FLIGHT SAFETY FOUNDATION

FEBRUARY 2002

FLIGHT SAFETY DIGEST

Runway Incursion Severity Trends at Towered Airports in the United States: 1997–2000

FLIGHT SAFETY FOUNDATION
SINCE 1947

Flight Safety Digest

Vol. 21 No. 2 **February 2002**

In This Issue

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 850 member organizations in more than 140 countries.

Runway Incursion Severity Trends at Towered Airports in the United States: 1997–2000

Five runway incursions occurred for every 1 million airport operations conducted during the period. Of the 1,369 runway incursions during the period, 257 resulted in near collisions between aircraft and three resulted in collisions. The average rate at which near collisions and collisions occurred at the 32 busiest U.S. towered airports was twice the average rate for other U.S. towered airports.

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U.S. Federal Aviation Administration

Executive Summary

The U.S. National Airspace System (NAS) collectively managed approximately 266 million flights, or airport operations, at the more than 450 towered airports in the United States during the period 1997–2000. Of these 266 million airport operations, 1,369 resulted in runway incursions. That is approximately five runway incursions for every 1 million operations. Of the 1,369 runway incursions, three resulted in accidents. In 2000, the number of runway incursions increased by 110 events, from 321 to 431.[1]

Until now, there was no characterization of runway-incursion severity — the potential consequence of these incursions. Underlying variables, such as the proximity and speed of the aircraft involved, must be considered along with the frequency of runway incursions to accurately portray the risk posed by these events. The U.S. Federal Aviation Administration (FAA) commissioned this analysis to assess the relative severity of runway incursions.

A multidisciplinary team of aviation professionals reviewed the 1,369 runway incursions that occurred from 1997 through 2000 and systematically characterized the relative severity of each event based on specific operational dimensions. The nature of runway incursions ranges from relatively minor events where there is little or no chance of a collision to major events that result in a narrowly avoided collision or an accident. Nationwide, this analysis found that 81 percent of the runway incursions evaluated were minor in severity. These minor events accounted for the majority of the increase in runway incursions in 2000. The number of runway incursions considered to be major in severity remained relatively stable during the four-year period studied.

To assess the trends at towered airports with respect to their traffic volume, the rate of runway incursions was considered. This analysis found that the rate of runway incursions was not strongly correlated with the number of airport operations. When severity was considered, however, the average rate of major runway incursions at the 32 busiest U.S. towered airports was shown to be approximately twice the average rate for the rest of the airports.

Reducing the frequency of runway incursions requires the implementation of prevention strategies. Reducing the severity of runway incursions requires the implementation of strategies to reduce the consequences of failures or human errors.

The findings of this analysis will help guide the development and implementation of strategies that target both the frequency and the severity of runway incursions.

Introduction

The NAS is the busiest airspace system in the world. There are more than 450 towered airports that handle more than 180,000 airport operations — takeoffs and landings — a day. The NAS relies on smooth coordination among 15,000 air traffic controllers, 600,000 pilots and many other people and organizations to operate safely and efficiently.

The growing demand for air travel and NAS capacity limitations put increasing pressure on the aviation community — the FAA, airlines, airports, air traffic controllers — to operate with greater efficiency and flexibility to reduce air-travel delays. At the same time, there are demands to enhance aviation safety, with heightened attention to runway safety. In the airport environment, the FAA must balance pressures to increase operational efficiency with pressures to enhance runway safety. These goals are embodied in the FAA's Operational Evolution Plan, a strategy to improve efficiency and capacity, and in the National Blueprint for Runway Safety, a plan for enhancing runway safety.

One step toward finding solutions that accomplish both of these goals is to better understand the factors that affect runway safety. In executing its mission to ensure that aviation safety remains uncompromised, the FAA collects and analyzes safety-related data, such as information on runway incursions. The analysis of runway-safety data is a necessary step toward developing approaches that will be used to anticipate emerging runway-safety issues and institute preventive measures that are both timely and cost-effective. This study examined currently available runway safety data to better characterize the scope and severity of runway incursions.

U.S. airports with air traffic control towers (towered airports) report the occurrence of runway incursions. From 1997 through 2000, there were more than 450 towered airports which collectively averaged 66.7 million airport operations a year. Of the approximately 266 million airport operations at U.S. towered airports from 1997 through 2000, 1,369 resulted in runway incursions. That is approximately five runway incursions for every 1 million operations. Of the 1,369 incursions, three resulted in accidents.

This performance record is the product of a complex web of systems, procedures and well-trained professionals working in concert to reduce aviation safety risks. Encompassing both technology and people, these measures are designed to prevent runway incursions and to reduce the chance of incursions resulting in accidents. Developed to protect against the consequences of human error and technical failure, airport operations are resilient and error tolerant by design. To continue to enhance runway safety, it is essential to understand not only the frequency of runway incursions but also the severity of runway incursions. This new understanding will guide the implementation of technologies and procedures to enhance runway safety and increase airport capacity.

Background

Runway safety is managed according to rigorous protocols that pilots and air traffic controllers use to control aircraft on runways. Imagine that an invisible bubble forms around an airplane when it enters a runway. This bubble acts as a buffer zone to protect the airplane from accidents or errors during takeoff and landing. The depth of the bubble — the space between an airplane and another object on the runway — is referred to as separation. Maintaining the perimeter of the bubble is analogous to maintaining separation. Any penetration of the bubble is an incursion. The more deeply the bubble is penetrated, the more serious is the incursion. The formal definition of a runway incursion is any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land.

Purpose

The purpose of this study is to assess runway-incursion-severity trends in the United States, providing a more comprehensive understanding of the risks that runway incursions pose to the flying public. The FAA intends to use the information in this report to:

- Reduce the number, rate and severity of runway incursions;
- Enhance the error tolerance of the aviation system and further reduce the risk of accidents;
- Refine runway safety benchmarks and metrics;
- Improve the quality of runway-safety data collection, analysis and reporting; and,
- Educate the aviation community and the public about runway incursions.

Method

The runway-incursion data for this study were obtained from the FAA's National Airspace Incidents Monitoring System (NAIMS). The four-year time period provided the most complete and consistent FAA data for runway incursions at U.S. towered airports. The data obtained from the NAIMS database included the 1,369 runway incursions that are the subject of this study.

The FAA convened a government-industry team of aviation analysts with expertise in air traffic control, airway facilities, airports, flight standards, human factors and system safety to conduct this study. The team systematically reviewed all 1,369 runway incursions that occurred.

Metrics

Three basic runway-safety metrics typically are used to examine runway-incursion trends: the number of runway incursions, the rate of runway incursions and the types of runway incursions (characterized by attributable errors). The FAA investigates runway incursions and attributes the occurrences to one or more of the following error types:

- Operational error — an action of an air traffic controller that results in:
  - Less than the required minimum separation between two or more aircraft, or between an aircraft and obstacles (e.g., vehicles, equipment or personnel on runways); or,
  - An aircraft that lands or departs on a runway closed to aircraft;
- Pilot deviation — an action of a pilot that violates any U.S. Federal Aviation Regulation (e.g., failure to obey air traffic control instructions to hold short of an active runway when following the authorized route to an airport gate); and,
- Vehicle/pedestrian deviation — interference with aircraft operations by entering or moving on the runway movement area without authorization from air traffic control.

None of the metrics typically used to examine runway-incursion trends, however, provides reliable insight into the relative margin of safety associated with these events.

Therefore, an additional metric — runway-incursion severity — was used for the study. The severity of runway incursions, as well as the frequency of occurrence, must be considered to make accurate judgments about runway safety.

The runway incursion profiles included in Figure 1 (page 4) show why more descriptive runway incursion categorizations were necessary to capture the different margins of safety — or, conversely, varying degrees of severity — associated with each runway incursion. An accurate portrayal of runway incursion trends is essential to finding solutions that target prevalent errors and system deficiencies.

Defining Runway Incursion Severity

Underlying the simple case studies in Figure 1 is a wide range of variables that dramatically affect the relative severity of a runway incursion. From these variables, five key parameters were selected to add dimension to the evaluation of relative severity (Table 1, page 5). The five operational dimensions are interdependent — for example, aircraft speed affects available reaction time.

The five operational dimensions formed the basis for developing runway incursion categories that capture the spectrum of severity (Figure 2, page 6). The runway incursion categories capture the relative margin of safety for a given runway incursion. The categories, labeled A through D, range from near collisions or accidents to incidental events. Category A and Category B include major runway incursions where there was high risk of a collision based on the operational dimensions. Category C and Category D include minor runway incursions where there was little risk of collision or no risk of collision.

Categorizing Runway Incursions Based on Relative Severity

The 1,369 reported runway incursions were reviewed individually. Each runway incursion event was reconstructed to the degree possible based on available information. The study team reviewed and classified each event as one of the four runway incursion categories based on its relative severity. Reports on 10 of the 1,369 events did not contain any information to support a reliable categorization of severity; therefore, these 10 events were excluded from further runway incursion severity analyses. The supporting data are provided in the appendix (page 15). Events in reports that contained only limited information were categorized in a conservative manner and placed in a more severe category. Runway incursion locations were plotted on airport diagrams at the 32 busiest U.S. airports (ranked by total number of operations from 1997 through 2000) to visualize the circumstances involved in these events and assist in the categorization.

Analyzing Trends in Runway Incursion Severity

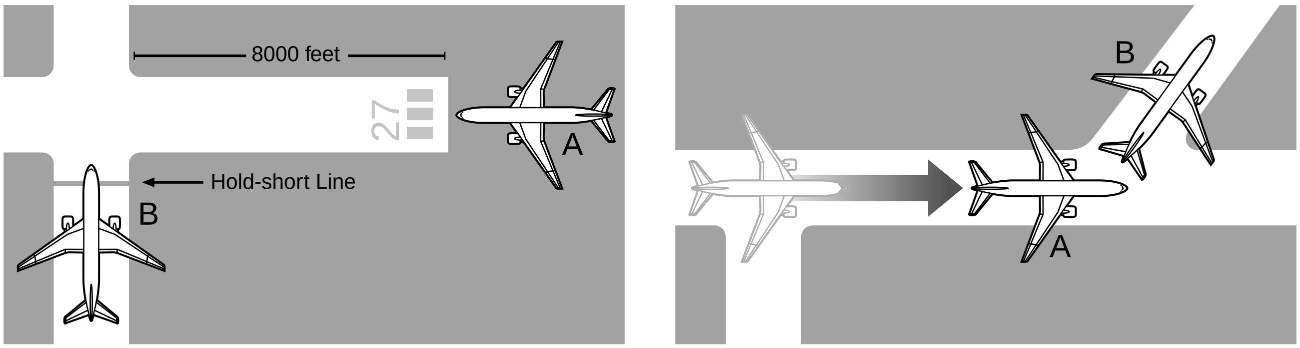
Using the runway incursion severity categories, the study team performed an analysis of runway incursion trends. The distribution of runway incursions across the four categories was examined in aggregate for the four-year period. This aggregate distribution was then broken down by year to identify any annual trends. Annual operational errors, pilot deviations and vehicle/pedestrian deviations were analyzed according to their respective runway incursion categorizations to determine whether trends varied according to the runway incursion type (error type).

Runway incursions also were characterized by aircraft operation. This differentiation was necessary to examine interactions among different kinds of aircraft operations from 1997 through 2000, as well as the annual variations. Using aircraft performance, size and capacity as the primary criteria, aircraft operations were divided into the following three categories:

- Commercial operations (Comm), including the following groups:
  - Jet transport (JT);

Runway Incursion Profiles

CASE 1	CASE 2
This incident meets the definition of a runway incursion, but there is little or no chance of collision.	This is a severe situation where the margin of safety is so low that a collision is barely avoided.



Case 1

Aircraft A is on approach to Runway 27, an 8,000-foot (2,440-meter) runway. Aircraft B is taxiing to a parking area on the north side of the airport and has been instructed by air traffic control to “hold short of Runway 27” in anticipation of the arrival of Aircraft A. When Aircraft A is on a quarter-mile (half-kilometer) final approach, Aircraft B’s pilot informs the controller that he has accidentally crossed the hold-short line for Runway 27. Although Aircraft B is not on the runway, the aircraft’s nose is across the hold-short line, usually 175 feet (53 meters) from the runway.

A runway incursion has occurred since separation rules require that a runway be clear of any obstacle before an aircraft can land or take off on that runway. The controller instructs Aircraft A to “go around.”

▶ The potential for a collision is low, but by definition, a runway incursion has taken place.

▶ This case exemplifies most frequently reported runway incursions.

Case 2

Aircraft A has been cleared to taxi into position and hold on Runway 9 following Aircraft B, which has just landed on the same runway and is rolling out. Aircraft B is instructed to turn left at a taxiway. Aircraft B acknowledges. The controller observes Aircraft B exiting the runway and clears Aircraft A for takeoff. A moment later the controller notices too late that Aircraft B has not fully cleared the runway and, in fact, appears to have come to a complete stop with much of the aircraft remaining on the runway.

Aircraft A has accelerated to the point it cannot stop and has only the option to fly over the top of Aircraft B.

▶ The potential for a collision is high and typifies the common perception of a runway incursion.

▶ This case is more severe but occurs infrequently.

Source: U.S. Federal Aviation Administration

Figure 1

– Commuter (CR); and,

– Commercially operated general aviation (CGA);

- General aviation (GA) operations (generally small, private aircraft); and,
- Military operations (Mil).

Finally, runway incursions were analyzed to determine the potential trends in number, frequency and severity with respect to airport operations (see appendix). The findings from this analysis are presented in the following sections.

Table 1
Operational Dimensions Affecting Runway Incursion Severity

Operational Dimensions	Description
Available Reaction Time	Available reaction time considers how much time the pilots, controllers and/or vehicle operators had to react to the situation based on aircraft type, phase of flight and separation distance.
Evasive or Corrective Action	Evasive or corrective action considers the need for and type of evasive or corrective maneuvers required to avoid a runway collision by pilots and/or air traffic controllers.
Environmental Conditions	Environmental conditions considers visibility, surface conditions and light conditions.
Speed of Aircraft and/or Vehicle	Speed of aircraft and/or vehicle is a function of aircraft type and phase of flight (taxi, takeoff, landing).
Proximity of Aircraft and/or Vehicle	Proximity of aircraft and/or vehicle, or their separation distance from one another.

Source: U.S. Federal Aviation Administration

Findings

Figure 3 (page 7) depicts the number and severity of reported runway incursions at U.S. towered airports from 1997 through 2000. There was a marked increase in the number of reported runway incursions at U.S. towered airports in the year 2000; the number of runway incursions increased by 110 — from 321 to 431 — from the previous year. Most of this increase comprised runway incursions that were minor in severity: 96 percent were in Category C and Category D. That is, most incursions involved events where there was ample time and distance to avoid a potential collision, or there was little or no chance of a collision.

The distribution of runway incursions over the four-year period also was examined in aggregate to assess the relative severity of all reported runway incursions. The findings indicate that the majority of the incidents (81 percent) were Category C and Category D events (Figure 4, page 7).

To examine the increase in Category C and Category D runway incursions in 2000, the three runway incursion types were investigated: operational errors, pilot deviations and vehicle/pedestrian deviations. Figure 5 (page 8) shows the number of reported operational errors, pilot deviations and vehicle/pedestrian deviations with respect to runway incursion severity categories for 1999 and 2000. In 2000, 60 percent of reported runway incursions were attributed to pilot deviations, 20 percent to operational errors and 20 percent to vehicle/pedestrian deviations. The increase in reported Category C and Category D runway incursions in 2000 was attributed primarily to pilot deviations: Airports reported 77 more pilot deviations, nine more operational errors and 24 more vehicle/pedestrian deviations compared to 1999.

Table 2 (page 8) shows the distribution of aircraft operations within the United States from 1997 through 2000 and the distribution of reported runway incursions involving each type of aircraft operation.

Reported runway incursions were distributed among aircraft operations as follows: 38 percent were commercial operations, 60 percent were general aviation operations, and 2 percent were military operations. This distribution of reported runway incursions among aircraft operations is consistent with the distribution of the operations in the NAS.

The analysis was expanded to examine the interactions among pairs of aircraft operations involved in runway incursions (e.g., GA/GA, Comm/Comm, Comm/GA). This analysis also investigated the interactions between aircraft operations and vehicles/pedestrians. This analysis sought to determine whether trends in runway incursion severity varied according to the aircraft operations involved. Figure 6 (page 9) shows aggregate runway incursion severity trends from 1997 through 2000 according to the combination of operations that were involved. Runway incursions most commonly involved two general aviation operations and were predominantly minor in relative severity (Category C and Category D).

Annual runway incursion data were analyzed to investigate yearly trends. Figure 7 (page 9) shows the number and type of runway incursions by aircraft operations for each of the four years. There was a steady increase in runway incursions involving two general aviation operations from 1997 through 2000, which can be attributed to an increase in pilot deviations.

Although there was a decline in runway incursions between general aviation operations and vehicles/pedestrians from 1997 through 1999, there was a noticeable reversal of this trend in 2000. Most of the increase in 2000 was attributed to vehicle/pedestrian deviations.

Figure 8 (page 10) shows the distribution of runway incursion severity for events involving commercial operations groups (e.g., JT/JT, JT/GA, CR/GA) from 1997 through 2000. Most incursions involved two jet transports. The majority of these runway incursions were minor in severity (Category C and Category D).

