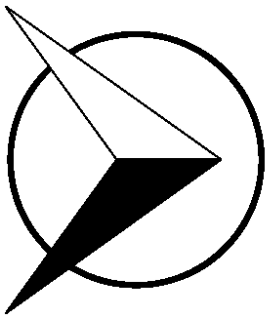

CIVIL AVIATION
SAFETY AUTHORITY
AUSTRALIA

AIR TRANSPORT PILOT (AEROPLANE) LICENCE

AERONAUTICAL KNOWLEDGE SYLLABUS

Issue 1.1 - June 2000

INFORMATION COVER SHEET

TO

AIR TRANSPORT PILOT (AEROPLANE) LICENCE

AERONAUTICAL KNOWLEDGE SYLLABUS

ISSUE 1.1 - June 2000

This is the first re-issue since its original print in 1992. The amendments contained are in the main few and of a minor nature, merely formalizing those that have effectively occurred over the years since initial publication; a few items have been 'touched up' to provide greater clarification, and to commonalize these with the equivalent sections of the Helicopter ATPL.

A summary of the amendments are as follows:

- deletion of VLF/OMEGA from 4.7.1(b) and 4.7.5
- replication of 2.2.6.4(e) fuel jettison (first 2 dot points) in Section 3 as 3.14(q)
- rewritten 4.3.1(a) to included IVSI, and the 'relationship' between various speeds
- rewritten 4.6.1 to include measurement & calculation of various speeds under the item 'choice of speeds'
- rewritten 4.7.6 to reflect current Australian practice

Copies of the syllabus are available from:

Airservices Australia Publications Centre
715 Swanston Street
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AIR TRANSPORT PILOT LICENCE

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 (Aeroplane) Information Book, which should be read in conjunction with this syllabus.

1.2 The syllabus sets out the aeronautical knowledge required for the issue of an ATPL (Aeroplane). It assumes prior satisfactory knowledge of material set out in the VFR (Day) Syllabus. 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 turbine powered aircraft, 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 (A) theory examination before he/she will be permitted to undertake the ATPL (A) theory examination.

2 - AIRCRAFT GENERAL KNOWLEDGE

2.1 ADVANCED AERODYNAMICS

2.1.1 Review of Terminology

(a) IAS, CAS, EAS, TAS, Mach No;
(b) reference speeds including M_{CRIT}, V_{MO}, M_{MO}, V_s

2.1.2 Aerodynamic Forces

(a) review forces acting in flight;
(b) balance of forces in trimmed asymmetric flight;
(c) V_{MCA} and V_{MCG}.

2.1.3 Shock Waves

(a) reasons for their formation at subsonic speeds;
(b) their effect on the handling and operation of the aircraft;
(c) high-speed buffet and its possible similarity to low-speed buffet and speedbrake buffet.

2.1.4 Performance and Speed

(a) manoeuvring and gust envelope;
(b) changes to C_L and C_D with increasing speed at constant angle of attack;
(c) performance degradation, the effect of Mach drag on thrust required and fuel flow;
(d) aileron reversal;
(e) effects of wing sweep back;
(f) maximising low-speed performance (use windshear on take-off as discussion case).

2.1.5 Performance and Altitude

(a) effect of high altitude on:
- buffet boundaries
- stall and stability
- manoeuvring capability (inertia effects)

(b) stall and V_{MCA} considerations with engine failure at high altitude.

2.2 AIRFRAME AND SYSTEMS

2.2.1 Flight Controls

2.2.1.1 Review flight controls:
(a) primary flight controls:
- ailerons, elevators, rudder

(b) secondary flight controls:
- spoilers/airbrakes
- trim systems
  - flying tail, stabiliser trim

2.2.1.2 Leading edge flaps:
(a) review trailing edge flaps;
(b) leading edge flaps/devices:
- purpose/function of LE flaps
- types in common use
- typical interconnection with TE flaps

(c) common methods of operation:
- hydraulic, electric, pneumatic
  (outline only; actuating systems are at later section)

2.2.1.3 Powered Controls:
(a) methods of transmitting demand to control surfaces;
(b) feedback;
(c) feel, natural/artificial;
(d) possibility/availability of manual reversion.

