

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

Volume 2

Human Performance and Limitations & Meteorology

*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.

Copyright © 2022 Pooleys-Air Pilot Publishing

ISBN 978-1-84336-314-9

First edition published May 2022

All rights reserved. No part of this book may be reproduced or transmitted in any form by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval system, without permission from the publisher in writing.

Origination by Pooleys-Air Pilot Publishing Limited.

Published by Pooleys-Air Pilot Publishing Ltd
Elstree Aerodrome, Elstree
Hertfordshire, WD6 3AW
United Kingdom.

Tel: +44(0)20 8953 4870

Web: www.pooleys.com

Email: sales@pooleys.com

Volume 2

Contents

Human Performance and Limitations

Chapter 1	
Human Physiology and High Altitudes	9
Chapter 2	
Eyesight and Visual Illusions	29
Chapter 3	
Hearing and Balance	55
Chapter 4	
I'm Safe?	71
Chapter 5	
Stress Management, Fatigue and Sleep	81
Chapter 6	
Information Processing	113
Chapter 7	
Judgement and Decision-Making	135
Chapter 8	
Airmanship and Threat and Error Management	147
Chapter 9	
The Flight Deck	157
Chapter 10	
Safety and Care of Passengers	197
Chapter 11	
First Aid	209
Chapter 12	
Survival	217

Meteorology

Chapter 13

Aviation Meteorology 247

Chapter 14

Heating Effects in the Atmosphere 261

Chapter 15

Wind 275

Chapter 16

Cloud and Precipitation 301

Chapter 17

Visibility 323

Chapter 18

Air Masses, Pressure Systems and Frontal Weather 333

Chapter 19

Hazardous Conditions 353

Chapter 20

Weather Patterns of the African Continent 369

Chapter 21

Weather Forecasts and Reports 383

Index 413

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 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.

Helena Hughes

On leaving university in 1989 Helena obtained a PPL in America, converting to UK licence on her return. Shortly afterwards she started work in Air Traffic Control at London Luton Airport, earning her controller's licence in 1990. During her time at Luton she was involved in controller training as both an instructor and assessor. Helena continues to be an operational Air Traffic Control Officer and is currently posted to Thames Radar. She holds a CPL/IR and has been a flying instructor since 1998, teaching PPL and associated ratings. She is a Ground and R/T examiner and has written both PPL and ATPL Radiotelephony Training Manuals.

Gary Hutchinson

Gary caught the aviation 'bug' at an early age, since plane-spotting at London Gatwick as a boy. He has since held a variety of aviation roles, from airport check-in desks and passenger profiling to operational roles in air cargo involving Health and Safety improvements. He has also travelled extensively worldwide using his airline staff travel privileges.

After gaining a CPL (A) Multi IR, and operating local charters and calibration flights, he won a GAPAN Flight Instructor Scholarship and now instructs at Shoreham.

He studied Psychology at London University, including Ergonomics and Cockpit Resource Management (CRM). As a member of the British Psychological Society, GAPAN and the Air League, he has been published in Psychological journals and since then has sought to combine these interests into a career as a 'Human Factors in Aviation' specialist. His aim is to increase safety, quality and efficiency in aviation, primarily through reducing human error and improving decision making.

He loves flying and would ultimately like to be an airline training captain/Human Factors Psychologist.

On a lighter note, he dreams of one day flying a P 51 Mustang, but at 6'10" fears his height may preclude this!.

Jenny Dodman

Jenny inherited her passion for aviation from her father and spent many happy hours as a child either at the airfield or sitting in a light aircraft. She then went on to learn to fly with the help of scholarship awards from the Swire Charitable Trust and British Women Pilots Association. On graduating from medical school and completing junior medical training, Jenny undertook specialist training in Occupational Medicine through an NHS and National Institute for Health Research funded joint clinical and academic role within the NHS and at The University of Manchester, where her research focused on safety critical occupations and assessing medical fitness. Jenny completed specialist training and training in aviation medicine and now works as a Consultant Occupational Physician and Aeromedical Examiner for British Airways, as well as an independent Aeromedical Examiner and Honorary Lecturer within the Centre for Occupational and Environmental Medicine at The University of Manchester. Her spare time is spent with family, friends and dogs; usually still centred around the airfield!

