CIVIL AVIATION
SAFETY AUTHORITY
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AIR TRANSPORT PILOT (HELICOPTER) LICENCE

AERONAUTICAL KNOWLEDGE SYLLABUS

Issue 3- January 1999

EXPLANATORY PAGE TO ISSUE 3 - January 1999

This issue commonalizes four sections of the ATPL (Helicopter) syllabus with that of the Aeroplane version, namely, Human Factors, Navigation, Meteorology and Air Law. Some elements of Air Law unique to Helicopters, and also pertinent to Flight Planning, have been included in the latter section.

This new syllabus enables mutual recognition of these four examination credits at the ATPL level, and represents a cost and effort saving approach for candidates who intend to acquire licences for both aircraft categories. More importantly, it ensures that aspirants to the helicopter ATPL may be trained to possess the relevant knowledge that will enable safe operations in the demanding environment of the modern helicopter, that hitherto has been monopolised by aeroplanes.

Copies of the syllabus are available from:

- Civil Aviation Safety Authority's Web-site - http://www.casa.gov.au

- Airservices Australia Publications Centre
  715 Swanston Street
  CARLTON VIC 3053
  Telephone: (03) 9342 2000 or 1300 306 630

AIR TRANSPORT PILOT LICENCE (HELICOPTER)
AERONAUTICAL KNOWLEDGE SYLLABUS

CONTENTS

1 - INTRODUCTION

1.1 This syllabus of training is effective in conjunction with Civil Aviation Regulations. As the syllabus is primarily concerned with ground training objectives and standards, detail covering administration, flying hours requirements and examinations of the new flight crew licensing system have been excluded. These details will be included in CAR Part 5, and the ATPL (Helicopter) Information Book, which should be read in conjunction with this syllabus.

1.2 This syllabus sets out the aeronautical knowledge required for the issue of an ATPL (Helicopter). The syllabus assumes prior satisfactory knowledge of material set out in the VFR (Day) syllabus and a thorough knowledge of operations under the IFR. Notwithstanding this assumption, certain material from the VFR (Day) syllabus is repeated in the ATPL syllabus. This has been done for the following reasons: in some cases, the material is seen to be of such fundamental importance that candidates at ATPL level will be required to confirm their knowledge and understanding of it, usually at a more advanced level, whilst in other cases, a review of previous material is seen to be necessary in order to clearly grasp new aspects of the same subject. All material contained in this syllabus is examinable at the ATPL level even though it may previously have been examined at a lower level

1.3 The syllabus is primarily directed towards air transport operations in a multi engine turbine powered helicopter with emphasis being placed on the knowledge required of the pilot in command. International aspects of such operations are included, but more emphasis has been placed on domestic operations. Aircraft systems itemised are representative of those in current use. Additional items, particularly area navigation systems, may be added to the syllabus as they enter into common usage.

1.4 A person must hold a credit in the CPL(H) theory examination before he/she will be permitted to undertake the ATPL(H) examination.

2 - AERODYNAMICS AND AIRCRAFT SYSTEMS

2.1 ADVANCED AERODYNAMICS

2.1.1 Review of Terminology and Definitions

(a) IAS, CAS, EAS, TAS, TMN
(b) reference speeds including Vtoss, CDP, LDP
(c) define; tip path, tip path plane, axis of rotation, shaft axis, disc area, chord line, pitch angle**,** angle of attack, coning angle, feathering, feathering axis, disc loading, blade loading, solidity, flapping, dragging, teetering rotor, articulated rotor, semi rigid rotor

2.1.2 Aerodynamic Forces

(a) the atmosphere as applies to aerodynamics
(b) lift, induced and parasite drag, lift/drag ratio
(c) effect of RAF on angle of attack, induced airflow and effects, total reaction, rotor thrust, torque, torque reaction, rotor thrust/rotor drag ratio, forces opposing weight, factors influencing rotor thrust, Bernoulli's theorem, Hookes joint effect

2.1.3 Stability

(a) static and dynamic stability
(b) stability during hover
(c) stability during forward flight
(d) effect of off set flapping hinges
(e) effect of stabilizer bar
(f) effect of Centre of Gravity (CG)
(g) effects of altitude and speed on stability
(h) effect of horizontal stabilizer

2.1.4 Forward Flight

(a) arrangement of forces and effects of CG position
(b) basic aspects-tilting the disc through cyclic
(c) dissymmetry of lift, dissymmetry lift elimination through flapping
(d) flapback, designs to reduce flapping amplitude, Delta-3 hinge, offset pitch horn
(e) reverse flow, transitional lift, inflow roll

2.1.5 Climbing and Descending

(a) forces in a vertical climb
(b) Horse Power Available (HP_{AV}) curve and factors affecting the HP_{AV}: altitude, DA, collective setting
(c) rate and angle of climb and relationship to HP_{AV} and Horse Power Required (HP_{REQ}) curve
(d) effect of wind, altitude, and sling loads on rate and angle of climb
(e) forces in a vertical descent
(f) over pitching
(g) rate and angle of descent and relationship to HP_{AV} and HP_{REQ} curves
(h) effect of wind, all up weight (AUW), altitude and sling loads on rate and angle of descent

2.1.6 Hovering

(a) definition
(b) hover in and out of ground effect (IGE, OGE)
(c) factors affecting ground effect, height, DA, AUW, nature of surface, slope, wind, recirculation

2.1.7 Turning

(a) centripetal force and angle of bank
(b) rate and radius of turn, relationship of angle of bank
(c) steep turn, load factor, power requirement
(d) forces in climbing and descending turns
(e) effect of attitude and bank angle on rate and radius of turn
(f) effect of AUW on rate/radius
(g) effect of wind when turning around a ground feature
(h) effects of slipping and skidding

2.1.8 Autorotation

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(b) autorotative forces/drag
(c) effects of airflow on vertical autorotation
(d) effects of airflow on forward autorotation
(e) rate of descent requirements for autorotation,
- minimum rate of descent, maximum air range
(f) effect of weight, altitude, temperature

2.1.9 Rotor Blades

(a) feathering, taper, washout, lift distribution
(b) flapping, flapping to equality
(c) dragging
(d) changing blade C of G
(e) limits of rotor RPM

2.1.10 Tail Rotor

(a) principles of operation - pitch control
(b) primary and additional purpose
(c) auto rotation
(d) tail rotor drift
(e) tail rotor roll
(f) tail rotor flapping, shrouded rotors

2.1.11 Ground Resonance

(a) definition
(b) causes of ground resonance
(c) recovery action

2.1.12 Vortex Ring State

(a) how vortex rings develop
(b) effect of ROD-flow and tip vortex action on rotor thrust
(c) effects of power and airspeed on vortex ring state
(d) flight conditions leading to vortex ring state
(e) tail rotor vortex ring state
(f) loss of tail rotor effectiveness (LTE)

2.1.13 Retreating Blade Stall

(a) conditions which could cause retreating blade stall
(b) effect of reverse flow, effect of airspeed on stall angle
(c) factors effecting the advancing blade
(d) symptoms and recovery from retreating blade stall
(e) methods to minimize retreating blade stall (swept tips)
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2.1.14 Blade Sailing, Dynamic Roll-Over, Mast Bumping

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(b) cause of blade sailing and prevention
(c) forces in dynamic roll-over
(d) avoidance of dynamic roll-over
(e) factors effecting mast bumping/ flapping amplitude
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2.2 AIRFRAME AND SYSTEMS

2.2.1 Flight Controls

2.2.1.1 Review flight controls**:**

(a) primary flight controls
- pitch & roll (cyclic), yaw, collective
- trim systems
- canted tail rotor
- sweep back on tips
- shrouded tail rotor

2.2.1.2 Aerodynamic enhancements:

- canted tail rotor
- sweep back on tips
- shrouded tail rotor
- tail surfaces, fins, end plates, stabilators

2.2.1.3 Powered controls**:**

(a) methods of transmitting demand to control surfaces
(b) feedback
(c) natural and artificial feel
(d) possibility/availability of manual reversion

2.2.1.4 Hydraulic systems:

(a) functioning of a typical hydraulic system with multiple pumps and services; main, standby and emergency systems
(b) understand purpose/function of major components: pumps, accumulators, reservoirs, selector valves, check (one-way) valves
(c) recognizing on a diagram the symbols for major components and be able to trace the functioning of a diagrammatic system (system detail at the level of a typical Flight Manual)
(d) typical services operated (typical system of allocating priority to certain services)