Figure 9 (page 10) shows the annual numbers and types of runway incursions by commercial operations group. Runway

U.S. Federal Aviation Administration Runway Incursion Severity Categories

Increasing Severity →

Category D	Category C	Category B	Category A	Accident
Little or no chance of collision but meets the definition of a runway incursion	Separation decreases but there is ample time and distance to avoid a potential collision	Separation decreases and there is a significant potential for collision	Separation decreases and participants take extreme action to narrowly avoid a collision	An incursion that resulted in a ***runway collision***
Available Reaction Time: Not a factor; adequate time to consider multiple alternatives	**Available Reaction Time:** Adequate; sufficient time to smoothly execute an unplanned action	**Available Reaction Time:** Minimal. Barely adequate to take an emergency action	**Available Reaction Time:** None. Instantaneous reaction was required	
Need for Evasive/ Corrective Action: Evasive/corrective action not necessary	**Need for Evasive/ Corrective Action:** Advisable. Definitive action was taken (or could have been taken)	**Need for Evasive/ Corrective Action:** Essential. Time-critical action required (or should have been taken) to ensure safety	**Need for Evasive/ Corrective Action:** Critical. Radical evasive action was the only reason that a collision was avoided	
Environmental Conditions: Good. Played no role in the event	**Environmental Conditions:** Fair. Minimal influence on operational performance	**Environmental Conditions:** Marginal. Likely a factor but not overridingly important	**Environmental Conditions:** Poor. Definitely a factor	
Aircraft /vehicle Speed: Slow. Aircraft were traveling slowly; speed not a factor	**Aircraft/vehicle Speed:** Moderate. Aircraft/ vehicle were moving fast enough to be of concern; speed was not a significant factor	**Aircraft/vehicle Speed:** High. Potential for significant damage and injury	**Aircraft/vehicle Speed:** Extreme. One or both aircraft/vehicle traveling at a speed sufficient to reduce pilot or ATC reaction time. Potential to cause catastrophic damage/loss of life in the event of a collision	
Proximity of Aircraft/vehicle: Close. Aircraft/vehicle did not approach one another	**Proximity of Aircraft/vehicle:** Close. Aircraft/vehicle approached one another at a low/ moderate rate of speed	**Proximity of Aircraft/vehicle:** Very close. Aircraft/ vehicle approached one another at a high rate of speed	**Proximity of Aircraft/vehicle:** Near-collision. Aircraft/ vehicle traveling at high speed narrowly missing one another	

Three runway collisions occurred from 1997 through 2000. The three accidents were included in Category A for this analysis.

(1) La Guardia (LGA): Operational error involving a privately owned twin-engine aircraft and an airport maintenance vehicle (1997).

(2) Sarasota-Bradenton (SRQ): Operational error involving two small privately owned propeller aircraft (2000).

(3) Fort Lauderdale (FLL): A vehicle/ pedestrian deviation involving an airport truck and a commercial passenger jet (2000).

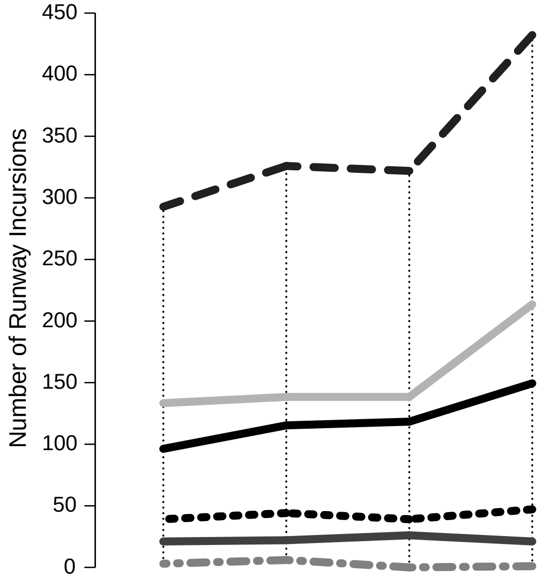
ATC = Air traffic control
FLL = Fort Lauderdale–Hollywood (Florida, U.S.) International Airport
LGA = La Guardia Airport, New York, New York, U.S.
SRQ = Sarasota/Bradenton (Florida, U.S.) International Airport

Source: U.S. Federal Aviation Administration

Figure 2

incursions involving two jet transports decreased in 1999 but increased in 2000. This variation is largely explained by the variation in the number of operational errors reported for these years. In addition, runway incursions involving a jet transport and a general aviation operation increased from 1997 through 2000.

Annual Number of Reported Runway Incursions at U.S. Towered Airports by Severity, 1997–2000



Year	1997	1998	1999	2000
Category A[1]	21	22	26	21
Category B[2]	39	44	39	47
Category C[3]	96	115	118	149
Category D[4]	133	138	138	213
Insufficient Data	3	6	0	1
Total	**292**	**325**	**321**	**431**

[1] Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

[2] Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

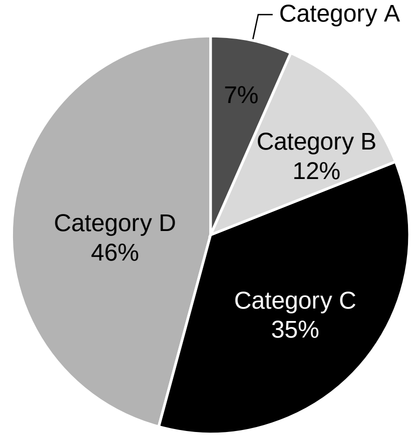
[3] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

[4] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

Source: U.S. Federal Aviation Administration

Figure 3

Severity Distribution of Reported Runway Incursions at U.S. Towered Airports, 1997–2000



Notes: Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision. Category B runway incursion occurs when separation decreases and there is significant potential for a collision. Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision. Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

Source: U.S. Federal Aviation Administration

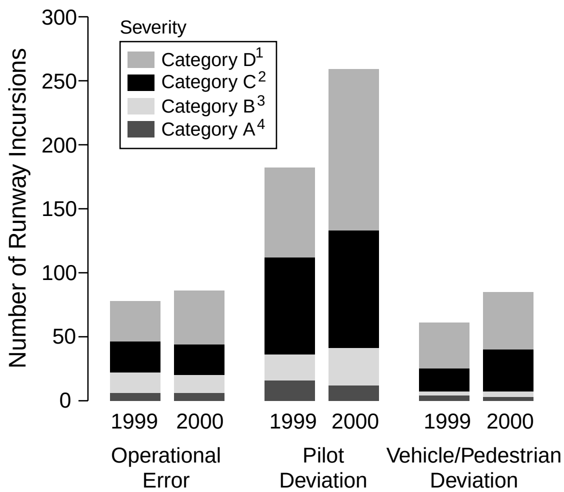
Figure 4

Runway incursions were analyzed to determine their distribution among U.S. towered airports from 1997 through 2000. The 1,369 runway incursions from 1997 to 2000 were distributed among 297 of the 459 U.S. towered airports in operation in 2000. Figure 10 (page 11) shows that approximately 162 towered airports (35 percent) had no reported runway incursions during the period; 220 airports (48 percent) had between one and five runway incursions; 46 airports (10 percent) experienced between six and 10 runway incursions; and the remaining 31 airports (7 percent) had between 11 and 33 runway incursions.

Runway incursion trends were analyzed across U.S. towered airports to investigate how the number and rate of runway incursions vary with the number of airport operations (i.e., airport volume). The 32 busiest U.S. airports, which had 24 percent of the total operations at towered airports for this period, had approximately 29 percent (403) of the 1,369 runway incursions from 1997 through 2000. Analysis showed that there was no strong correlation between the rate of runway incursions and the number of airport operations.

Runway incursion severity at U.S. towered airports was analyzed to determine where the most severe events occurred. Figure 11 (page 12) shows the total number of runway incursions at the 32 busiest U.S airports and the distribution of runway incursion severity. From 1997 through 2000, the 32 busiest U.S. airports accounted for 37 percent of the 259 major runway incursions (Category A and Category B), and 28 percent of the 1,100 minor runway incursions (Category C and Category D). When the rate of incursions is considered,

Severity Distribution by Runway Incursion Type at U.S. Towered Airports, 1999–2000



[1] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

[2] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

[3] A Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

[4] A Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

Source: U.S. Federal Aviation Administration

Figure 5

Table 2
Comparisons of Runway Incursions at U.S. Towered Airports for Aircraft Operations, 1997–2000

Aircraft Operations	Percentage of Aircraft Operations	Percentage of Runway Incursions
Commercial Aircraft	38%	38%
General Aviation	58%	60%
Military	4%	2%

Source: U.S. Federal Aviation Administration

the average rate of major runway incursions at the 32 busiest airports (0.15 incursion per 100,000 operations) was approximately twice the average rate at the rest of the airports (0.08 incursion per 100,000 operations). There was, however, no substantial difference in the rate for minor incursions; the rate for minor incursions was 0.48 incursion per 100,000 operations at the 32 busiest airports vs. 0.39 incursion per 100,000 at the rest of the airports.

Summary and Conclusions

The FAA performed this study to gain a better understanding of runway incursion severity trends at U.S. towered airports. Runway incursions range from relatively minor events involving little or no risk of collision to major events where an accident is narrowly avoided or an accident occurs. The severity of the incidents, as well as the number and rate of runway incursions, must be considered in order to make reliable judgments regarding the risk posed by runway incursions.

Reducing the *frequency* of runway incursions requires implementation of prevention strategies to reduce *occurrences*. Reducing the *severity* of runway incursions depends on the implementation of strategies to reduce the *consequences* of failures or human errors. Underlying, or causal, factors represent vulnerabilities that permit runway incursions to occur and also affect the degree of severity.

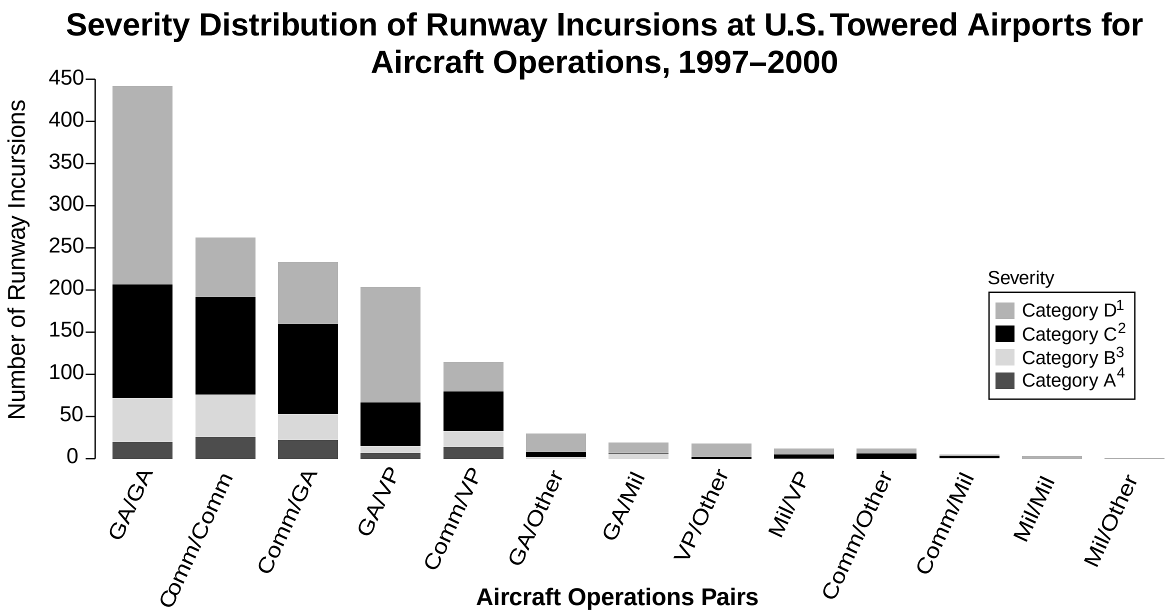
Strategies to enhance runway safety and reduce the frequency and severity of runway incursions must target factors or dimensions that represent these vulnerabilities — specifically, factors that permit runway incursions to happen. Broad-based and airport-specific runway safety initiatives are required, in light of the following findings:

- *Runway incursions are infrequent events, and runway collisions are rare occurrences.* Of the approximately 266 million operations at U.S. towered airports from 1997 through 2000, 1,369 resulted in runway incursions — or approximately five runway incursions per 1 million operations. Three of the runway incursions resulted in collisions (accidents). Most runway incursions are minor in severity. This is largely due to the rigorous margin of safety that is built into the aviation system with a network of technologies, procedures and well-trained professionals.

  The distribution of runway incursion severity from 1997 through 2000 indicates that the majority of the incidents (81 percent) were minor in terms of severity. In 2000, the number of reported runway incursions increased by 110 compared to the previous year. Ninety-six percent of this increase comprised runway incursions that were relatively minor in severity.

- *Every airport is unique in terms of its configuration, traffic mix, etc. This diversity makes it difficult to establish a correlation between the number of runway incursions and the number of operations.* The 1,369 runway incursions from 1997 through 2000 were

Continued on page 11



GA = General aviation operation, Comm = Commercial operation, Mil = Military operation, VP = Vehicle/pedestrian operation

[1] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

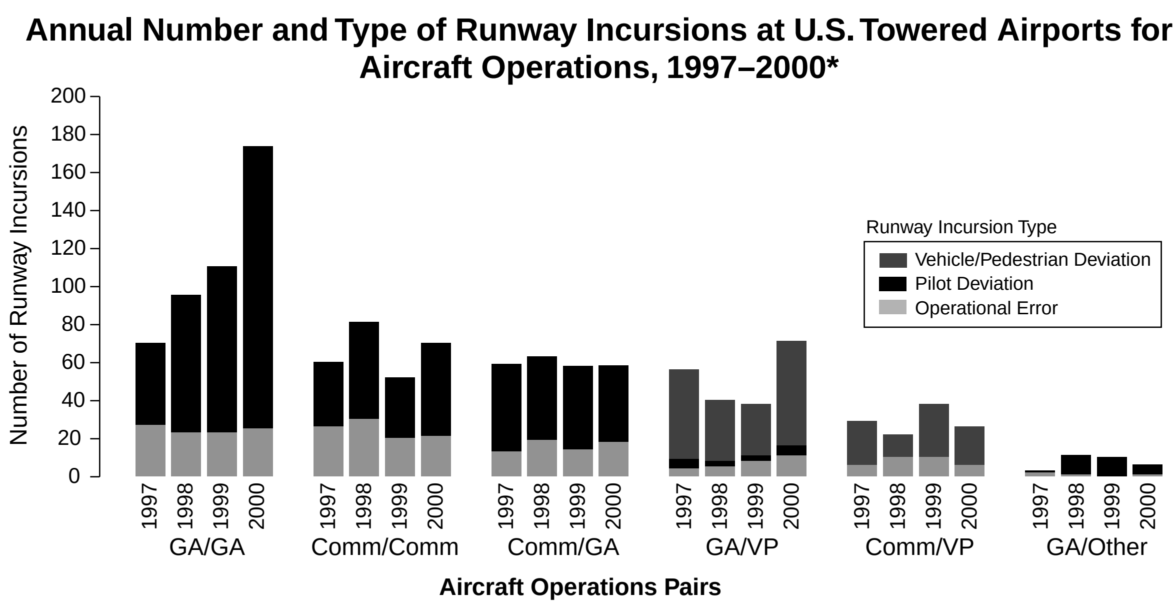
[2] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

[3] Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

[4] Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

Source: U.S. Federal Aviation Administration

Figure 6

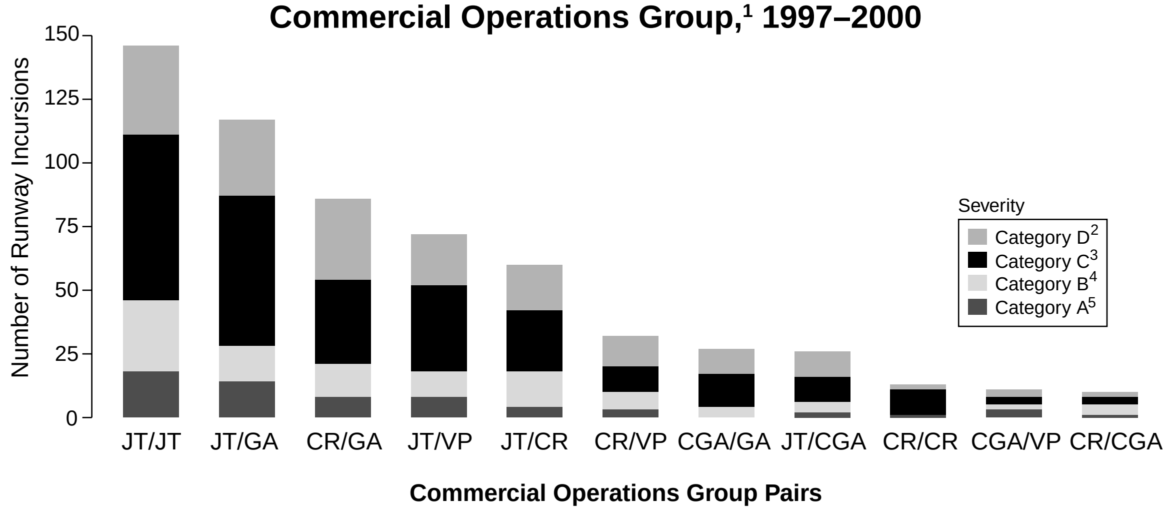


GA = General aviation operation, Comm = Commercial operation, VP = Vehicle/pedestrian operation
* Only those aircraft pairs involved in more than 20 runway incursions from 1997–2000 are shown.

Source: U.S. Federal Aviation Administration

Figure 7

Severity Distribution of Runway Incursions at U.S. Towered Airports for Commercial Operations Group,[1] 1997–2000



JT = Jet transport operation, GA = General aviation operation, CR = Commuter operation, VP = Vehicle/pedestrian operation, CGA = Commercially operated general aviation operation

[1] Only those commercial operations group pairs involved in at least 10 runway incursions from 1997–2000 are shown.

