Flight Safety Foundation

ALAR

Approach-and-landing Accident Reduction

Tool Kit

FSF ALAR Briefing Note 7.4 — Visual Approaches

Accepting an air traffic control (ATC) clearance for a visual approach or requesting a visual approach should be balanced carefully against the following:

- Ceiling and visibility conditions;
- Darkness;
- Weather:
  - Wind, turbulence;
  - Rain or snow; and/or,
  - Fog or smoke;
- Crew experience with airport and airport environment:
  - Surrounding terrain; and/or,
  - Specific airport and runway hazards (obstructions, etc.); and,
- Runway visual aids:
  - Type of approach light system (ALS); and,
  - Availability of visual approach slope indicator (VASI) or precision approach path indicator (PAPI).

Statistical Data

The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force found that visual approaches were being conducted in 41 percent of 118 fatal approach-and-landing accidents worldwide in 1980 through 1996 involving jet aircraft and turboprop aircraft with maximum takeoff weights above 12,500 pounds/5,700 kilograms, and in which the type of approach being conducted was known.[1]

Definition

Although slightly different definitions are provided by the International Civil Aviation Organization (ICAO), the European Joint Aviation Authorities and the U.S. Federal Aviation Administration (FAA), the following definition, from the FAA *Aeronautical Information Manual*, will be used in this discussion:

- "[A visual approach is] an approach conducted on an instrument flight rules (IFR) flight plan which authorizes the pilot to proceed visually and clear of clouds to the airport;
- "The pilot must, at all times, have either the airport or the preceding aircraft in sight;
- "[The visual] approach must be authorized and under the control of the appropriate air traffic control facility; [and],
- "Reported weather at the airport must be ceiling at or above 1,000 feet and visibility three miles or greater."

Visual Approach at Night

During a visual approach at night, fewer visual references are usable, and visual illusions and spatial disorientation occur more frequently.

Visual illusions (such as the "black-hole effect"[2]) affect the flight crew's vertical situational awareness and horizontal situational awareness, particularly on the base leg and when turning final.

A visual approach at night should be considered only if:

- Weather is suitable for flight under visual flight rules (VFR);
- A close-in pattern is used (or a published visual approach is available);
- A pattern altitude is defined; and,
- The flight crew is familiar with airport hazards and obstructions. (This includes the availability of current notices to airmen [NOTAMS].)

At night, whenever an instrument approach is available (particularly an instrument landing system [ILS] approach), an instrument approach should be preferred to a visual approach.

If a precision approach is not available, select an approach supported by VASI or PAPI.

Overview

The following overview provides a description of the various phases and techniques associated with visual approaches.

References

Visual approaches should be conducted with reference to either:

- A published visual approach chart for the intended runway; or,
- The visual approach procedure (altitude, aircraft configuration and airspeed) published in the aircraft operating manual (AOM)/quick reference handbook (QRH) or the pattern published in the AOM/QRH

Terrain Awareness

When selecting or accepting a visual approach, the flight crew should be aware of the surrounding terrain and man-made obstacles.

For example, at night, with an unlighted hillside between a lighted area and the runway, the flight crew may not see the rising terrain.

Objective

The objective of a visual approach is to conduct an approach:

- Using visual references; and,
- Being stabilized by 500 feet above airport elevation according to company standard operating procedures (SOPs). (See Table 1.)

If the aircraft is not stabilized by 500 feet above airport elevation or if the approach becomes unstabilized below 500 feet above airport elevation, go around.

Table 1
Recommended Elements Of a Stabilized Approach

All flights must be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). *An approach is stabilized when all of the following criteria are met*:

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than V_{REF} + 20 knots indicated airspeed and not less than V_{REF};
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation; and,
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1 November 2000)

Automated Systems

Automated systems (autopilot, flight director, autothrottles) should be adapted to the type of visual approach (i.e., visual approach chart or AOM/QRH visual approach procedure/pattern) and to the ATC environment (radar vectors or crew navigation).

During the final phase of the approach, the crew should disconnect the autopilot, clear the flight director command bars, maintain the autothrottles in speed mode and select the flight-path vector symbol (as available on the primary flight display [PFD] or head-up display [HUD]).

Initial/Intermediate Approach

The flight management system (FMS) may be used to build the teardrop outbound leg or the downwind leg, for enhanced situational awareness. This should be done when programming the FMS before reaching the top-of-descent point.

As applicable, set navaids for the instrument approach associated with the landing runway (for monitoring and in case of loss of visual references).

Review the primary elements of the visual approach and the primary elements of the associated instrument approach.

Review the appropriate missed approach procedure.

Extend slats and fly at the corresponding maneuvering speed.

Barometric-altimeter and radio-altimeter bugs may be set (per company SOPs) for enhanced terrain awareness.

Outbound/Downwind Leg

To be aligned on the final approach course and stabilized at 500 feet above airport elevation, the crew should intercept typically the final approach course at *three nautical miles from the runway threshold* (time the outbound leg or downwind leg accordingly, as a function of the prevailing airspeed and wind component).

Maintain typically 1,500 feet above airport elevation (or the charted altitude) until beginning the final descent or turning base leg.

Configure the aircraft per SOPs, typically turning base leg with approach flaps, landing gear extended and ground spoilers armed.

Do not exceed a 30-degree bank angle when turning onto base leg.

Base Leg

Resist the tendency to fly a continuous closing-in turn toward the runway threshold.

Before turning final (depending on the distance from the runway threshold), extend landing flaps and begin reducing to the target final approach speed.