2.2.2 Landing Gear

2.2.2.1 Wheel systems
(a) arrangements:
- multi-wheel
- bogie wheel
- effects on PCN/ACN

(b) main components;
(c) brief outline of typical retract/extend operation:
- normal, alternate, emergency operation
- LG doors may be disabled under some conditions

2.2.2.2 Wheels and tyres
(a) wheels and brake energy limits, thermal plugs
(b) cooling charts, minimum turn-around times

2.2.2.3 Braking systems
(a) typical multi-wheel systems:
- typical sources of power for normal, alternate, emergency use
  - hydraulic supply and back-up
  - emergency air bottles

(c) parking brake
(d) principles of operations/limitations of:
- anti skid system
- auto brake system

2.2.2.4 Hydroplaning
(a) cause and effect;
(b) factors affecting hydroplaning, including speed formulae.

2.2.2.5 Steering systems
(a) types available:
- rudder pedal steering
- hand/wheel/tiller steering
- body-gear steering on some aircraft

(b) degree of steering commonly available with each:
- understand that some steering systems are incompatible with asymmetric brake and/or power, while others are improved by them.

2.2.3 Actuating Systems

2.2.3.1 Basic principles of hydromechanics
(a) principle of transmission of force by an incompressible fluid;
(b) brief comparison with use of a compressible fluid.

2.2.3.2 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) recognise 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 typical Operations Manual diagram);
(d) typical services operated
- typical system of allocating priority to certain services.

2.2.3.3 Pneumatic systems
(a) basic system knowledge as for hydraulics;
(b) compare system differences with hydraulic system;
(c) compare operating differences with hydraulic system;
- speed of response
- force available
- supply of operating fluid
- weight of system.

2.2.4 Air Conditioning and Pressurisation

2.2.4.1 Typical air supply system
(a) power sources:
- engine driven compressors
- bleed air:
  - gas turbine compressor
  - turbo charger compressor

(b) typical services provided;
(c) availability of services:
- possibility of limitations under take-off or asymmetric power conditions, or during engine start.

2.2.4.2 Air conditioning system
(a) types of systems:
- freon
- air cycle machine

(b) brief outline of operation of system
- single zone cabin
- multiple zones

(c) purpose of/necessity for humidifiers

2.2.4.3 Pressurisation system
(a) terminology:
- cabin altitude, differential pressure

(b) brief outline of operation of typical system:
- supply
- outflow valves
- overpressure and negative pressure relief
- control of cabin altitude and rate (no detail of internal mechanism of controller required)

(c) normal pressurised zones in the aircraft
(d) rapid decompression, cabin altitude warning

2.2.5 Ice and rain protection

2.2.5.1 Distinction between anti-ice and de-ice system

2.2.5.2 Pneumatic systems (brief coverage only)
(a) where used:
- leading edges

(b) limitations

2.2.5.3 Thermal ice protection
(a) where used:
- propellers, flying surfaces, air intakes, pitot and other sensors, windshields

(b) methods:
- electrical, air, oil

(c) limitations

2.2.5.4 Fluid ice protection
(a) where used:
- inflight leading edge of flying surfaces, propellers, windshield
- ground de-icing

(b) limitations.

2.2.5.5 Rain removal from windscreen
(a) methods:
- wipers
- fluid dispersant
- air jets.

2.2.5.6 Effects on aeroplane performance
(discussion only)
(a) ice accumulations;
(b) use of ice control systems.

2.2.6 Fuel System

2.2.6.1 Jet fuels
(a) Avtur (Jet A1); difference from other fuel cuts
- volatility
- additives (discussion only)

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

2.2.6.2 Carriage of fuel on aircraft
(a) fuel tanks:
- individual tanks, wet wing, tail tanks

(b) structural consequences:
- wing bending, zero-fuel weight, CG movement

(c) problems (brief discussion only)
- algae, corrosion, water content

(d) need for venting.

2.2.6.3 Operation of fuel system
(a) functioning of a typical multi-engine fuel system with multiple fuel tanks, tank-to-tank transfer and fuel jettison;
(b) understand purpose/function of major components:
- engine-driven (LP/HP) pumps; fuel tank pumps, override/transfer pumps, jettison pumps, fuel/oil heat exchanger, vent lines, single-point refuelling

(c) recognise 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 typical Operations Manual diagram);
(d) understand suction feed and gravity feed/transfer as backup for pressure feed/transfer.