[2] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

[3] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

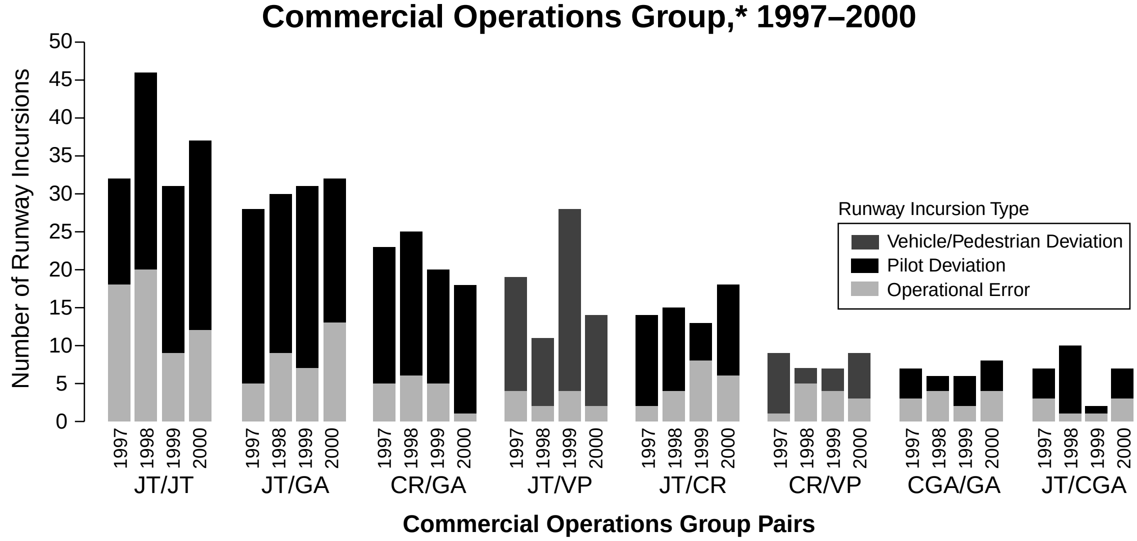
[4] Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

[5] Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

Source: U.S. Federal Aviation Administration

Figure 8

Annual Number and Type of Runway Incursions at U.S. Towered Airports by Commercial Operations Group,* 1997–2000



JT = Jet transport operation, GA = General aviation operation, CR = Commuter operation, VP = Vehicle/pedestrian operation, CGA = Commercially operated general aviation operation

*Only those commercial operations group pairs involved in at least 10 runway incursions from 1997–2000 are shown.

Source: U.S. Federal Aviation Administration

Figure 9

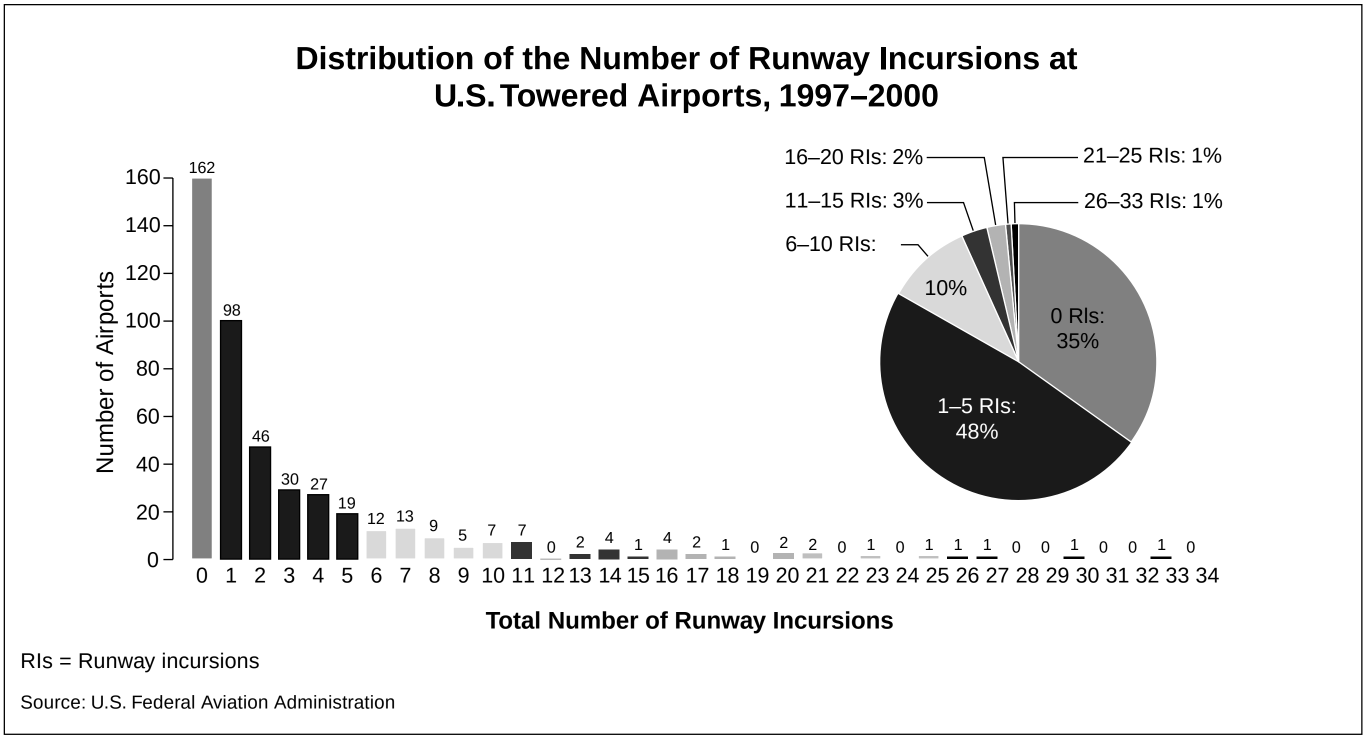


Figure 10

distributed across 297 out of approximately 459 U.S. towered airports. There were no reported runway incursions for 162 towered airports during the period. The rate of runway incursions was not strongly correlated with the number of airport operations. When severity was considered, however, the average rate of major runway incursions at the 32 busiest U.S. towered airports was approximately twice the average rate for the rest of the airports.

- *FAA runway incursion data do not consistently show the level of detail necessary to reliably determine the root causes of runway incursions.* Minimizing runway incursions requires effective coordination and communication among all participants in the aviation system (e.g., pilots, controllers, vehicle operators). Because each participant relies on the others to operate safely and efficiently, using runway incursion data that focus on operational errors, pilot deviations and vehicle/pedestrian deviations to determine "fault" may be counterproductive to determining root causes. As currently defined, "runway incursion types" do not provide any insight into why runway incursions happened. Rather, these labels simply identify to whom the incursion was attributed: the controller, the pilot and/or a vehicle operator or pedestrian.

- *Specific types of aircraft operations (commercial, general aviation, military) are proportionately involved in runway incursions based on their representation in the NAS.*

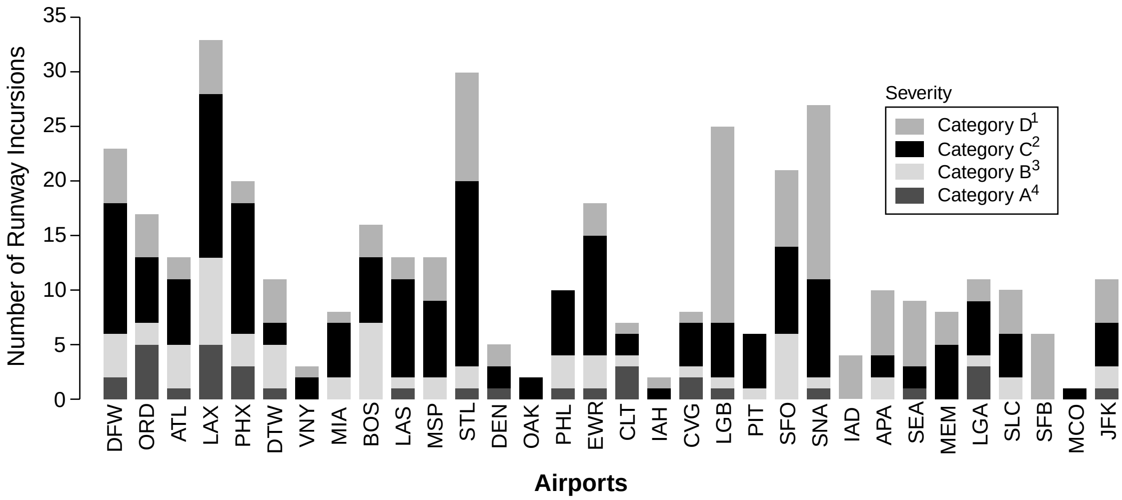
The most common types of runway incursions involved two general aviation operations and were predominantly minor in severity. There was a steady increase in the number of runway incursions involving two general aviation operations from 1997 through 2000, which can be attributed to an increase in pilot deviations. Although there was a consistent decrease in runway incursions between general aviation operations and vehicles/pedestrians from 1997 through 1999, there was a reversal in this trend in 2000. The majority of the increase in 2000 was attributed to vehicle/pedestrian deviations.

For runway incursions that involved at least one aircraft from a commercial operations group, most incursions occurred between two jet transports. The majority of these runway incursions were minor in severity. The number of runway incursions involving two jet transports decreased in 1999 but increased in 2000. This variation is largely explained by the variation in the number of operational errors reported for these years. The number of runway incursions involving a jet transport and a general aviation operation steadily increased from 1997 through 2000. The increase in 2000 represents an increase in operational errors and a decrease in pilot deviations.

Next Steps

The FAA is considering actions to guide the implementation of runway safety initiatives already in progress or planned. The next steps will involve identifying potential causal factors

Severity Distribution of Runway Incursions for the 32 Busiest U.S. Airports, 1997–2000



[1] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

[2] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

[3] Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

[4] Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

DFW = Dallas–Fort Worth (Texas) International, ORD = Chicago (Illinois) O'Hare International, ATL = William B. Hartsfield Atlanta (Georgia) International, LAX = Los Angeles (California) International, PHX = Phoenix (Arizona) Sky Harbor International, DTW = Detroit City (Michigan), VNY = Van Nuys (California), MIA = Miami (Florida) International, BOS = Gen. Edward Lawrence Logan International (Boston, Massachusetts), LAS = McCarran International (Las Vegas, Nevada), MSP = Minneapolis–St. Paul (Minnesota) International, STL = Lambert–St. Louis (Missouri) International, DEN = Denver (Colorado) International, OAK = Metropolitan Oakland (California) International, PHL = Philadelphia (Pennsylvania) International, EWR = Newark (New Jersey) International, CLT = Charlotte/Douglas (North Carolina) International, IAH = George Bush Houston (Texas) International, CVG = Cincinnati (Ohio)/Northern Kentucky International, LGB = Long Beach (California) Daugherty Field, PIT = Pittsburgh (Pennsylvania) International, SFO = San Francisco (California) International, SNA = John Wayne Airport/ Orange County (California), IAD = Washington (D.C.) Dulles International, APA = Centennial (Denver, Colorado), SEA = Seattle–Tacoma (Washington) International, MEM = Memphis (Tennessee) International, LGA = La Guardia (New York, New York), SLC = Salt Lake City (Utah) International, MCO = Orlando (Florida) International, JFK = John F. Kennedy International (New York, New York)

Source: U.S. Federal Aviation Administration

Figure 11

to quantify why runway incursions happen. Only by understanding the circumstances that provoked errors leading to runway incursions can we hope to limit their recurrence. The next steps include the following:

- *Define an "airport complexity" metric.* Airport-specific factors such as airport layout, configuration, traffic volume, traffic mix, local procedures and construction may influence the complexity of airport surface movement operations. An airport complexity metric that accounts for these variables would be useful for identifying the causal factors of runway incursions for more productive risk reduction. This metric is analogous to the sector complexity metric, which is used in the en route environment and terminal environment to predict the effect of air traffic on workload and human performance. Because airport complexity factors likely will influence both the frequency and the severity of runway incursions, these factors are essential for assessing risk as well as measuring the effectiveness of safety initiatives. Finally, focusing on airport complexity (in addition to airport volume, which is just one dimension of airport complexity) may offer valuable information to guide technology-deployment strategies that will produce the earliest and largest impact on improving runway safety.

- *Analyze surface incidents, specifically focusing on incidents that occur on the runway.* Because major runway incursions occur far less frequently than minor runway incursions — and accidents occur at a rate that is not much greater than chance — it is important to focus on both the minor incursion trends and the major incursion trends to achieve runway safety improvements. Persistent trends in minor runway incursions may be harbingers of more major events. Minor runway incursions, if allowed to proliferate, may increase the likelihood of experiencing more major runway incursions in the future. Therefore, trends in minor runway incursions signify opportunities for improving runway safety by targeting the more frequently occurring but less severe events. Accordingly, surface incidents that occur on a runway offer an even greater opportunity to uncover patterns and root causes of latent runway safety problems and to identify causal factors. A surface incident that occurs on the runway is different from a runway incursion. Surface incidents involve a single aircraft or vehicle and a technical violation (or error) that does not result in loss of separation.

- *Improve both the quality of runway incursion data and the data-collection-and-reporting process.* The FAA has placed a greater emphasis on reporting runway incursions in recent years. The FAA has worked to improve runway safety by implementing initiatives such as education and training programs for pilots, controllers and vehicle operators to increase awareness of potential hazards. Heightened awareness of runway safety has most likely translated into more frequent reports of runway incursions that were minor in severity and may have previously gone unreported.

  There is a pressing need to improve the quality of information provided to describe runway incursions. The need is for better information, not necessarily more information. Steps that should be taken to improve the quality of runway incursion information include:

  – Revamping data-collection forms to systematically capture more detailed information regarding human performance, procedural, technical and environmental factors that may have interacted to contribute to runway incursions;

  – Improving the mechanism for sharing runway safety data among members of the aviation community;

  – Providing a more user-friendly system for analyzing runway incursion data according to specific parameters; and,

  – Enlisting the participation of aviation human factors specialists in the data-analysis process.

  Diligent and complete reporting of both minor runway incursions and major runway incursions, and the consistent collection of critical runway safety parameters are vital for identifying underlying causes and contributing factors.

- *Define meaningful benchmarks and reliable performance indicators to measure progress toward runway safety goals.* Perform an assessment of other industries that demand an extremely high level of safety and exhibit a low base rate of failures, errors and accidents. Identify benchmarks and best practices that may be applicable to improving aviation safety and, in particular, runway safety. Tailor best practices and measures of safety and risk to establish refined runway safety goals, and devise useful mechanisms for measuring progress toward these goals. Improve the fidelity of runway safety risk metrics by including measures of frequency and severity (as discussed in this report). Couple these measures with data on causal factors and develop prospective risk assessment models to complement the current retrospective approach.

- *Implement solutions that attack human error on multiple fronts — that is, from a technology, procedural and training perspective.* The dual requirements to improve runway safety and to improve airport capacity/efficiency will place new demands on the professionals involved in aviation operations. Every initiative must be analyzed to describe the impact on human error potential and how the initiative will prevent or lessen human error. Since human error plays a role in almost every runway incursion, reducing human error will reduce the frequency of runway incursions, and reducing the impact of human errors that do occur will reduce the severity of runway incursions.

The FAA is encouraged by the findings of this report: a closer look at the severity of runway incursions shows that, while incursions are on the rise, the great majority are relatively minor and pose little chance of collision. The FAA will continue to pursue improvements to its runway safety record by targeting both the frequency and severity of runway incursions. For more information, call the FAA Office of Runway Safety at +1 (202) 267-9131.♦

[FSF editorial note: To ensure wider distribution in the interest of aviation safety, this report has been adapted from the U.S. Federal Aviation Administration's *FAA Runway Safety Report— Runway Incursion Severity Trends at Towered Airports in the United States: 1997–2000*, FAA Office of Runway Safety, June 2001. Some editorial changes were made by FSF staff for clarity and for style.]

Note

1. Fraser Jones, U.S. Federal Aviation Administration (FAA) spokesman, said on Feb. 5, 2002, that preliminary data indicate that 380 runway incursions were recorded by U.S. airports in 2001 and that the runway incursion rate decreased to 0.59 per 100,000 operations (i.e., takeoffs and landings) in 2001 from 0.64 per 100,000 operations in 2000. The preliminary data for 2001 include 18

Category A runway incursions, which FAA defines as occurring when required minimum "separation [between two or more aircraft or between an aircraft and a vehicle, person or object] decreases and participants take extreme action to narrowly avoid a collision." The preliminary data for 2001 include 32 Category B runway incursions, which occur when "separation decreases and there is significant potential for a collision." The preliminary data for 2001 include 127 Category C runway incursions, which occur when "separation decreases but there is ample time and distance to avoid a potential collision." The preliminary data for 2001 include 202 Category D runway incursions, which involve "little or no chance of collision but meet the definition of a runway incursion." FAA defines a runway incursion as "any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land." Jones said that insufficient data were available to categorize one runway incursion recorded in 2001.

Further Reading From FSF Publications

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FSF Editorial Staff. "Methods of Preventing Runway Collisions Evolve in Europe and the United States." *Airport Operations* Volume 26 (July–August 2000): 1–12.

FSF Editorial Staff. "Gulfstream II Collides With Stalled, Unlighted Vehicle After Tower Controller's Clearance to Land." *Airport Operations* Volume 25 (July–August 1999): 1–8.

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Matthews, Stuart. "Safety and Statistics: What the Numbers Tell Us About Aviation Safety at the End of the 20th Century." *Flight Safety Digest* Volume 16 (December 1997): 7, 9.

Rosenberg, Barry. "Radar Technology, Satellite Systems at Forefront of Global Effort to Reduce Runway Incursions." *Airport Operations* Volume 22 (March–April 1996): 1–8.