2.2.2 Air Conditioning

2.2.2.1 Typical air supply system:

(a) power sources:
- engine, transmission, driven compressor
- bleed air
- gas turbine compressor
- turbo-charger compressor

(b) typical services provided

(c) availability of services:
- possibility of limitations during take-off and landing or during engine start

2.2.2.2 Air conditioning system

(a) types of systems
- freon
- air cycle machine

(b) brief outline of operation of system:
- single and multi zone

(c) purpose and need for humidifier

2.2.3 Ice and rain protection

2.2.3.1 Distinction between anti-ice and de-ice systems

2.2.4 Landing Gear

2.2.4.1 Wheel systems

(a) main components

(b) brief outline of typical retract/extend operation
- normal, alternative, emergency operation

2.2.4.2 Wheels and tyres

Wheel and brake energy limits

2.2.4.3 Braking systems

(a) typical systems
(b) typical sources of power for normal, alternate and emergency systems -hydraulic supply and backup emergency air bottles
(c) parking brake

2.2.4.4 Steering systems

(a) types available:
- tail rotor steering (pedals)
- differential braking
(b) degree of steering available with each-possibility of roll over

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2.2.5.1 Basic principles of hydromechanics

(a) principle of transmission of force by an incompressible fluid
(b) brief comparison with use of a compressible fluid

2.2.5.2 Thermal ice protection

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- flying surfaces, air intakes, pitot and other sensors, windshields
(b) methods:
- electric, air, oil
(c) limitations

2.2.5.3 Fluid ice protection

(a) where used:
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(b) limitations,

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2.2.5.5 Effects on helicopter performance

- ice accumulation
- use of engine air bleed ice control systems

2.2.6 Fuel Systems

2.2.6.1 Jet fuels

(a) Avtur (Jet Al); different forms, other fuel cuts
- volatility
- additives

(b) specific gravity
- meaning
- variation with temperature
- effect of variation

2.2.6.2 Carriage of fuel on aircraft

(a) fuel tanks:
- individual tanks

(b CG balance during fuel usage

(c) problems:
- algae, corrosion, water content

(d) need for venting

2.2.6.3 Operation of fuel system

(a) understand function of a typical multi-engine fuel system with multiple fuel tanks, tank to tank transfer

(b) understand purpose/function of major components, (eg. engine driven pumps (HP/LP), fuel tank pumps, override/transfer pumps jettison pumps, fuel/oil heat exchange, vent lines, single point refuelling

(c) recognize on diagrams the symbols for major components and be able to trace the functioning off a diagrammatic system (system details at level of flight manual diagrams)

(d) understand suction feed/transfer as backup for pressure feed/transfer

2.2.6.4 Operational considerations

(a) fuel temperature (max/min):
- need for fuel heating (oil, bleed air)

(b) cooling/lubrication of pumps

(c) cooling of oil/hydraulic systems:
- effect of fuel flow rates

(d) minimum fuel level:
- pick up for delivery to engine
- maintain oil/hydraulic cooling
- effects of aircraft attitude
- fuel jettison

2.2.6.5 Fuel system monitoring

(a) gauges:
- fuel contents, flow meters
- effect of check angle
- likely errors

(b) warning systems
- low fuel level, low pressure warning

(c) measurement of tank contents:
- dipstick/dripstick/floatsticks
- importance of having aircraft level
- precautions in use

2.2.7 Electrical Systems

2.2.7.1 Selected components

(a) bus:
- concept of a bus
- common terminology
- hot bus, emergency bus, essential bus

(b) circuit breaker:
- function, precautions it resetting
- multiple CB panels - need for identification
- grid system of nomenclature (eg CB G22 on P3 panel)

(c) battery:
- types of high performance batteries in common use
- charge/discharge characteristics
- precautions needed

(d) electrical power generation
- advantages of AC versus DC
- types of generator

Alternating Current (AC)
- types of generators
- advantages
- limitations

Direct Current (DC)
- types of generators
- advantages
- limitations

(e) TR unit:
- purpose
- function of diodes/RCRs

(f) power distribution:
- connecting generator to a bus
- connecting multiple generators to bus system - split buses
- paralleling generators
- priority supplies in event of partial failure

2.2.7.2 Operation of electrical system

(a) functioning of a typical AC-based electrical system with multiple generators, multiple AC and DC buses, APU and GPU;
(b) recognize on a diagram the symbols for the major components, and be able to trace the functioning of the diagrammatic system (system detail at the level of typical Operations Manual diagram)

2.2.7.3 The aircraft structure as an electrical conductor

(a) application
(b) bonding requirement

2.3 POWER PLANTS - TURBINE ENGINE

2.3.1 Thrust

(a) thrust formula;
(b) thrust as a function of air density, pressure and temperature, and RPM

2.3.2 Principle of operation

(a) basic jet propulsion theory:
- gas flow
changes in velocity, pressure, temperature

(b) working cycle:
- gas flow
- changes in velocity, pressure, temperature
- engine pressure ratio

(c) types of engine:
- differences and advantages
- centrifugal flow
- axial flow
- bypass engine
- bypass ratio

(d) power train
- fixed shaft - 'clutch'
- free power turbine
- twin pack, combining gear box
- torque sharing

2.3.3 Engine Construction

(a) intake:
- purpose/function of intake
- location relative to engine
- vulnerability to icing

(b) compressor:
- purpose/function of compressor
- centrifugal, axial
  - single/twin/multiple
- inlet guide vanes
- vulnerability to icing
- bleed air provisions
- compressor stalling
  - causes, symptoms, avoidance
  - unloading compressor during start

(c) combustion system:
- purpose (function of combustion system)
- combustion chamber
  - individual/annular
- fuel injectors
- igniters
- air/fuel ratios

(d) turbine:
- purpose/function of turbine
- thermal and mechanical stress
- effects of damage
- monitoring turbine temperature
  - need to monitor inlet temperature
  - difficulties/compromise in monitoring
  - terminology - TIT, ITT, TGT, etc

(e) exhaust:
- purpose/function of exhaust
- sources of noise
- EGT, JPT

(f) torque measuring/torque sharing
- governor inputs

2.3.4 Auxiliary Power Unit (APU)

(a) purpose/function of APU;
(b) types commonly available;
(c) outputs available;
(d) availability determined by AFM:
- use in flight
- start in flight
- outputs available in flight

2.3.5 Operational considerations

(a) use of bleed air
- effect on performance
- engine indications
- EGT, RPM

2.3.6 Engine starting

(a) electrical starters
- source of power
- cross tie requirements

(b) critical engine RPM:
- initiating fuel flow/ignition
- self-sustaining RPM
- stable idle

(c) typical engine start sequences;

(d) typical start malfunctions:
- cause and remedy
- fails to light off
- hot start
- hung start
- fails to stabilize at idle
- starter fails to disengage
- torching/tailpipe fire.

(e) starter/generator
- principle of operation/function

2.4 ENGINE INSTRUMENTS

2.4.1 Displays

(a) types of displays commonly available:
- pointer-and-dial
- vertical strip
- EICAS, Cathode Ray Tubes (CRT), Light Emitting Diodes (LED)

(b) purpose of monitoring engine parameters:
- comparison of engine performance
- trends/use of analogue displays/indications
- identification of malfunctions/failures

(c) desirability of rapidly being able to identify a gauge with its engine:
- examples of good/bad instrumentation layouts
- brief reference to misidentification of engine

2.4.2 Torque meter

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(b) types of indicators and units of torque;

(c) typical appearance of a set of gauges in a modern multi-engine helicopter

2.4.3 RPM indicator

(a) types of display:
- RPM, percent
- 100% not necessarily a limit-biasing

(b) multiple RPM displays - N1, N2, NR
- conventional order of numbering

(c) typical appearance of a set of gauges in a modern multi-engine helicopter

2.4.4 Temperature indicator

(a) types of display:
- analogue/digital

(b) over temperature warnings

(c) typical appearance of a set of gauges in a modern multi-engine helicopter

2.4.5 Fuel Consumption

(a) flow meters:
- analogue/digital indications
- importance on start-up and shut-down

(b) fuel-used gauges:
- may be separate or incorporated with flow meter

(c) typical appearance of a set of gauges in a modern multi-engine helicopter

2.4.6 Total Air temperature (TAT) gauge

(Note: not an engine system *gauge, but included here for simplicity of coverage)*

(a) purpose and functioning of TAT gauge:

