SECTION 1.7 NAVIGATION (NV)

Unit 1.7.1 PNVC: PPL navigation – all aircraft categories

1. Reserved

2. General navigation

2.1 Form of the earth

2.1.1 Describe:

(a) the shape and rotation of the earth;

(b) latitude, longitude;

(c) the difference between true and magnetic north;

(d) how distance and direction are measured and applied to navigation;

(e) magnetic variation and compass deviation;

(f) the relationship between magnetic heading, relative heading and magnetic bearing.

2.2 Time

2.2.1 Explain the terms UTC, local mean time, local (standard) time, local summer time.

2.2.2 Determine within +/- 5 min the beginning and end of civil twilight from AIP daylight and darkness graphs.

2.2.3 Complete conversions between LMT, UTC, local (standard) times, including local summer time.

2.2.4 List factors which may cause daylight to end earlier than the time extracted from AIP darkness graphs.

2.3 Basics – Extract information from documents

2.3.1 On a WAC and AIP 'visual' charts (if applicable) which cover the local area of operation:

(a) identify, without reference to the chart legend:

(i) major features to assist in map reading, for example, roads, rivers, lakes;

(ii) obstacles and spot heights, including elevation or height above terrain;

(iii) CTA, PRDs, and aerodrome data on VTC/ERC (if applicable);

(b) decode other symbols with reference to the chart legend;

(c) assess the general height of the terrain from hypsometric tints and contours;

(d) estimate track and distance;

(e) demonstrate and explain the reason for chart orientation in flight.

2.3.2 On visual AIP charts identify airspace boundaries and symbols with reference to the chart legend.

2.3.3 Use ERSA to extract:

(a) runway data;

(b) data pertaining to prohibited, restricted and danger areas.

2.4 Computation techniques

2.4.1 Use mental rules of thumb to estimate:

(a) time interval using estimated GS and distance, for example, 120 kt = 2 nm/min;

(b) endurance given fuel flow and fuel available (excluding reserve fuel).

2.4.2 Apply magnetic variation to obtain magnetic direction.

2.4.3 Carry out conversions between:

(a) feet/metres;

(b) nm/km;

(c) lbs/kg;

(d) US gal/litres/kg of avgas.

2.4.4 Calculate headwind, tailwind and cross-wind components given W/V and HDG using:

(a) a navigation computer; and

(b) conversion and wind component tables in ERSA.

2.4.5 Calculate the following:

(a) CAS and TAS given air temperature and pressure height;

(b) HDG, GS and drift given TAS, W/V, TR;

(c) TR given HDG, TAS, W/V;

(d) climb and decent rates and gradients;

(e) TOPC and TOPD positions using average airspeed, W/V and rates of climb and descent.

2.5 Pilot navigation

2.5.1 Principles of map reading:

(a) describe the method of chart orientation; and

(b) list situations when a pilot should read:

(i) from map to ground; and

(ii) from ground to map; and

(c) select appropriate position lines to establish:

(i) ground speed; and

(ii) track error; and

(iii) a fix; and

(d) select appropriate ground features to establish position when flying:

(i) at low level (500 ft AGL); and

(ii) between (approximately) 2,000 and 10,000 ft; and

(iii) over mountainous terrain, coastal areas, densely populated and sparsely populated areas.

2.5.2 Chart preparation and selection (practice):

(a) draw tracks, track error lines, time/distance markings; and

(b) given a route – select WAC(s) and appropriate AIP ‘visual charts’.

2.5.3 With reference to a planned or given track and given appropriate data:

(a) determine track made good (TMG); and

(b) calculate drift; and

(c) determine alteration of heading or HDG(M) to:

(i) parallel track; and

(ii) intercept track at a nominated point; and

(iii) maintain track once track is intercepted; and

(d) revise/confirm estimates or ETA using latest ground speed or time/distance proportion; and

(e) establish a DR position using latest TR and GS; and

(f) using a map plotter, employ mental dead reckoning and proportional techniques to solve inflight navigational problems, including:

(i) mentally apply the 1 in 60 rule; and

(ii) mentally revise estimates/ETA’s; and

(iii) estimate TR and ETI to a selected diversion point.

