AD NUMBER
ADA800706
CLASSIFICATION CHANGES
TO: **unclassified**
FROM: **restricted**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to DoD only; Foreign Government Information; DEC 1946. Other requests shall be referred to British Embassy, 3100 Massachusetts Avenue, NW, Washington, DC 20008.**
AUTHORITY
DSTL, AVIA 6/12959, 19 Oct 2009; DSTL, AVIA 6/12959, 19 Oct 2009

Reproduction Quality Notice

This document is part of the Air Technical Index [ATI] collection. The ATI collection is over 50 years old and was imaged from roll film. The collection has deteriorated over time and is in poor condition. DTIC has reproduced the best available copy utilizing the most current imaging technology. ATI documents that are partially legible have been included in the DTIC collection due to their historical value.

If you are dissatisfied with this document, please feel free to contact our Directorate of User Services at [703] 767-9066/9068 or DSN 427-9066/9068.

Do Not Return This Document To DTIC

The U.S. GOVERNMENT

IS ABSOLVED

FROM ANY LITIGATION WHICH MAY ENSUE FROM THE CONTRACTORS IN-FRINGING ON THE FOREIGN PATENT RIGHTS WHICH MAY BE INVOLVED.

WRIGHT FIELD, DAYTON, OHIO

REEL - C

349

A.T.I.

9411


RESTRICTED

TECHNICAL NOTE No: PH. 406

ROYAL AIRCRAFT ESTABLISHMENT

Farnborough. Hants.

FLYING FOR AIR SURVEY

SUGGESTED NAVIGATIONAL METHOD OF FLYING PARALLEL STRIPS

by

B. J. ATTWELL

and

WING COMMANDER P. R. BURCHALL, O.B.E.

U.D.C. No. 629.13.004.2 : 526.918.52

Technical Note No. PH.406

December, 1946

ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

Flying for Air Survey

Suggested navigational method of flying parallel strips

by

B.J. Attwell
and
Wing Commander P.R. Burchall, O.B.E.

R.A.E. Ref: Air PH.707/17/PRB/171

SUMMARY

In air survey photography it is desirable that the strips shall be straight, parallel and equally spaced. While pilots rely on visual methods of navigation they require prolonged training before their work reaches an acceptable standard, and the effort wasted at present is enormous.

It is suggested that a technique relying solely on normal aircraft instruments can be made to yield entirely satisfactory results.

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

1 Introduction

The difficulty of flying parallel photographic strips with constant lateral overlap is well known. The normal technique calls upon the navigator to follow flight lines already drawn on a map of the area to be surveyed. Maps containing enough clearly defined ground features are not always available.

This visual tracking along flight lines determined before the commencement of the sortie commits the crew to a definite course without regard to the wind; and with modern aircraft the small corrections made to the course, either manually or on autos, during the runs nearly always produce some amount of undesirable roll.

At present long-range radio aids do not appear to provide the accuracy required, while short range radar aids require their own chain of ground stations near the area to be surveyed.

The Director of Survey, War Office, has stated "The effort wasted at present due to unsatisfactory navigation is enormous". (Air Survey Development Committee, March 1946.)

Recent developments in aircraft flying aids suggest that a sufficiently accurate method could be devised relying, with great convenience, solely upon the use of normal aircraft instruments.

The suggested method is based on two main considerations:-

(a) Modern methods enable wind direction to be determined in the aircraft with a high degree of accuracy.

(b) Although modern automatic controls give banked turns, they are linked to the gyro compass and their course-keeping accuracy is high. Further, they can be used to turn the aircraft through any required number of degrees at a known and constant rate of turn. They avoid the normal turning errors of the pilot's magnetic compass, and they relieve the pilot of the strain and difficulty of manually holding a steady rate of turn.

2 Description of Suggested Technique

Referring to Fig.1 consider an aircraft making a 90 degrees turn to port at a steady rate. Then if a is the length of the arc the radius r will be $2a/\pi$.

If the aircraft is flying at velocity v and takes time t to turn through 90 degrees then $a = vt$, and $r = 2vt/\pi$.

Now consider that the air camera produces a negative of width w, and that a contact scale of $1/s$ is required; then the width of ground covered by the photograph will be ws. It is usual to specify 30% lateral overlap of strips, so that the required distance between strips will be $0.7ws$.

Referring now to Fig.2 suppose the navigator has made an accurate determination of the direction of the wind by any of the well known methods and suppose the first photographic strip has been flown directly up wind across the survey area until position A has been reached.

