

Keeping It on the Runway

BY RICK DARBY

A new product combines findings and tools developed by the Runway Safety Initiative for reducing runway excursions.

The long, straight pavement lies ahead, waiting to launch an airplane into the sky or welcome it to the ground.

A runway is an invitation.

The invitation is accepted, the meeting takes place and nearly always everything goes well. But nothing in takeoffs or landings is guaranteed. When an airplane rolls past the end of the runway — an overrun — or off the side — a veer-off — the runway excursion puts its occupants at risk.¹ James M. Burin, Flight Safety Foundation (FSF) director of technical programs, reported that in 2008 six of the 19 major accidents

involving commercial jets worldwide were runway excursions, four occurring on takeoff (*ASW*, 2/09, p. 18).²

A new joint product from Flight Safety Foundation and the International Air Transport Association (IATA), the *Runway Excursion Risk Reduction Toolkit*, promises to significantly help operators reduce the risk of runway excursions. The compact disc combines the final report of the FSF Runway Safety Initiative (RSI) and material from IATA. The tool kit is available from the Foundation and IATA; check the FSF Web site for ordering information.

The RSI report, “Reducing the Risk of Runway Excursions,” summarizes the findings of two and one-half years of industry effort. The RSI effort brought together disciplines that included aircraft manufacturers, operators, management, pilots, regulators, researchers, airports and air traffic management organizations.

The team initially studied the data on three kinds of runway risk: runway incursions, runway excursions and runway confusion. It found that both incursion and confusion accidents had higher fatality rates than excursions. However, the proportion of excursions

among runway-related accidents far exceeded those for incursion and confusion accidents (Figure 1). As a result, the number of fatal excursion accidents was substantially greater than the number of fatal incursion and confusion accidents (Figure 2). The RSI team decided that it would be most useful to focus its efforts on reducing excursion accidents.

Excursions are little noted in mainstream news media unless they involve fatalities or extensive injuries, or present spectacular photo and video opportunities. Perhaps there is a perception that excursions are not “crashes” but just low-consequence careless driving, the

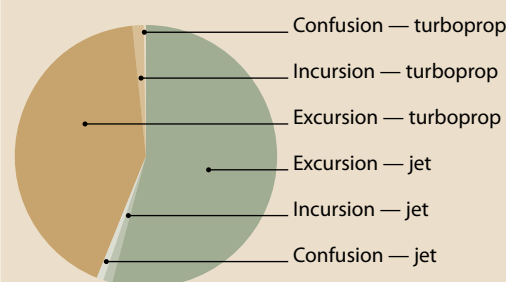
aviation equivalent of automobile fender benders. However, every excursion has the potential for serious consequences. From 1995 through 2008, of 417 runway excursions by commercial transport aircraft, 34 involved fatalities and 712 people were killed.³

Although no accident can strictly be described as typical, an excursion that occurred on Sept. 19, 2008, gives an idea of what lies behind the statistics. A safety recommendation letter by the U.S. National Transportation Safety Board (NTSB) to the U.S. Federal Aviation Administration (FAA) described the occurrence.⁴

“A Bombardier Learjet 60 ... overran Runway 11 while departing Columbia Metropolitan Airport, Columbia, South Carolina,” the letter said. “The pilot, copilot and two of the four passengers were killed; the two other passengers were seriously injured. The aircraft was destroyed by postcrash fire. ...

“According to witness interviews and the cockpit voice recorder transcript, the beginning of the takeoff roll appeared normal. However, sparks were observed as the airplane traveled along the runway. The airplane continued beyond the runway and through the approximately 1,000-ft [305-m] runway safety area and, beyond that, struck airport lighting, navigation facilities, a perimeter fence and concrete marker posts. The airplane then crossed a roadway and came to rest when it struck an embankment across the road from the airport.”⁵

