The Air Pilot's Manual **Series for Southern Africa**

Volume 3

Air Navigation

Reference material for the SACAA PPL Syllabus

POOLEY'S
Air Pilot Publishing

Nothing in this manual supersedes any South African CAT or CAR or procedures; or any operational documents issued by the Civil Aviation Authority, the manufacturers of aircraft, engines and systems, or by the operators of aircraft throughout the world. As maps and chart are changed regularly, any extracts reproduced in this book must not be used for flight planning or flight operations.

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Section FOUR **Practical Navigation**

Editorial Team

Louise Hahn

Louise comes from an aviation family and spent many hours as a child in DC8s and 747s. Louise has 20 years' experience in Aviation in a wide range of operations from light aircraft to humanitarian aid contracts and corporate jets. She has operated mainly in Africa but now lives in Dublin. As well as a pilot she has held many post-holder positions in safety, quality and flight operations. For the last 6 years she has owned and run an ATO specialising in advanced training and theoretical knowledge. During this period she wrote all her own training manuals and worked with many airlines training their foreign crews in the theoretical knowledge required for the South African validation process.

Dorothy Saul-Pooley LLB (Hons) FRAeS FRIN

Dorothy held both an ATPL (A) and CPL (H) and was an instructor and examiner on aeroplanes and an instructor on helicopters for over 25 years. For 15 years she was Head of Training of a school dedicated to running Flight Instructor and examiner courses at Shoreham Airport. For 20 years Dorothy was also a CAA Flight Instructor Examiner (Senior Examiner).

Dorothy originally qualified as a solicitor in 1982 and acted for many years as a specialist dealing with aviation insurance liability issues and aircraft accident investigation work. She has lectured widely on aviation law and insurance matters. This highly unusual combination of qualifications and experience led to Dorothy's appointment as one of the Honorary Solicitors to the Guild of Air Pilots and Air Navigators (GAPAN).

Dorothy is a Fellow of the Royal Aeronautical Society and of the Royal Institute of Navigation. She is the Past Chairman of the GAPAN Instructor Committee, of which she was a founding member and she was the prime instigator of the Guild's biennial joint Forum with the Central Flying School at RAF Cranwell for Senior Flight Instructors, both civil and military. She is also Past Chairman of the Education and Training Committee. Dorothy was elected to the post of Master of the Honourable Company of Air Pilots (formerly GAPAN) for the year 2014-2015, the first woman to hold that post. Dorothy currently holds the post of Chairman of the Professional Flying Instructors Association and is the Governor of the British Section of the 99s, an international women pilots' organisation.

In 2003, Dorothy was awarded the Jean Lennox Bird Trophy for her contribution to aviation and support of Women in Aviation and the British Women Pilots Association (BWPA). In 2013, Dorothy was honoured to receive the prestigious award of a Master Air Pilot certificate from GAPAN. In 2015 she was awarded the Brabazon Cup by the BWPA for her outstanding achievements in aviation. In 2019 Dorothy was awarded the Pike Trophy by the Honourable Company of Air Pilots for her outstanding contribution to the maintenance of civil flying instruction standards.

As consulting editor for Air Pilot Manuals and for Pooleys Flight Equipment, Dorothy has written, edited and contributed to more than 30 training manuals and has published many articles in aviation magazines, legal journals and on-line publications.

Stephen Wicks PhD

Steve won an ATC Flying Scholarship and made his first solo flight at Ipswich Airport, moving on to join the Stapleford Flying Club as a PPL. He was a member of the Bristol University Air Squadron and trained on Bulldogs at Filton and RAF St Mawgan whilst at the University of Bath. Steve acted for many years both as a university lecturer and industrial scientist, publishing patents and articles in scientific journals. He is a regular contributor to scientific conferences, seminars and executive education workshops and is a visiting professor at the University of Bath and the University of Greenwich. After retiring from an industrial career, he started flying with TG Aviation at Manston and obtained a CPL(A) from the London Metropolitan University and the Sussex Flight Centre at Shoreham.

He obtained a Flight Instructor Certificate from Pooley's Flying Instructor School and is now active in *ab initio* flight training at the Skytrek Flying School Ltd at Rochester City Airport in Kent, UK.

Acknowledgements

The Civil Aviation Authority; ICAO; Cessna, Piper, and Gulfstream American for technical material; Daljeet Gill, Peter Godwin, Capt. R.W. K. Snell, Lotti Skeen, Sebastian Pooley and Dan Robertson; and the many other instructors and students whose comments have helped to improve this manual.

