DOT/FAA/TC-12/28

Federal Aviation Administration
William J. Hughes Technical Center
Aviation Research Division
Atlantic City International Airport
New Jersey 08405

Airport Surface Event Analysis for Airport Design January 2006—September 2011

June 2012

Final Report

This document is available to the U.S. public through the National Technical Information Services (NTIS), Springfield, Virginia 22161.

This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/TC-12/28		

4. Title and Subtitle	5. Report Date
AIRPORT SURFACE EVENT ANALYSIS FOR AIRPORT DESIGN JANUARY 2006—SEPTEMBER 2011	June 2012
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Michael Derrick*, Emily Dziedzic*, Donald W. Gallagher**, and Lauren Vitagliano**	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
*PAI Consulting 4900 Seminary Road Suite 360 Alexandria, Virginia 22311 **Federal Aviation Administration William J. Hughes Technical Center Aviation Research Division Airport Technology Branch Atlantic City International Airport, NJ 08405	11. Contract or Grant No. DTFACT-10-D-00008
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Aviation Research Division Airport Technology Branch Atlantic City International Airport, NJ 08405	Final Report
	14. Sponsoring Agency Code AAS-300

15. Supplementary Notes

Contributors to this report were William Allen of SRA International, Inc.

16. Abstract

The objective of this effort was to identify airport design factors that may have been responsible for causing incidents and accidents, which could then be mitigated. A database was created, which was populated with accidents and incidents from January 1, 2006 through September 30, 2011. This database is maintained as a searchable database and updated as new events are reported.

The database includes data from the following sources: National Aeronautics and Space Administration, National Transportation Safety Board, Federal Aviation Administration (FAA) Office of Runway Safety, FAA Air Traffic Quality Assurance, and FAA Service Difficulty Reporting System. There were approximately 7200 events analyzed, which included accidents, incidents, runway incursions (including those caused by vehicles and pedestrians), and takeoffs and landings from or on taxiways and wrong runways.

The analysis indicated that there were no events in which an airport design factor was the primary cause of the accident. However, there were events in which an airport design factor may have contributed to the severity of the event. Based on the analysis, the top five areas of concern relevant to airport design are runway incursion prevention; maintenance of airport surface markings, signage, and lighting; obstacles near runway safety areas; retention of runway protection zones; and mitigation of runway overrun risks at airports with obstructions or steep drops near overrun areas.

17. Key Words	18. Distribution Statement
Airport design, Runway incursions/excursions, Incidents, Surface events, Airport safety	This document is available to the U.S. public through the National Technical Information Service (NTIS), Springfield, Virginia 22161. This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	49	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ABQ	Albuquerque International Sunport Airport
ASAP	Aviation Safety Action Program
ASDE	Airport surface detection equipment
ASRS	Aviation Safety Reporting System
ATC	Air traffic control
ATP	Airline transport pilot
ATQA	Air Traffic Quality Assurance
CFR	Code of Federal Regulations
DEN	Denver International Airport
DFW	Dallas/Fort Worth International Airport
EMAS	Engineered Materials Arresting System
FAA	Federal Aviation Administration
FAI	Fairbanks International Airport
FOD	Foreign object debris
FY	Fiscal year
GPU	Ground power unit
ICAO	International Civil Aviation Organization
ILS	Instrument landing system
LED	Light-emitting diode
LRD	Laredo International Airport
NASA	National Aeronautics and Space Administration
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
OE	Operational errors
OE/OD	Operational errors/deviations
ORD	Chicago O’Hare International Airport
PD	Pilot deviation
PHX	Phoenix Sky Harbor International Airport
PVD	T.F. Green Memorial Airport
RWSL	Runway status lights
RVR	Runway visual range
SDRS	Service Difficulty Reporting System
SFO	San Francisco International Airport
VMC	Visual meteorological conditions
V/PD	Vehicle/pedestrian deviations

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) requested a review of surface events to identify airport design factors that may have been responsible for a number of aviation accidents and incidents and to determine the airport design improvements that may be effective in mitigating these types of events. A searchable database populated with reported accidents and incidents was developed as a tool in this effort. This database is updated as new events are reported.

The database is populated with data from the National Aeronautics and Space Administration, National Transportation Safety Board, FAA Office of Runway Safety, FAA Air Traffic Quality Assurance, and FAA Service Difficulty Reporting System (SRDS).

This report presents the findings of a review of airport surface events that occurred, began, or ended inside the airport fence from January 1, 2006 to September 30, 2011. Aviation analysts reviewed approximately 7200 events, which comprised accidents, incidents, runway incursions (including those caused by vehicles and pedestrians), and takeoffs and landings from or on taxiways and wrong runways.

An in-depth analysis was conducted of airport surface events involving aircraft incidents and accidents. Foreign object debris events from the FAA SRDS database were also reviewed and categorized. Over 600 reports were reviewed further. Of those 600 reports, 129 were retained for having possible links to airport design factors. Of the 129 events, 6 were omitted for not having any link to airport design factors. Of the remaining 123 events, 36 had contributing airport design factors.

Events were highlighted in which aircraft in the takeoff or landing phase collided with an obstruction after experiencing a mechanical failure or while operating at a lower than authorized altitude. Because almost all fatalities occurred during the takeoff or landing phase, there was no justification to reduce runway protection zones at airports.

There were no events in which an airport design factor was determined the primary cause. However, there were events in which an airport design factor may have contributed to the severity of the event.

Based on the overall analysis of airport surface events, the top five areas suggested for the attention of the FAA Office of Airports are:

1. Runway incursion prevention

2. Maintenance of airport surface markings, signage, and lighting

3. Obstacles near runway safety areas

4. Retention of runway protection zones

5. Mitigation of runway overrun risks at airports with obstructions or steep drops near overrun areas

Future analysis should increase the scope of data by including busier reliever and general aviation airports, accidents/incident on nonmovement areas, and expand the types of issues the database captures such as: wildlife, runway friction and contaminant reporting, runway safety areas and runway protection zones.

1. INTRODUCTION.

In an effort to determine if any airport design factor was a contributing element to incidents and accidents, a review of airport surface events was conducted. This report shows the results of the review of airport surface events that occurred inside the airport fence between January 1, 2006 and September 30, 2011. Aviation analysts reviewed approximately 7200 events, which comprised accidents, incidents, runway incursions (including those caused by vehicles and pedestrians), and takeoffs and landings from or on taxiways and wrong runways.

This report contains detailed information, relevant data, statistics, and graphs in each event category, as well as a breakdown detailing the database from which the reports were retrieved. In addition, the event categories contain excerpts of reports analyzed. If applicable, possible airport design factors are italicized for emphasis. Although not all reports contain airport design factors, they are demonstrative of the types of surface events occurring at airports.

Eight aviation analysts categorized these airport surface events. The minimum qualification for reviewers was certification as a Federal Aviation Administration (FAA) private pilot. The reviewers' experience varied from private pilot to airline transport pilot (ATP) and FAA aircraft dispatcher certificates, and included backgrounds in general aviation (including corporate operations), military, regional and major air carriers, and airport operations.

2. BACKGROUND.

The FAA Office of Airport Safety and Standards requested a review of surface events to identify airport design factors that may have been responsible for a number of aviation accidents and incidents and to determine the airport design improvements that may be effective in mitigating these types of events. The database was populated with data from the following sources.

- The National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)—a voluntary reporting database that contains safety reports from all facets of aviation. Reports are submitted by pilots, cabin crew, maintenance personnel, or air traffic controllers. The reports are reviewed and monitored by NASA and are entered into the database after final review by a committee of aviation safety analysts at NASA. These reports are not limited to a particular field, but can range from general comments to reports of possible accidents and incidents.

- The National Transportation Safety Board (NTSB) accident/incident database—primarily used as the source for tracking aviation accidents; this data system contains all accidents and incidents reported to the NTSB. All reports are collected and processed through the NTSB and are then entered into the data system. The NTSB defines an aircraft accident as an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage [1]. The NTSB defines an incident as an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations [1].

- FAA Office of Runway Safety Runway Incursion Database—maintained by the FAA, this database is the primary reporting system and contains all reports for runway and taxiway incursions; it contains reports of incursions that happened on the airport surface with an operating air traffic control (ATC) tower.

- FAA Air Traffic Quality Assurance (ATQA) database—designed by the Air Traffic Organization, these databases include pilot deviations (PD), operational errors (OE), and vehicle/pedestrian deviations (V/PD). Air traffic controllers submit the initial report. When an investigation of the event is conducted by the appropriate line of business, a final report is submitted. Some crossover to other databases may occur.

- FAA Service Difficulty Reporting System (SDRS)—these are reports maintained by the FAA Flight Standards Office that describe the malfunction or failure of an aircraft part or system. Either the aviation industry (air carriers, air taxis) or aviation community (pilots, mechanics, and aircraft owners) can report these incidents to the SDRS. These reports are reviewed by the local Flight Standards district office and then sent to the Safety Analysis Group in Oklahoma City, Oklahoma, for processing. They are then entered into the searchable database.

All the databases listed above are part of the Aviation Safety Information Analysis and Sharing system.

The FAA requested using the data from the Aviation Safety Action Program (ASAP). After discussions with the contractor responsible for maintaining the ASAP data, it was made very clear that although the ASAP is an FAA program, the safety data remains the property of participating air carriers. It would be exceedingly difficult to obtain the permissions necessary to complete a multiyear pull of historical data.

Additionally, participating air carriers submit de-identified ASAP data to the NASA ASRS program. NASA ASRS cites that 76% of ASRS data is now sourced from ASAP contributions [2]. Because ASAP data is difficult to obtain and largely duplicated by ASRS, it was not used in this review.

3. OBJECTIVE.

The objective of this effort was to perform a review of surface events to identify airport design factors that may have been responsible for a number of aviation accidents and incidents and to determine the airport design improvements that may be effective in mitigating these types of events. This was done by constructing a database of these accidents and incidents.

4. DATA COLLECTION.

The data pull for the period from January 1, 2006 to September 30, 2011, returned 16,779 surface events, including accidents and incidents categorized as occurring "on airport." To identify surface event trends occurring at airports where improvements and mitigations have been made (such as runway safety areas and runway protection zones), only airports certified under Title 14 Code of Federal Regulations (CFR) Part 139 [3] were listed in the database. Although this list of airports was not comprehensive, it captured a broad representation of 14 CFR Part 139, as well as other towered and federally obligated primary airports in the National Plan of Integrated Airport Systems [4]. It was determined this would offer a more accurate representation of design factors typical of airports where the FAA has funded safety mitigations and provide a review of which design factors are most effective and which are not. The list of airports represented in the database can be found in appendix A.

After the filtering process, nonconforming records were removed, resulting in a final record count of 9615 for review. However, duplicate reports were discovered within the data retrieved from the Runway Incursion and ATQA databases. This was because ATQA reports are the initial notification for the FAA Office of Runway Safety that an event occurred.

The FAA Office of Runway Safety verified that the reports in the Runway Incursion Database should be used as the primary report. Duplicates were removed, and it was determined that 6487 were within the scope of the review. Reports that pertained to an event that did not occur on an airport or contained information not pertinent to airport safety as it relates to airport design (such as ATC handling procedures) were determined to be out of scope. Sixty-six reports had inadequate data concerning the reported event and are not included in any further breakdown in this report.

5. SUMMARY OF CATEGORIZED EVENTS.

Table 1 shows the sources of the 6487 events.

Table 1. Source Breakdown of the Reported Events

Source	No. of Events
FAA Runway Incursion Database	4753
NASA ASRS	730
NTSB Accident/Incident Database	860
ATQA (PD)	64
ATQA (OE)	46
ATQA (V/PD)	27
SDRS	7

Table 2 shows the events involving operations under which 14 CFR part.

