Approach-and-Landing Briefing Note

3.1 - Altimeter Setting - Use of Radio Altimeter

Introduction

Operators with international routes are exposed to different standards in terms of:

- Altitude measurement (i.e., feet or meters);
- Altitude reference setting-units (i.e., hectopascal or inch-of-mercury, QNH or QFE); and,
- Environmental conditions (i.e., atmospheric pressure changes and/or low OAT operation).

This Briefing Note provides a review and discussion of the following aspects, highlighting the lessons learned from approach-and-landing incidents and accidents:

- Barometric-altimeter reference (QNH or QFE);
- Use of different units for altitude measurement (i.e., feet versus meters) and altimeter setting (i.e., In.Hg versus hPa);
- Setting of baro-altimeter bug and radio-altimeter DH;
- Radio-altimeter callouts; and,
- Low-OAT operation.

Statistical Data

Deviation from the intended vertical flight profile (caused by omission of an action or by an incorrect action) is frequently observed during line checks and audits.

The lack of situational awareness, particularly the lack of vertical situational awareness, is a causal factor in 50 % of approach-and-landing accidents (this includes most accidents involving CFIT).

QNH or QFE ?

The use of QNH for operations below the transition level / altitude eliminates the need for changing the altimeter-setting:

- During the approach and landing; and,
- During the missed approach, as required.

When QFE is used for the approach, the altimeter must be change to QNH for the missed-approach, unless the missed-approach procedure is defined with reference to QFE.

Some operators set the altimeter to QFE in areas of operation where the ATC and the majority of other operators use QNH. This requires adequate SOPs for altimeter-setting and for conversion of assigned altitudes to heights.

Altimeter-setting Units

Operators with international routes are exposed to the use of different altimeter setting units:

- Hectopascals (hPa), previously referred to as milibars (mb),
- Inches-of-mercury (in. Hg).

When in.Hg is used for altimeter setting, unusual barometric pressures such as:

- 28.XX in.Hg (i.e., an unusually low pressure); or,
- 30.XX in.Hg (i.e., an unusually high pressure),

may go undetected when listening to the ATIS or ATC, resulting in a more usual 29.XX altimeter setting being set.

A 1.00 in.Hg discrepancy in the altimeter setting results in a **1000-ft error** in the intended (actual) altitude, as illustrated by **Figure 1** (Figure 1, Figure 2 and Figure 3 assume a 2000 ft airfield elevation and a 4000 ft indicated altitude).

In **Figure 1**, the actual QNH is an usually low 28.XX in.Hg but the altimeter setting was mistakenly set to a more usual 29.XX in.Hg, resulting in the actual altitude / height being 1000 ft **lower** than indicated:

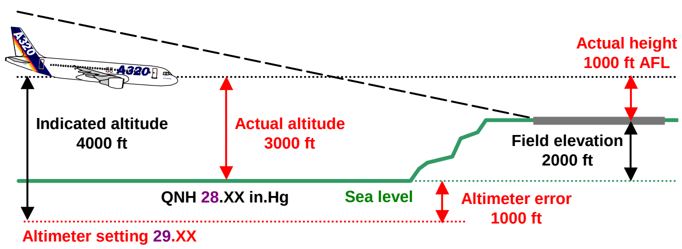

Figure 1

In **Figure 2**, the actual QNH is an usually high 30.XX in.Hg but the altimeter setting was mistakenly set to a more usual 29.XX in.Hg, resulting in the actual altitude / height being 1000 ft **higher** than indicated.

