FLIGHT SAFETY FOUNDATION

ALAR

APPROACH-AND-LANDING ACCIDENT REDUCTION

TOOL KIT

FSF ALAR BRIEFING NOTE 8.1

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.[1]

The FSF Runway Safety Initiative (RSI) team found that commercial transport aircraft were involved in 417 runway-excursion 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-excursion accidents were fatal, with 712 fatalities. Among the landing runway-excursion accidents, 53 percent were veer-offs and 47 percent were overruns.[2]

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.

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:

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 kt 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 fpm; if an approach requires a sink rate greater than 1,000 fpm, 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 ft 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 ft above airport elevation in IMC or below 500 ft above airport elevation in VMC requires an immediate go-around.

Source: FSF ALAR Task Force

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 crosswind 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

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. Flight Safety Foundation. "Reducing the Risk of Runway Excursions." Report of the FSF Runway Safety Initiative, May 2009.

Related Reading From FSF Publications

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FSF Editorial Staff. "Runway Overrun Occurs After Captain Cancels Go-around." *Accident Prevention* Volume 58 (June 2001).

FSF Editorial Staff. "Business Jet Overruns Wet Runway After Landing Past Touchdown Zone." *Accident Prevention* Volume 56 (December 1999).

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