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# AVIATION SAFETY

## Improved Data Quality and Analysis Capabilities Are Needed as FAA Plans a Risk-Based Approach to Safety Oversight



GAO

Accountability \* Integrity \* Reliability



Highlights of [GAO-10-414](#), a report to congressional requesters.

## Why GAO Did This Study

To improve aviation safety, the Federal Aviation Administration (FAA) plans to have in place the initial capabilities of a risk-based approach to safety oversight, known as a safety management system (SMS), by the end of fiscal year 2010. FAA is also implementing new procedures and technologies to enhance the safety, capacity, and efficiency of the national airspace system. Data are central to SMS and FAA's ability to test the impact of these changes on safety.

This congressionally requested report addresses FAA's (1) current and planned use of data to oversee aviation safety, (2) access to data for monitoring aviation safety and the safety performance of various industry sectors, and (3) efforts to help ensure data quality. To perform this work, GAO reviewed 13 databases that contain data on key aviation safety events, assessed data quality controls for the databases, and interviewed agency and industry officials, as well as 10 experts in aviation safety and data.

## What GAO Recommends

GAO recommends efforts to improve FAA's capability to use data for oversight, including developing a comprehensive data management plan; identifying and, to the extent feasible, addressing reasons for nonparticipation in voluntary reporting programs; and applying data quality controls to more databases, as appropriate. The agency agreed to consider GAO's recommendations.

View [GAO-10-414](#) or [key components](#). For more information, contact Gerald L. Dillingham, Ph.D., at (202) 512-2834 or [dillinghamg@gao.gov](mailto:dillinghamg@gao.gov).

## AVIATION SAFETY

### Improved Data Quality and Analysis Capabilities Are Needed as FAA Plans a Risk-Based Approach to Safety Oversight

#### What GAO Found

FAA analyzes data on past safety events, such as engine failures, to prevent their recurrence and plans to use data to support a more proactive approach to managing risk. For example, weather and air traffic control data helped identify factors associated with injuries from turbulence. As part of SMS, FAA plans to analyze data proactively to support a risk-based approach to safety oversight. For example, FAA plans to use data to model the impact of proposed changes in procedures and technologies on the safety of the national airspace system. Experts said that identifying risks is necessary to maintain the current level of safety and possibly achieve a higher level of safety in the future. Because SMS relies on data to identify emerging risks, FAA has an effort under way to enhance its access to industry data and improve its capability for automated analysis of multiple databases. According to FAA, this effort will allow for more efficient safety analyses. FAA is also developing a plan for managing data under SMS, but the plan does not fully address data, analysis, or staffing requirements. Without such requirements, the plan will not provide timely guidance for implementing SMS.

FAA has access to some voluntarily reported data, which are important for SMS, but not all carriers and aviation personnel participate in FAA's voluntary reporting programs. Such data are gathered electronically by equipment on aircraft or reported by aviation personnel or carriers following noncriminal, unintentional violations or safety events. Industry personnel have some incentives to participate in voluntary programs, such as promised immunity from disciplinary action, but concerns about sanctions and the cost of equipment have deterred full participation, especially by smaller carriers. While FAA has some information on reasons for nonparticipation and has taken some steps to promote greater participation, it lacks carrier-specific information on why air carriers are not participating. FAA also lacks data to assess the safety performance of certain industry sectors, such as air cargo and air ambulance operators. GAO has previously made recommendations to address this lack of data. FAA concurred with GAO's prior recommendations and is taking actions to address them.

To help ensure data quality—that is, data that are reliable (complete and accurate) and valid (measure what is intended)—FAA has implemented a number of data quality controls that are consistent with GAO's standards for data quality, but some weaknesses exist. For example, all the databases GAO reviewed had at least some controls in place to ensure that erroneous data are identified, reported, and corrected. However, about half the databases lack an important control—managers do not review the data prior to entry into the data system. FAA is taking steps to address its data weaknesses, but vulnerabilities remain, potentially limiting the usefulness of FAA's data for the safety analyses planned to support SMS.

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# Contents

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|                    |  |    |
|--------------------|--|----|
| <b>Letter</b>      |  | 1  |
|                    | Background   | 3  |
|                    | FAA Analyzes Data on Past Safety Events to Prevent Their<br>Recurrence and Plans to Use Data to Support a More Proactive<br>Approach to Managing Risks | 6  |
|                    | FAA Has Limited Access to Some Voluntarily Reported Data and<br>Lacks Key Data to Assess the Safety Performance of Certain<br>Industry Sectors         | 17 |
|                    | FAA Has Various Processes in Place to Help Ensure Data Quality,<br>but Weaknesses Still Exist  | 25 |
|                    | Conclusions  | 31 |
|                    | Recommendations for Executive Action   | 32 |
|                    | Agency Comments  | 32 |
| <b>Appendix I</b>  | <b>Objectives, Scope, and Methodology</b>  | 36 |
| <b>Appendix II</b> | <b>GAO Contact and Staff Acknowledgments</b>   | 40 |
| <b>Tables</b>      |  |    |
|                    | Table 1: Aviation Safety Databases We Reviewed   | 5  |
|                    | Table 2: Examples of How Data Have Been Used by FAA or<br>Industry in Reactive Approaches to Managing Risk   | 7  |
|                    | Table 3: Examples of Additional Controls for Managing Data<br>Quality  | 28 |
|                    | Table 4: Aviation Safety Events Included in Our Review   | 36 |
|                    | Table 5: Organizations That GAO Contacted  | 38 |
| <b>Figures</b>     |  |    |
|                    | Figure 1: FAA's Emphasis Is Shifting from Reactive to Proactive<br>Approaches to Data Analysis   | 9  |
|                    | Figure 2: Number of General Aviation Accidents and Fatalities,<br>2000 through 2008  | 23 |
|                    | Figure 3: Extent to Which Aviation Safety Databases Reviewed<br>Have Standard Data Quality Controls  | 27 |

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## Abbreviations

|         |  |
|---------|--|
| AIDS    | Accident/Incident Data System                    |
| ASAP    | Aviation Safety Action Program                   |
| ASIAS   | Aviation Safety Information Analysis and Sharing |
| ASRS    | Aviation Safety Reporting System                 |
| ATO     | Air Traffic Organization                         |
| ATOS    | Air Transportation Oversight System              |
| ATSAP   | Air Traffic Safety Action Program                |
| CAST    | Commercial Aviation Safety Team                  |
| DOT     | Department of Transportation                     |
| FAA     | Federal Aviation Administration                  |
| FOQA    | Flight Operational Quality Assurance             |
| ICAO    | International Civil Aviation Organization        |
| IG      | inspector general                                |
| NAOMS   | National Aviation Operations Monitoring Service  |
| NASA    | National Aeronautics and Space Administration    |
| NextGen | Next Generation Air Transportation System        |
| NMACS   | Near Midair Collision System                     |
| NTSB    | National Transportation Safety Board             |
| OEDS    | Operational Error/Deviation System               |
| PDS     | Pilot Deviation System                           |
| SDRS    | Service Difficulty Report                        |
| SMS     | safety management system                         |
| UK      | United Kingdom                                   |
| USDA    | U.S. Department of Agriculture                   |
| VPDS    | Vehicle Pedestrian Deviation System              |
| VDRP    | Voluntary Disclosure Reporting Program           |

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May 6, 2010

### Congressional Requesters

To increase the safety, capacity, and efficiency of the national airspace system, the Federal Aviation Administration (FAA), in cooperation with aviation industry stakeholders and other federal agencies, is developing a new, technologically advanced air traffic management system—the Next Generation Air Transportation System (NextGen). At the same time, FAA is attempting to further enhance aviation safety by shifting to a new data-driven, risk-based safety oversight approach, which industry and international air traffic management organizations are also adopting. Under this new approach, called a safety management system (SMS) approach, FAA will continue to use data on aviation accidents and incidents—referred to collectively as safety events—to identify and address their causes. In addition, under SMS, FAA plans to use aviation safety data to identify conditions that could lead to safety events and to address them through changes in organizational processes, management, and culture. Furthermore, SMS will allow FAA to test the impact of NextGen changes on aviation safety and to identify safety vulnerabilities and mitigating measures.

You asked us to assess FAA’s capacity to use available data to oversee aviation safety.<sup>1</sup> To do so, we addressed the following questions:

1. How does FAA use data to oversee aviation safety and what changes, if any, has it planned?
2. To what extent does FAA have access to data for monitoring aviation safety and the safety of various aviation industry sectors?
3. What does FAA do to help ensure the quality of the data it uses to oversee aviation safety?

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<sup>1</sup>In this report, we define “oversight” broadly as FAA’s activities to monitor aviation safety through the use of data. By comparison, FAA uses the term “oversight” only to refer to its determination of regulatory compliance and “monitoring” to refer to FAA’s voluntary safety programs (defined later in this report), which monitor aviation safety through the use of voluntarily supplied data that provides insight into the total flight operations environment.

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To answer these questions, we reviewed 13 aviation safety databases maintained by FAA, the National Aeronautics and Space Administration (NASA), the National Transportation Safety Board (NTSB), and the U.S. Department of Agriculture (USDA). We selected these databases because they covered key safety events identified by an FAA-industry effort, the Commercial Aviation Safety Team (CAST),<sup>2</sup> and NASA's National Aviation Operations Monitoring Service (NAOMS) project—a research and development effort that examined the feasibility of using surveys of randomly selected pilots to identify accident precursors and potential safety issues.<sup>3</sup> Those safety events are

- equipment problems, including engine shutdowns and cargo shifts;
- turbulence;
- weather events while airborne, including icing and wind shear;
- passenger-related events, including medical emergencies;
- flight crew problems, such as pilot fatigue;
- airborne conflicts, including bird strikes;
- ground events, including near collisions on the runway;
- aircraft handling-related events, including near collisions with terrain, deviations from assigned routes, and hard landings;
- altitude deviations; and
- adverse interactions with air traffic control, including the inability to communicate with air traffic controllers.

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<sup>2</sup>CAST selects and analyzes past aviation safety events to identify their precipitating conditions and causes and formulates an intervention strategy to reduce the likelihood of a recurrence.

<sup>3</sup>In assessing NASA's project, we determined that the safety events used in the survey were developed based on a solid foundation of available data, literature, and information from aviation stakeholders. See GAO, *Aviation Safety: NASA's National Aviation Operations Monitoring Service Project Was Designed Appropriately, but Sampling and Other Issues Complicate Data Analysis*, [GAO-09-112](#) (Washington, D.C.: Mar. 13, 2009).

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We also selected these databases because they contain data from a range of internal FAA and external sources. To determine the quality of these data, we collected and compared information on the data quality controls used by FAA and others with GAO-identified practices for helping to ensure data reliability.<sup>4</sup> These practices include ensuring that the data are complete and accurate, measure intended safety concerns, and are useful for their intended oversight purposes. FAA and industry gather many other types of data—such as FAA’s air carriers’ operations and maintenance data—that we did not assess as part of this review.