(b) typical indicators

2.4.7 Inflight tracking

Principles of operation

2.4.8 Monitoring systems

- indicators, units
- warning systems
- mechanical and electrical remote signal transmission systems
- HUMS operation and indication

2.5 FLIGHT INSTRUMENTATION SYSTEMS

2.5.1 Application of computers to aircraft

(a) flight management systems;
(b) performance management systems;
(c) fly-by-wire aircraft

2.5.2 Electronic Flight instrument System (EFIS)

(a) advantages compared to conventional system;
(b) typical inputs and outputs;
(c) data input;
(d) control panel, display unit;
(e) example of a typical aircraft installation

2.5.3 Flight Management System (FMS)

(a) advantages compared to conventional systems
(b) general principles of operation;
(c) typical inputs and outputs;
(d) control panel, display unit;
(e) example of a typical aircraft installation

2.6 STABILITY, AUGMENTATION AND AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

2.6.1 AFCS

(a) purpose/function of AP;
- common types (different axes)/inputs
- pitch
- collective
- other

(c) components;
(d) typical AP controller
(e) command and manual modes:
- typical sub-modes
- Stability Augmentation System (SAS)
- attitude retention system (ARS/ATT)
- ALT/HDG/IAS hold
- VOR/LOC/ILS/INS/GPS tracking
- FMS coupling
- auto hover

(f) typical limitations/restrictions

2.6.2 Flight director (FD)

(a) purpose/function of FD;
(b) common types of presentation:
- V-bars, cross-bars
(c) typical components
(d) typical FD controller
(e) typical modes of operation:
- mode indicator

2.6.3 Autoflight

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(b) relationship between FMS and FD/AP;
(c) redundancy requirements

2.7 WARNING AND RECORDING EQUIPMENT

2.7.1 Ground Proximity Warning Systems (GPWS) and Auto Voice Activated Decision System (AVADS)

(a) purpose/function of GPWS;
(b) modes of operation: operating envelopes;
(c) hard and soft warnings - aural and visual;
(d) inputs and outputs;
(e) limitations/restrictions;
(f) typical GPWS display/control panel;
(g) AVADS:
- principles of operation, warnings, limitations

2.7.2 Airborne Collision Avoidance System (ACAS)

(a) what is an ACAS
(b) purpose/function of TCAS
- TCAS versions and changes
(c) operating envelope:
- inputs and outputs
(d) aural and visual warnings;
(e) limitations/restrictions;
(f) typical TCAS display/control panel

2.7.3 Rotor overspeed/underspeed warning system components

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2.7.4 Digital Flight Data Recorder (DFDR)

(a) purpose/function of DFDR;
(b) typical data coverage available;
(c) physical appearance of a set of gauges of typical recorder and recorded data

2.7.5 Health Usage Monitoring System (HUMS)

- actuation
- down loading

2.7.6 Cockpit Voice Recorder (CVR)

(a) purpose/function of CVR;
(b) typical audio/radio channel coverage available in multi-seat flight deck environment
(c) physical appearance of a set of gauges of typical recorder and control panel

2.7.7 Master Warning Systems

(a) purpose/function of MWS;
(b) typical warning systems incorporated or covered by MWS;
(c) aural/visual outputs:
- warnings
- cautions

(d) typical displays provided;
(e) take-off inhibiting of MWS outputs

2.8.8 Fire Detection, Warning, Extinguishing Systems

- types
- warnings
- limitations
- actuation
- effects

3 - FLIGHT RULES AND AIR LAW

3.1 AIRCRAFT NATIONALITY AND REGISTRATION

3.1.1 **ICAO Provisions** (Annex)

General applicability - brief reference only

3.1.2 **Australian national legislation**

(a) requirement to register aircraft;
(b) registration of aircraft in Australia;
(c) transfer of interest and cancellation of registration

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3.2.1 **ICAO Provisions** (Annex 8)

General applicability - brief reference only

3.2.2 **Australian national legislation**

(a) requirements for Certificates of Airworthiness;
(b) conditions relating to Certificates of Airworthiness;
(c) suspension or cancellation of Certificates of Airworthiness;
(d) permissible unserviceability;
- use of PUS
- MEL as an alternative to PUS
- use of an MEL

(e) requirements for maintenance;
(f) pilot's responsibilities with respect to maintenance within Australia;
(g) pilot's responsibilities with respect to maintenance outside Australia;
(h) maintenance release requirements;
(i) suspension, cancellation of a maintenance release;
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(k) pilot's responsibilities with respect to defects or damage;
(l) compliance and certification of Airworthiness Directives;
(m) classes of controlled airspace.

3.3 PERSONNEL LICENSING

3.3.1 ICAO Provisions (Annex 1)

General applicability - brief reference only

3.3.2 Australian national legislation

(a) general provisions:
licences
ratings
(b) ATPL:
- classes of ATPL
- privileges
- limitations
- recency requirements

(c) instrument ratings:
- requirement for:
  - command multi-engine instrument rating
    - privileges, limitations, recent experience
    - renewal requirements
  - copilot instrument rating
    - privileges, limitations, recent experience
    - renewal requirements
  - flight by night under VFR procedures requirements
  - privileges of instrument rated pilots
  - renewal of instrument rating overseas with a foreign carrier

(d) classification of operations;

(e) multi-crew aircraft:
- composition of crew
- flight and duty time limitations
- two-pilot crews

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General applicability - brief reference only

3.4.2 Australian national legislation

3.4.2.1 Rules of the Air Review (CAR Part XI)

3.4.2.2 Conditions of flight (CAR PART X)

(a) flight manuals;
(b) documents required for flight;
(c) carriage and discharge of firearms;
(d) drunkenness and violence on board an aircraft;
(e) dropping of articles;
(f) flight over public gatherings;
(g) low flying

3.5 PROCEDURES FOR AIR NAVIGATION

3.5.1 ICAO Doc 81 68 - OPS/611

General provisions - brief reference only

3.5.2 Australian national legislation

Review AIP (DAP)
(a) general requirements;
(b) alternate planning requirements;
(c) approach procedures;
(d) entry and holding procedures;
(e) meteorological minima:
- aerodrome
- application of minima
- alternate

(f) Instrument Landing System:
- failures
- altimeter checks

(g) category 1 and 2 minima;
(h) SIDs, STARs and NAPs;
(h) DME and GPS Arrival Procedures;
(i) GPS as a route navigation and approach aid

3.6 AIR TRAFFIC SERVICES

3.6.1 ICAO Annex I I and Doc 4444

General provisions - brief reference only

3.6.2 Australian national legislation

3.6.2.1 General Provisions

(a) objectives of ATS;
(b) division of ATS;
(c) designation of the portions of the airspace and controlled aerodromes where ATS will be provided;
(d) establishment and designation of the units providing ATS;
(e) specifications:
- flight information regions
- control areas
- control zones
(f) minimum flight attitudes;
(g) priority for aircraft in emergency;
(h) inflight contingencies in ATS

3.6.2.2 Air Traffic Control Service

(a) function and purpose of ATC;
(b) provision of ATC service;
(c) operation of ATC service;
(d) separation minima;
(e) contents of clearances;
(f) coordination of clearances;
(g) control of persons and vehicles at aerodromes

3.6.2.3 Flight Information Service

(a) application and scope of flight information service:
- IFR traffic
- VFR traffic
(b) operational flight information service broadcasts

3.6.2.4 Alerting Service

(a) function/purpose;
(b) phases of alert: INCERFA, ALERFA, DISTRESFA
(c) notification of rescue co-ordination centre;
(d) information to aircraft in a state of emergency

3.6.2.5 Principles governing the identification of ATS routes other than standard departure and arrival routes

3.7 RULES OF THE AIR AND AIR TRAFFIC SERVICES

3.7.1 ICAO Doc 444 and RAC/501111

General provisions - brief reference only

3.7.2 Australian national legislation

3.7.2.1 General provisions

(a) general air traffic services operating practices:
- submission of a flight plan
- change from IFR to VFR
- flight clearances and information
- control of air traffic flow
- altimeter setting procedures
- position reporting
- requirements and format for AIREP

3.7.2.2 Area Control Service

(a) vertical separation:
- requirements
- vertical separation minima
- minimum cruising level
- assignment of cruising level
- vertical separation during climb or descent

(b) horizontal separation (subsonic aircraft only):
- requirements
- geographical separation
- track separation for aircraft using the same navaid
- longitudinal separation

(c) reduction in separation minima;

