HOW TO DETERMINE TRANSITION LEVEL

1. Introduction

This article's goal is to help the air traffic controller to use the correct altimetry in his airspace.
You will learn the different terms and how to use them.

2. Transition altitude and transition level definition

In their airspace, air traffic controllers must define the transition altitude and transition flight level. These data are available on airfield ATIS information or on charts.

2.1. Transition altitude

The transition altitude is:

- The **upper limit from the surface to use local QNH altimeter setting** applicable to all aircraft.
- Published on charts (IAC, ARR, DEP)
- Broadcasted in the ATIS of air traffic controller.
- Defined inside the associated TMA (terminal area) where it is published.
- Usually given in feet but can be in meters in some countries.
- The ICAO transition altitude abbreviation is **TA**

2.2. Transition level

The transition level is:

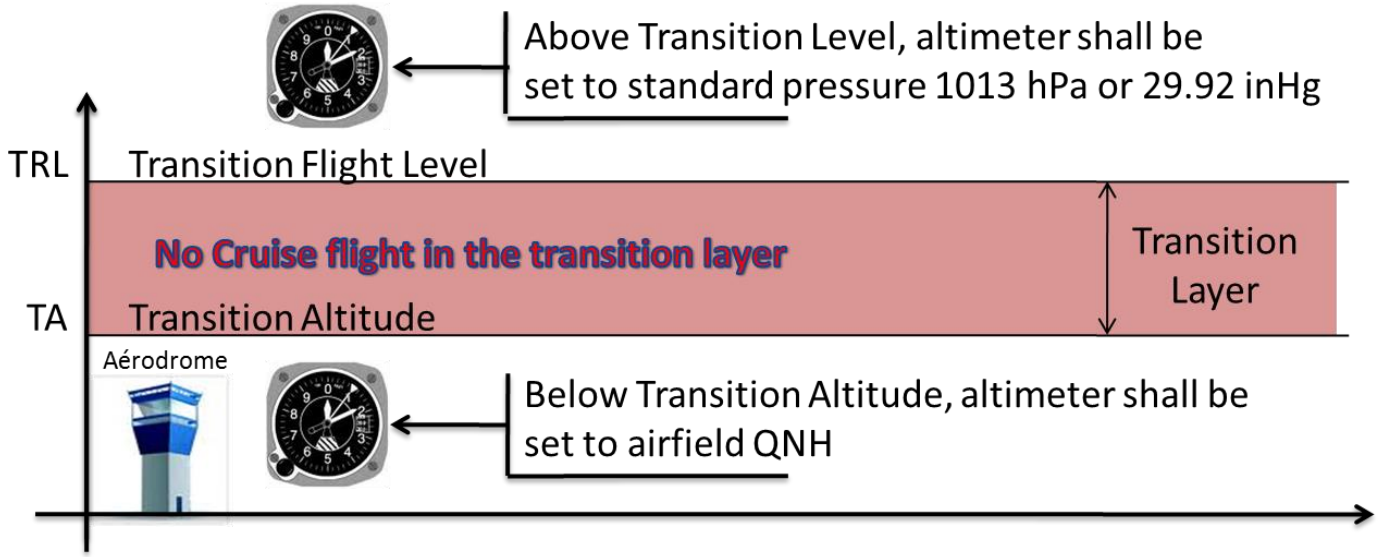
- The **lower limit to use standard 1013hPa altimeter setting** applicable to all aircraft.
- Sometimes published on charts (IAC, ARR, DEP) but not often.
- Usually calculated by air traffic controller in function of transition altitude and QNH.
- Broadcasted in the ATIS of air traffic controller.
- Defined inside the associated TMA (terminal area) where transition altitude is published.
- Always given in flight level.
- The ICAO transition level abbreviation is **TRL.** (But we can find TL sometimes on charts and documents)

Note that the altitude of the transition level must be greater than the transition altitude.

2.3. Transition layer

The transition layer is the airspace located between the transition altitude and the transition level.

The transition layer is defined inside the associated TMA (terminal area) where the transition altitude is published.



No cruise flight in the transition layer is permitted. An aircraft can only cross the transition layer.

The transition layer thickness is laid down in the country regulation and can be:

- Between 0ft and 999ft.
- Between 0ft and 499ft.
- Between 1000ft and 1999ft.
- Between 1000ft and 1499ft.

2.4. No transition altitude published

There are airfields outside TMA with no altitude transition published. Then, the default transition altitude should be 3000ft above the surface.

In this case there is no transition level.

3. Use of altimetry

A pilot can configure his aircraft with only three possible altimeter settings:

- Altimeter set on local QNH
- Altimeter set on standard pressure 1013hPa
- Altimeter set on local QFE (still used in some regions)

3.1. Altitude separation problem

For a pilot the problem is that the QNH varies from one airport to another. If the local pressure is not known, the pilot has no choice but to keep the old value, even if it is the pilot's duty to find out the right value.

When two aircraft fly at different altitudes with a different QNH, the vertical separation can be not guaranteed.

The same altimeter setting in all aircraft in one zone is the unique manner to guarantee that two close aircraft are properly separated vertically.

