Runway Excursions

Runway excursions occur when an aircraft on the runway surface departs the end or the side of the runway surface. Runway excursions can occur on takeoff or landing. They consist of two types of events:

- **Veer-off** — a runway excursion in which an aircraft departs the side of a runway; and,
- **Overrun** — a runway excursion in which an aircraft departs the end of a runway.

Runway excursions can occur after any type of approach in any light condition or environmental condition.

**Statistical Data**

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force found that runway excursions were involved in 20 percent of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997.

The FSF Runway Safety Initiative (RSI) team found that commercial transport aircraft were involved in 417 runway-excision accidents worldwide from 1995 through March 2008. Of the total, 329 accidents (79 percent) occurred on landing, and 88 accidents (21 percent) occurred on takeoff. Thirty-four runway-excision accidents were fatal, with 712 fatalities. Among the landing runway-excision accidents, 53 percent were veer-offs and 47 percent were overruns.

**Factors Involved in Runway Veer-Off Accidents**

Runway veer-offs are usually the result of one or more of the following factors:

- **Weather Factors**
  - Runway condition (wet or contaminated by standing water, snow, slush or ice);
  - Wind shear;
  - Crosswind;
  - Inaccurate information on wind conditions and/or runway conditions; and,
  - Reverse-thrust effect in a crosswind and on a wet runway or a contaminated runway.

- **Crew Technique/Decision Factors**
  - Incorrect crosswind landing technique (e.g., drifting during the transition from a wings-level crosswind approach ["crabbed"] approach to a steady-sideslip crosswind approach, or failing to transition from a wings-level approach to a steady-sideslip approach ["decrab"] when landing in strong crosswind conditions);
  - Inappropriate differential braking by the crew;
  - Use of the nosewheel-steering tiller at airspeeds that are too fast; and,
  - Airspeed too fast on the runway to exit safely.

- **Systems Factors**
  - Asymmetric thrust (i.e., forward thrust on one side, reverse thrust on the opposite side);
  - Speed brakes fail to deploy; or,
  - Uncommanded differential braking.

**Factors Involved in Runway Overrun Accidents**

Runway overruns are usually the result of one or more of the following factors:

- **Weather Factors**
  - Unanticipated runway condition (i.e., worse than anticipated);
• Inaccurate surface wind information; and,
• Unanticipated wind shear or tail wind.

Performance Factors
• Incorrect assessment of landing distance following a malfunction or minimum equipment list (MEL)/dispatch deviation guide (DDG) condition affecting aircraft configuration or braking capability; and,
• Incorrect assessment of landing distance for prevailing wind and runway conditions.

Crew Technique/Decision Factors
• Unstable approach path (steep and fast):
  – Landing fast; and,
  – Excessive height over threshold, resulting in landing long;
• No go-around decision when warranted;
• Decision by captain (when acting as pilot not flying/pilot monitoring) to land, countermanding first officer’s (pilot flying’s) decision to go around;
• Extended flare (allowing the aircraft to float and to decelerate [bleed excess airspeed] in the air uses typically three times more runway than decelerating on the ground);
• Failure to arm ground spoilers (usually associated with thrust reversers being inoperative);
• Power-on touchdown (i.e., preventing the auto-extension of ground spoilers, as applicable);
• Failure to detect nondeployment of ground spoilers (e.g., absence of related standard call);
• Bouncing and incorrect bounce recovery;
• Late braking (or late takeover from autobrake system, if required); and,
• Increased landing distance resulting from the use of differential braking or the discontinued use of reverse thrust to maintain directional control in crosswind conditions.

Systems Factors
• Loss of pedal braking;
• Anti-skid system malfunction; or;
• Hydroplaning.

Accident-Prevention Strategies and Lines of Defense
The following company accident-prevention strategies and personal lines of defense are recommended:

Policies
• Define policy to promote readiness and commitment to go around (discouraging any attempt to “rescue” a situation that is likely to result in a hazardous landing);
• Define policy to ensure that inoperative brakes (“cold brakes”) are reported in the aircraft logbook and that they receive attention in accordance with the MEL/DDG;
• Define policy for a rejected landing (bounce recovery);
• Define policy prohibiting landing beyond the touchdown zone; and,
• Define policy encouraging a firm touchdown when operating on a contaminated runway.