Table 2. Number of Events Involving Operations From 14 CFR Parts

14 CFR Part	No. of Events
91	3045
121/129/135	2158
Other (such as military, 14 CFR Part 137)	1162
Not specified	122

6. RUNWAY/TAXIWAY INCURSIONS.

For runway/taxiway incursions, the filter of airports certified under 14 CFR Part 139 and others (discussed in section 2) were removed. Due to the high profile of runway incursion cases and the FAA Office of Runway Safety's frequent publishing of runway incursion statistics, this data filter would have caused anomalies between runway incursion statistics and trends in this report and others published by the FAA, possibly misleading readers. To avoid confusion, the data in this section is unfiltered and captures runway/taxiway incursion events at all towered airports, regardless of whether those airports are certified under 14 CFR Part 139. These events are also grouped by fiscal year to be consistent with the FAA Office of Runway Safety data.

The analysis showed that 4426 events were runway incursions. Of the runway incursion events, approximately 20% resulted in an aircraft executing a go-around and approximately 10% resulted in an aborted takeoff. These go-arounds and aborted takeoffs were conducted either by the offending aircraft (such as when an aircraft begins takeoff without clearance) or by another aircraft that has begun its takeoff (including an aircraft that has its takeoff clearance canceled due to an aircraft/vehicle/pedestrian entering the runway or runway safety area). Of the runway incursions, approximately 15% were caused by vehicles, and approximately 2% were caused by pedestrians.

Table 3 shows the sources of the 4426 runway incursion events evaluated in this review.

Table 3. Sources of Reported Runway Incursion Events

Source	No. of Events
FAA Runway Incursion Database	4081
NASA ASRS	249
NTSB Accident/Incident Database	15
ATQA (PD)	49
ATQA (OE)	29
ATQA (V/PD)	3

The FAA previously considered a runway incursion to be “Any occurrence in the airport runway environment 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.” However, in October 2007, the FAA adopted the International Civil Aviation Organization’s (ICAO) more restrictive definition [5]: “Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft.”

Additionally, the FAA Office of Runway Safety categorizes runway incursions by the following severity classifications [6]:

- Category A: A serious incident in which a collision was narrowly avoided.
- Category B: An incident in which separation decreases and a significant potential for collision exists, which may result in a time-critical corrective/evasive response to avoid a collision.
- Category C: An incident characterized by ample time and/or distance to avoid a collision.
- Category D: An incident that meets the definition of runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and takeoff of aircraft but with no immediate safety consequences.

Figure 1 shows that the runway incursion rate increased significantly between 2007 and 2008 because of the FAA’s adoption of ICAO’s more restrictive definition. The red trend line in figure 1 depicts the percentage of runway incursions per 1million airport operations. The trend has remained steady from fiscal year (FY) 2008 through FY 2011.

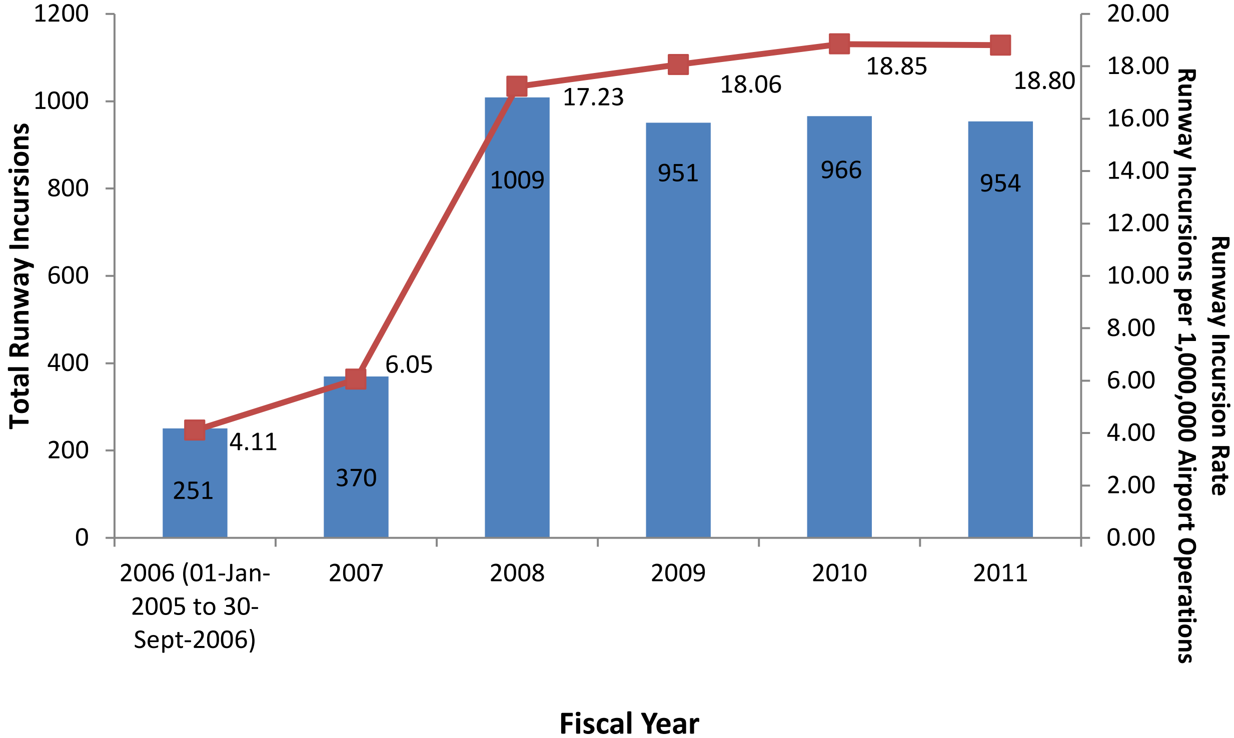
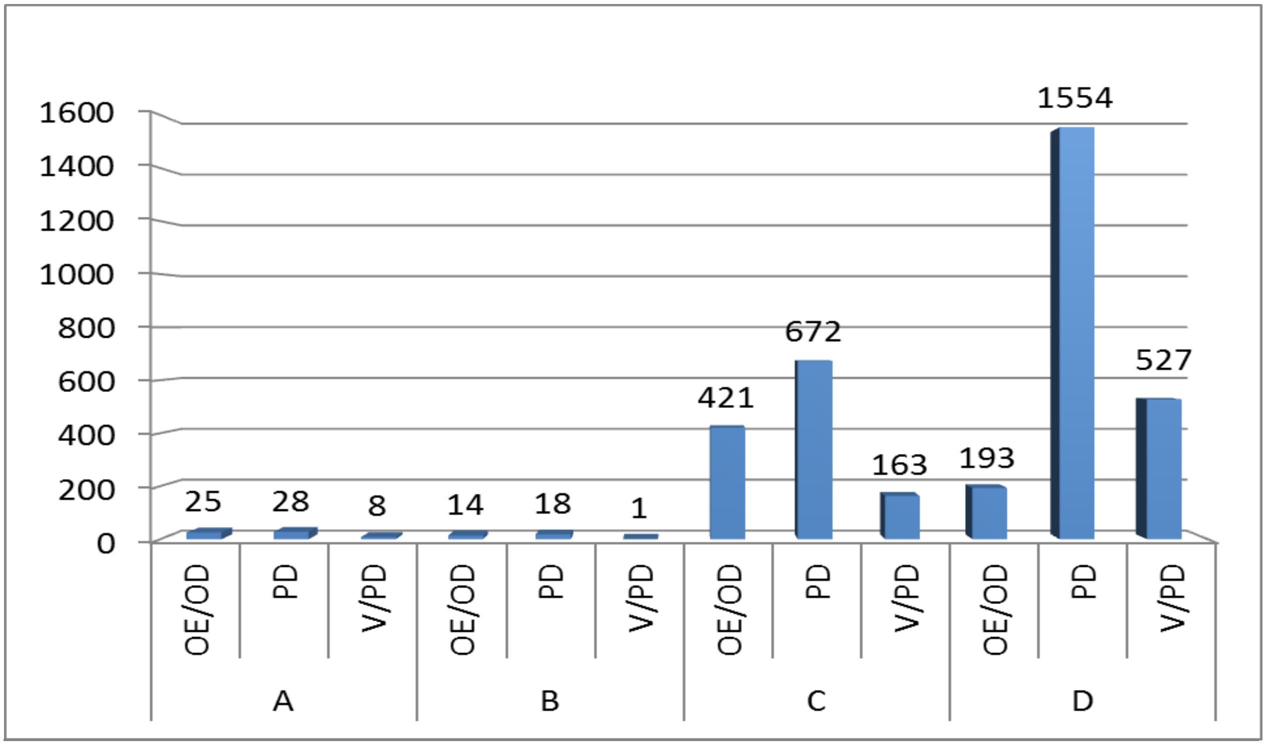


Figure 1. Runway Incursions by Year

It should be noted that a single event at Charlotte/Douglas International Airport (CLT), Charlotte, North Carolina, resulted in 157 runway incursions on August 25, 2011. The total number of runway incursions for FY 2011 would have been 16% lower if this event had not occurred or if corrective action had been taken sooner. After this analysis was completed, the FAA ultimately reclassified this event as a nonevent in the Runway Incursion Database. This event occurred during a 3-hour, 40-minute timeframe that resulted in 157 arrival/departure operations while a Canadair Regional Jet 900 (CRJ9) was over the hold line on Taxiway W7. The CRJ9 was taxiing to Runway 18R when another aircraft advised the CRJ9's flight crew that its left main gear tires were low, and it appeared the tires were tracking rubber while taxiing out. The CRJ9 pilot requested to taxi somewhere to evaluate the tires. The local controller instructed the CRJ9 to turn left on Runway 18R, left on Taxiway W7, and hold short of Taxiway Whiskey. A subsequent runway inspection found no debris. Before releasing a departure, the local controller asked an airport vehicle to verify that both the airport vehicle and the CRJ9 were clear of the runway. The airport vehicle operator reported the vehicle was clear of the runway and that the CRJ9's main landing gear was off the runway. An Airbus A321 was cleared for takeoff on Runway 18R. Approximately 3 hours and 40 minutes later, a departing A320 advised the local controller that the CRJ9 was over the hold-short line on Taxiway W7. Another airport vehicle operator then confirmed that the tail of the CRJ9 was approximately 3 to 5 feet over the hold line on Taxiway W7. Airport surface detection equipment (ASDE) analysis based on the aircraft's length of 119 feet placed the aircraft tail anywhere from 5 to 10 feet over the hold line. The closest horizontal proximity reported between the position of the CRJ9 and a landing or departing aircraft was 262 feet.

Figure 2 shows the PDs in Category D are the most prevalent type of runway incursion. Although Category C and D incursions are far more common than other incursions, the safety implications are less severe than Category A and B incursions. There have been 94 Category A and B incursions from 2006 through November 2010.



(OE/OD = Operational error/deviation, PD = Pilot deviation, and V/PD = Vehicle/pedestrian deviation)[1]

Figure 2. Runway Incursions by Category and Occurrence Type

Figure 3 shows that the number of Category A runway incursions has decreased steadily since 2006, with only two Category A incursions in 2010. The number of Category B runway incursions has decreased since 2008. In 2008, the number of Category C and D runway incursions increased because of the stricter ICAO definition; however, occurrences in those categories remained relatively constant from 2008 through 2010.

[1] See appendix A for detailed definitions of these occurrences.

