ROBERT HUGH FRANCIS MSc, FRAeS 1908-1972

ROBERT HUGH FRANCIS, who was Executive Director, Research at Hawker Siddeley Aviation, had been actively engaged in aeronautics for four decades. He was gifted with talent for originality, blended with perceptive scientific judgement, and was in the forefront of some of the most challenging innovations over this stimulating period. He was somewhat retiring and preferred to work quietly rather than in the limelight but he thought deeply and brought great wisdom to bear on a wide variety of novel technical developments.

Hugh Francis was born on 9th August 1908, in Caernarvon, Wales and was educated at Llanberis secondary school, thereafter going to the University of Wales at Bangor. A Busk Studentship in aeronautics took him to Cambridge University under Melville Jones and William Farren after which he joined the Royal Aircraft Establishment at Farnborough on 27th October 1932.

He was a member of the Aerodynamics Department (originally BA Department) until February 1943, concentrating on stability and control in flight and in the low speed spinning tunnel which was housed in the old airship hangar—the Beta Shed. The Full Scale section was rich with talent during this period: Morien B. Morgan (now Sir Morien, the Director of RAE), P. A. Hufton (lately Deputy Director (A) RAE), D. E. Morris, D. J. Lyons, and R. Ewans to name but a few. Under the mathematical genius of S. B. Gates, and during wartime, also with Professor Duncan, great steps were made in the application of mathematical technique to the prediction and understanding of stability and control of military and civil aircraft. During this period Francis produced several ARC Reports and Memoranda on a variety of research into low speed handling problems. The coming of the war accelerated the number of *ad hoc* problems needing the attention of the Full Scale section, including aileron short-comings of the Spitfire, the handling of the Stirling and Beaufighter, all of which required considerable scientific analysis. In addition, however, much innovative research was initiated, culminating in the development of the troop and equipment gliders, their tugs and the new problems of performance and handling which was a vital part of the creation of the British Airborne Forces, soon to be used in the liberation of Europe.

In February 1943, Hugh Francis was appointed Superintendent of the Marine Aircraft Experimental Establishment, which had been evacuated from Felixstowe in Suffolk to Helensburgh in Scotland. MAEE was then a busy centre testing many new flying boats built in the UK and also commissioning American boats for the RAF including the Catalina, Mariner, and Coronado. In this work MAEE was performing a similar function to that of the A and AEE, then in its new headquarters at Boscombe Down, and yet it was still continuing hydrodynamic research into new hull shapes, investigating water impact loads and model tests of a new jet flying boat fighter. He also became involved for the first time with armament work. This related to the development of new anti-submarine bombs, air-to-surface rockets and the building of the bomb and rocket water entry research tank at Glen Fruin. During this active period MAEE was virtually an RAE in miniature and as Superintendent at a remarkably young 35, he was exposed to the full range of leadership and management problems, from the experience of which he derived much of his success in future work. Nobody doubted the future of the flying boat and there was technical interest in the quest for reduced hull drag, particularly on ventilated and faired hull steps both in model experiments and in full scale tests on a modified Short Scion Senior with Shetland shaped hull capable of measuring water forces. Francis was involved in the initial steps leading to the jet flying boat fighter intended for operations in the Pacific. Other members of the staff during this period in Scotland included J. L. Hutchinson, A. G. Smith, R. A. Shaw, A. N. Whitfield and J. A. Hamilton. In 1945, the Establishment returned to Felixstowe and after a flight to Denmark in a Sunderland to inspect German flying boats, Francis added a further 10 German marine aircraft to his inventory.

After the war, the main preoccupations were research towards the large Saro Princess flying boat which eventually flew in 1952 and flight testing the Saro SR/A1 jet flying boat fighter and further developments of the highly faired and naturally ventilated hull step. Francis always wanted to gain first-hand experience of the work for which he was responsible and was often to be seen in the second pilot's seat in these experimental flying boats. There was a historic occasion in 1948 when Mr. F. W. S. Locke Junior of the United States Bureau of the Navy flew in a Felixstowe Sunderland which had a fully faired step, naturally vented, and which performed very satisfactorily in take-offs and landings. It is unfortunate that the hopeful attack being mounted on reduced hull drag should not have found its way into better flying boats, but the progress made in the landplane during the war years and the world-wide availability of long concrete runways doomed the flying boat to extinction.

However, in 1949, as an SPSO, Hugh Francis moved back to RAE to become Superintendent of the Armament Development Division. Here he had to exchange Froude number for Mach number as the variable in common use, with the development of new weapon systems of prototype aircraft, particularly a nuclear weapon for the V-bombers. Francis seemed destined to appear at the right time in all his new appointments. In this one his background in aerodynamics in general, and stability and control in particular was very useful in understanding the new weapon problems raised by the growing fleet of fast jet aircraft. The release disturbance problem of bombs and rockets was at its height during his stay in the Weapons Department as also was the phenomenon of jet engine flame-out arising from gun firing at altitude. As at MAEE Francis was heavily involved in practical day-to-day developments, and yet had time to take initiatives in novel concepts. He first promoted the concept of low level nuclear attack and evaluated aerodynamic solutions to the difficult problem of escape. As secretary of the ARC Weapon Research Committee, under Sir William Farren, he was thoroughly acquainted with the wide range of missile and weapon possibilities which were of national importance at this time. When the time came to consider how V-bombers and their ballistic weapons should be further developed to maintain their survivability, he became involved with preliminary studies of stand-off weapons. In 1953 he was a member of a UK technical mission to the USA studying the designs adopted by Bell with "Rascal" and Convair with the rocket missile for the B-58.