Standard Operating Procedures (SOPs)
• Define criteria and standard calls for a stabilized approach, and define minimum stabilization heights in SOPs (see stabilized approach recommendations);
• Define task sharing and standard calls for final approach and roll-out phases in SOPs; and,
• Incorporate in SOPs a standard call for “… [feet or meters] runway remaining” or “… [feet or meters] to go” in low-visibility conditions, based on:
  – Runway-lighting color change;
  – Runway-distance-to-go markers (as available); or,
  – Other available visual references (such as runway/taxiway intersections).

Performance Data
• Publish data and define procedures for adverse runway conditions; and,
• Provide flight crews with specific landing-distance data for runways with a downhill slope/high elevation.

Procedures
• Publish SOPs and provide training for crosswind-landing techniques;
• Publish SOPs and provide training for flare techniques;
• Publish SOPs for the optimum use of autobrakes and thrust reversers on contaminated runways;
• Provide recommendations for the use of rudder and differential braking/nosewheel steering for directional control, depending on airspeed and runway condition; and,
• Publish specific recommendations for aircraft lateral control and directional control after a crosswind landing.
Crew Awareness

- Ensure flight crew awareness and understanding of all factors affecting landing distances;
- Ensure flight crew awareness and understanding of conditions conducive to hydroplaning;
- Ensure flight crew awareness and understanding of cross-wind and wheel-cornering issues;
- Ensure flight crew awareness of wind shear and develop corresponding procedures (particularly for the monitoring of groundspeed variations during approach);
- Ensure flight crew awareness of the relationships among braking action, friction coefficient and runway-condition index, and maximum crosswind components recommended for runway conditions; and,
- Ensure flight crew awareness of runway lighting changes when approaching the runway end:
  - Standard centerline lighting: white lights changing to alternating red and white lights between 3,000 feet and 1,000 feet from runway end, and to red lights for the last 1,000 feet; and,
  - Runway edge lighting (high-intensity runway light system): white lights changing to yellow lights on the last 2,000 feet of the runway.

Summary

Runway excursions can be categorized as resulting from the following causal factors:

- Unstabilized approaches;
- Incorrect flare technique;
- Unanticipated or more-severe-than-expected adverse weather conditions;
- Reduced braking or loss of braking;
- Abnormal configuration (e.g., because the aircraft was dispatched under MEL conditions or DDG conditions, or because of an in-flight malfunction); and,
- Incorrect crew action and coordination, under adverse conditions.

Corresponding company accident-prevention strategies and personal lines of defense can be developed to help prevent runway veer-offs and runway overruns by:

- Adherence to SOPs;
- Enhanced awareness of environmental factors;
- Enhanced understanding of aircraft performance and handling techniques; and,
- Enhanced alertness for flight-parameter monitoring, deviation calls and crew cross-check.

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

- 1.1 — Operating Philosophy;
- 1.4 — Standard Calls;
- 6.4 — Bounce Recovery — Rejected Landing;
- 7.1 — Stabilized Approach;
- 8.2 — The Final Approach Speed;
- 8.3 — Landing Distances;
- 8.4 — Braking Devices;
- 8.5 — Wet or Contaminated Runways; and,
- 8.7 — Crosswind Landings.
The following RSI Briefing Notes also provide information to supplement this discussion:

- Pilot Braking Action Reports; and,
- Runway Condition Reporting.

**Notes**


**Related Reading From FSF Publications**


FSF Editorial Staff. "MD-82 Overruns Runway While Landing in Proximity of Severe Thunderstorms." *Accident Prevention* Volume 59 (February 2002).


---

**Notice**

The Flight Safety Foundation (FSF) Approach-and-Landing Accident Reduction (ALAR) Task Force produced this briefing note to help prevent approach-and-landing accidents, 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’s Joint Safety Analysis Team and the European Joint Aviation Authorities Safety Strategy Initiative.

This briefing note is one of 33 briefing notes that comprise a fundamental part of the FSF ALAR Tool Kit, which includes a variety of other safety products that also have been developed to help prevent approach-and-landing accidents.

The briefing notes have been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines, but they can be adapted for those who operate airplanes with fuselage-mounted turbine engines, turboprop power plants or piston engines. The briefing notes also address operations with the following: electronic flight instrument systems; integrated autopilots, flight directors and autothrottle systems; flight management systems; automatic ground spoilers; autobrakes; thrust reversers; manufacturers/operators’ standard operating procedures; and, two-person flight crews.

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

**Copyright © 2009 Flight Safety Foundation**

601 Madison Street, Suite 300, Alexandria, VA 22314-1756 USA
Tel. +1 703.739.6700 Fax +1 703.739.6708 www.flightsafety.org

In the interest of aviation safety, this publication may be reproduced, in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All uses must credit Flight Safety Foundation.