2.2.6.4 Operational considerations
(a) fuel temperatures (max/min):
- need for fuel heating (oil, bleed air)

(b) cooling/lubrication of pumps;
(c) cooling of oil/hydraulic system:
- effect of fuel flow rates

(d) minimum fuel levels:
- pickup for delivery to engine
- maintain oil/hydraulic cooling
- effect of aircraft attitude
  (eg. missed approach)

(e) fuel jettison:
- legislation
- precautions to be observed
- minimum fuel after jettison (stand-pipes).

2.2.6.5 Fuel system monitoring
(a) gauges:
- fuel contents, flowmeters

(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 if 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) AC generation:
- advantages of AC versus DC
- types of generator
  - permanent magnet generator
  - field excitation generator
    = differences between them

- constant speed drive
  - purpose
  - disconnecting drive;

(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) recognise 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 Manager diagram)

2.2.7.3 The aircraft structure as an electrical conductor

2.3 POWER PLANTS - TURBINE ENGINE

2.3.1 Thrust

(a) thrust formula;

(b) thrust as a function of airspeed, air density, pressure and temperature, and RPM.

2.3.2 Principle of operation

(a) basic jet propulsion theory;

(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) turboprop:
- advantages and limitations/problems.

2.3.3 Engine constructions

(a) intake (subsonic only):
- location on airframe relative to free-stream airflow
- location relative to engine (eg. B727 centre engine)
- vulnerability to icing

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

(c) fan:
- purpose/function of fan
- relationship to compressor
- inlet guide vanes
- reverse thrust

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

(e) turbine:
- purpose/function of turbine
- single/twin/triple turbines
  - eg. driving two-stage compressor with fan
- thermal and mechanical stress
- effects of damage
- monitoring turbine temperature
  - desired to monitor inlet temperature
  - difficulties/compromise in monitoring
  - terminology - EGT, TGT, TIT
- reverse thrust mechanisms
  - cascade, buckets
  - safety interlocks

(f) exhaust:
- purpose/function of exhaust
- sources of noise
- hushkits.

2.3.4 Turbo-prop

(a) drive train from engine:
- flight range and ground range

(b) control of propeller:
- variable speed engine
- constant speed engine

(c) reverse thrust:
- concept of zero thrust

(d) feathering

(e) propeller brake.

2.3.5 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

2.3.6 Operational considerations

(a) use of reverse thrust:
- effectiveness with decreasing speed
- instability of airflow in reverse at low groundspeeds
- monitoring and precautions
- deliberate or inadvertent use in flight (where not permitted by AFM)

(b) use of bleed air:
- effect on thrust and performance
- engine indications
  - EGT, RPM, EPR.

2.3.7 Engine starting

(a) air-driven starters:
- characteristics
- sources of air
- failure to disconnect

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

(c) typical engine start sequence;

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

2.4 ENGINE INSTRUMENTS

2.4.1 Displays

(a) types of displays commonly available:
- pointer-and-dial
- vertical strip
- EICAS

(b) purpose of monitoring engine parameters:
- comparison of engine performance
- trends
- 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
  (eg. BA B737 Midlands accident)

2.4.2. EPR gauge

(a) inputs;

(b) displays:
- analogue/digital readout
- setting target EPR
  - manual/auto settings

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

2.4.3 Torque meter

(a) inputs and methods of functioning;

(b) types of indicators and units of torque;

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

2.4.4 RPM indicator

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

(b) multiple RPM displays - N1, N2, N3:
- conventional order of numbering

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

2.4.5 Turbine temperature indicator

(a) types of display:
- analogue/digital

(b) overtemp warnings;

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

2.4.6 Fuel consumption

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

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

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

2.4.7 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:
- ram rise, recovery factor

(b) typical indicators.

2.5 FLIGHT INSTRUMENTATION SYSTEMS

2.5.1 Application of computers to aircraft

(discussion only)
(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 system;
(b) general principles of operation;
(c) typical inputs and outputs;
(d) control panel, display unit;
(e) example of a typical aircraft installation.

