Level Bust Briefing Notes
Air Traffic Management

ATM 1

Understanding the Causes of Level Busts

1. Introduction

1.1. Most level busts result because the pilot flies the aircraft through the cleared level (either above or below), or levels the aircraft before the cleared level is reached, or deviates from the cleared level.

1.2. An understanding of the problems faced by pilots will help the controller to anticipate situations where a level bust is possible. This may permit the controller to take action to avoid such situations, or to detect them at an early stage before a dangerous situation develops.

1.3. In an ideal world, pilots and controllers would learn about each other's problems from practical experience. Pilots would visit control towers and air traffic control centres; controllers would fly on the flight deck on commercial flights; each would train in each other's simulators. In reality, the opportunity for cross-training is extremely limited; nevertheless, it should be encouraged where possible.

2. Safety Management

2.1. A sound safety management system within the air traffic control organisation is at the heart of accident and incident prevention. Such a system will identify and control risks that may lead to an aircraft accident and will provide solutions, within the more general framework of national and international regulations, appropriate to the ATM operations at specific locations.

2.2. The use of safety management systems by air navigation service providers (ANSPs) is covered in detail by EUROCONTROL regulations, policy statements and related guidance material.[1]

[1] ESARR 3: Use of Safety Management Systems by Air Navigation Service Providers; EATMP Safety Policy document; EATMP Safety Management Implementation Plan; related guidance material.

3. ATC Appreciation of Flightdeck Workload

3.1. Pilots have many tasks to perform; these are normally shared, for example:

(a) The pilot flying (PF) is responsible for controlling the flight path of the aircraft (steering, climbing, levelling, descending) and for managing the engines, by supervising operation of automatic flight systems or by hand-flying the aircraft;

(b) The pilot not flying (PNF) (pilot monitoring) is responsible for monitoring tasks and for assisting the PF. His duties include actioning standard operating procedures (SOPs); managing flight instrumentation when the PF is hand-flying; monitoring systems and aircraft configuration; and, cross-checking the PF to provide back-up as required.

3.2. At all times, one pilot is responsible for operation of the radios, although both pilots normally listen to calls directed to them when other duties permit.

3.3. In addition to operational messages from air traffic control (ATC), the pilots have to make administrative calls to handling agents, airline operations, etc., and listen to voice weather broadcasts and the automated terminal information service (ATIS).

3.4. Periods of very high workload include:

(a) Engine start, taxi, take-off and initial climb, standard instrument departure (SID);

(b) Descent, approach and landing;

(c) Abnormal situations such as equipment malfunction or extreme weather; and,

(d) Emergency situations.

3.5. Multiple frequency changes are often given during high workload periods following takeoff and during the SID. This can cause confusion and distraction from important monitoring tasks.

3.6. Controllers may not be able to avoid passing or revising clearances during periods of high workload. However, by understanding when these occur, by passing clearances as early as possible and by carefully monitoring feedback, they can reduce the possibility of error. Further improvements may be possible by taking account of likely flightdeck workload when designing or revising ATC procedures.

3.7. Climbing through a previously restricted level, and particularly through the First Stop Altitude (FSA), has been identified as a causal factor for level busts. If a new clearance is issued relating to levels, the pilot may assume that the previous restriction no longer applies[2]. To prevent this misunderstanding, the level restriction must be repeated. (e.g. an aircraft on a SID has a height restriction of 3,000 feet until passing waypoint ABC. If the controller wishes to clear the aircraft to FL240 after ABC, the height restriction at ABC should be repeated).

4. Communication

4.1. Break-down in pilot-controller communication is a major cause of level busts.

4.2. Some circumstances make communication break-down more likely. These fall into two classes:

(a) Circumstances associated with the transmission of the message by the controller; and,

(b) Circumstances associated with the reception of the message by the pilots and their subsequent action.

