FLIGHT SAFETY FOUNDATION

ALAR

APPROACH-AND-LANDING ACCIDENT REDUCTION

TOOL KIT

FSF ALAR BRIEFING NOTE 3.2

Altitude Deviations

Altitude deviations may result in substantial loss of aircraft vertical separation or horizontal separation, which could cause a midair collision.

Maneuvers to avoid other aircraft often result in injuries to passengers, flight crewmembers and, particularly, to cabin crewmembers.

Statistical Data

An analysis by the U.S. Federal Aviation Administration (FAA) and by USAir (now US Airways) of altitude-deviation events[1] showed that:

- Approximately 70 percent of altitude deviations were the result of a breakdown in pilot-controller communication; and,
- Nearly 40 percent of altitude deviations resulted when air traffic control (ATC) assigned 10,000 feet and the flight crew set 11,000 feet in the selected-altitude window, or when ATC assigned 11,000 feet and the flight crew set 10,000 feet in the selected-altitude window.

Defining Altitude Deviations

An altitude deviation is a deviation from the assigned altitude (or flight level) equal to or greater than 300 feet.

Causes of Altitude Deviations

Altitude deviations are usually the result of a breakdown in either:

- The pilot-system interface:
  - Altimeter setting, use of autopilot, monitoring of instruments and displays; or,
- The pilot-controller interface:
  - Communication loop (i.e., the confirmation/correction process).

Altitude deviations occur usually as the result of one or more of the following conditions:

- The controller assigns an incorrect altitude or reassigns a *flight level* after the pilot was cleared to an *altitude*;
- Pilot-controller communication breakdown — mainly read-back/hearback errors such as the following:
  - Controller transmits an incorrect altitude, the pilot does not read back the altitude and the controller does not challenge the absence of a readback;
  - Pilot reads back an incorrect altitude, but the controller does not hear the erroneous readback and does not correct the pilot's readback; or,
  - Pilot accepts an altitude clearance intended for another aircraft (confusion of call signs);
- Pilot receives, understands and reads back the correct altitude or flight level but selects an incorrect altitude or flight level because of:
  - Confusion of numbers with another element of the message (e.g., airspeed, heading or flight number);
  - Expectation of another altitude/flight level;
  - Interruption/distraction; or,
  - Breakdown in crew cross-checking;
- Autopilot fails to capture the selected altitude;
- The crew does not respond to altitude-alert aural warnings and visual warnings when hand flying; or,
- The crew conducts an incorrect go-around procedure.

Altitude-Awareness Program

The development and implementation of altitude-awareness programs by several airlines have reduced significantly the number of altitude deviations.

To help prevent the primary causes of altitude deviations, an altitude-awareness program should include the following:

General

An altitude-awareness program should enhance the monitoring roles of the pilot flying (PF) and the pilot not flying/pilot monitoring (PNF/PM) by emphasizing the importance of:

- Announcing intentions and actions, particularly when they are different from expectations (e.g., delayed climb or descent, management of altitude or airspeed restrictions); and,
- Cross-checking.

Communication

The FAA-USAir study showed that approximately 70 percent of altitude deviations are the result of a breakdown in the pilot-controller communication loop caused by:

- Readback/hearback errors (this risk is greater when one pilot does not monitor radio communications because of other duties such as listening to the automatic terminal information service [ATIS], complying with company-communication requirements or making public-address announcements);
- Blocked transmissions; or,
- Confusion of call signs.

The following recommendations improve communication and situational awareness:

- 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 when reading back the instruction (this bias is also termed *wish-hearing*), or may be confused by similar call signs; and,
  - The controller may confuse similar call signs, be distracted by other radio communications or by telephone communications, or be affected by blocked transmissions or by workload;
- Use standard phraseology for clear and unambiguous pilot-controller communication 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;
- Use expanded phraseology, such as:
  - Announcing when leaving an altitude (e.g., "Leaving [...] for [...]," or, "leaving [...] and climbing to [...]"), thus increasing the controller's situational awareness;
  - The announcement "leaving [altitude or flight level]" should be made only when a vertical speed of 500 feet per minute (fpm) has been established and the altimeter confirms departure from the previous altitude;
  - Combining different expressions of specific altitudes ("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"]); and,
- When in doubt about a clearance, request confirmation from the controller; do not guess about the clearance based on crew discussion.

Task Prioritization and Task Sharing

The following recommendations enable optimum prioritization of tasks and task sharing:

- Reduce nonessential tasks during climb and descent (in addition to the "critical phases of flight" defined in the "sterile cockpit rule,"[2] some operators consider the final 1,000 feet before reaching the assigned altitude as a sterile-cockpit period);
- Monitor/supervise the operation of the autopilot to confirm correct level-off at the cleared altitude and for compliance with altitude restrictions or time restrictions;
- Plan tasks that preclude listening to ATC communications (e.g., ATIS, company calls, public-address announcements) for periods of infrequent ATC communication; and,
- 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 receiving 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 completes other duties or returns to the flight deck, and communicate relevant new information and any change in ATC clearances or instructions.

Altitude-Setting Procedures

The following techniques enhance standard operating procedures (SOPs):

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

Standard Calls

Use the following calls to increase PF-PNF/PM situational awareness and to ensure effective backup and challenge (and to detect a previous error in the assigned altitude/flight level):

- 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);
- "Leaving [...] for [...]" when a 500 fpm (minimum) vertical speed has been established; and,
- "One to go," "One thousand to go" or "[...] for [...]" when within 1,000 feet of the assigned/cleared altitude/flight level.