2.6 AUTOMATIC FLIGHT CONTROL SYSTEM

2.6.1 Autopilot (AP)

(a) purpose/function of AP;
(b) common types (different axes);
(c) components;
(d) typical heavy aircraft AP controller;
(e) command and manual modes:
- typical sub-modes
  - ALT/HDG/IAS/MACH/VS hold
  - VORLOC/ILS/INS tracking
  - FMS coupling
  - autoland and auto-go-around

(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 heavy aircraft FD controller;
(e) typical modes of operation:
- mode indicator.

2.6.3 Auto-throttle (AT)

(a) purpose/function of AT;
(b) typical modes of operation:
- thrust hold
- speed hold
- VNAV coupling

(c) auto-derate of take-off power;
(d) typical engage/disengage/go-around controls;
(e) typical limitations/restrictions.

2.6.4 Autoflight

(a) relationship between AT, FD and AP;
(b) relationship between FMS and AT/FD/AP;
(c) redundancy requirements for autoland.

2.6.5 Flight envelope protection in autoflight

(a) types for protection available:
- high speed; low speed
- alpha floor
- flap/gear speed protection

(b) functioning of typical system:
- inputs and outputs

(c) modified functioning during flare and touchdown.

2.6.6 Associated autosystems

(a) yaw damper:
- purpose/function of yaw damper
  - typical low/high speed behaviour requiring installation of yaw damper
- method of functioning
  - input and output
- series and parallel types
  - advantages/disadvantages of each type
- typical yaw damper controls

(b) automatic pitch trim:
- purpose/function of auto-trim
- input and output
- typical auto-trim controls

(c) thrust computation:
- purpose/function of thrust computation system
- input and output
- relationship to FMS

2.7 WARNING AND RECORDING EQUIPMENT

2.7.1 Ground Proximity Warning Systems (GPWS)

(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) GPWS inhibiting with low flap settings:
- flap malfunction
- asymmetric approach with reduced flap.

2.7.2 Traffic Collision Avoidance System (TCAS)

(a) purpose/function of TCAS;
(b) operating envelope:
- inputs and outputs

(c) aural and visual warnings;
(d) limitations/restrictions;
(e) typical TCAS display/control panel.

2.7.3 Overspeed Warning System

(a) components:
- inputs and outputs

(b) may be selectable according to weight/CG/fuel distribution;
(c) typical selectors and warning indicators:
- aural and visual warnings.

2.7.4 Stall Warning

(a) purpose/function of system;
(b) components of a typical heavy aircraft system:
- ADC inputs including AOA
- stick shaker/pusher
- visual/aural warnings.

2.7.5 Take-off Warning System (TWS)

(a) purpose/function of TWS;
(b) typical items monitored;
(c) aural/visual warnings.

2.7.6 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.

2.7.7 Cockpit Voice Recorder (CVR)

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

2.7.8 Master Warning Systems

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

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

3 - FLIGHT RULES AND AIR LAW

3.1 AIRCRAFT NATIONALITY AND REGISTRATION

3.1.1 ICAO provisions (Annex 7)

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;
(d) cancellation of registration.

3.2 AIRWORTHINESS OF AIRCRAFT

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 unserviceabilities;
- 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;
(j) cessation or re-commencement of a maintenance release;
(k) pilot's responsibilities with respect to defects or damage.

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 instrument rating as part of ATPL
- command multi-engine instrument rating
  - privileges
  - limitations
  - recent experience renewal
  - requirements
- co-pilot 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
- inflight relief of crew members
  - pilots
  - flight engineers
- flight and duty time limitations
  - two-pilot crews
  - more than two pilots
  - one flight engineer
  - more than one flight engineer
  - conditions for a pilot to relieve flight engineer or vice versa.

3.4 RULES OF THE AIR

3.4.1 ICAO Annex 2

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 of firearms;
(d) discharge of firearms;
(e) dropping of articles;
(f) flight over public gatherings;
(g) low flying.

3.5 PROCEDURES FOR AIR NAVIGATION - AIRCRAFT OPERATIONS

3.5.1 ICAO Doc. 8186 - OPS/611

General provisions - brief reference only

3.5.2 Australian national legislation

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

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

(f) category 1 and 2 minima;
(g) SIDs and NAP;
(h) DME Arrival Procedures.

