



August 2019

AVIATION SAFETY

Opportunities Exist for FAA to Improve Airport Terminal Area Safety Efforts

Accessible Version

GAO Highlights

Highlights of [GAO-19-639](#), a report to congressional requesters

Why GAO Did This Study

U.S. airspace system is one of the safest in the world, but incidents and near misses at and around U.S. terminal areas still occur. FAA oversees the safety of runways and taxiways and works with industry partners—including airlines, airports, pilots, and others—to improve safety in these areas. Despite FAA’s continued efforts, the number of reported terminal area incidents has increased over time.

GAO was asked to review various issues related to runway safety and to update its prior work on airport terminal areas. This report examines: (1) the extent to which FAA uses data to analyze terminal area incidents and (2) efforts FAA and others have implemented to improve terminal area safety, and how FAA assesses their effectiveness. GAO analyzed FAA data; interviewed officials from 10 airports selected based on high runway incident rates in the past 3 years, among other factors; and interviewed federal and industry officials.

What GAO Recommends

GAO is making five recommendations including that FAA identify and remove duplicate excursion data, develop processes to analyze ramp area incidents, and establish a plan to assess the effectiveness of its terminal area safety efforts.

FAA concurred with the recommendations.

View [GAO-19-639](#). For more information, contact Heather Krause at (202) 512-2834 or krauseh@gao.gov.

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Opportunities Exist for FAA to Improve Airport Terminal Area Safety Efforts

What GAO Found

The Federal Aviation Administration (FAA) uses data to analyze some types of incidents in airport “terminal areas”—runways, taxiways, and ramps. For example, FAA uses data to analyze runway “incursions”—the incorrect presence of an aircraft, vehicle, or person on the runway. According to FAA data, the rate of reported runway incursions nearly doubled from fiscal years 2011 through 2018, with most of this increase due to a rise in reports of less severe incursions, or those without immediate safety consequences. However, GAO found that FAA has not identified or removed all duplicates from its data on runway “excursions”—when an aircraft veers off or overruns a runway—which limits FAA’s ability to accurately analyze these incidents. Additionally, FAA does not use data to analyze incidents that occur in ramp areas—the parts of terminal areas where aircraft are prepared for departure and arrival—where injuries to workers and damage to aircraft can occur. Without a process to leverage accurate excursion and ramp incident data, FAA may not be able to assess the risk these incidents pose to passengers, airport staff, and others.

Example of a Potential Runway Incursion as a Plane Approaches an Occupied Runway



Source: Transportation Safety Board of Canada. | GAO-19-639

FAA, airports, and airlines have implemented multiple efforts to improve terminal area safety, but FAA has not assessed the effectiveness of many of its efforts. For example, FAA has funded multiple technologies to improve runway safety, such as Airport Surface Detection Equipment, Model X (ASDE-X)—a ground surveillance system that enables air traffic controllers to track landing and departing aircraft and alerts controllers of potential collisions. However, FAA has not assessed the effectiveness of ASDE-X. Similarly, FAA has not assessed the effectiveness of its Runway Safety Program, whereby FAA staff, along with local airport stakeholders, provide data and support to local air traffic managers to help identify and manage terminal area safety incidents. FAA has taken steps to evaluate some of its terminal-area safety efforts, such as tracking the number of runway excursions safely stopped by a lightweight, crushable concrete designed to stop or greatly slow an aircraft that overruns the runway. However, without assessing how all of FAA’s efforts contribute to its goal of improving runway and taxiway safety, FAA cannot determine the extent to which it is targeting its limited resources to the most effective strategies.

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Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
ASDE-X	Airport Surface Detection Equipment, Model X
ASIAS	Aviation Safety Information Analysis and Sharing (database)
ASSC	Airport Surface Surveillance Capability
ATO	Air Traffic Organization
CAST	Commercial Aviation Safety Team
DOT	Department of Transportation
EMAS	Engineered Material Arresting System
FAA	Federal Aviation Administration
NTSB	National Transportation Safety Board
OSHA	Occupational Safety and Health Administration
RIM	Runway Incursion Mitigation
RSAT	Runway Safety Action Team
SMS	Safety Management System

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August 30, 2019

The Honorable Peter DeFazio
Chairman
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Rick Larsen
Chairman
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Mark DeSaulnier
House of Representatives

The U.S. airspace system is one of the safest in the world, but incidents and near misses at and around U.S. airport runways and taxiways still occur.¹ For example, in 2017 at San Francisco International Airport, an airplane came within 60 feet of landing on a taxiway occupied by four airplanes full of passengers before the pilot was able to pull up and attempt another landing. In addition, in fiscal year 2018, the Federal Aviation Administration (FAA) recorded over 1,800 incidents of planes, vehicles, or pedestrians entering runways when they were not authorized to do so. Since establishing runway safety as a strategic objective in 2002, FAA has undertaken many efforts to address this issue, including collecting and sharing information on incidents and deploying technologies that can alert air traffic controllers of potential collisions. Additionally, FAA has implemented a data-driven, risk-based safety oversight approach that is designed to identify hazards, manage risks, and take corrective action before an accident occurs.² Despite these efforts, reported runway incidents have continued to increase.³ FAA data

¹Taxiways are routes that aircraft follow to and from runways.

²For GAO reports on this approach, see: GAO, *Aviation Safety: Additional Oversight Planning by FAA Could Enhance Safety Risk Management*, [GAO-14-516](#) (Washington, D.C.: June 25, 2014) and GAO, *Aviation Safety: Additional FAA Efforts Could Enhance Safety Risk Management*, [GAO-12-898](#) (Washington D.C.: Sept. 12, 2012).

³When we refer to runway “incidents” increasing, we are referring to runway incursions, which involve the incorrect presence of an aircraft, vehicle, or person on a runway.

show runway incidents nearly doubled between fiscal years 2011 and 2018.

You asked us to review FAA’s safety oversight of airport terminal areas—runways, taxiways, and ramp areas (the area from the gate to the taxiway or runway, where aircraft are prepared for departure and arrival)—and update our prior work, including our 2011 report on terminal area safety.⁴ This report discusses:

1. To what extent does FAA use data to analyze terminal area incidents?
2. What efforts have FAA and others implemented to improve terminal area safety, and how does FAA assess their effectiveness?

To address both objectives, we reviewed our prior work and other published work on FAA’s runway and taxiway safety efforts, including those from FAA, the Department of Transportation’s (DOT) Inspector General, and the National Transportation Safety Board (NTSB).⁵ We interviewed officials from these agencies as well as the Occupational Safety and Health Administration (OSHA), airport and airline associations, and aviation safety organizations. We conducted semi-structured interviews with airport operators and air traffic controllers from 10 airports selected from certificated airports to include those with high runway incident rates in the last 3 years, certain runway safety technologies in place, and variation in geography.⁶ We interviewed officials in person and observed facility operations at 4 of these 10 airports—Los Angeles International Airport; Ronald Reagan Washington National Airport

⁴See GAO, *Aviation Runway and Ramp Safety: Sustained Efforts to Address Leadership, Technology, and Other Challenges Needed to Reduce Accidents and Incidents*, [GAO-08-29](#) (Washington, D.C.: Nov. 20, 2007); and GAO, *Aviation Safety: Enhanced Oversight and Improved Availability of Risk-Based Data Could Further Improve Data*, [GAO-12-24](#) (Washington, D.C.: Oct. 5, 2011).

