Aviation safety experts aim for the Runway Safety Initiative to provide the tools to help prevent runway excursions.

SAFETY ON THE Straight and Narrow

BY LINDA WERFELMAN

All five crewmembers survived the runway excursion crash of this Kalitta Air 747 on takeoff from Brussels Airport in May.

Runway excursions comprise 96 percent of all runway accidents, 80 percent of fatal runway accidents and 75 percent of related fatalities (Table 1, p. 14). Nevertheless, although these accidents have been the subject of a few studies, the number has been relatively small, and the recommended preventive measures have been relatively few, compared with numerous programs devoted to runway incursions, which account for less than one accident a year.

The Runway Safety Initiative (RSI), an international effort involving about 20 participants — including regulatory authorities and investigative agencies, industry groups and aircraft manufacturers — and coordinated by Flight Safety Foundation, is designed to intensify the attention being focused on all runway safety issues but especially on runway excursions.

The RSI defines a runway safety issue as "any safety issue that deals with the runway environment (or any surface being used as a runway) and the areas immediately adjacent to it [such as runway end safety areas and high-speed taxiways]." Runway safety issues include runway incursions, runway excursions and the inappropriate use of runways — a category sometimes referred to as runway confusion.

Runway excursions include events of two types: veer-offs, in which an aircraft goes off the side of a runway, and overruns, in which an aircraft runs off the end of a runway.

"Runway excursion accidents are not rare events," said James M. Burin, FSF director of technical programs. "Many don't involve much damage and there are no injuries, some are serious and involve substantial damage, and a few are deadly."

In most instances, a runway excursion is "not a total surprise" to the flight crew, Burin said. "We have proven several times each year that, if you land long and fast, with a tailwind, on a contaminated runway, the consequences are predictable."

Among the recent examples:

- The July 17, 2007, crash of a TAM Linhas Aéreas Airbus A320, which overran Runway 35L at Congonhas Airport in São Paulo, Brazil. Preliminary reports said that weather conditions included rain and the asphalt runway was wet; that the airplane's right thrust reverser was not serviceable; and that the runway had been resurfaced shortly before the accident but had not been grooved. All 187 people in the airplane, and 12 on the ground, were killed, and the airplane was destroyed.[1]
- The March 7, 2007, crash of a Garuda Indonesia Boeing 737-400 at Yogyakarta, Indonesia. The airplane crossed the runway threshold at 232 kt — 98 kt faster than the landing reference speed — and touched down at 221 kt about 860 m (2,822 ft) from the threshold of the 2,200-m (7,218-m) runway. Twenty-one of the 140 people in the airplane were killed and 12 received

serious injuries; the airplane was destroyed.[2]

- The July 9, 2006, crash of an S7 Airlines A320 at Irkutsk Airport in Russia. The airplane had been released for the flight with six minimum equipment list (MEL) defects, including a deactivated left engine thrust reverser. After the airplane touched down on the wet runway, the captain "inadvertently … moved the throttle lever for the left engine … from the 'idle' [position] to the significant forward thrust position," the accident report said. "Inadequate monitoring and callouts of airplane speed and engine parameters by the copilot made it impossible for the crew to perform the necessary actions, either by moving the left throttle back to idle or shutting down the engines." The airplane overran the runway, struck a concrete fence and buildings and burned; 125 of the 203 people in the airplane were killed.[3]
- The Dec. 8, 2005, crash of a Southwest Airlines 737-700 at Chicago Midway International Airport in snow and freezing fog. The U.S. National Transportation Safety Board (NTSB) cited both the slippery runway and the tailwind component of more than 5 kt, as well as the delayed application of reverse thrust, in its final report on the accident, which killed one person on the ground and seriously injured another. The airplane was substantially damaged.[4]

News reports have described several excursion accidents in recent months, including a June 10 crash involving a Sudan Airways A310, which overran a runway while landing in Khartoum

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Runway Safety Accident Data, 1995–2007

	Number of Accidents	Percent of Total Accidents[1]	Number of Fatal Accidents	Number of Onboard Fatalities
Incursions	10 (0.8/year)	0.7%	5	129
Excursions	379 (29.1/year)	28.5%	31	680
Confusion	4 (0.3/year)	0.3%	2	132

1. 1,332 total accidents

Source: Flight Safety Foundation

Table 1

amid thunderstorms. Reports were incomplete but indicated that at least 29 — and possibly more — of the approximately 250 people in the airplane were killed and the airplane was destroyed.[5]

In a May 25 runway excursion, a Kalitta Air 747-200 cargo flight crashed not on landing but on takeoff from Brussels Airport in Belgium. Reports said that crewmembers heard one or two loud bangs during the takeoff run before the airplane overran the 9,800-ft (2,989-m) runway and broke into three pieces. All five crewmembers — the only people in the airplane — survived; the airplane was destroyed.[6]

An April 15 runway excursion accident involving a Hewa Bora Airlines Douglas DC-9 occurred on takeoff from Goma, Democratic Republic of the Congo. One report said that the captain applied the brakes after experiencing engine trouble, and the airplane skidded off the wet runway, which had been damaged — and shortened — because of lava flow from a nearby volcano during a 2002 eruption. At least 37 people, most of them on the ground, were killed in the crash, which destroyed the airplane.[7]

Burin said that the severity of runway excursion accidents depends primarily on the energy of the airplane as it departs the runway, and the airport's layout, geography and rescue capability.

