



Flight Safety Foundation

# ALAR

Approach-and-landing Accident Reduction

# Tool Kit

## FSF ALAR Briefing Note 2.1 — Human Factors

Human factors identified in approach-and-landing accidents (ALAs) should be used to assess a company's risk exposure and develop corresponding company accident-prevention strategies, or to assess an individual's risk exposure and develop corresponding personal lines of defense.

Whether involving crew, air traffic control (ATC), maintenance, organizational factors or aircraft design, each link of the error chain involves human beings and, therefore, human decisions and behaviors.

### Statistical Data

There is general agreement that human error is involved in more than 70 percent of aviation accidents.

### Human Factors Issues

#### Standard Operating Procedures (SOPs)

To ensure adherence to published standard operating procedures (SOPs) and associated normal checklists and standard calls, it is important to understand why pilots may deviate from SOPs.

Pilots sometimes deviate intentionally from SOPs; some deviations occur because the procedure that was followed in place of the SOP seemed to be appropriate for the prevailing situation. Other deviations are usually unintentional.

The following factors often are cited in discussing deviations from SOPs:

- Task saturation;

- Inadequate knowledge or failure to understand the rule, procedure or action because of:
  - Inadequate training;
  - Printed information not easily understood; and/or,
  - Perception that a procedure is inappropriate;
- Insufficient emphasis on adherence to SOPs during transition training and recurrent training;
- Inadequate vigilance (fatigue);
- Interruptions (e.g., because of pilot-controller communication);
- Distractions (e.g., because of flight deck activities);
- Incorrect management of priorities (lack of decision-making model for time-critical situations);
- Reduced attention (tunnel vision) in abnormal conditions or high-workload conditions;
- Incorrect crew resource management (CRM) techniques (for crew coordination, cross-check and backup);
- Company policies (e.g., schedules, costs, go-arounds and diversions);
- Other policies (e.g., crew duty time);
- Personal desires or constraints (schedule, mission completion);
- Complacency; and/or,
- Overconfidence.

#### Automation

Errors in using automatic flight systems (AFSs) and insufficient knowledge of AFS operation have been contributing factors

in approach-and-landing accidents and incidents, including those involving controlled flight into terrain.

The following are some of the more common errors in using AFSs:

- Inadvertent selection of an incorrect mode;
- Failure to verify the selected mode by reference to the flight-mode annunciator (FMA);
- Failure to arm a mode (e.g., failure to arm the approach mode) at the correct time;
- Inadvertent change of a target entry (e.g., changing the target airspeed instead of entering a new heading);
- Failure to enter a required target (e.g., failure to enter the correct final approach course);
- Incorrect altitude entry and failure to confirm the entry on the primary flight display (PFD);
- Entering a target altitude that is lower than the final approach intercept altitude during approach;
- Preoccupation with FMS programming during a critical flight phase, with consequent loss of situational awareness; and/or,
- Failure to monitor automation and cross-check parameters with raw data.<sup>1</sup>

Other frequent causal factors<sup>2</sup> in ALAs include:

- Inadequate situational awareness;
- Incorrect interaction with automation;
- Overreliance on automation; and/or,
- Inadequate effective crew coordination, cross-check and backup.<sup>3</sup>

### **Briefing Techniques**

The importance of briefing techniques often is underestimated, although effective briefings enhance crew standardization and communication.

Routine and formal repetition of the same information on each flight may become counterproductive; adapting and expanding the briefing by highlighting the special aspects of the approach or the actual weather conditions will result in more effective briefings.

In short, the briefing should attract the attention of the pilot not flying (PNF).

The briefing should help the pilot flying (PF) and the PNF to know the sequence of events and actions, as well as the special hazards and circumstances of the approach.

An interactive briefing style provides the PF and the PNF with an opportunity to fulfill two important goals of the briefing:

- Correct each other; and,
- Share a common mental image of the approach.

### **Crew-ATC Communication**

Effective communication is achieved when our intellectual process for interpreting the information contained in a message accommodates the message being received.

This process can be summarized as follows:

- How do we perceive the message?
- How do we reconstruct the information contained in the message?
- How do we link the information to an objective or to an expectation?
- What amount of bias or error is introduced in this process?

CRM highlights the relevance of the *context* and the *expectations* in communication.

The following factors may affect adversely the understanding of communications:

- High workload;
- Fatigue;
- Nonadherence to the “sterile cockpit rule”<sup>4</sup>;
- Interruptions;
- Distractions; and/or,
- Conflicts and pressures.

The results may include:

- Incomplete communication;
- Omission of the aircraft call sign or use of an incorrect call sign;
- Use of nonstandard phraseology; and,
- Failure to listen or to respond.

### **Crew Communication**

Interruptions and distractions on the flight deck break the flow pattern of ongoing activities, such as:

- SOPs;
- Normal checklists;
- Communication (listening, processing, responding);
- Monitoring tasks; and,
- Problem-solving activities.