⁵As discussed later in this report, FAA has focused its terminal area oversight on airport runways and taxiways, and has worked with airports and airlines to oversee the safety of ramp areas.

⁶We limited our selection to FAA-certificated commercial airports—those that are required to have FAA-issued operating certificates. See 14 C.F.R. Part 139. The 10 commercial airports we selected were Boston Logan International Airport; Daniel K. Inouye International Airport (Honolulu, Hawaii); La Crosse Regional Airport (La Crosse, Wisconsin); Los Angeles International Airport; Minneapolis-St. Paul International Airport; Philadelphia International Airport; Ronald Reagan National Airport (Washington, D.C.); San Antonio International Airport; San Francisco International Airport; and William P. Hobby Airport (Houston, Texas).

(Washington, D.C.); San Antonio International Airport; and William P. Hobby Airport (Houston, Texas). The perspectives of officials at these 10 airports are not generalizable to those at other airports. However, they allow us to provide examples of how some air traffic controllers and airport operator officials manage terminal area safety.

To assess the extent to which FAA uses data to analyze terminal area incidents, we reviewed FAA data from fiscal years 2011 through 2018 on reported runway and taxiway incidents and calculated trends in incident types, severity, and aircraft involved. We selected 2011 because that is when FAA began collecting data on runway “excursions”—incidents that occur when an aircraft veers off the side or end of a runway. To assess the reliability of these data, we reviewed FAA documentation, interviewed FAA officials, and reviewed incident data for errors such as duplicates or incomplete records. We also compared FAA’s processes for collecting and analyzing runway, taxiway, and ramp area data to GAO internal control and data reliability standards.⁷ We found FAA incursion data to be reliable for the purposes of our reporting objectives but found limitations with FAA excursion and ramp area data, which are discussed later in this report.

To identify FAA’s and other stakeholders’ efforts, including technologies, to improve terminal area safety and determine how FAA assesses their effectiveness, we reviewed documentation of FAA, airports’ and airlines’ current or planned terminal area initiatives. We analyzed the content of interviews with airport and air traffic officials and compared common themes to federal internal control standards, including those on information and communication.⁸ Finally, we compared FAA’s assessment of its terminal area efforts and technologies to leading program evaluation practices.⁹

We conducted this performance audit from August 2018 to August 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain

⁷GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 10, 2014); and GAO, *Assessing the Reliability of Computer-Processed Data*, [GAO-09-680G](#) (Washington, D.C.: July 2009).

⁸[GAO-14-704G](#).

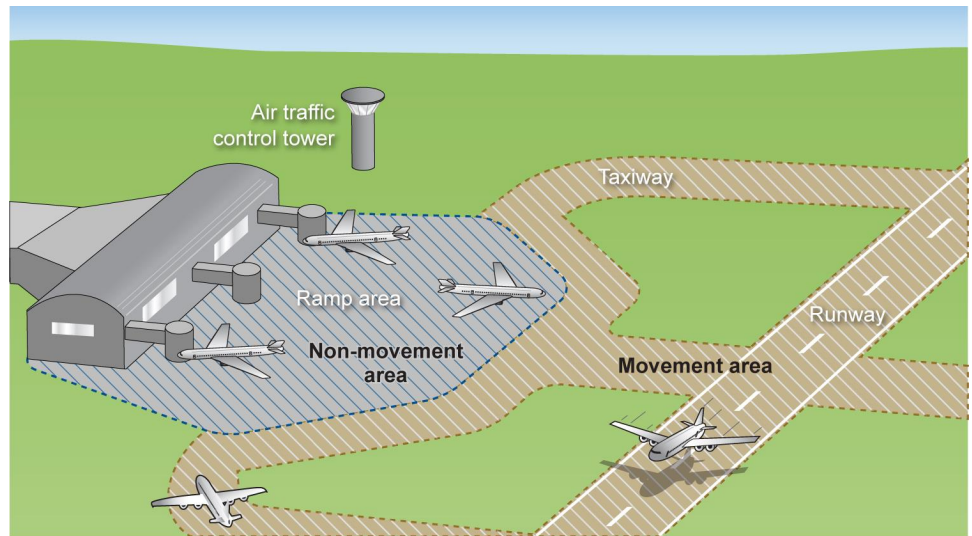
⁹American Evaluation Association, *An Evaluation Roadmap for a More Effective Government* (Washington, D.C.: October 2016).

sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

FAA air traffic controllers are responsible for guiding aircraft that are departing, landing, and moving around the terminal area at 518 U.S. airports. Airport terminal areas include “movement areas,” such as runways and taxiways, and “non-movement areas” such as ramp areas (see fig. 1).¹⁰

Figure 1: Parts of Airport Terminal Area



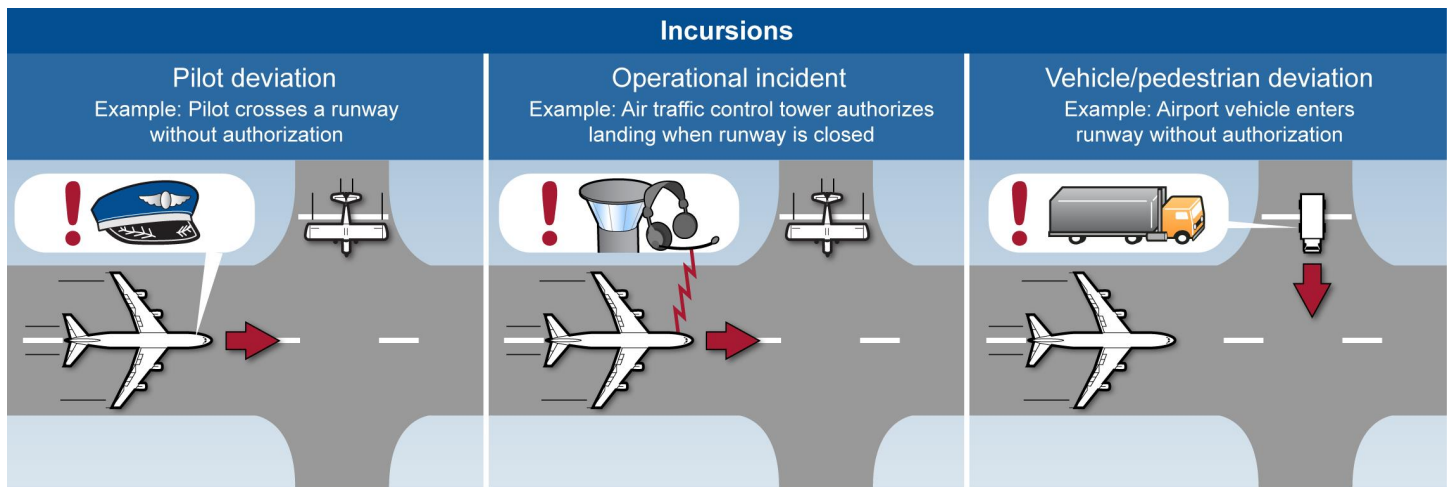
Source: GAO. | GAO-19-639

Incidents can occur in either the movement or non-movement area and include:

¹⁰ FAA defines the movement area as “the runways, taxiways, and other areas of an airport that aircraft use for taxiing, takeoff, and landing, exclusive of loading aprons (areas around movement areas) and aircraft parking areas.” FAA defines non-movement areas as “the area, other than that described as the movement area, used for the loading, unloading, parking of aircraft.” These areas may include the aprons and fueling areas. See FAA Advisory Circular 150/5210-20A (Sept. 1, 2015).

