Revision 32 Effective 26 June 2018

Subject No. 20 CPL Meteorology

Notes: This syllabus is principally based on the regional meteorology as applicable to flying a twin engine aircraft IFR, within the South Pacific region at or below FL 250.

Detailed acronyms and service provider titles (e.g. SKC, METAR AUTO) are indicative of the <u>area of knowledge</u> required and do not limit the syllabus to those specifically listed.

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on knowledge deficiency reports and will provide valuable feedback to the examination candidate. These reference numbers are common across the subject levels and therefore may not be consecutive.

This syllabus presupposes a thorough knowledge and understanding of the PPL Meteorology syllabus. Any item repeated here indicates a higher level of understanding or a wider scope is required.

20.2 Regional Meteorological Services, Reports and Forecasts

20.2.2 Explain in plain language the coded or pictorial information contained in:

(a) GRAFOR;

(b) ROFOR;

(c) METAR;

(d) SPECI;

(e) METAR AUTO;

(f) TREND;

(g) TAF;

(h) SIGMET;

(i) ATIS;

(j) AWIB;

(k) BWR;

(l) VAA;

(m) PIREP;

(n) AIREP;

(o) AAW;

(p) GSM;

(q) GNZSIGWX;

(r) medium-level SIGWX;

(s) wind/temp charts.

20.2.4 Determine whether a particular meteorological product in para 20.2.2 (a) to (s) is valid for a flight.

20.2.6 Apply the information contained in the reports and charts in para 20.2.2 (a) to (s) to planning and conducting a flight.

20.2.8 Given a typical weather briefing, evaluate weather information applicable to the flight, and:

(a) assess likely changes (either improving or deteriorating) in weather during the flight;

(b) identify phenomena which may adversely affect the flight.

20.4 Weather Maps

20.4.2 State the difference between analysis and prognosis charts.

20.4.4 Describe the general weather feature or conditions associated with each of the following pressure systems:

(a) isobars;

(b) depression (or “low”);

(c) tropical cyclone (or “hurricane” or “typhoon”);

(d) trough of low pressure;

(e) anticyclone (or “high”);

(f) ridge of high pressure;

(g) col.

20.4.6 Describe the general flying conditions associated with:

(a) cold fronts;

(b) warm fronts;

(c) occluded fronts;

(d) stationary fronts.

20.4.8 Describe typical wind speeds and directions ahead of and behind these fronts in mid-latitudes.

20.4.10 Explain how subsidence and ascent of air influences the type of weather commonly associated with pressure systems.

20.4.12 Identify the general direction of movement of pressure systems in the mid-latitudes of the Southern Hemisphere.

20.4.14 Define the “westerly index” over New Zealand.

20.4.16 Identify ‘high’ and ‘low’ westerly indices on weather maps.

20.4.18 Explain the weather distribution across New Zealand in high and low westerly index situations.

20.4.20 Describe the significance of high and low westerly index situations across New Zealand to aviation.

20.4.22 Assess and interpret information presented on mean sea level analysis and prognosis weather charts covering the Southwest Pacific region.

20.6 The Atmosphere

20.6.2 Define the terms:

(a) troposphere;

(b) tropopause;

(c) stratosphere.

20.6.4 Explain how the following changes within the tropospheric column affect the height of the tropopause:

(a) surface pressure;

(b) temperature.

20.6.6 State the average tropopause heights and tropopause temperatures at:

(a) the equator;

(b) the poles;

(c) in mid-latitudes.

20.6.8 Explain:

(a) the sources of aerosols within the atmosphere;

(b) the effects of aerosols within the atmosphere;

(c) the importance of aerosols within the atmosphere.

20.6.10 In general terms, describe the effect of increasing height and/or latitude on water vapour and aerosol content within the atmosphere.

20.6.12 Explain the effects on temperature within the atmosphere due to:

(a) water vapour;

(b) carbon dioxide;

(c) ozone.

20.8 Temperature and Heat Exchange Processes

20.8.2 Describe the temperature reference points of the centigrade scale used in New Zealand aviation.

20.8.4 Explain the factors that influence the amount of solar radiation received at the earth's surface.

20.8.6 Explain the warming or cooling of the atmosphere with reference to solar and terrestrial radiation.

20.8.8 Describe the following:

(a) conduction;

(b) convection;

(c) advection.

20.8.10 Explain how the atmosphere is warmed or cooled by:

(a) conduction;

(b) convection;

(c) advection.

20.8.12 Define the term 'specific heat'.

20.8.14 Define the term 'albedo'.

20.8.16 Explain the significance in terms of heating at the earth's surface of:

(a) specific heat;

(b) albedo;

(c) insolation.

