Keys to a Safe Arrival

BY JAMES M. BURIN

Foundation introduces new approach-and-landing accident reduction tool.

Touching down on the runway centerline helps ensure an uneventful landing.

Flight Safety Foundation (FSF) has developed a new tool to reduce the risk of approach-and-landing accidents, particularly those involving runway excursions. The latest product is a set of safe-landing guidelines that are intended to be used by aircraft operators to enhance existing standard operating procedures.

The Foundation began its approach-and-landing accident reduction (ALAR) effort in 1998 with the release of a report titled "Killers in Aviation."[1] This was followed in 2001 by the introduction of the *ALAR Tool Kit*, a CD-based product that includes pilot briefing notes, videos, presentations, risk-awareness checklists and other material designed to prevent approach-and-landing accidents. The Foundation completed a major update of the tool kit in 2010.[2]

More than 40,000 *ALAR Tool Kits* have been distributed worldwide, and the Foundation's CFIT and Approach-and-Landing Action Group has conducted 35 ALAR workshops around the world to help disseminate this important information.

In 2006, several international aviation organizations asked the Foundation to conduct a study of runway safety. After a comprehensive analysis of runway safety data, the Foundation determined that runway excursions, including overruns and veer-offs, pose a greater risk than other types of runway-related accidents. The data showed that one of every three turbojet airplane accidents and one of every four turboprop accidents is a runway excursion.

Because of the significance of these findings, the Foundation focused its attention on runway excursions. This effort culminated in 2009 with the publication of a report titled "Reducing the Risk of Runway Excursions," which addresses the high-risk areas of overruns and veer-offs, and provides specific tools to reduce the risks.[3]

The tools for reducing runway-excursion accidents are applicable for the full spectrum of the aviation community, including flight crews, management, air traffic control, airports and regulators.

Filling a Gap

The FSF runway safety initiative revealed a gap in the risk reduction tools provided by the *ALAR Tool Kit* — the landing itself. To fill the gap, the *Safe Landing Guidelines* (p. 16) were developed by the Foundation in conjunction with a team of experts that included representatives of aircraft manufacturers, seasoned airline pilots with training and check airman experience, aviation safety specialists and corporate aircraft operators, all with extensive backgrounds in the Foundation's ALAR effort.

The first thing to notice when looking at the guidelines is the name itself — *guidelines*. They are not rules or regulations. They are data-driven guidelines that address the key aspects of conducting a safe landing.

Taking a closer look at the guidelines, the first note is important. Data have shown that the risk of an approach-and-landing accident increases if any one of the guidelines is not met. Even more important, the overall risk of an accident is increased greatly if more than one guideline is not met. Some combinations of elements are highly conducive to a runway excursion, such as landing long and fast, or landing with a tail wind on a runway contaminated with standing water, snow, slush or ice.

The guidelines start with the basics — and number one is to fly a stabilized approach. As noted in both the Foundation's ALAR work and its runway safety initiative, this is the cornerstone of a safe approach and landing. The recommended elements of a stabilized approach developed by the ALAR Task Force have been widely adopted and adapted by aircraft operators.

The next guideline is to cross the runway threshold at 50 ft. For every 10 ft above that height, the landing distance is increased by 200 ft (61 m).

Closely related to threshold crossing height is the next guideline, which addresses speed. Acceptable airspeeds during a stabilized approach range from not less than V_{REF}, the reference landing speed, to not more than V_{REF} plus 20 kt. The *Safe Landing Guidelines* recommend that this range be narrowed to not less than V_{REF} and not more than V_{REF} plus 10 kt by the time the aircraft arrives over the runway threshold.

FLIGHT SAFETY FOUNDATION

Safe Landing Guidelines

The risk of an approach-and-landing accident is increased if any of the following guidelines is not met. If more than one guideline is not met, the overall risk is greatly increased.

1. Fly a stabilized approach.[1]
2. Height at threshold crossing is 50 ft.
3. Speed at threshold crossing is not more than V_{REF} + 10 kt indicated airspeed and not less than V_{REF}.
4. Tail wind is no more than 10 kt for a non-contaminated runway, no more than 0 kt for a contaminated runway.
5. Touch down on runway centerline at the touchdown aim point.[2]
6. After touchdown, promptly transition to the desired deceleration configuration:
   - —Brakes
   - —Spoilers/speed brakes
   - —Thrust reversers or equivalent (e.g., lift dump)

   Note: Once thrust reversers have been activated, a go-around is no longer an option.
7. Speed is less than 80 kt with 2,000 ft of runway remaining.