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Koenig, Robert L. "FAA Report Surveys U.S. Airline Pilots to Discover Factors That Promote Runway Incursions." *Airport Operations* Volume 21 (July–August 1995): 1–8.

Fewings, Rodney. "Ultra-high-capacity Aircraft Will Intensify Airport Safety Issues." *Airport Operations* Volume 21 (January–February 1995): 3–4.

Lawton, Russell. "U.S. Federal Aviation Administration Aviation System Indicators Show Drop in Delays and Runway Incursions." *Airport Operations* Volume 20 (January–February 1994): 1–5.

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Pope, John A. "The Airport Side of Runway Incursions." *Airport Operations* Volume 16 (September–October 1990): 1–5.

Hewes, B. Victor. "Design Airports for Safety." *Airport Operations* Volume 16 (July–August 1990): 1–6.

Appendix

- Glossary
- Acronyms
- Runway Incursion Data for the 10 Unclassified Events
- Airport Identifiers and 1997–2000 Runway Incursion Data by Airport

Glossary

Commercial operations — Consist of air taxis/commuters, cargo and air carriers. For the purpose of this analysis, three groups of commercial operations were defined: jet transport, commuters and commercially operated general aviation.

Commuter — Typically a medium-size turboprop airplane that carries a maximum of 30 passengers (e.g., Embraer 120, de Havilland Dash 8).

Error tolerance — The degree to which a system detects and prevents the propagation of errors. In the context of runway safety, error tolerance is the degree to which the system detects and prevents the propagation of human error, procedural breakdowns and technical failures to reduce the likelihood of a runway incursion resulting in an accident.

FAA Office of Runway Safety — The FAA office responsible for and accountable for coordinating initiatives to enhance runway safety at U.S. airports.

FAA Operational Evolution Plan — Integrates and aligns FAA activities with those of industry and users to meet the growing capacity demand for the next 10 years.

General aviation — Noncommercially operated aircraft.

Hold short — An air traffic control instruction to the pilot of an aircraft to not proceed beyond a designated point such as a specified runway or taxiway.

Jet transport — Typically, a large jet that can carry more than 30 passengers.

Military operation — Any aircraft operated by the U.S. military, or any visiting military aircraft from outside the United States.

Noncommercial operation — Consists of general aviation operations and military operations.

Operational error — An action by an air traffic controller that results in less than the required minimum separation between two aircraft or more than two aircraft, or between an aircraft and obstacles (e.g., vehicles, equipment or personnel on runways).

Pilot deviation — An action of a pilot that violates any U.S. Federal Aviation Regulation.

Runway incursion — Any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land.

Runway incursion type — Operational error, pilot deviation or vehicle/pedestrian deviation.

Surface incident — Any event in which unauthorized or unapproved movement occurs within the movement area, or an occurrence in the movement area associated with the operation of an aircraft that affects or could affect the safety of flight. A surface incident can occur anywhere on the airport surface, including the runway.

Taxi into position and hold — An air traffic control instruction to a pilot of an aircraft to taxi onto the active departure runway, to hold in that position and to not take off until specifically cleared to do so.

Towered airport — One of approximately 459 airports in the United States with a U.S. Federal Aviation Administration (FAA) operated or FAA contracted air traffic control tower.

Vehicle/pedestrian deviation — A vehicle or pedestrian movement on the runway movement area that is conducted without authorization from air traffic control and that interferes with aircraft operations.

Acronyms

FAA — U.S. Federal Aviation Administration

NAIMS — FAA's National Airspace Incidents Monitoring System

NAS — U.S. National Airspace System

OEP — FAA's Operational Evolution Plan

OIG — U.S. Department of Transportation, Office of the Inspector General

Table 1
Runway Incursion Data for the 10 Unclassified Runway Incusions at U.S. Towered Airports, 1997–2000*

				Aircraft Operations Pair		
Airport	**Airport Identifier**	**Year**	**Runway Incursion Type**	**GA/GA**	**JT/GA**	**GA/VP**
Oxnard Airport, Oxnard, California	OXR	1997	OE	1		
Teterboro Airport, Teterboro, New Jersey	TEB	1997	PD	1		
Santa Monica Municipal Airport, Santa Monica, California	SMO	1997	VPD			1
Chicago–Midway Airport, Chicago, Illinois	MDW	1998	OE		1	
Monterey Peninsula Airport, Monterey, California	MRY	1998	OE		1	
Minneapolis–St. Paul International Airport, Minneapolis, Minnesota	MSP	1998	OE	1		
San Antonio International Airport, San Antonio, Texas	SAT	1998	PD		1	
Deer Valley Municipal Airport, Phoenix, Arizona	DVT	1998	PD	1		
Purdue University Airport, Lafayatte, Indiana	LAF	1998	PD	1		
Pittsburgh International Airport, Pittsburgh, Pennsylvania	PIT	2000	OE		1	
Grand Total				**5**	**4**	**1**

GA = General aviation, JT = Jet transport, VP = Vehicle/pedestrian, OE = Operational error, PD = Pilot deviation, VPD = Vehicle/pedestrian deviation

* Ten of the 1,369 runway incursions did not contain enough information to support a reliable categorization of severity. These events are identified in this table for completeness.

Source: U.S. Federal Aviation Administration

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
Alabama	Birmingham International, Birmingham (BHM)	1998		1					1	0.65
		1999	1		1	1			3	1.93
	Mobile Downtown Airport, Mobile (BFM)	1998		1					1	1.15
	Montgomery Regional Airport, Montgomery (MGM)	1998				1			1	1.12
Alaska	Anchorage–Ted Stevens International, Anchorage (ANC)	1997			1	1			2	0.63
		1998		1	1	3			5	1.60
		1999			1				1	0.32
		2000				2			2	0.63
	Fairbanks International, Fairbanks (FAI)	1999				1			1	0.76
		2000				1			1	0.72
	Juneau International, Juneau (JNU)	1997			1				1	0.73
		2000				1			1	0.68
	Merrill Field, Anchorage (MRI)	1997			1	6			7	3.74
		1998			1	1			2	0.97
		2000			2	6			8	4.20
American Samoa[6]	Pago Pago International, Pago Pago (PPG)	2000				1			1	6.92
Arizona	Chandler Municipal, Chandler (CHD)	2000				2			2	0.80
	Deer Valley Municipal, Phoenix (DVT)	1997	2	1		3			6	2.25
		1998			1	3		1	5	1.78
		1999			1	1			2	0.70
		2000			2				2	0.54
	Laughlin–Bullhead International, Bullhead City (IFP)	1998				1			1	NA
		2000				2			2	3.87
	Love Airport, Prescott (PRC)	1998			1				1	0.29
		2000		1		1			2	0.62
	Mesa–Falcon Field, Mesa (FFZ)	1997				1			1	0.48
		1998				1			1	0.45
		1999			1	1			2	0.76
		2000			1				1	0.36
	Phoenix–Sky Harbor International, Phoenix (PHX)	1997			4				4	0.75
		1998	1	1	4	1			7	1.32
		1999	1		1	1			3	0.53
		2000	1	2	3				6	0.94
	Phoenix–Goodyear Airport, Goodyear (GYR)	2000				1			1	0.70
	Scottsdale Airport, Scottsdale (SDL)	1997				1			1	0.54
	Tucson International, Tucson (TUS)	1997			1	2			3	1.25
		2000		1		1			2	0.80
	Williams Gateway Airport, Phoenix (IWA)	2000				3			3	2.12
Arkansas	Fort Smith Regional Airport, Fort Smith (FSM)	1997		1					1	1.59
	Little Rock–Adams Field, Little Rock (LIT)	1998				2			2	1.17
		1999				1			1	0.55
		2000			1	1			2	1.14
California	Brackett Field, La Verne (POC)	1998			1				1	0.47
		1999			1				1	0.40
		2000		2					2	0.79
	Brown Field Municipal, San Diego (SDM)	1999			1				1	1.01
	Burbank–Glendale–Pasadena Airport, Burbank (BUR)	1997		2	1	1			4	2.23
		1998			2	1			3	1.65
		1999			1				1	0.57
		2000			1	1			2	1.24
	Camarillo Airport, Camarillo (CMA)	1997			2				2	1.11
		2000			1	2			3	1.61
	Chino Airport, Chino (CNO)	1997				1			1	0.51
		1998				1			1	0.53
		1999				1			1	0.56

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Concord–Buchanan Field, Concord (CCR)	1998		1					1	0.46
		1999			3				3	1.29
		2000			1	6			7	3.47
	El Monte Airport, El Monte (EMT)	2000				2			2	1.49
	Fort Lauderdale–Hollywood International, Fort Lauderdale (FLL)	1997		1		1			2	0.81
		1999			1	1			2	0.71
		2000		1		2	1		4	1.37
	Fresno–Yosemite International, Fresno (FAT)	1998				1			1	0.58
		2000		1		2			3	1.16
	Fullerton Municipal Airport, Fullerton (FUL)	1999				2			2	2.14
	Hawthorne Municipal–Northrop Field, Hawthorne (HHR)	1999				3			3	3.52
		2000	1			1			2	2.55
	John Wayne–Orange County Airport, Santa Ana (SNA)	1997		1	1	6			8	1.73
		1998			1	2			3	0.72
		1999	1		4	4			9	1.91
		2000			3	4			7	1.80
	Long Beach–Daugherty Field, Long Beach (LGB)	1997			1	6			7	1.55
		1998		1	1	2			4	0.85
		1999	1		1	4			6	1.20
		2000			2	6			8	2.11
	Los Angeles–Whiteman Field, Los Angeles (WHP)	1998		1	1				2	1.68
		2000			2	1			3	2.20
	Los Angeles International, Los Angeles (LAX)	1997		1		2			3	0.38
		1998	1	1	7	3			12	1.55
		1999	3	2	5				10	1.28
		2000	1	4	3				8	1.02
	Meadows Field, Bakersfield (BFL)	1998	1						1	0.63
	Metropolitan Oakland International, Oakland (OAK)	1999			2				2	0.38
	Monterey Peninsula Airport, Monterey (MRY)	1998						1	1	1.03
		1999				1			1	0.92
		2000		1					1	0.98
	Napa County Airport, Napa (APC)	2000				1			1	0.69
	Ontario International, Ontario (ONT)	1997			2				2	1.26
		1998	2		1	1			4	2.76
		2000			1				1	0.65
	Oxnard Airport, Oxnard (OXR)	1997						1	1	0.83
	Palm Springs International, Palm Springs (PSP)	1999		1	2	1			4	3.85
	Palo Alto of Santa Clara County, Palo Alto (PAO)	1999				1			1	0.49
		2000				1			1	0.50
	Redding Municipal, Redding (RDD)	1997				1			1	1.08
	Reid-Hillview of Santa Clara County Airport, San Jose (RHV)	1999			1				1	0.46
	Riverside Municipal, Riverside (RAL)	1997		1					1	1.36
	Sacramento International, Sacramento (SMF)	1997			1				1	0.60
	Salinas Municipal Airport, Salinas (SNS)	1997				1			1	1.18
		1999	1						1	1.11
		2000			1				1	1.12
	San Carlos Airport, San Carlos (SQL)	2000			1				1	0.62
	San Diego–Gillespie Field, San Diego (SEE)	1997	1						1	0.54
		1999			1				1	0.48
		2000			2				2	1.07
	San Diego–Montgomery Field, San Diego (MYF)	1997			1	1			2	0.83
		1998			1	4			5	1.88
		1999			1	4			5	1.82
		2000		1	1	7			9	3.88

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	San Diego International–Lindbergh Field, San Diego (SAN)	1997			1				1	0.45
		1998			1				1	0.45
		1999				1			1	0.45
		2000				2			2	0.96
	San Francisco International, San Francisco (SFO)	1997		2	2	2			6	1.33
		1998		1	2	1			4	0.93
		1999		2	2	3			7	1.59
		2000		1	2	1			4	0.93
	San Jose International, San Jose (SJC)	1997		1	1	2			4	1.30
		1998		1	1	3			5	1.75
		1999			1	1			2	0.65
		2000		1	1	3			5	1.67
	Santa Barbara Municipal, Santa Barbara (SBA)	1997	1	1					2	1.14
		1998	1						1	0.62
		1999			1	1			2	1.19
		2000			2	4			6	3.58
	Santa Maria Public–Hancock Field, Santa Maria (SMX)	2000				1			1	1.31
	Santa Monica Municipal, Santa Monica (SMO)	1997				2		1	3	1.41
		1998				1			1	0.46
		1999			1				1	0.43
	Sonoma County Airport, Santa Rosa (STS)	2000			1	1			2	1.51
	Van Nuys Airport, Van Nuys (VNY)	1998			1				1	0.18
		2000			1	1			2	0.41
	Zamperini Field, Torrance (TOA)	2000			1				1	0.56
Colorado	City of Colorado Springs Municipal, Colorado Springs (COS)	1997			1				1	0.49
		1998			1				1	0.55
		1999				1			1	0.42
	Denver–Centennial Airport, Denver (APA)	1997				1			1	0.24
		1998		1		2			3	0.64
		1999		1	1	2			4	0.92
		2000			1	1			2	0.50
	Denver–Jeffco Airport, Denver (BJC)	1999			1				1	0.59
		2000		1		6			7	4.06
	Denver International, Denver (DEN)	1997	1			1			2	0.41
		1998			1				1	0.21
		2000			1	1			2	0.38
	Eagle County Regional Airport, Eagle (EGE)	1998				2			2	6.80
		2000			1				1	2.52
Connecticut	Bridgeport–Sikorsky Memorial, Bridgeport (BDR)	1999				1			1	1.07
		2000			2	2			4	4.43
	Danbury Municipal, Danbury (DXR)	1999		1		1			2	1.67
	Groton–New London Airport, Groton (GON)	2000			1	1			2	2.69
	Tweed–New Haven Airport, New Haven (HVN)	2000			1				1	1.63
		1998			1				1	0.56
	Windsor Locks–Bradley International, Windsor Locks (BDL)	2000		1	1	1			3	1.77
Delaware	New Castle County Airport, Wilmington (ILG)	1997			1				1	0.68
District of Columbia	Ronald Reagan Washington National, Washington (DCA)	1997		1					1	0.32
		1998			1				1	0.32
		1999		1					1	0.30
		2000				1			1	0.29
Florida	Craig Municipal, Jacksonville (CRG)	1998			1				1	0.74
		1999				1			1	0.70
	Daytona Beach International, Daytona Beach (DAB)	1997				2			2	0.72
		1998			1	2			3	0.98
		1999	3	1	1	1			6	1.65

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	Severity Category B[2]	Severity Category C[3]	Severity Category D[4]	Accident	ID	Total RI	Yearly Rate[5]
		2000			1	2			3	0.81
	Fort Lauderdale–Executive, Fort Lauderdale (FXE)	1997			1	2			3	1.29
		1998			1	2			3	1.24
		1999			1	4			5	2.04
		2000			4	5			9	3.46
	Jacksonville International, Jacksonville (JAX)	1998				1			1	0.64
		2000	1						1	0.67
	Kendall–Tamiami–Executive Airport, Miami (TMB)	2000				1			1	0.52
	Key West International, Key West (EYW)	1998				1			1	0.84
	Kissimmee Municipal Airport, Orlando (ISM)	1999				1			1	0.70
		2000				1			1	0.82
	Lakeland–Linder Regional Airport, Lakeland (LAL)	1997				1			1	0.51
		1998		1					1	0.50
		1999		1		1			2	0.91
		2000			1	1			2	1.03
	Melbourne International, Melbourne (MLB)	1999			1				1	0.64
		2000		1					1	0.52
	Miami International, Miami (MIA)	1997		1	1				2	0.38
		1998				1			1	0.19
		1999			2				2	0.39
		2000		1	2				3	0.58
	Naples Municipal, Naples (APF)	1999			1				1	0.81
		2000				1			1	0.84
	North Perry Airport, Hollywood (HWO)	1998		1					1	0.63
	Opa Locka Airport, Miami (OPF)	1998		1					1	0.97
	Orlando–Executive Airport, Orlando (ORL)	1997			1	1			2	1.09
		1998			1				1	0.50
		1999			1				1	0.44
		2000	1						1	0.44
	Orlando–Sanford International, Orlando (SFB)	1998				3			3	0.79
		1999				1			1	0.28
		2000				2			2	0.54
	Orlando International, Orlando (MCO)	1999			1				1	0.27
	Page Field, Fort Myers (FMY)	1997	1						1	1.21
	Panama City–Bay County International, Panama City (PFN)	1998			1				1	0.95
	Sarasota–Bradenton International, Sarasota (SRQ)	1997	1		1	1			3	1.78
		2000			1	2	1		4	2.36
	St. Lucie County International, Fort Pierce (FPR)	2000			1				1	0.57
	St. Petersburg–Clearwater International, St. Petersburg (PIE)	1999			1				1	0.44
	Tampa International, Tampa (TPA)	1998	2						2	0.78
		2000			1				1	0.36
	Vero Beach Municipal, Vero Beach (VRB)	1997			1				1	0.44
	West Palm Beach–Palm Beach International, West Palm Beach (PBI)	1998			2	3			5	2.58
		1999			2				2	1.01
		2000		1		1			2	0.93
Georgia	Atlanta–Dekalb–Peachtree Airport, Atlanta (PDK)	1998				1			1	0.44
		1999		2					2	0.86
		2000				1			1	0.42
	Atlanta–Hartsfield International, Atlanta (ATL)	1997			1	1			2	0.25
		1998		1		1			2	0.24
		1999		2	4				6	0.66
		2000	1	1	1				3	0.33
	Columbus Metropolitan, Columbus (CSG)	2000			1				1	1.62
	Fulton County Airport–Brown Field, Atlanta (FTY)	1999			1				1	0.87
		2000				1			1	0.85
	Gwinnett County Airport, Lawrenceville (LZU)	1998				1			1	0.93