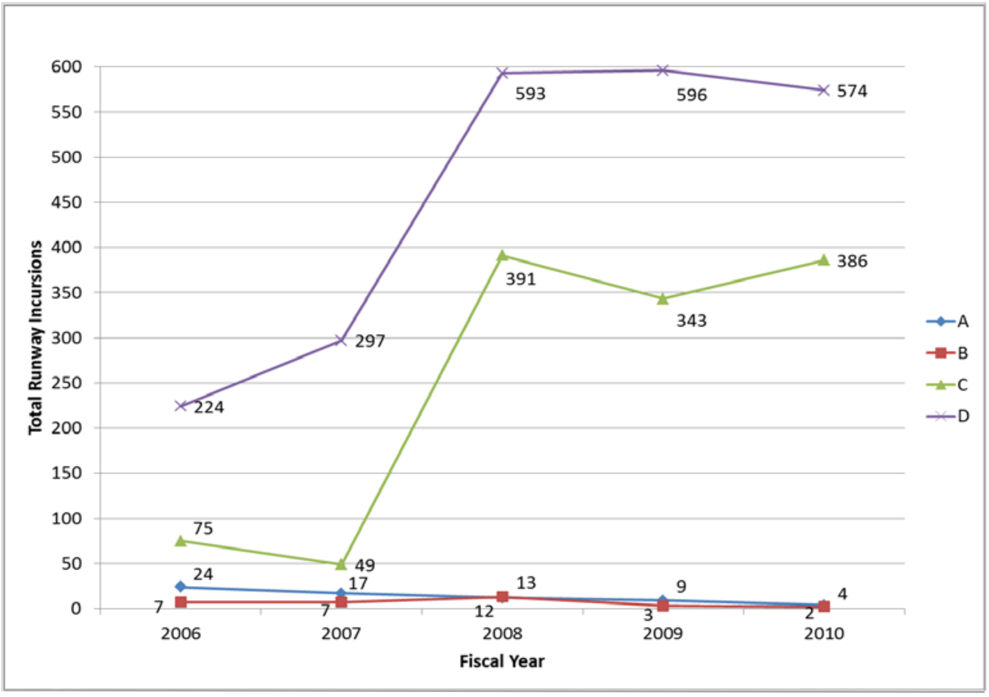


Figure 3. Runway Incursions by Severity Category

Figure 4 shows PDs are the most common type of runway incursions. All runway incursion types have remained relatively steady from 2008 to 2010.

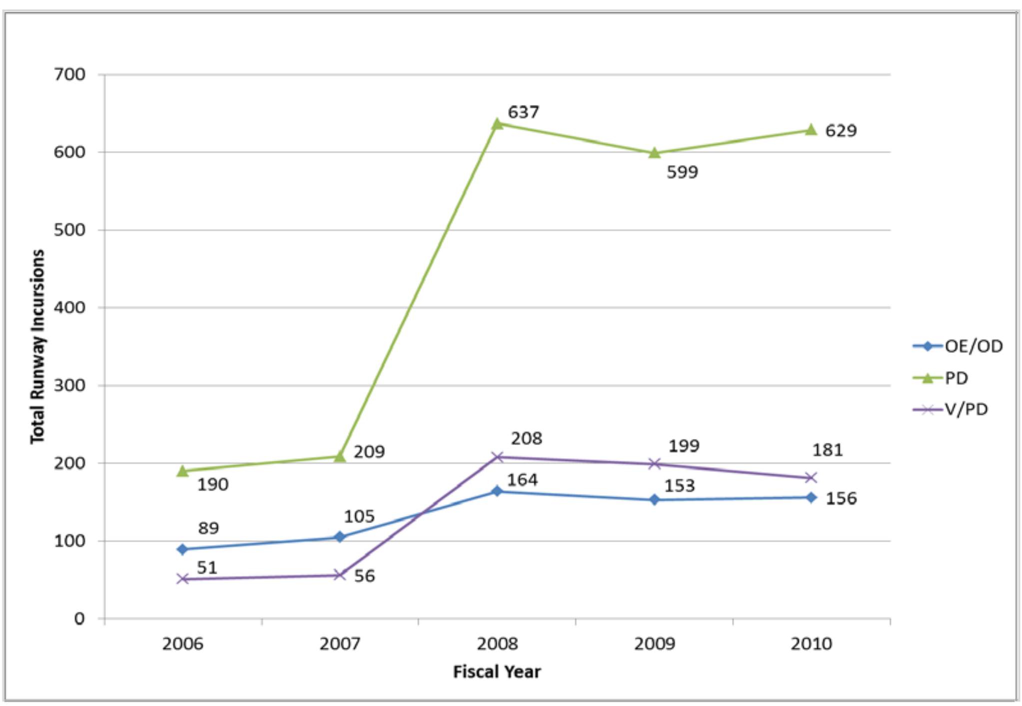


Figure 4. Runway Incursions by Occurrence Type

Figure 5 shows PDs occurring in daytime visual meteorological conditions (VMC) are the most common. The highest number of OE/OD and V/PD runway incursions occurred during daytime VMC as well. Because not all incursion reports identified the time of day, the time of day in many reports was categorized as unknown.

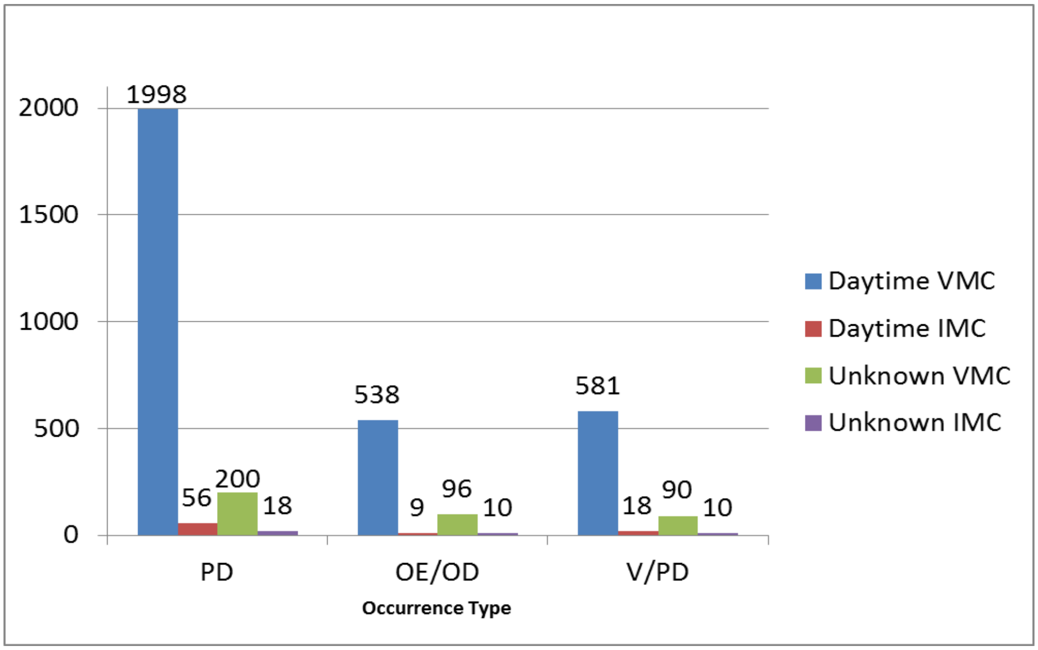


Figure 5. Runway Incursions by Occurrence Type and Weather Conditions

An analysis of each runway incursion location revealed that out of 4426 incursions, 648 events were taxiway incursions. Of the 648 taxiway incursions, 244 were caused by vehicles and 56 were caused by pedestrians.

Table 4 shows the sources for the 648 taxiway incursion events.

Table 4. Sources of Reported Taxiway Incursion Events

Source	No. of Events
FAA Runway Incursion Database	550
NASA ASRS	31
NTSB Accident/Incident Database	61
ATQA (PD)	3
ATQA (OE)	0
ATQA (V/PD)	3

Figure 6 shows the taxiway incursion rate has remained relatively steady since 2007, with a slightly increasing trend for 2010. It should be noted the number of taxiway incursions is incomplete for 2011, as the scope of this review ended on September 30, 2011. The number of taxiway incursions is much lower than the number of runway incursions. Taxiway incursions may likely be underreported because many of the wrong turns common on taxiways cause no conflict with other aircraft or vehicles.

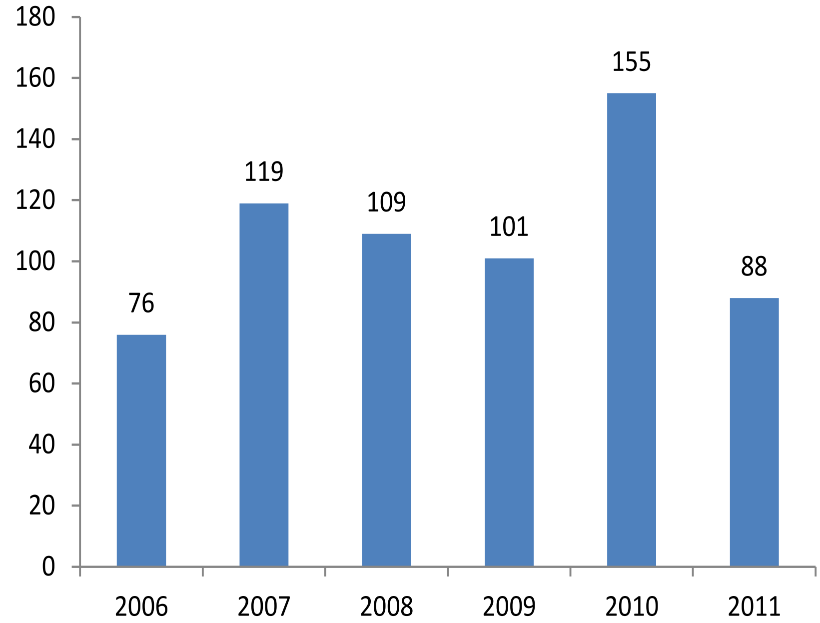


Figure 6. Taxiway Incursions by Year

Although runway/taxiway incursions are the most frequently occurring of all retrieved events, very few have resulted in an incident or accident, as defined by the NTSB. Of the 4426 runway incursion events reviewed, one resulted in an accident and 14 resulted in incidents. The one runway incursion event that resulted in an accident is summarized below.

On January 29, 2011, at Southeast Iowa Regional Airport, Burlington, Iowa, a Model 1 biplane landed while a Zodiac aircraft was still on the runway. The pilot of the Zodiac made radio calls when he was 10 and 5 miles from the airport, and on short final approach for landing. After landing approximately 90 feet from the taxiway turnoff, the Zodiac was hit from the rear by the Model 1 biplane's propeller. The pilot of the Model 1, who was in the rear seat of the aircraft during the flight, reported that he did not see the Zodiac prior to landing or while taxiing. The Model 1 was not equipped with either an installed or hand-held radio. The horizontal and vertical stabilizers of the Zodiac were destroyed by the propeller strike from the Model 1. The Model 1 received minor damage to the engine cowl.

Of the 648 taxiway incursions reviewed, 8 resulted in accidents, and 1 resulted in an incident. No injuries or fatalities resulting from a runway/taxiway incursion were recorded in this review.

The following are examples of the most severe runway/taxiway incursions.

- At Teterboro Airport (TEB), Teterboro, New Jersey, on June 17, 2007, a Piaggio P180 was cleared for takeoff on Runway 24 under instrument flight rules departure. Forty-nine seconds later, a Cirrus SR22 was cleared for takeoff on intersecting Runway 19 under visual flight rules departure. The flight crew of the P180 saw the SR22 on departure roll and applied maximum braking, blowing a tire on the main landing gear as the SR22 rolled through the intersection 50 feet in front of the P180. The P180 stopped in the intersection. The local controller stated that he did not see the incursion, so no clearances were cancelled.