(d) ATC clearances:
- requirement for clearance
- function of clearance
- contents of clearance
- maintaining own separation while in VMC
- essential traffic information while in VMC
- essential traffic information
- clearance of a requested change in flight plan

(e) emergency:
- general, priority, emergency descent only
- (action by pilot-in-command only)

(f) communication failure:
- air-ground communication failure (actions by pilot in command only)

(g) interception of civil aircraft

3.7.2.3 Approach Control Service

(a) departing aircraft:
- general procedures for departing aircraft
- information for departing aircraft
- clearances to climb maintaining own separation while in VMC
- wake turbulence separation

(b) arriving aircraft:
- general procedures for arriving aircraft
- clearance to descend maintaining own separation while in VMC
- visual approach
- instrument approach
- holding
- approach sequence
- expected approach
- time information for arriving aircraft

3.7.2.4 Aerodrome Control Service

(a) functions of aerodrome control towers:
- general functions
- alerting service
- suspension of VFR operations

(b) control of traffic:
- traffic circuit(s)
- start-up
- taxying traffic
- vehicular traffic
- co-ordination of take-off and landings
- order of priority for arriving and departing aircraft
- control of departing and arriving aircraft

(c) information provided to aircraft:
- operation of the aircraft
- aerodrome conditions

3.7.2.5 Flight Information Service and Alerting Service

(a) air traffic advisory service;
(b) alerting service

3.7.2.6 Use of Radar in Air Traffic Services

(a) limitations in the use of radar;
(b) functions of radar service:
- identification procedure (establishment of radar identity only)
- position information
- radar vectoring
- speed control

(c) use of radar in the air traffic control service;
(d) descent below MSA under radar control

3.8 AERONAUTICAL INFORMATION SERVICE

3.8.1 ICAO Annex 15

General provisions - brief reference only

3.8.2 Australian documentation

Availability and procurement of AIP, NOTAMS, AIC

3.9 AERODROMES

3.9.1 ICAO Annex 14

(a) general provisions - brief reference only
(b) helicopter landing sites and off shore HLS

3.9.2 Australian national legislation

(a) AIP AGA requirements:
- aerodrome markers and markings
- aerodrome lighting
- visual aids
- domestic aerodrome directory (ERSA)
- pavement strength limitations

3.10 FACILITATION

3.10.1 ICAO Annex 9

General provisions - brief reference only

3.10.2 Australian national legislation

AIP/FAL requirements:

(a) responsibility of Federal Airports Corporation;
(b) differences to International Standards and Practices: 9 Annex 9
(c) entry and departure of international aircraft:
- documents required
- description, purpose and use

(d) entry and departure of persons and baggage:
- normal requirements
- procedures for flight crew and similar personnel

(e) identification of Designated International Airports

3.11 SEARCH AND RESCUE

3.11.1 ICAO Annex 12

General provisions - brief reference only

3.11.2 Australian national legislation

(a) SAR organisation:
- establishment of SAR regions
- establishment and designation of SAR services units

(b) operating procedures:
- SAR phases
- distress and urgency signals
- use of SSR transponder
- procedures for pilots-in-command at the scene of a accident
- procedures for pilots-in-command intercepting
- distress transmissions
- participation in searches

3.12 SECURITY

3.12.1 ICAO Annex 17

General provisions - brief reference only

3.12.2 Air Defence Identification Zones (ADIZ)

(a) pilot's responsibilities for flight within the zone;
(b) exemptions;
(c) non-compliance;
(d) action in the event of interception;
(e) interpretation of visual signals;
(f) powers of pilot-in-command.

3.13 AIRCRAFT ACCIDENTS AND INCIDENTS

(a) terminology:
- definition of accident
- definition of incident

(b) responsibilities of pilot-in-command regarding notification

3.14 AIR SERVICE OPERATIONS

(Air Transport Operations only)

(a) route qualifications;
(b) admission to crew compartment
(c) carriage of approved persons:
- in crew compartment
- in cabin
(d) operational procedures in relation to computers;
(e) fuel quantity measurement: (requirements for aircraft above 5700 kg)
(f) hand signals;
(g) oxygen and protective breathing equipment;
(h) engine failure in multi-engine aircraft;
(i) carriage and use of radio;
(j) precautions in refuelling, engine and radar ground operations;
(k) emergency equipment;
(l) loading general;
(m) carriage of cargo;
(n) carriage of persons;
(o) aircraft equipment:
- basic operational requirements
(p) dangerous goods handling;
(q) fuel jettison:
- legislation
(r) ferry flights with one engine inoperative.

4 - NAVIGATION

4.1 NAVIGATION CHARTS

4.1.1 Lambert Conformal Conic Projection

(a) review properties:
- great circles, rhumb lines, ruled lines
- scales, chart convergence

(b) brief comparison with properties of other projections:
- Mercator
- Polar stereographic

4.1.2 Use of AIP (MAP) charts

4.2 TIME ZONES

(a) Review:
- time zones, date-line
- LMT, LST, UTC
- conversion from LMT/LST to UTC and vice-versa

(b) practical examples of LST arrival/departure calculations for flights across time zones:
- with and without date-line involvement

4.3 FLIGHT INSTRUMENTS

4.3.1 Air Data Instruments:

(a) Review of altimeter, ASI, VSI, IVSI, Machmeter
- principles of operation
- errors
- relationship between IAS, CAS, EAS, TAS and TMN

(b) modern instrumentation:
- integrated displays
- EFIS
- standby instruments

4.3.2 Air Data Computer (ADC)

(a) principles of operation;
(b) input and output data;
(c) uses of output data

4.3.3 Gyroscopic principles

(a) rigidity, precession:
- real and apparent precession
- correcting for precession (no mathematics required)

(b) types of gyros in common use:
- mechanical
- laser gyros

(c) gyro platforms:
- two and three-dimensional stability

(d) introduce concept of self-contained instruments versus gyro-platform output displays

4.3.4 Compasses

4.3.4.1 Direct Reading Compass

(a) principle of operation and errors;
(b) advantages and disadvantages.

4.3.4.2 Slaved Gyro-Stabilised Compass

(a) principles of operation and errors;
(b) Attitude Heading Reference Systems (AHRS);
(c) advantages and disadvantages;
(d) uses of output data

4.4 RADIO NAVIGATION

4.4.1 Radio wave propagation

4.4.1.1 Terminology

(a) Understand general principles of radio propagation;
(b) Understand and be able to use in correct sense:
- wavelength
- amplitude
- frequency
- phase angle
- frequency bands
- SSB, LSB, USB
- carrier
- modulation
- amplitude, frequency, pulse, multiplex
- demodulation

4.4.1.2 Wave propagation

(a) ground waves, space (direct) waves, sky waves
(b) propagation within the frequency bands;
(c) factors affecting reception:
- fading, static
(d) use of HF for communications:
- frequency prognosis
- SELCAL

4.4.1.3 Antennas

(a) function/purpose of antennas;
(b) types of antennas in common use for aircraft:
- uses
- characteristics (outline only)
- directionality
- polarisation

4.4.2 Radio NavAids

4.4.2.1 ADF (including NDBs and use of RMI)

(a) application for navigation;
(b) principles;
(c) presentation and interpretation;
(d) coverage;
(e) range;
(f) errors and accuracy;
(g) factors affecting range and accuracy

4.4.2.2 VOR and Doppler-VOR (including use of RMI)

(a) application for navigation;
(b) principles,
(c) presentation and interpretation;
(d) coverage;
(e) range;
(f) errors and accuracy;
(g) factors affecting range and accuracy

4.4.2.3 DME (distance measurement equipment)

(a) application for navigation;
(b) principles;
(c) presentation and interpretation;
(d) range;
(e) errors and accuracy;
(f) factors affecting range and accuracy

4.4.2.4 ILS (instrument landing system)

(a) application for navigation;
(b) principles;
(c) presentation and interpretation;
(d) coverage;
(e) range;
(f) errors and accuracy;
(g) factors affecting range and accuracy

4.4.2.5 MLS (microwave landing system)

(a) application for navigation;
(b) principles;
(c) presentation and interpretation;
(d) coverage;
(e) range;
(f) errors and accuracy;
(g) factors affecting range and accuracy.