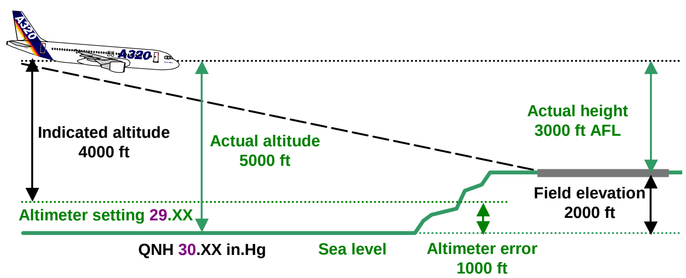

Figure 2

Confusion between altimeter setting units (i.e. hPa versus in.Hg) leads to similar errors in the actual altitude and actual height above airfield elevation.

In **Figure 3**, an actual QNH of 991 hPa was mistakenly set on the altimeter as 29.91 in.Hg (equivalent to 1012 hPa), resulting in the actual altitude / height being 640 ft **lower** than indicated.

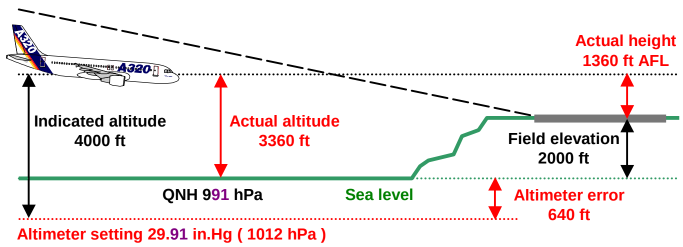

Figure 3

Setting the altimeter reference

In order to eliminate or lessen the risk associated with the use of different altimeter-setting units or with the use of unusual (low or high) altimeter-setting values, the following rules should be used by controllers (when recording the ATIS message or when transmitting the altimeter-setting) and by pilots (when reading back the altimeter-setting):

- All digits as well as the unit (e.g., inches or hectopascals) should be indicated.

  A transmission such as "altimeter setting six seven" can be interpreted as 28.67, 29.67 or 30.67 in.Hg, or as 967 hPa.

  Indicating the altimeter-setting unit prevents confusion or allows detection and correction of a previous error.

- When using inches of mercury (in.Hg), "low" should precede an altimeter setting of 28.XX in.Hg and "high" should precede an altimeter setting of 30.XX in.Hg.

  The U.S. FAA accepts this practice, if deemed desirable by regional or local air traffic services.

The incorrect setting of the altimeter reference often is the result of one or more of the following factors:

- High workload;
- Deviation from normal task sharing;
- Interruptions and distractions; and,
- Absence of effective cross-check and backup between crewmembers.

Adherence to the defined task sharing (for normal or abnormal / emergency conditions) and the use of normal checklists are the most effective lines-of-defense against altimeter setting errors.

Use of Metric Altimeter

Using metric altitudes in certain countries (such as the Commonwealth of Independent States [CIS] and The People's Republic of China) also requires adapted procedures for setting the selected altitude on the FCU and the use of metric altimeters (or conversion tables) for reading the altitude in meters.

Reset of Altimeter Setting in Climb or Descent

The transition altitude / flight level can be either:

- Fixed for the whole country (e.g. FL 180 in the United States);
- Fixed for a given airport (as indicated in the approach chart); or,
- Variable, depending on QNH (as indicated in the ATIS message).

Depending on the airline's / flight crew's usual area of operation, changing from fixed transition altitudes / FL to variable transition altitudes / FL may result in a premature or late setting of the altimeter reference.

An altitude constraint (expressed in terms of FL in climb or expressed in terms of altitude in descent) may advance or delay the change of the altimeter reference and cause crew confusion.

Setting of Barometric-altimeter Bug and Radio-altimeter DH

The barometric-altimeter bug and of the radio-altimeter DH should be set in line with Airbus Industrie' SOP's or company' SOPs.

Approach	Baro Bug	RA DH
Visual	MDA/DA of instrument approach or 200 ft above airfield elevation	200 ft *Note 1*
Non-ILS	MDA	200 ft *Note 1*
ILS CAT I **No RA**	DA	200 ft *Note 1*
ILS CAT I RA **ILS CAT II**	DA *Note 2*	RA DH
ILS CAT III **With DH**	DA *Note 2*	RA DH
ILS CAT III **With no DH**	TDZ altitude	

Table 1
(Table based on use of QNH)

Note 1 :

The RA DH may be set (e.g., at 200 ft) only for terrain awareness purposes. Using the RA DH should be discussed in the approach briefing.