- At San Francisco International Airport (SFO), San Francisco, California, on May 26, 2007, at 1336 Pacific daylight time, aircraft 1, an Embraer 170 regional jet, and aircraft 2, an Embraer Brasilia turboprop, nearly collided in the intersection of Runway 1L and Runway 28R. The local controller cleared aircraft 2 to land on Runway 28R. According to Northern California terminal radar data, aircraft 2 crossed the runway threshold at 1335:13. Aircraft 1 taxied to Runway 1L, was instructed to taxi onto the runway to hold at 1333:36, and was cleared for takeoff at 1335:12. The crew acknowledged the instruction. At 1335:40, an aural Airport Movement Area Safety System warning was activated. At 1335:44, the local controller instructed aircraft 2 to stop, transmitting, "aircraft 2 HOLD HOLD HOLD." According to controllers' written statements, aircraft 2 stopped in the intersection of Runways 1L and 28R. Aircraft 1 lifted off and overflew aircraft 2. The initial FAA tower report estimated the aircraft missed a collision by 300 feet. However, the aircraft 2 flight crew estimated the distance was between 30 and 50 feet, and the aircraft 1 flight crew estimated that it was 150 feet. The NTSB determined the incident was caused by the SFO tower controller's failure to provide adequate separation between two aircraft departing intersecting runways.

- At General Mitchell International Airport (MKE), Milwaukee, Wisconsin, on January 24, 2007, a Beechcraft 99 and a Cessna 402 were damaged substantially in a ground collision that occurred during nighttime taxi operations. After landing, both pilots followed the controllers' instructions to proceed to the same cargo ramp using intersecting taxiways. Neither controller advised either pilot that other aircraft would be approaching the same taxiway intersection. Neither pilot reported seeing the other aircraft approach the taxiway intersection. The Cessna 402 landed on Runway 25R and was instructed to taxi to the cargo ramp via Golf, Bravo, and Alpha taxiways. The Beechcraft 99 landed on Runway 25L. The Beechcraft 99 pilot was instructed to turn right at Taxiway A2 (high-speed taxiway), monitor ground on frequency 121.8, and taxi to the cargo ramp. The local controller reported he scanned Taxiway A and the runway, and saw the Beechcraft 99 clear of the runway. As the Beechcraft 99 prepared to turn off Taxiway A2 onto Taxiway A, the Cessna 402 approached the intersection of Taxiway A and Taxiway A2. The Beechcraft 99's right propeller impacted the Cessna 402's left wing tip fuel tank, causing a fire. Both pilots evacuated their aircraft. The accident was caused by the pilots' failure to adequately scan for and avoid other aircraft traffic during taxi operations, and the failure of ATC to issue a traffic advisory to the pilots. Nighttime light conditions contributed to the accident.

7. RUNWAY/TAXIWAY EXCURSIONS.

There were 244 events that were categorized as runway excursions. Of these, 2 resulted in fatalities, 19 resulted in injuries, 203 were classified as accidents by the NTSB, and 232 resulted in aircraft damage. In some events, contributing airport design factors were noted.

There were 37 events that were categorized as taxiway excursions. None of those events resulted in injuries, one resulted in substantial aircraft damage, one resulted in minor aircraft damage, and two resulted in airport damage.

Table 5 shows the sources of the 244 runway excursion events for this review.

Table 5. Sources of Reported Runway Excursion Events

Source	No. of Events
FAA Runway Incursion Database	6
NASA ASRS	21
NTSB Accident/Incident Database	217
ATQA (PD)	0
ATQA (OE)	0
ATQA (V/PD)	0

Table 6 shows the sources of the 37 taxiway excursion events for this review.

Table 6. Sources of Reported Taxiway Excursion Events

Source	No. of Events
FAA Runway Incursion Database	2
NASA ASRS	26
NTSB Accident/Incident Database	9
ATQA (PD)	0
ATQA (OE)	0
ATQA (V/PD)	0

The following are examples of runway excursions, with possible contributing airport design factors in italics.

- At Fairbanks International Airport (FAI), Fairbanks, Alaska, on August 1, 2008, an aircraft was on Runway 19L on short final approach. At the same time, vehicles on Ski Strip 19, which is located to the northeast, were leaving the ski strip heading southwest along the surface and proceeded into the unmarked safety area of Runway 19L (which is made of the same material as the ski strip surface). The vehicles were instructed to hold their positions while the local controller sent the aircraft around. The report states that *the lack of runway safety area demarcation has been an ongoing issue on the airfield*.

- At FAI, on May 28, 2010, a Cessna 150 landed on Ski Strip 20 and, on rollout, was instructed to turn right at taxiway Uniform at the end of the ski strip. The pilot acknowledged *and then continued to taxi straight ahead onto the safety area at the end of the ski strip and into the approach end of Runway 20L*.

The following events, while clearly caused by pilot error or aircraft mechanical failure, demonstrate how items in close proximity to runways, although they may be in compliance with FAA regulations, can make a surface event worse. Although some obstructions in these examples may have been outside runway safety areas or runway protection zones, they exemplify the need to keep the runway environment as clear as possible.

- At Coeur d'Alene Airport (COE), Hayden, Idaho, on December 2, 2007, an aircraft was landing at night on a runway contaminated with 2.5 inches of slush and hindered by a 60° left crosswind at 16 knots, gusting to 22 knots. After the aircraft touched down, it immediately began to hydroplane to the right. *The pilot attempted to correct by adding power to the right engine to regain directional control; however, the nose landing gear struck a concrete pad, which was supporting a lighted runway sign.* The landing gear separated from the aircraft and struck the leading edge of the left wing, which created an indentation and hole. The nose landing gear wheel well was structurally deformed and required a major repair to rectify. Prior to landing, a vehicle had tested the runway's braking action, and the pilot was informed that it was "Poor."

- At Westchester County Airport (HPN), Rye Brook, New York, on October 21, 2009, a pilot reported that while approaching the airport during night conditions, ATC advised him to expect to use Runway 29. From his approach chart, the pilot noted the runway was more than 4400 feet long, but he learned after the accident that it had a displaced threshold, reducing the available landing space to 3164 feet. The pilot elected to land with no flaps; on final approach, the controller advised him to expedite through the intersection of Runways 11/29 and 16/34. The aircraft touched down past the runway intersection, which, at the center, has approximately 2854 feet of runway remaining to the departure end of Runway 29.

  In a statement to the FAA inspector, a pilot-certificated passenger estimated the aircraft's speed to the runway was 110 knots. *The pilot further stated that after touchdown, he was unable to stop the aircraft. It traveled off the end of the runway, down an embankment, onto a service road, and collapsed the nose landing gear*. The pilot reported no pre-impact malfunctions. The pilot's failure to attain the proper touchdown point caused the accident and resulted in a landing overrun. The pilot used excessive airspeed in an attempt to comply with ATC's request to expedite his landing, which contributed to the accident.

- At Tampa International Airport (TPA), Tampa, Florida, on February 16, 2006, a pilot landed on Runway 18L. During the landing rollout, with brakes applied, the aircraft swerved to the right. The pilot corrected to the runway centerline with the rudder. He reapplied brakes and the aircraft swerved to the right again. The pilot corrected back to the runway centerline and applied the brakes for a third time. Again, the aircraft swerved to the right and the pilot applied the emergency brake. *The aircraft departed the right side of the runway and struck the concrete pad of a runway marker sign.* An FAA inspector reported finding hydraulic fluid covering the left main landing gear. He said the main and auxiliary left brake lines were both fractured, and the right main landing gear tire was "shredded off the wheel." According to the report, the brake line transmits hydraulic fluid and the auxiliary brake line transmits compressed nitrogen. Both brake line fractures were caused by fatigue cracking. No mechanical or other damage was evident on the exterior of the brake line in the initiation area. Maintenance records dating back to the aircraft's date of manufacture revealed that the brake lines had never been removed or replaced. Although not the main cause, *the airport sign's concrete pad was a contributing factor in this accident*.

8. WRONG RUNWAY/TAXIWAY EVENTS.

Wrong runway/taxiway events included aircraft landing or taking off on an incorrect runway, or on a taxiway. A total of 372 events were identified, of which 145 involved an aircraft landing on the wrong runway, and 71 involved takeoffs from the wrong runway. It was noted that many of the wrong runway takeoffs occurred when an aircraft was cleared for takeoff from a taxiway intersection, and the aircraft departed in the wrong direction or from a point where two runways intersected. One event reported a vehicle present on the wrong runway.

There were 116 landings on taxiways and 39 takeoffs from taxiways. Many of these events were taken to full landings or takeoffs, although a few resulted in touch-and-go landings during the go-around phase or aborted takeoffs after the error was noted by ATC.

Table 7 lists the sources of the 372 wrong runway/taxiway events.

Table 7. Sources of Reported Wrong Runway/Taxiway Events

Sources	No. of Events
FAA Runway Incursion Database	295
NASA ASRS	61
NTSB Accident/Incident Database	6
ATQA (PD)	6
ATQA (OE)	4
ATQA (V/PD)	0

9. ACCIDENTS/INCIDENTS.

A total of 823 events were categorized as accidents or incidents as defined by the NTSB [1]; of the 823, 727 were accidents and 96 were incidents. All but one accident was retrieved from the NTSB Accident/Incident Database.

Of the 727 accidents, fatalities occurred in 41 and injuries in 81; two accidents reported both fatalities and injuries. Aircraft damage was reported in 719 accidents; 98 of which reported substantial aircraft damage. Of the 727 accidents, 49 occurred in nonmovement areas (which are areas not controlled by ATC) of the airport. Of the total accidents, 463 (about 64%) occurred during the landing phase. The remainder occurred during ground operations, go-around, and takeoff phases.

For the 96 aircraft incidents, injuries occurred in 2 incidents and aircraft damage in 58. Of the total incidents, nine occurred in the nonmovement areas of the airport. Incidents during the landing phase occurred 53 times (55%). The majority of the remaining incidents occurred during ground operations.

Table 8 lists the sources for the 823 accidents/incidents.

Table 8. Sources for the Reported Accident/Incident Events

Sources	No. of Events
FAA Runway Incursion Database	1
NASA ASRS	0
NTSB Accident/Incident Database	822
ATQA (PD)	0
ATQA (OE)	0
ATQA (V/PD)	0

Examples of accidents and incidents where airport design factors may have contributed, primarily due to obstructions in relatively close proximity to runways, are listed below. Events were highlighted in which aircraft in the takeoff or landing phase collided with an obstruction after experiencing a mechanical failure or while operating at a lower than authorized altitude. Because almost all fatalities occurred during the takeoff or landing phase, it was determined that there was no justification to reduce the runway protection zones at airports. Although accidents are rare, it is important to have as clear an area as possible around airports to protect persons and property on the ground, increase the chances of survival for aircraft occupants, and minimize aircraft damage. Based on the limited information available from the reports, possible contributing airport design factors are in italics.

- At Portland International Airport (PDX), Portland, Oregon, on February 16, 2008, before initiating an instrument landing system (ILS) approach to Runway 10R, the controller advised the pilot that the runway visual range (RVR) was 600 feet, then cleared the aircraft for landing. Two minutes later, the pilot declared a missed approach and was given radar vectors for a second ILS approach. After turning inbound on the localizer, the pilot was advised that the RVR was 600 feet, midfield was 800 feet, and rollout was 800 feet. The pilot was then cleared to land. When the controller observed the aircraft turning to the south of the runway on the radar display, she issued missed approach instructions, which were followed by an inaudible transmission from the pilot. There were no further transmissions from the pilot. *The aircraft impacted the top of an 85-foot* *tree with its right wingtip, 3200 feet southeast of the approach end of the runway, and then continued about 845 feet from the initial impact point with the tree before impacting the ground.* The aircraft was subsequently consumed by fire. The weather minimums for the approach required a ceiling of 200 feet and an RVR of 1800 feet, or one-half mile; the decision altitude was 224 feet mean sea level. The FAA-published missed approach procedure instructed the pilot to climb to 900 feet, perform a climbing right turn to 4000 feet, intercept the 160° radial of the very high frequency (VHF) omnidirectional range (VOR), and proceed to a distance-measuring equipment fix and hold. The aircraft's turn to the southeast was consistent with the missed approach course of 160°; however, a climb to 900 feet is required prior to commencing the right turn, as outlined on the approach plate's missed approach instructions. *It appears the pilot likely misinterpreted the missed approach instructions by making the right-hand turn prior to initiating a climb to 900 feet, which resulted in the subsequent impact with the tree.* No pre-impact anomalies were found during an examination of the airframe and engine. The aircraft's avionics components revealed that they were too damaged by the force of impact and postcrash fire to provide any data. No anomalies were found during a postaccident examination of ILS components.