The navigator switches off his camera and the pilot holds course for a few minutes (the exact time is not important) until he arrives at B, then applies a turn to port at the 90° per minute rate and holds it for

exactly 90 degrees as indicated on his repeater compass. In still air he would then be at position C. But drift will have brought him to position D. At the end of the turn he finds himself heading towards E. He continues on this heading and drift will bring him to position F.

He applies another turn to port at the same rate as before and holds it for exactly 90 degrees. In still air he would then be at position G, but drift will have brought him to position H. At the end of the turn he finds himself heading towards K. The camera is switched on and the pilot holds course until he arrives at the limit of the survey area. After the camera is switched off the pilot applies another turn to port as before and holds it for exactly 90 degrees.

In still air he would arrive at position L, but drift will bring him to position M. At the end of the turn he finds himself heading towards N. He continues on this heading and drift will bring him to position O.

He applies another turn to port as before and holds it for exactly 90 degrees. In still air he would arrive at position P, but drift will bring him to position Q. At the end of the turn he finds himself heading towards R on a track exactly parallel to his original track. The camera is switched on and the pilot holds course until he reaches the limit of the survey area.

The whole procedure is then repeated as often as may be required, each circuit adding two photographic strips.

Now, it is necessary that the transverse distance AR between adjacent strips shall be equal to 0.7ws, and we require the distance RS to be n(0.7ws), where n is any convenient whole number.

We have seen above that the radius TB = $2vt/\pi$.

We require to know the length DE so that we may hold course between turns for the appropriate time.

Now DE is clearly equal to AS - 2r

And AS = (n+1)0.7ws, while r = $2vs/\pi$.

So that DE = (n+1)0.7ws - $4vt/\pi$

And the time taken on the leg DF will be

$$DE/v = (n+1)0.7ws/v - 4t/\pi$$

Similarly the time taken on the leg MO will be

$$(n)\ 0.7ws/v - 4t/\pi$$

It is to be noted that both these times can be pre-computed. Negative width, scale, cruising speed and rate of turn can all be known before take-off. The flying of a survey block can thus become a simple routine in which the automatic pilot performs its series of evolutions according to a time table.

It is convenient at this stage to consider a typical numerical example.

Let the width of the negative (w) be 9 inches = 0.75 ft.

scale (1/s) = 1/20000

Airspeed (v) = 150 m.p.h. = 220 ft. per sec.

time taken to turn 90 degrees (t) = 1 minute = 60 seconds

and let n = 4.

Then the time taken on the leg DF will be

$$\frac{(n+1)0.7ws}{v} - \frac{4t}{\pi}$$

$$= \frac{5 \times 0.7 \times 0.75 \times 20000}{220} - \frac{4 \times 60}{\pi}$$

= 162 seconds.

And the time taken on the leg MD will be

$$\frac{4 \times 0.7 \times 0.75 \times 20000}{220} - \frac{4 \times 60}{\pi}$$

= 115 seconds.

If the flight continues on the lines suggested allowing 162 seconds for the straight portions of each of the up-wind-end crossings and 115 seconds for the straight portions of each of the down-wind-end crossings we shall cover an area symmetrically with eight strips at the required scale, maintaining correct lateral separation of the strips throughout.

If the instruments function correctly all strips should be strictly parallel and equally spaced and none of them should show convergence or bowing.

The flying height is found from the well-known equation $h = sf$ where $1/s$ is the required scale and f the focal length employed.

The technique therefore would be first to determine accurately the wind direction. The runs would be made exactly up and down wind, continuing approximately five miles downwind and ten miles upwind beyond the limits of the area being surveyed; the actual distances would vary with wind velocity but are not critical. The turns would be made solely on the automatic controls and the run up would allow the autos to settle on the new course, which should be kept with an error less than 1°.

When covering large areas a frequent check on the wind could be made by reference to the Air Position Indicator or similar instrument.

3 An Experimental Trial

At the time this technique was being studied no suitably equipped

aircraft was available to the authors, but it was evident that a valuable and vivid simulation could be carried out in the Link trainer using the standard blind-flying instrument panel.

An exercise was therefore performed with S/L.The Hon.M.C.Adderley,A.F.C., O.C. Instrument Flight, R.A.E., at the controls, with hood down. A wind speed of 30 m.p.h. was set and the Link was flown at an air speed of 150 m.p.h.

The pilot applied and held the necessary turns (rate $\frac{1}{2}$, i.e. 90° in one minute) with the aid of a stop watch.

