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GENERAL OPERATIONS, FLIGHT PLANNING AND PERFORMANCE

CHAPTER 8 – THE ATMOSPHERE

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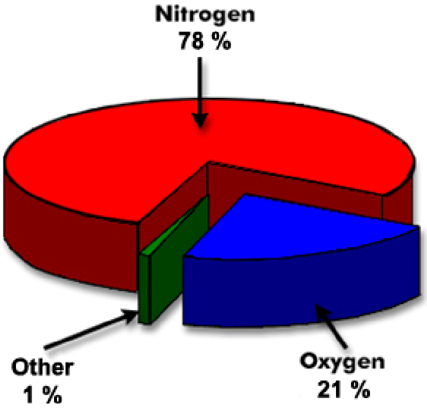
THE ATMOSPHERE

STRUCTURE OF THE ATMOSPHERE

The atmosphere is an envelope of air that surrounds the Earth and rests upon its surface. It is as much a part of the Earth as the seas or the land. However, air differs from land and water inasmuch as it is a mixture of gases. It has mass, weight, and indefinite shape.



Air, like any other fluid, is able to flow and change its shape when subjected to even minute pressures because of the lack of strong molecular cohesion. For example, gas will completely fill any container into which it is placed, expanding or contracting to adjust its shape to the limits of the container.

The atmosphere is composed of 78 % Nitrogen, 21 % Oxygen, and 1 % other gases, such as Argon or Helium. Most of the oxygen is contained below 35 000 ft altitude.

ATMOSPHERIC PRESSURE

Though there are various kinds of pressure, pilots are mainly concerned with atmospheric pressure. It is one of the basic factors in weather changes, helps to lift the aircraft, and actuates some of the important flight instruments in the aircraft. These instruments are:

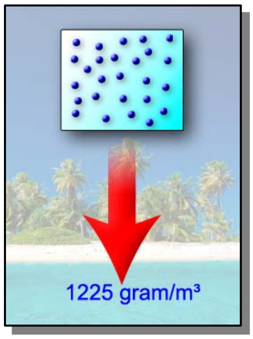
Altimeter

Airspeed indicator

Rate-of-climb indicator

Manifold pressure

Though air is very light, it has mass and is affected by the attraction of gravity. Therefore, like any other substance, it has weight, and because of its weight, it has force. Since it is a fluid substance, this force is exerted equally in all directions, and its effect on bodies within the air is called pressure.

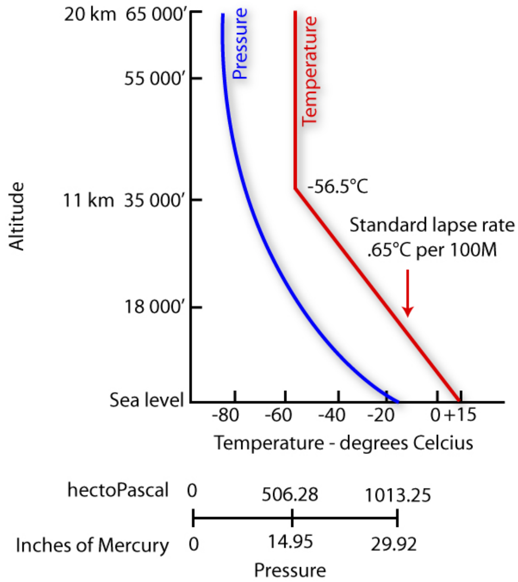


Under standard conditions at sea level, the average pressure exerted by the weight of the atmosphere is approximately 1 225 g/m^3. The density of air has significant effects on the aircraft's performance.

As air becomes less dense, it reduces:

- Power, because the engine takes in less air,
- Thrust, because the propeller is less efficient in thin air, and
- Lift, because the thin air exerts less force on the airfoils.

The pressure of the atmosphere varies with time and location. Due to the changing atmospheric pressure, a standard reference was developed. The assumed values for the standard atmosphere at sea level is a temperature of 15°C and a pressure of 1013.25 millibars (hPa).

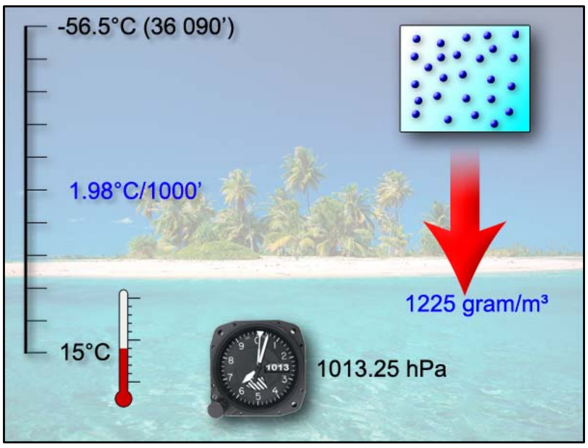


A standard temperature lapse rate is one in which the temperature decreases at the rate of approximately 2°C per thousand ft up to 36 000 ft. Above this point, the temperature is considered constant up to 80 000 ft. A standard pressure lapse rate is one in which pressure decreases at a rate of approximately 1 hPa per 30 ft of altitude gain to 20 000 ft.