20.10 Pressure and Density

20.10.2 Explain what is meant by the 'partial pressure' of a gas.

20.10.4 Explain the significance of air pressure with reference to:

(a) barometric tendency;

(b) altimetry.

20.10.6 Explain the effects of temperature changes within the troposphere on the pressure lapse rates.

20.10.8 Define ‘pressure gradient’.

20.10.10 Identify strong and weak pressure gradients on a weather map.

20.10.12 Given examples of ambient temperature at a stated altitude, calculate:

- (a) the ISA temperature at that altitude;
- (b) the ISA height at that temperature.

20.10.14 Define:

- (a) QFE;
- (b) QNH;
- (c) QNE;
- (d) pressure altitude;
- (e) flight levels (FL).

20.10.16 Describe:

- (a) QNE;
- (b) pressure altitude;
- (c) flight levels (FL).

20.10.18 Define the transition layer (as it applies in New Zealand), with reference to the:

- (a) transition altitude;
- (b) transition level;
- (c) exceptions that apply to (a) and (b) above.

20.10.20 Explain why transition layers in other countries are found at lower or higher levels in the atmosphere.

20.10.22 Define ‘elevation’.

20.10.24 Explain what happens to an aircraft’s flight profile when the altimeter sub-scale is not reset during flights between areas with differing MSL pressures.

20.10.26 Describe how localised pressure changes occur in association with:

- (a) lee troughs;
- (b) thermal (or ‘heat’) lows;
- (c) thunderstorms.

20.10.28 Describe ‘diurnal’ pressure variations.

20.10.30 State the latitudes where diurnal pressure variation is most significant.

20.10.32 Explain the effects of changes in the following elements on air density:

(a) pressure;

(b) temperature;

(c) altitude;

(d) moisture content of the air.

20.10.34 Define ‘density altitude’ (DA).

20.10.36 Calculate ‘density altitude’.

20.12 Wind

20.12.2 Describe the effect of the Coriolis force on moving air.

20.12.4 State the horizontal component of the Coriolis force equation.

20.12.6 State the:

(a) changes in the magnitude of Coriolis force with latitude;

(b) relationship between the wind speed and the Coriolis force;

(c) direction of the Coriolis force relative to the wind direction in the Southern Hemisphere.

20.12.8 Define the ‘geostrophic wind’ in the Southern Hemisphere.

20.12.10 Describe the ‘geostrophic wind’ in the Southern Hemisphere.

20.12.12 Describe the ‘gradient wind’ in the Southern Hemisphere with respect:

(a) anticyclonically curved isobars;

(b) cyclonically curved isobars.

20.12.14 Describe the ‘frictional wind balance’.

20.12.16 State typical wind direction deflections due to friction over:

(a) the sea;

(b) flat to undulating ground;

(c) mountainous regions.

20.12.18 Explain how the following affect the depth of the friction layer:

(a) atmospheric stability;

(b) wind strength;

(c) surface roughness.

20.14 Local Winds – New Zealand and the South Pacific

20.14.2 Describe the general characteristics of a mountain wave set-up with reference to:

(a) wave-lengths;

(b) position and rotation of any possible rotor zones;

(c) position and type of any possible cloud development;

(d) the heights of the friction layer;

(e) areas of probable severe turbulence;

(f) areas of possible severe airframe icing.

20.14.4 With reference to mountain waves:

(a) explain the factors that affect the wave amplitude;

(b) explain the factors that affect the wave-length;

(c) describe the flight conditions associated with mountain waves.

20.14.6 Explain the rotor streaming process.

20.14.8 Describe the flight conditions associated with rotor streaming.

20.14.10 Define the Föhn wind.

20.14.12 State the requirements for the development of a Föhn wind.

20.14.22 Describe the flight conditions when flying in Föhn conditions in the following positions:

(a) to windward of the mountain range;

(b) over the mountain range;

(c) on the lee side of the mountain range.

20.14.24 Describe the development of sea breezes about the islands of the sub-tropical SW Pacific.

20.14.26 Describe the south-east trade winds about the islands of the sub-tropical SW Pacific.

20.14.28 Describe:

(a) a katabatic wind;

(b) an anabatic wind.

20.14.30 Describe the conditions that support the development of:

(a) katabatic winds;

(b) anabatic winds.