5. Circumstances associated with the transmission of the message by the controller

5.1. A message from the controller may be misunderstood, or a pilot may take a clearance intended for another aircraft. This is especially likely in the following circumstances:

(a) Frequency congestion (perhaps leading to the controller speaking too quickly);

(b) Long clearances, containing several pieces of information that may be confused (e.g. flight level [FL], speed, or heading);

(c) Blocked or simultaneous transmissions;

(d) Late clearances (leaving insufficient time for pilots to re-brief to take account of the changes);

(e) Language difficulties (including the use of colloquial[3] expressions); and/or,

(f) Non-standard phraseology, including abbreviation of callsigns and messages.

6. Circumstances associated with the reception of the message by the pilots

6.1. The pilots may miss or incorrectly interpret a message from the controller due to circumstances on board the aircraft. This is most likely in the following circumstances:

(a) High workload (especially during departure or arrival, or following equipment malfunction);

(b) Fatigue (pilot schedules may consist of a large number of short sectors repeated for several days or very long flights crossing a large number of time-zones);

(c) Distractions or interruptions (from other crew-members or from company messages on a different frequency); and/or,

(d) Language difficulties (the pilot's command of English may be limited).

6.2. It has been found that confusion sometimes arises when pilots are cleared to certain flight levels or altitudes, especially FL100, which may be interpreted as FL110, or vice versa (or 10,000 feet may be interpreted as 11,000 feet).

6.3. The controller cannot know what is happening on the flight deck; nevertheless the following defensive measures by the controller will reduce the likelihood of error:

(a) Always use the full company callsign and request confirmation of full callsign if the pilot abbreviates the callsign;

(b) Give clearances, including re-clearances, in good time, if possible anticipating periods of high pilot workload;

(c) Where possible, avoid late changes to a clearance especially where the change necessitates lengthy re-briefing by pilots (e.g. change of take-off runway, change of standard

[2] ICAO is aware of this potential source of error and confirms that a level restriction *will need to be repeated* in order to continue to be in effect after a new clearance related to levels has been issued. This issue will be addressed in an amendment proposal to PANS-ATM which is currently being prepared.

[3] Colloquial language is the every day informal language used by native speakers.

instrument departure [SID], change of landing runway);

(d) Avoid rapid speech when transmitting clearances;

(e) Break down lengthy clearances into chunks, preferably avoiding transmitting elements that could be confused (e.g. flight level, speed, or heading) in the same chunk;

(f) Precede each number in a clearance 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"])[4];

(g) Take particular care when issuing a clearance to level at flight levels or altitudes that are often confused (e.g. FL100 or FL110)[3];

(h) Avoid colloquial language, especially when the pilots are not native English speakers;

(i) Always use standard phraseology;

(j) Insist on readback; listen carefully to readback; always correct errors; and, insist on correct readback following an error for as many times as is necessary to ensure that the correct clearance has been understood.

6.4. For a detailed discussion of communication problems see Briefing Note *GEN 2 – Pilot-Controller Communications*.

7. Altimeter Pressure Setting

7.1. Altimeter pressure setting presents several possibilities for error, for example:

(a) A pressure setting in hectopascals (hPa) may be confused with a setting in inches of mercury (in.Hg) (e.g. 993 hPa interpreted as 2993 in.Hg);

(b) The pilot may set the incorrect pressure setting (standard, QNH or QFE) resulting in:

– A clearance to climb to a flight level being understood as a clearance to climb to an altitude, (or a clearance to descend to an altitude being interpreted as a clearance to a flight level);

– An altitude (expressed with reference to QNH) being interpreted as a height above touchdown (expressed with reference to QFE);

(c) The pilot may change pressure setting too soon or too late due to a mistaken assumption of the height of the transition altitude (TA) or transition level (TL).[5]

(d) A flight level or altitude expressed in metres may be interpreted as a flight level or altitude expressed in feet, or vice versa.