We also interviewed 10 aviation safety and data experts to identify critical data-related issues facing FAA and, where applicable, to assess the agency’s approaches for addressing data-related issues. We selected experts in aircraft operations, human factors, aircraft maintenance, and air traffic control. These experts have general knowledge about aviation safety and represent a cross section of the aviation industry. Throughout this report we have highlighted key comments of these stakeholders as sidebars. In addition, we analyzed documents and interviewed officials from FAA, NASA, NTSB, USDA, and air carriers; government contractors that analyze or help collect selected data; aviation industry organizations; data vendors; and air carrier employee groups. We also used the results of GAO studies that considered the availability, quality, and use of data in aviation safety oversight. We conducted this performance audit from August 2008 through May 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. (See app. I for additional information on our methods.)

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## Background

Federal agencies and aviation industry stakeholders gather and analyze aviation data for a variety of purposes. Federal agencies gather and analyze aviation data primarily to improve safety. To oversee aviation safety across the national airspace system, FAA maintains data on various aviation sectors, including passenger airlines, air cargo carriers, general aviation, and air ambulance operators. FAA also gathers and analyzes data on industry performance through its inspection and certification programs

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<sup>4</sup>GAO, *Internal Control Management and Evaluation Tool*, GAO-01-1008G (Washington, D.C.: Aug. 1, 2001).

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and uses these data to ensure that the industry complies with its safety regulations.<sup>5</sup> In addition, FAA obtains information on safety events and incidents collected by other federal agencies, including NTSB, NASA, and USDA.

The aviation industry gathers quantitative and narrative data on the performance of flights and analyzes these data to increase safety, efficiency, and profitability. Industry stakeholders also maintain historical data on equipment and maintenance issues. These stakeholders are required to report some data to FAA, such as data on accidents, engine failures, and near midair collisions, and they have agreements with FAA and other agencies to share other data voluntarily. The voluntarily shared data include both electronically recorded data from aircraft equipment under the Flight Operational Quality Assurance program (FOQA) and information on violations of federal regulations or on safety events self-reported by pilots, mechanics, and other airmen under three programs—Aviation Safety Action Program (ASAP), Aviation Safety Reporting System (ASRS), and Voluntary Disclosure Reporting Program (VDRP).<sup>6</sup> FAA also recently established the Air Traffic Safety Action Program (ATSAP), modeled after the airlines' ASAP program. It is a confidential, voluntary reporting system available to FAA's approximately 17,000 air traffic control personnel, who can use the program to identify and report safety and operational concerns.<sup>7</sup>

Table 1 describes the 13 aviation safety databases that we reviewed.

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<sup>5</sup>For example, FAA regulates both U.S. commercial passenger and air cargo carriers under parts 121 and 135 of Title 14 of the Code of Federal Regulations. Briefly stated, part 121 applies to air carrier operations involving airplanes with a seating capacity of 10 or more passengers or a maximum payload capacity of more than 7,500 pounds. Part 135 governs small aircraft that have a seating capacity of fewer than 10 passengers or a payload of less than 7,500 pounds. The agency regulates general aviation under part 91 and air ambulances under part 135 (when patients are on board) and part 91 (when patients are not present).

<sup>6</sup>FAA agrees not to take enforcement actions against self-reported violations of regulations to encourage reporting. The types of violations not covered under the programs are described later in this report.

<sup>7</sup>We did not include ATSAP in our analysis of voluntarily reported data systems because of the recentness of this program. However, according to an FAA analysis, in 3,860 (or 38 percent) of more than 12,000 reports, air traffic control personnel have provided information that they believe could introduce risk into the system, thereby facilitating proactive containment of the hazard in question.

**Table 1: Aviation Safety Databases We Reviewed**

| Database/date established   | Responsible entity | Source of data   | Data collected  | Data format                            |
|---|--------------------|--|---|--|
| <b>Voluntary databases</b>  |                    |  |   |  |
| Aviation Safety Action Program/1997   | FAA, air carriers  | Members of participating aviation industry employee groups   | All types of safety events  | Narrative                              |
| Aviation Safety Reporting System /1987  | NASA               | Industry personnel in the air and on the ground (e.g., air traffic controllers, mechanics, flight attendants, and ground crews)    | All types of safety events  | Narrative, quantitative                |
| Flight Operational Quality Assurance /1995  | FAA, air carriers  | Devices on specially equipped aircraft that collect data from the aircraft's flight data recorders                                 | In-flight operations  | Quantitative                           |
| Voluntary Disclosure Reporting Program /1990                                      | FAA                | Air carriers, repair stations, production approval holders, and fractional ownership programs operating under part 91 <sup>a</sup> | All types of safety events  | Narrative                              |
| <b>Other databases</b>  |                    |  |   |  |
| Accident/Incident Data System (AIDS)/1978   | FAA                | FAA inspectors   | Some aviation accidents and those incidents not investigated by NTSB <sup>b</sup> | Primarily narrative, some quantitative |
| Air Transportation Oversight System (ATOS)/1998                                   | FAA                | FAA inspectors   | Inspection results  | Narrative, quantitative                |
| National Wildlife Strike Database (Wildlife)/1990                                 | FAA, USDA          | Pilots, air traffic control personnel, and others involved in civil aviation   | Bird and other wildlife strikes   | Narrative, quantitative                |
| Near Midair Collision System (NMACS)/1987   | FAA                | Pilots and other flight crew members   | Near midair collisions  | Narrative, quantitative                |
| National Transportation Safety Board Aviation Accident and Incident Database/1982 | NTSB               | NTSB investigators   | Aviation accidents and major incidents  | Primarily quantitative, some narrative |
| Operational Error/Deviation System (OEDS)/1985                                    | FAA                | Air traffic controllers and air traffic equipment  | Air traffic control operational errors and pilot deviations <sup>c</sup>          | Primarily quantitative, some narrative |
| Pilot Deviation System (PDS)/1987   | FAA                | Air traffic controllers and other FAA personnel  | Pilot deviations  | Primarily quantitative, some narrative |
| Service Difficulty Reports (SDRS)/1986  | FAA                | Pilots, mechanics, inspectors, and others  | Aircraft equipment problems   | Narrative, quantitative                |
| Vehicle Pedestrian Deviation System (VPDS)/1988                                   | FAA                | Air traffic controllers, other FAA and industry personnel  | Unauthorized entry on a runway by a vehicle, pedestrian, or aircraft              | Narrative, quantitative                |

Sources: FAA, NASA, NTSB, USDA, and GAO.

<sup>a</sup>A production approval holder is an entity that holds a certificate, approval, or authorization from FAA to manufacture aircraft, aircraft engines, propellers, and related parts and articles. Fractional ownership refers to shared aircraft ownership.

<sup>b</sup>NTSB investigates all aviation accidents and major aviation incidents.

<sup>c</sup>An operational error/deviation is a violation of FAA separation standards that define minimum safe distances between aircraft, between aircraft and other physical structures, and between aircraft and otherwise restricted airspace. The event is classified as an operational error when an air traffic controller's actions cause the loss of minimum separation; the event is classified as a pilot deviation when a pilot's actions cause the loss, or both.

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## FAA Analyzes Data on Past Safety Events to Prevent Their Recurrence and Plans to Use Data to Support a More Proactive Approach to Managing Risks

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### FAA Is Shifting from a Reactive to a Proactive Approach to Using Data to Manage Risk

For decades, the aviation industry and federal regulators, including FAA, have used data reactively to identify the causes of aviation accidents and incidents and take actions to prevent their recurrence. Since 1998, for example, FAA has partnered with the airline industry through CAST with the goal of continuously improving aviation safety. Over the years, CAST has looked at the causes of past accidents—such as controlled flight into terrain<sup>8</sup>—and various safety events—such as turbulence or runway incursions. CAST analyzes past instances of such accidents and events to identify precipitating conditions and causes. CAST then uses its analysis to formulate an intervention strategy designed to reduce the likelihood of a recurrence and validate the effectiveness of the intervention. According to CAST, its work has helped to decrease commercial airline fatalities—exceeding its goal to reduce fatal commercial accidents by 80 percent by 2007—and is an important aspect of FAA’s efforts to increase aviation safety by sharing and analyzing data. Table 2 provides examples of how FAA and industry have used CAST’s work. (Recent work by CAST to work with FAA’s Aviation Safety Information Analysis and Sharing [ASIAS] initiative to develop safety enhancements and mitigate future threats is discussed later in this report.)

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<sup>8</sup>Controlled flight into terrain occurs when an airworthy aircraft under the control of the pilot is inadvertently flown into terrain, water, or an obstacle. The pilot is generally unaware of the danger until it is too late.

**Table 2: Examples of How Data Have Been Used by FAA or Industry in Reactive Approaches to Managing Risk**

| Safety event identified by CAST as important | Use of data to manage risk   |
|--|--|
| Airborne conflict                            | Reporting of bird strikes has led to the identification of runways at over 290 airports that may require wildlife mitigation efforts.  |
| Aircraft handling                            | A review of ASRS reports identified a risk of potential midair collisions at the Minden-Tahoe airport in Nevada near a parachuting center’s drop zone, and the drop zone was moved to reduce this risk.  |
| Controlled flight into terrain               | A study of the Terrain Awareness and Warning System—which warns pilots that their aircraft is about to collide with terrain—revealed that all air carrier flight crew training should emphasize situational awareness and escape procedures in the event of a warning.                                       |
| Flight deck automation                       | A review of automation-related events found inadequate pilot training and knowledge of automation systems and led airlines to change their automation policies and training to address these deficiencies.   |
| Runway incursion                             | Analysis of data on the frequency of unauthorized entry or activity on an airport runway by a vehicle, pedestrian, or aircraft led to changes in signage at all airports with more than 370,000 annual enplaned passengers.  |
| Turbulence                                   | Integration of meteorological, crew activity, and air traffic control data led to the identification of factors associated with injuries from turbulence and recommendations for improvements in the use of available information and in communications between pilots and flight attendants and passengers. |
| Uncontained engine failure                   | An analysis of the causes of engine-related accidents led FAA to issue an airworthiness directive requiring airlines to inspect engine components.   |

Sources: CAST, FAA, and GAO.

Besides analyzing data on past safety events to develop intervention strategies, FAA staff perform such analyses to inform changes in agency policies. For example, to inform the rule-making requirement that the costs and benefits of a proposed regulation be determined under Executive Order 12866, FAA analysts identified the number of aircraft that could be certified as “light sport” aircraft and were involved in accidents.<sup>9</sup>

<sup>9</sup>Light sport aircraft have, among other criteria, a maximum gross takeoff weight of not more than 1,320 pounds, a maximum airspeed of 140 miles per hour, and seating for only one passenger besides the pilot.

