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.

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**Above Transition Level, altimeter shall be set to standard pressure 1013 hPa or 29.92 inHg**

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**Below Transition Altitude, altimeter shall be set to airfield QNH**

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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 1013 hPa
- 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.

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

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

Variation of air pressure (hPa) = - variation of altitude (ft) / 28

Formula: ΔP = -Δz / 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:

\[(\text{Local QNH} - \text{Standard pressure}) = (\text{Transition altitude at local QNH} - \text{Transition altitude at standard pressure}) / 28\]

\[\text{Transition altitude at standard pressure} = \text{Transition altitude at local QNH} + 28 \times (\text{Standard pressure} - \text{Local QNH})\]

\[\text{Transition altitude at standard pressure} = \text{Transition altitude} + 28 \times (1013 - \text{Local QNH})\]

**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.

<table>
<thead>
<tr>
<th>TRL table</th>
<th>Pressure (hpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA(m)</td>
<td>TA(ft)</td>
</tr>
<tr>
<td>610</td>
<td>2000</td>
</tr>
<tr>
<td>762</td>
<td>2500</td>
</tr>
<tr>
<td>914</td>
<td>3000</td>
</tr>
<tr>
<td>1067</td>
<td>3500</td>
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<tr>
<td>1219</td>
<td>4000</td>
</tr>
<tr>
<td>1372</td>
<td>4500</td>
</tr>
<tr>
<td>1524</td>
<td>5000</td>
</tr>
<tr>
<td>1676</td>
<td>5500</td>
</tr>
<tr>
<td>1829</td>
<td>6000</td>
</tr>
<tr>
<td>1981</td>
<td>6500</td>
</tr>
<tr>
<td>2134</td>
<td>7000</td>
</tr>
<tr>
<td>2286</td>
<td>7500</td>
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<td>8500</td>
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<tr>
<td>2743</td>
<td>9000</td>
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<tr>
<td>2896</td>
<td>9500</td>
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<tr>
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<td>10000</td>
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<tr>
<td>3200</td>
<td>10500</td>
</tr>
<tr>
<td>3353</td>
<td>11000</td>
</tr>
<tr>
<td>3505</td>
<td>11500</td>
</tr>
<tr>
<td>3658</td>
<td>12000</td>
</tr>
</tbody>
</table>

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