



Capt. Jim Mc Kercher runs up the Alvis Leonides engines of Flight One's Scottish Aviation Twin Pioneer Srs.3 G-AYFA at Blackpool during the 1981 season. A few days later the aircraft left Blackpool on detachment to Prestwick and Aberdeen

# Aerial Surveying by Twin Pioneer

*Flight One's work for the Ordnance Survey Office*

by PAUL TOMLIN

(Author's photos)

ALL OF us, virtually, use maps but in these days of technological advancement, with the conveniences of life taken so much for granted, how many of us spare a thought as to how such charts originated.

The National Survey of Great Britain was founded in 1791 under the auspices of the Board of Ordnance—hence the name "Ordnance Survey" which it was later to acquire. The first task of the newly formed National Survey Office was the making of a 1-inch to 1-mile map of the country, starting with the south-eastern counties of England. In 1825 the principal task lay in compiling a 6-inch to 1-mile survey of the

whole of Ireland, and it was during this time that many of the principles and techniques that have been applied to Ordnance Survey work were formulated.

By 1914 a first revision had been completed and a second and third started. But severe government economy cuts made it increasingly impossible to keep the national series of large-scale maps up-to-date and by the late 1930s, with both public and professional opinion angered by the neglect of a valued national asset, a committee of enquiry was formed. Some of the committee's recommendations included the need to introduce a

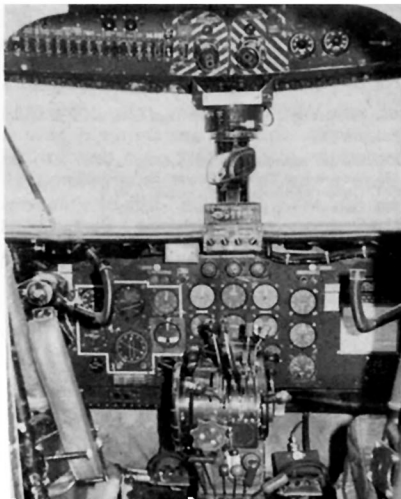
continuous revision system; mapping to be on a national projection rather than by counties; and the use of a national grid reference system on all maps. Other recommendations, such as additional mapping at 50 in. and 2½ in. to 1 mile, became the main Ordnance Survey guidelines from the mid-1940s until the end of the 1970s. In 1978 a Review Committee was set up by the Government to provide work and financial guidelines through to the year 2000.

Today the Ordnance Survey Office, as a civilian and independent civil service department, is responsible for the official surveys and mapping of Great Britain, including geodetic surveys and associated scientific work, topographical surveys and the production of maps at appropriate scales from these surveys.

The main task, just completed, has been one of revision and restoration. This included bringing the 19th and early 20th century surveys up-to-date and compiling them on a National Sheet Line system, and also making entirely new surveys of the major towns.

Three basic scales are used. Urban areas of not less than 1,000 hectares containing a population of 20,000 or more are surveyed at 1:1,250 scale (50 in. to 1 mile, or 80 cm. to 1 km.). All other areas of Great Britain with the exception of mountain and moorland are surveyed at 1:2,500 scale (25 in. to 1 mile, or 40 cm. to 1 km.). Mountain and moorland areas are surveyed at

Detail shots of G-AYFA (left to right): cockpit; cabin looking forward; and belly, showing open camera ports and tracking sight



1:10,000 scale (6 in. to 1 mile, or 1 cm. to 1 km.).

Except in slow-change areas which only require periodic revision, all the new and revised maps are kept up-to-date by a system of continuous revision which ensures that changes on the ground are surveyed soon after they occur.

Whenever possible aerial photography is used to aid O.S. surveyors. World War II and the need for aerial reconnaissance gave added impetus to the development of this branch of photography. Following the cessation of hostilities, the techniques which had been evolved were passed over for civilian use and became an indispensable part of the Ordnance Survey's work.

Each summer the Ordnance Survey Office invites tenders for aerial photography. Towards the end of the year, usually around November, a group of senior O.S. officials will open sealed bids and select the most suitable candidate(s) to provide aircraft and crews for the coming season. Depending upon the amount of work involved, a contract may be awarded to one or any number of companies for the season, which generally lasts from March to September. Both aircraft and crews are required to be available on a daily basis, seven days a week, throughout the seven-month period, weekends and bank holidays included. The O.S. provides its own cameras and associated equipment, together with a team leader/camera operator.

