

Level Bust Briefing Notes

Aircraft Operators

Level Bust

OPS 2

Altimeter Setting Procedures

1. Introduction

- 1.1. Flight crew on international routes encounter different units of measurement for setting barometric altimeters, thus requiring altimeter cross-checking procedures.

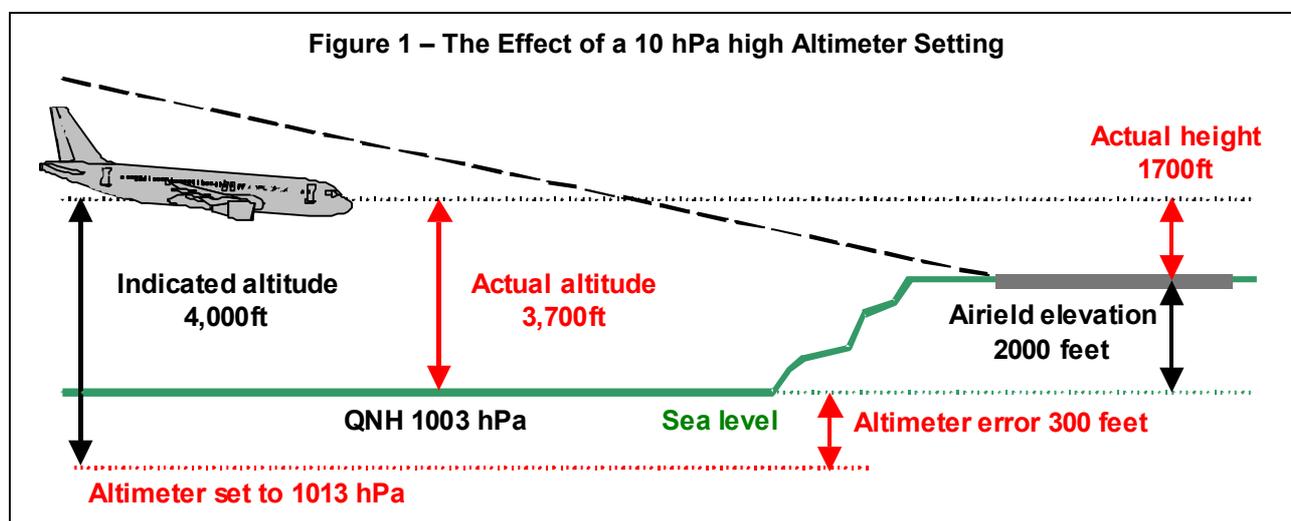
2. QNH or QFE?

- 2.1. QNH is the altimeter setting that causes the altimeter to indicate vertical distance above mean sea level, e.g. airfield elevation at touchdown on the runway.
- 2.2. QFE is the altimeter setting that causes the altimeter to indicate vertical distance above the QFE reference datum, i.e. zero at touchdown on the runway.
- 2.3. QNH has the advantage over QFE of eliminating the need to change the altimeter setting during operations below the transition level or transition altitude.
- 2.4. QNH also eliminates the need to change the altimeter setting during a missed approach, whereas such a change would usually be required when QFE is used.
- 2.5. Some operators set the altimeter to QFE in areas where the air traffic control (ATC) and the majority

of other operators use QNH. Standard operating procedures (SOPs) can prevent altimeter setting errors.