For all approaches - except CAT I with RA, CAT II and CAT III ILS approaches - the approach MINIMUM callout is based on the barometric-altimeter bug set at the MDA(H) or DA(H).

ote 2 :

CAT III DA, or the CAT I DA in readiness for a possible reversion to CAT I minimas.

Radio-altimeter Callouts

Radio-altimeter callouts can be either:

- Announced (verbalized) by the PNF or the Flight Engineer; or,
- Automatically generated by a synthesized voice.

Callouts should be tailored to the airline' operating policy and to the type of approach.

To enhance the flight crew's terrain awareness, a callout " Radio altimeter alive ", should be announced by the first crewmember observing the radio altimeter activation at 2500 ft height AGL.

The radio altimeter reading should then be included in the instrument scanning for the remainder of the approach.

Radio altimeter readings below obstacle clearance levels listed below, should alert the flight crew:

- Initial approach : 1000 ft AGL;
- Intermediate approach (or minimum radar vectoring altitude) : 500 ft AGL;
- Final approach (non-precision approaches with defined FAF) : 250 ft AGL.

Note : The radio altimeter indicates the aircraft current height above the ground (height AGL) and not the height above the airfield elevation.

Unless the airport features high close-in terrain, the radio-altimeter reading should reasonably agree with the height above airfield elevation (obtained by direct reading of the altimeter if using QFE or by computation if using QNH).

Low OAT Operation

In a standard atmosphere, the indicated altitude reflects the true altitude above the mean sea level (MSL) and therefore provides a reliable indication of terrain clearance.

Whenever, the temperature deviates significantly from the standard temperature, the indicated altitude correspondingly deviates from the true altitude, as follows:

- Extreme **high** temperature :
  - the true altitude is **higher** than the indicated altitude,
- Extreme **low** temperature :
  - the true altitude is **lower** than the indicated altitude, thus creating a lower than anticipated terrain separation and a potential obstacle-clearance hazard.

For example, when performing an ILS approach with a published 2000 ft minimum glide-slope interception-altitude and a – 40 ° C OAT, the minimum glide-slope interception altitude should be **increased by 480 ft**.

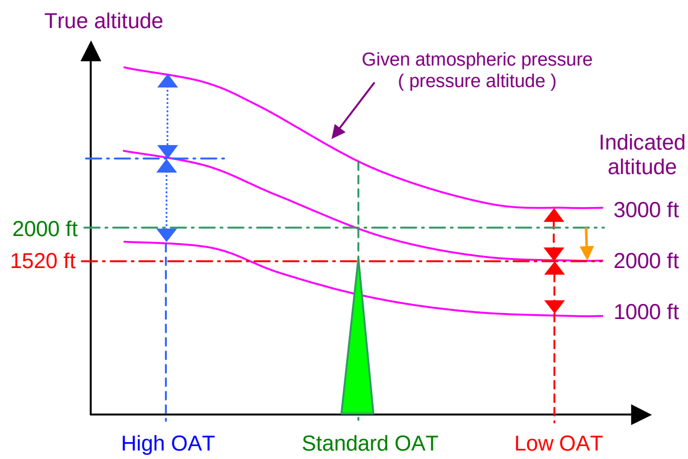

Figure 4

Effect of OAT on True Altitude

The ICAO PANS-OPS, Volume I, provides altitude corrections to be added to the published minimum safe altitudes (heights).

The temperature correction (i.e., correction to be added to the indicated altitude) depends on the aerodrome surface temperature and on the desired true altitude (height) above the elevation of the altimeter-setting source.