Notes

1. The FSF Approach-and-Landing Accident Reduction (ALAR) Task Force developed the following recommended elements of a stabilized approach:

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

   - The aircraft is on the correct flight path.
   - Only small changes in heading/pitch are required to maintain the correct flight path.
   - The aircraft speed is not more than V_{REF} + 20 kt indicated airspeed and not less than V_{REF}.
   - The aircraft is in the correct landing configuration.
   - Sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted.
   - Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined in the aircraft operating manual.
   - All briefings and checklists have been conducted.
   - 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; during a circling approach, wings should be level on final when the aircraft reaches 300 ft above airport elevation.
   - 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 ft above airport elevation in IMC or below 500 ft above airport elevation in VMC requires an immediate go-around.

2. *Touchdown aim point* is defined by the U.S. Federal Aviation Administration as 1,000 ft from the runway threshold. The International Civil Aviation Organization defines *touchdown aim point* in reference to the available landing area, as follows:

Available landing area	< 800 m	800–1,200 m	1,200–2,400 m	> 2,400 m
Touchdown aim point	150 m	250 m	300 m	400 m

   Touchdown aim point markings are 150-ft-long white rectangular stripes, one on each side of the runway centerline, that begin at the distances indicated above. The width of the aim-point markings varies with the width of the runway.

For every 10 kt above V_{REF}, the landing distance is increased by 20 percent. Thus, speed is a very important element of a safe landing, and being fast greatly increases the risk of a runway excursion.

Combination to Avoid

The next guideline addresses allowable tail wind. It recommends a maximum acceptable tail wind component of 10 kt. Moreover, as mentioned earlier, data show that tail winds become a greater risk when combined with contaminated runways. This is why the guidelines recommend that no landing should be attempted with any amount of tail wind when the runway is contaminated.

Exactly where the aircraft should touch down on the runway to minimize the risk of an excursion is the topic of the next guideline. In the United States, most runways used by air carrier and corporate operators, especially runways served by a precision approach, have touchdown aim point markings — a broad white stripe on each side of the runway centerline — 1,000 ft from the runway threshold. The aircraft should touch down on the runway centerline and at the touchdown aim point.

The International Civil Aviation Organization (ICAO) prescribes a more complex formula for touchdown aim points, based on the runway distance available for landing. For example, if the available landing distance is less than 800 m (2,625 ft), the touchdown aim point markings are placed 150 m (492 ft) down the runway. Runways providing a landing distance of more than 2,400 m (7,874 ft) have their aim point markings at 400 m (1,312 ft). ICAO also has set touchdown aim point ranges for intermediate landing distances.

The next guideline provides information on the process of slowing and stopping the aircraft. The order in which the aircraft's deceleration devices — wheel brakes, spoilers/speed brakes and thrust reversers (or their equivalent) — are deployed may vary from the order shown by the guideline, depending on the manufacturer's recommended procedure for the specific aircraft.

An important note that accompanies this guideline is that once thrust reversers or their equivalent (e.g., a lift-dump system) have been activated, going around is no longer an option, and the flight crew is committed to land (*ASW*, 9/11, p. 36).

Finally, the guidelines recommend that the aircraft be slowed to less than 80 kt by the time it reaches the point on the runway where only 2,000 ft (610 m) of pavement remain.

Grist for an SOP

The *Safe Landing Guidelines* tie together the Foundation's 20 years of ALAR experience and its recent work on preventing runway excursions. They provide concise, data-based information on what needs to be done to reduce the risk of a runway excursion.

They are intended to be used as their title suggests — as guidelines. The Foundation is not advocating that the guidelines be copied and handed out to flight crews. We do recommend that they be used by aircraft operators, in conjunction with information from aircraft manufacturers, to create their own rules and policies.

Every operator should have a standard operating procedure (SOP) that addresses this high-risk phase of flight, and every operator should monitor its operational data to determine the effectiveness of the SOP.

It is hoped that these guidelines will assist operational personnel in reducing the risk of approach accidents and runway excursions, and thus enable the Foundation to achieve its goal of making flying safer by reducing the risk of an accident.

James M. Burin is director of technical programs for Flight Safety Foundation.

Once thrust reversers have been activated, going around is no longer an option, and the flight crew is committed to land.

Notes

1. The report is included in the *ALAR Tool Kit Update* and is available on the FSF website <flightsafety.org>.
2. The *ALAR Tool Kit Update* is available for purchase from FSF at <flightsafety.org>.
3. The report is available at <flightsafety.org>.