When within 1,000 feet of the assigned altitude/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).

Flight Level (FL) Confusion

Confusion between 10,000 feet and 11,000 feet (FL 100 and FL 110) is usually the result of the combination of two or more of the following factors:

- Readback/hearback error because of similar-sounding phrases;
- Lack of standard phraseology:
  - International Civil Aviation Organization (ICAO): "flight level one *zero zero*/flight level one one zero";
  - U.K. National Air Traffic Services (NATS): "flight level one *hundred*/flight level one one zero";
- Mindset tending to focus only on "one zero" and thus to more easily understand "10,000 feet";
- Failing to question the unusual (e.g., bias of expectation on a familiar standard terminal arrival [STAR]); and/or,
- Interpreting subconsciously a request to slow to 250 knots as a clearance to descend to FL 100 (or 10,000 feet).

Transition Altitude/Flight Level

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 on the approach chart); or,
- Variable as a function of QNH (an altimeter setting that causes the altimeter to indicate height above mean sea level [i.e., field elevation at touchdown on the runway]) as indicated in the ATIS broadcast.

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

An altitude restriction (expressed in altitude or flight level) also may delay or advance the setting of the standard altimeter setting (1013.2 hPa or 29.92 in. Hg), possibly resulting in crew confusion.

In countries operating with QFE (altimeter setting that causes the altimeter to indicate height above the QFE reference datum [i.e., zero at touchdown on the runway]), the readback should indicate the altimeter reference (i.e., QFE).

Altitude Deviations in Holding Patterns

Controllers assume that the pilot will adhere to a clearance that the pilot has read back correctly.

Two separate holding patterns may be under the control of the same controller, on the same frequency.

With aircraft in holding patterns, controllers particularly rely on pilots because the overlay of aircraft data tags on the controller's radar display may not allow the immediate detection of an impending traffic conflict.

Secondary surveillance radars provide conflict alert but not resolution advisory; thus, accurate pilot-controller communication is essential when descending in a holding pattern.

The following pilot actions are important when in a holding pattern:

- Do not take a communication intended for another aircraft (by confusion of similar call signs);
- Prevent/minimize the risk of blocked transmission (e.g., simultaneous readback by two aircraft with similar call signs or simultaneous transmissions by the pilot and the controller); and,
- Announce "leaving [altitude or flight level]" only when a vertical speed of 500 fpm has been established and the altimeter confirms departure from the previous altitude.

TCAS (ACAS)

The traffic-alert and collision avoidance system (airborne collision avoidance system) is an effective tool to help prevent midair collisions, which can result from altitude deviations.

Summary

Altitude deviations can be prevented by adhering to SOPs to:

- Set the altimeter reference; and,
- Select the assigned altitude/flight level.

To be effective, a company altitude-awareness program should be emphasized during transition training, recurrent training and line checks.

Blame-free reporting of altitude-deviation events should be encouraged to broaden the company's knowledge and the industry's knowledge of the causal factors of altitude deviations.

The following should be promoted:

- Adhere to the pilot-controller confirmation/correction process (communication loop);
- Practice flight crew cross-checking to ensure that the *selected* altitude is the *assigned* altitude;
- Cross-check that the assigned altitude is *above the MSA* (unless the flight crew is aware that the assigned altitude is above the minimum vectoring altitude);
- Monitor instruments and automation when reaching the assigned altitude/flight level; and,
- In VMC, apply the practice of one head down and one head up when reaching the assigned altitude/flight level.

The following FSF ALAR Briefing Notes provide information to supplement this discussion:

- 1.1 — Operating Philosophy;
- 1.3 — Golden Rules;
- 1.4 — Standard Calls;
- 2.3 — Pilot-Controller Communication;
- 2.4 — Interruptions/Distractions; and,
- 3.1 — Barometric Altimeter and Radio Altimeter.

Notes

1. Pope, John A. "Research Identifies Common Errors Behind Altitude Deviations." *Flight Safety Digest* Volume 12 (June 1993): 1–13.
2. The *sterile cockpit rule* refers to U.S. Federal Aviation Regulations Part 121.542, which states: "No flight crewmember may engage in, nor may any pilot-in-command permit, any activity during a critical phase of flight which could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft. For the purposes of this section, critical phases of flight include all ground operations involving taxi, takeoff and landing, and all other flight operations below 10,000 feet, except cruise flight." [The FSF ALAR Task Force says that "10,000 feet" should be height above ground level during flight operations over high terrain.]

Related Reading From FSF Publications

Gurney, Dan. "Last Line of Defense." *AeroSafety World* Volume 2 (January 2007).

Flight Safety Foundation (FSF) Editorial Staff. "ATR 42 Strikes Mountain on Approach in Poor Visibility to Pristina, Kosovo." *Accident Prevention* Volume 57 (October 2000).

Sumwalt, Robert L. III. "Enhancing Flight-crew Monitoring Skills Can Increase Flight Safety." *Flight Safety Digest* Volume 18 (March 1999).

FSF Editorial Staff. "Boeing 737 Pilot Flying Selects Incorrect Altitude in Holding Pattern, Causes Dangerous Loss of Separation with MD-81." *Accident Prevention* Volume 55 (April 1998).

FSF Editorial Staff. "Different Altimeter Displays and Crew Fatigue Likely Contributed to Canadian Controlled-flight-into-terrain Accident." *Accident Prevention* Volume 52 (December 1995).

Sumwalt, Robert L. III. "Altitude Awareness Programs Can Reduce Altitude Deviations." *Flight Safety Digest* Volume 14 (December 1995).