2.6 Radio navigation aids

2.6.1 Extract NDB and VOR information from ERSA or ERC and state the rated coverage of a VOR up to 10,000 ft.

2.7 Area navigation systems

2.7.1 Types of systems:

(a) external sensor systems:

(i) VOR/DME;

(ii) GNSS.

2.7.2 General principles:

(a) inputs required:

(i) air data inputs;

(ii) other inputs;

(b) outputs generated:

(i) types of outputs;

(ii) uses.

2.7.3 RNAV systems:

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

(b) advantages and disadvantages;

(c) limitations and restrictions:

(i) errors, accuracy, reliability;

(ii) coverage;

(iii) range.

(d) typical control panel.

2.7.4 Reserved:

2.7.5 Satellite navigation systems:

(a) principle of GNSS navigation:

(i) elements of GNSS (for example, GPS, GLONASS);

(b) advantages and disadvantages;

(c) limitations and restrictions:

(i) errors, accuracy, reliability;

(ii) coverage;

(iii) range;

(d) typical control panel;

(e) approvals for IFR Navigation;

(f) GNSS system enhancements (for example, DGNSS, GLS, WAAS).

2.7.6 Updating area navigation systems:

(a) need for updating position;

(b) requirements for updating:

(i) manual inserting;

(ii) automatic updating;

(iii) inhibiting updating;

(c) common indications when system updates position.

Unit 1.7.2 CNVC: CPL navigation – all aircraft categories

1. Reserved

2. Navigation

2.1 Form of the earth

2.1.1 Explain the following terms listed in (a) to (g):

(a) the shape and rotation of the earth; and

(b) latitude, longitude; and

(c) equator, Greenwich meridian; and

(d) great circles, small circles, rhumb lines; and

(e) difference between true and magnetic north; and

(f) terrestrial magnetism, magnetic variation and the change in variation with time; and

(g) distance on the earth i.e. relationship between a minute of latitude and a nautical mile; and, if applicable, their effect on:

(i) position on the earth; and

(ii) time differences; and

(iii) distance and direction.

2.2 Time

2.2.1 Explain the terms UTC, local mean time, local (standard) time, local summer time.

2.2.2 Determine within +/- 5 min the beginning and end of civil twilight from AIP daylight and darkness graphs.

2.2.3 Complete conversions between:

(a) LMT, UTC, local (standard) times, including local summer time.

2.2.4 List factors which may cause daylight to end earlier than the time extracted from AIP darkness graphs.

2.2.5 Describe the effect of the earth's rotation and revolution around the sun on the:

(a) beginning and end of daylight;

(b) period of daylight.

2.2.6 Describe the effect of changes in longitude on Local Mean Time.

2.3 Charts and publications

2.3.1 From:

(a) AIP visual charts, that is ERC, VTC and AUS PCA, including any subsequent changes to charts required for flight under VFR; and

(b) ERSA;

select the chart(s) or document(s) which contain information about a given item of operational significance.

2.3.2 Decode symbols and apply information displayed on AIP visual charts.

2.3.3 Interpret topographic detail and decode symbols displayed on a WAC and VTC.

2.3.4 On WAC and AIP visual charts using chart and latitude scale:

(a) estimate tracks and distances; and

(b) measure rhumb line track; and

(c) measure distance; and

(d) plot a position given:

(i) latitude and longitude; and

(ii) bearing and distance.

2.3.5 Describe the different kinds of map projections used in aviation and:

(a) identify the following properties of a Lamberts Conformal:

(i) appearance of rhumb lines, great circles, meridians and the graticule;

(ii) distortion of shapes and areas;

(iii) scale variation;

(b) describe the methods of representing scale.

2.4 Computations

2.4.1 Review computations and conversions and:

(a) solve GS, distance, fuel used, fuel required, fuel remaining and fuel consumption problems, given appropriate combinations of these factors; and

(b) solve CAS/TAS problems given air temperature and pressure height; and

(c) determine HDG, GS and drift given TAS, W/V, TR; and

(d) determine TR given HDG, TAS, W/V; and

(e) solve problems relating to rates/gradients of climb and descent; and

(f) determine TOPC and TOPD position using average airspeed, W/V, and rates of climb/descent.