20.16 Water Vapour

20.16.2 Explain the sources of water vapour in the atmosphere.

20.16.4 Describe 'vapour pressure' and 'saturation vapour pressure'.

20.16.6 Define 'latent heat'.

20.16.8 Describe the condensation process.

20.16.10 Describe the freezing and melting processes with reference to latent heat.

20.16.12 Describe the diurnal variation of relative humidity and dew point.

20.16.14 Describe the effects of moisture content on the density of the air.

20.18 Atmospheric Stability

20.18.2 Explain how atmospheric stability is determined.

20.18.4 Given plotted graphs of temperature (ELR) versus height, identify and describe:

(a) super-adiabatic temperature lapse-rates (steep ELRs);

(b) inversions and isothermal layers (shallow ELRs).

20.18.6 Calculate atmospheric stability by lifting parcels of air given assumed ELR's, dew point temperatures and mountain heights.

20.18.8 Describe the typical diurnal variation of stability.

20.22 Cloud

20.22.2 Describe the relationship between stability of air and cloud type.

20.22.4 List the vertical extents of the three main cloud layers in:

(a) mid-latitudes;

(b) tropical latitudes.

20.22.6 State the difference between the Lifting Condensation Level (LCL) and the Convective Condensation Level (CCL).

20.22.8 Demonstrate the use of simple formulae to calculate the LCL and CCL.

20.22.10 Describe the 10 main cloud types as defined by the WMO.

20.22.12 Describe typical conditions for each of the 10 main cloud types with respect to:

(a) turbulence;

(b) icing;

(c) precipitation.

20.22.14 Identify the following cloud sub-sets and outline the atmospheric conditions indicated by each:

(a) Asperitas;

(b) Mammatus;

(c) Altocumulus Lenticularis;

(d) Rotor Cloud;

(e) Kelvin Helmholtz waves;

(f) Altocumulus Castellanus;

(g) Banner cloud.

20.22.16 Explain the cloud dispersal processes of:

(a) direct warming;

(b) sinking of air;

(c) mixing with clear air.

20.24 Precipitation

20.24.2 Describe the Bergeron theory of rainfall development.

20.24.4 Describe the Coalescence theory of rainfall development.

20.24.6 List the factors that affect the fall rate of water droplets.

20.26 Visibility and Fog

20.26.2 Define runway visual range (RVR).

20.26.4 Explain the effect of altitude on visibility.

20.26.6 State the difference between fog, mist and haze.

20.26.8 Describe the principle of formation of radiation and advection fog with respect to:

(a) required meteorological conditions;

(b) factors affecting the extent of the fog;

(c) factors affecting the timing of the fog;

(d) factors affecting the dispersal of the fog.

20.28 Aircraft Icing

20.28.2 Define ‘super-cooled water droplets’.

20.28.4 Describe the formation process of:

(a) clear (glaze) ice;

(b) rime (opaque) ice;

(c) mixed ice;

(d) hoar frost;

(e) freezing rain.

20.28.6 With reference to clear, rime and mixed ice, describe the following:

(a) associated cloud types;

(b) temperature ranges;

(c) droplet size;

(d) height range relative to the freezing level;

(e) enhancing factors.

20.28.8 Explain the factors that influence the rate of ice accretion.

20.28.10 Describe the hazards of airframe icing to aircraft in flight.

20.28.12 List the intensity classifications of icing.

20.28.14 Describe the effect of different intensity classifications of icing on aircraft.

20.28.16 Explain methods of avoiding or mitigating airframe icing.

20.30 Thunderstorms

20.30.2 Describe the conditions required for the development of thunderstorms.

20.30.4 Describe the characteristics and development of:

(a) convective localised (stationary) thunderstorms;

(b) convective traveling thunderstorms;

(c) orographic thunderstorms;

(d) nocturnal tropical thunderstorms;

(e) frontal and convergence-type thunderstorms;

(f) surface trough and upper trough thunderstorms;

(g) warm front embedded thunderstorms.

20.30.6 With reference to flight in and around thunderstorms, describe the development, severity, and areas where the following are likely to be encountered:

(a) turbulence;

(b) icing;

(c) microbursts;

(d) first gust (or gust front);

(e) electrical phenomena;

(f) tornadoes (if any);

(g) hail;

(h) poor visibility.

20.30.8 Describe the characteristics of multi-cell thunderstorms.

20.30.10 Describe the use of radar to identify thunderstorms.

20.30.12 Explain the precautions that can be taken by pilots to avoid or minimise the effects of flying in the vicinity of thunderstorms.

20.34 AnticyClones

20.34.2 Describe anticyclones (‘highs’) with reference to:

(a) their formation processes;

(b) pressure patterns and wind flow;

(c) subsidence and subsidence inversions;

(d) typical associated weather conditions.