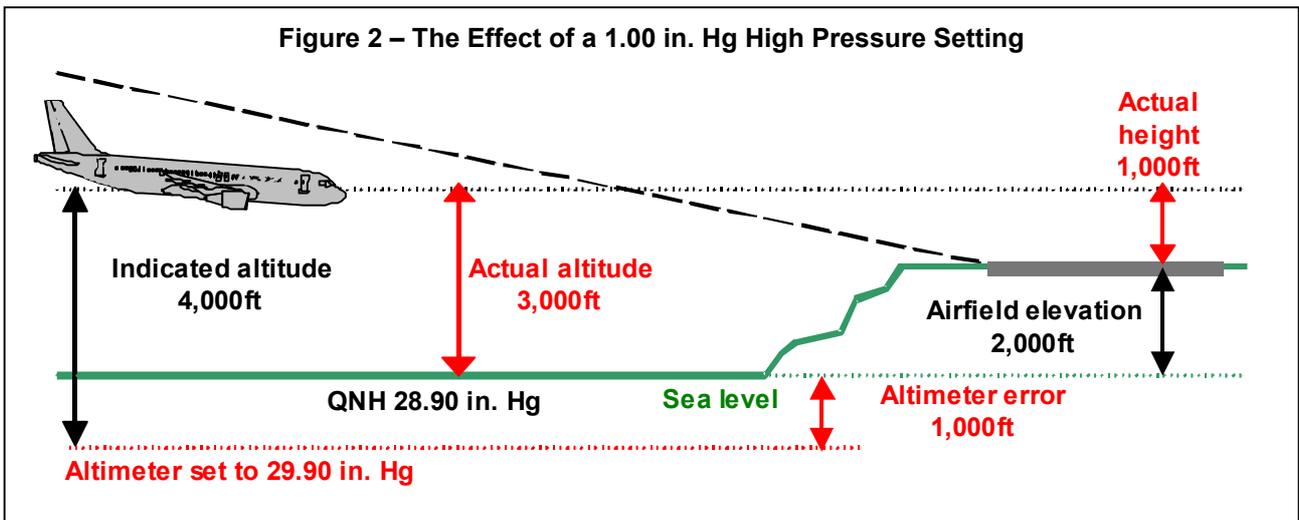
3. Units of Measurement

- 3.1. The most common units of measurement for setting altimeters are:
 - (a) Hectopascals (hPa), still referred to as millibars (mb) in some countries; and,
 - (b) Inches of mercury (in. Hg).
- 3.2. Throughout Europe, hPa (or mb) is the primary altimeter setting. Within North America, the primary altimeter setting is in.Hg. Elsewhere, either system may be encountered.
- 3.3. Altimeter settings are occasionally misheard when listening to ATIS or ATC and the error may sometimes go undetected. When hPa is used as altimeter setting, an error of 10 hPa will correspond to approximately 300 feet error in indicated altitude.
- 3.4. In Figure 1, QNH is 1003 hPa, but the altimeter was mistakenly set to the standard pressure setting, 1013 hPa, resulting in the true altitude (i.e. the aircraft's actual height above mean sea-level) being 300 feet lower than indicated.



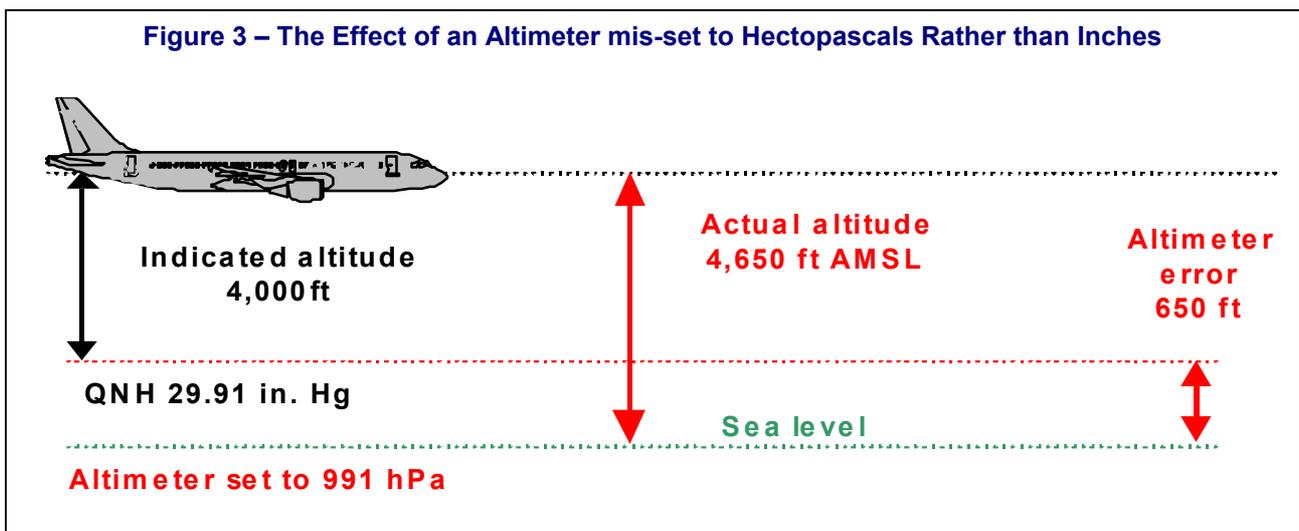
- 3.5. In this example, an uncorrected error when flying a non-precision approach to land could result in impact with the ground about 1nm before touchdown point.
- 3.6. When in. Hg is used for altimeter setting, unusual barometric pressures such as 28.XX in. Hg (low pressure) or 30.XX in. Hg (high pressure) may go undetected with more serious results if a more usual 29.XX is erroneously set.