- **Runway incursions:** These incidents involve the incorrect presence of an aircraft, vehicle, or person on a runway. Incursions fall into three categories—pilot deviations, operational incidents, and vehicle or pedestrian deviations—depending on their cause (see fig. 2).

Figure 2: Examples of Runway Incursions

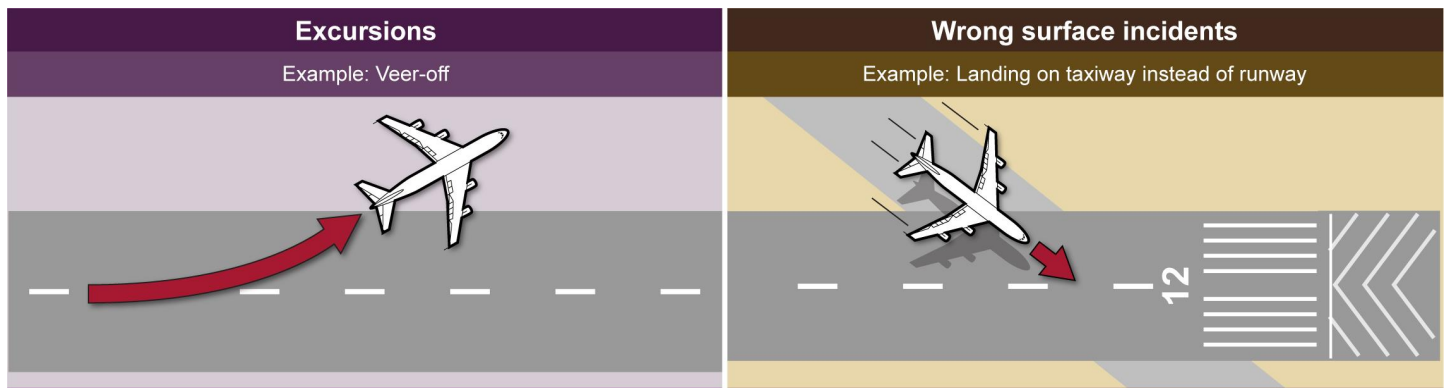


Source: GAO. | GAO-19-639

- **Runway excursions:** These incidents occur when an aircraft veers off the side, or overruns the end, of a runway.
- **Wrong-surface:** These incidents occur when an aircraft lands or departs, or tries to land or depart, on the wrong runway or on a taxiway (see fig. 3).¹¹ Wrong surface incidents also include when an aircraft lands or tries to land at the wrong airport.

¹¹ FAA officials said FAA likely classifies wrong surface incidents as runway incursions if the aircraft lands on the wrong runway, and as "surface incidents" if the aircraft lands on a taxiway. FAA officials said that all terminal area incidents, other than incursions or excursions, are categorized as "surface incidents."

Figure 3: Examples of Runway Excursions and Wrong Surface Incidents



Source: GAO. | GAO-19-639

- **Ramp area:** These incidents occur when aircraft, vehicles, or people cause damage or injuries in the ramp area.

FAA oversees the safety of runways and taxiways and works with partners such as airlines, airports, pilots, and others to improve safety in these areas. FAA's oversight of ramp areas is generally exercised indirectly through its certification of airports and airlines, which have been more directly responsible for safety in these areas.

Several FAA offices—with staff in D.C. headquarters, FAA regional offices, and local district offices—oversee terminal area safety, including:

- *The Air Traffic Organization (ATO)* manages air traffic control, validates reports of terminal area incidents, develops and maintains runway safety technology, and leads investigations of operational incidents. ATO also administers the mandatory reporting system, which requires air traffic controllers to report certain incidents, including runway incursions, excursions, and wrong surface landings.¹²
- *ATO's Runway Safety Group* leads and coordinates all FAA terminal area safety efforts. The goal of the Runway Safety Group is to improve runway and taxiway safety by reducing the risk of runway incursions, excursions, and other incidents.

¹² ATO Order J7210.632 lists incidents air traffic controllers are required to report. These incidents also include emergencies such as a fuel quantity emergency, bird strike, or bomb threat.

- *The Office of Airports* oversees airport-related safety, including inspecting and certifying operations at commercial airports and establishing airport design and safety standards. The Office of Airports also provides grants to airports to help support safety improvements, and leads investigations of incursions caused by vehicle/pedestrian deviation.
- *Office of Aviation Safety* investigates aircraft incidents and accidents, sets aviation safety standards, and certifies aircraft and pilots.
 - *Office of Aviation Safety, Flight Standards Service (Flight Standards)* inspects and certifies airlines, promotes runway safety initiatives, and provides policies and guidance for pilots. Flight Standards also administers a reporting program to obtain information on incidents involving pilots and leads investigations of incursions caused by pilot deviation.
 - *Office of Aviation Safety, Accident Investigation and Prevention* oversees investigations of terminal area-safety accidents and incidents, a role which includes coordinating with the NTSB, OSHA, and other FAA offices.¹³

Runway and taxiway safety has long been a focus of FAA efforts. FAA's fiscal year 2019-2022 strategic plan establishes four safety initiatives related to its data-driven, risk-based safety oversight approach, known as a Safety Management System (SMS), including two fiscal year 2019 safety initiatives:

- proactively addressing emerging safety risk by using data-informed approaches to make risk-based decisions, and

¹³ NTSB investigates aircraft "accidents." NTSB defines an aircraft accident as "an occurrence associated with the operation of an aircraft which 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." 49 C.F.R. § 830.2. Both NTSB and OSHA investigate accidents in the ramp area that meet certain injury or damage thresholds. For example, NTSB investigates ramp accidents—and other accidents involving aircraft—in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. OSHA can conduct an inspection in response to a fatality, injuries, or a complaint, unless it is preempted by an exercise of statutory authority by FAA. 29 U.S.C. § 653(b)(1). Under the Occupational Safety and Health Act (OSH Act), OSHA has statutory authority to regulate the occupational safety and health of employees. 29 U.S.C. §§651 et seq. NTSB may also investigate aircraft incidents, which NTSB defines as "an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations." 49 C.F.R. § 830.2.

- reducing the risk of runway incursions and wrong surface incidents.