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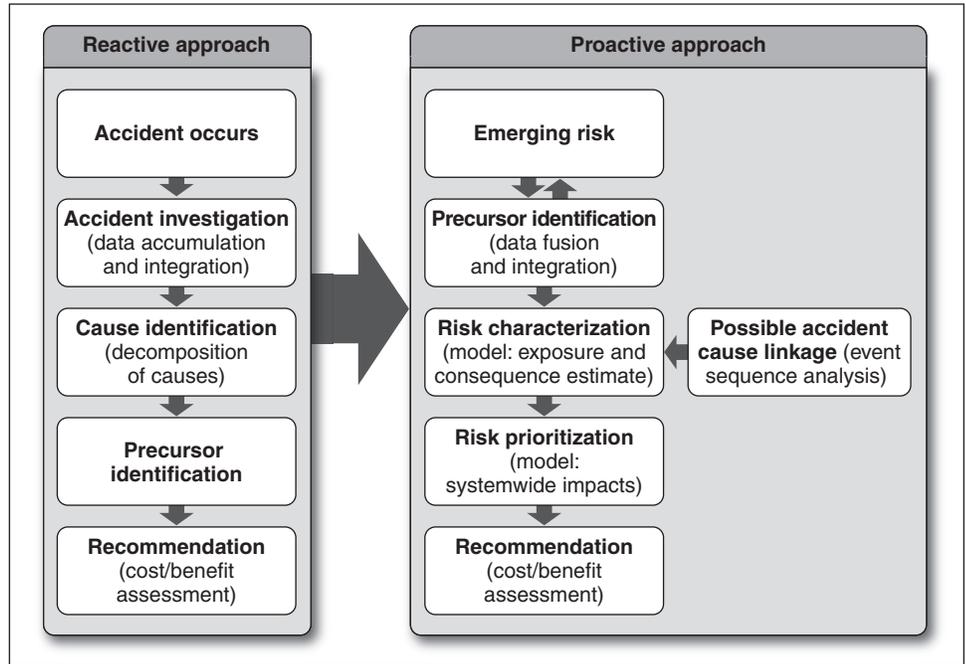
In some cases, FAA program managers request specific analyses to inform policy changes. For instance, in response to a 2007 recommendation by NTSB and a petition from Hawaiian air tour operators, FAA program managers requested an analysis of aircraft crashes associated with FAA's requirement for tour aircraft to maintain a 1,500-foot separation from the ground. After analyzing air crashes involving Hawaiian tour aircraft 13 years before and 13 years after the requirement was implemented, FAA concluded that the requirement helped to reduce the number of crashes and significantly improved safety.

While FAA will continue to use data to analyze past safety events, it is also working to use data proactively to search for risks and take actions to mitigate them before they result in accidents. FAA's emphasis is shifting to a proactive approach to data analysis because as accidents have become increasingly rare, less information is available for reactive analyses of their causes. As a result, according to a study of FAA's safety oversight by a 2008 independent review team, information that can be used to help identify accident and incident precursors, such as voluntarily reported data, has become more critical for accident prevention.<sup>10</sup> In addition, several experts we spoke with said that proactively identifying risks is necessary to maintain the current level of safety and possibly achieve an even higher level of safety in the future. FAA is undertaking this transition in coordination with the international aviation community, working with the International Civil Aviation Organization (ICAO) to adopt applicable global standards for safety management. Senior FAA officials and ICAO agree that effective safety management is data driven and that data are essential to identifying emerging risks. Figure 1 illustrates the type of transition FAA plans as the agency shifts its emphasis to a proactive assessment of emerging safety risks, according to FAA officials.

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<sup>10</sup>Independent Review Team, *Managing Risks in Civil Aviation: A Review of the FAA's Approach to Safety* (Washington, D.C.: Sept. 2, 2008). The team was chartered by the Secretary of Transportation to assess FAA's safety culture and approach to safety management.

**Figure 1: FAA's Emphasis Is Shifting from Reactive to Proactive Approaches to Data Analysis**



Sources: FAA and GAO.

### FAA Plans to Use Data Proactively to Model the Impact of NextGen Changes on the Safety of the National Airspace System

The new technologies and procedures that FAA will implement for NextGen, which are intended to increase the safety, efficiency, and capacity of the national airspace system, could also lead to consequences that have unintended effects on system safety. For example, NextGen changes to landing procedures, which are designed to allow more frequent landings, could reduce congestion in the air and improve fuel efficiency, but might have the unintended effect of increasing congestion and safety risks on airport taxiways. To avoid such unintended consequences, FAA plans, as it improves its ability to integrate data and analyze trends, to model the impact of changes planned for NextGen. To do so, it has begun to develop a baseline of current conditions and then expects to analyze how NextGen changes will affect those conditions, according to a senior FAA official. FAA is in the process of designing tools that will allow it to model the changes. For example, a project called the National Level System Safety Assessment is designed to allow FAA to assess risks across the national airspace system. Currently, FAA assesses risks for specific NextGen procedures and technologies, but cannot model the risks across the national airspace system in a comprehensive manner. This project will integrate data on past safety events from a number of FAA offices and

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external sources to proactively identify risks that might emerge with the introduction of changes planned for NextGen. FAA has begun to obtain some operational data for the project and has contracted with the Volpe National Transportation Systems Center, which will be responsible for integrating airport runway surface data, including surface radar, weather, aircraft, and other data.<sup>11</sup> A senior FAA official told us that although safety assessments had been conducted on individual NextGen technologies, until the agency has finalized this modeling project, it cannot begin systemwide assessments of the safety of NextGen technologies and procedures that are already being deployed, including 700 new navigational procedures that had been deployed as of October 2009.

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### SMS and Its Use of Data Form the Linchpin of FAA's Risk-Based Approach, but Full Implementation of SMS Could Be Years Away

SMS is an integrated, data-driven approach to managing safety risk that FAA expects will help it continuously improve aviation safety.<sup>12</sup> FAA stated that successfully implementing SMS is critical to meeting the challenges of a rapidly changing and expanding aviation system. As stated earlier in this report, FAA's traditional approach is to analyze data to determine the causes of an accident or incident after the fact. To achieve the next level of safety, FAA says, it now requires a more forward-thinking approach, which SMS provides, to identify systemwide trends and manage emerging risks before they result in incidents or accidents. To identify emerging risks, FAA plans to collect and analyze safety data, and it can then use the results of its analyses to make data-driven decisions about how to address safety risks. Issued in September 2008, FAA's guidance on implementing SMS explains the importance of data collection and analysis to the execution of SMS.<sup>13</sup> This guidance defines four main components for SMS: safety policy and objectives, safety risk management, safety assurance, and safety promotion. First, safety policy and objectives describe an organization's requirements and oversight responsibilities for aviation activities. Second, safety risk management describes how an organization will identify hazards and safety risks in aviation operations,

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<sup>11</sup>The Volpe Center, which is part of the Department of Transportation's Research and Innovative Technology Administration, is a federal fee-for-service organization that focuses on crosscutting transportation, research, education, innovation, and other multimodal issues.

<sup>12</sup>In this report, SMS refers only to FAA's internal implementation of SMS as it applies to the Office of Aviation Safety, the Air Traffic Organization, and the Office of Airports. FAA intends that the aviation industry will also implement SMS.

<sup>13</sup>This guidance is modeled on ICAO's international framework and standards for safety management.

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including how it will develop rules, regulations, and safety performance measures. Third, the safety assurance component of SMS uses data analyses to discover emerging risks and to model the impact of safety changes. Fourth, safety promotion is an organization's plan to ensure that training, communication, and dissemination of safety information take place. According to FAA, SMS with these components will enable the agency to provide the air transportation system and the public at large with enhanced safety.

FAA's goal is for the Office of Aviation Safety to have initial operating capabilities in place for SMS by the end of fiscal year 2010. According to FAA officials, these initial operating capabilities include training employees and defining how to apply SMS to the agency's overall oversight activities. To accomplish this, FAA's guidance for implementing SMS requires the Office of Aviation Safety, the Office of Airports, and the Air Traffic Organization (ATO) each to develop implementation plans that include schedules, procedures for acquiring and analyzing data, and measures to track implementation progress. ATO has issued its SMS implementation plan and has also created an SMS manual that provides specific operational information and guidance regarding the daily activities of ATO employees. In addition, it met its target to implement its initial SMS operating capabilities in March 2010. The Offices of Airports and Aviation Safety have yet to issue their implementation plans. However, the Office of Aviation Safety has issued guidance and safety documents that provide a general discussion of SMS, but they do not include a schedule of specific activities or time frames for completion as called for in the agencywide SMS guidance. Senior FAA officials told us Aviation Safety has formed working groups and expects those groups that are charged with defining the various SMS activities to meet the guidance requirements. In addition, according to FAA officials, various offices within Aviation Safety will be responsible for implementing processes to fulfill SMS requirements.

Additionally, FAA's guidance for implementing SMS requires the formation of an agencywide SMS committee, which was chartered in July 2009. The committee includes an executive council—whose members are the FAA associate administrators from the offices of Aviation Safety, Airports, and Commercial Space Transportation, and the Chief Operating Officer of ATO—and a committee composed of SMS professionals from each of those FAA offices. Chaired by the Office of Aviation Safety, the agencywide committee is tasked with recommending policy and guidance to the implementing FAA organizations and management.

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Because SMS relies on data to identify emerging risks, FAA has an effort under way to enhance its access to industry data and improve its analysis capability. The ASIAs initiative is a collaborative government-industry effort to share and analyze data. The Office of Aviation Safety's SMS implementation plan reiterates that data exchanges between ASIAs and other sources are crucial elements of emerging risk analysis. FAA's draft plan for ASIAs notes that this effort will require access to existing and previously unattainable data sources, enhanced analytical methodologies, and technical advancements to support safety risk analysis that are not achievable with current databases and analytical strategies. The draft plan would cover ASIAs activities through 2022. FAA did not confirm when a final plan would be completed.

While FAA has issued agencywide guidance on implementing SMS and has some efforts such as ASIAs under way, it does not have a way to measure or specific times to indicate full implementation. FAA officials told us that the current efforts would provide a foundation for the full implementation of SMS. But without a clear description of the activities to be completed and time frames for their completion, it may be years before SMS is fully implemented and its benefits are realized. In commenting on a draft of this report, FAA officials noted that even with a clear description of the activities to be completed and time frames for their completion, it will be years before SMS is fully implemented and its benefits are realized. We agree with FAA and note that specific time frames establish expectations for FAA's implementation of SMS and provide a means of accountability for meeting those expectations.

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## FAA Has Identified and Is Addressing Challenges to Using Data for Safety Oversight

FAA has efforts under way to address two key challenges to using data more effectively to manage risk. First, data are not coded to permit electronic integration, analysis, and sharing. Second, data from two voluntary reporting programs lack identifying details needed for some types of analysis, and the data do not remain available for long-term analysis.