- 3.7. Figure 2 shows that a 1.00 in. Hg discrepancy in the altimeter setting results in a 1,000 foot error in the indicated altitude.
- 3.8. In Figure 2, QNH is an unusually low 28.90 in. Hg, but the altimeter was mistakenly set to a more usual 29.90 in. Hg, resulting in the true altitude (i.e. the aircraft's actual height above mean sea-level) being 1,000 feet lower than indicated.



- 3.9. Confusion about units of measurement (i.e. hPa and in. Hg) leads to similar errors.

- 3.10. In Figure 3, a QNH of 2991 in. Hg was mistakenly set on the altimeter as 991 hPa resulting in the true altitude being 650 feet higher than indicated.



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4. Setting the Altimeter

- 4.1. To help prevent errors associated with different units of measurement or with unusual values (low or high), the following SOPs should be used when broadcasting (automated traffic information service [ATIS] or controllers) or reading back (pilots) an altimeter setting:
 - All digits, as well as the unit of measurement (e.g. *hectopascals* or *inches*), should be announced.
- 4.2. A transmission such as “altimeter setting six seven” can be interpreted as 967 hPa, 28.67 in. Hg, 29.67 in. Hg or 30.67 in. Hg.
- 4.3. Stating the complete altimeter setting prevents confusion and allows detection and correction of previous error.
- 4.4. An incorrect altimeter setting is often the result of one or more of the following factors:
 - (a) High workload;
 - (b) A deviation from defined task sharing;
 - (c) An interruption or distraction;
 - (d) Inadequate cross-checking by flight crewmembers; or,
 - (e) Confusion about units of measurement.
- 4.5. Adherence to the defined task sharing (for normal or abnormal conditions) and normal checklists are the effective defences to help prevent altimeter setting errors.

5. Metric Altimeter

- 5.1. Metric altitudes in certain countries (e.g. the Commonwealth of Independent States [CIS] and The People’s Republic of China) also require SOPs for the use of metric altimeters or conversion tables.

6. Crossing the Transition Altitude

- 6.1. The transition altitude can be either:
 - (a) Fixed for the whole country (e.g. 18,000 feet in the United States);
 - (b) Fixed for a given airport (as indicated in the approach chart); or,
- 6.2. Transition Level may vary, depending on QNH (as indicated in the ATIS broadcast).

- 6.3. Changing from variable Transition Level to fixed transition altitude may result in a premature or late setting of the altimeter reference (e.g. US aircraft flying into Europe or vice-versa).
- 6.4. An altitude constraint (expressed in terms of altitude or flight level) may also advance or delay the change of the altimeter reference possibly resulting in crew confusion.

7. Changing Altimeter Setting Reference

- 7.1. ICAO PANS-OPS¹ requires that the altimeter pressure setting should be changed to the new reference when crossing the transition altitude/level.
- 7.2. Some national authorities stipulate that, when an aircraft has been cleared to climb from an altitude to a flight level, vertical position will be reported in terms of flight level unless intermediate altitude reports have been specifically requested by ATC. Similarly when a pilot is descending from a flight level to an altitude the pilot will change to the aerodrome QNH unless further flight level vacating reports have been requested by ATC, in which case the QNH will be set following the final flight level vacating report.
- 7.3. Elsewhere, operators have adopted a similar policy in an attempt to minimise the potential for failing to set the correct pressure setting. This policy takes account of the:
 - (a) high pilot workload, usually occurring at or around the transition altitude/level;
 - (b) high rates of climb and descent, which are a feature of modern air transport.
- 7.4. In countries where the above procedure is in force, controllers must realise that the datum will have been changed, and be prepared to act accordingly.
- 7.5. Pilots following this procedure must be aware of the consequences in countries where this procedure is not standard if the controller requires the aircraft to level before the cleared flight level/altitude is reached. (e.g. aircraft cleared to descend from FL 100 to altitude 3,000 feet. Transition level FL 40. Pilot will set QNH and commence descent. If controller subsequently requires the aircraft to level at FL 60 the standard pressure setting must be reset.)

