

1. Introduction

- 1.1. EUROCONTROL has become increasingly aware of the Level Bust issue. In 2001 EUROCONTROL issued a series of Safety Letters¹ within the industry to raise the awareness of aircraft operators and air navigation service providers (ANSPs) to the dangers associated with level busts, and to provide guidance on the correct use of airborne collision avoidance systems (ACAS).
- 1.2. In 2002, a Level Bust Task Force (LBTF) was established and EUROCONTROL held two Level Bust Workshops, the first in Northern Europe; the second in the South. These workshops attracted delegates from all sectors of the airline industry. Various parties who have studied the issue made presentations² and there was valuable discussion, including an exchange of ideas as to the best way forward.
- 1.3. Following the second workshop the LBTF made a number of [recommendations](#)³ aimed at addressing and reducing the level bust threat.
- 1.4. It was decided that a Level Bust Toolkit should be developed to assist aircraft operators and ANSPs to incorporate best practice in their operational procedures. The Level Bust Toolkit includes all the recommendations of the LBTF.
- 1.5. Level Busts or Altitude Deviations, are a potentially serious aviation hazard and occur when an aircraft fails to fly at the level required for safe separation. When reduced vertical separation minima (RVSM) apply, the potential for a dangerous situation to arise is increased.
- 1.6. This operational hazard may result in serious harm, either from a mid-air collision or from collision with the ground (controlled flight into terrain [CFIT]). Occasionally, a rapid avoidance

manoeuvre may be necessary, which may result in injuries to passengers, flight crewmembers, and particularly to cabin crewmembers.

- 1.7. This Briefing Note provides an overview of the factors involved in level busts.

2. Statistical Data

- 2.1. An analysis of level busts⁴ by the US Federal Aviation Administration (FAA) and by USAir (now US Airways) showed that:
 - (a) Approximately 70% of level busts were the result of a breakdown in pilot-controller communications; and,
 - (b) Nearly 40% of level busts resulted when air traffic control (ATC) assigned 10,000 feet and the flight crew set 11,000 feet in the selected altitude window, or vice-versa.
- 2.2. The "[On the Level](#)"⁵ project conducted by the UK CAA during 1999 found that of 626 level bust incidents reported, the top six causal factors, amounting to more than 70% of all incidents, were
 - (a) Operation in SIDs;
 - (b) Autopilot problems;
 - (c) Failure to follow ATC instructions;
 - (d) Altimeter mis-setting;
 - (e) Pilot handling; and,
 - (f) Confusion over cleared level.

¹ EUROCONTROL Safety Letters. See Training Material (Page 6) and <http://www.eurocontrol.int/safety/SafetyLetters.htm>

² Proceedings of the second level bust workshop. See http://www.eurocontrol.int/safety/LevelBust_LevelBust.htm

³ See [Level Bust Action Plan](#)

⁴ [Flight Safety Foundation \(FSF\) Digest 6/93 – Research Identifies Common Errors behind Altitude Deviation](#)

⁵ [UK CAA: CAP 710 – “On the Level” and associated recommendations](#)

3. Defining a Level Bust

- 3.1. The EUROCONTROL (HEIDI⁶) definition of a level bust is:

Any unauthorised vertical deviation of more than 300 feet from an ATC flight clearance.

- 3.2. The definitions of other authorities refer to a deviation equal to or greater than 300 feet.
- 3.3. Within RVSM airspace this limit is reduced to 200 feet.
- 3.4. These briefing notes address solely the level bust issue as defined by EUROCONTROL. Actual or potential loss of separation resulting from controller error will not be considered.