3.6 AIR TRAFFIC SERVICES

3.6.1 ICAO Annex 11 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 altitudes;
(g) priority for aircraft in emergency;
(h) inflight contingencies in ATS.

3.6.2.2 Air Traffic Control Service
(a) function/purpose of ATC;
(b) provision of ATC service;
(c) operation of ATC service;
(d) separation minima;
(e) contents of clearances;
(f) co-ordination 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
- DETRESFA

(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/501/11

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:
- selection of runway-in-use
- traffic circuit(s)
- start-up and pushback
- taxying traffic
- vehicular traffic
- co-ordination of take-offs 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
General provisions - brief reference only

3.9.2 Australian national legislation

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:

- 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 an accident
- procedures for pilots-in-command intercepting a distress transmission
- participation in searches

3.12 SECURITY

3.12.1 ICAO Annex 17

General provisions - brief reference only

3.12.2 Air Defence Identification Zones

(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 of approved persons:
- in crew compartment
- in cabin

(c) operational procedures in relations to computers;
(d) fuel quantity measurement:
(requirements for aircraft above 5700kg)
(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
- precautions to be observed

4 - NAVIGATION

4.1 NAVIGATION CHARTS

4.1.1 Lambert Conformal Conic Projection

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

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

4.1.2 Use of AIP (MAP) charts

4.2 TIME ZONES

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

4.3.4.2 Slaved Gyro-stabilised Compass
(a) principles of operation;
(b) errors;
(c) advantages and disadvantages;
(d) uses of output data.

4.3.4.3 Inertial heading
(a) use of a gyro platform to compute true heading:
- principles
- significance of initial positions insert

(b) magnetic heading as a modification of true heading.

4.4 RADIO NAVIGATION

4.4.1 Radiowave 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
- sidebands
  - SSB.LSB.USB
- carrier
- modulation
  - amplitude, frequency, pulse, multiplex
- demodulation

4.4.1.2 Wave propagation
(a) groundwaves, space (direct) waves, skywaves;
(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

- great circle tracks
- choice of speed and flight level
  - measurement & calculation of IAS, CAS, EAS, TAS, TMN, and GS
- ETOPS considerations

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 groundspeed

(a) review basic track and groundspeed calculations:
- plotted positions, IAS/TAS/GS, HDG/TRK
- determination of wind velocity
  (track and groundspeed methods only)
- calculation of ETAs, EETs

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

(d) typical control panel.

4.7.5 (Item deleted)

4.7.6 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)

4.7.7 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 PERFORMANCE AND PLANNING

(MULTI-ENGINE GAS TURBINE AEROPLANES ABOVE 5700 kg MTOW)

5.1 TAKE-OFF AND LANDING PERFORMANCE

5.1.1 Terminology

Understand and be able to use terms in correct context:

(a) speeds:
- V_1, V_R, V_2
- V_S and derivatives (eg. 1.3 V_S)
- max rate and max angle climb speed
- V_{MCA}, V_{MCG}
- flap retraction speed schedule

(b) distances:
- 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) take-off segments:
- first, second, third and fourth segments

(e) pavement segments:
- LCN, CAN, PCN
- pavement concession
- wheel loading.

5.1.2 Theory - take-off performance

5.1.2.1 Runway

(a) derivation/basis of take-off distance;

(b) derivation/basis of accelerate-stop distance:
- delay factors assumed
- use of reverse thrust

(c) derivation/basis of V_1;

(d) concept of balanced field length;

(e) clearways and stopways:
- function
- effect on V_1
- effect on TOW when runway-limited

(f) V_R and V_2:
- inter-relationship with V_1
- range of acceptable values

(g) allowance for head/tail wind;

(h) allowance for abnormal runway surfaces:
- wet
- standing water/snow
- gravel.

5.1.2.2 Take-off climb

(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
- two-, three- and four-engine aircraft

(e) obstacle clearance requirements:
- take-off area (IMC case only)
- vertical clearance

(f) curved departures:
- point at which turn may commence
- bank angle
- vertical clearance.