Further, FAA's SMS guides its terminal area oversight. For example, FAA's order establishing the Runway Safety Program states that FAA use SMS to ensure the safety of the national airspace through evaluations, data tracking, and analysis of incidents to identify new hazards and risks, and to assess existing safety controls. In our 2011 report on FAA's oversight of terminal area safety, we made three recommendations related to excursions, ramp areas, and information sharing, all three of which FAA has since implemented.¹⁴

FAA Uses Data to Analyze Some Terminal Area Incidents

FAA Uses Data to Analyze Runway Incursions

FAA uses data from reports and investigations to analyze runway incursions. For example, a team of representatives from the Air Traffic Organization, the Office of Airports, and the Office of Flight Standards, uses information on each incursion to classify its severity into one of four categories—A through D.¹⁵ An example of a category A incursion occurred in June 2018 in Springfield, Missouri, when an aircraft with 53 people on board accelerated for takeoff before noticing an airport operations vehicle crossing the runway. No injuries or damage were reported, but a collision was narrowly avoided. An example of a Category C or D incursion is a pilot entering a runway without authorization, but without significant potential for a collision. FAA reports the rate of severe category A and B incursions to Congress and the public in its annual performance plan.¹⁶

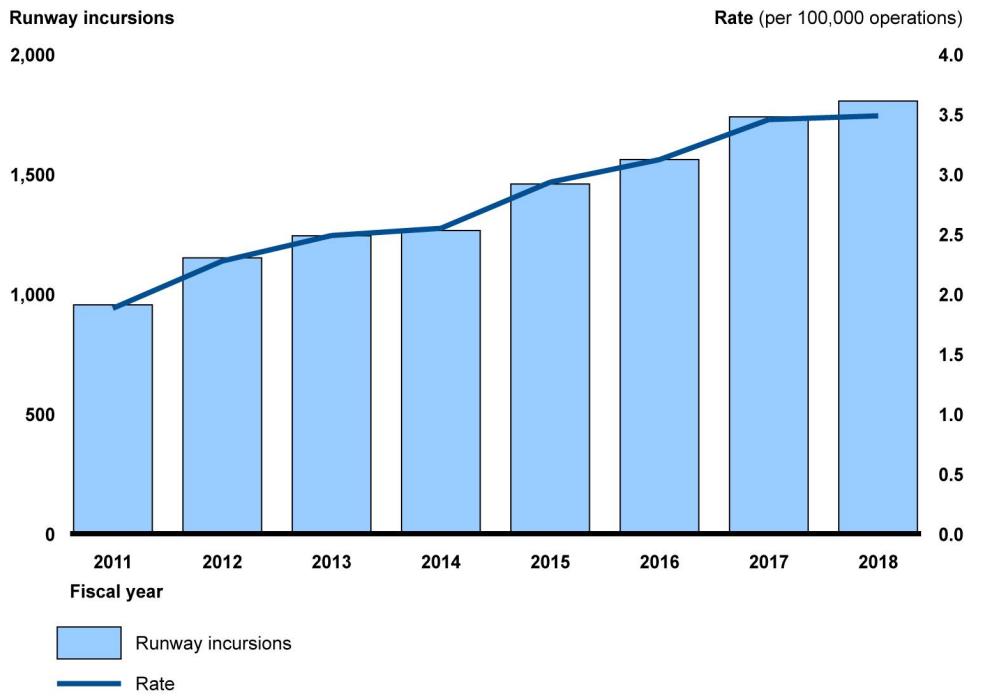
¹⁴ [GAO-12-24](#).

¹⁵ FAA categorizes incursions in which a collision was narrowly avoided as category A, those with significant potential for collision as category B, those with ample time and/or distance to avoid a collision as category C, and those without immediate safety consequences as category D.

¹⁶ FAA's performance goal is to maintain a rate of category A and B incursions below 0.395 per 1-million operations, which officials said amounts to roughly 20 of these incursions each year. FAA met this goal in each year we reviewed—from 2011 through 2018.

FAA also uses data to analyze runway incursions over time. For example, FAA data show that the number and rate of reported runway incursions nearly doubled from 954 in fiscal year 2011 to 1804 in fiscal year 2018 (see fig. 4). The majority of reported runway incursions (62 percent) were pilot deviations¹⁷ followed by operational incidents (20 percent) and vehicle/pedestrian deviations (18 percent).¹⁸

Figure 4: Number and Rate of Reported Runway Incursions, Fiscal Years 2011 through 2018



Source: GAO analysis of Federal Aviation Administration (FAA) data. | GAO-19-639

According to our analysis of FAA data, the increase in reported incursions was largely due to an increase in less severe incursions. Our analysis

¹⁷ This finding is similar to what we previously reported, in [GAO-12-24](#). We also previously noted that the majority of runway incursions, regardless of type, involved general aviation aircraft. General aviation encompasses all civil aviation except commercial and military operations, and includes air medical-ambulance operations, flight schools, corporate aviation, and privately owned aircraft. The majority of runway incursions from fiscal years 2011 through 2018 also involved general aviation aircraft.

¹⁸ In addition, there were a small number of events defined as “other,” which is the designation FAA uses when an event does not meet the criteria for operational incident, pilot deviation, or vehicle/pedestrian deviation.

showed that severe incursions (category A and B) in which there is a significant potential for a collision, are relatively infrequent. Category C and D incursions, in which there is less potential for a collision, are more frequent. According to FAA officials, the increase in less severe incursions may be due to increased reporting of these incidents, which we also noted in our 2011 report on terminal area safety.¹⁹ However, the number and rate of reported runway incursions has continued to steadily increase since then, and may also indicate an increase in the actual occurrence of incidents.

In 2017, FAA developed a new metric to analyze excursions and other incidents, as well as incursions. According to FAA officials, the new metric (“Surface Safety Metric”) measures the relative riskiness of terminal area incidents by assigning a different severity weight to each incursion, excursion, or other incident depending on its proximity to a fatal accident. For example, FAA documentation states that the new metric assigns a severity weight of 1 to incidents that result in a fatal injury, 0.6 to incidents with serious injuries, and 0.3 to incidents with minor injuries. Incidents in which there are no injuries are assigned even lower severity weights—for example 0.003 for a category A incursion and 0.002 for a category B incursion.²⁰ FAA officials said they will analyze these severity weights year-to-year, so they can identify trends in each type of incident and across all incidents. For example, FAA officials noted that despite an increase in the number of runway incursions from fiscal years 2011 through 2018, the estimated risk of these incidents, as measured by their severity weights, declined. FAA has developed new performance goals tied to this metric, which it plans to report to Congress and the public by the end of fiscal year 2019.

¹⁹ [GAO-12-24](#).

²⁰ See FAA, “Runway Safety Metric: Weighting Scheme,” August 2017. We use the term “incident” here to refer to accidents and incidents, but according to this metric, FAA defines events resulting in injury or aircraft damage as accidents. Those that do not result in injury or aircraft damage are categorized as incidents, which include category A-D runway incursions, runway excursions, and other surface incidents. FAA categorizes incursions for which it does not have sufficient information as category E.