Proportions of Runway-Related Accidents, 1995–2008

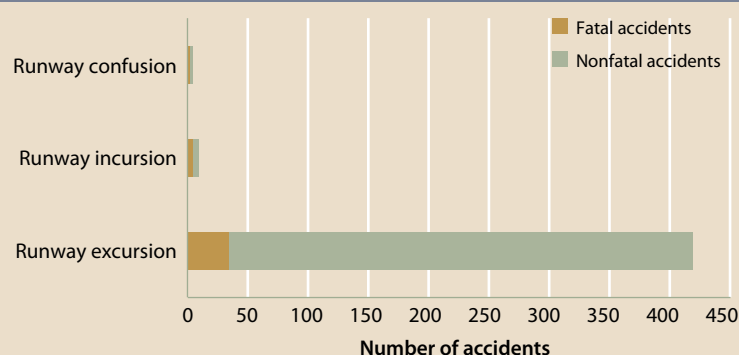


Note: Data represent commercial transport aircraft worldwide.

Source: Runway Excursion Risk Reduction Toolkit

Figure 1

Proportions of Fatal and Nonfatal Runway Accidents, 1995–2008



Note: Data represent commercial transport aircraft worldwide.

Source: Runway Excursion Risk Reduction Toolkit

Figure 2

Sifting the Data

The RSI team studied a database of excursions to identify high-risk areas. The entire study, including the study basis, data set and constraints, can be found in a “Report on the Design and Analysis of a Runway Excursion Database,” an appendix to the RSI report.

Among the findings were that landing excursions outnumbered takeoff excursions by about four to one; almost two-thirds of the takeoff excursions were overruns; landing excursion overruns and veer-offs occurred at nearly the same rate; and turboprops were involved in the highest percentage of takeoff excursions. In

landing excursions, jets were involved in more excursions than turboprops.

The data were analyzed to determine the prevalence of various risk factors associated with takeoff excursions (Figure 3) and landing excursions (Figure 4).

“Multiple risk factors create a synergistic effect.”

Risk factors were not confined to pilot actions or airplane mechanical problems. The following is a selection from the list — given in full in the RSI report section of the tool kit — of other factors boosting the odds of an excursion:

Air traffic management. Late runway changes during the approach, such as after the final approach fix; failure to provide timely or accurate wind and weather information to the

crew; and failure to provide timely or accurate runway condition information to the crew.

Airport. Runways that are not constructed and maintained to maximize effective friction levels and drainage; incorrect or obscured runway markings; failure to allow use of the optimal runways for the prevailing wind; and an inadequate runway end safety area (RESA) or equivalent deceleration system.

Regulators. Lack of a regulatory requirement to give flight crews takeoff and landing data for all runway conditions in a consistent format.

Double Trouble

Risk factors for excursions can be compounded. Two, or even more, sometimes coexist in a takeoff or landing.

“Multiple risk factors create a synergistic effect (i.e., two risk factors more than double the risk),” the report says. “Combining the effects of the risk indicators via a proper safety management system (SMS) methodology could effectively identify increased-risk operations.”

Risk factors that showed up in the database analysis were cross-tabulated for veer-offs and overruns, both in takeoffs and landings. Four tables in the report show the degrees of interaction among factors.

“The small number of events comprising the takeoff excursions data set — made even smaller when considering only veer-offs — limits our ability to know whether differences in the tabulated values are significant,” the report says. “However, it is interesting to note where there are associations of factors that may warrant further, more detailed study. For instance, aborts [rejected takeoffs] at or below V_1 often still resulted in a veer-off when there was an engine power loss, a runway contaminant or a crosswind. There is also some indication that the increased risks created by crosswinds and tail winds are magnified when gusts, turbulence or wind shear is present.”

In the table showing takeoff overrun factor interactions, “the numbers in these data suggest that there might be interesting associations between engine power loss and aborts initiated