In addition, a major factor is whether the crew has flown a stabilized approach.

"Not every unstabilized approach ends up as a runway excursion, but almost every runway excursion starts as an unstabilized approach," Burin said.

Conversely, a major factor in risk reduction is a stabilized approach, with a landing in the touchdown zone, but other factors — including speed, use of brakes and reverse thrust, and runway condition — also play contributing roles.

Global Plan

For years, any discussion of runway safety has emphasized runway incursions. Many of the groups involved with the RSI already have developed products intended to prevent runway incursions; only a few existing products address runway excursions.[8] Plans call for the RSI to support and promote existing and ongoing programs by these and other organizations to prevent runway incursions while leading the effort against runway excursions.

"There is a lot of visibility, high-level attention and work on preventing runway incursions," Burin said. "Data show we are being effective in preventing runway incursion accidents, but the number of incidents and their severity still indicates a very high risk.

"There is *not* a lot of activity in the runway excursion area, and the RSI team will lead the efforts to reduce the risk in this area."

The RSI's ongoing development of its *Global Plan for the Prevention and Mitigation of Runway Excursions* is its primary effort to help all segments of the aviation industry to address the safety issues involved in runway excursions.

In recent months, three RSI committees have been drafting briefing notes that will be consolidated into the *Global Plan*. An August meeting was planned to review an early draft; the final product — consisting of 20 to 30 briefing notes

This Lion Air McDonnell Douglas MD-82 overran the runway after a flight from Jakarta, Indonesia, to Solo City in 2004, killing 25 people.

and supporting data — is expected to be completed in 2009.

Planned segments of the *Global Plan* will address runway excursion causal factors and best practices — including discussions of the contributions that constant-angle nonprecision approaches, and precision and precision-like approaches can make toward achieving stabilized approaches.

The plan will address all segments of the aviation industry, including manufacturers, which must provide reliable data and procedures for both normal and non-normal operations; operators, which must provide stabilized approach criteria and a "true no-fault go-around policy," as well as appropriate training; and pilots, who must practice good decision making during runway operations.

Other recommendations and briefing notes will be directed at airport operators, which are responsible for runway design, markings and signage, clearing and cleaning, and condition measurement; installation of runway end safety areas; approach aids; lighting; and aircraft rescue and fire fighting; and air traffic control (ATC), which must assist flight crews in their performance of stabilized approaches and provide pertinent and timely information about weather and runway conditions.

In some cases, programs have been adopted that helped improve mutual understanding between pilots and air traffic controllers, Burin said, citing the joint training/discussion sessions involving US Airways pilots and controllers in Charlotte, North Carolina, U.S. The sessions, designed to increase awareness of task management, risk management, error management and team building, resulted in a significant reduction in unstabilized approaches and go-arounds.[9]

In the Netherlands, similar sessions were conducted after the fatal 1992 crash of a 747 into an apartment building in suburban Amsterdam. One phase of the program, designed to acquaint controllers with the operational requirements of pilots during unusual situations, involved flight simulator sessions in which participating controllers were assigned to act as a copilot and communicate first with a "very demanding controller with a negative and noncontributory … attitude" and later with a positive and understanding controller. One participant described the session as "an eye opener."[10]

Regulatory Role

Briefing notes also will address the responsibilities of regulatory authorities, which must provide appropriate oversight and — in countries where regulators also are responsible for approaches — increase the availability of approaches with vertical guidance.

Some regulatory authorities have recently published guidance intended to aid pilots and

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: Flight Safety Foundation Approach-and-Landing Accident Reduction (ALAR) Task Force operators of turbine airplanes in avoiding runway excursions during the landing phase of flight. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 91-79, *Runway Overrun Prevention*, also offers operators information to be used in developing standard operating procedures (SOPs) to mitigate the risks of runway excursions.[11]

The AC cites data from the FAA and the NTSB showing that, in the United States, runway excursions during landing account for about 10 incidents and accidents — many of which are fatal — every year.

"These events continue to occur despite efforts by the FAA and industry to ensure that operators develop SOPs and that flight crewmembers are properly trained and operate in accordance with the SOPs," the FAA said.