5.1.2.3 Take-off weight restrictions

Factors affecting the maximum permissible take-off weight
(a) structural limit;
(b) TODA limit;
(c) ASDA limit;
(d) second-segment climb limit;
(e) effect of different flap settings:
- lift-off speed
- lift-off distance
- second segment performance

(f) effect of increased V_2 ("V_2 overspeed"):
- lift-off speed
- lift-off distance
- second segment climb performance

(g) typical penalties applied for non-standard take-off:
(brief discussion only)
- line-up allowance
  - eg. back-tracking on runway
- use of anti-ice
- non-availability of reverse thrust
- non-availability of anti-skid braking
- non-availability of ground spoilers
- abnormal runway surface

5.1.2.4 Effects of operating technique
(General discussion only)
(a) effects of early or late rotation speed:
- runway distance to lift-off
- vertical clearance at runway end

(b) effects of too-rapid or too-slow rotation rate:
- runway distance to lift-off
- obstacle clearance

(c) possibility of tail-strike or stall with early or rapid rotation.

5.1.2.5 Take-off thrust de-rating
(a) concept of de-rated thrust;
(b) typical restrictions/limitations on use of de-rate;
(c) typical de-rate values.

5.1.3 Practical application - take-off
(a) use typical Operations Manual data to determine either:
- MTOW on given runway; or
- min runway length at given take-off weight

incorporating any or all of the following variables:
- runway slope
- wet runway
- wind component
- temperature
- altitude
- flap setting
- engine type and/or power derate setting
- obstacles of various heights at various distances

(b) use typical Operations Manual data to determine V_1, V_R and V_2.

5.1.4 Theory - landing performance

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

(b) normal/abnormal runway surfaces;
(c) allowance for wind.

5.1.4.2 Approach and touch-down
(a) determination/basis of V_{REF}:
- nominally $1.3V_S$
- typical additives for gust

(b) nominal approach path:
- three-degree slope
- runway aim point (1000 feet from threshold)
- threshold crossing height
- compare with certification landing technique

(c) effect of different flap settings:
- approach speed
- visibility (cockpit cutoff angle)
- low-speed stability
- go-around capability.

5.1.4.3 Flight Path Gradients - landing
(a) net path at 1500 feet above airfield;
(b) missed approach climb:
- configuration
- required gradients
  - two-, three- and four-engine aircraft

(c) landing climb:
- configuration
- required gradients
  - two-, three- and four-engine aircraft

5.1.4.4 Landing weight restrictions
Factors affecting the maximum permissible landing weight
(a) structural limit;
(b) LDA limit;
(c) missed approach climb limit;
(d) landing climb limit;
(e) typical penalties applied for non-standard landing (brief discussion only):
- non-availability of reverse thrust
- non-availability of anti-skid
- non-availability of ground spoilers

(f) abnormal runway surface.

5.1.4.5 Effects of operating technique
(General discussion only)
(a) effect of excessive touchdown speed;
(b) effect of late touchdown:
- prolonged flare/"holding off"

(c) effect of delayed reverse thrust.

5.1.5 Practical application - landing
(a) use typical Operations Manual data to determine either:
- MLW on given runway; or
- min runway length at given landing weight

incorporating any or all of the following variables:
- runway slope
- wet runway
- wind component
- temperature
- altitude
- flap setting

(b) use typical Operations Manual data to determine V_{REF}.

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

5.2 CLIMB, CRUISE AND DESCENT PERFORMANCE

5.2.1 Terminology

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 (ETP)
- ISA and temperature derivatives (eg. ISA+10)

5.2.2 Theory

5.2.2.1 Basis of speed/thrust management

(a) basic theory

- drag (thrust) versus speed
- thrust/speed required for min drag
- thrust/speed required for min fuel consumption
- specific range
- thrust available versus thrust required
  - excess thrust
  - climb speeds
  - best rate of climb
  - best angle of climb

Note: Mathematical derivations are not required, but may be used for illustration if desired. Graphical presentation is recommended.