#### Photographic scales

Photographic scales are: 1:5,000 for the 1:1,250 survey; 1:7,000 for the 1:2,500 revision; 1:10,000 for the 1:2,500 survey; and between 1:24,000 and 1:31,000 for the 1:10,000 survey and contouring. All photography is monochrome, although infra-red film, at different scales, is used to carry out the survey of high and low water marks.

Features seen on a pair of overlapping aerial photographs are converted to map details and contours using precise stereoscopic plotting instruments. These instruments, combined with previously determined horizontal and height control points, enable the features seen on the photographs to be plotted at the relevant map scale and in their correct relative positions. As some features on aerial photographs may be hidden by trees, shadows or overhanging roofs and do not show place or house number, an O.S. surveyor always visits the ground to complete the air survey plot by ground methods.

Although the locations to be photographed stretch the length and breadth of Great Britain, the principal Ordnance Survey base for many years has been Blackpool Airport. From this north-west seaside resort a large area of the country is within reach and where necessary detachments to other airfields can be



Above: Three views of Twin Pioneer G-BBVF, flown by Flight One's Chief Pilot, Capt. Hugh Thompson. Lower picture was taken on the flight home to Shobdon

Below: G-BBVF and G-AYFA on their last day at Blackpool about to leave for Shobdon





Four Flight One Twin Pioneers lined up at their Shobdon base, November 1981: G-BCWF, G-AYFA, G-BBVF and G-AZHJ

## Aerial Surveying . . .

made as and when favourable meteorological forecasts suggest that such a move will meet with the right photographic conditions.

The weather plays a dominant role in the daily operations of the O.S. Air Survey Branch. Ideal photographic conditions are clear blue sky with little or no haze, or at the very least, extremely bright overcast. It may be deduced from these two fairly limiting factors that in view of the unpredictability of the British climate, a higher than average proportion of the week may be spent sitting around waiting for the weather to improve. As one pilot put it: "It certainly isn't a job to choose if you are looking for a way to increase your flying hours!" Certain high-level "Blocks" remained unphotographed for almost six years due to poor visibility and were only finally covered during the 1981 season.

For the 1981 survey season, Flight One Ltd., with their base at Shobdon airfield near Leominster, Herefordshire, were the sole Ordnance Survey contractor. This involved two of the company's aircraft on full-time photographic work around Great Britain.

## Flight One's history

Flight One's history dates back over fourteen years to the winter of 1969 when an aircraft maintenance organisation, based at Staverton airport, came into being. During those early years the company expanded its facilities and by 1971 had assumed, among others, the responsibility for the routine maintenance and major servicing of the Portsmouth-based Scottish Aviation Twin Pioneer fleet belonging to Jersey Ferry Airlines. Flight One were later to acquire these aircraft when JFA replaced them with a Britten-Norman Islander and a Trislander.

In November 1971 the company acquired two former R.A.F. Twin Pioneers and work began at once to prepare these aircraft for their new role, following upon the award of Flight One's first Ordnance Survey contract covering the 1972 season.

Flight One are one of the world's last operators of the Twin Pioneer. On a worldwide basis few of these aircraft remain active, but out of a grand total of eight "Twin Pins" to have passed through their hands, Flight One pres-

ently operate three aircraft (G-AYFA, G-AZHJ and G-BCWF); for the record all eight aircraft are listed below.

Apart from Ordnance Survey contracts, Flight One's Twin Pioneers have been kept busy on a variety of tasks over the last few years. G-AZHJ was resident in northern Nigeria for most of October 1977 on a photo-survey mission. Similarly G-BBVF embarked on a five-day positioning flight to the Middle East during April 1979 to conduct an aerial survey of the entire State of Kuwait, both in monochrome and infra-red.

Mentioned earlier was the prime requirement for aerial photography, namely clear blue skies, something of a rarity in Britain, of late, so one would suppose that with an abundance of blue sky over Kuwait there should have been no problem. Wrong! Continuous haze and frequent sandstorms meant that the survey had to be abandoned after three months, and it was only towards the end of the year that it was subsequently completed.