"Focused training and testing of crewmembers, along with practical planning tools, are the keys to avoiding runway overrun events. This emphasis on training and checking should be targeted at initial pilot certification, as well as recurrent training and checking events. The training and checking should not be merely academic in nature. These events should emphasize real world aeronautical decision making and use scenario-based presentations in order to increase pilot recognition of high risk landing operations.

"Proper identification of the risks will help pilots employ mitigation strategies or eliminate certain risks prior to the landing event."

Included among the FAA guidance material is a "rule of thumb" table for calculating landing distances and a caution that an unstabilized approach is an unpredictable approach.

In a related action, the FAA has established an aviation rule making committee (ARC) to review regulations that affect the certification and operation of aircraft and airports for takeoff and landing on runways contaminated by snow, slush, ice or standing water.[12]

Among the ARC's responsibilities are providing recommendations on establishing landing distance assessment requirements, including safety margins, and establishing standards for runway surface condition reporting.

Unstabilized Approaches

Another regulator — the French Directorate General of Civil Aviation (DGAC) Department of Safety Management (DSM) — has published related guidance material. Because many runway excursion accidents have been associated with unstabilized approaches, the DSM developed an action plan aimed at preventing such approaches. The plan includes training reference sheets based on information from the French Air Accident Investigation Board (BEA) and a "good practice guide" for flight crews and air traffic controllers.[13]

DSM research, including a survey of 20 French airlines and a review of data from flight data monitoring systems, found that about 3 percent of approaches flown nationally were unstabilized, with "big differences between aircraft types."

The national action plan developed from DSM research emphasizes that a go-around should be the response to an unstabilized approach and that a new type of callout should be introduced during approach, when an airplane has descended to the minimum stabilization height.

"We must … continue to put out the message that an unstabilized approach is a risk and that carrying out a go-around is always a good decision in case of an unstabilized approach," the action plan says.

"Therefore, we propose that airlines standardize their callouts at the minimum stabilization height (1,000 ft, in general) on this format: At the minimum stabilization height, call out 'x ft stabilized' and if the aircraft is not stabilized, call out 'go around.'"

Other elements of the action plan include a call for airline crews to practice missed approaches beginning at minimum stabilization height rather than minimum descent altitude or decision height and for increased emphasis on training for unstabilized approach awareness. In addition, during go-arounds, air traffic controllers should avoid issuing altitude clearances, which increase pilot workload, the action plan says.

Other recommendations for ATC include improving controller awareness of the risks associated with their actions during approach and improving training on unstabilized approaches.

"Pilot-controller interactions are a contributory factor to unstabilized approaches," the action plan says. "Controllers have been censured following [accidents associated with unstabilized approaches] and overall, the pilot-controller interface is often fundamental in the genesis of unstabilized approaches.

"Good knowledge by the controller of the potential consequences of clearances or information he provides during the approach is a key factor in the campaign against unstabilized approaches."

The action plan also calls on airlines to define the operational parameters under which a visual approach is acceptable and prescribes that line training include the conduct of visual approaches. At night, instrument approach procedures should be favored, the action plan says, noting accidents in which nighttime visual approach procedures have led to unstabilized approaches and crashes.

No one was injured when this Atlas Blue 737-400 overran the runway at Deauville, France, in January.

"Given the inherent risks in these types of approaches, especially at night, it would be desirable to discourage operators from using these procedures except when an [instrument flight rules] arrival is not possible and under certain other specifically defined conditions," the plan said.

ALAR Briefing

The *Global Plan* follows the publication in 2000 of the Flight Safety Foundation *Approach-and-Landing Accident Reduction (ALAR) Tool Kit*, which includes briefing notes that discuss runway excursions and stabilized approaches (see "Recommended Elements of a Stabilized Approach," p. 15). At the time of publication, data showed that runway excursions were involved in 20 percent of the 76 approach-and-landing accidents and serious incidents that occurred worldwide from 1984 through 1997.[14]

In those crashes — and in others since then — excursions typically occurred because of some combination of weather factors, crew technique/decision factors and systems factors.

The briefing note said that runway excursions could be categorized according to their primary causal factor into one of six "families of events": events resulting from unstabilized approaches, incorrect flare technique, unanticipated or "more-severe-than-expected" adverse weather conditions, reduced braking or loss of braking, an abnormal configuration — perhaps caused by an aircraft being dispatched under MEL conditions or by an in-flight malfunction — and incorrect crew action and coordination under adverse conditions.

Recommended accident-prevention strategies called for:

- "Adherence to standard operating procedures;
- "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."

Eight years after production of the *ALAR Tool Kit*, runway safety issues persist. The goal of the RSI is to reiterate the runway safety message that was one of the themes of the ALAR project and find new ways to specifically address the risks of runway excursion accidents.

Notes

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