(b) effect of altitude and temperature variations:

- fuel consumption
- range
- specific range
- rate of climb

5.2.2.2 Effect of operational decisions

(a) factors affecting choice of cruise speed
(general discussion only):

- direct costs
- indirect costs
- scheduled departure/arrival times
- effect on connecting flights
- effects of competition
- making up for delayed departure

(b) selection of cruise schedules:
- economic cruise
- LRC
- use of high speed cruise
- selection of cruise altitude
- performance index for FMS input

(c) selection of descent point:
- fuel used on descent
- fuel used at low level
- effect of early/late descent

(d) engine-out considerations.

5.2.2.3 Enroute flight path gradients

(a) enroute climb gradient:
- two-engine aircraft
- three- and four-engine aircraft

(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.

5.2.3 Practical application

5.2.3.1 Climb

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

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

(b) fuel/distance/time requirements for intermediate level changes.

5.2.3.2 Cruise and descent

Given appropriate initial data, including variations from ISA, use typical Operations 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 airconditioning packs, 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/fuel used on descent.

5.3 WEIGHT AND BALANCE

5.3.1 Terminology

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.

5.3.2 Theory

5.3.2.1 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 overloading on:
- take-off performance
- climb/cruise performance
- aircraft structure

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

5.3.2.2 Load control system

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

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

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

(d) load sheet:
- requirements
- contents.

5.3.3 Practical application

5.3.3.1 Use typical Operations 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 and/or flaps

(b) determine CG limits for take-off, cruise and landing;
(c) determine adjustments (if any) required to fuel or payload to permit operations within the CG envelope.
Note: Passenger load may be presented as block loads (e.g. 24 adults in Zone A, 36 adults and four children in Zone B, etc)

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

5.4 PRACTICAL FLIGHT PLANNING AND FLIGHT MONITORING

Complete a practical flight 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 or landing factors
- calculation of V-speeds and take-off distances

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

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

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

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

(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
- holding
- assisting in search

(g) interpretation of AIP maps and symbols;
(h) interpretation of (given) ATC requirements:
- SID and/or STAR routings
- DME descent steps

(i) calculation of CP, ETP and PNR:
- normal
- engine-out
- depressurised.

6 - METEOROLOGY

Note: 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-

(c) hazards (if any) presented by different types.

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) Cause 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 Ballot's 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.

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 groundspeed
- 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 on runway
  - directional control, especially asymmetric roll control
  - 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's present height
  - tendency to duck under glide path
  - tendency to allow sink rate to increase
- reduction of visibility after flaring.

6.4.2 Fog

(a) Formation of fog:
- mechanism
- pre-requisite 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.

6.6 AIRMASSES AND FRONTS

6.6.1 Properties of an airmass

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

6.6.2 Classification of airmasses

(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 airmasses

(b) boundaries between airmasses:
- 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.

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.

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 discriminate 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) recognise 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 minimise 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.

6.10 UPPER LEVEL WEATHER CHARTS

6.10.1 Presentation of charts

(a) types of charts:
- upper level prognostic charts (brief general discussion only)
- SIGWX charts
- gridpoint wind and temperature forecasts

(b) presentation of data and symbology used in the different charts;
(c) altitudes/mb 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/alternate;
(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

(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

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

6.12.2 Q Codes

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:

- AIP Format for Full Position Report

6.12.4 Satellite observations

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

6.12.5 Australian flight weather documentation

(a) comprehension and interpretation of all weather forecast or report 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 PERFORMANCE AND LIMITATIONS

NOTE: Though a number of physiological aspects of this syllabus have been covered in the Day VFR 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.
7.1.1.2 Oxygen requirement of tissues.
7.1.1.3 Composition of the atmosphere.
7.1.1.4 The gas laws.

7.1.2 The respiratory system and circulation of the blood

7.1.2.1 Inter-relationship of respiration and circulation.
7.1.2.2 Composition and function of the blood.
7.1.2.3 Blood pressure:
(a) control of blood pressure;
(b) hypo- and hypertension;
(c) hemodynamic effects of acceleration.

7.1.2.4 Functional anatomy of the respiratory system
7.1.2.5 Ventilation of the alveolar space, respiratory control.

7.1.2.6 Hypoxia:
(a) definition and causes of hypoxia;
(b) symptoms of oxygen deficiency and treatment;
(c) time of useful consciousness.