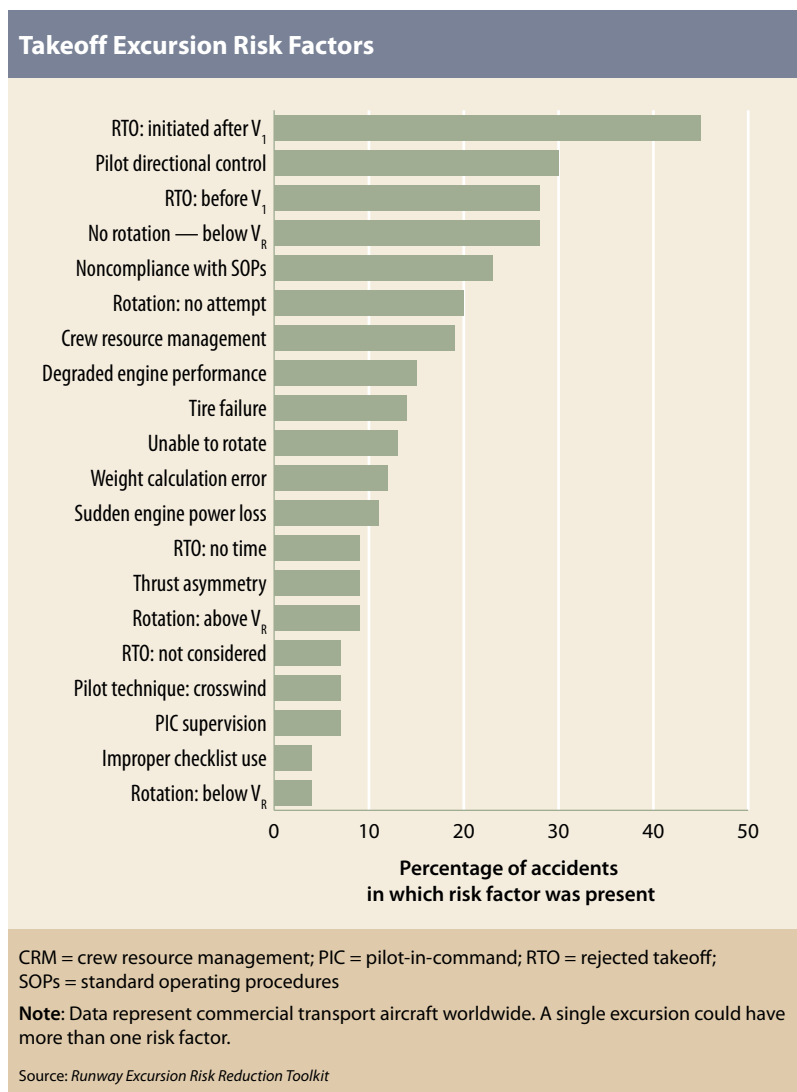


Figure 3

above V_1 , as well as an association between these high-speed aborts and the presence of runway contaminants,” the report says.

Observations about risk interactions for landing excursion veer-offs and landing excursion overruns were based on a larger sample. The cross-tabulations showed that “the landing excursion data have some strong associations between pairs of factors,” the report says. “For instance, ... for veer-offs, the factor(s) ‘touchdown long/fast’ have little association with the other listed factors. However, ... ‘touchdown hard/bounce,’ shows strong associations with many of the other factors.”

Adopting Mitigations

Following the descriptions of the research findings, the report delivers its payload: recommended mitigations. The prevention strategies embrace five stakeholder groups: flight operations, air traffic management, airport operators, aircraft manufacturers and regulators.

Here are samples, from an extensive list, in each category:

Flight operations. “Operators should define criteria that require a go-around”; “Operators should define and train the execution of the RTO [rejected takeoff] decision.”

Airport operators. “Define criteria to determine when to close a runway to prevent runway

Landing Excursion Risk Factors



SOPs = standard operating procedures

Note: Data represent commercial transport aircraft worldwide. A single excursion could have more than one risk factor.

Source: Runway Excursion Risk Reduction Toolkit

Figure 4



A Bangkok Airways ATR 72 skidded off the runway while landing in heavy rain on Aug. 5, 2009. The captain was killed and 11 occupants were injured.

excursions”; “Ensure that runways are constructed and maintained to ICAO [International Civil Aviation Organization] specifications, so that effective friction levels and drainage are achieved (e.g., runway grooving, porous friction overlay).”

Air traffic management. “Ensure all ATC/ATM [air traffic control/air traffic management] personnel understand the concept and benefits of a stabilized approach”; “Encourage joint familiarization programs between ATC/ATM personnel and pilots.”