IN SHORT

Any practical considerations involving the atmosphere will be possible only when accepted datum points are used. The International Standard Atmosphere (**ISA**) is defined by assuming that :

- The air is a perfect dry gas,
- The temperature at sea level is 15^0 Celsius,
- The pressure at sea level is 1013.2 hectopascals,
- The temperature gradient from sea level to the altitude at which the temperature is –56.5^0 C is –1.98^0 C per 1000 feet and zero lapse rate above that.



The International Civil Aviation Organisation (ICAO) has established this as a worldwide standard, and it is often referred to as International Standard Atmosphere (ISA) or ICAO Standard Atmosphere. Any temperature or pressure that differs from the standard lapse rates is considered non-standard temperature and pressure. Adjustments for non-standard temperatures and pressures are provided on the aircraft manufacturer's performance charts.

Since all aircraft performance is compared and evaluated with respect to the standard atmosphere, all aircraft instruments are calibrated for the standard atmosphere. Thus, certain corrections must apply to the instrumentation, as well as the aircraft performance, if the actual operating conditions do not fit the standard atmosphere.

ATMOSPHERIC CONDITIONS

In order to predict the performance of our aeroplane, we need to find the atmospheric conditions in which the aeroplane is to operate.

We may need to consider :

- Ambient Conditions.
- Forecast Conditions.
- Declared conditions.

These conditions may be used to find the maximum take-off and landing weights for the aeroplane.

CAO 20.7 defines these conditions.

AMBIENT CONDITIONS

Ambient conditions are those which prevail at any moment at an aerodrome.

To find the ambient conditions we may :

- Estimate wind speed and direction by reference to the windsock
- Take a temperature reading from a thermometer
- Find the QNH by setting the altimeter to read the airfield elevation and then read the value on the subscale.

Or, when available, listen to the Air Terminal Information Service (**ATIS**)

As ambient conditions can change rapidly, particularly in terms of wind velocity, ambient conditions are defined as those prevailing for a period not exceeding 15 minutes. prior to take off.

The take off performance should be checked by using ambient conditions.

FORECAST CONDITIONS

Forecast conditions will need to be considered when planning en-route and landing performance.

The definition in the CAO 20.7 clearly indicates that a forecast can be issued only by the Australian Bureau of Meteorology.

DECLARED CONDITIONS

Declared conditions can be extracted from the Appendices of CAO 20.7.0. These appendices are charts showing the MEAN SEASONAL SEA LEVEL DENSITY HEIGHTS in Australia.

If a forecast for a particular location is unavailable, the declared density altitude charts may be used to extract declared conditions for the destination aerodrome or ALA to find the maximum weights.

Any weights found by using declared conditions are called DECLARED WEIGHTS.

To extract the Declared Density Conditions for a location on a particular day:-.

- Find the Latitude and Longitude of the required aerodrome
- Identify the correct chart for the time of the year in question
- Read the altitude correction for the position of the aerodrome
- Add the correction value to the airfield elevation.

<u>Example</u>

Aerodrome YABC Elevation : 820 ft

Position: 30°S 130°W

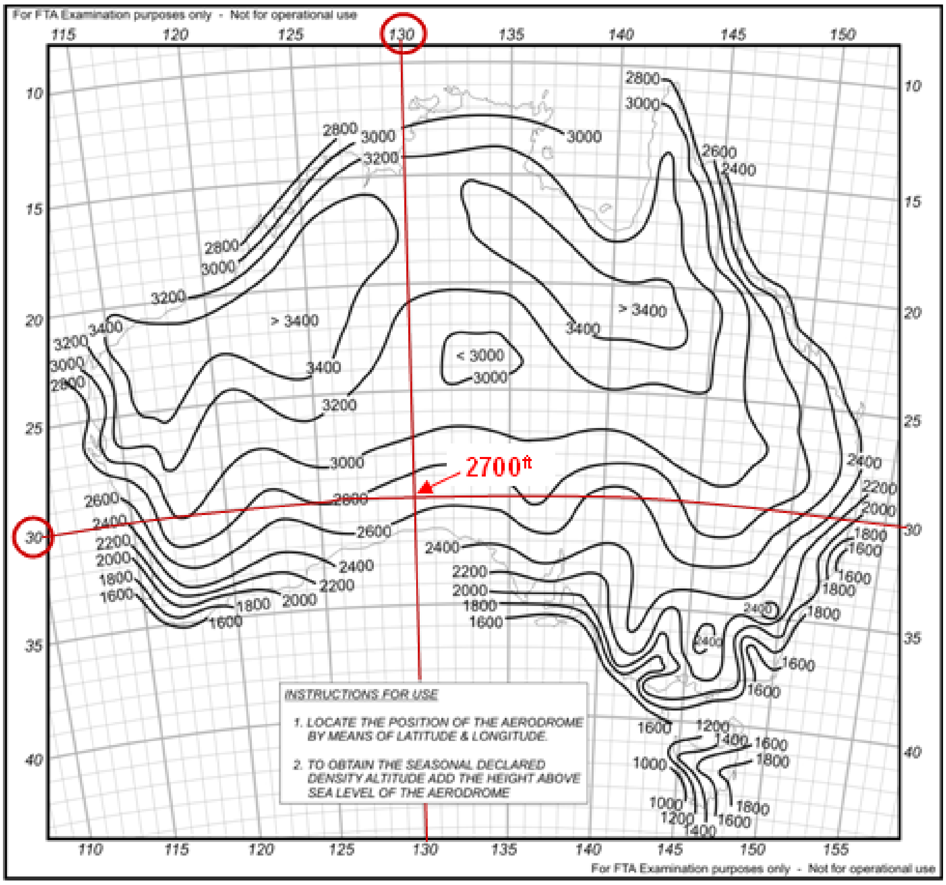
Find the declared density conditions at that aerodrome on the 15th of April.