The diverted attention resulting from the interruption or distraction usually causes the flight crew to feel rushed and to be confronted by competing tasks.

Moreover, when confronted with concurrent task demands, the natural human tendency is to perform one task to the detriment of another.

Unless mitigated by adequate techniques to set priorities, interruptions and distractions may result in the flight crew:

- Not monitoring the flight path (possibly resulting in an altitude deviation, course deviation or controlled flight into terrain);
- Missing or misinterpreting an ATC instruction (possibly resulting in a traffic conflict or runway incursion);
- Omitting an action and failing to detect and correct the resulting abnormal condition or configuration, if interrupted during a normal checklist; and,
- Leaving uncertainties unresolved (e.g., an ATC instruction or an abnormal condition).

### **Altimeter-setting Error**

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

- High workload;
- Incorrect pilot-system interface;
- Incorrect pilot-controller communication;
- Deviation from normal task-sharing;
- Interruptions and distractions; and/or,
- Insufficient backup between crewmembers.

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

### **Unstabilized Approaches**

The following often are cited when discussing unstabilized approaches:

- Fatigue in short-haul, medium-haul or long-haul operations (which highlights the need for developing countermeasures to restore vigilance and alertness for the descent, approach and landing);
- Pressure of flight schedule (making up for delays);
- Any crew-induced circumstance or ATC-induced circumstance resulting in insufficient time to plan, prepare and conduct a safe approach (including accepting requests from ATC to fly higher, to fly faster or to fly shorter routings than desired);
- Inadequate ATC awareness of crew capability or aircraft capability to accommodate a last-minute change;

- Late takeover from automation (e.g., after the autopilot fails to capture the localizer or glideslope, usually because the crew failed to arm the approach mode);
- Inadequate awareness of adverse wind conditions;
- Incorrect anticipation of aircraft deceleration characteristics in level flight or on a three-degree glide path;
- Failure to recognize deviations or to remember the excessive-parameter-deviation limits;
- Belief that the aircraft will be stabilized at the minimum stabilization height (i.e., 1,000 feet above airport elevation in instrument meteorological conditions or 500 feet above airport elevation in visual meteorological conditions) or shortly thereafter;
- PNF overconfidence in the PF to achieve timely stabilization;
- PF/PNF overreliance on each other to call excessive deviations or to call for a go-around; and/or,
- Visual illusions during the acquisition of visual references or during the visual segment.

### **Runway Excursions and Runway Overruns**

The following are human factors (involving ATC, flight crew and/or maintenance personnel) in runway excursions and runway overruns:

- No go-around decision when warranted;
- Inaccurate information on surface wind, runway condition or wind shear;
- Incorrect assessment of crosswind limit for prevailing runway conditions;
- Incorrect assessment of landing distance for prevailing wind conditions and runway conditions, or for a malfunction affecting aircraft configuration or braking capability;
- Captain taking over the controls and landing the aircraft despite the announcement or initiation of a go-around by the first officer (the PF);
- Late takeover from automation, when required (e.g., late takeover from autobrakes because of system malfunction);
- Inoperative equipment not noted per the minimum equipment list (e.g., one or more brakes being inoperative); and/or,
- Undetected thrust asymmetry (forward/reverse asymmetric thrust condition).

### **Adverse Wind Conditions**

The following human factors often are cited in discussing events involving adverse winds (e.g., crosswinds, tail winds):

- Reluctance to recognize changes in landing data over time (e.g., change in wind direction/velocity, increase in gusts);
- Failure to seek evidence to confirm landing data and established options (i.e., reluctance to change plans);
- Reluctance to divert to an airport with more favorable wind conditions; and/or,
- Insufficient time to observe, evaluate and control the aircraft attitude and flight path in a dynamic situation.

## Summary

Addressing human factors in ALAs must include:

- Defined company safety culture;
- Defined company safety policies;
- Company accident-prevention strategies;
- SOPs;
- CRM practices; and,
- Personal lines of defense.

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

- 1.1 — *Operating Philosophy*;
- 1.3 — *Golden Rules*;
- 1.4 — *Standard Calls*;
- 1.5 — *Normal Checklists*;
- 1.6 — *Approach Briefing*;
- 2.2 — *Crew Resource Management*;
- 2.3 — *Pilot-Controller Communication*;
- 2.4 — *Interruptions/Distractions*;
- 3.1 — *Barometric Altimeter and Radio Altimeter*;
- 3.2 — *Altitude Deviations*;
- 7.1 — *Stabilized Approach*; and,
- 8.1 — *Runway Excursions and Runway Overruns*.♦

## References

1. The FSF ALAR Task Force defines *raw data* as “data received directly (not via the flight director or flight management computer) from basic navigation aids (e.g., ADF, VOR, DME, barometric altimeter).”
2. The FSF ALAR Task Force defines *causal factor* as “an event or item judged to be directly instrumental in the causal chain of events leading to the accident [or incident].”
3. Flight Safety Foundation. “Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and

Controlled-flight-into-terrain Accidents.” *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999): 1–121. The facts presented by the FSF ALAR Task Force were based on analyses of 287 fatal approach-and-landing accidents (ALAs) that occurred in 1980 through 1996 involving turbine aircraft weighing more than 12,500 pounds/5,700 kilograms, detailed studies of 76 ALAs and serious incidents in 1984 through 1997 and audits of about 3,300 flights.

