Subject No. 8 PPL Meteorology

Note: *This syllabus is principally based on the meteorology as applicable to flying a single piston-engine general aviation type aeroplane or helicopter, within New Zealand at altitudes at or below 13,000 feet.*

Detailed acronyms and service provider titles (e.g. SKC, MetService) are indicative of the area of knowledge required and do not limit this 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.

8.2 Decode Domestic Meteorological Reports and Forecasts

8.2.2 Demonstrate how to access aviation meteorological information for New Zealand through the MetFlight internet website.

8.2.4 In plain language, decode the information contained in the following forecasts and reports:

(a) GRAFOR;

(b) TAF;

(c) TREND;

(d) METAR;

(e) SPECI;

(f) METAR AUTO;

(g) SIGMET;

(h) ATIS;

(i) AWIB;

(j) BWR;

(k) Pilot Reports;

(l) AAW;

(m) GSM;

(n) GNZSIGWX.

8.4 Weather Maps

8.4.2 Identify the following features found on surface weather maps:

(a) isobars;

(b) anticyclone (“high”);

(c) depression (“low” or “cyclone”);

(d) ridge of high pressure;

(e) trough of low pressure;

(f) col;

(g) fronts (cold, warm (warm sectors), occluded and stationary);

(h) tropical cyclones.

8.4.4 Explain the most common weather characteristics of each feature.

8.4.6 Define pressure gradient.

8.4.8 Identify areas of light, moderate and strong winds on a weather map.

8.6 The Atmosphere

8.6.2 Describe the structure of the troposphere and lower stratosphere.

8.6.4 Outline the characteristics of the troposphere in terms of:

(a) horizontal and vertical motions;

(b) vertical variation of density;

(c) vertical variation of temperature;

(d) depth.

8.6.6 List the percentages of the following gases in the troposphere:

(a) nitrogen;

(b) oxygen;

(c) all other trace gases combined.

8.6.8 Describe the presence and importance of the following in the atmosphere:

(a) water vapour;

(b) aerosols.

8.8 Temperature and Heat Exchange Processes

8.8.2 Outline the measurement of surface air temperature in New Zealand (as reported in aviation observations), and relate that to actual temperatures experienced above a sealed or grass runway.

8.8.4 Define solar and terrestrial radiation.

8.8.6 Outline the balance of incoming solar radiation versus outgoing terrestrial radiation.

8.8.8 Explain the effect of solar and terrestrial radiation on the daily temperature range.

8.8.10 Describe the effect of the following on daily air temperature:

(a) latitude;

(b) season;

(c) strong winds;

(d) wind direction;

(e) cloud cover;

(f) coastal or inland location;

(g) surface type.

8.8.12 Describe the transfer of heat in the atmosphere with reference to the processes of:

(a) conduction;

(b) convection;

(c) advection.

8.10 Atmospheric Pressure and Density

8.10.2 Define ‘atmospheric pressure’.

8.10.4 State the pressure units used in New Zealand aviation.

8.10.6 State the significance of air pressure to aviation.

8.10.8 Define ‘pressure lapse rate’.

8.10.10 State the approximate pressure lapse rate in the atmosphere below 10,000ft.

8.10.12 Explain how surface pressure rises when air is added to the vertical column above the ground, and vice versa.

8.10.14 Define the International Standard Atmosphere (ISA).

8.10.16 Describe how New Zealand conditions differ from ISA.

8.10.18 Explain how deviation from ISA values influences performance of aircraft and aircraft engines.

8.10.20 Define:

(a) QNH and altitude;

(b) QFE and height.

8.10.22 Explain the effects of changes in MSL pressure on aircraft in flight, and why a pressure altimeter requires a subscale adjustment.

8.10.24 Explain the importance of correct subscale setting.

8.12 Wind

8.12.2 Define the measurement of the standard surface wind in aviation meteorological reports and forecasts.

8.12.4 State the units used to describe wind speed.

8.12.6 State the units used to describe wind direction with reference to:

(a) forecasts and observations issued by MetService;

(b) spot winds relayed to pilots by Air Traffic Control.