Philip Baxter BA (Hons) LLB (Hons)

Philip held a UK ATPL (A), is an Instructor and has been a PPL Examiner. He began his working life in the Civil Service, having joined from school, and stayed for more years than he now cares to remember! He worked in a wide variety of (mostly) very interesting jobs, within several Departments, which included one period as Private Secretary to a government Minister, another (reflecting his long-standing interest in aviation matters) dealing with aircraft noise and ICAO 'Annex 16' issues as well as pollution from aircraft engines; and another as a technical author. Much of the remainder of his Civil Service career was related to telecommunications, ranging from international Treaties to technical standardisation. This included representing his departmental interests on Standards Committees in particular, both internationally and domestically. Both his Degrees, the first in Science and Technology, the second in Law (providing an unusual combination) were awarded following part-time study with the Open University. Since 'retiring' early from a senior middle-management grade, Philip worked for six years as a full-time Flight Instructor and Flight Examiner, accruing some three and a half thousand instructional hours. Phil teaches ground school subjects for the Flying Instructor course and has also been Vice Chairman of the Professional Flight Instructors' Association (PFIA).

Robert Seaman BSc MRI FRMetS

Rob Seaman is a professional pilot on the Airbus family, a flight instructor and meteorologist who is committed to connecting these professions together for the benefit of flight safety. With a life-long passion for aviation he was awarded a Royal Air Force flying scholarship (1998), the Norman Motley Flight Instructor Scholarship (2007), elected Liveryman of the Honourable Company of Air Pilots (2016) and was expert advisor on the United Kingdom Flight Safety Committee. Rob's key interest is in the practical application of human factors to meteorological threats so as to enhance their management on the flight deck. His previous career in the Met Office culminated as Head of Policy Advice relating climate change and the environment to foreign and defence policy. This drew on experience gained from previous roles supporting civil and military aviation operations; as a Senior Applied Scientist developing weather related decision aids to increase efficiency and effectiveness, and as an Operational Meteorologist supporting the military at HQ Air Command, the Falklands and the Middle East. Rob studied Physics at Imperial College, is an Associate of the Royal College of Science and Fellow of the Royal Meteorological Society.

Acknowledgements

The Civil Aviation Authority, Captain R. W. K. Snell, Shaun McConnell, the late David Hockings, Geoffrey Farmiloe, Daljeet Gill, Esther Law, Sebastian Pooley 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 30 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, 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 and now includes the Question & Answer Exam Books, Volumes 1-9 Examination and Preparation.

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 and which continued until quite recently. 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, are published from our offices at Shoreham Airport.

The Air Pilot Manuals have an outstanding reputation for accuracy and are continuously updated. They are recommended CAA reading material and are referred to extensively in the CAA examination answer booklet.

Robert Pooley

MBE CSJ FRIN FRAeS

Preface to the First Edition

Keeping up to date with legal changes is challenging because the law is changing all the time. So you must check the SACAA websites frequently.

To highlight the difference between SACAA material and ICAO or EASA material, we use a lighter typeface for the ICAO material.

NOTE Please check our websites for updates and links to references mentioned in the text. Please refer to *www.pooleysapp.com* and to the Pooleys website: *www.pooleys.com*.

Human Performance and Limitations

Chapter 1

Human Physiology and High Altitudes	9
The Nervous System.....	9
The Brain	10
The Cardiovascular System (or Circulatory System)	11
The Systemic Circulation.....	12
The Pulmonary Circulation.....	13
The Respiratory System	14
Respiration.....	14
Flying at Altitude.....	17
The Gas Laws.....	19
Hypoxia.....	20
Decompression Sickness.....	24
Carbon Monoxide Poisoning	25
Barotrauma.....	26
Upper Respiratory Tract Problems	26

Chapter 2

Eyesight and Visual Illusions	29
The Structure of the Eye.....	29
Normal Functions of the Eye	35
Visual Illusions.....	42
Visual Illusions on Approach	47
Glasses and Contact Lenses.....	51