4.5 BASIC RADAR PRINCIPLES

4.5.1 Pulse techniques and associated terminology

4.5.2 Ground radar

(a) coverage of ATC radars, factors affecting range and accuracy;
(b) facilities provided by Met radars for storm warning and avoidance

4.5.3 Airborne weather radar

(a) principles;
(b) types;
(c) presentation and interpretation;
(d) factors affecting range and accuracy

4.5.4 SSR (secondary surveillance radar) and transponder

(a) principles;
(b) application for traffic control;
(c) presentation and interpretation;
(d) advantages compared to primary radar for traffic control

4.5.5 Radio Altimeter

(a) principle of operation;
(b) display;
(c) accuracy, errors

4.6 ROUTE NAVIGATION

4.6.1 Route selection

(a) great circle tracks
(b) choice of speed and flight level
- (measurement & calculation of IAS, CAS, EAS, TAS, TMN, and GS)

4.6.2 Navigation on climb and descent

(a) wind and temperature variations:
- desirability of allowing for variations
- availability of data in actual situations

(b) weather/traffic avoidance:
- concept of track miles

(c) allowance for use of anti-ice equipment:
- reduced rate of climb
- reduced rate of descent

4.6.3 Use of Radio NavAids

(a) requirement for regular position fixing;
(b) use of navaid position lines to establish position:
- along track
- across track
- desired/preferred form of P/L intersections

(c) computer-controlled navaid receivers:
- auto-tuning
- manual selection
- precautions

4.6.4 Calculation of track and ground speed

(a) review basic track and ground speed calculations:
- plotted positions, IAS/TAS/GS/HDG/TRK
- determination of wind velocity
- (track and ground speed methods only)
- calculation of ETA, EET

(b) review ETP and PNR calculations;

(c) inflight diversion to fixed point:
- last PSD
- time and fuel required

4.7 AREA NAVIGATION SYSTEMS

4.7.1 Types of systems

(a) self contained on-board systems:
- INS
- DOPPLER

(b) external sensor systems:
- VOR/DME
- GPS

4.7.2 General principles

(a) inputs required:
- air data inputs
- other inputs

(b) outputs generated:
- types of outputs
- uses

4.7.3 RNAV Systems

(a) principle of VOR/DME area navigation (RNAV);

(b) advantages and disadvantages;

(c) limitations and restrictions:
- errors
- accuracy
- reliability
- coverage
- range

(d) typical control panel

4.7.4 Inertial Navigation Systems (INS)

(a) principle of INS navigation;
(b) advantages and disadvantages;
(d) limitations and restrictions:
- errors
- accuracy
- reliability
- coverage range

(d) typical control panel

4.7.5 Satellite Navigation Systems

(a) principle of GNSS navigation:
- elements of GNSS (eg. GPS, GLONASS)

(b) advantages and disadvantages;
(c) limitations and restrictions:
- errors
- accuracy
- reliability
- coverage
- range

(d) typical control panel
(e) approvals for IFR Navigation
(f) GPS system enhancements (eg. DGPS, GLS, WAAS)

4.7.6 Updating Area Navigation Systems

(a) need for updating position;
(b) requirements for updating:
- manual inserting
- automatic updating
- inhibiting updating

(c) common indications when system updates position

5 - FLIGHT PLANNING

5.1 PRACTICAL FLIGHT PLANNING

Complete a practical fight planning exercise using specified initial conditions and Operations Manual data. Other conditions may be inserted or varied enroute for test purposes. The exercise is intended as a consolidated test of a candidate's ability to apply flight planning, performance and navigational principles, and will include:

(a) calculation of take-off limits:
- selection of runway
- payload/fuel uplift capability
- MTOW including limits imposed by cruise factors
- calculation of take-off distances

(b) preparation of a weight and balance proforma:
- adjustment of load/fuel it required

(c) selection of route and altitude:
- allowing for wind and temperature
- based on (given) forecast or actual conditions
  - synoptic
  - SIGMET
  - winds
  - TAF, TTF, METARs
- including departure, destination and alternate requirements

(d) preparation of a fuel plan:
- sector fuel burns
- mid zone weight (MZW)
- total fuel burn
- alternate and reserve fuel
- total fuel required

(e) preparation of a navigation plan:
- sector times, distances, tracks
- headings and ground speeds
- minimum enroute altitudes
- allowance for climb and descent
- lowest safe altitudes

(f) inflight computations, revisions or replanning:
- fuel state, fuel requirements, fuel reserves
- navigational progress
  - tracks, ETAs, enroute wind
- diversion from track
- change of cruising level
- engine-out flight

(g) interpretation of AIP maps and symbols
(h) interpretation of (given) ATC requirements
- SID and/or STAR routings
- DME and GPS descent steps
(i) calculation of CP (ETP) and PNR
- normal
- engine-out

5.2 PRE FLIGHT PLANNING CONSIDERATIONS

5.21 Aircraft Equipment Fits

5.22 General Helicopter Exemptions

(a) performance of straight in approaches
(b) turns before 500 feet after take off
(c) non requirement to conduct flight control checks before take off
(d) refueling requirements
(e) crew seating requirements
(f) hoisting, rappelling and sling loads

6 - METEOROLOGY

Certain elements of basic meteorology have already been covered in the Day VFR syllabus. Nevertheless, candidates at ATPL level will be expected to demonstrate a working knowledge of the aspects listed in this section. Instructors are expected to decide the degree of revision necessary to ensure that knowledge.

6.1 THE ATMOSPHERE

6.1.1 Structure of the atmosphere

(a) composition and extent;
(b) vertical division (to lower stratosphere only)

6.1.2 Pressure, temperature and density

(a) interrelationship of pressure, temperature and density;
(b) barometric pressure, isobars;
(c) pressure, temperature and density variation with height,
(d) temperature near earth's surface:
- lapse rate
- surface effects
- diurnal variation
- effect of clouds

(e) adiabatic processes:
- meaning of adiabatic
- dry air
- evaporation
- condensation
- latent heat
- saturated air

(f) temperature inversions:
- development
- types
- influence on the weather

(g) stability and instability:
- DALR, SALR, ELR
- stable and unstable conditions, conditional instability
- stability changes caused by:
  - radiation
  - turbulence
  - convection
  - advection
  - subsidence
  - convergence
  - divergence
  - precipitation

6.1.3 Humidity

(a) water vapour in the atmosphere;
(b) vapour pressure, effect on density;
(c) dry/wet bulb temperature:
- dewpoint
- relative humidity

6.2 CLOUDS AND PRECIPITATION

6.2.1 Cloud

(a) types of cloud and level at which found:
- stratus
- cumulus
- cirrus

(b) variations of basic types:
- strato-
- cumulo-
- nimbo
- alto

6.2.2 Formation of cloud

(a) methods/mechanisms by which clouds form;
(b) conditions favourable to formation:
- atmospheric
- topographic.

6.2.3 Precipitation

(a) causes of precipitation;
(b) types:
- drizzle, rain, snow, hail
- distinction between showers and rain

(c) characteristics of precipitation:
- orographic
- frontal
- showers

(d) hazards presented by precipitation:
- reduced visibility (eg landing)
- icing
- radar masking (water layer on radome)
- weight/impact (severe rain on large aircraft)

6.2.4 Thunderstorms

(a) development of a single cell:
- pre-requisite conditions
- stages of development
- structure of mature cell

(b) hazards presented by a thunderstorm:
- down draught (near ground)
- turbulence
- icing
- lightning

(c) flight in or near thunderstorms:
- hazards in flight close to thunderstorms
- optimum flight paths/ flight levels if penetration of a thunderstorm is necessary

6.3 MOTION OF THE ATMOSPHERE

6.3.1 Wind and pressure

(a) relationship between isobars and wind:
- Buys Ballots Law

(b) primary cause of wind:
Note: formulae are not required
- pressure gradient
- coriolis force
- gradient wind
- convergence and divergence

(c) diurnal variation of wind;

(d) turbulence and gustiness:
- factors affecting turbulence
- effect of turbulence on lapse rate

6.3.2 Local winds

(a) land and sea breezes;
(b) anabatic, katabatic and fohn winds;
(c) low level jet

6.3.3 Mountain effects

(a) standing waves, rotors;
(b) conditions favourable to development;
(c) hazards presented by mountain effects

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6.3.4 Microbursts

(a) structure of a microburst;
(b) meteorological conditions conducive to microburst formation;
(c) visual identifying features;
(d) hazards presented by microbursts:
- windshear
- effect on IAS and ground
- speed sink rate
- turbulence

(e) windshear reporting procedures

6.3.5 Variation of wind with height

(a) general/common characteristics:
- loss of mechanical turbulence
- tends to increase speed
- tends westerly