### Data Are Not Coded to Permit Automated Analysis

FAA and the other federal agencies that gather the data FAA uses for analysis lack standard definitions, common identifiers, and common classification schemes for both quantitative and narrative data. For example, according to an NTSB official, databases used in ASIAs were not designed for searches of specific products, manufacturers, or airlines. As a result, FAA has had to develop common identifiers and standard classification schemes so that automation can be used to quickly integrate and analyze data from multiple external and internal sources. In addition,

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narrative information, in particular, poses challenges. Narrative reports from NTSB investigators and FAA inspectors, as well as narrative reports submitted voluntarily by pilots, air traffic controllers, mechanics, and others, constitute a rich source of information about safety events, but could not be coded to permit automated analysis until the ASIAs text analysis process was developed.<sup>14</sup> Consequently, analysts are now able to automate coding, integration, and analysis of data from different databases—a time-consuming and costly process when manually performed. According to a senior FAA official, this automated analysis process is unique and pathbreaking and will allow for more efficient safety analyses. When FAA studied wrong runway departures, for example, data from six different databases—from NTSB, NASA, and its own offices—were extracted for analysis. FAA compared the cost and time needed to extract and integrate data from multiple databases using an automated versus a manual process for coding the data. FAA found that using the automated coding process would cost about \$6,000 and take 52 hours, while the manual process was estimated to cost over \$750,000 and take more than 6,500 hours to complete. However, NASA noted that by using a “data mapping” approach, it can conduct an automated analysis of ASRS and other data sources in about 2 to 8 hours, depending on the complexity of the analysis.

### Data from Voluntary Reporting Programs Have Characteristics That Impede Analysis

Details of reported incidents are redacted from ASAP and FOQA data before an FAA contractor analyzes the data. These details include the date, time and flight number, and the names of the carrier or individuals involved. We previously reported that these identifying details are redacted to safeguard the participants in ASAP from enforcement or disciplinary action and participants in FOQA from public release of the data.<sup>15</sup> Additionally, ASAP and FOQA data are retained for only 3 years. Without identifying details and without maintaining data for longer periods, opportunities for some analyses are limited. To allow the contractor to perform more detailed analyses for FAA, the agency and the industry have agreed on a process through which the ASIAs Executive Board provides permission for the contractor to perform a specific,

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<sup>14</sup>According to an NTSB official, in addition to narrative text, NTSB’s Aviation Accident and Incident Database includes approximately 200 coded fields that record aircraft, engine, and flight crew details. The database also includes coded fields identifying other accident information such as phase of flight, events, and findings of probable cause. In addition, according to NASA, ASRS data have 1,200 potentially coded fields.

<sup>15</sup>GAO, *Aviation Safety: Better Management Controls Are Needed to Improve FAA’s Safety Enforcement and Compliance Efforts*, [GAO-04-646](#) (Washington, D.C.: July 6, 2004).

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defined analysis and to use data with the identifying details needed for that particular analysis. At the conclusion of the analysis and with the approval of the ASIAS Executive Board, a final report containing detailed results is given to CAST to develop safety enhancements to mitigate the identified safety issues. As of March 2010, three such analyses had been completed.

The Department of Transportation (DOT) Inspector General (IG) and the 2008 independent review team found that FAA could improve its use of ASAP data by analyzing these data for national trends, noting that by not doing so, the agency is missing opportunities to help reduce recurrences of safety events or to identify national patterns indicative of risks.<sup>16</sup> FAA concurred with this finding and said that it already has the ability to conduct national trend analyses. The IG reported, however, that FAA receives quarterly summaries of ASAP information from carriers of how many ASAP reports they received each month, and these summaries do not provide sufficient detail about ASAP events or corrective actions. According to the IG, these reports generally contain information about the number but not nature of ASAP submissions for that quarter and any resulting safety enhancement.<sup>17</sup>

While FAA's contractor loses access to ASAP reports after 3 years, about 62 percent of ASAP reports appear in ASRS, along with other reports voluntarily submitted by industry personnel, according to a NASA official.<sup>18</sup> NASA, which maintains ASRS for FAA,<sup>19</sup> has access to the identifying details in the submitted reports for no more than 90 days so it can follow up as necessary to clarify any questions that the reports raise. After that time, NASA removes the identifying details and incorporates ASAP and ASRS reports into ASRS. ASRS is accessible to the public, and NASA performs special analyses of ASRS data for FAA at its request. NASA also publishes an online newsletter every month with summary statistics and examples of a few reports selected to illustrate certain safety

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<sup>16</sup>Independent Review Team, *Managing Risks in Civil Aviation: A Review of the FAA's Approach to Safety*.

<sup>17</sup>DOT Office of Inspector General, *FAA is not Realizing the Full Benefits of the Aviation Safety Action Program*, Report No. AV-2009-057 (Washington, D.C.: May 14, 2009).

<sup>18</sup>In addition to the ASAP reports, ASRS receives reports from eight other airlines that do not participate in ASAP, including corporate, emergency medical services, and other air operators, according to NASA.

<sup>19</sup>NASA maintains ASRS on behalf of FAA because it is knowledgeable about aviation safety issues, is not a regulator, and has a reputation for protecting reporters' anonymity.

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issues, such as general aviation pilots' use of new cockpit technology, and issues safety alerts regarding significant safety events identified by ASRS reports. However, NASA does not comment on these reports or respond to any questions or issues raised by the authors, since its role is to act as an "honest broker" as it collects and analyzes the data. By comparison, in the United Kingdom (UK), an advisory board reviews a selection of reports received, commenting on the appropriateness of the action taken and answering questions. These responses are useful to the aviation community because they communicate on commonly experienced safety issues. In commenting on a draft of this report, NASA indicated that the UK model would not be practicable for ASRS data because the UK receives only about 300 reports annually compared with about 50,000 reports for ASRS. However, NASA noted that in the past it had an ASRS advisory committee that had provided a forum for FAA and industry to discuss corrective action. The agency acknowledged the need to reestablish this committee. In addition, NASA noted that it receives feedback on its safety alerts, which indicated positive corrective actions for about 60 percent of the alerts.

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### FAA Is Developing a Plan for Using Data under SMS, but the Plan Does Not Fully Address Data, Analysis, and Staffing Requirements

As part of its efforts to develop initial SMS capabilities, FAA expects to address how data and analysis will help it identify emerging aviation safety risks. Specifically, FAA has a draft plan—which it calls a safety management plan<sup>20</sup>—that defines the agency's analytical requirements and the role of safety analysis in improving safety, especially as NextGen is implemented. FAA's draft plan—which covers the risk management and safety assurance components of SMS discussed earlier in this report—recognizes the agency's future need for data and analysis, but does not specify requirements for them. For example, the draft safety management plan does not define the level of accuracy and completeness needed for the data, indicate what metrics and processes FAA will use to assess the data, or identify any specific data. According to senior FAA officials, as of February 2010, there was no specific date for finalizing the draft plan.

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<sup>20</sup>FAA, Aviation Safety Analytical Services, *System Safety Management Transformation Program Plan*, version 1.0 (Washington, D.C.: Dec. 24, 2009).

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**Experts Say . . .**

FAA needs analysts with operational experience as well as statistical skills.

FAA needs to hire more analysts with operational and statistical knowledge to analyze data.

To meet its data challenges and develop needed analytical approaches, FAA will also have to identify staff with both aviation operational experience and statistical expertise to effectively analyze aviation safety data in the future. While aviation safety experts we interviewed were generally satisfied with the qualifications of current FAA analysts, they expressed concerns about FAA's capacity to meet future needs. Several experts we interviewed said FAA needs additional qualified analysts, but the draft safety management plan does not mention staffing requirements for implementing FAA's analysis strategy. In our 2009 report on FAA's human capital system, we made several recommendations to FAA on how it can help ensure the continued hiring, recruitment, and retention of staff needed to operate the national airspace system.<sup>21</sup> According to FAA, it has not yet determined how many additional analysts it will need; however, the Office of Accident Investigation and Prevention has been approved to hire 11 additional analysts in fiscal year 2010. Without a plan that includes data and analysis requirements and staffing needs, the agency will not be able to link the resources it needs to the data capabilities it requires for its risk-based approach.

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<sup>21</sup>GAO, *Federal Aviation Administration: Human Capital System Incorporates Many Leading Practices, but Improving Employees' Satisfaction with Their Workplace Remains a Challenge*, [GAO-10-89](#) (Washington, D.C.: Oct. 28, 2009).

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## FAA Has Limited Access to Some Voluntarily Reported Data and Lacks Key Data to Assess the Safety Performance of Certain Industry Sectors

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### Voluntary Reporting Programs Generate Safety Information That Is Not Available from Other Sources, although the Data Have Some Limitations

#### Experts Say . . .

##### Voluntary programs

- Enable “a forward look at risk.”
- Are the way to expose and address problems; without them, the risk level would go up.
- Are the best source of information for hidden risk in the system.
- “FOQA and ASAP data are the best data we have.”
- Will be key to evaluating the effectiveness of NextGen. They provide insight into problems that would not be shared any other way.

FAA’s voluntary reporting programs—ASAP, ASRS, FOQA, and VDRP—generate safety information that FAA does not identify through other means. Whereas data from other sources are derived from inspections, audits, and other agency reports, these voluntary programs rely solely on cooperation between FAA and industry personnel. To obtain voluntarily reported information that can be used to improve safety, FAA agrees not to take enforcement action against carriers or industry personnel who self-report violations through ASAP, ASRS, and VDRP. Similarly, carriers that operate ASAPs agree not to take disciplinary action against personnel who self-report violations of FAA regulations or carriers’ operating procedures. In both cases, this agreement holds only for actions that are reported in a timely manner, were not intentional or criminal, did not involve drugs or alcohol, did not result in accidents, and have not already been detected by FAA. Conversely, personnel who do not voluntarily report violations within the specified time face the threat of enforcement or disciplinary action if the violations are discovered later. This combination of promised immunity for self-reporting and threat of enforcement and disciplinary action for remaining silent creates an incentive for industry personnel to participate in the voluntary reporting programs.

Through ASAP, ASRS, and VDRP, airspace users, including air carriers, air operators, and employees, self-report safety events and violations of their operating certificates or company procedures. For example, under ASAP, an employee reports an incident or event, which an event review committee, composed of representatives from FAA, the carrier, and the applicable employee group, then reviews. The ASAP event review committee assesses a report to determine (1) if it meets the criteria previously mentioned for inclusion in the program and (2), if included, what follow-up actions, enhancements, or mitigations should be implemented to address the safety concern.