7.2. The controller can reduce the likelihood of error by paying close attention to use of standard phraseology and by insisting on the correct readback procedure.

7.3. Standard phraseology is especially important when:

(a) Passing a clearance to pilots whose familiarity with the English language is limited;

(b) Specifying the altitude reference when this changes (e.g. "descend to 3,000 feet QNH" or "set QNH 993 hPa and descend to 3,000 feet");

(c) Passing the pressure setting to the pilot of a North American aircraft. In the USA and Canada, pressure settings are always expressed in in.Hg.; the pressure setting reference should therefore be stressed (e.g. "set QNH 993 hPa," not, "set 993");

(d) Passing an altitude or flight level clearance to a pilot accustomed to use metres as altitude reference. When passing a new altitude or level clearance the altitude reference should be stressed.

7.4. Pilots from the USA and Canada are accustomed to a standard TA of 18,000 feet. There is therefore an enhanced risk of error when clearing them to a flight level below 18,000 feet. This risk may be reduced by repeating the clearance (e.g. descend to flight level one two zero I say again flight level one two zero).

8. Low Temperature Operation

8.1. In a standard atmosphere, the indicated QNH altitude is the true altitude.

[4] Within UK several non-standard practices are followed, in particular the word 'to' is omitted from messages relating to flight levels and expressions such as FL100 are spoken as 'flight level wun hundred'. *See GEN2, Section 7*.

[5] Within UK, it is standard practice to set QNH on altimeters as soon as clearance to an altitude is received, and to set standard pressure setting as soon as clearance to a flight level is received. Similar practices are followed by operators elsewhere.

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

(a) At extremely *high* temperatures, the true altitude is *higher* than the indicated altitude; and,

(b) At extremely *low* temperatures, the true altitude is *lower* than the indicated altitude, resulting in reduced terrain clearance.

8.3. If relevant, controllers must take care not to allocate the lowest altitude in extremely cold conditions.

9. Airborne Collision Avoidance Systems

9.1. Airborne collision avoidance systems (ACAS) are designed to improve safety by acting as a "last resort" method of preventing mid-air collisions. This is achieved by the ACAS requiring pilots to manoeuvre in the vertical plane when the equipment detects an imminent risk of collision.

9.2. ACAS issues two types of warning of potential collision:

(a) A traffic advisory (TA) is issued 20 to 48 seconds before the closest point of approach (CPA) to warn the pilots that a resolution advisory (RA) may follow and to assist in a visual search for the traffic;

(b) An RA is issued 15 to 35 second before CPA to warn the pilots that a high collision risk exists unless the indicated avoiding action is followed.

9.3. Whenever two aircraft are operating ACAS in RA mode, ACAS co-ordinates the RAs so that avoiding action is complementary in order to reduce the potential for collision.

9.4. Manoeuvres, or lack of manoeuvres, that result in vertical rates opposite to the sense of an RA could result in a collision with the threat aircraft.

9.5. Separation is based on the assumption that both pilots follow the indicated manoeuvre; if one pilot does not do so, separation may be less than if that aircraft was not ACAS equipped.

9.6. The update rate of the radar display, even with radar data processing system (RDPS) multi-radar data, is slower than the ACAS update rate. A change in the vertical situation seen by the controller may be delayed, particularly when aircraft are rapidly climbing or descending.

9.7. ICAO[6] gives clear and unequivocal guidance to pilots on the use of ACAS. This may be summarised as follows:

(a) Do not take any avoiding action on the sole basis of a TA;

(b) On receipt of an RA:

- respond immediately by following the RA as indicated, unless doing so would jeopardise the safety of the aeroplane;
- follow the RA even if there is a conflict between the RA and an air traffic control (ATC) instruction to manoeuvre;
- do not manoeuvre in the opposite sense to an RA;
- as soon as possible, as permitted by flight crew workload, notify the appropriate ATC unit of the RA, including the direction of any deviation from the current air traffic control instruction or clearance;
- promptly comply with any modified RAs;
- limit the alterations of the flight path to the minimum extent necessary to comply with the RAs;
- promptly return to the terms of the ATC instruction or clearance when the conflict is resolved; and,
- notify ATC when returning to the current clearance.