¹ [ICAO Doc 8168 – Procedures for Air Navigation Services – Aircraft Operations \(PANS-OPS\), Volume I, Flight Procedures – Part VI – Altimeter Setting Procedures – Chapter 3](#)

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8. Summary

- 8.1. Altimeter-setting errors are a common cause for level busts and result in a lack of vertical situational awareness. The following minimise the potential for altimeter-setting errors:
- (a) Awareness of altimeter setting changes demanded by prevailing weather conditions (extreme cold fronts, steep frontal surfaces, semi-permanent low pressure areas or seasonal low pressure areas);
 - (b) Awareness of the unit of measurement for setting the altimeter at the destination airport;
 - (c) Awareness of the anticipated altimeter setting, (based on aviation routine weather reports [METARs] and ATIS broadcasts);
 - (d) PF/PNF cross-checking;
 - (e) Adherence to SOPs for:
 - Resetting altimeters at the transition altitude/level;
 - Using the standby altimeter to cross-check the primary altimeters;
 - Altitude calls.

9. Resources

Other Level Bust Briefing Notes

- 9.1. The following Level Bust Toolkit Briefing Notes contain information to supplement this discussion:

[GEN 2 – Pilot-Controller Communications;](#)

[OPS 1 – Standard Operating Procedures;](#)

[OPS 4 – Aircraft Technical Equipment;](#)

[ATM 1 – Understanding the Causes of Level Busts.](#)

Access to Resources

- 9.2. Most of the resources listed may be accessed free of charge from the Internet. Exceptions are:

ICAO documents, which may be purchased direct from [ICAO](#);

Certain Flight Safety Foundation (FSF) Documents, which may be purchased direct from [FSF](#);

Certain documents produced by the Joint Aviation Authorities, which may be purchased from [JAA](#).

Regulatory References

- 9.3. Documents produced by regulatory authorities such as ICAO, JAA and national aviation authorities are subject to amendment. Reference should be made to the current version of the document to establish the effect of any subsequent amendment.

[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 Doc 4444 – Procedures for Air Navigation Services – Rules of the Air and Air Traffic Services \(PANS-ATM\);](#)

[ICAO Doc 8168 – Procedures for Air Navigation Services – Aircraft Operations \(PANS-OPS\), Volume I, Flight Procedures – Part VI – Altimeter Setting Procedures – Chapter 3;](#)

[ICAO Doc 9376 – Preparation of an Operations Manual.](#)

Training Material & Incident Reports

[FSF Approach & Landing Accident Reduction \(ALAR\) Toolkit;](#)

[Briefing Note 3.1 – Barometric Altimeter & Radio Altimeter;](#)

[ICAO Video – Altimetry – Basic Principles;](#)

[ICAO Audioslides – Altimetry – Basic Principles;](#)

[ICAO Poster – Altimeter Setting Procedures;](#)

[UK CAA Poster: Low QNH – High Risk;](#)

[FSF Accident Prevention 54/1 – Learjet MEDEVAC Flight ends in CFIT Accident.](#)

Other Resources

[FSF Digest 6/93 – Research Identifies Common Errors behind Altitude Deviation;](#)

[NASA – International Altimetry;](#)

[The Bluecoat Forum – Avoiding Level Busts;](#)

[UK CAA CAP 710 – On the Level & Recommendations.](#)

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This briefing note has been prepared by the Safety Improvement Sub-Group (SIG) of EUROCONTROL to help prevent level busts. It is one of 14 briefing notes that form a fundamental part of the European Air Traffic Management (EATM) Level Bust Toolkit.

The authors acknowledge the assistance given by many sources, particularly Airbus Industrie and the Flight Safety Foundation (FSF), in developing these notes, some of which draw on material contained in the

FSF Approach and Landing Accident Reduction (ALAR) Toolkit.

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