A Condensed History of the Air Pilots Manuals

For over 35 years the Air Pilot Manuals have led the academic training of pilots in the United Kingdom and in many countries around the world.

I first met Trevor Thom, a professional pilot and natural teacher, in Melbourne during a visit to Australia in January 1985. He already had his series of PPL Manuals for the Australian market and I asked him to produce a series for the New Zealand market where we had a small aviation business. Having completed this task, Trevor immediately began writing the first of the Air Pilot Manuals for the United Kingdom market and this project began in earnest on 5th December 1985.

Both Trevor Thom and Robert Johnson commenced the task in my office at Felden, Hertfordshire. By the end of the following year, all four volumes were completed and were published in February 1987. By the end of that year, we estimated that 95% of all the UK Flying Schools were using our manuals. Volumes 5, 6 and 7 followed, so completing the full series which also now includes the Question & Answer Exam Books Volumes 1-9 and the Air Presentations series of PowerPoint Teaching Aids.

Unfortunately, Trevor Thom had a serious accident at home which prevented him from continuing with the editing of the manuals. His rights were eventually sold to David Robson, another experienced pilot and natural teacher, who progressively improved the drawings and brought colour into the manuals for the first time.

Over the years there have been many assistant editors, in particular Peter Godwin, whose help I first asked for in the very early days with Trevor Thom. The rights in the Air Pilot Manuals are now vested with the Pooley family and they continue to be edited by Dorothy Saul-Pooley, with the assistance of Daljeet Gill who is responsible for the design and layout, and are published from our offices at Cranfield.

The APM series of manuals are used in many countries around the world and have been used for many years in South Africa. We are delighted to have now published this new series of APMs specifically for the Southern African market and we are indebted to Louise Hahn for providing some South Africa specific material.

The Air Pilot Manuals have an outstanding reputation for accuracy and are continuously updated. They are SACAA recommended reading material.

Robert Pooley

LVO MBE CStJ FRIN FRAeS

Introduction

Volume 3 of The *Air Pilot's Manual Southern Africa Series* – *Air Navigation* – presents this important area of training for the Private Pilot's Licence in a logical sequence of theory, preparation and performance.

The Cockpit is a Difficult Environment in which to Learn

As with the other volumes of *The Air Pilot's Manual Series,* in *Air Navigation* we have avoided the presentation of 'facts only'. A thorough understanding of the principles will enable you to gain maximum benefit from your actual navigation exercise flights.

This approach will enable you to become a competent pilot/navigator and will also help to minimise your flight training hours. (It does, however, mean that our book is a little longer than it could be if the aim was only to cram in facts without a reasonable understanding.)

Understanding makes for remembering.

In determining the order in which the information is presented, care has been taken to keep things as logical and practical as possible.

Operational Decisions

Navigation of an aeroplane consists mainly of making common sense operational decisions. These decisions are based on knowledge and experience. Very few are difficult to make – most being logical and simple – but occasionally there are difficult decisions (both on the ground and in flight) to be made. These are the ones for which we must prepare.

We have adopted a professional approach right from the start, whether your ultimate aim is to be a private pilot or to go on and make aviation your career.

Operational decisions will often have to be taken well away from your home base, and to a large extent you will be on your own. They fall into two categories:

- **those made on the ground** during pre-flight planning; and
- **in-flight operational decisions**.

Many decisions are so simple and 'second nature' that you don't realise you are making them. Others require a calm, cool but quick assessment, followed by a decision and action. Proceeding into an area of poor visibility could fall into this category.

The aeroplane will not stand still while you decide what to do in difficult in-flight situations. You cannot just pull over to the side of the road and study your maps. Good pre-flight planning, with many operational decisions taken on the ground takes a lot of pressure off the pilot/navigator.

The Navigation Computer

As a pilot/navigator you will become adept at estimating angles, distances, time intervals, fuel consumption, and so on. The art of estimating is an important skill to develop. It is also important that you can calculate these various quantities easily and accurately. To achieve this you will use a navigation computer. It is a simple device (looks complicated but isn't) that allows us to carry out almost every navigation calculation with speed and accuracy.