2.5 Pilot navigation

2.5.1 Principles of map reading:

(a) describe the method of chart orientation; and

(b) list situations when a pilot should read:

(i) from map to ground; and

(ii) from ground to map; and

(c) select appropriate position lines to establish:

(i) ground speed; and

(ii) track error; and

(iii) a fix; and

(d) select appropriate ground features to establish position when flying:

(i) at low level (500 ft AGL); and

(ii) between (approximately) 2,000 and 10,000 ft; and

(iii) over mountainous terrain, coastal areas, densely populated and sparsely populated areas.

2.5.2 Chart preparation and selection (practice):

(a) draw tracks, track error lines, time/distance markings; and

(b) given a route – select WAC(s) and appropriate AIP ‘visual charts’.

2.5.3 With reference to a planned or given track and given appropriate data:

(a) determine track made good (TMG); and

(b) calculate drift; and

(c) determine alteration of heading or HDG(M) to:

(i) parallel track; and

(ii) intercept track at a nominated point; and

(iii) maintain track once track is intercepted; and

(d) revise/confirm estimates or ETA using latest ground speed or time/distance proportion; and

(e) establish a DR position using latest TR and GS; and

(f) using a map plotter, employ mental dead reckoning and proportional techniques to solve inflight navigational problems, including:

(i) mentally apply the 1 in 60 rule; and

(ii) mentally revise estimates/ETA's; and

(iii) estimate TR and ETI to a selected diversion point.

2.6 Radio navigation aids

2.6.1 Describe how to identify an aid and state the frequency of a nominated NDB or VOR.

2.6.2 Extract NDB and VOR information from ERSA or ERC and state the rated coverage of a VOR up to 10,000 ft.

2.6.3 State the effect (in Australia) of the following errors on the reliability of ADF cockpit indications:

(a) co-channel interference;

(b) mountain effect;

(c) effect of thunderstorms;

(d) coastal refraction.

2.6.4 Explain why information pertaining to broadcasting stations is included in ERSA.

2.6.5 Recall the 'aggregate' error of a VOR and explain what is meant by 'scalloping'.

2.6.6 Establish a position line given:

(a) HDG and ADF data; and

(b) VOR indications.

2.6.7 Describe how to use the VOR to determine TR to or from a station.

2.6.8 Describe how to use an ADF or VOR to home to a station, and recognise instrument indications that signify station passage.

2.6.9 Establish fixes and use these fixes to make off-track corrections using a DME distance and the following:

(a) HDG and ADF data; or

(b) VOR indications.

Unit 1.7.3 ANVC: ATPL navigation – all aircraft categories

1. Reserved

2. Advanced navigation

2.1 Navigation charts

2.1.1 Lambert Conformal Conic Projection:

(a) review properties:

(i) great circles, rhumb lines, rules lines;

(ii) scales, chart convergence;

(b) brief comparison with properties of other projections:

(i) Mercator;

(ii) Polar sterographic.

2.1.2 Use of AIP (MAP) charts.

2.2 Time zones

(a) brief review:

(i) time zones, date line;

(ii) LMT, LST, UTC;

(iii) conversion from LMT/LST to UTC and vice versa;

(b) practical examples of LST arrival/departure calculations for flights across time zones:

(i) with and without date line involvement.

2.3 Flight instruments

2.3.1 Air data instruments:

(a) review of altimeter, ASI, VSI, IVSI and Machmeter:

(i) principles of operation;

(ii) errors;

(iii) relationship between IAS, CAS, EAS, TAS and TMN;

(b) modern instrumentation:

(i) integrated displays;

(ii) EFIS;

(iii) standby instruments.

2.3.2 Air data computer (ADC):

(a) principles of operation;

(b) input and output data;

(c) uses of output data.

2.3.3 Gyroscopic principles:

(a) rigidity, precession:

(i) real and apparent precession;

(ii) correcting for precession;

(b) types of gyros in common use:

(i) mechanical;

(ii) laser gyros;

(c) gyro platforms:

(i) two- and three-dimensional stability;

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

2.4 Compasses

2.4.1 Direct reading compass:

(a) principle of operation and errors;

(b) advantages and disadvantages.

2.4.2 Slaved gyro-stabilised compass:

(a) principles of operation;

(b) errors;

(c) advantages and disadvantages;

(d) uses of output data.