The up-wind cross-strip time had been pre-computed as 1 minute 55 seconds: this being appropriate for n = 3.

The down-wind cross-strip time was made one minute. More precisely it should have been 57 seconds.

The pilot used his stop watch to control the length of these cross strips.

The only assistance the pilot received from the navigator was the signal "camera on" or "camera off" as the crab passed the boundary of the area to be surveyed.

The flight lasted 40 minutes and height variations never exceeded 50 ft.

The crab's plot is reproduced as Fig.3. It is apparent that all the strips are substantially parallel. The squares represent the areas covered by individual photographs and it is evident that satisfactory lateral overlap was maintained throughout the experiment.

There were no false starts to any of the runs and no flying time was wasted.

Attached:-

Figs.1 - 3

Circulation:

D.Inst./R.D.
A.D.R.D.Inst.
D.D. Photos (Ops.)
R.D.Inst/Ph.
R.T.P./T.I.B.
M.A.E.E.
A & A.E.E. Bosoombe Down
Central Photographic Establishment R.A.F. Benson
Directorate of Military Surveys, War Office
Directorate of Colonial Surveys
Camp Griffiss, Bushy Park,
Teddington, Middlesex.
Director General, Ordnance Survey,
Leatherhead Road, Chessington, Surrey.

(Action copy) (2)
(70)

D.D.R.A.E.
Library
Head of Dept.
Head of Air Photo Div.
Specifications
Heads of Sections (Circulation)(1)

FIG. 1 & 2.