Chapter 3

Hearing and Balance	55
The Ears.....	55
Hearing	57
What is Sound?	57
Fatigue and Damage From Noise	57
Loss of Hearing	58
Balance.....	59
Sensing Acceleration.....	59
How the Balance Mechanism Works.....	60
Orientation	63
Vestibular Illusions Involving Rolling.....	63

Vestibular and 'Seat-of-the-Pants' Illusions Caused by Accelerations	
and g-forces	67
Motion Sickness	69

Chapter 4

I'm Safe?	71
Physical Fitness.....	71
Diet	72
Mental Fitness	73
Illness and Drugs (including alcohol and smoking)	73
Medical Checks.....	74
Medication.....	74
Alcohol.....	75
Upper Respiratory Tract Problems	75
Carbon Monoxide Poisoning	77
Food Poisoning	77
Glasses and Contact Lenses.....	77
Smoking	78
Fatigue and Sleep Deprivation	78

Chapter 5

Stress Management, Fatigue and Sleep.....	81
Stress Management	81
Stress	81
Physical Stress – Fight or Flight?.....	83
Non-Physical Stress.....	84
Arousal	84
Stressors.....	85
Anxiety	89
Handling Pressure	90
Techniques of Stress Management.....	91
Unacceptable Means of Coping with Stress	92
Avoid Self-imposed Stress.....	93
Fatigue.....	94
The Symptoms of Fatigue	95
Sleep.....	96
The Purpose of Sleep	96
Sleep Disorders	97
Sleeping Drugs or Hypnotics	97
The Stages of Sleep	98
Sleep Patterns	100
Body Rhythms	104
Jet Lag – The Desynchronisation of Body Rhythms.....	108

Chapter 6

Information Processing.....	113
The System of Nerves.....	113
A Basic Model of Information Processing.....	114
Different Levels of Mental Activity.....	115
Stimulation, Sensing and Perception.....	117
Memory.....	123
The Central Decision-Maker.....	127
Action and Feedback.....	129
Mental Overload.....	132

Chapter 7

Judgement and Decision-Making.....	135
Making a Decision.....	136
Action.....	137
Personality and Attitude.....	137
Pilot Personality Traits Table.....	138
Cockpit Resource Management.....	139
Crew Coordination.....	140
Leadership Qualities.....	141
The Pilot-in-Command.....	142
Remaining in Command.....	144

Chapter 8

Airmanship and Threat and Error Management.....	147
Airmanship.....	147
Situational Awareness (SA).....	147
Importance of Situational Awareness (SA).....	149
Threat and Error Management (TEM).....	150
Threats.....	151
Management.....	152
Practical Applications.....	153

Chapter 9

The Flight Deck.....	157
The Pilot and the Machine.....	158
Designing the Work Space of the Flight Deck.....	159
Design of Cockpit Displays.....	167
Standardisation of Displays.....	167
The Attitude Indicator.....	168
Direction Indicators.....	171
The Airspeed Indicator.....	173
The Altimeter.....	174
The Vertical Speed Indicator.....	179
The Turn Coordinator.....	180

The Flight Director	181
The ADF and the RMI	182
The VOR and the HSI.....	183
The 'Glass' Navigation Display	185
Head-Up Displays.....	187
Cockpit Checklists.....	188
Manuals	192
Standard Operating Procedures.....	192
External Visual Aids.....	192

Chapter 10

Safety and Care of Passengers.....	197
Pilot Awareness.....	197
Prior to Boarding.....	198
Preflight Check of Emergency Equipment	198
On Board.....	199
Passenger Briefing.....	199
Life-Jackets.....	201
Life-Rafts.....	202
Oxygen Equipment.....	202
Fire	203
Fire Extinguishers.....	204

Chapter 11

First Aid	209
Minor Problems that may Occur In Flight.....	209
First Aid Following an Accident.....	211

Chapter 12

Survival.....	217
Survival Equipment.....	218
The Radio and the Transponder.....	218
The Emergency Locator Transmitter (ELT)	219
Optical Signals.....	221
Survival at Sea.....	226
Survival in Very Cold Climates	232
Survival in a Hot, Arid Climate	235
Survival in the Bush.....	240