2.4.3 Inertial heading:

(a) use of a gyro platform to compute true heading:

(i) principles;

(ii) significance of initial positions insert;

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

2.5 Radiowave propagation

2.5.1 Terminology:

(a) understand general principles of radio propagation;

(b) understand and be able to use in correct sense:

(i) wavelength;

(ii) amplitude;

(iii) frequency;

(iv) phase angle;

(v) frequency bands;

(vi) the following sidebands:

(A) SSB;

(B) LSB;

(C) USB;

(vii) carrier;

(viii) modulation, including the following:

(A) amplitude;

(B) frequency;

(C) pulse;

(D) multiplex;

(ix) demodulation.

2.5.2 Wave propagation:

(a) groundwaves, space (direct) waves, skywaves;

(b) propagation within the frequency bands;

(c) factors affecting reception:

(i) fading;

(ii) static;

(d) use of HF for communications:

(i) frequency prognosis;

(ii) SELCAL.

2.5.3 Antennas:

(a) function/purpose of antennas;

(b) types of antennas in common use for aircraft:
  (i) uses;
  (ii) characteristics (outline only):
    (A) directionality;
    (B) polarisation.

2.6 Radio NavAids

2.6.1 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.

2.6.2 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.

2.6.3 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.

2.6.4 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.

2.6.5 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.

2.7 Route navigation

2.7.1 Route selection:

(a) great circle tracks;

(b) choice of speed and flight level;

(c) ETOPS considerations.

2.7.2 Navigation on climb and descent:

(a) wind and temperature variations:

(i) desirability of allowing for variations;

(ii) availability of data in actual situations.

(b) weather/traffic avoidance:

(i) concept of track miles.

(c) allowance for use of anti-ice equipment:

(i) reduced rate of climb;

(ii) reduced rate of descent.

2.7.3 Use of radio NavAids:

(a) requirement for regular position fixing;

(b) use of navaid position lines to establish position:

(i) along track;

(ii) across track;

(iii) desired/preferred form of P/L intersections;

(c) computer-controlled navaid receivers:

(i) auto-tuning;

(ii) manual selection;

(iii) precautions.

2.7.4 Calculation of track and groundspeed:

(a) review basic track and groundspeed calculations:

(i) plotted positions, IAS/TAS/GS, HDG/TRK;

(ii) determination of wind velocity (track and groundspeed methods only);

(iii) calculation of ETAs, EETs;

(b) review ETP and PNR calculations;

(c) inflight diversion to fixed point:

(i) last PSD;

(ii) time and fuel required.

2.8 Basic radar principles

2.8.1 Pulse techniques and associated terminology.

2.8.2 Ground radar:

(a) coverage of ATC radars, factors affecting range and accuracy;

(b) facilities provided by Met radars for storm warning and avoidance.

2.8.3 Airborne weather radar:

(a) principles;

(b) types;

(c) presentation and interpretation;

(d) factors affecting range and accuracy.

2.8.4 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.

2.8.5 Radio altimeter:

(a) principle of operation;

(b) display;

(c) accuracy, errors.

2.9 Area navigation systems

2.9.1 Type of systems

(a) Self-contained on-board systems including the following;

(i) INS;

(ii) DOPPLER;

(b) External sensor systems including the following:

(i) VOR and DME;

(ii) GNSS.

2.9.2 General principles:

(a) inputs required:

(i) air data inputs;

(ii) other inputs;

(b) outputs generated:

(i) types of outputs;

(ii) uses.

2.9.3 RNAV systems:

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

(b) advantages and disadvantages;

(c) limitations and restrictions:

(i) errors, accuracy, reliability;

(ii) coverage;

(iii) range.

(d) typical control panel.

2.9.4 Reserved:

2.9.5 Satellite navigation systems:

(a) principle of GNSS navigation:

(i) elements of GNSS (for example, GPS, GLONASS);

(b) advantages and disadvantages;

(c) limitations and restrictions:

(i) errors, accuracy, reliability;

(ii) coverage;

(iii) range;

(d) typical control panel;

(e) approvals for IFR Navigation;

(f) GNSS system enhancements (for example, DGNSS, GLS, WAAS).

2.9.6 Updating area navigation systems:

(a) need for updating position;

(b) requirements for updating:

(i) manual inserting;

(ii) automatic updating;

(iii) inhibiting updating;

(a) common indications when system updates position.

Unit 1.7.4 ANVA: ATPL navigation – aeroplane – *Reserved*

Unit 1.7.5 ANVH: ATPL navigation – helicopter – *Reserved*