- At Columbus Metropolitan Airport (CSG), Columbus, Georgia, on July 19, 2009, about 1815 eastern daylight time, an amateur-built Rutan VariEze *was substantially damaged when it collided with buildings and a tractor after takeoff.* The certificated commercial pilot was fatally injured. VMC prevailed[2]. No flight plan was filed for the local personal flight, which was conducted under 14 CFR Part 91 that governs small, noncommercial aircraft. According to witness statements, the pilot was practicing takeoffs and landings (touch-and-go landings) on Runway 31. Just prior to the accident, the aircraft was observed to touchdown and takeoff. According to preliminary information provided by the report, *moments later the pilot of the accident aircraft radioed that he "had a problem." The aircraft then "veered to the right," "clipped a hangar," "skipped" off the top of a shed, and then impacted an unoccupied tractor and broke apart*.

10. OTHER OCCURRENCES.

The majority of reports retrieved from the FAA ATQA Database were duplicates of events captured in the Runway Incursion Database. After filtering the duplicate reports and applying a filter in the data pull to exclude PD, OE/OD, and V/PD events involving a runway incursion, many of these reports still pertained to a runway incursion event. To eliminate duplicates, additional filters were applied in the postcategorization process to remove runway/taxiway incursions and wrong runway/taxiway events. After filtering, only 13 events remained, 10 of which involved operations on closed runways or at a closed airport, and the remaining 3 pertained to miscellaneous ATC or pilot errors.

[2] Weather conditions in which visual flight rules apply; expressed in terms of visibility, ceiling height, and aircraft clearance from clouds along the path of flight. When these criteria do not exist, instrument meteorological conditions prevail and instrument flight rules must be used.

There were 132 NASA ASRS events involving no occurrence (i.e., the submission was a nonobjective observation of a safety hazard that could cause an incident), and 120 events were categorized as "other occurrences." Other occurrences included topics such as ground personnel and airport chart issues.

10.1 FOREIGN OBJECT DEBRIS EVENTS.

Fifteen foreign object debris (FOD) events were retrieved from the ASRS, NTSB, and Runway Incursion Databases for the period from January 1, 2006 to September 20, 2011. Of these, four resulted in minor aircraft damage, and two resulted in substantial damage. The data examined from the SDRS database showed 103 reports were identified with an FOD-related maintenance issue, five reports pertained to wildlife strikes, and one record detailed a collision between a jetway and an airstair door. Based on the relatively small number of events, the analysts were unable to identify any particular airport design factors that contributed to FOD events. The SDRS does not contain airport data, so these events could not be filtered against the airport list. However, one report showed that blowing dust could pose a large problem. At the time of this event, Denver International Airport (DEN), Denver, Colorado, had a runway construction project underway on the west side of the airport. DEN also places sand on its taxiways during winter weather events, which possibly contributed to this event. Although a conclusive cause has not yet been determined, this event is a reminder that dust control is a necessary part of airport operations. It is important to note that FOD is sometimes regarded as normal and may go unreported.

- At DEN, on February 16, 2007, an aircraft departed and was making a turn to a heading of 270° when the flight crew noticed the first officer's windscreen cracking and beginning to arc. The captain alerted ATC that the aircraft was returning to the airport, and then noticed that his windscreen was also cracking, but not arcing. The first officer's windscreen stopped arcing and the flight crew landed the aircraft without further incident. During the course of the afternoon, 14 aircraft experienced 26 fractured windscreens. Flight crew members of one aircraft reported that during the landing roll, they "heard a loud thump" and observed a "spider web" crack on the first officer's window. They did not see anything impact the windscreen. Another flight crew member reported taxiing through "dirt and dust being blown around." An examination revealed that the impact markings on all 26 windscreens were the result of FOD. No pre-impact anomalies were noted with any of the windscreens. Winds at the time of the event were reported as 280° to 030°, with sustained winds between 28 and 36 knots. Wind gusts as high as 44 knots were recorded.

10.2 SIGNAGE/CONSTRUCTION/NOTICE TO AIRMAN ISSUES.

The developers of the Microsoft® Access® database used for this report, in consultation with senior aviation analysts, created checkboxes for common airport issues so additional statistics could be gathered while reviewing the events from the various databases.

Although these factors may not have directly caused an event, the analysts checked boxes where the issues were mentioned in the narrative of the event. Table 9 shows the issues and the number of events in which they were mentioned in the narrative.

Table 9. Common Airport Issues Noted in the Report Narrative

Issues Noted	No. of Events
Airport signage and/or surface markings	299
Construction	113
Notice to Airmen issue	54

These issues appeared in all of the queried databases, but most came from those with reporter narratives, such as NASA ASRS. Almost all reports citing signage or surface markings came from ASRS reports, and many of these were in the "no occurrence" category, in which the reporter observed how confusing signage or surface markings could lead to an event. Construction often indirectly contributed to events by causing taxiway and/or runway closures that required the use of different taxi routes and temporary surface markings. Construction vehicles were also involved in a number of runway/taxiway incursions. Issues typically cited with the Notice to Airmen were the confusing wording and/or format, or difficulty finding a particular notice for an airport.

Examples of airport signage and/or surface marking issues are summarized below.

- At Paine Field Airport (PAE), Everett, Washington, on August 21, 2009, a pilot of a conventional landing gear aircraft began to taxi between two rows of hangars. As he approached the east-west taxiway at the end of the rows, he stopped to contact ground control and look at the windsock. After several minutes, ground control cleared him to taxi to Runway 16L. The pilot taxied toward the east-west taxiway and was about to start making S-turns to look for obstacles. After traveling 40 to 60 feet, the propeller, right wing, and right landing gear contacted poles surrounding a fire hydrant. The right wing sustained substantial damage. The pilot noted that the aircraft had conventional landing gear, and he could not see the hydrant or surrounding poles over its nose. He also indicated that there was no taxi stripe between the hangars to the east-west taxiway that would lead a pilot away from the poles.

- At Florida Keys Marathon Airport (MTH), Marathon, Florida, on April 1, 2010, while taxiing into position on Runway 07, a flight crew member mistook faded runway markings for a usable taxi surface. When the aircraft entered the area, the flight crew realized the surface markings were actually yellow chevrons that designated the area as an unusable surface. The flight crew quickly applied power and rolled off the surface, then initiated the takeoff roll. The surface was marred with tire markings from other aircraft, which led to further confusion. The reporter stated that, while entering Runway 07 at the approach end, it appeared that the runway extended farther to the west, so the pilot made a left turn to use the runway's full length.

Examples of construction issues are summarized below.

- At Boise Airport (BOI), Boise, Idaho, on October 5, 2006, a pilot reported that he was taxiing to the hangar with the aircraft's nose wheel on the centerline of the taxiway. The aircraft's left wing struck a temporary construction fence that had been moved onto the edge of the taxiway. The left wing leading edge was damaged approximately 6 feet in from the wingtip and the left aileron was separated from the wing. A contributing factor was the temporary construction fence next to the taxiway.

- At LaGuardia Airport (LGA), Flushing, New York, on June 8, 2006, an aircraft was damaged when a piece of aluminum diamond plate material became airborne and struck the tail of the aircraft while it was taxiing for takeoff. An FAA examination revealed that the plate had been left by workers performing maintenance on the taxiway. The plate was being used to cover the maintenance area on the taxiway. According to the FAA, the plate should have been made from thicker, heavier steel, which would have prevented it from being affected by the jet blast from taxiing aircraft. The FAA and airport authority provided guidance to the construction company regarding the use of such plates.

10.3 SNOW REMOVAL.

Several events were noted in which an aircraft struck snow drifts or snow banks left after snow removal operations. For example, at Santa Fe Municipal Airport (SAF), Santa Fe, New Mexico, on December 23, 2008, a pilot was performing a night visual landing to Runway 20. He stated that this was the only runway available for night landings. During the approach, winds were 290° at 25 knots, gusting to 35 knots. After touchdown, the aircraft veered to the right and impacted a snow drift beside the runway. The maximum demonstrated crosswind velocity for this aircraft was 21 knots. Examination of the aircraft revealed that both wing spars were bent.

10.4 ENGINEERED MATERIAL ARRESTOR SYSTEM EVENTS.

Engineered Materials Arresting System (EMAS) beds are comprised of crushable concrete and located at the ends of runways. EMAS beds are intended to stop aircraft that have overshot a runway when there is an insufficient space for a standard runway safety area. Although EMAS is an effective system for mitigating runway overruns, pilots can mistake it for concrete and inadvertently enter the EMAS area.

- At Chicago O'Hare International Airport (ORD), Chicago, Illinois, on July 1, 2008, during an approach to Runway 4R, pilots were unaware that the runway was wet. During touchdown, the first officer applied maximum reverse and maximum braking with the antiskid, re-elevating pressure asymmetrically until the aircraft completely stopped at the end of the runway. Once the pilot had set the brakes, the tower controller asked if the aircraft needed any assistance. The pilot responded that he would move forward to make a 180° turn. *When applying thrust for the maneuver, the aircraft taxied into the newly constructed EMAS and the nose wheel became stuck in the collapsed concrete. The* *commercial chart gives no information on ORD's EMAS, and there are no markings at the end of Runway 4R for the EMAS.*

- At Laredo International Airport (LRD), Laredo, Texas, on August 1, 2010, an aircraft landed and rolled to the end of the runway to exit on the last taxiway (Foxtrot). Because of construction at the airport, the lighting on taxiways was very poor and inconsistent. In addition, there were no identifier lights installed at the end of the runway. After bringing the aircraft to a full stop, the flight crew realized they had passed the last taxiway. Then the pilot started a left turn to taxi back to Taxiway Foxtrot. *During the left turn, the aircraft's nose tire and right main wheels entered the EMAS. The left main wheels remained on runway surface. The flight crew called a wrecker service to safely pull the aircraft out of the EMAS area. The EMAS is painted gray and looks like concrete or asphalt, and no markings were present to indicate the start of the EMAS.*

10.5 RAMP EVENTS.

There were 158 events that occurred in nonmovement areas, most involving aircraft damage from contact with a vehicle or another aircraft. The overwhelming majority of ramp events are attributed to human factors, with collisions resulting from pilots' or ground personnel's failure to maintain an adequate lookout. Some ground collisions resulted from equipment parked outside of designated safety areas, and unsecured ground equipment that came into contact with aircraft. Examples of ground damage to aircraft are summarized below.

- At Boston Logan International Airport (BOS), Boston, Massachusetts, on May 12, 2006, a flight crew was waiting to be pushed back from the gate when a tug impacted the aircraft's left wing. The aircraft was parked with its engines off. The tug driver was bringing luggage to a different aircraft and did not see the impacted aircraft until the collision. At the time of the event, there was fog at the airport with a reported visibility of 1/4 mile.

- At Dallas Love Field Airport (DAL), Dallas, Texas, on March 1, 2008, an aircraft was taxiing to a terminal gate, using the taxiway centerline as it passed a stationary aircraft that had completed a pushback from a terminal gate. The taxiing ATP perceived the distance between the two aircraft as adequate to continue to the terminal gate; however, the left winglet from the taxiing aircraft struck the right horizontal stabilizer of the stationary aircraft. The top portion of the winglet sheared off and became embedded in the horizontal stabilizer of the stationary aircraft, resulting in minor damage to both aircraft. The taxiing flight crew's failure to maintain adequate clearance from the stationary aircraft caused the incident.