Duplicate Data May Affect FAA's Ability to Analyze Excursions

FAA has analyzed excursion data through special FAA task teams and other joint industry efforts with airlines, associations, and other government agencies. Excursions occur when an aircraft veers off the side or end of a runway, and can result in serious injury, death, or property damage. For example, on September 27, 2018, a small aircraft slid off the side of the runway at Greenville Downtown Airport in South Carolina shortly after landing. The aircraft continued down a 50-foot cliff, resulting in the deaths of two people. According to data FAA provided to us, nearly 700 excursions were reported in fiscal year 2018. Additionally, several joint industry efforts and special task teams have recently analyzed excursions.²¹ For example, the Commercial Aviation Safety Team (CAST), which FAA co-leads, found that about a third of the commercial accidents in the U.S. that resulted in fatalities or irreparable damage to the aircraft from 2006 through 2015 were attributed to runway excursions.²²

In 2013, FAA began collecting additional data on excursions, but our review of FAA's data found the excursion data FAA has collected since then contain duplicates. In 2011, we found that FAA was not formally tracking runway excursions and recommended that FAA develop a plan to track and assess them,²³ which FAA began doing in 2013. Prior to 2013, FAA collected excursion data from two sources—the NTSB Aviation Accident Database, which contains information gathered during NTSB investigations, and FAA's own Aviation Safety Information Analysis and Sharing (ASIAS) database, which includes information on incidents that may not reach the level of an NTSB investigation, such as an incident without serious injuries or fatalities. In 2013, FAA began identifying excursions in a third source—mandatory occurrence reports that FAA requires air traffic controllers to file when they observe an incident. FAA officials said that the additional excursions they identified through these

²¹ See, for example, Federal Aviation Administration, *Runway Excursion Risk: A Study by the Runway Excursion Tactical Team* (Washington, D.C., June 20, 2017).

²² The Commercial Aviation Safety Team is a joint FAA-industry effort created in 1997 whose goal is to reduce the U.S. commercial fatality risk by 50 percent from 2010 to 2025. See CAST research cited in Federal Aviation Administration, *Runway Excursion Risk: A Study by the Runway Excursion Tactical Team* (Washington, D.C., June 20, 2017).

²³ [GAO-12-24](#).

mandatory occurrence reports added 15 percent more annual reports to those that they had identified through only the other two sources.

However, FAA officials said there are likely duplicate records in their excursion data as a single excursion could be reported in more than one of these three sources. Although we did not have enough identifying information in the excursion data FAA provided to confirm the number of duplicate reports, our analysis of excursion data did identify possible duplicates. Further, despite containing possible duplicates, FAA recently began using these excursion data in its new surface safety metric. Federal standards for internal control state that data should be appropriate, current, complete, and accurate.²⁴ A 2017 FAA internal analysis also noted the importance of identifying duplicates in order to ensure accurate runway excursion data.²⁵ FAA officials said that they do not know how many duplicate records there are, and that they do not have an automated way to identify (and remove) all duplicates. FAA officials said that they could manually identify and remove duplicates, but that they do not currently do this nor plan to do so because duplicate excursion records would not affect their assessment of excursion risk. FAA officials said that excursions captured solely by the mandatory occurrence reports tend to be minor, lower-risk events. However, without a process to identify duplicates, FAA is not able to verify that this statement is true, and therefore cannot accurately assess and mitigate the risk excursions pose to terminal area safety.

FAA Does Not Use Data to Analyze Ramp Area Incidents

FAA does not use data to analyze most ramp area incidents, and does not plan to do so in its new surface safety metric. While the manager of the Runway Safety Group said FAA analyzes fatal ramp accidents through its participation in CAST, it does not analyze non-fatal ramp incidents, which are estimated to occur more frequently. In addition to some airport and airline officials telling us that they likely collect ramp data, FAA's Runway Safety Group manager said that FAA likely has data on some non-fatal ramp incidents. For example, some air traffic controllers we interviewed said that they would report any ramp area incidents they observed through FAA's mandatory reporting process, and

²⁴ [GAO-14-704G](#).

²⁵ Federal Aviation Administration, *Runway Excursion Risk: A Study by the Runway Excursion Tactical Team* (Washington, D.C., June 20, 2017).

officials from a pilot association told us they would also report such incidents. However, FAA officials said that FAA does not plan to analyze ramp incidents in the agency's new surface safety metric. FAA's Runway Safety Program Manager said that FAA has not analyzed most ramp area incidents because the risk of these incidents is lower than that in other areas, such as runways, and therefore does not merit analysis. For example, the manager said that aircraft speed in the ramp area is generally slower than take-off or landing speed, and fatalities are infrequent.

However, we have previously reported that ramp areas are typically small, congested areas in which departing and arriving aircraft are serviced by ramp workers, who include baggage, catering, and fueling personnel. These areas can be dangerous for ground workers and passengers.²⁶ The Flight Safety Foundation, which has collected its own data on ramp safety, estimated that each year 27,000 ramp accidents and incidents occur worldwide and can be costly due to effects such as damage to aircraft and schedule disruptions.²⁷ In addition, ramp areas are complex because safety responsibilities in these areas vary by airport and even by terminal. For example, officials at Boston Logan International Airport told us that the airport operator shares some responsibilities with airlines but maintains control over all ramp areas. By contrast, officials at Los Angeles International Airport told us that in terminals leased by individual airlines, the airline controls the ramp area, while the airport operator controls the ramp areas in terminals where multiple airlines operate. Officials from the Air Line Pilots Association told us that ramp areas are the "scariest part of airports." One official gave an example of inconsistencies between airports that can cause confusion and risk, such as some airport ramp areas being marked with painted lines while others are not.

Federal internal control standards state that data should be appropriate, current, complete, and accurate.²⁸ In addition, FAA's own SMS calls for FAA to use a data-driven approach to analyze safety risks so that it can control that risk. As part of those efforts, FAA began the rulemaking

²⁶ [GAO-12-24](#).

²⁷ The Flight Safety Foundation estimated the cost of ramp accidents to major airlines worldwide, and did not separate the cost by country. See Flight Safety Foundation, "Defusing the Ramp," *Aero Safety World* (May 2007).

²⁸ [GAO-14-704G](#).

process in 2010 to require airports to implement SMS, through which airports would analyze risks in runways, taxiways, and ramp areas, but as of August 2019 this rule had not been finalized.²⁹ Although some airport officials we interviewed said they are voluntarily implementing SMS and could be collecting data on ramp area incidents, FAA—with its role in overseeing safety at all commercial airports—is better positioned to take steps to analyze ramp incidents across all U.S. airports. For example, an individual airport implementing SMS would analyze ramp area incidents at that airport, but FAA could analyze ramp area incidents and identify trends across hundreds of airports as it does for other terminal area incidents described above. Beginning to analyze ramp area incidents, for example in its new metric, would provide FAA with information necessary to mitigate ramp area incidents and ensure that it is directing its efforts to the riskiest parts of the terminal area.

FAA and Others Have Implemented Multiple Efforts to Address Terminal Area Safety, but FAA Has Not Assessed the Effectiveness of Many of Its Efforts

FAA, Airports, and Airlines Have Implemented Multiple Efforts to Improve Terminal Area Safety

FAA, airports, and airlines have implemented multiple efforts, including technologies, to improve runway, taxiway, and ramp safety; FAA's efforts, which are coordinated by the Runway Safety Group, focus primarily on runway and taxiway safety.