8.12.8 List the three forces acting to generate wind at low-levels.

8.12.10 Outline the cause of Coriolis force.

8.12.12 List the three properties of Coriolis force.

8.12.14 Define the 'geostrophic wind'.

8.12.16 Explain how friction affects the surface wind velocity.

8.12.18 Explain what is meant by the 'friction layer'.

8.12.20 Describe the elements that influence the depth of the 'friction layer'.

8.12.22 Define the following terms:

(a) gust;

(b) squall;

(c) veering;

(d) backing.

8.12.24 Describe the diurnal variation of the surface wind over the:

(a) land;

(b) sea.

8.12.26 Describe the changes in wind velocity when climbing out of, or descending through, the friction layer.

8.12.28 Describe the limitations of windsocks in New Zealand.

8.12.30 Describe how an approximate wind direction can be determined from:

(a) ripples on water;

(b) wind lanes on water;

(c) wind shadow on bodies of water;

(d) cloud shadows.

8.12.32 State Buys Ballot's Law.

8.12.34 Explain how applying Buys Ballot's Law can:

(a) determine the location of high and low pressure areas;

(b) be used as a basic forecasting tool.

8.14 Local Winds

8.14.2 Describe the development of sea breezes with reference to:

(a) horizontal and vertical limits around New Zealand;

(b) timing of the occurrence;

(c) average strength of the sea breeze;

(d) associated cloud and precipitation;

(e) associated turbulence.

8.14.4 Describe the development of katabatic winds with reference to:

(a) timing of the occurrence;

(b) average strength of katabatic winds over New Zealand.

8.14.6 Describe the effect of local obstructions on wind flow.

8.14.8 Describe terrain channelling in New Zealand.

8.14.10 Explain how atmospheric stability enhances terrain channelling.

8.16 Water Vapour

8.16.2 Explain how the temperature of air influences its capacity to hold water vapour.

8.16.4 Define the term 'relative humidity'.

8.16.6 Define the term 'dew point'.

8.16.8 Explain the effect of moisture content of air on the dew point.

8.16.10 Explain why 'dew point' is a better measure than 'relative humidity' for aviation purposes.

8.16.12 Describe each of the following processes with regard to the changes of state of water:

(a) condensation;

(b) evaporation;

(c) deposition;

(d) sublimation;

(e) melting;

(f) freezing.

8.16.14 Explain how water vapour enters the atmosphere by the process of:

(a) evaporation;

(b) transpiration.

8.16.16 State the effect of the following on the rate of evaporation:

(a) air and water temperature;

(b) moisture content of air;

(c) wind speed.

8.16.18 Define ‘latent heat’.

8.16.20 State the significance of the release of latent heat into the atmosphere during the cloud formation process.

8.18 Atmospheric Stability

8.18.2 Define:

(a) stable air;

(b) unstable air;

(c) conditionally unstable air.

8.18.4 Describe how the stability of a rising (or sinking) parcel of air is determined by its temperature compared with the temperature of the surrounding environment.

8.18.6 Describe what is meant by ‘environment lapse rate’ (ELR).

8.18.8 Explain how the environmental temperature and dew point lapse rates are found.

8.18.10 Outline the term ‘adiabatic process’.

8.18.12 State the value of the dry adiabatic lapse rate (DALR) at low-levels in mid latitudes.

8.18.14 State the approximate value of the saturated adiabatic lapse rate (SALR) at low levels in mid-latitudes.

8.18.16 State the conditions needed for conditionally unstable air to be forced to become unstable.

8.18.18 Define:

(a) inversion;

(b) isothermal layer.

8.18.20 Explain why inversions and isothermal layers are atmospherically stable.

8.18.22 Determine atmospheric stability by applying basic lifting scenarios with given ELRs.

8.20 Inversions

8.20.2 Explain the factors involved in the development of a:

(a) radiation inversion;

(b) turbulence inversion;

(c) subsidence inversion;

(d) frontal inversion.