Flying into a low temperature area has the same effect as flying into a low-pressure area; the aircraft is lower than the altimeter indicates.

These effects are summarized and illustrated in **Table 2**, featuring a well-known aviation golden rule:

	From	To	
Atmospheric Pressure	High	Low	**Look out below**
OAT	Warm	Cold	

Table 2

The pilot is responsible for performing this correction, except when under radar control in a radar vectoring area; in this case, the controller normally is responsible for terrain clearance, including accounting for the cold temperature correction.

Nevertheless, the operator and/or pilot should confirm this responsibility with the air traffic services of the country of operation.

The temperature correction on altitude affects the following published altitudes, which therefore should be increased under low OAT operation:

- MEA, MSA;
- Transition routes altitude;
- Procedure turn altitude (as applicable);
- FAF altitude;
- Step-down altitude(s) and MDA(H) during a non-precision (non-ILS) approach;
- OM crossing altitude during an ILS approach; and,
- Waypoint crossing altitudes during a GPS approach flown with vertical navigation.

ICAO PANS-OPS does not provide altitude corrections for extreme high temperatures; the temperature effect on the true altitude should not be ignored when planning for a constant-angle non-precision approach (i.e., to maintain the required flight path angle and/or vertical speed).

Summary of key points

Altimeter-setting errors result in a lack of vertical situational awareness; the following key points should be emphasized to minimize altimeter-setting errors and to optimize the use of the barometric-altimeter bug and radio-altimeter DH:

- Awareness of altimeter setting changes due to prevailing weather conditions (extreme cold or warm fronts, steep frontal surfaces, semi-permanent or seasonal low pressure areas);
- Awareness of the altimeter setting unit in use at the destination airport;
- Awareness of the anticipated altimeter setting, using two independent sources for cross-check (e.g., METAR and ATIS messages);
- Effective PF/PNF crosscheck and backup;
- Adherence to SOPs for:
  - reset of barometric-altimeters in climb and descent, for example:
    - in climb : at the transition altitude; and,
    - in descent : when cleared to an altitude;
  - use of standby-altimeter to crosscheck main altimeters;
  - altitude callouts;
  - radio-altimeter callouts; and,
  - setting of barometric-altimeter bug and radio-altimeter DH.

Associated Briefing Notes

The following Briefing Notes also refer to altimeter-setting and altitude issues:

- ***1.1 - Operating Philosophy – SOPs,***
- ***2.3 - Effective Crew/ATC Communications,***
- ***2.4 - Intra-Cockpit Communications – Managing Interruptions and Distractions,***
- ***3.2 - Altitude Deviations.***

Regulatory references

- ICAO Annex 3 – Meteorological Service for International Air navigation, Chapter 4.
- ICAO Annex 5 – Units of Measurement to be used in Air and Ground Operations, Table 3-4, 3.2.
- ICAO Annex 6 – Operations of Aircraft, Part I – International Commercial Air transport – Aeroplane, 6.9.1 c) and Appendix 2, 5.13.
- ICAO Annex 6 – Procedures for Air Navigation Services – Rules of the Air and Air Traffic Services (PANS-RAC, Doc 4444).
- ICAO Annex 6 – Procedures for Air navigation Services – Aircraft Operations (PANS-OPS, Doc 8168), Volume I – Flight procedures - Part VI – Altimeter Setting Procedures - Chapter 3 - New table of temperature corrections to be added to the indicated altitude when operating in low OAT conditions.

  The new Part VI – Chapter 3 will be effective in Nov.2001 and will replace and supersede the current Chapter 3 of Part III.
- Preparation of an Operations manual (Doc 9376).
- Manual of radiotelephony (Doc 9432).
- Human Factors Training Manual (Doc 9683).
- Human Factors Digest No.8 – Human Factors in Air Traffic Control (Circular 241).
- FAA - Draft AC 91-XX - Altimeter Errors at Cold Temperatures.