STOL runway was painted on Runway 24 for the flight trials and the kine-theodolites were used to provide flight path data for subsequent analysis.

A set of 4 light units that projected a high intensity beam was available from a previous project. Each unit projected a collimated beam. A red filter, suitably placed in the units, produced a 2-sector beam, the upper half white and the lower half red with a very sharp colour change between the two signal colours. Over a period of about two weeks I deployed the 4 lights in a number of patterns and in a series of flights the pilots evaluated the resulting guidance in terms of work load and task difficulty. We carried out approaches at various glide-slope angles up to 15 degrees. (A 50ft flare off a 15 degree approach was quite exciting; rather like sitting in a Stuka!) At the end of the trial it was clear that what became PAPI was the best design and it was shown by flight data that it resulted in the desired glide-slope holding performance. PAPI was then used throughout the city centre STOL evaluation programme.

Having used PAPI, the pilots suggested to me that it should be promoted as a replacement for VASI, the existing visual guidance aid at airports, because it offered improved visual guidance and solved a number of long-standing deficiencies in the older system. For example, by offering precision guidance down to the flare it was shown to give early warning of a wind-shear encounter (a hot safety issue in the 1970's). The PAPI concept was offered to both the MOD (RAF) and the CAA. After a prolonged and comprehensive set of operational trials at Heathrow, Gatwick and a number of RAF stations the aid was adopted for use in the UK. It was then proposed to both ICAO and NATO as a global replacement for VASI. It was finally adopted into service in 1983, 10 years after the concept was first evaluated.

During the evaluation phase, systems were installed (by Sam Kidd) to solve particular operational problems. At Binbrook the Lightning aircraft were regularly landing short and doing extensive damage to the emergency barrier equipment. Once PAPI was installed there were no more undershoots (the Station Commander was very grateful). At Cottesmore the tri-partite Tornado squadron had no visual glide-slope aid. A PAPI installation quickly fixed that problem. In Belize a PAPI enabled VC10's to land at night in support of Harrier operations. Perhaps the most prestigious use of PAPI was to provide guidance for the final hand-flown stage of early Space Shuttle landings.

**The Bedford Wind Tunnels & Concorde** (by Mike Dobson) The support given by the Bedford wind tunnels to the Supersonic Transport Programme, right up to the final design of Concorde, was by any standards enormous. During the development of the slender wing in the late 1950s and 1960s, over 70 models were tested in the 13x9, 3x3 and 8x8 tunnels. Three of the physically largest models ever to be tested in the 3x3 tunnel were used to study the interference effects between engines in a multi-engine nacelle should one or more engines fail. However, work in the

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8x8 tunnel, on the refinement of the aircraft and engine nacelle drag, the definition of engine intake performance and the optimisation of the air intake control system, probably represented the most intensive period of testing ever undertaken in any of the Bedford tunnels. To cope with the volume of work, two full teams of staff were assigned to allow the tunnel to be operated on a shift basis for fourteen hours a day, for test periods of many weeks, over an elapsed time of many months. Tunnel running was so intense that a shutdown was necessary every few days to allow the supplier of gas-oil for the gas turbine electrical generating sets to catch up on supply - the tunnel consumption outstripped his delivery capability. Starting at number one, the final configuration tested during this period was 396! The subsequent RAE Report TR71031 "Concorde Performance Assessment" (145 pages) was published in 1971.

**Talk at FASTA** On 21 May 2013, Mike Dobson will be talking to the Farnborough Air Sciences Trust Association on the theme "The Evolution of the Bedford Wind Tunnels", at the Holiday Inn, Farnborough, 7.30PM. Visitors welcome.

**Meteor Smuggling** (by Ian Conradi, Test Pilot Bedford 1968-72) In 1969 Meteor NF14, WS804, was often to be seen on the Aeroflight apron, pre-flighted and ready to go. It was mainly used as a hack - if somebody needed to be taken somewhere or brought back - use the Meteor. It was quite a surprise when we heard that it had been sold. I was nominated to fly it to Blackbushe to be transferred to the new owners. On 5 September, 1969, my log book records that I spent 20 minutes flying 804 to Blackbushe. The men who met me were somewhat disappointed that the under-wing fuel tanks were not connected and that the ventral tank was empty. In fact on this aeroplane, the fuel in the ventral tank had to be used up before it got down to landing weight. I was then flown back to Bedford in a Cherokee and I forgot about it - for a while!



What I did not know at the time was that WS804 immediately became G-AXNE. With its long nose advertising "Enterprise Films", it flew off next day to Exeter. A day later it reached Bordeaux, on a temporary export licence. In fact, it was following in the footsteps of another Meteor NF14, bought by the same people from Rolls-Royce at Hucknall, and also exported on a temporary licence two months earlier.

Our Meteor reached Faro, in Portugal, two days later and there joined the other Meteor from Rolls-Royce. Each aeroplane was



then fitted with weapons - four 20mm canon and a bomb rack. On 21 September they both left Faro for Funchal, Madeira. The truth was that they were ultimately destined for Biafra to join the struggle for independence from Nigeria. The Rolls-Royce Meteor, G-ASLW, left Funchal on 21 September, after some technical and weather delays. The pilot headed south but, reportedly short of fuel, he abandoned the aircraft off the African coast and was picked up by a ship. Our Meteor G-AXNE flew from Funchal to Dakar and on to Bissau, in what was then Portuguese Guinea. The aeroplane was never to fly again!

By this time the authorities in Britain, which was backing the Nigerian Government against the Biafran "rebels", had realised that these Meteors had slipped through the net. The Portuguese authorities agreed to impound the aeroplane at Bissau. In May 1970, the men responsible were brought to trial and I provided a written statement about my brief involvement. At Berkshire Assizes they pleaded guilty to various charges of illegally exporting the Meteors, spare parts and gun barrels. The five men were fined a total of £5000. As for the aeroplane - as far as I know, Meteor NF14 WS804 is still on the ground at Bissau, decaying under the tropical sun.

**Jet Flap Correction** In the Feb 2013 Newsletter, the date of the first flight of the Hunting H.126 Jet Flap was incorrect. It should have been 26 March 1963. Fortunately, we could cross-check via Clive Rustin's pilot's log book, which we have scanned. He acted as Chase Pilot in a Meteor. The Bedfordshire Times & Citizen on 4 April featured a brief item about the Jet Flap, but failed to mention us at BAHG - although we supplied the information!

**New RAE Book - "Wind Beneath the Wings"** To complement the previously published *Wings Over Thurleigh*, Mike Dobson has written a new book *Wind Beneath the Wings*, which traces the evolution of Bedford's tunnels from earliest thoughts on supersonic flow in RAE, via a "German connection", through to their construction at Bedford. It also details some of the experimental facilities for flight research on Thurleigh airfield. *Wind Beneath the Wings*, illustrated with more than 250 photos, mostly from the BAHG Archive, can be obtained from the author; [mddobson@daytasure.com](mailto:mddobson@daytasure.com) or 01234 771685, price £15.00 softback plus £6.00 p&p [UK]. It, together with the fourth (softback) edition of *Wings Over Thurleigh* available at the same price, can also be obtained via BAHG (email below).

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