Estimate the glide-path angle to the runway threshold based on available visual references (e.g., VASI) or raw data[3] (ILS glideslope or altitude/distance). (Glideslope indications and VASI indications are reliable only within 30 degrees of the final approach course.)

Do not exceed a 30-degree bank angle when tuning final.

Anticipate the crosswind effect (as applicable) to complete the turn correctly established on the extended runway centerline with the required drift correction.

Final Approach

Plan to be aligned with the runway (wings level) and stabilized at the final approach speed by 500 feet above airport elevation.

Monitor groundspeed variations (for wind shear awareness) and call altitudes and excessive flight-parameter deviations as for instrument approaches.

Maintain visual scanning toward the aiming point (typically 1,000 feet from the runway threshold) to avoid any tendency to inadvertently descend below the final approach path (use raw data or the VASI/PAPI, as available, for a cross-check).

Visual Approach Factors

The following factors often are cited when discussing unstabilized visual approaches:

- Pressure of flight schedule (making up for delays);
- Crew-induced circumstances or ATC-induced circumstances resulting in insufficient time to plan, prepare and conduct a safe approach;
- Excessive altitude or excessive airspeed (e.g., inadequate energy management) early in the approach;
- Downwind leg too short (visual pattern) or interception too close (direct base-leg interception);
- Inadequate awareness of tail-wind component and/or crosswind component;
- Incorrect anticipation of aircraft deceleration characteristics in level flight or on a three-degree glide path;
- Failure to recognize deviations or failure to adhere to excessive-parameter-deviation criteria;
- Belief that the aircraft will be stabilized at the minimum stabilization height or shortly thereafter;
- Excessive confidence by the pilot not flying (PNF) that the pilot flying (PF) will achieve a timely stabilization, or reluctance by the PNF to challenge the PF;
- PF/PNF too reliant on each other to call excessive deviations or to call for a go-around;
- Visual illusions;
- Inadvertent modification of the aircraft trajectory to maintain a constant view of visual references; and,
- Loss of ground visual references, airport visual references or runway visual references, with the PF and the PNF both looking outside to reacquire visual references.

Unstabilized Visual Approaches

The following deviations are typical of unstabilized visual approaches:

- Steep approach (high and fast, with excessive rate of descent);
- Shallow approach (below desired glide path);
- Ground-proximity warning system (GPWS)/terrain awareness warning system (TAWS)[4] activation:
  - Mode 1: "sink rate";
  - Mode 2A: "terrain" (less than full flaps);
  - Mode 2B: "terrain" (full flaps);
- Final-approach-course interception too close to the runway threshold because of an inadequate outbound teardrop leg or downwind leg;
- Laterally unstabilized final approach because of failure to correct for crosswind;
- Excessive bank angle and maneuvering to capture the extended runway centerline or to conduct a side-step maneuver;
- Unstabilized approach with late go-around decision or no go-around decision; and,
- Inadvertent descent below the three-degree glide path.

Summary

The following should be discussed and understood for safe visual approaches:

- Weighing the time saved against the risk;
- Awareness of all weather factors;
- Awareness of surrounding terrain and obstacles;
- Awareness of airport environment, airport and runway hazards;
- Use of a visual approach chart or AOM/QRH procedures/pattern;
- Tuning and monitoring all available navaids;
- Optimizing use of automation with timely reversion to hand-flying;
- Adhering to defined PF/PNF task-sharing (monitoring by PNF of head-down references [i.e., instrument references] while PF flies and looks outside);
- Maintaining visual contact with the runway and other traffic at all times; and,
- Announcing altitudes and excessive flight-parameter deviations, and adhering to the go-around policy for instrument approaches.

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

- *1.1 — Operating Philosophy*;
- *1.2 — Automation*;
- *1.3 — Golden Rules*;
- *1.4 — Standard Calls*;
- *1.5 — Normal Checklists*;
- *1.6 — Approach Briefing*;
- *3.1 — Barometric Altimeter and Radio Altimeter*;
- *4.2 — Energy Management*;
- *5.2 — Terrain*;
- *5.3 — Visual Illusions*; and,
- *7.1 — Stabilized Approach.*♦

References

1. 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.
2. The *black-hole effect* typically occurs during a visual approach conducted on a moonless or overcast night, over water or over dark, featureless terrain where the only visual stimuli are lights on and/or near the airport. The absence of visual references in the pilot's near vision affect depth perception and cause the illusion that the airport is closer than it actually is and, thus, that the aircraft is too high. The pilot may respond to this illusion by conducting an approach below the correct flight path (i.e., a low approach).
3. The Flight Safety Foundation Approach-and-landing Accident Reduction (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)."
4. Terrain awareness and warning system (TAWS) is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration to describe equipment meeting International Civil Aviation

Organization standards and recommendations for ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings. "Enhanced GPWS" and "ground collision avoidance system" are other terms used to describe TAWS equipment.

Related Reading from FSF Publications

Flight Safety Foundation (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. "MD-88 Strikes Approach Light Structure in Nonfatal Accident." *Accident Prevention* Volume 54 (December 1997).

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

Regulatory Resources

U.S. Federal Aviation Administration (FAA). *Federal Aviation Regulations*. 91.175 "Takeoff and landing under IFR." January 1, 2000.

FAA. Advisory Circular 60-A, *Pilot's Spatial Disorientation*. February 8, 1983.

Joint Aviation Authorities. *Joint Aviation Requirements – Operations 1. Commercial Air Transport (Aeroplanes)*. 1.435 "Terminology." July 1, 2000.

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.

Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S.
Telephone +1 (703) 739-6700, Fax: +1 (703) 739-6708
www.flightsafety.org