Line-Scan flights to show temperature loss on river estuaries, illegal effluent dumping in rivers and infra-red sensing for factory heat-loss investigations have taken the Twin Pioneers to Austria and Holland. G-AZHJ, which at the time was the only Flight One aircraft to be equipped with DME and radio altimeter, completed a geophysical survey of Southern Ireland during the middle of 1981, flying daily from Dublin at a precise 600 ft., towing a magnetometer "bomb". The Twin Pioneer has found increased favour with aerospace companies for test-flying new equipment; its spacious cabin interior allows the easy installation of test rigs with plenty of room for accompanying technicians.

Although the Twin Pioneer is now in the twilight of its years, it was in advance of its time when the prototype first took to the skies over Prestwick on 24th June 1955. The "Twin" incorporated many lessons learnt during the development of the single-engined Pioneer and, like its predecessor, the type was to see service in the many inhospitable regions of the world, where

its short-field performance could be utilised to the full.

The R.A.F. became the largest operator of Twin Pioneers, ordering a total of thirty-six. In its military guise, a variety of roles found the aircraft operating as an air ambulance on casualty evacuation, supply-dropping, photo-survey and counter-insurgency duties with provision for bomb attachments to the undercarriage stub wings. In its passenger role the Twin Pioneer could accommodate between 16-19 passengers.

Two Alvis Leonides radial engines powered the Series 1 and 3. A number of Series 1s were later upgraded to Series 3 standard, thereby enhancing their payload/range capabilities. The Series 2, as ordered by Philippine Air Lines, was fitted with Pratt & Whitney R1340 engines.

The Twin Pioneer has a well-earned reputation for being a pilot's aeroplane. To quote Flight One pilot Jim McKercher: "Anyone who can operate a Space Invaders machine can probably fly today's push-button airliners. A lot of the old flying skills are, like the aircraft themselves, passing into history." Jim has around 6,000 flying hours in his log-book, accumulated mostly on Bristol 170s, Carvairs, Doves and Herons and of course everybody's favourite, the DC-3, plus a sprinkling of modern types such as the Twin Otter.

As may be expected from the three-finned configuration, the Twin Pioneer is endowed with a responsive rudder control, especially at low speed. Aileron control seems to require coarser movements of the wheel than later generations of aircraft and the high wing can be more susceptible to turbulence. The occasional turbulence apart, once trimmed out the "Twin Pin" becomes a steady platform, there is no vibration and the noise level is quite low. Normal cruising speed is around 100 knots—same as a Cessna 172!—with a stalling speed of 50 kt.

Some while ago, when the 1981

## SCOTTISH AVIATION TWIN PIONEERS

c/n.	Reg'n.	Srs.	Del'd.	Remarks
507	G-APHX	1	11/72	Ex JFA. Broken up for spares 8/80
508	G-APHY	1	11/72	Ex JFA. Sold to Canada 7/74 as C-GSTX
512	LN-BFO	3	10/71	Originally for JFA, never entered service. Reg'd. G-BDLX 13/11/75, but not converted and broken up 8/80
515	LN-BFK	3	11/71	Originally for JFA, never entered service. Broken up 8/78
538	G-AYFA	3	11/71	In service 3/72. Ex G-31-15/XM285
558	G-BBVF	3	6/73	In service 5/74. Ex 7978M/XM961; written off 3/82
561	G-BCWF	3	2/75	In service 3/82. Ex XT610/G-APRS
577	G-AZHJ	3	11/71	In service 9/72. Ex G-31-16/XP295



survey season was well advanced, I visited Blackpool early in July to see the work of the O.S. Air Survey Branch.

The three-man team comprises a pilot, a tracker/navigator and the camera operator. Each flight is planned in meticulous detail. A section of an existing chart of the area to be photographed is placed in an operations folder; on this chart are inscribed parallel lines denoting the position and length of each run over the target, at the beginning and end of which are two cross lines which indicate the start and finish of the actual target area and when the camera must be activated and stopped.

These extended parallel tracks enable the tracker visually to position the aircraft on the correct heading a few miles from the start-line. Once established on track the pilot must then maintain his heading and height for the entire length of the target run, which could be anything from one mile to well over thirty miles.