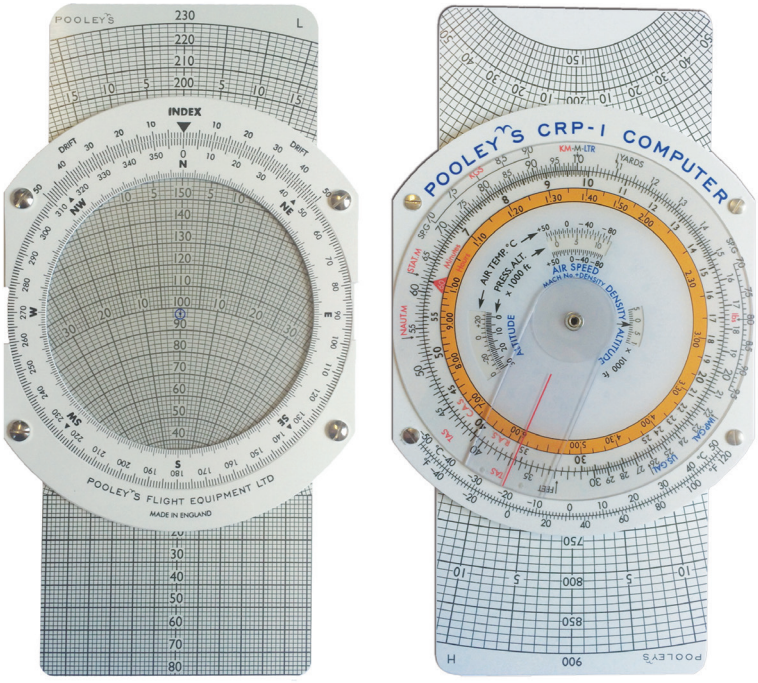
Electronic navigation computers are available, but we suggest you steer away from them, at least initially, because they do not encourage the pilot/navigator to visualise each situation – an important ability to develop. Once you are adept at the various computing problems involved in air navigation, you might decide to 'go electronic'. Beware of becoming over-reliant on electronic computers in case the battery goes flat at an inopportune moment.

The basic concept of the slide navigation computer dates back to early navigation days. The modern version is an essential piece of equipment for a pilot/navigator.

The slide navigation computer has two sides:

- **a wind side**, which enables solution of *triangle of velocities* problems for flight-planning and en-route navigation; and
- **a calculator side** (the main component of which is a circular slide-rule on the outer scales), used to perform the simple arithmetical calculations involved in flight operations, e.g. distance, speed and time; conversion of units; fuel quantities and consumption; true airspeed.

Use of the navigation computer is explained in Section 2. Although it may appear a little complicated at first, working through the examples and illustrations we have set out will make using the computer logical and simple.



■ ***The wind & calculator sides of a Pooleys CRP-1 navigation computer***

The Theory Examination

Navigation is part of one of the theory examinations for the Private Pilot's Licence (PPL), which you will sit at your flying school. Prior to this you should be achieving considerable success in completing questions at the end of most of the chapters. In this volume some chapters have exercises interspersed through the text to give you practice on a particular aspect of the chapter before moving on.

The Exercises form an important part of the course and we recommend that you work through them carefully.

This manual is more than just a text to allow you to pass the examination, though this is one of its aims. It is designed to remain as a reference text on your shelf for as long as you fly.

The En-route Navigation Section (PPL Skill Test)

This is the province of your flying instructor. The test is carried out at the completion of your flying training and is part of the PPL Skill Test (although with the agreement of your examiner it may be flown as a separate section.) It is designed to assess your ability as a pilot/navigator. This manual, and your navigation cross-country training, will prepare you fully for the Navigation element of the PPL Skill Test.

Private Pilot Licences

This edition covers the material contained in SACAA Appendix 1.0 Theoretical knowledge for the private pilots licence.

Operational Information

For safe flight operations it is essential that all pilots refer to current operational information. This basically involves using latest issues of aeronautical charts, and amended flight information publications, circulars and NOTAM (Notices to Airmen).

In SA, the primary source of operational information is SA Aeronautical Information Publication (AIP), a large, frequently amended manual produced to an international standard by the Civil Aviation Authority. Your flying school and Air Traffic Services (ATS) units should have amended copies of SA AIP available for reference, although these days they are often available on a CD rom, or directly on the internet from the AIS website: **www.caa.co.za**.

NOTE There are many examples of extracts of tables from the AIP and other sources and excerpts from aeronautical charts and their legends in this manual. It is not always practical to replace these illustrations every time the source document becomes out of date, so please be aware that information contained in these table and charts is not necessarily current. The tables or charts illustrate a particular point in the text for which their insertion into this manual is relevant.

Section **One**

Basic Navigation Theory

Chapter 4