4. Causes of Level Busts

- 4.1. Level busts are usually the result of a breakdown in either:
- (a) The pilot-equipment interface (altimeter setting, use of autopilot, monitoring of instruments and displays); or,
 - (b) The pilot-controller interface (the confirmation/correction process).
- 4.2. Level busts usually occur as the result of one or more of the following conditions:
- (a) Controller-induced situations, such as the following:
 - Late reclearance;
 - The controller assigns an *altitude* after the pilot was cleared to a *flight level* (climbing);
 - The controller assigns a *flight level* after the pilot was cleared to an *altitude* (descending).
 - (b) Pilot-controller communication breakdown – mainly readback/hearback errors such as the following:
 - Pilot mishears level clearance, the pilot does not read back the level and the controller does not challenge the absence of readback;
 - Pilot reads back an incorrect level but controller does not hear the erroneous readback and does not correct the pilot's readback; or,

- Pilot accepts a level clearance intended for another aircraft (confusion of callsigns).
- (c) Pilot understands and reads back the correct altitude or flight level, but select an incorrect altitude or flight level because of:
 - Confusion of numbers with another element of the message (e.g. speed, heading or flight number);
 - Expectation of another altitude or flight level;
 - Interruption/distraction; or,
 - Breakdown in crew cross-checking;
- (d) Autopilot fails to capture the selected altitude;
- (e) The crew does not respond to the altitude-alert aural and visual warnings when hand flying; or,
- (f) The crew conducts an incorrect go-around procedure.

5. Altitude Awareness Programme

- 5.1. The development and implementation of altitude awareness programmes by several airlines has significantly reduced the number of level busts.
- 5.2. To address the main causes of level busts, an altitude awareness programme should include the following aspects.

General

- 5.3. An altitude awareness programme should enhance the monitoring roles of the pilot flying (PF) and the pilot not flying (PNF) (pilot monitoring) by emphasising the importance of:
- (a) Communicating intentions and actions, particularly when they are different from expectations (e.g. delayed climb or descent, management of altitude or speed restrictions); and,
 - (b) Cross-checking and actively monitoring.

Communications

- 5.4. The [FAA-USAir study](#)⁴ showed that approximately 70 percent of level busts are the result of breakdown in the pilot-controller communication loop caused by:
- (a) Readback/hearback errors (this risk is greater when one pilot does not monitor radio communications because of other duties such as listening to the automated terminal

⁶ HEIDI – Harmonisation of European Incident Definitions for ATM.

Level Bust Briefing Notes

General

information service (ATIS), complying with company communications requirements or making public-address announcements);

- (b) Blocked transmissions; or,
- (c) Confusion of callsigns.

5.5. The following recommendations improve communications and situational awareness:

- (a) Be aware that readback/hearback errors involve both the pilot and the controller;
 - The pilot may be interrupted or distracted when listening to a clearance, be subject to forgetfulness or be subject to the bias of expectation when listening to or reading back the instruction (this bias is also termed *wish-hearing*) or may be confused by similar callsigns; and,
 - The controller may confuse similar callsigns, be distracted by other radio communications or by telephone communications, or be affected by blocked transmissions or by workload.
- (b) Use standard phraseology for clear and unambiguous pilot-controller communications and crew communication:
 - Standard phraseology is a common language for pilots and controllers, and this common language increases the likelihood of detecting and correcting errors.
- (c) Use expanded phraseology such as:
 - Announcing when leaving a flight level or altitude (e.g. “leaving [...] for [...],” or, “leaving [...] and climbing/descending to [...]”), thus increasing the controller’s situational awareness;
 - Combining different expressions of specific altitudes (e.g. “one one thousand feet – that is eleven thousand feet”); and,
 - Preceding each number by the corresponding flight parameter (flight level, heading, airspeed [e.g. “descend to flight level two four zero” instead of “descend to two four zero”]).
- (d) When in doubt about a clearance, request confirmation from the controller; do not guess about the clearance based on crew discussion.