Runway Safety-Related Programs

FAA's primary runway and taxiway safety effort is the Runway Safety Program, whereby staff develop national and regional runway safety

²⁹ See 75 Fed. Reg. 62008 (Oct. 7, 2010) and 81 Fed. Reg. 45872 (July 14, 2016).

plans, analyze data on runway and taxiway incidents, and help local air traffic control managers organize annual Runway Safety Action Team (RSAT) meetings at which FAA, airport operator, and other stakeholders at each airport discuss recent runway and taxiway incidents. Prior to each RSAT, FAA's Regional Runway Safety Program Managers we met with told us they compile and share available information on each incident that occurred in the last year at the airport with the local air traffic manager. This information may include trends in incursions, the location of each incident on an airport map, and results from vehicle/pedestrian deviation investigations conducted by the FAA Office of Airports. Each air traffic manager then presents this information to attendees, who may include staff from FAA's Office of Airports or Flights Standards, the airport operator, and local pilots.³⁰

Participants discuss the prior year's incidents, identify risks, and develop a plan to mitigate these risks. For example, attendees at an RSAT in Phoenix, Arizona, discussed risk factors that could be contributing to pilot deviations, and identified that pilots could be missing taxiway markings that instruct pilots to stop before proceeding onto a runway. Consequently, these RSAT attendees developed a plan to add lights to the surrounding area to improve visibility. The attendees also tasked air traffic managers with developing a program to provide annual tours of the tower and airfield to local pilots and personnel working on the airfield to show both parties what the other sees during flight operations.

Another important FAA effort is the Runway Incursion Mitigation (RIM) Program established by the Office of Airports in 2015 to identify strategies to mitigate areas of airport runways or taxiways that do not meet current FAA airport design standards and have high incursions rates ("RIM locations").³¹ There can be multiple RIM locations at a single airport. FAA considers locations for inclusion in the RIM inventory based on whether the location has a non-standard design and has experienced three or more incursions in a given calendar year, or averaged at least one

³⁰ Federal Aviation Administration, *Runway Safety Program*, Order 7050.1B (Washington, D.C.: Nov. 7, 2013).

³¹ Federal Aviation Administration, *Airport Design*, Advisory Circular AC 150/5300-13A (Washington, D.C.: Feb. 26, 2014). Design standards include features such as limiting a pilot to three options at intersections (i.e. left, right, or straight ahead); designing taxiways to cross runways at 90-degree angles where possible; and designing taxiways in such a way that pilots cannot go directly from the ramp area to the runway without making at least one turn.

incursion per year over the course of the RIM program.³² At RIM locations, FAA provides funding and technical assistance to airports to mitigate the risk of incursions, such as by changing airport design and by improving runway and taxiway signage. For example, the airport may reconfigure a taxiway to intersect a runway at a 90-degree angle (the FAA standard), or install “hold position” signs at intersections between two runways. According to FAA, at the end of fiscal year 2018, FAA had helped airports mitigate 33 RIM locations through the program, leaving 135 locations across 79 airports that still needed to be mitigated.

FAA also collaborates with industry stakeholders to identify and address runway and taxiway safety issues. For example, FAA serves as Co-Chair of CAST, which analyzes data across airports to identify root causes of incidents and develop and track mitigations to address those causes. For instance, through CAST, FAA and industry stakeholders developed training for air traffic controllers to mitigate the risk of runway excursions. The training described factors that can contribute to runway excursions such as adverse winds, wet or contaminated runways, or unstable aircraft approaches. In addition, in 2015, FAA convened a forum of aviation stakeholders representing government, industry, and labor called the *Runway Safety Call to Action* which developed 22 short-, medium-, and long-range mitigations to address the rising number of reported runway incursions. In 2018, the DOT Office of Inspector General reviewed FAA’s progress in implementing these 22 mitigations and made three recommendations to address implementation challenges it identified, including consolidating duplicate mitigations and, as mentioned below, developing a plan to measure their effectiveness.³³ As of August 2019, FAA had not implemented these recommendations.

Individual airport operators and airlines have implemented their own efforts to improve runway, taxiway, and ramp safety. For example, officials who manage Daniel K. Inouye International Airport in Honolulu, Hawaii, told us that they changed the location of markings in an airport

³² Federal Aviation Administration, *Runway Incursion Mitigation Fiscal Year 2018 Annual Summary* Report, DOT/FAA/TC-19/9 (Washington, D.C.: Feb. 2019). Non-standard geometry characteristics include Y-shaped taxiways crossing a runway, two runway thresholds in close proximity, short taxiways between runways, and taxiways that intersect a runway at other than a 90-degree angle.

³³ U.S. Department of Transportation Office of Inspector General, *FAA Faces Challenges in Implementing and Measuring the Effectiveness of Its 2015 Runway Safety Call to Action Initiatives*, Report No. AV2018058 (Washington, D.C.: June 27, 2018).

area known to be confusing to some pilots, which reduced incursions at this location. In addition, officials from Airlines for America and the Regional Airlines Association told us airlines host safety meetings where they leverage their collective data to identify and address industry-wide safety trends. Officials told us that one of the working groups at these airline safety meetings specifically discusses issues and solutions pertaining to the ramp area.

Technologies

FAA, airports, and airlines fund multiple technologies to improve runway and taxiway safety, primarily through increasing air traffic controller, pilot, and vehicle operator awareness of their surroundings. See Table 1 for technologies in place or in development.

Table 1: Technologies Intended to Mitigate Terminal Area-Safety Risks

Technology	Description	Number of airports with technology ^a (as of July 2019)
Air Traffic Control Technologies (FAA): Airport Surface Detection Equipment, Model X (ASDE-X)	A surveillance system that integrates data from a variety of sources, including radars and transponders, to provide air traffic controllers with a surface-traffic situation display with visual and audible alerting of potential collisions.	35
Air Traffic Control Technologies (FAA): Taxiway Arrival Prediction	An enhancement to ASDE-X that detects and alerts air traffic controllers when an aircraft is lined up to land on a taxiway. FAA plans to install this enhancement at all 35 ASDE-X locations.	6
Air Traffic Control Technologies (FAA): Airport Surface Surveillance Capability (ASSC)	The successor to ASDE-X provides similar information to air traffic controllers regarding the location and movement of surface vehicles and aircraft.	2
Air Traffic Control Technologies (FAA): Small Airport Surveillance Sensor	A surveillance technology that FAA is developing to improve an air traffic controller's ability to track aircraft and ground vehicle locations and movements at small and medium-sized airports where an ASDE-X or ASSC system may be cost prohibitive.	n/a ^b
Aircraft Technologies: Automatic Dependent Surveillance-Broadcast (ADS-B) Out	A surveillance technology in aircraft that uses Global Positioning System (GPS) signals to transmit an aircraft's location to air traffic controllers, and potentially to other aircraft ^c	n/a ^d
Aircraft Technologies: Moving Map Displays/Own Ship Position	Voluntary, portable, or installed electronic navigational systems used in the cockpit that show pilots where their aircraft is positioned during taxi operations.	n/a ^d
Airport Technologies: Runway Status Lights	A lighting system that processes surveillance information from ASDE-X or ASSC, and then commands the airport's lighting system to turn the runway status lights on, thereby telling pilots and vehicle operators to stop when runways are not safe to enter or take off from.	20
Airport Technologies: Engineered Material Arresting System	Lightweight, crushable concrete that is placed at the end of a runway where there is not enough land for a standard runway safety area to stop or greatly slow an aircraft that overruns the runway.	69
Airport Technologies: Transponders in ground vehicles	Automatic Dependent Surveillance-Broadcast Out transponders installed in airport ground vehicles, known as "squitters," that transmit location and vehicle identification information to air traffic controllers and airport operations staff.	22

Source: GAO analysis of FAA and aviation industry information. | GAO-19-639

^aThere are 518 airports in the United States where the Federal Aviation Administration is responsible for guiding aircraft that are departing, landing, and moving around the terminal area.