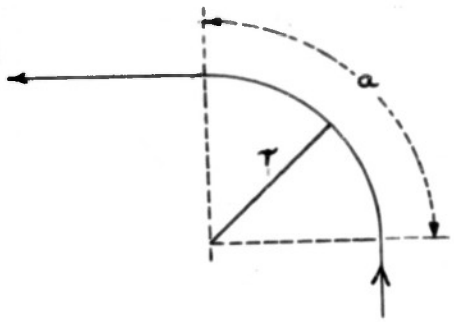

FIG.1 TURNING RADIUS

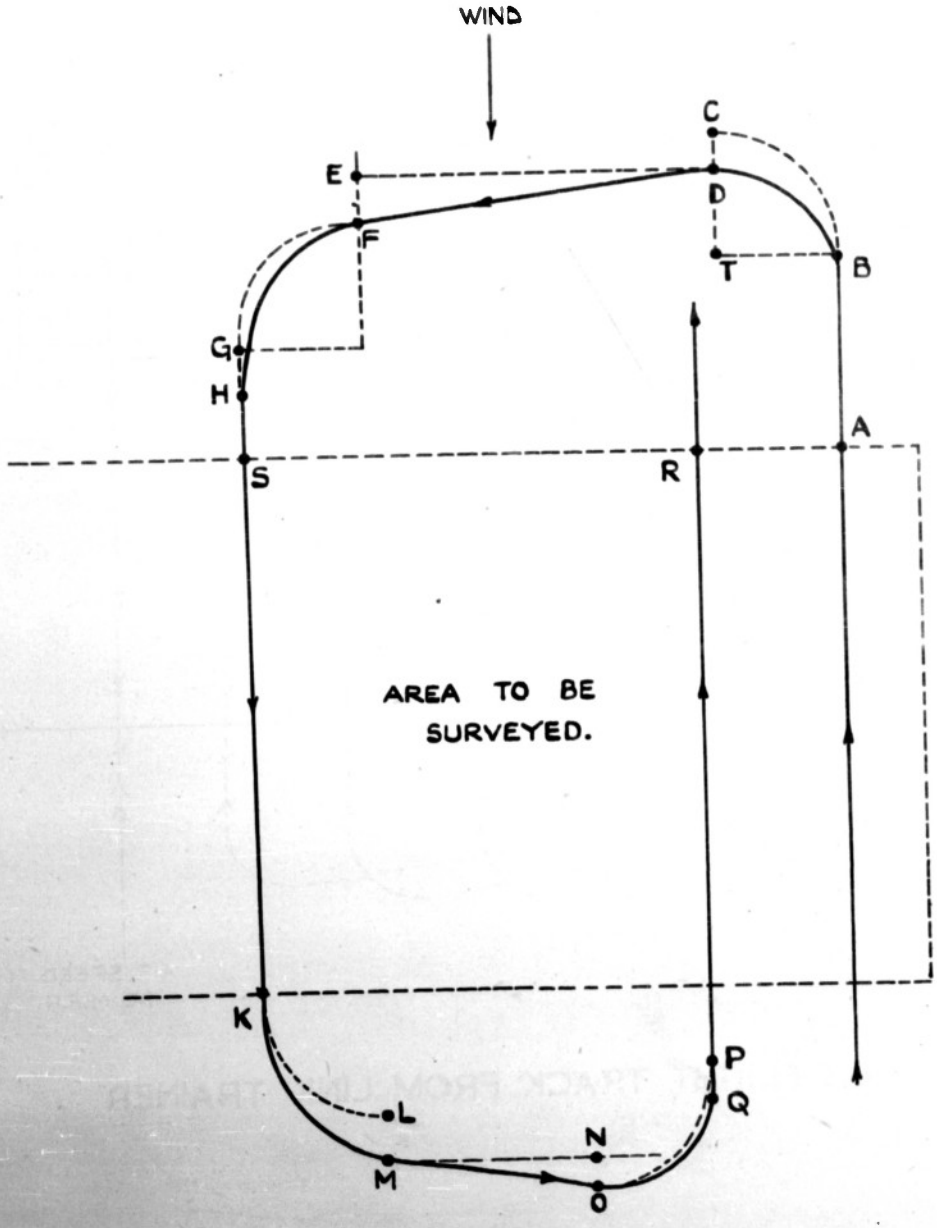

FIG. 2. SURVEY FLIGHT PLAN.