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While ASAP, ASRS, and VDRP rely on individuals or the air carrier to file reports, FOQA data are generated by electronic equipment on aircraft, which continuously records more than a thousand parameters of data for individual flights. Vendors collect the data from carriers and can then, on their behalf, analyze the data and transfer files to the carriers' internal analysis teams or forward the data files to an FAA contractor for inclusion in ASIAS and subsequent analysis if a carrier is partnering with FAA. The FAA contractor also receives ASAP reports approved by event review committees. The contractor aggregates and analyzes the data from participating carriers and, starting in 2010, will brief the ASIAS Executive Board on a quarterly basis. These briefings will consist of the status reports on directed studies, the number of FOQA and ASAP records, and industry benchmarks that will enable carriers to compare their individual safety performance relative to the national trends and prioritize their internal safety initiatives. According to FAA, 28 carriers participate in ASIAS. All ASIAS participants share ASAP data, and 13 carriers also share FOQA data. FAA estimates that airlines contributing ASAP data to ASIAS account for 80 percent of the flights of all commercial airlines with FAA-approved ASAP programs.

FAA and industry officials, as well as experts we talked to, agreed that voluntarily reported data are critical to improving aviation safety. Moreover, according to ICAO, FAA officials, and safety experts we interviewed, voluntary reporting by operational personnel is a cornerstone of SMS, because, as ICAO has stated, operational personnel are in the best position to report the existence of safety hazards and to attest to what works and does not work during everyday operations. In 2007, NTSB reported that FOQA and ASAP programs are relevant to the safety assurance component of SMS because they provide a direct means for air carriers to evaluate the quality of their training and operations.<sup>22</sup> Further, these programs can also be used in the safety risk management component of SMS because they can help identify emerging risks. In addition, FAA and industry officials agreed that voluntary programs help promote a healthy reporting culture and an increased awareness of safety by industry personnel. Furthermore, FAA officials told us they believe that the voluntary programs, such as ASAP, gather safety information that would not be discovered 95 percent of the time. In addition, in commenting on a draft of this report, NASA noted that voluntarily reported data are valuable in learning why an event occurred.

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<sup>22</sup>NTSB, Safety Recommendation Letter to FAA, and A-07-1 through 11 (Washington, D.C.: Jan. 23, 2007).

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Industry officials told us how their companies have used voluntarily reported data to implement changes that respond to safety concerns. For example, one airline analyzed ASAP data to decrease the number of unstable approaches.<sup>23</sup> Safety officials from another airline told us that ASAP reports and FOQA data helped them to identify potential pilot issues, suggest additional training, and adjust processes and checklists based on human factors issues. They further commented that if pilots do not self-disclose potential safety issues, airlines may be limited in their ability to identify emerging safety trends.

Because of the importance of voluntarily reported data to proactive safety analysis, NTSB and the DOT IG have also recommended that FAA further encourage participation in voluntary programs. For example, in 2010, NTSB recommended that FAA require the establishment of FOQA programs by carriers regulated under part 121.<sup>24</sup> As another example, the DOT IG reported in May 2009 that FAA was not realizing the full benefits of ASAP and recommended that the agency develop a central database for all air carriers' ASAP reports to be used for nationwide trend analysis.<sup>25</sup>

While voluntarily reported data have been used to enhance safety, they also have some limitations. First, the completeness of the data is unknown, since reporting is voluntary, and there is no way to know how many violations or safety situations are not reported. For example, according to FAA, factors such as an individual's awareness of ASRS, motivation to report a situation, and perception of an incident's severity may influence the decision to submit an ASRS report. Second, the completeness of the data is further limited because participation varies among airlines, with 73 airlines participating in ASAP and 36 participating in FOQA. Third, as discussed later in this report, inadequate data quality controls can also limit the completeness of the data. For example, controls may not be adequate to ensure that the data entered into a database have

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<sup>23</sup> A stable approach typically occurs when an aircraft approaches a runway with a glide path that allows it to descend at a constant rate of 300 feet per nautical mile traveled forward. An unstable approach occurs when an aircraft is approaching a runway too fast, too high, or with insufficient engine power, causing it to deviate from the glide path.

<sup>24</sup> NTSB, *Aircraft Accident Report: Loss of Control on Approach, Colgan Air, Inc. Operating as Continental Connection Flight 3407 Bombardier DHC-8-400, N200WQ Clarence Center, New York, February 12, 2009*, NTSB/AAR-10/01 (Washington, D.C.: Feb. 2, 2010).

<sup>25</sup> DOT Office of Inspector General, *FAA is not Realizing the Full Benefits of the Aviation Safety Action Program*.

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been accurately compiled or processed. Fourth, the accuracy of voluntarily reported data cannot always be verified. Voluntarily reported data are subjective and are not always accompanied by supporting documentation, such as statistics, measurements, or other quantifiable information related to the reported events. According to an FAA analyst, a variety of factors can influence the accuracy of the data, including the reporter's experience, visibility conditions, the duration of the event, and any trauma experienced by the reporter. FAA notes, for example, that even senior pilots' estimates of how far aircraft descend during encounters with turbulence often differ considerably from the actual distances recorded on aircraft flight data recorders. Acknowledging this limitation, NASA notes that the information is nonetheless valuable, since a reporter is providing information on how it perceived the situation, which in large part determines its reactions. Fifth, electronically collected data from FOQA also have limitations. Vendors that process FOQA data explained that software bugs and inaccurate sensors can affect data results. To mitigate these problems, vendors review anomaly reports and validate data prior to analysis.

In an effort to address the limitations of voluntarily reported data, NASA developed a survey methodology project—NAOMS—in 1997 to systematically collect information on safety events by conducting telephone interviews with randomly selected airspace users such as pilots. In our 2009 assessment of the survey, we concluded that NAOMS was a successful proof of concept and that a similar project, adequately funded and appropriately planned, could enhance FAA's safety knowledge.<sup>26</sup> However, FAA maintained that FOQA provides better data by providing precise rates of occurrence on multiple parameters collected by flight data recorders that could obviate the benefits from NAOMS data. Nonetheless, we concluded that the NAOMS survey could be useful in complementing other databases, such as ASRS. The survey data, when properly analyzed, could be used to call attention to low-risk events that could serve as potential indicators for further investigation in conjunction with other data sources. Furthermore, in commenting on a draft of this report, both NTSB and NASA agreed on the usefulness of a survey similar to NAOMS in complementing other data. NASA pointed out that NAOMS-type data could provide the data for trends and explain "what" is happening in the system while ASRS provides "why" it is happening. NTSB further noted that its investigations of numerous serious incidents and accidents found that FOQA data gave no indication of underlying problems.

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<sup>26</sup>[GAO-09-112](#).

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## Participants' Concerns Limit FAA's Access to Voluntarily Reported Data

### Air Carrier and Union Experts Say . . .

Confidentiality is key to all the voluntary programs.

Protection for participants is key to ensuring continued and increased participation in voluntary programs.

Although FAA, carriers, and experts we interviewed agreed that voluntarily reported data are an important source of information for understanding and addressing safety issues, some carriers and industry personnel are not participating in FAA's ASAP and FOQA voluntary reporting programs. According to airline and FAA officials, two factors have primarily affected participation: (1) the fears of employees that their employers will take disciplinary action to address self-reported violations and (2) the costs to the airlines of purchasing and installing FOQA equipment and analyzing the data.<sup>27</sup>

Specifically, we found that, partly because of employees' fears of disciplinary action, from 2006 through 2008, four large air carriers<sup>28</sup> and their pilot unions suspended their ASAP.<sup>29</sup> According to safety officials at one airline, pilots had raised concerns about letters of reprimand or unpaid time off that directly resulted from ASAP reports. Pilot unions and air carriers that we spoke with agreed on the importance of confidentiality. However, pilot union officials we interviewed also expressed concern about whether airlines were ensuring the confidentiality of ASAP reports and suggested that, for an airline's safety culture to improve, pilots, in particular, must be able report certain events without fear of reprisal. Despite these concerns, as of June 2009, the four carriers and pilot unions that had suspended their ASAP had restarted or were restarting their participation in the program.

Additionally, according to industry officials and experts we interviewed, the costs of purchasing and installing equipment and analyzing data have

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<sup>27</sup> Proposed legislation, H.R. 1586, §554, 111th Cong. (2009) (Senate version of FAA Reauthorization), offers additional protections for FOQA and ASAP data. Additionally, H.R. 1586, §353, 111th Cong. (2009) (House version of FAA Reauthorization), would require FAA to report on the status of voluntary programs, including which carriers are participating and why others do not have voluntary programs. (In consideration of FAA Reauthorization, the Senate adopted the House bill, H.R. 1586, and amended it inserting its own language. Differences between the House version of H.R. 1586 and the Senate version of H.R. 1586 will have to be reconciled in a conference committee.)

<sup>28</sup> We defined "large carriers" as the top 25 U.S. carriers with 5,000,000 or more enplaned passengers from July 2008 through June 2009. We defined "small carriers" as those with fewer than 5,000,000 passengers for the same period.

<sup>29</sup> Concerns that litigants could require them under the Freedom of Information Act to disclose the information to the public may also have contributed to the carriers' and unions' decisions to withdraw from ASAP. These concerns were heightened after court rulings called for the release of Comair ASAP reports in the aftermath of the fatal crash of a Comair jet in Lexington, Kentucky, in 2006.

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deterred participation in FOQA, especially for smaller carriers.<sup>30</sup> Several large carriers we interviewed said more than 50 percent of their fleets already have FOQA equipment and they plan to expand their fleets' capability by retrofitting aircraft or ensuring that new aircraft include the equipment. By contrast, officials from smaller carriers were concerned about costs and estimated that installing FOQA equipment would cost an average of \$12,000 for each new aircraft and up to \$35,000 for retrofits of older aircraft models. As a result of cost concerns, according to airline officials, only 11 of 65 smaller carriers have approved FOQA programs, and according to FAA, an additional small carrier FOQA program is pending. Officials from these smaller carriers said that incentives to cover equipment costs, which are not currently available, would help increase participation. FAA officials noted that as carrier fleets age, newer replacement aircraft will already be fitted for FOQA equipment and, therefore, costs for participating will continue to decrease. However, the life span of an aircraft is usually at least 30 years for large carriers, so the transition to a fully equipped fleet could take decades.

Currently, large carriers are the principal participants in FOQA and ASAP, and they provide service for the majority of passengers on domestic and international flights. Nonetheless, we found that 4 of the 25 large carriers do not have active FOQA programs and 1 large carrier did not have an ASAP. According to FAA officials, an additional 4 carriers have FOQA programs pending. To the extent that operators do not participate in the programs, they do not obtain information that they could use to monitor and improve the safety performance of their aircraft, related equipment, and personnel, and to the extent that they do not partner with FAA, opportunities to identify nationwide safety trends and improvements are lost. To encourage greater participation in FOQA and ASAP, FAA provides training to smaller carriers on how to develop versions of both programs that do not require as much capital investment but do allow the carriers to collect unique safety data. However, FAA lacks carrier-specific information on why air carriers are not participating in voluntary reporting programs. Having such information would allow FAA to identify further actions to encourage participation.