^bThis technology is still in the development phase.

^cMost aircraft are required to be equipped with ADS-B Out transponders by 2020. See 14 C.F.R. § 91.225. FAA data as of May 2019 show that over 83,000 U.S. aircraft were equipped with ADS-B out of an estimated 241,000 aircraft that will need to equip by the 2020 deadline.

^dThis technology is installed in aircraft and is not installed at airports.

FAA surveillance technologies are multi-million dollar programs designed to help air traffic controllers identify aircraft and vehicles in the terminal

area. For example, at the 35 airports where ASDE-X has been installed since 2011, FAA estimated the total program cost to FAA to be more than \$800 million. In-aircraft technologies like those mentioned above help pilots identify their location on runways and taxiways, and could mitigate risks of injuries and damage caused by excursions.

FAA Has Not Assessed the Effectiveness of Many of Its Terminal-Area Safety Efforts

FAA has taken steps to improve terminal area safety, but has not assessed the effectiveness of many of its runway and taxiway safety efforts. For example, FAA has not evaluated how its primary efforts such as ASDE-X, ASSC, or the Runway Safety Program contribute to runway and taxiway safety, despite having implemented these efforts years ago. In some instances, FAA has taken steps to evaluate its terminal-area safety efforts. For example, FAA tracks the Runway Incursion Mitigation Program's outcomes and the number of runway excursions safely stopped by an Engineered Material Arresting System (EMAS).³⁴ FAA also contracted with a research organization in 2017 to evaluate the effectiveness of Runway Status Lights on the runway incursion rate at 15 airports.³⁵ Further, the Runway Safety Program manager described other instances in which local airport officials have taken steps to evaluate the effect of mitigations at those airports. For example, one of FAA's runway safety offices assessed the effect of five informational videos it produced, to highlight issues identified at specific airports, on runway incursions at those locations after the videos were released.³⁶

However, FAA has not assessed the effectiveness of many of its numerous other runway and taxiway efforts described above and FAA officials told us that FAA does not have a plan to do so. Officials told us

³⁴ FAA also tracks the number of passengers and crew on aircrafts involved in excursions that EMAS stopped. For example, FAA reported that since 1999, EMAS stopped 15 aircraft that contained 406 crew and passengers from running off the end of a runway.

³⁵ MITRE found declines in the runway incursion rate at 14 of these 15 airports. See The MITRE Corporation, *An Investigation of Runway Status Lights System Effectiveness and Voice Data Integration*. MITRE Technical Report 180509, (McLean, V.A.: September, 2018).

³⁶ This assessment found that four of the five videos were associated with a reduction in incursions.

that they believe that the assessments described above are sufficient, based on the availability of agency resources. In June 2018, the DOT IG reported a similar finding related to its assessment of FAA's 2015 *Runway Safety Call to Action*, described above. The DOT IG reported that FAA had a plan to track the completion of mitigations aimed at improving runway and taxiway safety, but not to link the mitigations to quantifiable goals or metrics that would measure their effectiveness in reducing runway incursions.³⁷

FAA's guidance on the Runway Safety Program states that FAA may evaluate the effectiveness of its runway safety programs, and the extent to which they are helping FAA meet its safety goals. In addition, in the 2016 *Evaluation Roadmap for a More Effective Government*, the American Evaluation Association stated that agencies should consistently use program evaluation and systematic analysis to improve program design, implementation, and effectiveness and to assess what works, what does not work, and why.³⁸ Evaluating a program's effectiveness can include methods such as surveying a program's managers (e.g., regional runway safety program managers), or comparing a program's performance to an evaluative criterion (e.g., a measure of terminal area safety). Without assessing the effectiveness of its range of efforts, FAA cannot determine the extent to which each of its efforts contribute to its goal of improving runway and taxiway safety, or whether other actions are needed. As discussed previously, FAA has efforts designed to increase runway and taxiway safety that range from periodic stakeholder meetings to multi-million dollar ground surveillance systems. By assessing the effectiveness of its primary efforts, FAA may be better positioned to make decisions about how to target its limited resources within and among these efforts.

FAA May Be Missing Opportunities to Improve Its Terminal-Area Safety Efforts

We also found that FAA may be missing opportunities to improve its terminal-area safety efforts, including improving communication within

³⁷ U.S. Department of Transportation, Office of Inspector General, *FAA Faces Challenges in Implementing and Measuring the Effectiveness of Its 2015 Runway Safety Call to Action Initiatives*, Report No. AV2018058 (Washington, D.C.: June 27, 2018).

³⁸ American Evaluation Association, *An Evaluation Roadmap for a More Effective Government* (Washington, D.C.: October 2016).

FAA. Specifically, FAA Regional Runway Safety Program staff told us that they do not receive the results of most runway incursion investigations—information that could aid RSAT discussions about preventing these incidents in the future. Four of FAA’s five Regional Runway Safety Program Managers we interviewed reported that, they did not receive the results of investigations of pilot deviations—which constitute the majority of runway incursions—from the Office of Flight Standards. As part of its investigations of these incursions, Flight Standards identifies possible causes and implements mitigations, such as additional pilot training. However, FAA does not require Flight Standards to automatically provide their investigations of runway and taxiway incidents to the Runway Safety Group, which could enhance runway and taxiway safety. FAA officials said that FAA requires Flight Standards to make its investigations available to Runway Safety Group staff, if requested, but acknowledged that this does not always result in Runway Safety Group staff receiving these investigations in a timely manner.

FAA officials said they are in the process of implementing additional processes to improve communication between Flight Standards and the Runway Safety Group, but documentation on these processes FAA provided to us did not address getting investigations to Runway Safety program staff in a timely manner. Without this information, the Regional Runway Safety Program Managers may be unable to provide air traffic managers with relevant information on most incursion investigations as they prepare to host their annual RSAT meetings.³⁹ The manager of the Runway Safety Group told us that Regional Runway Safety Program Managers may request individual investigations from regional Flight Standards officials, but that it would be time consuming for these regional managers to make such requests for every pilot deviation.

One of FAA’s objectives is to improve runway and taxiway safety, and federal internal control standards state that management should internally communicate the information necessary to help meet its objectives.⁴⁰ Without timely access to the results of Flight Standards’ incident investigations, Regional Runway Safety Program Managers—and therefore, local air traffic control managers—may not have all of the

³⁹ Federal Aviation Administration, *Runway Safety Program*, Order 7050.1B (Washington, D.C.: November 7, 2013).

⁴⁰ [GAO-14-704G](#).

relevant information they need to develop appropriate runway and taxiway safety mitigation strategies and plans.