Regulators. “Develop a policy to standardize takeoff and landing data format as a function of runway condition.”

Aircraft manufacturers. “Manufacturers should provide appropriate operational and performance information to operators that account for the spectrum of runway conditions they might experience.”

The RSI report, “Reducing the Risk of Runway Excursions,” describes the seriousness of the problem; the causal factors involved, distinguishing between overruns and veer-offs, and between takeoff excursions and landing excursions; the data through which the conclusions were reached; and detailed discussion of mitigations, conclusions and recommendations of the RSI team.

Appendix I is the FSF *Runway Excursion Risk Awareness Tool* (RERAT). Similar in principle to the FSF *Approach and Landing Risk Awareness Tool* (RAT), the RERAT lists factors that contribute to excursion risk on any given flight: for example, “No current/accurate weather/runway condition information,” “High crosswinds/gusty winds” and “Nonprecision approach, especially with multiple step-downs.”

The factors are categorized by headings such as “Flight Crew,” “Airport” and “Environment.” Warning symbols

indicate the degree of risk severity for each factor. “Elements of this tool should be integrated, as appropriate, with the standard approach and departure briefings to improve awareness of factors that can increase the risk of a runway excursion,” the RERAT says.

“Runway Excursion Risk Reduction Strategies” are included in a condensed format so that the RERAT can be used as a stand-alone tool when appropriate. The document includes the recommended elements of a stabilized approach, which are discussed in detail in the RSI report.

Briefing Notes

Appendix II of the RSI report consists of “Approach and Landing Briefing Notes” from the FSF *Approach and Landing Accident Reduction Tool Kit*, plus two new briefing notes from the RSI: “Pilot Braking Action Reports” and “Runway Condition Reporting.”

The briefing notes summarize, thoroughly but concisely, the important points for topics, which are subdivided under broader headings including “Crew Coordination,” “Altimeter and Altitude,” “Descent and Approach,” “Approach Hazards Awareness,” “The Go-Around,” “Approach Techniques” and “Landing Techniques.”

Most of the briefing notes include summaries, references, further reading from FSF publications, and regulatory resources.

Appendix III is “Report on the Design and Analysis of a Runway Excursions Database,” a detailed explanation of the database of runway excursion accidents from 1995 through March 2008, which formed the basis for the RSI report. Readers seeking to understand the methodology used to create the database and read an analysis of data in greater depth than the report provides will find this section of interest.

This appendix puts excursion risk factors under the microscope, dealing with specifics such as “wheel factors.” It was found, for example, that “tire failures are often a consequence of rejected takeoffs, but 13 of the 16 ‘tire failure’ citations in this field occurred during the takeoff roll and motivated the takeoff abort. The other three occurred during the abort process and contributed to the aircraft departing the runways.”

Appendix IV, “Selected Flight Safety Foundation Publications,” includes articles — mainly published in the past four years — bearing on the subject. They are all available on the Web site <www.flightsafety.org>.

An appendix titled “Additional Resources” includes reports from the Australian Transport Safety Bureau, the FAA and the Direction Générale de l’Aviation Civile, France.

The IATA contributions to the *Runway Excursion Risk Reduction Toolkit* include a “Video Introduction” in a Microsoft Windows media video (.wmv) file; an “Executive Introduction”; a “CEO and COO Brief”; “Preventing Runway Excursions”; “Preventing Runway Excursions, Pilots’ Training Kit”; and “Air Carrier Self-Audit Checklist.”

Additional supporting material from IATA comprises “ANSP [air navigation service provider] Roles in Runway Excursion Prevention”; “Engineered Materials Arresting System (EMAS)”; three files of runway excursion accident data from 2004 to 2008; a Boeing Co. document, “Runway Condition Reporting”; an Air France publication, “Runway Excursion Prevention”; “Technological Aids to Support the Runway Safety Initiative”; “Measure Runway Braking Conditions”; and several other documents.