When using the standard altimeter setting, you must understand that a plane altitude will vary in function of the local atmospheric pressure of the crossed zones.

4. How to calculate the transition level

4.1. Standard atmosphere

The International Standard Atmosphere (ISA) is an atmospheric model of how the pressure, temperature and density of the Earth's atmosphere change over a wide range of altitudes.

It has been established to provide a common reference for temperature and pressure and consists of tables of values at various altitudes.

Height km / ft	Temperature °C	Pressure hPa	Lapse Rate °C/1000 ft
0 km / 0 ft (MSL)	15.0	1013.25	−1.98 (Tropospheric)
11 km / 36 000 ft	−56.5	226.00	0.00 (Stratospheric)
20 km / 65 000 ft	−56.5	54.70	+0.3 (Stratospheric)
32 km / 105 000 ft	−44.5	8.68	

At low altitude, we have the following relation in a standard atmosphere:

Variation of air pressure (hPa) = - variation of altitude (ft) / 28
Formula: $\Delta P = -\Delta z / 28$

Variation of temperature (°C) = - variation of altitude (m) / 154

Variation of temperature (°C) = - variation of altitude (ft) * 2 / 1000

4.2. Altitude calculation above the standard isobaric surface

In order to calculate the transition level, we must calculate the pressure altitude of the transition altitude (equivalent of the flight level).
We will use the following equation, in function of the variation of air pressure equation:

(Local QNH – Standard_pressure) = (Transition altitude at local QNH – Transition altitude at standard pressure) / 28

Transition altitude at standard pressure = Transition altitude at local QNH + 28 * (Standard pressure – Local QNH)

Transition altitude at standard pressure = Transition altitude + 28 * (1013 – Local QNH)

Example: QNH=1019, TA=5000ft

Transition altitude at standard pressure = 5000 + 28 * (1013-1019) = 5000 – 168 ft = 4832ft

Equivalent FL = Transition altitude at standard pressure / 100 = FL48

Example: QNH=1002, TA=5000ft

Transition altitude at standard pressure = 5000 + 28 * (1013-1002) = 5000 + 308 ft = 5308ft

Equivalent FL = Transition altitude at standard pressure / 100 = FL53

4.3. How to determine the transition level

The transition level is in function of the rule chosen by the rules of the country and the thickness of the transition level.

4.3.1. For thickness between 0ft and 599ft:

Calculate the Equivalent FL. Then choose the FL ending with ‘0’ or ‘5’ using the following equation:

Equivalent FL ≤ Transition flight level < Equivalent FL + 5

Example: FL48 ≤ TL < FL 53, then TL = 50; FL53 ≤ TL < FL 58, then TL = 55

4.3.2. For thickness between 0ft and 999ft:

Calculate the Equivalent FL. Then choose the FL ending with ‘0’ using the following equation:

Equivalent FL ≤ Transition flight level < Equivalent FL + 10

Example: FL48 ≤ TL < FL 58, then TL = 50; FL53 ≤ TL < FL 63, then TL = 60

4.3.3. For thickness between 1000ft and 1499ft:

Calculate the Equivalent FL. Then choose the FL ending with '0' or '5' using the following equation:

Equivalent FL + 10 ≤ Transition flight level < Equivalent FL + 15

Example: FL58 ≤ TL < FL 63, then TL = 60; FL63 ≤ TL < FL 68, then TL = 65

4.3.4. For thickness between 1000ft and 1999ft:

Calculate the Equivalent FL. Then choose the FL ending with '0' using the following equation:

Equivalent FL + 10 ≤ Transition flight level < Equivalent FL + 20

Example: FL58 ≤ TL < FL 68, then TL = 60; FL63 ≤ TL < FL 73, then TL = 70

5. Transition level table

This table will present the transition level in function of transition altitude.

This table is given for a transition layer thickness between 0ft and 500ft.
You shall add 5, 10 or 15 value to the value in the table to respect the wanted thickness.

TRL table		Pressure (hpa)					
TA(m)	TA(ft)	p>942.1	p>959.4	p>997.1	P>995	P>1013.2	p>1031.6
610	2000	40	35	30	25	20	15
762	2500	45	40	35	30	25	20
914	3000	50	45	40	35	30	25
1067	3500	55	50	45	40	35	30
1219	4000	60	55	50	45	40	35
1372	4500	65	60	55	50	45	40
1524	5000	70	65	60	55	50	45
1676	5500	75	70	65	60	55	50
1829	6000	80	75	70	65	60	55
1981	6500	85	80	75	70	65	60
2134	7000	90	85	80	75	70	65
2286	7500	95	90	85	80	75	70
2438	8000	100	95	90	85	80	75
2591	8500	105	100	95	90	85	80
2743	9000	110	105	100	95	90	85
2896	9500	115	110	105	100	95	90
3048	10000	120	115	110	105	100	95
3200	10500	125	120	115	110	105	100
3353	11000	130	125	120	115	110	105
3505	11500	135	130	125	120	115	110
3658	12000	140	135	130	125	120	115

Note: when pressure is rounded as 1013hpa, you can consider that the pressure is Standard 1013.25hpa.