- At Phoenix Sky Harbor International Airport (PHX), Phoenix, Arizona, on April 20, 2009, at 1738 hours mountain standard time, the right propeller of a de Havilland DHC-8-202 struck a ground power unit (GPU) while taxiing. There were no injuries to the flight crew, passengers, or to anyone on the ground. The aircraft sustained structural damage to the right wing, engine, and fuselage, along with damage to the left engine's propeller blades. According to PHX airport operations personnel, the aircraft was being ground-marshaled to the gate, aided by a marshaller and wing walkers. As the aircraft reached its final stopping point, the right propeller struck the GPU. FAA inspectors reported that the GPU was approximately 7 feet aft of its required parking.

- At ORD, on June 27, 2007, ATC gave a McDonnell Douglas MD 83 clearance to park in a hold pad. ATC gave a Boeing B-777-222 similar instructions. Rain and a microburst reportedly obscured visibility during taxiing. The Runway 9R hold pad chart advised that "pilots exercise caution taxiing past hold pad with parked aircraft—maintain centerline. Entire aircraft must be contained inside pad boundary line/lights." The B-777-222's captain stated that he maintained the taxiway centerline while taxiing. The B-777-222's flight crew used flight handbook reference points to remain clear of the parked aircraft. However, the B-777-222's right wing impacted the MD 83's rudder. Wreckage patterns on the ground indicated the MD 83 was not fully parked within the hold pad. An ATC representative reported that ATC had received no guidance from the airport certificate holder on the entry and exit of aircraft on the Runway 9R hold pad. The area encircling the hold pad was marked as taxiway. Taxiway Mike borders the south area of the Runway 9R hold pad, and Taxiway Kilo borders the north area of the Runway 9R hold pad. The accident was caused by the B-777-222 flight crew's failure to maintain clearance from the parked/standing MD 83, as well as the airport's failure to coordinate the taxi chart instructions with ATC. The MD 83's flight crew's failure to follow the taxi chart instructions to fully park within the pad contributed to the accident, as did the reduced visual lookout due to the weather.

- At Los Angeles International Airport (LAX) Los Angeles, California, on May 21, 2009, an Embraer EMB-135KL (aircraft 1) taxied into a parked and unoccupied Embraer EMB-135KL (aircraft 2) while leaving the terminal hub. There were no injuries to the flight crew, passengers, or anyone on the ground. According to the FAA inspector who responded to the accident, aircraft 1 had been pushed back from the gate via ground tow. Once disconnected from the tow bar, the captain of aircraft 2 taxied to the runway. As the captain maneuvered around parked aircraft 1, the left horizontal stabilizer of the taxiing aircraft struck the right horizontal stabilizer of aircraft 2. The FAA inspector further reported that aircraft 2 was improperly parked, with the right wing tip and horizontal stabilizer well outside the safety lines.

- At DEN, on January 19, 2006, an aircraft was parked at the remote deicing pad where a deicing truck with a boom was applying type 4 deicing fluid to the right rear quadrant and the right wing. The truck's boom was raised at the time. The driver maneuvered the vehicle too close to the right wing trailing edge at the aileron, resulting in the midsection of the boom coming in contact with the wing. The boom operator cleared the wing for movement when the boom was not actually clear. The aircraft and truck sustained minor damage. An operational inspection of the truck revealed no anomalies. The routine aviation weather report showed 1/2 statute miles visibility, light snow, and mist.

Table 10 lists the source databases for the nonmovement area events.

Table 10. Sources for Reported Nonmovement Area Events

Source	No. of Events
FAA Runway Incursion Database	10
NASA ASRS	66
NTSB Accident/Incident Database	78
SDRS	4

Within the 66 nonmovement area events retrieved from the NASA ASRS, there were 19 "no occurrence" events, which captured safety concerns within the nonmovement area.

11. IN-DEPTH ANALYSIS.

An in-depth analysis was conducted of airport surface events involving aircraft incidents and accidents (unrelated to landing), runway excursions, events deemed to be incidents and accidents occurring in nonmovement areas, and any events involving fatalities not captured in these categories. FOD events from the FAA Service Difficulty Report Database were also reviewed and categorized. The goal of this analysis was to determine if airport design factors contributed to the severity of these events.

Over 600 reports were reviewed. Of the 600 reports, 129 were retained for having possible links to airport design factors. Of the 129 events, 6 were omitted for not having any link to airport design factors. Of the remaining 123 events, 36 had contributing airport design factors.

No events were reported in which an airport design factor was the primary cause. However, a number of events were reported in which airport design factors contributed to the severity of the event, such as runway excursions that resulted in substantial aircraft damage after striking compliant concrete supports for runway signs. Airport design was considered a contributing factor for any event in which an aircraft struck an obstacle in relative proximity to a runway.

Runway and taxiway markings and lighting were the most frequently occurring contributing airport design factors. This includes misleading markings, the absence of lighting, and in one report, the presence of light-emitting diode (LED) lights at Albuquerque International Sunport Airport (ABQ), Albuquerque, New Mexico, that were too bright. Two of the 12 events that cited markings as the contributing airport design factor involved aircraft taxiing into an EMAS after mistaking the material for concrete and noting that it had no identifiable markings. Another report cited the lack of markings on the ski strip at FAI as causing runway excursions; and another cited a pilot at T.F. Green Airport (PVD), Warwick, Rhode Island, who became confused by bright runway edge lights and taxied off a runway into the grass.

The next most frequent contributing airport design factor reported was runway/taxiway signage. The runway/taxiway signage reports described a lack of signage, which led to confusion. In addition to markings, lighting, and signage, four reports cited incorrect airport diagrams. In the following example, the runway status lights (RWSL) were operating and a runway incursion still occurred at Dallas/Fort Worth International Airport (DFW), Dallas-Fort Worth, Texas.

On June 10, 2011, at DFW, a Boeing B-738 landed on Runway 35C and was instructed to hold short of Runway 35L at Taxiway EK. The pilot read back the hold short. An Embraer E145 was cleared for takeoff on Runway 35L full length. The B-738 pilot then reported entering Runway 35L at Taxiway EK, conflicting with the departing E145. The local controller cancelled the E145's takeoff clearance before the B-738 reported entering the runway. The E145 had rolled approximately 1200 feet and slowed within 1500 feet. The closest horizontal proximity reported was 6000 feet. The RWSLs were operating normally. This event met the parameters established within ASDE Model X to cause an alarm and an alert was received.

Table 11 shows a breakdown of the 36 events by contributing factors. (Note: multiple factors were applied on each event.)

Table 11. Events Categorized by Contributing Factor

Contributing Factor	No. of Events
Runway/taxiway markings/lighting	12
Runway/taxiway signage	6
Inaccurate/confusing airport diagram	5
Loss of aircraft control	5
Mechanical failure	4
Pilot confusion/distraction	4
Aircraft damage from striking airport sign/navigation aid/other	4
Physical condition of runway surface	4
Obstruction near runway	3
Failure to maintain clearance from object/aircraft	3
Runway contamination	2
Failure to follow checklist/Standard Operating Procedures	1
Lack of runway overrun area	1
Approach aid interference	1
Inaccurate braking action report	1
RWSL operative, resulted in runway incursion	1
Unsecured ground equipment	1

12. FINDINGS.

This section discusses the contributing factors discovered during the analysis that are related to airport design and/or overall airport safety.

12.1 EVENTS CAUSING INJURIES AND FATALITIES.

The FAA Office of Airports expressed interest in the types of events that cause injuries and fatalities at airports. Figure 7 shows the top six occurrence types that resulted in fatalities or injuries for the data collection period.

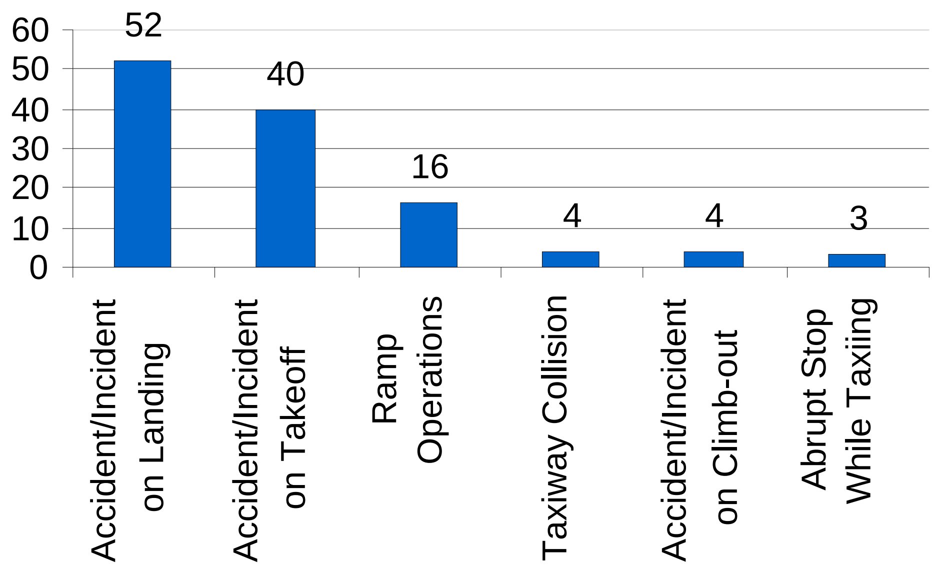


Figure 7. Number of Occurrences With Fatalities or Injuries

Figure 8 shows that the majority of fatalities and injuries occurred during accidents and incidents during the takeoff phase for the data collection period. The majority of these accidents and incidents were caused by a loss of aircraft control or mechanical failure.

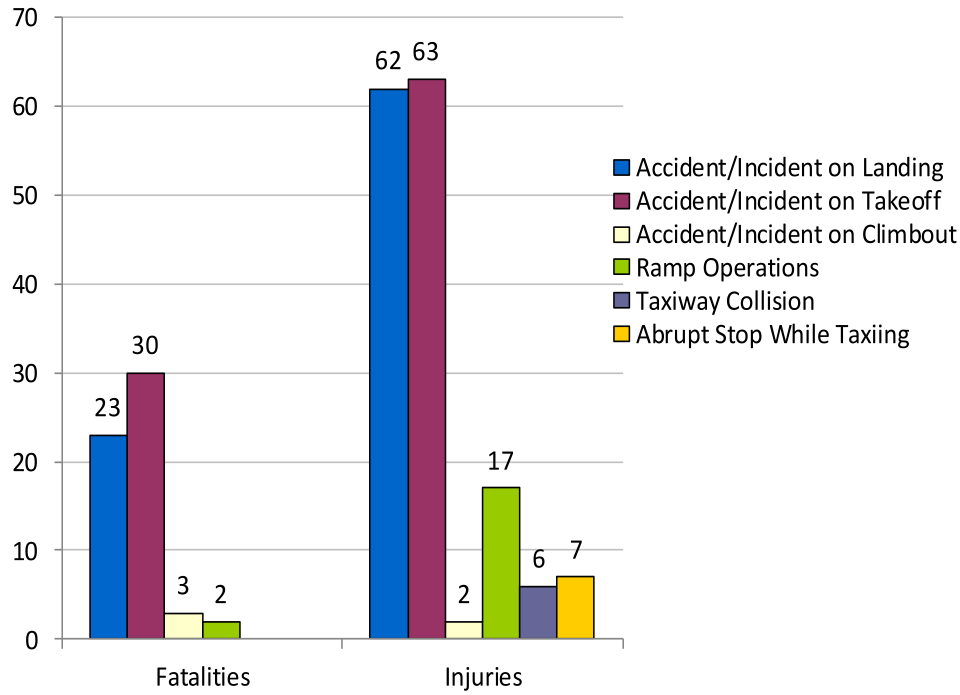


Figure 8. Fatalities and Injuries by Phase of Flight

<u>12.2 RUNWAY/TAXIWAY MARKINGS AND LIGHTING</u>.