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	Severity Category B[2]	Severity Category C[3]	Severity Category D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Savannah International, Savannah (SAV)	1997				1			1	1.04
		1998			1	1			2	1.87
		2000		1					1	0.89
	Valdosta Regional, Valdosta (VLD)	2000			1				1	1.74
Hawaii	Honolulu International, Honolulu (HNL)	1998			1				1	0.30
	Kahului International, Kahululi (OGG)	2000				1			1	0.57
Idaho	Boise Air Terminal–Gowen Field, Boise (BOI)	1997				1			1	0.51
		1999			2	1			3	1.67
		2000				2			2	1.17
	Fanning Field, Idaho Falls (IDA)	2000				1			1	2.37
	Pocatello Regional Airport, Pocatello (PIH)	1997	1						1	2.21
Illinois	Alton–St. Louis Regional Airport, Alton/St. Louis (ALN)	1997		1					1	1.24
	Bloomington–Central Illinois Regional Airport, Bloomington (BMI)	1997				1			1	1.39
		1999				2			2	3.07
	Chicago–Aurora Municipal, Chicago/Aurora (ARR)	1998				1			1	0.77
		1999			1				1	0.85
		2000	1						1	0.79
	Chicago–Du Page Airport, Chicago (DPA)	1997			1	1			2	0.93
		1998				1			1	0.46
		2000	1						1	0.50
	Chicago–Midway, Chicago (MDW)	1997			2				2	0.75
		1998		3	1			1	5	1.80
		1999		2	3				5	1.68
		2000	1	1		2			4	1.34
	Chicago–O'Hare International, Chicago (ORD)	1997	1	1		1			3	0.34
		1998			4				4	0.45
		1999	3	1		2			6	0.67
		2000	1		2	1			4	0.44
	Chicago–Palwaukee Municipal, Chicago (PWK)	1997			1				1	0.53
		1998		2	1	1			4	2.10
		2000			1	3			4	2.22
	Decatur Airport, Decatur (DEC)	1999	1						1	1.84
	Greater Peoria Regional Airport, Peoria (PIA)	2000				1			1	1.18
	Quad City International, Moline (MLI)	2000				1			1	1.61
	Rockford–Greater Rockford, Rockford (RFD)	1997			1	1			2	1.97
		1999				1			1	0.99
		2000			1	3			4	4.45
	Springfield–Capital Airport, Springfield (SPI)	1997		1					1	1.00
		1999			2	2			4	4.50
	St. Louis Downtown–Parks Airport, Cahokia/St. Louis (CPS)	1998				1			1	0.62
	Waukegan Regional Airport, Waukegan (UGN)	2000			1	1			2	2.18
Indiana	Fort Wayne International, Fort Wayne (FWA)	1997			1				1	1.00
		1999		1					1	0.83
		2000				1			1	0.81
	Indianapolis International, Indianapolis (IND)	1998			2	3			5	2.06
		1999			1				1	0.40
	Purdue University Airport, Lafayette (LAF)	1998						1	1	0.59
	South Bend Regional Airport, South Bend (SBN)	1997			1	1			2	2.37
		1998				1			1	1.19
		1999			1	1			2	2.36
		2000				1			1	1.29
	Terre Haute International–Hulman Field, Terre Haute (HUF)	1999				2			2	3.61
Iowa	Cedar Rapids–The Eastern Iowa Airport, Cedar Rapids (CID)	1997			1	1			2	2.57
		1999				1			1	1.19
		2000				1			1	1.22

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

			Severity Category							
State	**Airport Name, City (Airport Code)**	**Year**	**A[1]**	**B[2]**	**C[3]**	**D[4]**	**Accident**	**ID**	**Total RI**	**Yearly Rate[5]**
	Des Moines International, Des Moines (DSM)	1999				1			1	0.74
	Sioux Gateway Airport, Sioux City (SUX)	1997				1			1	2.01
		2000				1			1	2.43
	Waterloo Municipal, Waterloo (ALO)	1997		1	1				2	3.56
Kansas	Wichita Mid-Continent Airport, Wichita (ICT)	1997			1	2			3	1.54
		1998			1	1			2	0.97
		2000		1		1			2	0.92
Kentucky	Blue Grass Airport, Lexington (LEX)	1999				1			1	0.98
	Bowman Field, Louisville (LOU)	2000			1	1			2	1.43
	Covington–Cincinnati–Northern Kentucky Intnl, Covington (CVG)	1997				1			1	0.24
		1998	2						2	0.45
		1999			1				1	0.21
		2000		1	3				4	0.84
	Daviess County Airport, Owensboro (OWB)	1997			1				1	2.01
	Louisville International–Standiford Field, Louisville (SDF)	1997			1	2			3	1.69
		2000		1	1				2	1.10
Louisiana	Baton Rouge Metropolitan Airport, Baton Rouge (BTR)	1998				1			1	0.71
	Lakefront Airport, New Orleans (NEW)	1997		1					1	0.57
		1998		1					1	0.57
	Monroe Regional Airport, Monroe (MLU)	1999				1			1	1.61
		2000			1	1			2	3.22
	New Orleans International–Moisant Field, New Orleans (MSY)	1997				1			1	0.61
		2000			1	1			2	1.20
Maine	Bangor International, Bangor (BGR)	1998		1	1				2	2.03
		2000				1			1	1.12
	Portland International Jetport, Portland (PWM)	1997				1			1	0.78
		1998				1			1	0.78
		1999				2			2	1.60
Maryland	Andrews Air Force Base, Clinton (ADW)	1997				1			1	0.82
		1998				3			3	2.42
		1999				2			2	1.99
		2000			1				1	0.96
	Baltimore–Washington International, Baltimore (BWI)	1998			1				1	0.34
		1999	1						1	0.33
		2000			2				2	0.63
	Hagerstown Regional–Henson Field, Hagerstown (HGR)	1998			1	2			3	5.05
		2000			1				1	1.90
Massachussetts	Barnes Municipal, Westfield (BAF)	1997				1			1	1.19
	Barnstable Municipal, Hyannis (HYA)	1998		1					1	0.74
	Bedford–Laurence G. Hanscom Field, Bedford (BED)	1998				1			1	0.55
		1999		1		1			2	1.01
		2000			2				2	0.94
	Boston–Logan International, Boston (BOS)	1997				1			1	0.20
		1998		2	1	1			4	0.78
		1999		2		1			3	0.60
		2000		3	5				8	1.57
	Lawrence Municipal, Lawrence (LWM)	2000			2	1			3	3.28
	Norwood Memorial Airport, Norwood (OWD)	1997				1			1	1.12
		1998				1			1	0.92
Michigan	Ann Arbor Municipal Airport, Ann Arbor (ARB)	2000			1				1	0.96
	Cherry Capital Airport, Traverse City (TVC)	1998			1				1	0.77
	Detroit–Willow Run Airport, Detroit (YIP)	1997			1				1	0.60
		1998			1	1			2	1.08
		1999				2			2	1.25
		2000	1			1			2	1.46

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Detroit Metropolitan Wayne County International, Detroit (DTW)	1997		1	1				2	0.37
		1998		1	1	4			6	1.11
		1999		1					1	0.18
		2000	1	1					2	0.36
	Gerald R. Ford International, Grand Rapids (GRR)	2000			1				1	0.73
	Jackson County–Reynolds Field, Jackson (JXN)	1999				1			1	1.42
		2000			1	1			2	3.22
	Kalamazoo–Battle Creek International, Kalamazoo (AZO)	1997	1			2			3	3.20
		2000				1			1	1.00
	Kellogg Airport, Battle Creek (BTL)	2000			1				1	1.01
Minnesota	Anoka County–Blaine Airport, Minneapolis (ANE)	1997				1			1	0.70
		1999				1			1	0.67
	Downtown Holman Field, St. Paul (STP)	1997				1			1	0.74
	Duluth International, Duluth (DLH)	1997				1			1	1.66
		2000		1	1				2	3.25
	Minneapolis–Crystal Airport, Minneapolis (MIC)	1997				1			1	0.57
		1998			1	2			3	1.67
		1999		1	1	2			4	2.14
		2000		1		1			2	1.13
	Minneapolis–Flying Cloud Airport, Minneapolis (FCM)	1997	1		1				2	1.01
		1998				2			2	0.95
		1999			2	2			4	2.08
		2000			1	1			2	1.07
	Minneapolis–St. Paul International, Minneapolis (MSP)	1997		1	2	3			6	1.22
		1998				1		1	2	0.41
		1999			3				3	0.59
		2000		1	2				3	0.57
	Rochester International, Rochester (RST)	1998	1			1			2	2.95
		2000			1	1			2	2.69
Mississippi	Gulfport–Biloxi Regional Airport, Gulfport (GPT)	1998				2			2	2.05
		1999				1			1	0.84
		2000				1			1	0.80
	Tupelo Regional Airport, Tupelo (TUP)	2000				1			1	2.11
Missouri	Columbia Regional Airport, Columbia (COU)	1999				1			1	2.41
	Joplin Regional Airport, Joplin (JLN)	1998				1			1	2.52
	Kansas City Downtown Airport, Kansas City (MKC)	1997		1	1				2	1.49
		2000	1		1				2	1.56
	Springfield–Branson Regional Airport, Springfield (SGF)	1997	2						2	1.83
		1999				1			1	0.80
		2000				1			1	0.95
	Dayton International, Dayton (DAY)	1997				1			1	0.69
		1998				1			1	0.65
	Ohio State University Airport, Columbus (OSU)	1997			1				1	0.88
	Toledo Express Airport, Toledo (TOL)	1997				1			1	1.02
	Youngstown–Warren Regional Airport, Youngstown (YNG)	1998			1				1	0.91
Oklahoma	Mc Alester Regional Airport, Mc Alester (MLC)	1997	1						1	0.00
	Tulsa–Richard Lloyd Jones Jr. Airport, Tulsa (RVS)	1998				2			2	0.73
		1999			1	4			5	1.84
		2000				1			1	0.39
	Wiley Post Airport, Oklahoma City (PWA)	2000				1			1	1.15
	St. Louis–Lambert International, St. Louis (STL)	1997			6	2			8	1.55
		1998	1	2	2	4			9	1.79
		1999			5	2			7	1.40
		2000			4	2			6	1.24
	St. Louis–Spirit of St. Louis Field, St. Louis (SUS)	1997				1			1	0.52
		2000		1	1	1			3	1.47

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	Severity Category B[2]	Severity Category C[3]	Severity Category D[4]	Accident	ID	Total RI	Yearly Rate[5]
Nebraska	Lincoln Municipal Airport, Lincoln (LNK)	1998		1		1			2	1.62
		1999	1	1	1	1			4	3.18
		2000				1			1	0.87
	Omaha–Eppley Airfield, Omaha (OMA)	1997			1	1			2	1.20
		1998				1			1	0.58
		1999				1			1	0.53
		2000			2	1			3	1.79
Nevada	Elko Municipal, Elko (EKO)	1998				1			1	3.93
	Las Vegas–McCarran International, Las Vegas (LAS)	1997	1		1				2	0.42
		1998		1	3	1			5	1.06
		1999			3	1			4	0.74
		2000			2				2	0.38
	North Las Vegas Airport, Las Vegas (VGT)	1997	1	1					2	0.73
		1998		1	3				4	1.52
		1999		2		1			3	1.31
		2000		2	3	12			17	7.54
	Reno–Tahoe International, Reno (RNO)	1997			1	1			2	1.23
		1999				2			2	1.31
		2000		1					1	0.67
New Hampshire	Manchester Airport, Manchester (MHT)	1997				1			1	1.02
New Jersey	Caldwell Airport, Caldwell (CDW)	1997				1			1	0.52
		2000				1			1	0.50
	Millville Municipal, Millville (MIV)	1998		1					1	0.00
	Morristown Municipal, Morristown (MMU)	1998			1	1			2	0.76
	Newark International, Newark (EWR)	1997		1	1				2	0.43
		1998		1	6	1			8	1.73
		1999	1			2			3	0.65
		2000		1	4				5	1.09
	Teterboro Airport, Teterboro (TEB)	1997		2	1			1	4	1.93
		1998		1		1			2	0.89
		1999	1			2			3	1.20
		2000			2	3			5	1.77
	Trenton Mercer Airport, Trenton (TTN)	1998				1			1	0.82
New Mexico	Albuquerque International Sunport, Albuquerque (ABQ)	2000	1	1	1	1			4	1.72
	Four Corners Regional, Farmington (FMN)	1999		1					1	0.93
New York	Albany International, Albany (ALB)	1997				1			1	0.76
		2000			1	1			2	1.38
	Binghamton Regional, Binghamton (BGM)	1997	1						1	2.14
	Buffalo International, Buffalo (BUF)	2000			1				1	0.60
	Dutchess County Airport, Poughkeepsie (POU)	2000			1				1	0.81
	Farmingdale–Republic Airport, Farmingdale (FRG)	1997				1			1	0.42
		1998				1			1	0.42
		1999	1		4				5	2.09
		2000			1				1	0.47
	Long Island MacArthur International, Islip (ISP)	2000	1			2			3	1.26
	New York–John F. Kennedy International, New York (JFK)	1997		1	1	2			4	1.10
		1998		1	1				2	0.56
		1999	1		2	2			5	1.41
	New York–La Guardia International, New York (LGA)	1997		1		1	1		3	0.85
		1998	1		2				3	0.83
		1999			2				2	0.54
		2000	1		1	1			3	0.77
	Niagra Falls International, Niagra Falls (IAG)	1997				2			2	4.16

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Rochester–Greater Rochester International, Rochester (ROC)	1997			1				1	0.56
		1998				1			1	0.53
		1999			1	1			2	1.05
		2000				2			2	1.12
	Stewart International, Newburgh (SWF)	1997			1				1	0.63
		2000			1				1	0.73
	Syracuse Hancock International, Syracuse (SYR)	1998			1	1			2	1.33
		2000			1				1	0.71
	Tompkins County Airport, Ithaca (ITH)	2000				1			1	1.91
	Utica International, Utica (UCA)	2000				1			1	1.86
	White Plains–Westchester County Airport, White Plains (HPN)	1998	1						1	0.51
		1999	1						1	0.45
		2000			1	2			3	1.38
North Carolina	Charlotte–Douglas International, Charlotte (CLT)	1997		1		1			2	0.44
		1998	2						2	0.44
		1999	1						1	0.22
		2000			2				2	0.43
	Greensboro–Piedmont Triad International, Greensboro (GSO)	1997		1	1	1			3	2.46
		2000			1				1	0.72
	Raleigh–Durham International, Raleigh (RDU)	1997			2				2	0.83
		1999				2			2	0.69
		2000	1		2				3	1.01
	Smith Reynolds Airport, Winston-Salem (INT)	2000				1			1	1.38
	Wilmington International, Wilmington (ILM)	1997				1			1	1.43
		1998			1	1			2	2.81
		1999				1			1	1.34
		2000		1		1			2	2.36
North Dakota	Fargo–Hector International, Fargo (FAR)	1997			1				1	1.23
		1998				1			1	1.12
		1999		1		3			4	4.38
	Grand Forks International, Grand Forks (GFK)	1997			1				1	0.56
		1998				1			1	0.47
		2000				1			1	0.42
Ohio	Akron Fulton International, Akron (AKR)	1999				1			1	0.00
	Bolton Field Airport, Columbus (TZR)	1997				2			2	0.00
	Cleveland–Hopkins International, Cleveland (CLE)	1997	1		4	1			6	1.93
		1998			3	3			6	1.94
		1999			2	1			3	0.93
		2000			1				1	0.30
	Will Rogers World Airport, Oklahoma City (OKC)	1999				2			2	1.22
Oregon	Klamath Falls International, Klamath Falls (LMT)	1997			1				1	1.67
	Mahlon Sweet Field, Eugene (EUG)	1999		1		1			2	1.76
	Portland–Hillsboro Airport, Portland (HIO)	1998		1		1			2	0.87
	Portland–Troutdale Airport, Portland (TTD)	2000			3	2			5	6.66
	Portland International, Portland (PDX)	2000		1					1	0.31
	Roberts Field Airport, Redmond (RDM)	1997			1				1	2.49
		2000				2			2	3.58
Pennsylvania	Allegheny County Airport, Pittsburgh (AGC)	1997				1			1	0.67
		1998				1			1	0.73
	Lancaster Airport, Lancaster (LNS)	1997		1		1			2	1.69
		1998				2			2	1.82
	Lehigh Valley International, Allentown (ABE)	1999			2				2	1.37
	Philadelphia International, Philadelphia (PHL)	1997			1				1	0.21
		1998	1	1	3				5	1.07
		1999		1					1	0.21
		2000		1	2				3	0.62