9.8. Where a collision risk exists, ACAS provides the most effective means of collision avoidance.

9.9. When a controller is informed that a pilot is following an RA, he should not attempt to modify the aircraft flight path until the pilot reports returning to the clearance. He should provide traffic information as appropriate.

9.10. Automatic indication to the controller that a pilot has received an RA is expected to be introduced in the future.

10.ATC Procedure Design[7]

10.1. The design of instrument procedures (especially standard instrument departures [SIDs]) and their presentation in route manuals is a potential source of pilot error.

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[6] ICAO Procedures for Air Navigation Services – Aircraft Operations, Volume I – Flight Procedures (PANS-OPS, Doc 8168), Part VIII Chapter 3.

[7] See also Briefing Note ATM 4 – Airspace & Procedure Design

10.2. Route manuals are commercially produced documents that interpret the instructions contained in national aeronautical information publications (AIPs), either on paper or electronically. Different aircraft operators do not all use the same route manual.

10.3. The following are examples of situations where errors sometimes occur:

(a) The procedure is excessively complex (this may cause confusion or necessitate frequent reference back to the procedure plate); or,

(b) Alternative procedures for different runways contain different vertical clearance limits (a particular problem in the case of late runway change); or,

(c) The vertical clearance limit may be expressed as a flight level (changing pressure setting may be overlooked when workload is high); or,

(d) The presentation of the procedure in the route manual may be unsatisfactory (e.g. too much information displayed on an SID plate making it hard to spot vital information amongst other detail).

10.4. Possible defensive action includes the following:

(a) Analysis of the procedure with a view to identifying and removing any cause of possible confusion or error.

(b) Review of the presentation to ensure that it represents clearly and unambiguously the intention of the procedure. It may happen that the presentation of the procedure in one route manual causes problems whilst another does not; this can only be discovered by investigating the incident in co-operation with the aircraft operator;

(c) Reinforcing the element of the procedure that gives rise to confusion or error by additional verbal instructions.

11. Summary

11.1. ANSPs and Controllers can make a positive contribution to reducing level busts by:

(a) Reporting level bust incidents and potential incidents;

(b) Analysing incident reports to identify high-risk situations;

(c) Where possible, eliminating high-risk situations at source (e.g. revising procedure design);

(d) Understanding the situations that make level busts more likely;

(e) Adhering strictly to standard phraseology in all communications;

(f) Avoiding giving multiple clearances where possible;

(g) Where possible, reducing pilot distraction during high workload periods by timely transmission of messages and clearances;

(h) Insisting on standard readback procedure;

(i) Paying particular attention to communications with aircraft whose callsigns are similar to others on, or soon expected to be on the same RTF frequency;

(j) When a pilot is following an ACAS RA, the controller should cease giving instructions until the pilot informs her/him that she/he is resuming his clearance.

12. Resources

Other Level Bust Briefing Notes

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

GEN 2 – Pilot-Controller Communications;

GEN 3 – Callsign Confusion;

ATM 3 – Safety Reporting: ATM;

ATM 4 – Airspace & Procedure Design;

OPS 1 – Standard Operating Procedures;

OPS 2 – Altimeter Setting Procedures;

OPS 5 – Airborne Collision Avoidance Systems;

OPS 6 – Human Factors;

Access to Resources

12.2. 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

12.3. 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 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

Wun Wun Zero

Other Resources

NASA: What Goes Up Must Come Down;

Proceedings of the Royal Aeronautical Society Human Factors Group Altitude Bust Conference – ATC Radar: When it's Not Watching You.

This briefing note has been prepared by the Safety Improvement Sub-Group (SISG) 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.

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