<u>DECLARED DENSITY CHARTS</u>

AUTUMN (MARCH TO MAY) - SPRING (SEPT. TO NOV.)

Follow the instructions on the correct seasonal chart. (CAO 20.7)

- Mark the latitude line (30°S).
- Mark the longitude line (130°W).
- Where the two cross, interpolate the declared MSL density height. In this case, the position is between 2,800 ft and 2,600 ft. say 2,700 ft.



- Add the elevation (820 ft) to the MSL declared density height:

The declared density altitude is approximately 3,520ft

HEIGHTS

Height

Height is the vertical distance from a specified horizontal reference level.

In aviation, heights are measured as vertical distances from:

- GROUND LEVEL (AGL)
- THE ISA MEAN SEA LEVEL PRESSURE DATUM
- MEAN SEA LEVEL (MSL)

Elevation

Elevation is the height of a point Above Mean Sea Level (AMSL) measured in feet. An aerodrome is on the earth's surface and its height AMSL is called elevation.

Altitude

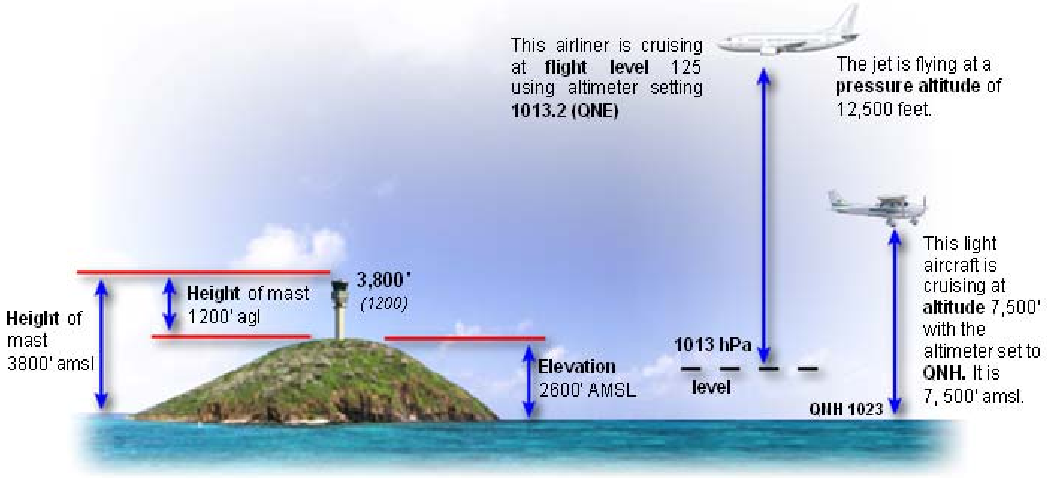
Altitude is the height of an object not affixed to the earth such as an aeroplane in flight. The height AMSL in flight is called altitude and is measured in feet.

Pressure Height

A pressure height is the height above the standard atmospheric pressure datum of 1013 hPa and is measured in feet. It is an expression of atmospheric pressure in terms of its equivalent height in ISA.

Flight Level

A Flight Level (**FL**) is also a Pressure Height but divided by 100. Thus FL125 is a Pressure Height of 12500 feet.



Q CODES

QFE is a code for the ambient pressure at the surface measured in hectopascals (hPa). Setting the altimeter to zero feet will cause the sub-scale to read the atmospheric pressure at the surface.

QNH is a code for the pressure at MSL When the sub-scale is set to a known QNH the altimeter will indicate the altitude in feet AMSL. On the surface, if the known elevation is set on the altimeter, then the sub-scale will read the QNH.

QNE Altimeter setting of 29.92 inches of mercury or 1013.2 Hectopascals (millibars).