(b) elementary knowledge of contour charts

6.4 VISIBILITY

6.4.1 Measurement of visibility

(a) brief outline of difficulties:
- practical measurement of Visibility
- visibility versus RVR
- visibility at night

(b) reduced visibility:
- distinction between fog, mist and haze

(c) hazards presented by reduced visibility:
- in flight
- on take-off or landing
- unseen obstacles
- control, especially direction and attitude
- obstacle avoidance if direction deviates

(d) difference between horizontal and vertical visibility;
(e) effects of vertical visibility being greater than horizontal visibility on final approach:
- impression of greater visibility below aircraft present height
- tendency to descend below glide path
- tendency to allow sink rate to increase

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6.4.2 Fog

(a) formation of fog
- mechanism
- prerequisite conditions

(b) synoptic conditions favourable to the formation and clearing of:
- radiation fog
- advection fog
- steam fog
- frontal fog

6.4.3 Other causes of reduced visibility

(a) effects of mist smoke, dust sand and sea spray;
(b) conditions favourable for such effects to develop

6.5 ICE ACCRETION

6.5.1 Airframe icing

(a) mechanism by which airframe ice is formed;
(b) types of icing:
- atmospheric conditions associated with each type

(c) airframe areas most susceptible to icing:
- factors affecting type, rate and severity of icing

(d) hazards presented by airframe icing;
(e) environmental conditions presenting an icing hazard:
- concept of visible moisture max and min air temperatures

6.5.2 Engine icing (turbine engines only)

(a) conditions conducive to engine icing:
- atmospheric conditions
- aircraft conditions

(b) sections of engine most susceptible to icing:
- factors affecting type, rate and severity of icing

(c) hazards presented by engine icing

6.5.3 Reports of icing

(a) requirement to report;
(b) classification of degree of icing

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6.6 AIRMASSES AND FRONTS

6.6.1 Properties of an air mass

(a) concept of an air mass;
(b) factors affecting the properties of an air mass:
- description of an air mass.

6.6.2 Classification of air masses

(a) classification on basis of area of origin;
(b) modifications due to advection.

6.6.3 Basic synoptic analysis

(a) high and low pressure areas:
relationship with air masses
(b) boundaries between air masses:
- non-frontal boundaries
- general/common situations
- ridges
- cols.

6.6.4 Fronts

(a) warm fronts:
- formation/mechanism of warm front
- associated clouds and weather
- hazards presented by warm fronts
(b) cold fronts:
-formation/mechanism of cold front
- associated clouds and weather
- hazards presented by cold fronts
(c) occluded fronts:
- formation/mechanism of occluded front
- associated clouds and weather
- hazards presented by occluded fronts
(d) quasi-stationary fronts:
- formation/mechanism of quasi-stationary front
associated clouds and weather
- hazards presented by quasi-stationary fronts.

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6.7 AIRMASSES AND FRONTAL ANALYSIS

6.7.1 Frontal depressions

(a) formation of frontal depressions;
(b) warm and cold fronts:
- occlusion process
(c) distribution of weather;
(d) depression families and troughs;
(e) flight conditions in and over depressions.

6.7.2 Non frontal depressions

(a) associated weather and flying conditions;
(b) thermal, orographic and secondary depressions.

6.7.3 Anticyclones

(a) general properties of anticyclones;
(b) cold and warm anticyclones.

6.7.4 Stream weather

(a) general properties of streams;
(b) weather to be expected in typical stream situations.

6.8 SYNOPTIC CHARTS

6.8.1 Presentation of synoptic charts

(a) common symbology and presentation of data;
(b) interpretation of data.

6.8.2 Basic analysis and prognostic rules

(a) movement of pressure systems and development of pressure systems in the Australian region;
(b) movement of fronts and development of fronts;
(c) general prognosis of situations represented on synoptic charts:
- in the next one to two hours, in the next 24 hours.

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6.8.3 Aviation significance of synoptic chart

(a) apply data from a synoptic chart to the selection of a route and destination/alternate;
(b) interpret data from a synoptic chart to estimate the surface weather expected at a selected point at the time represented by the chart or at a time shortly later - surface wind, type, amount and base of lowest cloud, probability of rain, probability of other features significant to aviation (eg dust, fog, etc).

Note: For examination purposes, candidates will be expected to differentiate between suggested winds, cloud cover, etc, to determine which is most probable at a nominated place.

6.9 UPPER LEVEL WEATHER

6.9.1 The tropopause

(a) atmospheric division represented by the tropopause:
- temperature profile below and above the tropopause
(b) variation in height of tropopause:
- at different latitudes
- in different seasons
(c) variation in wind in the vicinity of the tropopause;
(d) temperature profile above the tropical and polar tropopause

6.9.2 Upper level jet streams and CAT:

(a) recognize statements which define a jet stream;
(b) compare the strengths of typical tropical and polar jets;
(c) state conditions which may affect the strength and location of jet streams;
(d) recall that wind shear is usually greater on the polar side of the jet than on the equatorial side;
(e) list/identify signs which would suggest the presence of a jet stream and/or CAT;
(f) state pilot actions which would minimize the effect of CAT whilst flying:
-in the vicinity of a jet core;
-in CAT not associated with a jet stream

6.9.3 Flight conditions associated with:

(a) dense jet stream cirrus and cirrus haze;
(b) flight at high level in the vicinity of well developed thunderstorm tops

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6.10 UPPER LEVEL WEATHER CHARTS

6.10.1 Presentation of charts

(a) types of charts:
- upper level prognostic charts
- SIGWX charts
- grid point wind and temperature forecasts

(b) presentation of data and symbology used in the different charts;

(c) altitudes/hPa levels commonly charted

6.10.2 Application of upper level charts

(a) apply data from an upper level chart to the selection of a route and destination/alternates;

(b) interpret data from an upper level chart in terms of its aviation significance

6.11 CLIMATOLOGY

6.11.1 Global pressure distribution

(a) average surface pressure and temperature distribution over the world;

(b) global circulation:
- average circulation patterns in the troposphere and low stratosphere and their seasonal variation
- upper winds, stream lines and seasonal variation

(c) the Inter Tropical Convergence Zone (ITCZ) and its associated weather in different areas

6.11.2 Monsoonal weather

(a) wet and dry seasons;

(b) typical wet and dry weather conditions;

(c) hazards presented by monsoonal weather

(d) application of monsoonal conditions to Australia and near neighbours

6.11.3 Tropical storms

(a) pre-requisites for development:
- climatic
- equatorial latitudes

(b) global breeding grounds:
- understand that different areas have different local names for the same phenomenon

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(c) typical life history of storm;
(d) hazards presented by tropical storms:
- location of severest weather in relation to storm centre
(e) application of tropical storms to Australia and near neighbours.

6.12 MET OBSERVATIONS

6.12.1 Standard observation methods

Knowledge of standard methods of measuring:

- visibility
- cloud height
- pressure
- temperature
- humidity
- surface wind
- upper winds

(knowledge of the mechanics of the various instruments used is not required)

6.12.2 Q codes

(a) Understand the code groups QFE and QNH:
-understand the meaning of area QNH

6.12.3 Inflight Observations

(a) requirement for inflight observations by crew members;
(b) reporting criteria;
(c) form and circumstances in which observations are made and reported:
- refer AIP for Full Position Report format

6.12.4 Satellite observations

Use of satellite photographs (visual and infra-red) to recognize and describe weather systems and air masses

6.12.5 Australian flight weather documentation

(a) comprehension and interpretation of all weather forecasts or reports in common use in Australia for aviation purposes;
(b) decoding of TAF, METAR and SIGMET messages;
(c) understand the function of TREND type forecasts and the criteria for their use.

7 - HUMAN FACTORS

NOTE. Though a number *at physiological aspects of this syllabus have been covered in* the VFR *(Day) syllabus, an ATPL candidate is expected to demonstrate a greater depth of knowledge of these topics.*

7.1 ALTITUDE FLYING: RESPIRATION AND BLOOD CIRCULATION

7.1.1 Basic concepts

7.1.1.1 Metabolism

(a) oxygen requirement of tissues;
(b) composition of the atmosphere;
(c) the gas laws.

7.1.1.2 The respiratory system and circulation of the blood:

(a) interrelationship of respiration and circulation;
(b) composition and function of the blood.

7.1.1.3 Blood pressure:

(a) control of blood pressure;
(b) hypo and hypertension;
(c) hemodynamic effects of acceleration

7.1.1.4 Functional anatomy of the respiratory system

7.1.1.5 Ventilation of the alveolar space, respiratory control

7.1.1.6 Hypoxia:

(a) definition and causes of hypoxia;
(b) factors which may increase a person's susceptibility to hypoxia*;*
(c) symptoms of oxygen deficiency and treatment;
- time of useful consciousness;
(e) methods of combating the various forms of hypoxia.