8.20.4 Explain the effect of inversions on:

(a) formation of cloud;

(b) visibility;

(c) turbulence;

(d) dew point;

(e) the increased risk of Ruleburettor icing;

(f) the presence of wind shear;

(g) aircraft performance.

8.22 Clouds

8.22.2 Describe the cloud formation process.

8.22.4 Describe the operational characteristics of the cloud sensor used in Automatic Weather Stations (AWS), and reported in METAR AUTO reports.

8.22.6 State the approximate altitude limits (in New Zealand latitudes) of:

(a) high cloud;

(b) middle cloud;

(c) low cloud.

8.22.8 Describe the meaning of the following cloud terms:

(a) cumulus or cumulo (prefix);

(b) stratus or strato (prefix);

(c) alto (prefix);

(d) nimbo (prefix) or nimbus (suffix);

(e) cirrus or cirro (prefix).

8.22.10 Describe the following lifting mechanisms found in the atmosphere:

(a) orographic;

(b) convection (including 'thermals');

(c) turbulence;

(d) widespread ascent (including fronts).

8.22.12 List the cloud types associated with each lifting mechanism.

8.22.14 Describe the following cloud types including likely associated turbulence and precipitation:

(a) stratocumulus;

(b) stratus;

(c) cumulus;

(d) cumulonimbus/towering cumulus;

(e) lenticular.

8.22.16 Visually identify the following cloud types:

(a) towering cumulus;

(b) cumulonimbus.

8.22.18 Explain how, in well-mixed conditions, changes in surface temperature and/or dew point relate to the cloud base.

8.22.20 Describe the processes that lead to cloud dissipation.

8.24 Precipitation

8.24.2 Define:

(a) precipitation;

(b) virga.

8.24.4 Describe the following types of precipitation:

(a) rain;

(b) drizzle;

(c) snow;

(d) sleet;

(e) hail.

8.24.6 State the difference between large drizzle and small rain droplets.

8.24.8 Describe the following terms in relation to precipitation:

(a) continuous rain;

(b) intermittent rain;

(c) showers.

8.24.10 Define the following precipitation rates:

(a) light;

(b) moderate;

(c) heavy.

8.26 Visibility and Fog

8.26.2 Define prevailing visibility.

8.26.4 Explain why illumination from the sun or moon has no effect on prevailing visibility.

8.26.6 Describe the operational characteristics of the visibility sensor used in Automatic Weather Stations (AWS), and reported in METAR AUTO reports.

8.26.8 Describe the effect on visibility, of the following:

(a) precipitation;

(b) fog and mist;

(c) haze and smoke;

(d) sea spray;

(e) blowing snow;

(f) sun glare.

8.26.10 Explain the factors involved in slant range.

8.26.12 List the types of fog, classified by their method of formation.

8.26.14 Describe the meteorological conditions required for the formation and dispersal of:

(a) radiation fog;

(b) advection fog.

8.26.16 Explain how katabatic winds may enhance or inhibit radiation fog depending on their strength.

8.26.18 Describe the operational problems associated with fog.

8.28 Aircraft Icing

8.28.2 List the hazards of airframe icing to aircraft in flight.

8.28.4 Explain the processes involved in the formation of hoar frost on an aircraft on the ground and in flight.

8.28.6 State the dangers of hoar frost and the actions required to alleviate these dangers on the ground and in flight.

8.28.8 Explain why flight in cloud above the freezing-level can be very hazardous.

8.28.10 Explain how to avoid or alleviate all forms of airframe icing other than hoar frost.

8.28.12 State the hazards for light aircraft from:

(a) snow;

(b) sleet;

(c) hail.

8.28.14 Explain the environmental factors involved in Ruleburettor icing, including;

(a) moisture content;

(b) temperature;

(c) temperature gradient (inversions).