The analysis showed that runway/taxiway markings and runway/taxiway lighting are contributing factors to events at airports. Many reports cited the lack of appropriate markings and lighting as contributing factors. For example, at ORD, on July 1, 2008, and at LRD, on August 1, 2008, an aircraft at each airport taxied onto the EMAS at the end of the runway because there were no runway end lights or markings indicating the runway end and the EMAS starting point at the time of incident. EMAS beds are now marked with chevrons, which delineate pavement that should not be used by aircraft. At the time of this writing, a research project is being conducted to determine if additional EMAS markings are needed. At FAI, there have been many runway excursions due to the lack of markings. It is common at FAI for aircraft to touchdown in the gravel area between the ski strip and Runway 1R, short of the threshold of Runway 01R; however, aircraft and vehicles often taxi off the end of Ski Strips 19 and 20 into the unmarked safety areas. The lack of markings contributes to the high number of incidents at FAI.

In some of the events reported, lighting was in place; however, it may have negatively contributed to the situation. For example, at PVD, on March 1, 2006, the runway lights were on high intensity, which diminished visual acuity; there were no illuminated pavement references, and the pilot became momentarily disoriented. The pilot mistook the edge marker lights on the runway for centerline lights and taxied off the runway. At ABQ on August 1, 2011, the pilot stated the runway, taxiway, and airfield lights were converted to LED lighting and the lights were not adequate for operations at night because they were too bright. The pilot stated the excessive brightness led to a lack of depth perception during the landing phase. It was determined that the presence of appropriate markings and lighting mitigates occurrences.

12.3 RUNWAY AND TAXIWAY INCURSIONS.

It was found that the largest portion of airport surface events involve runway and taxiway incursions, with runway incursions totaling 68% and taxiway incursions totaling 10% of the reports. Although information on the actual events is limited in the Runway Incursion Database, the spectrum of reports revealed that every type of pilot has been involved in these events, from first-time solo students to highly experienced ATP certificate holders. Vehicle operators involved in these incidents ranged from operators of unauthorized vehicles on the airports (who have little or no training on proper surface operations) to operators of airport operations vehicles and airport rescue and firefighting personnel. While some incursions resulted from an ATC error, such as a controller forgetting that an aircraft or vehicle was occupying a runway and then clearing another aircraft for takeoff or landing, the majority were caused by pilots and vehicle operators. In short, there was no evident target audience that would benefit from additional training, because all pilots and vehicle operators are at risk of an incursion, and the need for awareness training is evident.

Although none of the reports cited airport design factors, some airport design factors are known to contribute to the occurrence of runway incursions, and as such, runway incursion prevention strategies should be incorporated into airport design. These include closely spaced parallel runways with high-speed taxiway exits that lead directly to the parallel runway, angled runway/taxiway intersections, and two runways sharing a common threshold area (colloquially known as a “V” to airline pilots).

12.4 OTHER SURFACE EVENTS.

After runway and taxiway incursions, other surface events accounted for the second highest number of airport surface events in the reports at 13%. These surface events were categorized as “other” due to the wide variety of surface events. It was determined that a host of factors are present during airport surface events, such as flight crew distraction, confusing airport layout, poor surface markings, temporary surface markings during construction, confusing surface markings and signage, flight crew unfamiliar with the airport, nonpilot (mechanic) taxiing aircraft, a general lack of understanding or confusion with ground de-icing procedures, and emergency vehicles responding to an emergency or participating in an airport exercise. These events occurred across all databases and all 14 CFR operations. As with the runway and taxiway incursions, all pilots and vehicle operators are at risk of an incursion and could benefit from initial or recurrent training.

12.5 RUNWAY AND TAXIWAY EXCURSIONS.

The runway and taxiway excursion category was the least noteworthy, totaling 3% and 1% of reports, respectively. Taxiway excursions were found to cause little damage and no injuries. Runway excursions tended to be more serious, and in some cases were exacerbated by airport design factors, including concrete support pads (which meet current specifications) for runway signs, concrete culverts, and lack of overrun areas.

12.6 EVENTS AT SPECIFIC AIRPORTS.

A few common occurrences that may warrant the attention of the FAA were identified during this review period. They include

- landings on Taxiway Lima at Palm Beach International Airport (PBI), West Palm Beach, Florida. Some reports from the review period specifically called this out as an issue. Although additional mitigations had already been instituted by the airport authority, events were still being recorded in 2010.

- pedestrian incursions at Merrill Field Airport (MRI), in Anchorage, Alaska. The ATC tower has a loudspeaker system to issue verbal warnings to pedestrians, but a large number of taxiway and runway incursions by pedestrians still occurred.

- runway incursions (by way of crossings without clearance and unauthorized vehicle entry) on the ski strip at FAI. From the reports, this is a gravel strip that may not be apparent as a runway to aircraft and vehicle operators. Runway excursions are also prevalent on the ski strip.

12.7 RUNWAY PROTECTION ZONES.

In an effort to determine whether runway protection zones should be reduced, the analysis included events involving obstacles in relative proximity to the runway. A small number of accidents were identified, and in many cases, the aircraft involved experienced a mechanical failure or the pilot failed to adhere to a published minimum altitude. Examples of accidents involving obstructions are listed below.

- At Flagstaff Pulliam Airport (FLG), in Flagstaff, Arizona, on September 18, 2007, a 33-hour student pilot was performing a short-field takeoff. He selected two notches of flaps and, while holding the brakes, applied full power. The aircraft accelerated to 65 knots and lifted from the runway. The airspeed then decreased, so the pilot pushed the nose over and retracted the flaps. He continued to descend, and the airspeed would not increase. The pilot force-landed the aircraft off the end of the runway and it impacted trees. According to the FAA inspector, there were no mechanical malfunctions with the airframe or engine. Winds at the time of the accident were from 240° at 10 knots, with 16-knot wind gusts. (It should be noted that the presence of trees in the runway protection zone is generally acceptable as long as they do not create an approach surface penetration).

- At Prescott Regional Airport (PRC) Prescott, Arizona, on September 2, 2006, a twin-engine puller/pusher aircraft departed the 7550-foot-long runway, but failed to climb more than 100 feet above ground level. The landing gear remained extended, and seconds before colliding with power lines, a transmission from a flight crew member indicated that they did not need assistance. During the accident sequence, the wreckage sustained extensive thermal damage. Two separate witnesses, who are pilots, saw the aircraft, after liftoff from the runway, flying at low altitude just barely clearing the tops of trees. The witnesses reported the aircraft was at a slow airspeed in a nose-high attitude with the landing gear down; and, after about 1000 yards, began a descent in the nose-high attitude until contacting the power lines. Examination of the engines did not reveal any anomalies that would have precluded normal operation. Examination of the propellers indicated that the front engine was operating in the normal range at impact; however, the rear engine was producing little or no power and had not been feathered. Performance calculations, using the atmospheric conditions existing at the time and the estimated gross weight of the aircraft, indicate that with the rear engine inoperative and the landing gear extended, the aircraft was incapable of climbing or maintaining level flight.

- At Smyrna Airport (MQY) Smyrna, Tennessee, on September 1, 2009, an aircraft was involved in an accident on its first flight with a newly installed engine. The pilot executed a normal takeoff and, during initial climbout, the engine began to overheat. Subsequently, engine power diminished and the pilot made a forced landing into the trees at the end of the runway. An FAA inspector examined the aircraft, which revealed no evidence of pre-impact mechanical malfunction. Due to the extensive fire damage to the engine, the reason for the loss of engine power could not be determined.

13. SUMMARY.

The analysis indicated that pilot error causes the majority of accidents at airports, and these accidents typically involve a loss of control of the aircraft. Mechanical failures also play a role and may ultimately cause a forced landing off the runway. Although airport design may not directly cause such occurrences, it can aggravate a relatively minor runway or taxiway excursion. For example, some events reported in this analysis resulted in substantial aircraft damage after the aircraft struck concrete supports for runway signs. Based on the data analysis in this review, resources should be applied to keep runway and taxiway safety areas free from obstacles to prevent injuries, fatalities, and aircraft damage at airports. This includes frangible signs and sign bases, fences, light poles, trees, power lines, and other structures. Airport signage is a necessity, but future designs should account for the possibility of aircraft colliding with signs or supporting structures, and minimize exposure of infrangible materials that may pose a hazard to errant aircraft. The concrete pads referred to in this report that support signs conform to the latest guidance materials contained in the Advisory Circulars but were still involved in a number of reported events.

Events were highlighted in which aircraft during the takeoff or landing phase collided with an obstruction after experiencing a mechanical failure or while operating at a lower than authorized altitude. Because almost all fatalities occurred during the takeoff or landing phases, there is no justification to reduce runway protection zones at airports. Although accidents are rare, it is important to have as clear an area as possible around airports to increase the chances of survival for aircraft occupants and to minimize aircraft damage.

Construction events at airports can introduce a number of hazards, and care must be taken to reduce hazards to aircraft. It was found that aircraft damage resulting from collisions with temporary fencing, blowing dust, and a steel plate of incorrect material type being blown into an aircraft, demonstrated potential hazards for consideration when airport construction projects are planned.

Most airport surface events from January 1, 2006 to September 30, 2011 were runway incursions; however, although runway incursions represented 68% of airport surface events, they caused no injuries or fatalities for the review period. These events resulted in one accident and five incidents, as defined by the NTSB. The runway incursions reported were severe enough to warrant an NTSB investigation of the accident and incidents.

It is imperative to focus safety resources on the prevention of pilots crossing the runway hold-short line when not cleared. ASDE effectively alerts personnel of incursions that have occurred or are imminent, at least to the point of an unauthorized hold-short line crossing. However, ASDE does not prevent the incursion from occurring in the first place. Runway incursion prevention should be a major consideration when designing an airport, or in the design of changes to an airport, with the goal of clearly providing situational awareness to a pilot or ground vehicle operator and decreasing the possibility of crossing a hold-short line.

14. CONCLUSIONS.

Airport surface event data was pulled and analyzed from several accident databases for the period between January 2006 and September 2011. In this analysis, there were no events in which an airport design factor was determined to be the primary cause. However, some events were reported in which an airport design factor may have contributed to the severity of the event.

Based on the overall analysis of airport surface events, the Federal Aviation Administration Office of Airports should consider the following five areas for further consideration.

- Runway incursion prevention—The overall data analysis highlights the need to continue to apply resources toward the reduction of runway incursions and to incorporate runway incursion prevention strategies into airport design. The number of runway incursions noted in this review is significant. The runway incursion events evaluated in this review produced no injuries or fatalities; however, according to current predictive safety methodology practices, the number of incidents that could have led to a major event is still alarming. For the review period, there were 61 recorded Category A runway incursions. Combined with an additional 33 Category B runway incursions, a total of 94 events resulted in near collisions or had significant potential for collision. The data indicated that the most common element was pilots inadvertently crossing a hold line. On average, nearly 20 incursion events per year result in a near collision or significant potential for collision between two aircraft, each of which may be carrying several hundred passengers.

- Maintenance of airport surface markings, signage, and lighting—In total, there were 260 reports of issues with airport surface markings, signage, and lighting. The data indicated a host of factors were present that can lead to pilot confusion. Specific issues that were identified included poor surface markings and signage; temporary surface markings during construction; confusing surface markings and signage; inadequate runway/taxiway lighting; and excessively bright runway/taxiway lighting. In many instances, the event reports indicated that the presence of appropriate markings and lighting may have mitigated the event.

- Obstacles near runway safety areas—Events were identified in which substantial aircraft damage occurred after the aircraft struck obstacles near the runway safety area. Concrete supports for runway signs and ditches were two of the more common items identified in the data. Reviewed reports cited frangible signs and sign bases, fences, light poles, trees, power lines, and other structures as additional items that have been struck.