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Pittsburgh International, Pittsburgh (PIT)	1997			1				1	0.22
		1998		1	3				4	0.89
		2000			1			1	2	0.45
	Reading Regional Airport, Reading (RDG)	1999			1	1			2	1.47
Puerto Rico[7]	San Juan–Luis Munoz Marin International, San Juan (SJU)	1997			1	1			2	1.08
		1998			1				1	0.50
		1999			2	4			6	2.68
Rhode Island	Providence–Green State Airport, Providence (PVD)	1998			1	1			2	1.28
		1999	1		1	3			5	3.20
		2000			2	2			4	2.57
South Carolina	Charleston Air Force Base/International Airport, Charleston (CHS)	1997			1				1	0.74
		1999			2	1			3	2.18
		2000				2			2	1.47
	Myrtle Beach International, Myrtle Beach (MYR)	1997				1			1	1.74
South Dakota	Rapid City Regional, Rapid City (RAP)	2000				1			1	1.75
	Sioux Falls–Joe Foss Field, Sioux Falls (FSD)	1997			1				1	1.19
		1998		1	1	1			3	3.10
		2000				1			1	1.05
Tennesse	Knoxville–McGhee–Tyson Airport, Knoxville (TYS)	1998			3				3	2.02
		1999				1			1	0.67
		2000				4			4	2.69
	Lovell Field Airport, Chattanooga (CHA)	1997				1			1	1.10
	Memphis International, Memphis (MEM)	1997			1	2			3	0.81
		1998			2				2	0.55
		1999			1				1	0.27
		2000			1	1			2	0.52
	Nashville International, Nashville (BNA)	1997				1			1	0.46
		1998			1	1			2	0.88
		1999			2	1			3	1.24
		2000				1			1	0.40
Texas	Abilene Regional Airport, Abilene (ABI)	1997				1			1	1.30
		1998			1				1	1.22
	Amarillo International, Amarillo (AMA)	1997			1				1	1.36
		2000			1				1	0.83
	Austin–Bergstrom International, Austin (AUS)	1997		1	1	2			4	1.99
		1998			1				1	0.53
		1999	1						1	0.54
	Corpus Christi International, Corpus Christi (CRP)	1997				1			1	0.81
	Dallas–Addison Airport, Dallas (ADS)	1997		1		1			2	1.17
		1998	1		1	1			3	1.71
		1999			1	1			2	1.16
		2000			1				1	0.61
	Dallas–Love Field, Dallas (DAL)	1997		1	1	1			3	1.31
		1998			1	2			3	1.27
		2000				1			1	0.39
	Dallas–Fort Worth International, Dallas (DFW)	1997	1	1	3	3			8	0.86
		1998		1	4				5	0.54
		1999	1	1	5				7	0.81
		2000		1		2			3	0.35
	El Paso International, El Paso (ELP)	1997				1			1	0.73
		1999			1				1	0.69
	Fort Worth Meacham International, Fort Worth (FTW)	1997				1			1	0.26
		1998		1					1	0.26
		2000			1				1	0.33

Table 2

Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	George Bush Intercontinental, Houston (IAH)	1998				1			1	0.22
		1999			1				1	0.22
	Grand Prarie Municipal, Grand Prarie (GPM)	1998				1			1	1.11
	Gregg County Airport, Longview (GGG)	1997				1			1	1.15
		1998			1				1	1.05
	Houston–David Wayne Hooks Memorial Airport, Houston (DWH)	1999				3			3	1.09
		2000			1	2			3	1.37
	Houston–Hobby International, Houston (HOU)	1997			1				1	0.38
		1998	1			1			2	0.78
		1999		1		1			2	0.77
		2000			1				1	0.40
	Laredo International, Laredo (LRD)	1998			1				1	1.35
	Lubbock International, Lubbock (LBB)	1997				1			1	1.14
		1999				1			1	0.82
		2000				2			2	1.56
	Mathis Field, San Angelo (SJT)	1999				1			1	1.03
	Midland International, Midland (MAF)	1997				1			1	1.19
	San Antonio International, San Antonio (SAT)	1997			4				4	1.56
		1998			2	1		1	4	1.46
		1999		1	1	2			4	1.56
		2000			2				2	0.81
	Southeast Texas Regional Airport, Beaumont-Port Arthur (BPT)	1997				1			1	1.83
		1999		1					1	1.80
	Sugar Land Municipal–Hull Field, Houston (SGR)	2000			1				1	NA
	Tyler Pounds Airport, Tyler (TYR)	2000			1				1	0.96
	Valley International, Harlingen (HRL)	1997				1			1	1.56
	Waco Regional Airport, Waco (ACT)	2000		1					1	1.75
Utah	Salt Lake City International, Salt Lake City (SLC)	1997		1	1				2	0.54
		1998				1			1	0.27
		1999			2	1			3	0.81
		2000		1	1	2			4	1.09
Vermont	Burlington International, Burlington (BTV)	1998	1						1	0.85
Virgin Islands[8]	Charlotte Amalie–Cyril King International, St. Thomas (STT)	1998	1			1			2	1.90
		1999				1			1	0.99
Virginia	Manassas Regional Airport, Manassas (HEF)	1997				1			1	0.77
	Norfolk International, Norfolk (ORF)	1999			1				1	0.71
	Richmond International, Richmond (RIC)	1997			1	1			2	1.36
		1998				1			1	0.71
	Roanoke Regional–Woodrum Field, Roanoke (ROA)	1997			1				1	0.95
		1998			2	1			3	2.82
		1999				1			1	0.97
	Washington Dulles International, Dulles (IAD)	1997				1			1	0.29
		1998				2			2	0.50
		2000				1			1	0.21
Washington	Bellingham International, Bellingham (BLI)	1998				1			1	1.42
	Felts Field, Spokane (SFF)	2000				1			1	1.33
	Grant County International, Moses Lake (MWH)	1998				1			1	0.74
		1999	1						1	0.78
	Olympia Airport, Olympia (OLM)	1997				1			1	1.90
	Renton Municipal Airport, Renton (RNT)	1997				2			2	2.02
		1998				1			1	0.99
		2000				1			1	0.73
	Seattle–Boeing Field–King County International, Seattle (BFI)	1997		1	1				2	0.54
		1998	1			1			2	0.58
		1999		1	1				2	0.61
		2000			1	2			3	0.82

Table 2
Runway Incursion Data at U.S. Towered Airports, by Airport, 1997–2000 *(continued)*

State	Airport Name, City (Airport Code)	Year	Severity Category A[1]	B[2]	C[3]	D[4]	Accident	ID	Total RI	Yearly Rate[5]
	Seattle–Tacoma International, Seattle (SEA)	1997	1		1	1			3	0.78
		1998				1			1	0.25
		1999			1	3			4	0.92
		2000				1			1	0.22
	Snohomish County–Paine Field, Everett (PAE)	1997				1			1	0.55
		1999				1			1	0.49
		2000				1			1	0.50
	Tri-Cities Airport, Pasco (PSC)	1998		1	1				2	2.26
		1999				1			1	1.04
		2000			1				1	1.08
	Walla Walla Regional Airport, Walla Walla (ALW)	2000				1			1	2.35
	Yakima Air Terminal–McAllister Field, Yakima (YKM)	1998			1				1	1.82
West Virginia	Charleston–Yeager Airport, Charleston (CRW)	1997		1					1	0.99
		2000				1			1	1.13
	Morgantown Municipal, Morgantown (MGW)	2000		1					1	2.05
Wisconsin	Dane County Regional–Truax Field, Madison (MSN)	1997			1				1	0.69
		1998			1				1	0.69
		2000				1			1	0.80
	Green Bay–Austin Straubel International, Green Bay (GRB)	2000			1	2			3	4.58
	Kenosha Regional Airport, Kenosha (ENW)	1998				1			1	1.27
	Milwaukee–General Mitchell International, Milwaukee (MKE)	1997			1				1	0.47
		1998		2	1	1			4	1.83
		1999		2		1			3	1.35
		2000	1		1	1			3	1.35
	Outagamie County Regional Airport, Appleton (ATW)	1999			1	1			2	3.24
	Rock County Airport, Janesville (JVL)	1999				1			1	1.21
	Wittman Regional Airport, Oshkosh (OSH)	2000				2			2	1.92
Grand Total			**87**	**169**	**478**	**622**	**3**	**10**	**1369**	

NA = Rate is not available due to unreported number of operations at the airport.
ID = Insufficient data (see Table 1, page 16)
RI = Runway incursion

[1] Category A runway incursion occurs when separation decreases and participants take extreme action to narrowly avoid a collision.

[2] Category B runway incursion occurs when separation decreases and there is significant potential for a collision.

[3] Category C runway incursion occurs when separation decreases but there is ample time and distance to avoid a potential collision.

[4] Category D runway incursion involves little or no chance of collision but meets the definition of a runway incursion (i.e., any occurrence on an airport runway involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land).

[5] Runway incursions per 100,000 operations.

[6] American Samoa is a territory of the United States.

[7] Puerto Rico is a self-governing commonwealth associated with the United States.

[8] The Virgin Islands are a territory of the United States.

Source: U.S. Federal Aviation Administration

Transportation Safety Board of Canada Reports 321 Accidents Involving Canadian-registered Aircraft in 2000

Data show that the accident rate for Canadian-registered aircraft was 7.5 accidents per 100,000 flight hours in 2000 — the lowest in more than 10 years. For airliners, the rate was 0.7 accidents per 100,000 flight hours.

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FSF Editorial Staff

Canadian-registered aircraft were involved in 321 accidents[1] in Canada in 2000, a decrease of about 6 percent from 341 accidents reported in 1999, the Transportation Safety Board of Canada (TSB) said in a report (Figure 1, page 30).

The report, *TSB Statistical Summary: Aviation Occurrences, 2000,* said that the 321 accidents (which excluded ultralight aircraft accidents) involved 78 commercial airplanes, 179 privately operated airplanes, one state-operated (government-operated) airplane and 53 helicopters. Twelve other accident aircraft were balloons, gliders or gyrocopters.[2]

The 78 commercial airplanes included nine airliners, four commuter aircraft and 65 aircraft used for air taxi and/or aerial work (Table 1, page 31). Of these, one airliner, one commuter aircraft and five air taxi/aerial work aircraft were involved in fatal accidents.

Of the 53 helicopters involved in accidents, 10 were involved in fatal accidents that resulted in 17 fatalities. Most helicopter accidents occurred during training (21 percent) and air transport operations (21 percent), the report said.

The report said that 18 foreign-registered aircraft were involved in accidents in Canada in 2000. Of the accidents involving foreign-registered aircraft, seven were fatal accidents that resulted in 18 fatalities.

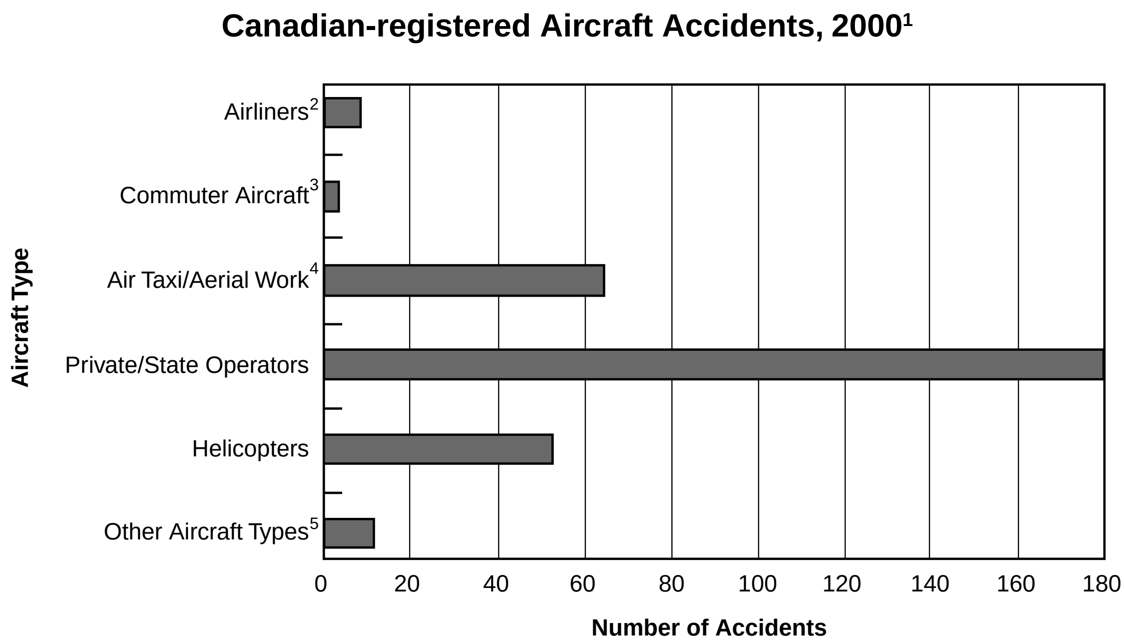
TSB said that 729 incidents[3] were reported in 2000, including 582 incidents involving Canadian-registered aircraft. The report said that the most frequently reported incidents involved declared emergency, 30 percent; collision, risk of collision or loss of separation, 24 percent; and engine failure, 23 percent. Most of the other incidents involved fire and/or smoke.

The accident rate for Canadian-registered aircraft in 2000 was 7.5 accidents per 100,000 flight hours, compared with 8.3 accidents per 100,000 flight hours in 1999 (Table 2, page 32). For airliners, the rate was 0.7 accidents per 100,000 flight hours in 2000, compared with 0.5 accidents per 100,000 flight hours in 1999. The accident rate for commuter aircraft declined in 2000 to 1.1 per 100,000 flight hours from 3.5 per 100,000 flight hours in 1999; the air taxi/aerial work accident rate also declined, to 6.1 per 100,000 flight hours in 2000 from 8.8 per 100,000 flight hours in 1999. For helicopters, the 2000 accident rate was 8.1 per 100,000 flight hours, compared with 7.1 per 100,000 flight hours in 1999.

Table 2 also includes data on fatalities among crewmembers and passengers. Thirty-nine crewmembers and 20 passengers on Canadian-registered aircraft were killed in accidents in 2000, compared with 33 crewmembers and 28 passengers in 1999.

Table 3 (page 33) classifies accidents according to the first event in the sequence that preceded the accident. Data for accidents involving Canadian-registered aircraft from 1991 through 2000 showed that the most frequent "first event" for airliners was collision with an object. For commuter airplanes and air taxi aircraft, the most frequent first event was a takeoff or landing event.

Data for fatal accidents involving Canadian-registered aircraft from 1991 through 2000 showed that the most frequent first



1 Ultralight aircraft are excluded.

2 The Transportation Safety Board of Canada (TSB) defines an airliner as an airplane used "in air transport service or in aerial work involving sightseeing operations that has a MCTOW [maximum certified takeoff weight] of more than 8,618 [kilograms] (19,000 pounds) or for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers."

3 TSB defines a commuter aircraft as an airplane used "in an air transport service or in aerial work involving sightseeing operations of any of the following aircraft: a multi-engined aircraft that has a MCTOW of 8,618 [kilograms] (19,000 pounds) or less and a seating configuration, excluding pilot seats, of 10 to 19 inclusive [or] a turbojet-powered airplane that has a maximum zero fuel weight of 22,680 [kilograms] (50,000 pounds) or less and for which a Canadian type certificate has been issued authorizing the transport of not more than 19 passengers."

4 TSB defines an air taxi/aerial work aircraft as an airplane used on a "for-hire basis that does not satisfy the definition of an airliner or a commuter aircraft."

5 "Other aircraft types" are balloons, gliders and gyrocopters.

Source: Transportation Safety Board of Canada

Figure 1

event for airliners, commuter airplanes and air taxi aircraft was collision with terrain (Table 4, page 34).

Table 5 (page 34) shows that, from 1991 through 2000, for helicopters involved in accidents during takeoff, the most frequent first event was collision with an object; for helicopters involved in accidents en route and during approach and landing, the most frequent first event was power loss. More accidents (26 percent of the total) occurred during approach and landing than during any other phase of flight.♦

Notes

1. The Transportation Safety Board of Canada (TSB) defines a reportable aviation accident as "an accident resulting directly from the operation of an aircraft where:
   - "A person sustains a serious injury or is killed as a result of: being on board the aircraft [or] coming into contact with any part of the aircraft or its contents [or] being directly exposed to the jet blast or rotor downwash of the aircraft;
   - "The aircraft sustains damage that adversely affects the structural strength, performance or flight characteristics of the aircraft and that requires major repair or replacement of any affected component part; or,
   - "The aircraft is missing or inaccessible."
2. The report said that, because some accidents involved more than one aircraft, the number of accidents does not equal the number of aircraft involved.
3. TSB defines a reportable aviation incident as "an incident resulting directly from the operation of an airplane having a maximum certificated takeoff weight (MCTOW) greater than 5,700 kilograms [/12,500 pounds], or from the operation of a rotorcraft having a MCTOW greater than 2,250 kilograms [4,960 pounds], where:
   - "An engine fails or is shut down as a precautionary measure;

Continued on page 33

Table 1
Canadian Aircraft Accidents and Incidents, 1991–2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Canadian-registered Aircraft Accidents[1]	**453**	**434**	**422**	**381**	**390**	**342**	**356**	**386**	**341**	**321**
Airplanes Involved[2]	378	384	366	304	315	274	295	316	288	258
Airliners[3]	11	7	14	6	7	4	8	14	6	9
Commuter Aircraft[4]	6	10	9	8	19	12	14	10	13	4
Air Taxi/Aerial Work[5]	145	132	122	115	134	106	120	128	90	65
Other Commercial Air Services[6]	–	–	–	–	–	–	–	–	8	–
Private/State	216	235	221	175	155	152	153	164	171	180
Helicopters Involved	64	34	52	61	68	56	56	57	45	53
Other Aircraft Involved[7]	14	17	8	21	12	12	10	17	15	12
Hours Flown (thousands)[8]	3,301	3,308	3,490	3,776	3,810	3,900	3,900	4,000	4,100	4,260
Accident Rate (per 100,000 hours)	13.7	13.1	12.1	10.1	10.2	8.8	9.1	9.7	8.3	7.5
Fatal Accidents	**64**	**47**	**48**	**33**	**52**	**44**	**36**	**31**	**34**	**36**
Airplanes Involved	56	39	45	30	44	34	29	24	28	25
Airliners	3	0	3	0	1	1	0	0	1	1
Commuter Aircraft	1	1	0	2	2	1	0	1	2	1
Air Taxi/Aerial Work	18	9	16	14	21	12	11	9	6	5
Other Commercial Air Services	–	–	–	–	–	–	–	–	0	–
Private/State	34	29	26	14	20	20	18	14	19	18
Helicopters Involved	7	3	3	3	11	7	8	6	4	10
Other Aircraft Involved	2	4	0	0	0	3	0	2	4	1
Fatalities	**373**	**80**	**102**	**80**	**107**	**71**	**77**	**85**	**65**	**63**
Serious Injuries	**55**	**64**	**63**	**36**	**54**	**38**	**69**	**49**	**42**	**54**
Foreign-registered Aircraft Accidents in Canada	**30**	**25**	**17**	**22**	**18**	**22**	**17**	**22**	**24**	**18**
Fatal Accidents	5	8	1	4	4	4	5	5	6	7
Fatalities	12	19	2	9	12	13	11	236	9	18
Serious Injuries	3	6	3	1	2	2	6	4	1	2
All Aircraft: Reportable Incidents	**680**	**664**	**599**	**578**	**618**	**717**	**691**	**781**	**705**	**729**
Collision/Risk of Collision/Loss of Separation	158	156	146	154	143	196	224	185	176	170
Canada, Northwest Atlantic–Airborne Air Proximity[9]	130	111	114	121	110	141	175	151	138	130
Canada, Northwest Atlantic–Loss of Separation[10]	75	55	61	72	54	72	120	116	98	98
Declared Emergency	220	200	190	138	191	201	195	229	209	227
Engine Failure	171	176	150	172	166	177	147	172	157	163
Smoke/Fire	68	71	55	62	53	78	61	111	86	84
Other	63	61	58	52	65	65	64	84	77	85

[1] Ultralight aircraft are excluded.