Perhaps the most demanding task in aerial survey work is flying the aircraft not only straight, but also level. "The most difficult of aerobatic manoeuvres", commented John Pierpoint, senior Ordnance Survey official until his recent retirement. John had been involved in extensive flying with numerous newcomers to aerial surveying, and recalled countless stories from his early flying days just after W.W.II. Although a tolerance of 50 ft. is grudgingly permitted in the altitude mode, the precision flying involved requires a high level of concentration. Many newcomers find it difficult to keep to the high degree of accuracy demanded by the O.S. office. "It takes a lot out of you," says Jim Mc Kercher. "Like flying instrument approaches for six or seven hours non-stop."

A positive wind direction is preferred, as light and variable winds can provide tricky conditions, when drifting off the centre-line may occur. Each run is planned so as to provide a 30% image overlap on the next.

To enable the aircraft's drift angle to be established, the tracker views the ground through an optical sight—akin to an inverted periscope—on which are etched black lines representing the picture area, which correspond to identical lines on the intervalometer. Throughout the run a constant check will be kept on both items of equipment to ensure that the aircraft is on the correct line. While position location is purely by visual means—checking appropriate features and landmarks against the existing chart—a high degree of accuracy is possible, but to achieve this a good level of teamwork is essential.

All the photographic equipment used in the operation is the property of the O.S. office. Two cameras are installed in the aircraft: a Wild RG8 or an RC10, both with 6-in. lens, or a Zeiss RMK fitted with a 12-in. lens. Each lens may be fitted with a choice of filter which



Latest Twin Pioneer to enter Flight One service is G-BCWF, seen at Shobdon



G-AZHJ at Shobdon, April 1981. With G-BCWF it is at present employed on BAe contracts

is clipped on the lens and which may be changed in flight if necessary. Basically two filters are used in black and white photography: yellow or orange. The camera operator's experience dictates which filter is used, but generally speaking the darker orange filter is normally preferred when there is an excessive amount of haze in the atmosphere.

Detachable film magazines are easily clipped into position on top of either camera body as required. The standard container holds sufficient film for approximately 250 to 285 exposures; larger magazines are available with a capacity for 500 exposures.

Over the target area an exposure meter measures the amount of light available and the appropriate shutter speed is set on the camera. Near the start-line an initial push on the button starts the camera which is controlled by the intervalometer, which itself has been pre-selected to give the required image overlap. The camera operator logs each run in the operations folder, noting height, speed, time, weather conditions, wind drift angle, shutter speed, film type, container number, etc.

As each film is used, it is despatched to O.S. Headquarters at Southampton, where it is processed and an initial mosaic of the area is constructed. The team receives a grid plot of the target on which are marked the track lines and position showing when each exposure was made and at what height. It is only then that the accuracy of the flight may be judged, as any drifting to either side of track—with the automatic height readout present in the camera and which is automatically photographed on to each frame—is present for all to see.

Once a mission has been accepted, work is put in hand to transcribe the results into the charts we are all familiar with.

#### Twin Pioneer postscript

As fate was to have it, the end-of-season ferry flight from Blackpool to Shobdon on 30th September 1981 was to be Twin Pioneer G-BBVF's last flight. On 11th March 1982, while parked at Flight One's Shobdon base, the aircraft suffered severe structural damage to its tail when it was blown backwards into G-AZHJ by gale-force winds. The tail assembly was damaged beyond economic repair and the aircraft was subsequently declared a write-off; total flying hours were 3,549.15. In September 1982 G-BBVF left by road to join the Royal Scottish Museum's "Museum of Flight" collection at East Fortune, some 20 miles east of Edinburgh.

G-AZHJ received a hole in its nose and this was repaired by Field Aircraft Services at East Midlands during April 1982.

To cover the permanent loss of one aircraft, and the temporary withdrawal for repairs of another, March 1982 saw G-BCWF entering service for the first time since its acquisition by Flight One in February 1975.

At the time of writing G-AYFA is retained in reserve in a non-airworthy state. European skies are, however, actively graced by G-AZHJ and G-BCWF, which have, 3,505 and 3,010 flying hours respectively to their credit as of 1st January 1983. These two aircraft are, at the moment, employed primarily on British Aerospace contracts, a number of which have taken the "Twin Pins" to West Germany.