FIG 3

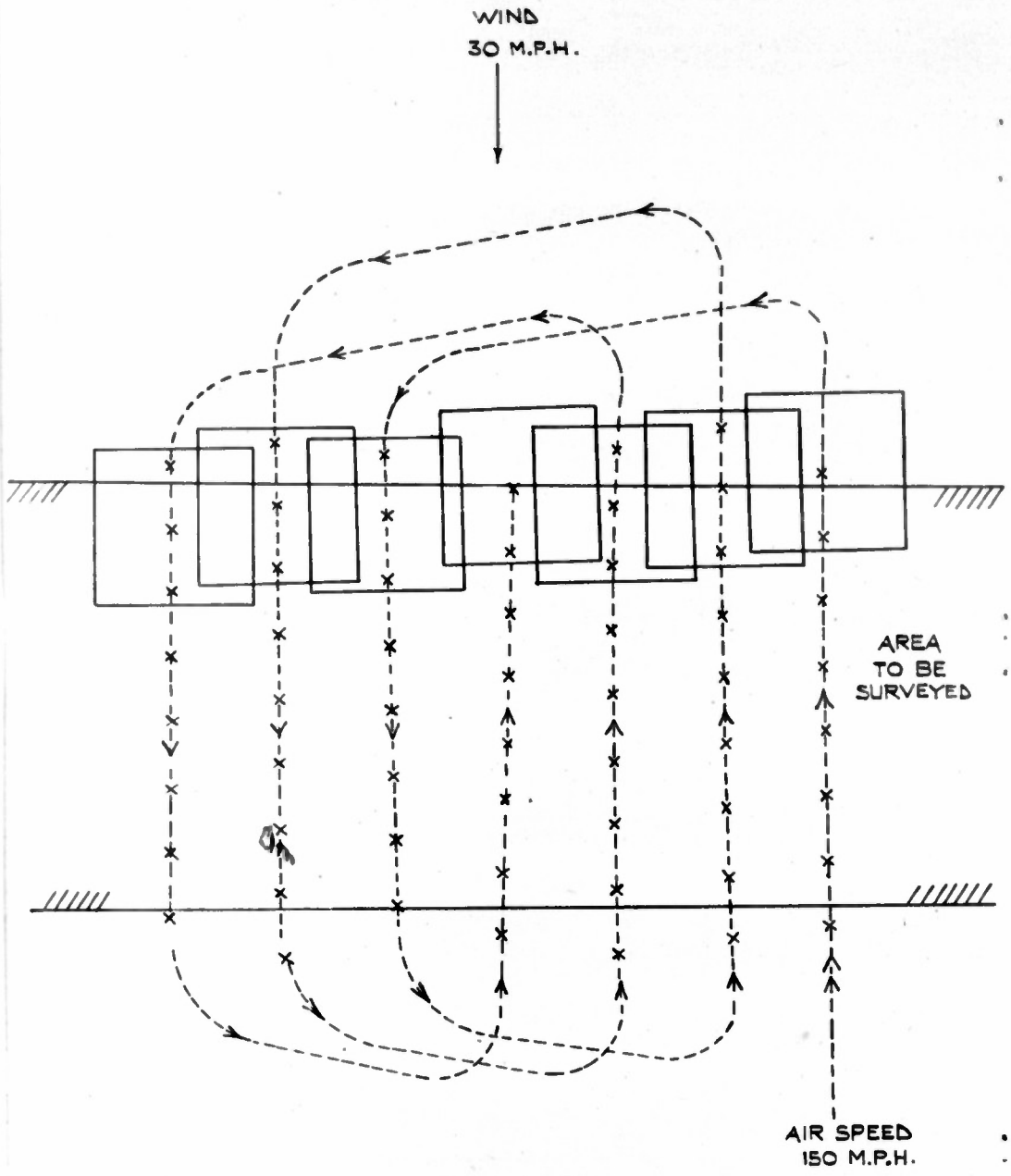

FIG.3 FLIGHT TRACK FROM LINK TRAINER

REEL - C

349

A.T.I.

9411

RESTRICTED

TITLE: Flying for Air Survey Suggested Navigational Method of Flying Parallel Strips

ATI- 9411

REVISION: (None)

AUTHOR(S) : Attwell, B. J.

ORIG. AGENCY : Royal Aircraft Establishment, Farnborough, Hants

ORIG. AGENCY NO.: PH-406

PUBLISHED BY : (Same)

PUBLISHING AGENCY NO.: (Same)

DATE	DOC. CLASS.	COUNTRY	LANGUAGE	PAGES	ILLUSTRATIONS
Dec '46	Restr.	Gt. Brit.	English	7	graphs

ABSTRACT:

In air survey photography it is desirable that strips shall be straight, parallel, and equally spaced. Technique is suggested, which relies entirely on normal instruments and can be made to yield entirely satisfactory results. Technique consists of first determining wind direction accurately. Runs are made exactly up and down wind, continuing approximately five miles downwind and ten miles upwind beyond limits of area being surveyed. Actual distances would vary with wind velocity but are not critical.

DISTRIBUTION: Copies of this report obtainable from CADO.

DIVISION: Photography (20)

SECTION: Aerial Photography (1)

SUBJECT HEADINGS: Photography, Aerial (70638.7); Mapping, Aerial (59992)

ATI SHEET NO.: R-26-1-5

RESTRICTED

TITLE: Flying for Air Survey Suggested Navigational Method of Flying Parallel Strips

AUTHOR(S) : Attwell, B. J.
ORIG. AGENCY : Royal Aircraft Establishment, Farnborough, Hants
PUBLISHED BY : (Same)

ATI- 9411
REVISION: (None)
ORIG. AGENCY NO.: PH-406
PUBLISHING AGENCY NO.: (Same)

DATE	DOC. CLASS.	COUNTRY	LANGUAGE	PAGES	ILLUSTRATIONS
Dec '46	Restr.	Gt. Brit.	English	7	graphs

ABSTRACT:

In air survey photography it is desirable that strips shall be straight, parallel, and equally spaced. Technique is suggested, which relies entirely on normal instruments and can be made to yield entirely satisfactory results. Technique consists of first determining wind direction accurately. Runs are made exactly up and down wind, continuing approximately five miles downwind and ten miles upwind beyond limits of area being surveyed. Actual distances would vary with wind velocity but are not critical.

DISTRIBUTION: Copies of this report obtainable from CADO.

DIVISION: Photography (26)
SECTION: Aerial Photography (1)

SUBJECT HEADINGS: Photography, Aerial (70638.7); Mapping, Aerial (59992)

ATI SHEET NO.: R-26-1-5

C

EO 10501 dd 5 NOV 1953

AD#: ADA800706

Date of Search: 19 Oct 2009

Record Summary: AVIA 6/12959
Title: Air survey: suggested navigational method of flying parallel strips
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department): TN Ph 406
Held by The National Archives, Kew

This document is now available at the National Archives, Kew, Surrey, United Kingdom.

DTIC has checked the National Archives Catalogue website (http://www.nationalarchives.gov.uk) and found the document is available and releasable to the public.

Access to UK public records is governed by statute, namely the Public Records Act, 1958, and the Public Records Act, 1967.
The document has been released under the 30 year rule.
(The vast majority of records selected for permanent preservation are made available to the public when they are 30 years old. This is commonly referred to as the 30 year rule and was established by the Public Records Act of 1967).

This document may be treated as UNLIMITED.