20.34.4 Describe the development of ‘cold’ highs.

20.34.6 Discuss the hazards associated with anticyclones.

20.36 Fronts and Depressions

20.36.2 Describe in terms of air-mass movement, the development of:

(a) cold fronts;

(b) warm fronts (warm sectors).

20.36.4 Describe:

(a) the wind and weather sequence associated with cold and warm fronts;

(b) the general movement of fronts and pressure systems across NZ.

20.36.6 Outline the characteristics of occluded and stationary fronts.

20.36.8 Outline the characteristics of:

(a) mid to high-latitude depressions ('lows');

(b) sub-tropical depressions;

(c) tropical cyclones.

20.36.10 Describe the development and the aspects of importance to aviation of:

(a) lee depressions;

(b) thermal lows;

(c) depressions crossing a mountain barrier.

20.40 Turbulence

20.40.2 Describe the four main formation mechanisms for turbulence:

(a) convection;

(b) mechanical processes;

(c) clear air turbulence (CAT);

(d) wake turbulence.

20.40.4 Describe the effects of the following enhancing factors on 20.40.2 (a), (b) and (c) from:

(a) atmospheric stability;

(b) surface roughness;

(c) wind speed/direction;

(d) vertical wind-shear.

20.40.6 Describe the cause(s) and factors involved with the effects of low-level wind-shear due to:

(a) surface friction;

(b) thunderstorms;

(c) temperature inversions;

(d) frontal activity;

(e) wake turbulence from fixed and rotary winged aircraft.

20.40.8 Describe the techniques used to avoid or minimize the effects of low-level wind-shear.

20.40.10 Describe, in accordance with the ICAO definitions, the characteristics of:

(a) light turbulence;

(b) moderate turbulence;

(c) severe turbulence.

20.42 Other Hazardous Meteorological Conditions

20.42.2 Explain the methods by which the aviation community is advised of volcanic eruptions within the New Zealand FIR.

20.42.4 Explain the hazards to aviation of volcanic ash encountered:

(a) in flight;

(b) during the take-off and landing phases on an ash contaminated runway.

20.42.6 Explain the development of, and the hazards associated with, flight in the following conditions:

(a) duststorms;

(b) blowing surface snow (blizzards);

(c) whiteout (visual illusion type).

20.46 The General Circulation

20.46.2 Explain what is meant by ‘the general circulation’.

20.46.4 Based on a diagram of the ‘general circulation’, explain why the following global weather features exist:

(a) polar highs;

(b) polar easterlies;

(c) polar lows;

(d) polar fronts;

(e) mid-latitude westerlies;

(f) mid-latitude anticyclones;

(g) sub-tropical trade winds;

(h) the equatorial trough.

20.48 Tropical Meteorology

20.48.2 State the approximate latitude limits of the tropics.

20.48.4 Describe the 'Hadley cell'.

20.48.6 Describe what is meant by:

(a) horse latitudes;

(b) doldrums.

20.48.8 Describe the equatorial trough and the inter-tropical convergence zone (ITCZ).

20.48.10 State the:

(a) seasonal location of the equatorial trough and ITCZ;

(b) typical low and mid-level weather in an active and inactive ITCZ.

20.48.12 Explain the origin and common location of the South Pacific Convergence Zone (SPCZ).

20.48.14 Describe weather associated with the SPCZ.

20.48.16 With regard to the Trade Winds, describe the:

(a) mechanisms that drive the Trade Winds;

(b) approximate latitudinal and vertical limits;

(c) seasonal location and direction;

(d) commonly associated weather;

(e) winds and weather usually experienced above the Trade Winds;

(f) topographical influences on the Trade Winds.

20.48.18 Define 'monsoon'.

20.48.20 Describe the mechanisms involved with regard to wet monsoons.

20.48.22 State the seasons during which the Australian monsoons occur.

20.48.24 Describe the requirements for the formation and development of tropical cyclones.

20.48.26 Describe the weather conditions associated with tropical cyclones.

20.48.28 Explain the factors causing:

(a) El Niño events;

(b) La Niña events.

20.48.30 Describe how El Niño and La Niña events influence the weather in New Zealand.

20.50 Satellite and Radar Imagery

20.50.2 With respect to NZ IFR operations, using given examples of satellite imagery, identify the following:

(a) areas of stable and unstable air;

(b) the processes causing each significant area or mass of cloud;

(c) likely cloud types and weather associated with each significant area of cloud.

20.50.4 With respect to NZ IFR operations, interpret radar imagery in terms of:

(a) precipitation types and intensity causing the radar echo;

(b) likely cloud types associated with the precipitation echo;

(c) speed of movement and timing of radar echoes, and the expected impact at given locations.