7.1.1.7 Hyperventilation:

(a) definition and causes of hyperventilation;
(b) symptoms and treatment.

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7.1.1.8 The pressure cabin

(a) rapid decompression, effects and counter measures;
(b) entrapped gases, barotrauma.

7.2 HUMAN INFORMATION PROCESSING

7.2.1 The general system

7.2.1.1 Central and peripheral nervous system.

7.2.1.2 Sensory threshold, sensitivity, adaptation, habituation.

7.2.1.3 Reflexes and biological control systems.

7.2.1.4 Information processing by the central nervous system:

(a) mental set, attention (selective, divided, failure);
(b) channel capacity, filtering;
(c) mechanics of perception, constancy, selective perception.

7.2.2 The senses

7.2.2.1 Vision

(a) functional anatomy of the eye;
(b) physiology of the visual system;
(c) visual acuity, refraction and refractive errors, presbyopia;
(d) the visual field, scanning of the environments;
(e) binocular vision;
(f) the intraocular pressure, glaucoma;
(g) hypoxia and vision;
(h) night vision (dark adaptation);
(i) defective colour vision.

7.2.2.2 Hearing

(a) functional anatomy of the ear;
(b) physiology of hearing;
(c) hearing loss (perceptiveness/inductive);
(d) flight-related hazards to hearing: noise-related hearing loss, barotrauma.

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7.2.2.3 Equilibrium

(a) functional anatomy and physiology;
(b) detection of rotary and linear acceleration;
(c) the subjective vertical;
(d) motion sickness.

7.2.3 Integration of sensory inputs: spatial disorientation and illusions

7.2.3.1 Basic concepts and definitions.

7.2.3.2 Categories of disorientation:

(a) flight circumstances;
(b) vertigo, coriolis effect, pressure vertigo, flicker vertigo, somatogravic & somatogyral illusions, black hole illusions;
(c) visual illusions (the leans, approach and landing problems);
(d) prevention and handling of disorientation;
(e) rotor flicker and propeller strobing.

7.2.4 Memory

7.2.4.1 Functional description.
7.2.4.2 Information storage and recall:

(a) short-term memory;
(b) long-term memory;
(d) motor memory;
(c) effects of stress and time of day.

7.3 HUMAN BEHAVIOUR

7.3.1 General concepts

7.3.1.1 Personality:

(a) characteristics, traits;
(b) individual differences;
(c) self concept;
(d) attitude development;
(e) cognitive dissonance.

7.3.1.2 Behaviour and skills:

(a) drives;
(b) leading;
(c) motivation and performance.

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7.3.1.3 Human error and reliability:

(a) human error chain;
(b) types of errors;
(c) prevention and counter measures;
(d) reliability of human behaviour;
- errors induced by external factors (ergonomics, SHEL & REASON model).

7.3.1.4 Working in an advanced technology environment:

(a) what is advanced cockpit?
- automated cockpit, with equipment such as FMS, INS, GPS, ACAS, ACARS, GPWS, etc;
(b) cockpit design
- human vs machine capabilities;
(c) automation
- definition
- levels of automation
- advantages & disadvantages;
(d) coping behaviour.

7.3.2 Cockpit management

(a) crew coordination;
(b) distribution of responsibilities;
(c) working with a crew.

7.3.2.1 Crew cooperation:

(a) small group dynamics
- team performance
- norms, atmosphere, pressure, communication, structure;
(b) conflict management.

7.3.2.2 Leadership, style of management:

(a) concern for performance;
(b) concern for people
- individual & team;
(e) democratic vs autocratic style
- participatory management;
(d) encouraging inputs and feedback;
(e) optimizing of crew performance in flight;

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7.3.2.3 Communications:

(a) verbal and non-verbal communication;
(b) communication skills;
(c) listening skills;
(d) questioning skills;
(e) effects of different communication styles;
(f) miscommunication:
- ambiguity
- misunderstanding
- cultural differences.

7.3.3 Judgement and decision-making

(a) pilot judgement concepts:

7.3.3.1 What is judgement?

(a) types of judgement
- perceptual judgement
- cognitive judgement;
(c) process of judgement;
(d) importance of judgement in flying;
(e) judgement training;
(f) knowledge, skills and experience;
(g) exercising judgement
- pilot, aircraft, time available, environment;
(h) identification of hazardous attitudes
- physical factors
- psychological factors.
(i) social influences and interface between people;
(j) countering hazardous attitudes.

7.3.3.2 Aeronautical decision making**:**

(a) decision-making concepts;
(b) limitations in working with information;
(c) types of decision (prediction, diagnosis, choice);
(d) hypotheses and determining causes;
(e) decision making traps;
- simple rules, law of small numbers, wishful thinking, confirmation bias, gambler's fallacy, sacrificing, mission-itis'(entrapment), false hypotheses
- expert decision making
  - experience biases
  - problems in using checklists

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7.3.3.3 Attitude development:

(a) origins;
(b) components;
(c) attitude, beliefs, opinions;
(d) stereotyping;
(e) factors affecting attitude;
(f) resistance to change;
(g) attitude modified through training;
(h) relevance to safety;
(i) risk management;
(j) behavioural aspects;
(k) risk assessment;
(l) risk taking.

7.3.3.4 Pilot judgement awareness:

(a) situation awareness/ assessment;
(b) cockpit stress management.

7.3.3.5 Applying decision-making concepts:

(a) training on behavioural aspects;
(b) avoiding decision-making traps.

7.4 FLYING AND HEALTH

7.4.1 The high-altitude environment (ozone, radiation, humidity)

7.4.2 Physiological and mental fitness

7.4.3 Incapacitation

7.4.3.1 Causes and symptoms:

(a) gastro intestinal;
(b) cardiovascular;
(c) side effects of drugs and medication;
(d) migraine;
(e) epilepsy;
(f) brain disorders.

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7.3.2 Recognition: insidious and sudden incapacitation.

(a) intoxication;
(b) tobacco;
(c) alcohol;
(d) drugs and self medication;
(e) various toxic materials.

7.4.4 Body rhythm disturbances

7.4.1 Biological clock

7.4.2 Disturbances of circadian rhythms:

(a) causes (shift work, time-zone crossing);
(b) symptoms;
(c) treatment.

7.4.5 Fatigue

(a) definition;
(b) causes;
(c) types and symptoms;
(d) prevention and treatment;
(e) cockpit napping.

7.4.6 Stress and anxiety

(a) definition of stress;
(b) stress components;
(c) causes, stresses;
(d) coping behaviour:
    - identifying and reducing stress
    - Life Stress Management.
(e) effects on performance:
    - Critical Incident Stress
    - coping strategies;
(f) anxiety:
    - defence mechanism
    - effects of anxiety and defence mechanisms.

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7.4.7 General health aspects

(a) common minor ailments (colds, influenza, gastrointestinal upsets);
(b) tropical climates: risk, regulatory aspects;
(c) personal hygiene: oral, external, internal hygiene;
(d) diabetes;
(e) hyper/hypotension;
(f) obesity - lack of exercise;
(g) epidemic diseases.

7.4.8 Dehydration

(a) causes;
(b) symptoms;
(c) rate of onset;
(d) water requirements vs OAT;
(e) effect on physical activity;
(f) effect on mental ability;
(g) action to re-hydrate;
(h) fluids suitable for re-hydration

7.5 THREAT & ERROR MANAGEMENT

7.5.1 Threat & Error Management Model (TEM)

7.5.1.1 Explain what is Threat and Error Management?

7.5.2 Basic principles of TEM

7.5.2.1 Explain the principles of TEM
7.5.2.2 Explain the components of TEM

7.5.3 Threat

7.5.3.1 Define and explain 'threat'.
7.5.3.2 Explain types of 'threats' such as 'expected', 'unexpected' and 'latent' threats; recognize and give examples.
7.5.3.3 Explain categories of 'threats' such as 'environmental' and 'organizational' threats; give examples of these 'threat(s) and recognize the 'threat(s)' in a given scenario.

7.5.4 Error

7.5.4.1 Define and explain 'error'
7.5.4.2 Explain types of 'errors', such as those independent of 'threat(s)', induced by 'threat(s)' and with the potential to escalate other 'errors' (chain of errors); recognize and give examples.