Task prioritisation and task sharing

5.6. The following recommendations should enable optimum prioritisation of tasks and task sharing:

- (a) Stop nonessential tasks during critical phases of flight.
 - In the USA, a “[Sterile Cockpit](#)”⁷ rule has been established which defines critical stages of flight and what activities are permitted during them. Many European operators enforce similar procedures by their crews.
 - Some operators consider the final 1,000 feet before reaching the cleared altitude or flight level as a critical stage of flight;
- (b) Monitor/supervise the operation of autopilot/FMS to confirm correct level-off at the cleared altitude and for correct compliance with altitude or time restrictions;
- (c) Plan tasks that preclude listening to ATC communications (e.g. ATIS, company calls, public-address announcements) for periods of infrequent ATC communication; and,
- (d) When one pilot does not monitor the ATC frequency while doing other duties (e.g. company calls) or when leaving the flight deck, the other pilot should:
 - Acknowledge that he/she has responsibility for ATC radio communication and aircraft control, as applicable;
 - Check that the radio volume is adequate to hear an ATC call;
 - Give increased attention to listening/confirming/reading back (because of the absence of cross-checking); and,
 - Brief the other pilot when he/she returns, highlighting any relevant new information and any change in ATC clearance or instructions.

Altitude-setting procedures

5.7. The following techniques enhance standard operating procedures (SOPs):

- (a) When receiving a level clearance, immediately set the cleared altitude in the selected altitude window;

⁷ [FSF Digest 7/94 – Accident and Incident Reports Show Importance of Sterile Cockpit Compliance.](#)

- (b) Ensure that the selected level is cross-checked by both pilots (e.g. each pilot should announce what he/she heard and then point to the selected altitude window to confirm that the correct value has been set);
- (c) Ensure that the cleared level is above the minimum safe altitude (MSA); and,
- (d) Positively confirm the level clearance when receiving radar vectors.

Callouts

- 5.8. Use the following calls to increase PF/PNF situational awareness and to ensure effective backup and challenge, (and to detect a previous error in the cleared altitude or flight level):
- (a) Mode changes on the flight mode annunciator (FMA) and changes of targets (e.g. airspeed, heading, altitude) on the primary flight display (PFD) and navigation display (ND);
 - (b) “Leaving [...] for [...]” and,
 - (c) “One to go”, “One thousand to go”, or “[...] for [...]” when within 1000 feet of the cleared altitude or flight level.
- 5.9. When within 1000 feet of the cleared altitude or flight level or an altitude restriction in visual meteorological conditions (VMC), one pilot should concentrate on scanning instruments (one head down) and one pilot should concentrate on traffic watch (one head up).

6. Flight Level or Altitude Confusion

- 6.1. Confusion between FL 100 and FL 110 (or between 10,000 feet and 11,000 feet)⁸ is usually the result of the combination of two or more of the following factors:
- (a) Readback/hearback error because of similar sounding phrases;
 - (b) Phraseology used, e.g.:
 - ICAO standard phraseology is “flight level one zero zero” and “flight level one one zero”;
 - The non-standard phraseology: “flight level one hundred” is used by a number of European air navigation service providers (ANSPs);

⁸ Transition altitudes as high as 10,000 feet are uncommon in Europe but are regularly found elsewhere, (e.g. in most parts of North America the Transition Altitude is 18,000 feet).

- (c) Mindset tending to focus only on “one zero” and thus to understand more easily “flight level one zero zero”;
- (d) Failing to question the unusual (e.g. bias of expectation on a familiar standard terminal arrival [STAR]); and/or,
- (e) Subconsciously interpreting a request to slow down to 250 kt as a clearance to descend to FL 100 (or 10,000 feet).

7. Transition Altitude/Level

- 7.1. The transition altitude is the altitude at or below which the vertical position of an aircraft is controlled by reference to altitude⁹. The transition level is a variable level above the transition altitude, above which the vertical position of the aircraft is determined by reference to flight level. The transition level varies according to the local atmospheric pressure and temperature.
- 7.2. The transition altitude may be either:
- (a) Fixed for the whole country (e.g. 18,000 feet in the United States); or,
 - (b) Fixed for a given airport (as indicated on the approach chart);
- 7.3. Depending on the airline’s or flight crew’s usual area of operation, changing from fixed transition altitude to variable transition level may result in a premature resetting or a late resetting of the altimeter.
- 7.4. An altitude restriction (expressed in altitude or flight level) may also advance or delay the change of the standard altimeter setting (1013.2 hPa or 29.92 in. Hg) possibly resulting in crew confusion.
- 7.5. In countries operating with QFE, the readback should indicate the altimeter reference (i.e. QFE).