[2] Because some accidents may involve multiple aircraft, the number of aircraft involved may differ from the total number of accidents.

[3] The Transportation Safety Board of Canada (TSB) defines an airliner as an airplane used "in air transport service or in aerial work involving sightseeing operations that has a MCTOW [maximum certified takeoff weight] of more than 8,618 [kilograms] (19,000 pounds) or for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers."

[4] TSB defines a commuter aircraft as an airplane used "in an air transport service or in aerial work involving sightseeing operations of any of the following aircraft: a multi-engined aircraft that has a MCTOW of 8,618 [kilograms] (19,000 pounds) or less and a seating configuration, excluding pilot seats, of 10 to 19 inclusive [or] a turbojet-powered airplane that has a maximum zero fuel weight of 22,680 [kilograms] (50,000 pounds) or less and for which a Canadian type certificate has been issued authorizing the transport of not more than 19 passengers."

[5] TSB defines an air taxi/aerial work aircraft as an airplane used on a "for-hire basis that does not satisfy the definition of an airliner or a commuter aircraft."

[6] Category broken down from air taxi/aerial work aircraft and includes training operations. It was not coded prior to 1999.

[7] Includes gliders, balloons and gyrocopters.

[8] Source: Statistics Canada (1996 to 2000 hours flown are estimated).

[9] This row is a subcomponent of the previous row and includes incidents in Canada or Canadian-controlled North Atlantic airspace in which an aircraft was unintentionally operated in close proximity to another.

[10] This row is a subcomponent of the previous row and includes incidents in which established separation criteria were violated in controlled airspace.

Source: Transportation Safety Board of Canada

Table 2
Canadian-registered Aircraft Accidents, Accident Rates and Fatalities by Operator Type, 1991–2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Accidents[1]	**442**	**418**	**418**	**365**	**383**	**330**	**351**	**373**	**333**	**311**
Airplanes Involved										
Airliners[2]	11	7	14	6	7	4	8	14	6	9
Commuter Aircraft[3]	6	10	9	8	19	12	14	10	13	4
Air Taxi/Aerial Work[4]	145	132	122	115	134	106	120	128	90	65
Other Commercial Air Services[5]	–	–	–	–	–	–	–	–	8	–
Private/State	216	235	221	175	155	152	153	164	171	180
Helicopters Involved	64	34	52	61	68	56	56	57	45	53
Hours Flown (thousands)[6]	**3,301**	**3,308**	**3,490**	**3,776**	**3,810**	**3,900**	**3,900**	**4,000**	**4,100**	**4,260**
Airplanes										
Airliners	885	960	980	1,049	1,122	1,150	1,200	1,250	1,270	1,330
Commuter Aircraft	299	286	284	302	316	320	330	350	370	375
Air Taxi/Aerial Work	982	923	922	985	978	980	990	1,000	1,025	1,060
Other Commercial Air Services	–	–	–	–	–	–	–	–	N/A	–
Private/State	726	735	849	872	779	780	780	780	800	840
Helicopters	409	405	466	567	615	620	620	620	635	655
Accident Rates (per 100,000 hours)	**13.7**	**13.1**	**12.1**	**10.1**	**10.2**	**8.8**	**9.1**	**9.7**	**8.3**	**7.5**
Airplanes										
Airliners	1.2	0.7	1.4	0.6	0.6	0.3	0.7	1.1	0.5	0.7
Commuter Aircraft	2.0	3.5	3.2	2.6	6.0	3.8	4.2	2.9	3.5	1.1
Air Taxi/Aerial Work	14.8	14.3	13.2	11.7	13.7	10.8	12.1	12.8	8.8	6.1
Other Commercial Air Services	–	–	–	–	–	–	–	–	N/A	–
Private/State	29.8	32.0	26.0	20.1	19.9	19.5	19.6	21.0	21.4	21.4
Helicopters	15.6	8.4	11.2	10.8	11.1	9.0	9.0	9.2	7.1	8.1
Fatalities: Crew[7]	**76**	**37**	**55**	**37**	**52**	**38**	**39**	**33**	**33**	**39**
Airplanes										
Airliners	19	0	8	0	1	0	0	0	2	2
Commuter Aircraft	0	1	0	4	4	2	0	2	2	2
Air Taxi/Aerial Work	20	8	18	18	19	11	13	10	7	5
Other Commercial Air Services	–	–	–	–	–	–	–	–	0	–
Private/State	31	26	26	12	20	21	17	16	17	21
Helicopters	6	2	3	3	8	4	9	5	5	9
Fatalities: Passengers	**291**	**35**	**46**	**43**	**55**	**26**	**38**	**49**	**28**	**20**
Airplanes										
Airliners	250	0	4	0	0	0	0	0	0	0
Commuter Aircraft	0	6	0	3	4	0	0	9	0	0
Air Taxi/Aerial Work	18	5	25	21	31	12	9	17	4	6
Other Commercial Air Services	–	–	–	–	–	–	–	–	0	–
Private/State	18	23	14	12	12	12	17	10	18	6
Helicopters	5	1	3	7	8	2	12	13	6	8

[1] Ultralight aircraft, balloons, gliders and gyrocopters are excluded.

[2] The Transportation Safety Board of Canada (TSB) defines an airliner as an airplane used "in air transport service or in aerial work involving sightseeing operations that has a MCTOW [maximum certified takeoff weight] of more than 8,618 [kilograms] (19,000 pounds) or for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers."

[3] TSB defines a commuter aircraft as an airplane used "in an air transport service or in aerial work involving sightseeing operations of any of the following aircraft: a multi-engined aircraft that has a MCTOW of 8,618 [kilograms] (19,000 pounds) or less and a seating configuration, excluding pilot seats, of 10 to 19 inclusive [or] a turbojet-powered airplane that has a maximum zero fuel weight of 22,680 [kilograms] (50,000 pounds) or less and for which a Canadian type certificate has been issued authorizing the transport of not more than 19 passengers."

[4] TSB defines an air taxi/aerial work aircraft as an airplane used on a "for-hire basis that does not satisfy the definition of an airliner or a commuter aircraft."

[5] Category broken down from air taxi/aerial work aircraft and includes training operations. It was not coded prior to 1999.

[6] Hours flown are estimated by the TSB, based on data supplied by Statistics Canada. Hours flown for 1996 to 2000 are estimates based on historical data.

[7] The 1991 total excludes two fatalities from a foreign aircraft that collided with a Canadian aircraft over the United States; the 1992 total excludes four fatalities from a foreign aircraft that collided with a Canadian aircraft over Canada.

Source: Transportation Safety Board of Canada

Table 3
Canadian-registered Airplane Accidents, by First Event, 1991–2000[1]

	Airplane Type					
	Airliner[2]	Commuter[3]	Air Taxi[4]	Aerial Work[4]	Other Commercial Air Services[5]	Private/State
Airplanes Involved in Accidents by First Event	**86**	**105**	**1,010**	**147**	**8**	**1,822**
Control Loss	4	13	120	12	2	277
Power Loss	7	2	142	34	1	312
Collision with Object	19	10	96	32	0	219
Collision with Terrain	4	8	82	12	0	113
Collision with Moving Aircraft	0	1	8	4	0	21
Operations-related Event	0	4	29	9	0	59
Component System Malfunction	7	10	80	6	0	88
Landing Gear Collapsed/Retracted	6	11	63	2	0	84
Runway Overrun	3	0	15	2	0	27
Takeoff/Landing Event	9	18	174	11	2	293
Wheels-up Landing	1	3	27	2	0	33
Component System-related Event	8	6	26	2	1	55
Weather-related Event	2	8	59	7	1	79
Aircraft Damage	8	4	22	2	0	38
Other/Unknown	8	7	67	10	1	124

[1] Ultralight aircraft are excluded.

[2] The Transportation Safety Board of Canada (TSB) defines an airliner as an airplane used "in air transport service or in aerial work involving sightseeing operations that has a MCTOW [maximum certified takeoff weight] of more than 8,618 [kilograms] (19,000 pounds) or for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers."

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[4] TSB defines an air taxi/aerial work aircraft as an airplane used on a "for-hire basis that does not satisfy the definition of an airliner or a commuter aircraft."

[5] Category broken down from air taxi/aerial work aircraft and includes training operations. It was not coded prior to 1999.

Source: Transportation Safety Board of Canada

- "A transmission gearbox malfunction occurs;
- "Smoke or fire occurs;
- "Difficulties in controlling the aircraft are encountered owing to any aircraft system malfunction, weather phenomena, wake turbulence, uncontrolled vibrations or operations outside the flight envelope;
- "The aircraft fails to remain within the intended landing or takeoff area, lands with all or part of the landing gear retracted, or drags a wingtip, an engine pod, or any other part of the aircraft;
- "Any crewmember whose duties are directly related to the safe operation of the aircraft is unable to perform the crewmember's duties as a result of physical incapacitation that poses a threat to the safety of any person, property or the environment;
- "Depressurization occurs that necessitates an emergency descent;
- "A fuel shortage occurs that necessitates a diversion or requires approach-and-landing priority at the destination of the aircraft;
- "The aircraft is refueled with the incorrect type of fuel or contaminated fuel;
- "A collision, risk of collision or loss of separation occurs;
- "A crewmember declares an emergency or indicates any degree of emergency that requires priority handling by an air traffic control unit or the standing by of emergency response services;
- "A slung load is released unintentionally or as a precautionary or emergency measure from the aircraft; or,
- "Any dangerous goods are released in or from the aircraft."

Table 4
Canadian-registered Airplane Fatal Accidents by First Event, 1991–2000[1]

	Airplane Type					
	Airliner[2]	Commuter[3]	Air Taxi4	Aerial Work[4]	Other Commercial Air Services[5]	Private/State
Airplanes Involved in Fatal Accidents by First Event	**10**	**11**	**113**	**8**	**0**	**212**
Control Loss	1	1	16	2	0	48
Power Loss	1	0	9	0	0	22
Collision with Object	0	0	7	1	0	24
Collision with Terrain	4	3	36	3	0	53
Collision with Moving Aircraft	0	1	4	0	0	10
Operations-related Event	0	2	3	0	0	9
Component System Malfunction	0	1	2	0	0	3
Landing Gear Collapsed/Retracted	0	0	1	0	0	1
Runway Overrun	0	0	0	0	0	0
Takeoff/Landing Event	0	0	2	1	0	4
Wheels-up Landing	0	0	0	0	0	0
Component System-related Event	2	0	2	0	0	0
Weather-related Event	0	0	11	0	0	11
Aircraft Damage	0	0	0	0	0	3
Other/Unknown	2	3	20	1	0	24

[1] Ultralight aircraft are excluded.

[2] The Transportation Safety Board of Canada (TSB) defines an airliner as an airplane used "in air transport service or in aerial work involving sightseeing operations that has a MCTOW [maximum certified takeoff weight] of more than 8,618 [kilograms] (19,000 pounds) or for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers."

[3] TSB defines a commuter aircraft as an airplane used "in an air transport service or in aerial work involving sightseeing operations of any of the following aircraft: a multi-engined aircraft that has a MCTOW of 8,618 [kilograms] (19,000 pounds) or less and a seating configuration, excluding pilot seats, of 10 to 19 inclusive [or] a turbojet-powered airplane that has a maximum zero fuel weight of 22,680 [kilograms] (50,000 pounds) or less and for which a Canadian type certificate has been issued authorizing the transport of not more than 19 passengers."

[4] TSB defines an air taxi/aerial work aircraft as an airplane used on a "for-hire basis that does not satisfy the definition of an airliner or a commuter aircraft."

[5] Category broken down from air taxi/aerial work aircraft and includes training operations. It was not coded prior to 1999.

Source: Transportation Safety Board of Canada

Table 5
Canadian-registered Helicopter Accidents by First Event and Phase of Flight, 1991–2000

	Phase of Flight							
	Standing	Takeoff	En Route	Hover/ Lift	Maneuvering	Approach/ Landing	Unknown	Total
Helicopters Involved in Accidents by First Event	**42**	**80**	**97**	**86**	**90**	**140**	**11**	**546**
Control Loss	4	17	1	8	6	23	1	60
Power Loss	0	12	29	15	14	11	0	81
Collision with Object	6	18	5	17	25	25	3	99
Collision with Terrain	2	4	12	3	8	4	2	35
Collision with Moving Aircraft	0	0	5	0	0	1	1	7
Operations-related Event	3	7	2	4	3	10	0	29
Sling-related Event	1	3	2	13	3	3	0	25
Dynamic System Malfunction	0	2	6	4	1	3	0	16
Dynamic Rollover	1	6	0	1	1	5	0	14
Autorotative landing	0	0	2	1	4	10	1	18
Weather-related Event	0	2	9	1	1	6	0	19
Aircraft Damage	14	0	3	8	3	15	0	43
Other/Unknown	11	9	21	11	21	24	3	100

Source: Transportation Safety Board of Canada

Publications Received at FSF Jerry Lederer Aviation Safety Library

Report Describes Challenges to Implementation of U.S. 'Free Flight' System

In a report to Congress, the General Accounting Office said that the free flight system has the potential to increase the capacity and efficiency of the nation's air traffic control system, but the Federal Aviation Administration may not have enough data to decide whether to proceed with the next phase of implementation of some parts of the system.

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FSF Library Staff

National Airspace System: Free Flight Tools Show Promise, but Implementation Challenges Remain. U.S. General Accounting Office (GAO). August 2001. GAO-01-932. 26 pp. Figures, tables, appendixes. Available from GAO.*

The U.S. Federal Aviation Administration (FAA) and the aviation community are working to implement "free flight," a new approach to air traffic management in which rules and procedures for air traffic operations will become more flexible. The free flight system comprises a set of automated technologies (tools) and procedures and is expected to increase the capacity and efficiency of the U.S. airspace system and to minimize delays in air travel.

The GAO, which conducts research for the U.S. Congress, was asked to review the program status and to help Congress determine whether FAA would be in a position by March 2002 to decide whether to begin the second phase of the operational evolution plan (OEP), a 10-year plan to increase efficiency and capacity of the airspace system, to manage delays and to maintain safety.

For this report, the GAO reviewed three of the five tools being developed for the free flight system; the three tools account for 80 percent of the funds budgeted for the first two phases of system implementation.

One of the three tools, the user request evaluation tool, allows aircraft to be flown on optimal routes or more direct routes, making more efficient use of existing airspace. The GAO said that FAA might not have enough time to gather data from installations before the March 2002 deadline for making a decision.

Another tool, the traffic management adviser, helps air traffic controllers manage properly separated aircraft as they transition into terminal airspace. FAA should have enough information to decide about investing in the next phase of implementation of this tool, the GAO said.

The third tool, the final approach spacing tool, allows air traffic controllers to schedule the final sequencing of aircraft in terminal airspace and assign runways for landing. FAA has decided not to deploy the tool during the next phase of system implementation, the GAO said.

The GAO said that preliminary data "indicated that the free flight tools have the potential to increase both capacity and efficiency. However, because the future demand for air traffic services is expected to outpace the increases expected from the tools, the collective length of the delays during peak periods will continue to increase but not to the extent they would have without them."

Investigating the Validity of Performance and Objective Workload Evaluating Research (POWER). Manning, C.A.; Mills, S.H.; Fox, C.; Pfleiderer, E.; Mogilka, H.J. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine (OAM). DOT/FAA/AM-01/10. July 2001. 40 pp. Tables, appendixes. Available from NTIS.**

A U.S. Federal Aviation Administration (FAA) document titled *Air Traffic Control* (ATC) [Order 7110.65M, 2000] says that the primary purpose of the ATC system is to "prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic." To help individual controllers meet ATC goals, many methods have been developed to define and measure mental workload, task load, sector complexity and controller performance. Measuring the inter-relationships among these elements is important in understanding and anticipating the effects on individuals and the ATC system when changes to procedures or the ATC system are made.

The purpose of this study was to develop measures of ATC activities that are objective, reliable, valid and easy to obtain. The researchers used Performance and Objective Workload Evaluation Research (POWER) software, data extracted from the National Airspace System (NAS), system-analysis recording files, and instructors from the FAA Academy. Comparisons were made between the instructors' assessments of controller workload and performance and the assessments made by POWER. The report said that some relationships between POWER measures and controller performance measures were not easy to interpret, that some POWER measures were unrelated to controller measures and that some aspects of workload did not correlate with POWER measures.