Selected airport operators we interviewed also reported that they may not have all information they need to develop appropriate terminal area safety mitigation strategies. Specifically, most of those we interviewed reported that air traffic control managers did not provide them with complete and timely information on all runway and taxiway incidents. Six of 10 airport operators we interviewed told us that air traffic control managers did not notify them of all runway and taxiway incidents as they happened. Further, some airport operators told us that they were not aware of all incidents until the annual RSAT meeting. For example, the operator of one airport told us that the air traffic manager notifies the airport of vehicle/pedestrian deviations immediately, but not of operational incidents or pilot deviations. The Manager of the Runway Safety Program also confirmed that communication varies by airport operator and air traffic manager.

According to federal internal control standards, management should communicate quality information externally so that external parties can help the entity achieve its objectives and address related risks.⁴¹ Further, according to air traffic control procedures, controllers are required to report as soon as possible to airport managers and others “any information which may have an adverse effect on air safety.”⁴² However, this requirement does not specify the types of terminal area safety incidents to which this applies. Also, through a 2018 internal risk management process, FAA identified the need for enhanced communication among airport management, the FAA Air Traffic Organization, and pilots at towered airport facilities, in order to mitigate the safety risks associated with runway incursions.⁴³ Lacking complete information on runway and taxiway incidents at their airports could hamper airport operators’ ability to develop appropriate safety strategies or make investment decisions related to safety in a timely manner. For example, the operator of one airport told us that not being notified of operational incidents means the airport does not have a complete picture

⁴¹ [GAO-14-704G](#).

⁴² Federal Aviation Administration, *Air Traffic Control*, Order JO 7110.65X, (Washington, D.C.: Oct. 12, 2017).

⁴³ FAA, *Runway Incursion Safety Issue Safety Risk Management Document*, Version 1.2 (Washington, D.C.: July 3, 2018).

of the safety incidents there, which limits their ability to identify trends or training needs.

Conclusions

FAA's safety oversight approach is designed to use data to identify hazards, manage risks, and mitigate them before an accident occurs. FAA uses data to analyze runway incursions, and recently developed a new metric to track the risk of terminal-area incidents. However, without leveraging data to analyze all terminal-area incidents, FAA may be missing opportunities to better target the agency's resources, and ultimately to further improve safety. For example, because FAA does not have a process to eliminate all duplicates from its excursion data, it does not have assurance that its excursion data are accurate, and it may be missing opportunities to mitigate the risks excursions pose. Similarly, taking steps to analyze ramp area incidents by identifying such incidents in its new metric would help FAA determine whether it needs to focus more on improving safety in ramp areas. In addition, establishing a plan to evaluate all of its runway and taxiway safety efforts would help FAA direct its resources toward activities and technologies proven to enhance safety and identify ways to strengthen those efforts. Moreover, improving internal communication among FAA offices could make the annual Runway Safety Action Team meetings—a key component of FAA's terminal area safety efforts—more effective. And last, improving external communication between air traffic managers and airport operators would help airports identify and implement needed mitigations more quickly.

Recommendations for Executive Action

We are making the following five recommendations to FAA:

1. The Runway Safety Manager should develop a process to identify and remove duplicate excursion records. (Recommendation 1)
2. The Runway Safety Manager should take steps to analyze data on ramp area incidents in FAA's new surface safety metric. (Recommendation 2)
3. The Runway Safety Manager should establish a plan to assess the effectiveness of all of FAA's terminal area-safety efforts, including

Airport Surface Detection Equipment, Model X (ASDE-X) and the Runway Safety Program. (Recommendation 3)

4. The Administrator of FAA should require Flight Standards to share the results of its investigations with the Runway Safety Group, in a timely manner. (Recommendation 4)
5. The Administrator of FAA should require air traffic control managers to share information on terminal area incidents, such as operational incidents and pilot deviations, with airport operators, in a timely manner. (Recommendation 5)

Agency Comments and Our Evaluation

We provided the Department of Transportation (DOT), the Department of Labor (DOL), the National Aeronautics and Space Administration (NASA), and the National Transportation Safety Board (NTSB), with a draft of this report for review and comment. In its written comments reproduced in appendix I, DOT concurred with our recommendations. DOL, NASA, and NTSB did not provide technical comments.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 11 days from the report date. At that time, we will send copies to the appropriate congressional committees, DOT, DOL, NASA, NTSB, and other interested parties. In addition, the report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or krauseh@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix II.



Heather Krause
Director, Physical Infrastructure

Appendix I: Comments from the Department of Transportation

**Appendix I: Comments from the Department of
Transportation**



**U.S. Department of
Transportation**
Office of the Secretary
of Transportation

Assistant Secretary
for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

AUG 13 2019

Heather Krause
Director, Physical Infrastructure Issues
U.S. Government Accountability Office (GAO)
441 G Street NW
Washington, DC 20548

Reducing the risks posed by surface accidents and other surface events remains a top priority for the Federal Aviation Administration (FAA). Historically, FAA's surface safety efforts focused upon reducing the number and severity of runway incursions. However, the National Airspace System (NAS) continues to grow and evolve, and emerging issues take on added significance such as increased surface traffic density in the terminal area. Thus, the FAA has expanded its focus beyond runway incursions to all areas of airport operations. The FAA's Runway Safety Group has established a collaborative approach to implementing integrated, data-informed strategies anchored by the Safety Management System and measured by the Surface Safety Risk Index. These data show:

- The number of runway safety accidents has remained relatively consistent.
- The number of reported runway incursions and surface events has increased, which is consistent with the FAA's policies establishing the value of precursor information instead of accident investigation. These policies allow more events to be reported to better inform the safety mitigation activities.
- The risk to surface safety in the NAS has decreased as a result of more informed mitigation activities.

The Department concurs with the recommendations and will provide a detailed response to each recommendation within 180-days of the final report's issuance.

We appreciate the opportunity to offer additional perspective on the GAO draft report. Please contact Madeline Chulumovich, Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional details about these comments.

Sincerely,

Keith Washington
Deputy Assistant Secretary for Administration

Appendix II: GAO Contact and Staff Acknowledgements

GAO Contact

Heather Krause, (202) 512-2834 or KrauseH@gao.gov

Staff Acknowledgments

In addition to the individual named above, other key contributors to this report were Heather MacLeod (Assistant Director); Sarah Farkas (Analyst-in-Charge); Dave Hooper; Josh Ormond; Madhav Panwar; Steven Rabinowitz; Laurel Voloder; Madeline Welter; and Elizabeth Wood.

Appendix III: Accessible Data

Data Tables

Accessible Data for Figure 4: Number and Rate of Reported Runway Incursions, Fiscal Years 2011 through 2018

Fiscal Year	Runway Incursions	Rate of Incursions per 100,000 operations
2011	954	1.88
2012	1150	2.274
2013	1242	2.487
2014	1264	2.547
2015	1458	2.932
2016	1560	3.12
2017	1738	3.454
2018	1804	3.485

Agency Comment Letter

Accessible Text for Appendix I Comments from the Department of Transportation

Heather Krause

Director, Physical Infrastructure Issues

AUG 13 2019

U.S. Government Accountability Office (GAO)

441 G Street NW

Washington, DC 20548

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Sincerely,

Madeline M. Chulumovich for

Keith Washington

Deputy Assistant Secretary for Administration

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