8.28.16 State the temperature range that Ruleburettor ice typically forms in.

8.28.18 Explain how the accretion rate of Ruleburettor ice is influenced by the throttle setting.

8.28.20 Explain the conditions that can cause Ruleburettor icing while on the ground.

8.30 Thunderstorms

8.30.2 State the three conditions required for the development of thunderstorms.

8.30.4 Describe the three stages in the life-cycle of a thunderstorm.

8.30.6 List the hazards associated with thunderstorms.

8.30.8 Explain why light aircraft should always avoid flight in the vicinity of thunderstorms.

8.32 Mountain Weather

8.32.2 Define the Föhn wind.

8.32.4 In Föhn wind conditions, describe the typical weather:

(a) to windward of the mountain range;

(b) above the mountain range;

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

8.32.6 Describe the mountain lee-wave (standing wave) development process.

8.32.8 Describe the formation of rotor zones.

8.32.10 Explain the associated dangers of rotor zones to aircraft operations.

8.32.12 With regard to VFR flight in a light aircraft in mountainous terrain, describe the meteorological factors that should be considered during the flight planning phase and en route, including:

(a) cloud base;

(b) turbulence;

(c) adverse and favourable winds;

(d) visibility;

(e) track selection;

(f) the anticipated timing of any expected weather change.

8.36 Air-masses and Fronts

8.36.2 Define an ‘air-mass’.

8.36.4 State the two air-masses that routinely affect the New Zealand region.

8.36.6 Define a ‘front’.

8.36.8 Describe the formation processes of the following frontal types:

(a) cold;

(b) warm;

(c) occluded;

(d) stationary.

8.36.10 Describe the range of weather conditions typically associated with fronts in the New Zealand region.

8.36.12 State the similarities and differences between cold and warm fronts, with reference to changes in:

(a) temperature;

(b) air pressure;

(c) wind;

(d) cloud;

(e) precipitation.

8.36.14 Describe the typical associated factors for a southerly flow onto New Zealand:

(a) stability;

(b) cloud types;

(c) likely precipitation;

(d) visibility reductions;

(e) turbulence.

8.36.16 Describe the typical associated factors for a northerly flow onto New Zealand.

(a) stability;

(b) cloud types;

(c) likely precipitation;

(d) visibility reductions;

(e) turbulence.

8.40 Turbulence

8.40.2 Define the term ‘wind shear’.

8.40.4 Describe the effects of low-level wind-shear on aircraft operations in the:

(a) take-off; and

(b) approach and landing phases of flight.

8.40.6 Describe the cause(s), factors involved and dangers associated with:

(a) convective (thermal) turbulence;

(b) mechanical turbulence – small scale and large scale;

(c) wake turbulence.

8.40.8 Describe the techniques commonly used to avoid or minimise:

(a) convective (thermal) turbulence;

(b) mechanical turbulence;

(c) wake turbulence.

8.44 New Zealand Weather

8.44.2 Describe how the following factors determine the general weather features found around New Zealand:

(a) latitude;

(b) oceanic surroundings;

(c) topography.

8.44.4 Identify 'westerly situations' and 'easterly situations' on a weather map.

8.44.6 Describe the impact of 'westerly situations' and 'easterly situations' on flying weather around New Zealand.

8.44.8 For any area or location in New Zealand, determine:

(a) the wind direction(s) which expose that location to very poor flying conditions;

(b) the wind direction(s) which result in sheltering.

8.50 Assess satellite and radar Imagery, and non-aviation-specific weather information.

8.50.2 With respect to NZ VFR operations, using satellite imagery available in MetFlight, identify the following:

(a) areas of stable and unstable air;

(b) frontal cloud bands;

(c) positions of lows and anticyclones.

8.50.4 With respect to NZ VFR operations, interpret radar imagery available in MetFlight in terms of:

(a) likely cloud types;

(b) precipitation types and intensity;

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

8.50.6 Describe the limitations of non-aviation-specific weather information.

8.52 Interpret Domestic Meteorological Services, Reports and Forecasts

8.52.2 Using information from domestic meteorological services, reports and forecasts decide which should be considered for an indicated flight between given locations.

8.52.4 Use information from domestic meteorological services, reports and forecasts to demonstrate sound planning and decision making.

8.52.6 State the significance of forecast or observed low-level moisture to flight.