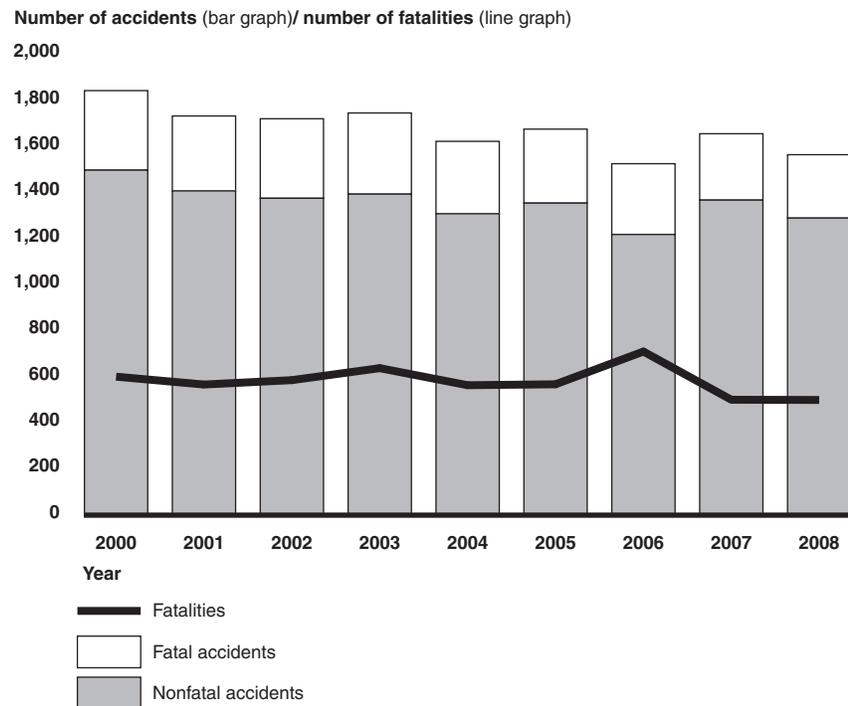
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<sup>30</sup>H.R. 1586, §354, 111<sup>th</sup> Cong. (2009) (House version of FAA Reauthorization), if enacted, would require FAA to develop and implement a plan that would facilitate the establishment of ASAP and FOQA programs by all part 121 air carriers. Furthermore, smaller fleets would be assisted, if necessary, in establishing FOQA programs.

## FAA Lacks Data to Assess the Safety of Certain Industry Sectors

FAA's ability to monitor and manage risk for certain industry sectors, such as general aviation, air ambulance operators, and air cargo carriers, is limited by incomplete data. While FAA collects data on actual flight hours and numbers of departures for large air carriers that operate under part 121 and scheduled flights with fewer than 10 seats that operate under part 135, it does not collect actual flight activity data for smaller air carriers that provide on-demand service, such as air taxis and air ambulances, and general aviation operators—sectors that have had a higher number of fatal accidents in recent years than large air carriers. For instance, in 2008, large air carriers providing scheduled service had 20 accidents, none of which were fatal. By comparison, during that same year, there were 1,559 general aviation accidents, including 275 fatal accidents involving 495 fatalities. (Fig. 2 shows the trends in general aviation accidents.) Without information on the number of general aviation flights, FAA cannot compare the safety performance among industry sectors or assess trends.

**Figure 2: Number of General Aviation Accidents and Fatalities, 2000 through 2008**



Source: NTSB.

Additionally, the number of accidents for air ambulance and air cargo operators points to safety vulnerabilities in these areas. From 1998 through 2008, the air ambulance sector averaged 13 accidents per year.

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While the total number of air ambulance accidents peaked at 19 in 2003, the number of fatal accidents peaked in 2008, when 9 fatal accidents occurred. Without data on the number of flights or flight hours, FAA and the air ambulance industry are unable to determine whether the increased number of accidents has resulted in an increased accident rate, or whether it is a reflection of growth in the industry. According to FAA, it annually surveys a sample of potentially active general aviation aircraft, and in the latest survey in 2008, it surveyed all air ambulance operators. However, we noted in our April 2009 testimony that less than 40 percent of the air ambulance operators responded, raising questions about the reliability of the information collected.<sup>31</sup> Similarly, our review of air cargo safety found that small cargo carriers had more accidents and fatal accidents than large cargo carriers, but the available information was not sufficient to assess the significance of this difference. We found that smaller air cargo carriers averaged 29 accidents per year from 1997 through 2008, while large cargo carriers averaged 8 accidents each year during this period. However, a lack of operations data for small cargo carriers makes it difficult for FAA to prioritize risks and better target safety improvements and oversight to the areas of highest risk.

To address the lack of data, we previously recommended that FAA identify the data necessary to better understand the air ambulance industry and develop a systematic approach for gathering and using these data.<sup>32</sup> Similarly, we recommended that FAA gather comprehensive and accurate data on smaller air cargo operations (those covered under part 135) to gain a better understanding of air cargo accident rates and better target safety initiatives.<sup>33</sup> FAA agreed with both recommendations, but has not fully addressed either. In response to our recommendation on air ambulance data, FAA has surveyed all helicopter air ambulance operators to collect flight activity data. However, as mentioned earlier in this report, FAA's survey response rate was low, raising questions about whether this information can serve as an accurate measure or indicator of flight activity. FAA plans to evaluate ways to collect the air cargo data over the long term.

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<sup>31</sup>GAO, *Aviation Safety: Potential Strategies to Address Air Ambulance Safety Concerns*, [GAO-09-627T](#) (Washington, D.C.: Apr. 22, 2009).

<sup>32</sup>GAO, *Aviation Safety: Improved Data Collection Needed for Effective Oversight of Air Ambulance Industry*, [GAO-07-353](#) (Washington, D.C.: Feb. 21, 2007).

<sup>33</sup>GAO, *Aviation Safety: Better Data and Targeted FAA Efforts Needed to Identify and Address Safety Issues of Small Air Cargo Carriers*, [GAO-09-614](#) (Washington, D.C.: June 24, 2009).

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## FAA Has Various Processes in Place to Help Ensure Data Quality, but Weaknesses Still Exist

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### FAA Has Taken a Number of Steps to Help Ensure Data Quality

FAA, along with the international aviation community, recognizes that high-quality data—that is, reliable, valid data—are essential to the effectiveness of a data-driven approach to safety, such as SMS.<sup>34</sup> To help ensure data quality, FAA has issued guidance, established procedures, and implemented controls. For example, FAA has issued an order that establishes an agencywide policy on data management.<sup>35</sup> This policy applies to all information from FAA and other sources used to perform the agency’s mission. In accordance with the data management order, FAA’s Office of Aviation Safety has established a data management framework that includes a four-step process for importing data from other FAA offices and external sources. This process includes

- data acquisition—obtaining information from various data owners,
- data standardization—validating data by comparing a new data set with previous data sets to identify inconsistencies,
- data integration—translating data values into plain English and correcting data errors, and
- data loading—importing data into the agency’s own systems.

This four-step process applies to 10 of the 13 databases we reviewed— 8 maintained by FAA offices and 2 maintained by NTSB and USDA. (The

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<sup>34</sup>In GAO, *Assessing the Reliability of Computer-Processed Data*, [GAO-09-680G](#), (Washington, D.C.: Feb.2, 2009), we defined reliable data as data that are reasonably complete and accurate, meet intended purposes, and are not subject to inappropriate alteration. “Completeness” refers to the extent to which relevant records are present and the fields in each record are populated appropriately. “Accuracy” refers to the extent to which recorded data reflect the actual underlying information. These terms define data reliability. “Validity” refers to whether the data actually represent what they are intended to measure.

<sup>35</sup>FAA Order 1375.1D, *Information/Data Management*, July 25, 2006.

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process applies to 2 of the 4 voluntary reporting databases.) NTSB and USDA also have data quality assurance processes that apply to their databases. For example, NTSB conducts annual reviews of aircraft accident data, and according to USDA, airport managers and wildlife biologists are asked to check data from their respective airports and report errors.

In addition, to help ensure the quality of its data, FAA applies various quality controls, such as validation and verification processes, to better ensure accuracy and completeness. We have identified some standard quality controls that an agency should employ to achieve these high-quality results.<sup>36</sup> For example, agencies should have managers review data, have procedures in place to verify that data are complete and accurate, and correct erroneous data. We assessed 12 databases against these standard quality controls and found that the extent to which such controls were applied varied.<sup>37</sup> (See fig. 3.) While NTSB's aviation accident and incident database (NTSB), VDRP, and USDA's wildlife strike database applied all five of the quality control activities we considered for this analysis to some extent, the remaining 9 databases lacked one or more quality control activity. In addition, we found that all of the databases we reviewed fully or to some extent had procedures in place to validate and edit data to help ensure that accurate data are entered into electronic systems and to help ensure that erroneous data are identified, reported, and corrected. To the extent that the databases lack various controls, FAA lacks assurance that the information it uses for oversight is accurate and complete.

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<sup>36</sup> [GAO-01-1008G](#).

<sup>37</sup> We did not assess controls for ASAP because it contains proprietary airline data that were not available for our review.

**Figure 3: Extent to Which Aviation Safety Databases Reviewed Have Standard Data Quality Controls**

| Quality characteristic   | Databases |      |      |      |       |      |      |     |      |      |      |          |   |
|--|-----------|------|------|------|-------|------|------|-----|------|------|------|----------|---|
|  | AIDS      | ASRS | FOQA | ATOS | NMACS | NTSB | OEDS | PDS | SDRS | VDRP | VPDS | Wildlife |   |
| Managers review data before they are entered into the data system.   | ○         | ●    | ○    | ○    | ○     | ◐    | ○    | ◐   | ◐    | ◐    | ◐    | ◐        | ● |
| Reconciliations are performed to verify the data's completeness. <sup>a</sup>  | ●         | ○    | ●    | ◐    | ◐     | ●    | ◐    | ○   | ◐    | ◐    | ◐    | ◐        | ● |
| Data entry processes are designed to enhance accuracy.   | ○         | ◐    | ●    | ○    | ○     | ●    | ○    | ○   | ○    | ◐    | ○    | ○        | ● |
| Procedures are in place to validate and edit data to help ensure that accurate data are entered into electronic systems. | ◐         | ◐    | ●    | ◐    | ◐     | ●    | ◐    | ◐   | ●    | ◐    | ◐    | ◐        | ◐ |
| Procedures are in place to help ensure that erroneous data are identified, reported, and corrected.                      | ●         | ●    | ◐    | ◐    | ◐     | ●    | ◐    | ◐   | ◐    | ◐    | ●    | ◐        | ◐ |
| <p>○ Not present</p> <p>◐ Present to some extent</p> <p>● Fully present</p>  |           |      |      |      |       |      |      |     |      |      |      |          |   |

Source: GAO.