7.5.4.3 Explain categories of 'errors' such as those due to aircraft handling, flight management, procedures and communication; give examples of these 'error(s) and recognize the 'error(s)' in a given scenario

7.5.4.4 Describe some measures or practices (eg. use of checklist, SOPs) to prevent occurrence of 'errors'.

7.5.4.5 Analyse scenarios of crew facing 'error(s)', and how crew may recognize and prevent 'errors' to ensure safe flight.

7.5.5 Undesired Aircraft States (UAS)

7.5.5.1 Define and explain UAS

7.5.5.2 Explain categories of 'UAS' such as those arising from ineffective 'threat' and/or 'error' management, and those spontaneously and directly from a 'threat'; recognize and give examples.

7.5.5.3 Explain categories of 'UAS' such as those due to aircraft handling, ground navigation and incorrect aircraft configuration; give examples of these 'UAS' and recognize the 'UAS' in a given scenario.

7.5.5.4 Explain the primacy of 'UAS' management over 'error' or 'threat' management; recognize and give examples of the importance of ensuring that tasks are prioritised to manage an 'UAS'.

7.5.5.5 Explain what resources an aircraft cockpit crew could identify and use to avoid or manage an 'UAS'.

7.5.5.6 Analyse scenarios of crew facing 'UAS', and what should be the recovery action, and what would be the end states (outcomes) if recovery action is not taken.

7.5.6 Countermeasures

7.5.6.1 Define and explain 'countermeasures'.

7.5.6.2 Describe and give examples of types of 'countermeasures' such as systemic-based, individual and team 'countermeasures'.

7.5.6.3 Describe and give examples of 'countermeasures'.

7.5.7 TEM in Multi-crew Operations

7.5.7.1 Detail a process to identify and manage threats and errors during multi-crew operations, such as data gathering, threat analysis, decision making.

7.5.7.2 Analyse scenarios of multi-crew operations with regards to TEM.

7.5.7.3 Give examples of how establishing and maintaining interpersonal relationships in multi-crew operations can promote safe flight.

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8 - FLIGHT PERFORMANCE AND LOADING

[A complete knowledge of the relevant CAOs/CARs/AIP sections is implied]

8.1 TAKE-OFF AND LANDING PERFORMANCE

8.1.1 Terminology

8.1.1.1 Understand and be able to use terms in correct context:

(a) speeds:
- Vtoss, Vyse
- max rate and max angle climb speed
- CDP (speed/time), LDP

(b) distance (a basic understanding is required at the ATPL level):
- TORR/TORA, TODR/TODA, ASDR/ASDA, LDR/LDA
- balanced field length
- clearway, stopway

(c) weights:
- TOW/MTOW, LW/MLW, ZFW/MZFW
- basic operating weight
- useable fuel
- payload

(d) pavement parameters:
- LCN, ACN, PCN
- pavement concession
- wheel loading

8.1.2 Theory - take-off performance

8.1.2.1 <u>Runway/Helipads</u>

(a) derivation/basis of take-off distance;
(b) derivation/basis of accelerate-stop distance:
- delay factors assumed
(c) clearways and stopways:
- function
(d) allowance for head/tail wind;

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8.1.2.2 Take off performance

(a) concept/purpose of take-off segments;
(b) composition of segments:
- first, second, third, fourth
(c) take-off climb gradients:
- distinction between gross and net gradient
- purpose of net gradient
(d) gradients required in each segment:
- gross and net obstacle clearance requirements take-off area (IMC case only)
- vertical clearance
(e) curved departures: point at which turn may commence bank angle
- vertical clearance

NOTE: Segments one to four are equivalent to D1, D2, D3, and D4 as used in the superseded Puma Manual.

8.1.2.3 Take-off weight restrictions

8.1.2.3.1 Factors affecting the maximum permissible take-off weight

(a) structural limit;
(b) enroute accountability VFR;
(c) enroute accountability night/IFR;
(d) second-segment climb limit;
(e) landing weight;
(f) enroute climb requirement

8.1.2.4 Power assessment

8.1.3 Practical application - take-off

(a) use typical Flights Manual data to determine either
- MTOW on given runway or helipad
- min runway length at given take-off weight incorporating any or all of the following variables:
- wind component
- temperature
- altitude
- engine type and/or power setting

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8.1.4 Theory - landing performance

8.1.4.1 Runway

(a) derivation/basis of landing distance:
- certification landing technique
- factoring

(b) allowance for wind

8.1.4.2 Approach and touch-down

(a) determination of LDP
- nominally

8.1.4.3 Landing weight restrictions

Factors affecting the maximum permissible landing weight

8.1.4.4 Effects of operating technique

8.1.5 Practical application-landing

(a) use typical Flight Manual data to determine
- MLW on given runway or helipad

Note: For examination purposes, candidates will be expected to be able to determine a maximum take-off or landing weight, considering the various limitations applicable to the (given) circumstances, and deciding which of those factors is the critical limiting one. In doing so, candidates must be aware that TOW may be limited by cruising level or landing considerations.
Candidates may also be asked to determine limiting variables:
eg. "What is the limiting temperature at which a (given) take-off can be made?"

8.2 CLIMB, CRUISE AND DESCENT PERFORMANCE

8.2.1 Terminology

8.2.1.1 Understand and be able to use terms in correct context:
- long range cruise (LRC)
- specific range
- point of no return (PNR)
- point of safe diversion (PSD)
- equi-time point (CP or ETP)
- ISA and temperature derivatives (eg ISA+10).

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8.2.2 Theory

8.2.2.1 Basis of speed management

(a) effect of altitude and temperature variations:
- fuel consumption
- range
- specific range
- rate of climb

8.2.2.2 Effect of operational decisions

(a) factors affecting choice of cruise speed;
(b) selection of descent point;
(c) engine-out considerations

8.2.2.3 Enroute flight path gradients

(a) enroute climb gradient:
(b) enroute obstacle clearance (IMC case):
- horizontal distance from obstacles
- vertical clearance of obstacles
- net gradient required at minimum clearance

(c) drift down procedure:
- increased vertical clearance required

8.2.3 Practical application

8.2.3.1 Climb

Given appropriate initial data, including variations from ISA,
use typical Flight Manual information to determine

(a) time/distance/fuel used to a given altitude, or altitude reached after a given time or distance

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8.2.3.2 Cruise and descent

Given appropriate initial data, including variations from ISA, use typical Flight Manual information to determine, under normal and engine-out conditions:

(a) maximum and optimum cruise levels;
(b) TAS and fuel consumption at specified altitudes, adjusting for use of bleed air, etc, as required;
(c) max weight or temperature at which specified performance and/or altitudes can be attained;
(d) holding speeds and fuel consumption at specified and optimum altitudes;
(e) appropriate descent points and calculate time on descent

8.3 WEIGHT AND BALANCE

8.3.1 Terminology

8.3.1.1 Understand and be able to apply in correct context the following terms and concepts:

- CG
- moment arm
- CG index
- CG envelope
- loading zones
- floor limits
- basic weight
- zero-fuel weight
- average weights for passengers and baggage
- approved load control system.

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8.3.2 Theory

8.3.2.1 Basic weight and balance

(a) review basic theory of CG and moments:
- CG index & CG envelope

(b) review standard terminology for weights:
- basic weight, operating weight, zero-fuel weight
- fuel weight, payload

(c) understand the consequences of over loading on:
- take off performance
- climb/cruise performance, aircraft structure

(d) understand requirement for passenger seat allocation and need to control seating changes in large aircraft

(e) effect of weight on auto-rotation and landing

8.3.2.2 Load control system

(a) purpose/function of a load control system:
- Weight Control Authority

(b) approved load controlled (ALC):
- responsibility of ALC

(c) responsibilities of pilot in command:
- pilots may assume responsibilities of ALC

(d) load sheet
- requirements
- contents

8.3.3 Practical application

8.3.3.1 Use typical Flight Manual information to extract weight and balance data:

(a) given appropriate initial data, determine any or all of:
- CG at empty weight
- movement of CG with addition of fuel and payload
- movement of CG due to fuel consumption in flight
- effect on CG of raising/lowering undercarriage;

(b) determine CG limits for take off, cruise and landing;

(c) determine adjustments (if any) required to the payload to permit operations within the CG envelope

8.3.3.2 Given appropriate initial data, assess a completed weight and balance proforma and determine whether it is acceptable for flight

8.3.3.3 Sling load/hoist
- effects on C of G