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

7.1.3 The pressure cabin

7.1.3.1 Rapid decompression, effects and counter measures.
7.1.3.2 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) mechanisms of perception, constancies, 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 environment;
(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 (perceptive, conductive);
(d) flight-related hazards to hearing: noise-related hearing loss, barotrauma.

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;
(c) visual illusions (the leans, approach and landing problems);
(d) prevention and handling of disorientation.

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;
(c) motor memory;
(d) effects of stress and time of day.

7.3 HUMAN BEHAVIOUR

7.3.1 General Concepts

7.3.1.1 Personality:

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

7.3.1.2 Behaviour and skills:
(a) drives;
(b) learning;
(c) motivation and performance.

7.3.1.3 Human error and reliability:
(a) human error model;
(b) types of errors;
(c) prevention and counter measures;
(d) reliability of human behaviour;
(e) errors induced by external factors (ergonomics, organisations).

7.3.1.4 Working in an automated cockpit:
(a) advantages;
(b) disadvantages;
(c) coping behaviour.

7.3.2 Cockpit management

7.3.2.1 Crew coordination:
(a) distribution of responsibilities;
(b) working with a crew concept.

7.3.2.2 Crew cooperation:
(a) small group dynamics (norms, atmosphere, pressure, communication, structure);
(b) conflict management.

7.3.2.3 Leadership, style of management:
(a) concern for performance;
(b) concern for people;
(c) democratic vs autocratic style;
(d) encouraging inputs and feedback;
(e) optimising of crew performance in flight;
(f) correcting crew coordination deficiencies.

7.3.2.4 Communication:
(a) verbal and non-verbal communication;
(b) one and two-way communication;
(c) effects of different communication styles;
(d) miscommunication (including cultural differences).

7.3.3 Judgement and decision-making

7.3.3.1 Pilot judgement concepts:
(a) types of judgement;
(b) motor skills and human factors.

7.3.3.2 Aeronautical decision-making:
(a) decision-making concepts;
(b) pilot responsibilities;
(c) behavioural aspects.

7.3.3.3 Identification of hazardous attitudes:
(a) physical factors;
(b) psychological factors;
(c) social influences and interface between people.

7.3.3.4 Pilot judgement awareness:
(a) risk assessment;
(b) cockpit stress management.

7.3.3.5 Applying decision-making concepts:
(a) practical application;
(b) managing resources;
(c) safety awareness.

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

7.3.4.1 Causes and symptoms:
(a) gastro intestinal;
(b) cardio-vascular;
(c) side effects of drug and medication;
(d) migraine;
(e) epilepsy;
(f) brain disorders.

7.4.3.2 Recognition: insidious and sudden incapacitation.
7.4.3.3 Procedures for dealing with incapacitation.

7.4.4 Intoxication

7.4.4.1 Tobacco
7.4.4.2 Alcohol
7.4.4.3 Drugs and self medication
7.4.4.4 Various toxic materials.

7.4.5 Body rhythm disturbances

7.4.5.1 The biological clock.

7.4.5.2 Disturbances of circadian rhythms:
(a) causes (shift work, time-zone crossing);
(b) symptoms;
(c) treatment.

7.4.5.3 Sleep:
(a) functions;
(b) patterns;
(c) effects of disturbances and treatment.

7.4.6 Fatigue
7.4.6.1 Definition.
7.4.6.2 Causes.
7.4.6.3 Types and symptoms.
7.4.6.4 Prevention and treatment.

7.4.7 Stress and anxiety
7.4.7.1 Definition of stress.
7.4.7.2 Stress components.
7.4.7.3 Causes, stressors.

7.4.7.4 Coping behaviour:
(a) identifying and reducing stress;
(b) Life Stress Management.

7.4.7.5 Effects on performance.
7.4.7.6 Anxiety
7.4.7.7 Defence mechanisms.
7.4.7.8 Effects of anxiety and defence mechanism.

7.4.8 General health aspects
7.4.8.1 Common minor ailments (colds, influenza, gastro-intestinal upsets).
7.4.8.2 Tropical climates: risk, regulatory aspects.
7.4.8.3 Personal hygiene: oral, external, internal hygiene.
7.4.8.4 Diabetes
7.4.8.5 Hyper/hypotension.
7.4.8.6 Obesitas, lack of exercise.
7.4.8.7 Epidermic diseases.

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.