- Retention of runway protection zones—There were five events in which aircraft in the takeoff or landing phase collided with an obstruction after experiencing a mechanical failure or while operating at a lower than authorized altitude. Specific obstructions that were mentioned in the event reports included trees and power lines. Because almost all fatalities occurred during the takeoff or landing phase, there is no justification to reduce runway protection zones at airports. Although accidents are rare, it is important to have as clear an area as possible around airports to protect persons and property on the ground, increase the chances of survival for aircraft occupants, and minimize aircraft damage.

- Mitigate runway overrun risks at airports with obstructions or steep drops near overrun areas—Incidents were identified in which an aircraft sustained damage due to striking an obstruction or encountering steep drops after overrunning the runway. The data indicated that runway overrun events are typically survivable; but in many cases, it was the lack of a sufficient overrun area that created the problem. In one particular report, the pilot stated that after touchdown, he was unable to stop the aircraft. It traveled off the end of the runway, down an embankment, onto a service road, and collapsed the nose landing gear. The pilot reported no pre-impact malfunctions. Lack of a sufficient overrun area was cited as a contributing factor adding to the severity of the incident.

15. FUTURE ANALYSIS.

The data for this report was filtered to only include Title 14 Code of Federal Regulations Part 139 airports and primary airports, as defined in the National Plan of Integrated Airport Systems, narrowing the scope of the investigation of how airport design contributed to the reported events. In future efforts, the scope will expand the analysis in several ways:

- increasing the number of airports in the database to including busier reliever and general aviation airports

- including accidents/incidents on additional areas of the airfield, such as nonmovement areas

- expanding the types of issues the database focuses on to include:

  – Wildlife—globally, wildlife strikes have killed more than 229 people and destroyed over 210 aircraft since 1988 [7]. Ninety-seven percent of these strikes involved birds. Approximately 75% of these bird strikes occurred at or below 500 feet above ground level.

  – Runway friction and contaminant reporting—worldwide, runway excursions comprise 97% of the runway-related accidents. In some cases, contaminants on the runway, such as rain or snow, are thought to be contributory causes because they can decrease the friction on the runway. The multiple ways that exist to measure friction and report contaminants can also be contributory factors.

  – Runway safety areas and runway protection zones—when excursions occur, collisions with equipment or other objects in the safety areas and zones can exacerbate the results.

The augmented data in the expanded database will be used to examine issues considered in this report further (e.g., foreign object debris). It will also be used to determine the relative importance of ongoing and proposed projects within the Federal Aviation Administration Office of Airports and support changes in work priorities.

16. REFERENCES.

1. U.S. Federal Register, Title 49 Code of Federal Regulations Part 830.2, "Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft and Preservation of Aircraft Wreckage, Mail, Cargo, and Records," Government Printing Office, Washington, DC.

2. Personal Communication with Ms. Linda Connell, NASA ASRS Program Director, September 22, 2010, Atlanta, Georgia.

3. U.S. Federal Register, Title 14 Code of Federal Regulations Part 139, "Certification of Airports," Government Printing Office, Washington, DC.

4. U.S. Department of Transportation, Federal Aviation Administration, Secretary of Transportation's Report to Congress "National Plan of Integrated Airport Systems: 2009-2013," September 2008.

5. International Civil Aviation Organization, "Manual on the Prevention of Runway Incursions," ICAO 9870-AN/463, October 2007.

6. U.S. Department of Transportation, Federal Aviation Administration Order 7050.1A, “Runway Safety Program,” Appendix B, “Runway Incursion Severity Classification,” September 2010.

7. U.S. Departments of Transportation and Agriculture, Report of the Associate Administrator of Airports, “Wildlife Strikes to Civil Aircraft in the United States 1990-2010,” February 2012.

APPENDIX A—LIST OF AIRPORTS IN DATABASE

ABE	ANC	BET	BPT	CEF
ABI	AND	BFD	BQK	CEZ
ABQ	ANI	BFF	BQN	CGI
ABR	AOO	BFI	BRD	CHA
ABY	APF	BFL	BRL	CHO
ACK	ART	BFM	BRO	CHS
ACT	ASE	BGM	BRW	CIC
ACV	ASN	BGR	BTM	CID
ACY	AST	BHB	BTR	CIU
ADK	ATL	BHM	BTV	CKB
ADQ	ATW	BIL	BUF	CLD
AEX	ATY	BIS	BUR	CLE
AFW	AUG	BJC	BVU	CLL
AGS	AUS	BJI	BWG	CLM
AHN	AVL	BKG	BWI	CLT
AIA	AVP	BKL	BZN	CMH
AKN	AZA	BKX	CAE	CMI
AKO	AZO	BLD	CAK	CMX
ALB	BAF	BLI	CCR	CNM
ALO	BAK	BLV	CDB	CNY
ALS	BBG	BMI	CDC	COD
ALW	BDL	BNA	CDR	COE
AMA	BDR	BOI	CDV	COS
ANB	BED	BOS	CEC	COU

CPR
CPS
CRP
CRW
CSG
CVG
CVN
CVX
CWA
CYS
DAB
DAL
DAY
DBQ
DCA
DDC
DEC
DEN
DFW
DHN
DIK
DLG
DLH
DRO
DRT
DSM

DTW
DUJ
DUT
DVL
EAR
EAT
EAU
ECP
EFD
EGE
EKM
EKO
ELD
ELM
ELP
ELY
ENA
END
ENV
ERI
ESC
EUG
EVV
EWB
EWN
EWR

EYW
FAI
FAR
FAT
FAY
FCA
FHR
FHU
FKL
FLG
FLL
FLO
FMN
FNL
FNT
FOD
FOE
FRD
FRG
FSD
FSM
FTW
FWA
FYV
GBD
GCC

GCK
GCN
GDV
GEG
GFK
GFL
GGG
GGW
GJT
GLH
GNV
GON
GPI
GPT
GRB
GRI
GRK
GRO
GRR
GSN
GSO
GSP
GST
GTF
GTR
GUC

GUM
GYH
GYY
HAS
HDN
HEZ
HGR
HHH
HIB
HII
HKY
HLN
HNL
HOM
HON
HOT
HOU
HPN
HRL
HSV
HTS
HUF
HUT
HVN
HVR
HXD

HYA
HYS
IAD
IAG
IAH
ICT
IDA
IFP
IGM
ILG
ILM
ILN
IMT
IND
INL
INT
IPL
IPT
IRK
ISN
ISO
ISP
ITH
ITO
IWA
IWD

IYK
JAC
JAN
JAX
JFK
JHW
JLN
JMS
JNU
JQF
JST
KMO
KOA
KTN
LAF
LAL
LAN
LAR
LAS
LAW
LAX
LBB
LBE
LBF
LBL
LBX

LCH
LCK
LEB
LEX
LFT
LGA
LGB
LGU
LIH
LIT
LMT
LNK
LNS
LNY
LRD
LRU
LSE
LUK
LWB
LWS
LYH
MAF
MBL
MBS
MCE
MCI

MCK
MCN
MCO
MCW
MDH
MDT
MDW
MDY
MEI
MEM
MFD
MFE
MFR
MGM
MGW
MHT
MIA
MIE
MKC
MKE
MKG
MKK
MKL
MLB
MLI
MLS

MLU
MMH
MOB
MOD
MOT
MQT
MQY
MRI
MRY
MSL
MSN
MSO
MSP
MSS
MSV
MSY
MTH
MTJ
MTO
MVN
MVY
MWA
MWH
MYR
NQA
NYL

OAJ	PGA	PUW	SAF	SIT
OAK	PGD	PVC	SAN	SJC
OCF	PGV	PVD	SAT	SJT
OGD	PHF	PVU	SAV	SJU
OGG	PHL	PWM	SAW	SLC
OGS	PHX	RAP	SBD	SLE
OKC	PIA	RDD	SBN	SLK
OLF	PIB	RDG	SBP	SLN
OMA	PIE	RDM	SBY	SMF
OME	PIH	RDU	SCC	SMX
ONP	PIR	RFD	SCE	SNA
ONT	PIT	RHI	SCK	SOP
ORD	PKB	RIC	SDF	SOW
ORF	PLN	RIW	SDY	SPI
ORH	PNS	RKD	SEA	SPN
OSU	POU	RKS	SFB	SPS
OTH	PPC	RME	SFO	SRQ
OTZ	PPG	RNO	SGF	SRR
OWB	PQI	ROA	SGH	STC
OXR	PRC	ROC	SGJ	STJ
PAE	PSC	ROP	SGU	STL
PAH	PSE	ROW	SGY	STS
PBG	PSG	RST	SHD	STT
PBI	PSM	RSW	SHR	STX
PDX	PSP	RUT	SHV	SUN
PFN	PTK	RWI	SIG	

SUS
SUX
SVC
SWF
SWO
SYR
TCL
TEB
TEX
TIQ

TIX
TLH
TNI
TOL
TPA
TPL
TRI
TTN
TUL
TUP
TUS

TVC
TVF
TVL
TWF
TXK
TYR
TYS
UIN
UNK
UNV
UOX

UST
UTA
UTM
VCT
VCV
VDZ
VEL
VGT
VIS
VLD
VPS

VPZ
VQS
WRG
WRL
WYS
XNA
YAK
YIP
YKM
YNG
YUM

APPENDIX B—DEFINITIONS

Title 14 Code of Federal Regulations (CFR) Part 139 Airport	Airports that • serve scheduled and unscheduled air carrier aircraft with more than 30 seats. • serve scheduled air carrier operations in aircraft with more than 9 seats but less than 31 seats. • is required to have a certificate.
Accident	As defined in Title 49 CFR 830.2 [B-1], an aircraft accident is an occurrence that takes place between boarding and deplaning, which results in a person suffering from severe injury or death or the aircraft receiving substantial damage.
Excursion	A veer-off or overrun off a surface—This could relate to either the marked pavement designated for takeoff and landing operations (runway) or the marked pavement designated for maneuvering of flight traffic for the purpose of flight operations (taxiway).
Foreign object debris	Any object, live or not, located in an inappropriate location in the airport environment that has the capacity to injure airport or air carrier personnel and damage aircraft.
Incident	As defined in 49 CFR 830.2 [B-1], an aircraft incident is any occurrence that does not fit the definition of an accident, but occurs while the aircraft is operating, and could affect the safety of operations.
Incursion	Any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface; either referring to the marked pavement designated for takeoff and landing operations (runway) or the marked pavement designated for maneuvering of flight traffic for the purpose of flight operations (taxiway).
Minor damage	Any damage not defined as substantial, but still requiring some maintenance to return the aircraft to airworthy status.
Operational errors/deviations	An operational error is an action by an air traffic controller that results in less than the required minimum separation between two or more aircraft, or between an aircraft and obstacles (obstacles include vehicles, equipment, personnel on runways), or an aircraft landing or departing on a runway closed to aircraft. An operational deviation is an air traffic

controller action that results in an aircraft, vehicle, equipment, or personnel encroaching upon a landing area that was delegated to another position of operation without prior coordination and approval.

Other occurrence	An occurrence that cannot be classified as either an incursion or an excursion, but still has significance in the scope of this review.
Pilot deviation	An action of a pilot that violates any Federal Aviation Regulation; for example, a pilot fails to obey air traffic control instructions to not cross an active runway when following the authorized route to an airport gate.
Primary airport	Commercial service airports that have more than 10,000 passenger boardings each year.
Substantial damage	As defined in 49 CFR 830.2 [B-1], substantial damage is any damage or failure that adversely affects structural strength, performance, or flight characteristics and would normally require major repair.
Vehicle/pedestrian deviations	Includes pedestrians, vehicles, or other objects interfering with aircraft operations by entering or moving on the movement area without authorization from ATC.
Wrong runway	Any occurrence in which an aircraft either takes off or lands, with or without clearance, on a different runway or other surface than assigned.

References.

B-1. U.S. Federal Register, Title 49 Code of Federal Regulations Part 830.2, “Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft and Preservation of Aircraft Wreckage, Mail, Cargo, and Records,” Government Printing Office, Washington, DC.