8. High Rates of Climb and Descent

- 8.1. High rates of climb and descent increase the likelihood of a level bust and reduce the opportunity for correcting error before a dangerous situation arises. High rates of climb or descent may also trigger ACAS nuisance warnings.
- 8.2. In any airspace ATC may impose minimum and maximum rates of climb and descent; this is particularly true within RVSM airspace during the last 1,000 feet of climb or descent to cleared flight level.

⁹ [ICAO Annex 2 Chapter 1.](#)

Level Bust Briefing Notes

General

Level Bust

- 8.3. Whether or not a restriction applies, it is good practice to reduce the rate of climb or descent to below 1,500 feet/min when within 1,000 feet of the cleared flight level.

9. Level Busts in Holding Patterns

- 9.1. Controllers assume that pilots will adhere to a clearance that the pilot has read back correctly.
- 9.2. Two separate holding patterns may be under the control of the same controller on the same frequency.
- 9.3. With aircraft in holding patterns, controllers place particular reliance on pilots because the overlay of aircraft data labels on the controller's radar display may not allow the immediate detection of an impending traffic conflict.
- 9.4. Accurate pilot-controller communication is essential when descending in a holding pattern because of the reduced effectiveness of the usual safety-net of short term conflict alert (STCA) and (ACAS):
- (a) STCA may in some cases be disabled;
 - (b) SSR transponders may be required to be switched off; and,
 - (c) ACAS may be required to be switched to TA-only.
- 9.5. The following pilot actions are important when in a holding pattern:
- (a) Do not take a communication intended for an other aircraft (by confusion of similar callsigns); and,
 - (b) Prevent or minimise the risk of blocked transmission, (e.g. simultaneous readback by two aircraft with similar callsigns, or simultaneous transmissions by the pilot and the controller);

10. ACAS (TCAS)

- 10.1. Used correctly, ACAS is an effective tool to help prevent mid-air collisions, which can result from level busts. Operators must develop and enforce SOPs that ensure that pilots respond correctly if the ACAS warning conflicts with instructions from ATC.

11. Summary

- 11.1. Level busts can be prevented by adhering to SOPs to:
- (a) Set the altimeter reference; and,

- (b) Select the cleared altitude or flight level.

- 11.2. To be effective, an altitude awareness programme should be emphasised during transition training, recurrent training and line checks.
- 11.3. Blame-free reporting of level bust events should be encouraged to broaden knowledge of the causal factors of level busts.
- 11.4. The following should be promoted:
- (a) Adhere to the pilot-controller confirmation/correction process (communication loop);
 - (b) Practice flight crew cross-checking to ensure that the *selected* altitude is the *cleared* altitude;
 - (c) Cross-check that the cleared altitude is above the MSA;
 - (d) Monitor instruments and automation when reaching the cleared altitude or flight level; and,
 - (e) In VMC, apply the technique one head down and one head up when reaching the cleared altitude or flight level.

12. Resources

Other Level Bust Briefing Notes

- 12.1. The Level Bust Toolkit includes fourteen briefing notes arranged in three series.
- 12.2. The first series consists of three general notes of equal relevance to pilots and controllers alike:
- GEN 1 – Level Busts: Overview;*
 - [GEN 2 – Pilot-Controller Communications;](#)
 - [GEN 3 – Callsign Confusion.](#)
- 12.3. The second series is slanted towards the needs of the aircraft operator and pilot:
- [OPS 1 – Standard Operating Procedures;](#)
 - [OPS 2 – Altimeter Setting Procedures;](#)
 - [OPS 3 – Standard Calls;](#)
 - [OPS 4 – Aircraft Technical Equipment;](#)
 - [OPS 5 – Airborne Collision Avoidance Systems;](#)
 - [OPS 6 – Human Factors;](#)
 - [OPS 7 – Safety Reporting: Operators.](#)

- 12.4. The third series is of particular importance for air traffic management (ATM) and the controller.