Books

Job Hunting for Pilots: Networking Your Way to a Flying Job. Brown, G.N. Ames, Iowa, U.S.: Iowa State University Press, Second Edition, 2001. 208 pp. Figures.

The theme of this book is networking, which the author describes as "the continuous process of meeting and staying in touch with people who may be helpful and supportive in advancing your career." The author emphasizes networking and discusses aspects of a job search, from resume-writing to interview follow-ups.

This new edition identifies ways to use the Internet and other tools of the information age in obtaining a job. The book is written for pilots of all experience levels. For student pilots, new professional pilots and military pilots transitioning to the civilian job market, the author has included a chapter to discuss how to increase flight experience, identify opportunities for growth and select jobs that provide good networking opportunities.

Regulatory Materials

Minimum Equipment Lists (MEL) and generic CASA Master MEL. Civil Aviation Safety Authority of Australia (CASA) Civil Aviation Advisory Publication (CAAP) 37-1(0). December 2001. 31 pp. Appendixes. Available from CASA.***

This CAAP, the first to be written about this topic, is advisory and discusses CASA's preferred method for complying with Australian Civil Aviation Regulations 1988. This CAAP provides information and guidance for obtaining CASA approval of MELs. Operational regulations and airworthiness regulations require that equipment installed in an aircraft must be operational at the beginning of a flight. Under some conditions, specific items of equipment may be inoperative for a limited period of time until repairs are made without affecting safety. An approved MEL lists equipment on a specific aircraft that may be inoperative at the time of dispatch while maintaining compliance with type design standards. A master minimum equipment list (MMEL) is developed by aircraft manufacturers in conjunction with operators. CASA only accepts MMELs approved by CASA or "the national airworthiness authority of the country of the type design as part of the type certificate or type acceptance certificate."

Appendixes include a sample MEL, a generic MMEL produced by CASA, and a sample format for possible inclusion in an operator's manual. Appendix C discusses current regulatory requirements.

FAA Certificated Pilot Schools Directory. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 140-2DD. Sept. 5, 2001. 30 pp. Appendix. Available from GPO.****

Appendix 1 of the AC is a directory of pilot schools certificated under U.S. Federal Aviation Regulations Part 141. Each entry is listed by U.S. state, possession or territory and includes the school's name, mailing address, certificate number and the courses and pilot certificates/ratings offered.

[This AC cancels AC 140-2CC, *FAA Certificated Pilot Schools Directory*, dated Sept. 20, 2000.]♦

Sources

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P.O. Box 37050
Washington, DC 20013 U.S.
Internet: <http://www.gao.gov>

** National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 U.S.
Internet: <http://www.ntis.org>

*** Civil Aviation Safety Authority Australia (CASA)
CASA Building
GPO Box 2005
Canberra ACT 2601
Internet: <http://www.casa.gov.au>

**** Superintendent of Documents
U.S. Government Printing Office (GPO)
Washington, DC 20402 U.S.
Internet: <http://www.access.gpo.gov>

Accident/Incident Briefs

A319 Engine Abnormality, Smoke in Airplane Prompt Emergency Landing

A post-incident inspection revealed an oily film on the cowling of the no. 1 engine and along the fuselage but no indication of an engine failure.

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The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

Air Carrier

Controllers Say They Saw Smoke Coming From Engine During Airplane's Approach

Airbus A319. No damage. No injuries.

Visual meteorological conditions prevailed for the domestic flight in the United States. The airplane was in cruise flight when the crew observed an "engine oil filter bypass" fault message and a high oil-pressure indication for the no. 1 engine. The crew observed smoke in the flight deck and in the cabin and felt a "high vibration," the incident report said.

The flight crew moved the throttle lever for the no. 1 engine to idle, declared an emergency and diverted the flight to an en route airport. During the approach, controllers in the air traffic control tower observed white smoke coming from the no. 1 engine. The crew landed the airplane, shut down the engines and conducted an emergency evacuation. (During the evacuation, the R1 door emergency slide failed to deploy. Passengers deplaned using the L1 and L2 emergency slides.)

A preliminary inspection revealed an oily film on the exterior of the no. 1 engine's cowling and along the fuselage, and metal particles on the no. 1 engine's chip detectors. The report said that there were no indications of an uncontained engine failure or engine fire. The investigation was continuing.

Airplane Veers Off Runway During Takeoff

Boeing 737-300. Minor damage. No injuries.

The captain was conducting a takeoff from an airport in Tanzania for a flight to Zanzibar when, as the airplane reached 60 knots to 70 knots, it veered right. After crewmembers were unable to correct the problem, the captain applied brakes and thrust reversers to reject the takeoff.

The airplane crossed the edge of the runway and rolled onto the adjacent sand and grass. The no. 4 main-wheel tire struck a concrete block and burst. The airplane then veered left and stopped next to the runway.

A post-accident investigation revealed that the nose-wheel steering system and the landing gear functioned normally and that engine parameters were normal.

Bounced Landing Follows Spoiler-extension Failure

McDonnell Douglas DC-8. Minor damage. No injuries.

After a flight from Egypt to England, the flight crew conducted a practice ground-controlled approach. The airplane touched down normally on the runway and at the correct airspeed, but automatic spoiler extension did not occur after the main wheels touched the runway. The airplane bounced, and when the wheels touched down the second time, the crew applied brakes. When the nosewheel touched the runway, the spoilers extended.

The captain said that a fault in the anti-skid brake system must have been responsible for the failure of the spoilers to extend automatically when the main wheels touched down, but maintenance personnel found no defect in the system.

The accident report said that the airplane has been flown "many hours with the same anti-skid components and without a recurrence of the problem."

Air Taxi
Commuter

Loss of Control Blamed for Airplane's In-flight Breakup

Piper Aerostar 600A. Destroyed. One fatality.

Night visual meteorological conditions prevailed for the domestic positioning flight in Australia. The pilot told air traffic control that he was taxiing the airplane for takeoff. Witnesses observed nothing unusual as the airplane departed from the airport. No further radio transmissions were heard.

The next morning, searchers found the outer part of the airplane's left wing and other structural components about 24 kilometers (15 statute miles) northeast of the departure airport near the pilot's intended flight path. Most of the wreckage was found four days later. The impact crater was a "considerable distance" from the structural components and indicated that the airplane had broken up during flight, the accident report said.

If the flight had progressed normally to a point above the area where the wreckage was found, the airplane would have been near the planned cruise altitude of 10,000 feet. An investigation revealed that the airplane broke up at an altitude between 2,700 feet and 4,000 feet.

An autopsy could not be conducted, but medical records showed that, 10 years before the accident, doctors had told the then 58-year-old pilot that his risk of heart disease required additional monitoring and medication for elevated cholesterol levels. Witnesses who saw the pilot the day of the accident said that he appeared healthy, with no indication of fatigue, illness or injury.

Witnesses said that the night was very dark, and the flight path was away from the crescent moon. The report said that the area north of the departure airport had few prominent features and that during climb, the natural horizon would have been "obscured or nonexistent."

The airplane was equipped with an autopilot, but a colleague said that the pilot typically engaged the autopilot only after the airplane reached cruise altitude.

The accident report said, "The possibility existed that during the climb, accomplished without the use of the autopilot, some unidentified fault or unexpected event diverted the pilot's attention from hand-flying the aircraft. In those circumstances, it would not have taken long for a spiral to develop and for the aircraft to rapidly increase airspeed and lose altitude. The low engine power at impact and the extended landing gear support the theory that the pilot may have been attempting recovery from a spiral maneuver when the structural failure occurred."

Airplane Strikes Hillside During Flight in Deteriorating Weather

Cessna 206. Destroyed. Five serious injuries.

Visual meteorological conditions prevailed for the morning takeoff from an airport in Tanzania. About 30 minutes after departure on the domestic flight, however, the cloud base was between 600 feet above ground level (AGL) and 800 feet AGL.

The pilot said that because the airplane was not approved for instrument flight rules flight, he flew the airplane below the clouds and about 500 feet to 600 feet above the mountainous terrain. He said that he complied with company procedures for flying over mountains with 20 degrees of flaps and an engine speed of 2,550 revolutions per minute. The resulting airspeed was 80 knots.

The pilot changed his course to avoid deteriorating weather, then observed a hill straight ahead.

"He immediately turned to the left with a 45-degree bank," the accident report said. "Two-thirds of the way into the turn, the stall-warning horn came on, and the aircraft sank rapidly. The pilot estimated the rate of sink at about 1,000 feet per minute. [The airplane] hit the ground on the side of a hill, bounced twice and ground-looped before it came to rest."

Other pilots have reported downdrafts near the site of the accident, where the elevation is 7,200 feet. Early morning low clouds and fog are common in the area, the report said.

Wing-fuselage Panel Loosens During Flight

ATR 42-300. Minor damage. No injuries.

The airplane was being flown on a descent for landing at an airport in Ireland when the flight crew felt severe airframe vibrations and declared an emergency.

After landing, examination of the airplane revealed that a large panel at the fuselage-wing joint had detached along the trailing edge and that the panel contained significant cracks.

An investigation revealed that the panel had loosened along the trailing edge because of a loss of bending stiffness that resulted from a crack that had been caused by "cyclic flexing stresses on the panel [that] were due to aerodynamic and wing-flexing loads," the report said. The loss of bending stiffness produced turbulent eddies that led to the vibrations felt by the crew.

Corporate
Business

Incorrect Positioning of Landing-gear Handle Cited in Gear-up Landing

Cessna T310R. Substantial damage. No injuries.

Visual meteorological conditions prevailed for the flight to an airport in the United States. The pilot said that he had planned to land the airplane on Runway 35 but decided after being informed of wind direction and wind speed to use Runway 17.

Because of the airplane's position, the pilot began a steeper descent than would have been required for Runway 35. He extended the wing flaps, repositioned the landing-gear handle and continued the approach with a steeper angle of descent and higher-than-normal airspeed. The landing-gear warning horn sounded as the propellers struck the runway during the landing flare.

The pilot said that when he moved the landing-gear handle, he placed the handle in the neutral position instead of the down position.

Engine Failure During Approach Prompts Off-airport Landing

Beech King Air C90. Substantial damage. One serious injury.

Visual meteorological conditions prevailed for the midday flight to an airport in the United States. The airplane was being flown on final approach when a controller in the air traffic control tower observed the airplane "descending out of sight behind hangars," the accident report said.

The controller asked the pilot if there was a problem; the pilot did not answer. The airplane continued descending and was landed in a residential area, striking power lines, a tree, a natural gas meter, two residences and a fence.

The pilot said later that while the airplane was on base leg, the right engine surged. The pilot turned on the boost pumps and retracted the landing gear. The engine lost all power, and, as airspeed deteriorated to minimum controllable airspeed (V_{MC}), the pilot reduced power on the left engine and conducted the off-airport landing in the residential area.

Other
General
Aviation

Loose Spark Plug Prompts Forced Landing

Piper PA-38-112 Tomahawk II. Minor damage. No injuries.

The airplane was being used by a student pilot to practice emergency landing procedures near an airport in England. After two practice emergency landings, the student pilot and flight instructor heard a loud "pop" and observed a reduction in engine power. The engine ran roughly, and the pilots felt vibration.

The flight instructor was unable to restore normal power and conducted an emergency landing in a field. The left wingtip and the left wing's leading edge were damaged when the airplane struck a hedge at the end of the field.

An inspection revealed that the lower spark plug of the no. 1 cylinder had come out of the threaded hole.

The accident report said, "Inspection of the threads of the plug and cylinder head showed that only the last two threads of both showed any evidence of engagement and wear, indicating that the plug had not been installed correctly and [had not been] tightened at the last 50-hour maintenance check, which had been done 16 [flight] hours before this incident."

Airplanes Collide Near Departure End of Runway

Mooney M-20C. Destroyed. Four fatalities.
Cessna 177RG. Destroyed. One fatality.

Visual meteorological conditions prevailed as the Mooney was flown, under visual flight rules (VFR), toward an airport in Canada. The pilot flew the airplane west of the extended centerline for Runway 34, then turned the airplane east on a track that would intersect the runway's departure path.

About the same time, the pilot of the Cessna taxied onto Runway 34 for a VFR departure and told a flight service station specialist that he was ready to depart.

The two airplanes collided in the air about 0.9 nautical mile (1.7 kilometers) from the departure end of Runway 34.

Rotorcraft

Incorrect Installation of Valve Rocker Arms Cited in Engine Failure

Hughes 269. Destroyed. One minor injury.

The helicopter had been in flight for about one hour en route to a cattle property in Australia and was being flown 1,000 feet above ground level when the engine suddenly ran roughly and then lost power. The pilot conducted a forced landing, and the helicopter touched down hard on the rocky terrain.

An investigation revealed that an intake-valve rocker arm was fitted to the exhaust-valve position and an exhaust-valve rocker arm was fitted to the inlet-valve position. The helicopter had been flown about 200 hours since the last engine overhaul and 26.5 hours since repairs to correct low-power indications.

The accident report said that the incorrect positioning of the valve rocker arms resulted in "significant misalignment of both the rocker arms and pushrods at the outboard (cylinder head) ends." Because of the misalignment, the exhaust pushrod eventually collapsed, initiating a series of events that allowed the exhaust valve to over-travel into the cylinder and strike the upcoming piston.

Skid Separates From Helicopter After Attempted Landing on Trailer

Aerospatiale AS 350B2. Substantial damage. One minor injury.

Visual meteorological conditions prevailed as the pilot conducted an approach to land the helicopter on a helicopter-landing trailer at an airport in Sweden. After touchdown on the trailer, the pilot lifted the helicopter slightly upward, intending to adjust the placement of the helicopter for parking.

As the helicopter lifted off the trailer, however, the pilot felt the right landing skid contact a steel strip on the trailer. When the landing skid broke away from the trailer, the helicopter yawed left. The pilot applied right rudder, but the yaw did not stop.

After the helicopter had rotated about 180 degrees and was about three meters (10 feet) above the ground, the pilot landed the helicopter on the ground. The impact caused the right landing skid and the aft spring strut to separate from the helicopter, which rolled onto its right side.

The accident report said that no technical problem was found on the helicopter that would have contributed to the accident. The design of the helicopter-landing trailer, however, was unsuitable for this type of helicopter, the report said.

The report said that the probable cause of the accident was that the pilot "did not promptly enough and with sufficient rudder deflection, arrest the sudden left yaw that was initiated when the entangled flexible steel strip freed itself from the helicopter trailer. A contributory cause could have been a transient aerodynamic disturbance of the tail-rotor function."♦

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Tool Kit

The Flight Safety Foundation *ALAR Tool Kit* is a comprehensive and practical resource on compact disc to help you prevent the leading causes of fatalities in commercial aviation: approach-and-landing accidents (ALAs), including those involving controlled flight into terrain (CFIT).

Put the FSF *ALAR Tool Kit* to work for you TODAY!

- Separate lifesaving facts from fiction among the data that confirm ALAs and CFIT are the leading killers in aviation. Use FSF data-driven studies to reveal eye-opening facts that are the nuts and bolts of the FSF *ALAR Tool Kit*.
- Volunteer specialists on FSF task forces from the international aviation industry studied the facts and developed data-based conclusions and recommendations to help pilots, air traffic controllers and others prevent ALAs and CFIT. You can apply the results of this work — NOW!
- Review an industrywide consensus of best practices included in 34 FSF *ALAR Briefing Notes*. They provide practical information that every pilot should know … *but the FSF data confirm that many pilots didn't know — or ignored — this information*. Use these benchmarks to build new standard operating procedures and to improve current ones.
- Related reading provides a library of more than 2,600 pages of factual information: sometimes chilling, but always useful. A versatile search engine will help you explore these pages and the other components of the FSF *ALAR Tool Kit*. (This collection of FSF publications would cost more than US$3,300 if purchased individually!)
- Print in six different languages the widely acclaimed FSF *CFIT Checklist*, which has been adapted by users for everything from checking routes to evaluating airports. This proven tool will enhance CFIT awareness in any flight department.
- Five ready-to-use slide presentations — with speakers' notes — can help spread the safety message to a group, and enhance self-development. They cover ATC communication, flight operations, CFIT prevention, ALA data and ATC/aircraft equipment. Customize them with your own notes.
- *An approach and landing accident: It could happen to you!* This 19-minute video can help enhance safety for every pilot — from student to professional — in the approach-and-landing environment.
- *CFIT Awareness and Prevention*: This 33-minute video includes a sobering description of ALAs/CFIT. And listening to the crews' words and watching the accidents unfold with graphic depictions will imprint an unforgettable lesson for every pilot and every air traffic controller who sees this video.
- Many more tools — including posters, the FSF *Approach-and-landing Risk Awareness Tool* and the FSF *Approach-and-landing Risk Reduction Guide* — are among the more than 590 megabytes of information in the FSF *ALAR Tool Kit*. An easy-to-navigate menu and bookmarks make the FSF *ALAR Tool Kit* user-friendly. Applications to view the slide presentations, videos and publications are included on the CD, which is designed to operate with Microsoft Windows or Apple Macintosh operating systems.

Order the FSF *ALAR Tool Kit*:

Member price: US$40
Nonmember price: $160
Quantity discounts available!

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Minimum System Requirements:

Windows® systems

- A Pentium-based PC or compatible computer
- At least 16MB of RAM
- Windows 95, Windows 98 or Windows NT 4.0 system software
- A Sound Blaster or compatible sound card and speakers
- DirectX version 3.0 or later recommended

Macintosh® systems

- A PowerPC processor-based Macintosh computer
- At least 16MB of RAM
- Mac OS 7.5.5 or later

Want more information about Flight Safety Foundation?

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Visit our World Wide Web site at http://www.flightsafety.org

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