From Deliberation to Product

“We knew we were going to concentrate on runway safety, but deciding to focus on runway excursions actually took a few meetings of deliberation by the team members,” said Glenn Michael of the FAA, who was involved in the Runway Safety Initiative from its beginning. “Once the decision was made to work on excursions, the team was divided into functional groups to address specific causal factors of runway excursions. Mitigation strategies were then constructed to address risks associated with runway excursions.”

Rob van Eekeren, a captain representing the International Federation of Air Line Pilots’ Associations, recalled, “The process involved industry partners as well as international organizations, all with their own interests and agendas. Four meetings per year were scheduled with a two-year time frame. It proved to be an interesting challenge to get everybody focused on a common goal. This goal could not be and was not reached in one meeting alone. In fact, it took almost 18 months.”

It was agreed to work along a data-driven approach. “Although in potential a lot of data were available — a runway excursion is always an incident and thus recorded — it had never been compiled in the runway safety field,” van Eekeren said. “So the Foundation contracted with a data specialist. During the two-year process, more and more data became available. Another advantage was that these data could be used as a baseline so that the effects of future improvements could be checked.

“So during the whole process, the complete picture became more clear and at a point it was decided to leave the original, purely briefing note, format and switch to a more systematic approach. Detailed point-by-point

discussions amongst the team members resulted in subgroup proposals which in turn were discussed in plenary sessions with the other groups.”

The group studying approach risk factors had a head start because of the work that had been done in connection with the FSF *ALAR Tool Kit*. The runway group was faced with a “zillion years of history,” as van Eekeren put it, on braking action problems. The airport study group started from ICAO Annex 14 recommendations for airport design.

“The challenge now was to go beyond existing material and produce new ideas and initiatives which could make a difference,” van Eekeren said. “That takes time. The representatives also had to address their normal day-to-day jobs, and only as an RSI meeting approached was there significant activity. Even a special Web-based page created by the Foundation for communicating and posting ideas could not overcome this. It must be said, however, that inside each organization the subject of runway excursions became prominent in its own right. The allotted time limit was pressing and a leap forward was achieved during the last formal meeting in Brussels in 2009. A final meeting at the FSF office brought the final result.”

Glenn Michael said, “This was an outstanding group of experts to work with and once we defined our goal, Jim Burin and [FSF Fellow] Earl Weener kept us on track and were fantastic at facilitating the overall process. This was a wonderful project to work on, and I am convinced that it will assist in runway safety efforts worldwide.”

“It is not perfect and my feeling is that more innovation could have been realized,” van Eekeren said. “I’m sure my fellow RSI team members will share this feeling. Sometimes compromises are required to reach a result. Nevertheless,

the RSI team was successful in identifying key areas and finding solutions for given problem areas. The Foundation did an outstanding job in raising worldwide awareness for runway excursions.

“I daresay that the awareness has reached the critical point, meaning that it is in so many heads now that runway safety will be addressed almost as a self-propelling process. This will undoubtedly lead to a process where we will see a reduction in the runway safety risk in the next five to 10 years. However, since there is no global coordination point or globally accepted plan, it might be expected that some runway safety measures will be done with the best intentions, but will fail. Others might prove highly successful.”

Notes

1. The FSF Runway Safety Initiative defined a runway excursion as “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.”
2. A major accident, which Flight Safety Foundation believes is the primary accident criterion for safety purposes, is defined as an accident that meets any of three conditions: First, the aircraft is destroyed or sustains major damage; second, there are multiple fatalities; third, there is one fatality and the aircraft is substantially damaged.
3. “Reducing the Risk of Runway Excursions,” from the *Runway Excursion Risk Reduction Toolkit*.
4. NTSB. July 17, 2009. Available via the Internet at <www.nts.gov/recs/letters/2009/A09_55_60.pdf>.
5. The accident is still under investigation, but the NTSB’s preliminary findings suggested inadvertent stowage of the thrust reversers and prompted a concern that “Learjet 60 pilots are not sufficiently trained to recognize that a failure could occur during takeoff as well as landing phases of flight and could subsequently result in the loss of [thrust reverser] system logic control requirements for maintaining deployed thrust reversers during a rejected takeoff.”