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

[ATM 2 – Reducing Level Busts;](#)

[ATM 3 – Safety Reporting: ATM;](#)

[ATM 4 – Airspace & Procedure Design.](#)

Access to Resources

- 12.5. 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

- 12.6. 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 2 – Rules of the Air:](#)

3.2: Avoidance of Collisions;

3.6.2: Adherence to Flight Plans;

[ICAO Annex 6, Operation of Aircraft, Part I – International Commercial Air Transport – Aeroplanes:](#)

Paragraph 4.2.6 – minimum flight altitudes;

Appendix 2 – Contents of an Operations Manual
Para 5.13 – Instructions on the maintenance of altitude awareness and the use of automated or flight crew altitude call-out;

[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.](#)

Training Material – Safety Letters

[EUROCONTROL Safety Letter – Level Bust: a Shared Issue?;](#)

[EUROCONTROL Safety Letter – Reducing Level Bust;](#)

[EUROCONTROL Safety Letter – En Route to Reducing Level Bust.](#)

Training Material – Posters

Level Bust Prevention posters produced by the UK CAA:

[2 Many Things;](#)

[Low QNH – High Risk;](#)

[No Rush – No Mistake;](#)

[Wun Wun Zero.](#)

Training Material – Videos

[UK NATS Video: Level Best.](#)

Incident Reports

[FSF Accident Prevention 12/98 – Aircraft Accidents Aren't Pt 1;](#)

[FSF Accident Prevention 1/99 – Aircraft Accidents Aren't Pt 2;](#)

[FSF Accident Prevention 4/97 – MD83 Descends Below Minimum Descent Altitude;](#)

[NASA ASRS Directline Issue No 10 – Crossing Restriction Altitude Deviations;](#)

[NASA Altitude Deviations – Breakdowns in an Error Tolerant System;](#)

[NASA ASRS Database Report Set – Altitude Deviations;](#)

[UKAIB – Airbus A330/Airbus A340 over Atlantic.](#)

Other References

[EUROCONTROL – Proceedings of the Second Level Bust Workshop;](#)

[EUROCONTROL – Recommendations of the Level Bust Task Force;](#)

[FSF Approach & Landing Accident Reduction \(ALAR\) Toolkit Briefing Note 3.2 – Altitude Deviations;](#)

Level Bust Briefing Notes

General

Level Bust

[FSF Approach & Landing Accident Reduction \(ALAR\) Toolkit Briefing Note 1.3 – Operations Golden Rules;](#)

[FSF Digest 11/98 – “Killers in Aviation”: Facts about Controlled Flight Into Terrain Accidents;](#)

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

[FSF Digest 7/94 – Accident and Incident Reports Show Importance of Sterile Cockpit Compliance;](#)

[FSF Digest 12/95 – Altitude Awareness Programs Can Reduce Altitude Deviations;](#)

[IATA Report: Problems Around the World with English Language in Civil Aviation;](#)

[Proceedings of the Royal Aeronautical Society \(RAeS\) Human Factors Group – Altitude Bust Conference;](#)

[UK Airprox Board Report Analysis of Airprox in UK Airspace – July 2001 to December 2001;](#)

[UK Airprox Board Report Analysis of Airprox in UK Airspace – January 2002 to June 2002;](#)

[UK CAA AIC 107/2000 – Callsign Confusion;](#)

[UK CAA CAP 710 – “On the Level” and associated recommendations;](#)

[UK CAA – Recommendations Originating from the “On the Level” Project;](#)

[UK CAA Flight Operations Department Communication 2/97 – Altitude Violations;](#)

[UK NATS – Incidents Around Stacks: A Pilot’s View.](#)



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