This occasion really set the scene for Francis's biggest task. At this time there was considerable national debate on the need for a stand-off weapon, and on whether it should have long range and be powered by a turbo-jet or fly faster and higher with a pure rocket. Another difficulty was in deciding the form of project management for the weapon which was likely to involve a costly development programme involving many new features with correspondingly serious risks. While these protracted discussions were being resolved A. V. Roe, then heavily committed on the Vulcan V-bomber, decided to create a new Weapons Research Division to take on the stand-off bomb and Francis was appointed Chief Engineer. In retrospect his choice seems to have been ideal: he already had a wide experience of aerodynamics and armaments including nuclear bombs and had demonstrated shrewd scientific judgement in tackling many engineering developments. Moreover, his recent experience in the USA and with the ARC had given him a comprehensive picture of the domain of this radically new weapon. So, in September 1954, Hugh Francis left the Government Service and joined Hawker Siddeley, with whom he stayed for the rest of his career. The Weapon Research Division, starting with a staff of six, built up to a total of 2000 personnel, and designed and produced Blue Steel for the squadrons of Vulcans and Victors. The project was unusual in that although clearly in the category of a guided weapon it was managed by the Aircraft Branch of the then Ministry of Supply. This was a recognition that the vehicle was not unlike an aircraft in overall characteristics and the integration of the weapon with the aircraft was more complex than it had been for the previous smaller air-to-air and air-to-ground missiles. Blue Steel was certainly an advanced weapon for UK at this time (it was 35 ft long and flew close to Mach 3) and required the development of a new high test peroxide rocket motor, the introduction of the first UK inertia navigator, automatically controlled long distance supersonic flight, a steel structure, and sophisticated air-conditioning system for the powerful warhead. During this period Francis steered the project over many novel technical and political difficulties. In spite of many pressures to maintain the programme and limit costs, he always allowed sufficient time for the explanation of flight failure to be understood and rectified, and furthermore to maintain a strict standard of safety. It must surely be one of his finest achievements that the whole Blue Steel air development programme involving several V-bombers and many experimental test vehicles was accomplished without injury or loss of life either on the ground or in the air.

R. H. Francis was awarded the George Taylor (of Australia) Prize by the Society in 1965, for his paper *Development of Blue Steel* published in the May 1964 issue of the JOURNAL of the RAeS. The Prize is given for the best paper on design, construction, production, and fabrication (including structures and materials).

As work proceeded on Blue Steel so Francis studied advanced weapons systems. Over 150 new projects were designed in this period and experiments and mock-ups were started for a Mark II Blue Steel powered by Bristol Siddeley ramjet motors. This project was subsequently cancelled in the false hope that the US Skybolt would be superior. Thereafter missile projects were studied for reconnaissance and long range automatic bombing.

However, spaceflight had already begun to interest Francis, who could see how the engineering technology used in Blue Steel could be extended to evolve vehicles having orbital capability. Proposals were made for using Blue Steel as a basis of a small orbiting payload and even more effective solutions were possible by using later rockets. This work indicated some distinct advantages for launching space vehicles from aircraft rather than from bases on Earth. In this way Francis's expertise moved into the aerospace scene while still at Woodford as Chief Engineer. He played an active role in the Eurospace Organisation formed by one of his colleagues, M. N. Golovine in 1961. The absence of an advanced stand-off weapon made WRD rather vulnerable and as part of a rationalisation was transferred to Hawker Siddeley Dynamics to continue in a supporting rather than a leading role and Francis became Chief Engineer of the Advanced Project Group of Hawker Siddeley Aviation at Kingston in July 1963. Francis continued project studies on novel aircraft, including hypersonic and space projects, variable geometry transports and fighters and many supporting research activities. In April 1965 he was appointed Executive Director Research to undertake the co-ordination of HSA's aircraft research activities particularly in aerodynamics and structures. In this work his experience and wide knowledge of the Government research apparatus was very telling. Since his more recent work has still to be published it is perhaps from his papers to various space organisations that his creativity over this period will be best remembered.

A main contribution has been in the Eurospace group concerned with reusable launchers and his influence was apparent in the report prepared by Eurospace, *Aerospace Transporter* in 1964 (a European Post Apollo?). Later on he supported the Post Apollo project regarding the scope it could give to European industry; but he was very conscious of the need for a decisive European participation which appeared not to materialise as time went on. At the Eurospace US—European Conference in Venice in 1970 he presented a paper *European Small Shuttle linked to Post Apollo* which visualised a concrete self-contained European contribution to a Post Apollo programme, in an area in which he felt Europe had much to offer. He also considered that Europe, perhaps through ELDO, should promote some small reusable project studies (e.g. making use of the conventional launcher hardware for a first stage).

In 1968 he was elected chairman of the Eurospace group involved with reusable systems which included representatives of all the major European companies in this field. This group was set up to review all European activity in this field and promote it with the relevant authorities (National, ELDO etc) and define an R & D programme.

He also participated actively in various *ad hoc* meetings in Eurospace at which the European organisations were represented, to discuss current problems associated with Post Apollo and the European contribution.

In his early days at RAE Francis developed a sound understanding of the research into the science of flight. He was quick to grasp the essentials of a problem and his writing showed the same simplifying discipline. His papers were never wordy—perhaps some felt they were somewhat bleak and that they lacked a warmth needed to convince others. His quiet manner was deceptive for he had great tenacity of purpose and a quiet mind ever seeking novel solutions to scientific and engineering problems of flight. His very diverse career emphasises his flexibility of outlook. He was born of a generation of aeronautical scientists who knew great challenges—and great accomplishments. He suffered ill-health periodically during his last twelve months, and was nursed devotedly by his wife and family, and died on 10th June 1972.