4. 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

FSF. “Aviation Grapples with Human-factors Accidents.” *Flight Safety Digest* Volume 18 (May 1999).

FSF Editorial Staff. “B-757 Damaged by Ground Strike During Late Go-around from Visual Approach.” *Accident Prevention* Volume 56 (May 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. “Inadequate Visual References in Flight Pose Threat of Spatial Disorientation.” *Human Factors & Aviation Medicine* Volume 44 (November–December 1997).

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

FSF Editorial Staff. “Poorly Flown Approach in Fog Results in Collision With Terrain Short of Runway.” *Accident Prevention* Volume 52 (August 1995).

Mohler, Stanley R. “The Human Balance System: A Refresher for Pilots.” *Human Factors & Aviation Medicine* Volume 42 (July–August 1995).

Lawton, Russell. "Steep Turn by Captain During Approach Results in Stall and Crash of DC-8 Freighter." *Accident Prevention* Volume 51 (October 1994).

FSF Editorial Staff. "Cockpit Coordination, Training Issues Pivotal in Fatal Approach-to-Landing Accident." *Accident Prevention* Volume 51 (January 1994).

FSF Editorial Staff. "Fatal Commuter Crash Blamed on Visual Illusion, Lack of Cockpit Coordination." *Accident Prevention* Volume 50 (November 1993).

Pope, John A. "Comparing Accident Reports: Looking Beyond Causes to Identify Recurrent Factors." *Flight Safety Digest* Volume 12 (June 1993).

FSF Editorial Staff. "Spatial Disorientation Linked to Fatal DC-8 Freighter Crash." *Accident Prevention* Volume 50 (March 1993).

Antuñano, Melchor J.; Mohler, Stanley R. "Inflight Spatial Disorientation." *Human Factors & Aviation Medicine* Volume 39 (January–February 1992).

Wilson, Donald R. "The Overall Approach to Cockpit Safety." *Accident Prevention* Volume 46 (June 1989).

## Regulatory Resources

International Civil Aviation Organization (ICAO). *International Standards and Recommended Practices, Annex 6 to the*

*Convention of International Civil Aviation, Operation of Aircraft. Part I, International Commercial Air Transport – Aeroplanes. Appendix 2, "Contents of an Operations Manual,"* 15. Seventh edition – July 1998, incorporating Amendments 1–25.

ICAO. *Procedures for Air Navigation Services. Aircraft Operations. Volume I, Flight Procedures.* Fourth edition, 1993. Reprinted May 2000, incorporating Amendments 1–10.

ICAO. *Accident Prevention Manual.* 1984.

ICAO. *Human Factors Training Manual.* First edition – 1998, incorporating Circular 216.

ICAO. Circular 241, *Human Factors Digest No. 8, "Human Factors in Air Traffic Control."* 1993.

U.S. Federal Aviation Administration. *U.S. Federal Aviation Regulations.* 121.406 "Reduction of CRM/DRM programmed hours based on credit for previous CRM/DRM training," 121.419 "Pilots and flight engineers: Initial, transition, and upgrade ground training," 121.421 "Flight attendants: Initial and transition ground training," 121.422 "Aircraft dispatchers: Initial and transition ground training." January 1, 2000.

Joint Aviation Authorities. *Joint Aviation Requirements - Operations 1. Commercial Air Transportation (Aeroplanes).* 1.945 "Conversion training and checking," 1.955 "Nomination as commander," 1.965 "Recurrent training and checking." March 1, 1998.

## Notice

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force has produced this briefing note to help prevent ALAs, including those involving controlled flight into terrain. The briefing note is based on the task force's data-driven conclusions and recommendations, as well as data from the U.S. Commercial Aviation Safety Team (CAST) Joint Safety Analysis Team (JSAT) and the European Joint Aviation Authorities Safety Strategy Initiative (JSSI).

The briefing note has been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines (but can be adapted for fuselage-mounted turbine engines, turboprop-powered aircraft and piston-powered aircraft) and with the following:

- Glass flight deck (i.e., an electronic flight instrument system with a primary flight display and a navigation display);
- Integrated autopilot, flight director and autothrottle systems;

- Flight management system;
- Automatic ground spoilers;
- Autobrakes;
- Thrust reversers;
- Manufacturers'/operators' standard operating procedures; and,
- Two-person flight crew.

This briefing note is one of 34 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit*, which includes a variety of other safety products that have been developed to help prevent ALAs.

This information is not intended to supersede operators' or manufacturers' policies, practices or requirements, and is not intended to supersede government regulations.

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