Note: We did not assess ASAP controls because ASAP contains proprietary airline data that were not available for review.

<sup>a</sup>“Data completeness” refers to the accuracy with which data entered into a database have been compiled or processed. It does not refer to the scope of the data that have been reported or collected.

While the databases we reviewed varied in the extent to which they had standard quality controls, FAA has other data quality controls in place for some databases that we consider good practices for handling data, as shown in table 3.<sup>38</sup>

<sup>38</sup>These and other data quality controls, which we use in assessing the reliability of data for our analyses, are found in [GAO-09-680G](#).

**Table 3: Examples of Additional Controls for Managing Data Quality**

| <b>Data quality controls<sup>a</sup></b>   | <b>Examples of databases with data quality controls implemented</b> |
|--|---|
| Event represented in a database is objectively defined so it can be replicated by a third party. | AIDS, FOQA, NTSB  |
| Data are validated to ensure that they represent what was intended.                              | AIDS, FOQA, NTSB  |
| Data systems training is available for users entering data into computer systems.                | AIDS, ATOS, NTSB  |
| Data users receive periodic updates about the data in electronic systems.                        | AIDS, ASRS, NMACS, NTSB   |
| Access to the database is restricted to personnel who are authorized to enter or edit the data.  | ATOS, OEDS, VDRP  |
| Electronic data system tracks and maintains changes to the database.                             | AIDS, ASRS, ATOS  |
| Data are verified after all electronic operations.   | All databases   |

Source: GAO.

<sup>a</sup>These data quality controls are found in [GAO-09-680G](#).

Furthermore, other data quality controls apply to the voluntary reporting systems we reviewed. For example, as previously discussed, an event review committee at each participating carrier is tasked with reviewing and analyzing reports submitted under ASAP. This committee determines whether such reports qualify for inclusion in the program, identifies and proposes solutions for actual or potential problems with information contained in the reports, and annually reviews the ASAP database to determine whether corrective actions have been effective in preventing or reducing the recurrence of targeted safety-related events.

For ASRS, NASA officials told us that each individual ASRS report is reviewed by two expert analysts within 3 days of receipt. Each report captures data for seven criteria and data fields, which are screened to ensure accuracy. The analysts also evaluate the database to ensure that publicly released ASRS data do not include information that might identify the reporter. In addition, for FOQA, vendors have quality assurance procedures in place. For instance, one vendor's procedures include automated checks and tests of each flight data file to detect parameter problems (for example, anomalies in the flight data attributable to faulty sensors), reports of anomalies created for the affected airline, and manual reviews of any data indicating warning-level risk events. These controls are designed to monitor the reliability and validity of FOQA data and to identify technical problems that affect data quality and need to be corrected. However, according to the vendor, some data will always be

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missing because of data-recording equipment failures or lost flight data cards, but such missing data do not affect the statistical validity of the large FOQA data set.

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### FAA Is Taking Steps to Address Data Quality Weaknesses Identified by Its Analysts and Others

FAA is taking steps to address data weaknesses identified by its analysts, the DOT IG, and us. For example, FAA officials told us that to mitigate problems from external data sources, they combine data from various sources to validate analysis results. According to FAA analysts, they typically combine AIDS data with wildlife strike, ASRS, or PDS data using a manual process to verify study findings. As another example, we previously reported the importance of aggregating data from multiple sources to understand icing-related incidents. We reported that the AIDS database included 200 icing-related incidents involving large commercial airplanes that occurred from 1998 through 2007.<sup>39</sup> During this same time period, ASRS received over 600 icing- and winter weather-related incident reports involving large commercial airplanes. These incidents revealed a variety of safety issues such as runways contaminated by snow or ice, ground deicing problems, and in-flight icing encounters. This suggested that risks from icing and other winter weather operating conditions may be greater than indicated by the AIDS database.

FAA analysts also communicate with other data providers and experts about quality concerns or sometimes make independent corrections to data. For example, one FAA official told us that analysts communicate with NTSB to report incorrect data in a field and then rely on NTSB to correct the data in its database. FAA analysts said that they retrieve data from public Web sites and then collaborate with subject matter experts to identify and correct any errors in those data. They make such corrections based on their knowledge of the data's reliability and their own expertise in working with such data. Analysts also said they use information from the narrative sections of a report to correct data fields.

In addition, the IG has identified weaknesses in the quality of specific data, which FAA is working to address. For instance, according to the IG, ATOS data are inconsistent and incomplete because the database has undergone multiple revisions since it was introduced in 1998 and some data fields have changed from one year to another. During these revisions, some data have been lost. Though designed to improve ATOS's value and usability as

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<sup>39</sup>GAO, *Aviation Safety: Preliminary Information on Aircraft Icing and Winter Operations*, [GAO-10-441T](#) (Washington, D.C.: Feb. 24, 2010).

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an inspection tool, the revisions limit opportunities for analysis of long-term trends to the extent that data fields have changed over time. The revisions do not, however, affect FAA's ability to analyze the data at a particular point in time.<sup>40</sup> In addition, the process for reporting inspection findings is time-consuming and creates an incentive for inspectors to underreport their inspection results. To report, inspectors must complete a *Yes/No* checklist and, for every *No* check, provide a narrative explanation. According to the 2008 independent review team, inspectors have an incentive to check *Yes* so they can complete their reports in a timely manner. Consequently, the system may underreport problems that inspectors have identified but not taken the time to report.

The IG has also found, and FAA agreed, that OEDS has some missing and incorrect data on operational errors and pilot deviations because personnel have intentionally or unintentionally misclassified these events. Such misclassification is problematic because it can lead to errors in FAA's assessment and reporting of how well the agency is meeting its annual performance targets for operational errors and pilot deviations. In 2007, the IG investigated operational errors at the Dallas-Fort Worth terminal radar approach control facility and found that FAA air traffic managers had intentionally misclassified operational errors as either pilot deviations or nonoccurrences.<sup>41</sup> On the basis of this finding, FAA agreed with the IG's recommendation that the agency establish a follow-up mechanism to ensure compliance with guidance for investigating pilot deviations.

Finally, over the years, we have identified weaknesses in the quality of aviation safety data that hinder FAA's ability to oversee the industry. In response, the agency has taken steps to address many of the problems that we have identified. For example, in our 2007 review of runway safety, we found that FAA's categorization of the severity of runway incursions involves a level of subjectivity, raising questions about the accuracy of the

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<sup>40</sup>H.R. 1586, §520, 111<sup>th</sup> Cong. (2009) (Senate version of FAA Reauthorization), if enacted, would require FAA to conduct monthly reviews of ATOS data and submit quarterly reports to Congress on the results of these reviews. Those reports would allow for analyses at a particular point in time and, if the same data were reported consistently over time, would eventually permit trend analyses.

<sup>41</sup>DOT Office of Inspector General, *FAA's Process for Reporting and Investigating Operational Errors*, Report No. AV-2009-045 (Washington, D.C.: Mar. 24, 2009).

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data.<sup>42</sup> We reported that an internal FAA audit of 2006 runway incursion data found that the subjectivity of the severity classifications has the potential to affect the accuracy of the classifications. We also found that FAA did not systematically collect data on the number of runway overruns that do not result in damage or injury that could be used for analytical purposes to study trends in and causes of these incidents. In July 2009, FAA indicated that it was working to establish procedures that will ensure that all runway overruns and other excursions are reported.

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## Conclusions

Aviation safety data are critical to FAA's safety oversight and its planned implementation of SMS. To its credit, FAA has taken steps to help ensure the quality of the data it uses, such as implementing quality controls to help ensure that errors are identified, reported, and corrected, but these procedures are not applied consistently across all databases. Although FAA is developing a plan that will address how data fit into its new oversight approach, that plan lacks a description of the data that will be required to conduct proactive data analyses, an inventory of the skills personnel will need to perform such analyses and help ensure data quality, and a description of the steps needed to address continuing data quality problems. Unless the plan links FAA's data requirements and staffing needs to the analyses that will drive its proactive safety management system and addresses the agency's data quality problems, available data may not be as reliable and useful as they could be to support SMS.

While NextGen technologies and procedures are intended to increase the safety, efficiency, and capacity of the national airspace system, their introduction could have unintended effects on system safety if not done in a comprehensive manner. As FAA improves its ability to integrate and analyze data from multiple sources, it plans to increase its capacity to model the impact of NextGen changes and to identify and manage risks. Because some NextGen changes are already taking place, it is urgent that FAA move with all deliberate speed to advance its analytical capability.

The data that FAA obtains through voluntary reporting programs afford insights into safety events that are not available from other sources and are critical to improving aviation safety, but participation in these programs has been limited by concerns about the impact of disclosure

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<sup>42</sup>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).

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and, especially in the case of smaller carriers, by cost considerations. Efforts such as the training FAA provides to smaller carriers on how to develop programs that require less capital investment have the potential to increase participation and improve safety. However, without carrier-specific information on why air carriers are not participating in these programs, FAA cannot determine if its efforts to increase participation are sufficient.

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## Recommendations for Executive Action

To help improve and expand FAA's capability to use data for aviation safety oversight, we recommend that the Secretary of Transportation direct the FAA Administrator to take the following four actions:

- develop and implement a comprehensive plan that addresses how data fit into FAA's implementation of a proactive approach to safety oversight and ensure that this plan fully describes the relevant data challenges (such as ensuring data quality and continued access to voluntarily reported safety data), analytical approaches, and staffing requirements and integrates efforts to address them;
- given the importance of high-quality data, extend standard quality controls, as appropriate, to the databases that support aviation safety oversight to ensure that the data are as reliable and valid as possible;
- proceed with all deliberate speed to develop the capability to model the impact of NextGen changes on the national airspace system and manage any risks emerging from these changes; and
- systematically identify the reasons that carriers are not participating in voluntary reporting programs, such as through a survey, and identify and implement further steps to encourage greater program participation, especially by smaller carriers.

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## Agency Comments

We provided copies of a draft of this report to DOT, NASA, USDA, and NTSB for their review and comment. DOT agreed to consider our recommendations. DOT and NASA provided technical corrections and clarifications, which we incorporated as appropriate. USDA had no comments. NTSB generally agreed with our findings and recommendations to FAA and provided several comments. First, NTSB noted that our use of the terms "reactive" and "proactive" implied a new approach to aviation safety data analysis that is different from past analyses of accidents and incidents to improve safety. The agency noted that a more efficient, effective approach to safety analysis should continue

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to include FAA's previous reactive approach as well as new, more predictive capabilities. We agree with NTSB's comment and note that our report indicates that FAA plans to continue to use data to analyze past safety events as it also works to use data more proactively. NTSB further noted that the success of SMS will depend on the maturation of FAA's data analysis capabilities.

Second, NTSB agreed with our finding that the lack of a final plan for ASIAs and for SMS implementation, which are key elements of FAA's planned proactive safety analysis capability, was a cause for concern. The agency noted that it had made several recommendations to FAA to require SMS programs for part 121, part 135, and part 91 carriers and that FAA had not yet taken action to require these programs.

Third, regarding FAA's access to voluntarily reported data, NTSB agreed with our finding that the redaction of flight details from ASAP and FOQA analyses is a serious constraint on the thoroughness and potential utility of ASIAs and other assessments of safety. If FAA does not address these data limitations, NTSB observed, such constraints are likely to pose serious and continuing threats to the broader use of voluntary reporting programs to support safety analysis. In NTSB's view, our recommendations to FAA do not go far enough to recommend mechanisms besides redaction, such as statutory exemptions from disclosure, to protect these data from enforcement and disciplinary uses or public release. We did not revise our recommendations to FAA to include these issues because, while we found that participation was temporarily affected, in part, by employees' fears of disciplinary action by their employers, we did not find evidence that participation was inhibited by the fear of enforcement action by FAA or public disclosure. In addition, our work indicated that the current mechanisms to protect the data appeared to be working.

Fourth, regarding FAA's access to data on various safety events, NTSB noted the importance of FAA collecting the necessary data to support its new approaches to data analysis rather than simply combining existing data sources into an analysis program. NTSB also agreed with our finding that independent survey efforts like NAOMS could provide a useful complement to other data sources, including FOQA, in providing improved data quality and analysis capabilities.

Finally, NTSB agreed with our finding that the availability of operations data for sectors other than large commercial carriers (i.e., part 121 operators) is severely limited. The agency noted that accurate flight activity data are not available for most of these operations and must be

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estimated from FAA's annual survey of a sample of active general aviation aircraft. NTSB also pointed out that FAA does not require reporting for the majority of equipment reliability or maintenance related events. To address these shortcomings, NTSB noted its recent recommendation to FAA to take steps to increase general aviation reporting to FAA's service difficulty reporting system. To correct these and other data deficiencies, NTSB believes that FAA should explore the development of new aviation safety data collection techniques or methods to supplement current areas of data deficiency.

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As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of this report to relevant congressional committees, the Secretaries of Transportation and Agriculture, the Administrator of the Federal Aviation Administration, the Chairman of the National Transportation Safety Board, and the Administrator of the National Aeronautics and Space Administration. We will also make copies available to others on request. In addition, this report will be made available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or [dillingham@gao.gov](mailto:dillingham@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.



Gerald L. Dillingham, Ph.D.  
Director, Physical Infrastructure Issues

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*List of Requesters*

The Honorable Bart Gordon  
Chairman  
Committee on Science and Technology  
House of Representatives

The Honorable Gabrielle Giffords  
Chair  
Subcommittee on Space and Aeronautics  
Committee on Science and Technology  
House of Representatives

The Honorable Brad Miller  
Chairman  
Subcommittee on Investigations and Oversight  
Committee on Science and Technology  
House of Representatives

The Honorable Mark Udall  
United States Senate

The Honorable Jerry Costello  
House of Representatives

The Honorable Daniel Lipinski  
House of Representatives

# Appendix I: Objectives, Scope, and Methodology

In this report, we assessed the Federal Aviation Administration’s (FAA) capacity to use available data to oversee aviation safety. To do so, we addressed the following questions: (1) How does FAA use data to oversee aviation safety, and what changes, if any, has it planned? (2) To what extent does FAA have access to data for monitoring aviation safety and the safety of various aviation industry sectors? (3) What does FAA do to help ensure the quality of the data it uses to oversee aviation safety?

To perform our review, we selected 10 safety events that were among those previously identified as key by the National Aeronautics and Space Administration’s (NASA) National Aviation Operations Monitoring Service (NAOMS) or by the FAA-industry Commercial Aviation Safety Team (CAST). This selection allowed us to focus our review on a manageable subset of FAA oversight activities and data sources. (See table 4.) We then identified 13 databases available to FAA that contained data on these safety events and reviewed these databases. The databases are described in the background section of this report.

**Table 4: Aviation Safety Events Included in Our Review**

| Type of safety event                          | Definition   | Examples of safety events   |
|---|--|---|
| Equipment problems                            | Any problem related to aircraft equipment  | Problems with computer navigation system, low fuel levels, engine failures, dirty or shattered windshields  |
| Turbulence                                    | Encounters with turbulence due to wake or weather  | Injuries to passengers and crew due to turbulence   |
| Weather events while airborne                 | Problems due to weather-related factors other than turbulence  | Strong winds, thunderstorms, icing, wind shear  |
| Passenger-related events                      | Any passenger-related problems   | Passengers walking around while seat belt light is on, engaging in drunken or disruptive conduct, smoking on board, and disabling smoke detectors                           |
| Flight crew problems                          | Flight crew performance issues other than those resulting in airborne conflicts, ground events, or altitude deviations | Pilot distraction, shortage of crew members, poor pilot judgment, insufficient pilot proficiency, pilot fatigue   |
| Airborne conflicts                            | Any conflicts with other aircraft in the air   | Congestion, insufficient spacing behind aircraft, pilots unaware of warnings  |
| Ground events                                 | Runway and taxiway transgressions, ground conflicts, and other ground-based events                                     | Congestion on taxiways or ramps, potential for planes to strike vehicles or equipment in areas where aircraft have the right of way   |
| Aircraft handling-related events              | Deviations in aircraft direction, speed, and configuration due to pilot error  | Near collisions with terrain, deviations from assigned routes, hard landings  |
| Altitude deviations                           | Any deviation from assigned altitude   | Altitude overshoots, descents below minimum safe altitude   |
| Adverse interactions with air traffic control | Events rooted in difficulties between pilot and air traffic control  | Improper use of phraseology resulting in miscommunication, blocked transmissions due to problems with frequency, language barriers when English is not the primary language |

Source: NAOMS and CAST.

To determine how FAA uses data to oversee aviation safety, we reviewed reports by FAA, the International Civil Aviation Organization, and industry and other published documents. In addition, we interviewed FAA, industry associations, and other selected industry groups.

To determine the extent to which FAA has access to data for monitoring aviation safety and the safety performance of various aviation industry sectors, we interviewed FAA data analysts, contractors, and other officials responsible for data management. We also reviewed previous GAO reports on FAA's access to data on certain aviation sectors, such as air ambulances and air cargo operations.

To determine how FAA ensures the quality of its data, we interviewed FAA and industry officials (see table 5). In addition, we reviewed assessments of selected FAA data by the Department of Transportation Inspector General and an independent review team appointed by the Secretary of Transportation in 2008. We also derived a number of data quality principles from our previous work on internal controls,<sup>1</sup> and we assessed the quality of 12 of the 13 selected aviation safety databases by comparing our data quality principles with FAA's practices for ensuring data quality.<sup>2</sup> These principles include ensuring that the data are complete and accurate, measure intended safety concerns, and are useful for their intended oversight purposes. To measure the extent to which FAA's practices were consistent with these principles, we evaluated information and all other materials regarding the databases using a three-point scale. To validate the results, multiple reviewers independently scored each principle. When the initial scores differed, the reviewers collectively agreed on a final score for each principle. Further, we used the results of GAO studies that considered the availability, quality, and use of data in aviation safety oversight.

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<sup>1</sup>GAO-01-1008G.

<sup>2</sup>We did not assess controls for the Aviation Safety Action Program because it contains proprietary airline data that were not available for our review.

**Table 5: Organizations That GAO Contacted**

| Type of organization    | Organization interviewed  |
|-------------------------|---|
| FAA office              | Air Traffic Organization<br>Airports<br>Aviation Safety, Office of Accident Investigation and Prevention (formerly the Office of Analytical Safety Services)<br>Aviation Safety, Air Traffic Oversight Service<br>Aviation Safety, Flight Standards   |
| Other government agency | <b>U.S.</b><br>U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services<br>U.S. Department of Transportation, Office of Inspector General<br>NASA<br>National Transportation Safety Board<br><b>International</b><br>International Civil Aviation Organization   |
| Industry organization   | <b>Associations and research institutes</b><br>Flight Safety Foundation<br>MITRE<br>Regional Airline Association<br><b>U.S. airlines</b><br>American Airlines<br>Comair<br>Continental Airlines<br>Delta/Northwest Airlines<br>Southwest Airlines<br>US Airways<br><b>Unions</b><br>Air Line Pilots Association, International<br>Professional Aviation Safety Specialists, AFL-CIO<br>U.S. Airline Pilots Association<br><b>Data vendors</b><br>Austin Digital<br>Sagem Avionics, Inc. |

Source: GAO.

In addition, to address all three research questions, we individually interviewed 10 aviation safety experts and asked them to identify challenges to using data for overseeing aviation safety, the reasonableness of FAA’s current and planned efforts to use aviation safety data, and ways that FAA could enhance its data collection and analysis processes to improve its oversight capabilities. We selected experts who represent a cross section of aviation stakeholders, including persons with general

knowledge of aviation safety, aircraft operations, human factors, aircraft maintenance, and air traffic control. The experts have operational, academic, or other professional expertise in these areas. Those experts are

- Mr. Basil Barimo, Vice President, Safety and Operations, Air Transport Association;
- Mr. James Burin, Director of Technical Plans and Programs, Flight Safety Foundation;
- Kim Cardosi, Ph.D., U.S. Department of Transportation, Volpe Center;
- Todd Curtis, Ph.D., Director, The Airsafe.com Foundation;
- Mr. John Goglia, Senior Vice President for Aviation Operations and Safety Programs, JDA Aviation Technology Solutions, former board member of the National Transportation Safety Board;
- Mr. Keith Hagy, Director, Engineering and Air Safety, Air Line Pilots Association, International;
- Brigadier General Leon Johnson (Air Force, retired), former Flight Operations Manager, United Parcel Service;
- Mr. Bruce Landsberg, Executive Director, Aircraft Owners and Pilots Association;
- Thomas Weitzel, Ed.D., Associate Professor, Embry Riddle Aeronautical University; and
- Mr. Dale Wright, Director, Safety and Technology, National Air Traffic Controllers Association.

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# Appendix II: GAO Contact and Staff Acknowledgments

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## GAO Contact

Gerald L. Dillingham, Ph.D., (202) 512-2834, or [dillinghamg@gao.gov](mailto:dillinghamg@gao.gov)

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## Staff Acknowledgments

In addition to the person named above, Teresa Spisak, Assistant Director; Elizabeth Eisenstadt; N'Kenge Gibson; H. Brandon Haller; Erica Miles; and Richard Scott made key contributions to this report.

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